Commission des Communautés
Européennes,
Centre Commun de Recherches
Etablissement Ispra

W O R K I N G P A P E R

Potential available for research work and basic design information in collaboration with European industries and organizations

Areas of activity
Competences acquired
Experimental facilities
Possible areas of application
Possible interested industries

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P R E F A C E

The Establishment Ispra of the CCR employes presently about 1800 persons, among whom about 1360 scientists and technicians.

The most important fact of the research carried out at Ispra during the last eight years has been integrated in the development of large reactor development projects, namely ORGEL (heavy water moderated - organic cooled reactor), fast neutron sodium cooled reactors, light water reactors. Furthermore, it includes moderate but well coordinated research activities in some areas such as neutronphysics, solid state physics, direct conversion, biology, radiation chemistry.

The purpose of the present document is to provide national projects, industries or other organizations with information on the research potential available in Ispra. Since the existing experimental facilities are of little value without adequate experienced personnel, the data were related to the activities of research units. For each team the information is condensed in 2 pages. Information is given on the following points:

- Short description of scope of work carried out so far or underway for each research unit and the characteristics of the experimental facilities available.
- Experience of the personnel and list of publications furnishing information on related studies.

This document actually represents a catalogue of possible utilizations. The indicated possible areas of application are given as examples without pretending completeness. It must be considered, that many groups with their installations can be employed without great difficulties in related research fields.

This paper will allow the interested organizations only a preliminary selection of possible utilizations. A confrontation of "clients" and scientists should in a later stage lead to the precise definition of the tasks to be carried out and the amount of people to be envolved.

List of Main Facilities or Activities [+)]

I. Test Reactors

I/1	ECO
I/2	Ispra I
I/3	Irradiation and Post Irradiation Tests

II. Physics

II/1	Reactor Physics
II/2	Solid State Physics

III. Engineering

III/1	Basic Design Problems
III/2	Heat Transfer
III/3	Electronics
III/4	Fabrication Methods
III/5	Component Testing

IV. Materials

IV/1	Material Testing
IV/2	Material Development

V. Chemistry

V/1	Organic Chemistry
V/2	Nuclear and Radiation Chemistry
V/3	High Temperature Chemistry
V/4	Chemical Engineering

VI. Informatics

VI/1	Basic Soft Ware
VI/2	Application of Soft Ware
VI/3	Transmission Systems

+) For ESSOR-Reactor and Heavy Water Activities see special document EUR/C-IS/471/68 e

I) Test Reactors

I/1 ECO

I/2 Ispra I

I/3 Irradiation and Post Irradiation Tests

Area of activity

ECO (critical facility for heavy water moderated reactors).

Competence acquired

Experimental programme in the field of heavy water reactors, Buckling measurements of several fuel element types (U metal, UC, UO_2 with different cluster geometry and coolant) at different lattice pitches in the range from 18,8 to 30 cm. (progressive substitution and flux mapping methods). Detailed parameters measurements by foil activation technique in moderator and special fuel elements (ε , p, I.C.R., spectral indices, thermal flux fine structure, Doppler effect), burn-up measurements by fuel element oscillation, transfer function and reactivity measurements.

Experimental facilities

a) ECO - Zero power critical experiment
Max. power 1 KW, Max. thermal neutron flux 10^9 n/cm^2s
D_2O moderator (25 tons), natural uranium fuel (200 fuel elements), simulated organic coolant
Reactor tank: diameter 3m, height 4, 22 m
Bottom and side graphite reflector 0,9 m
Biological concrete shielding 1,7 m

b) Loop for heating and circulating liquids in pile (organic coolants up to 300°C and H_2O - D_2O up to 200°C).

c) High precision period meter, analog and digital reactivity meters for calibration of control and safety devices (from 10^{-2} pcm to about 5000 pcm).

d) Fuel element oscillator for burn-up studies with irradiated fuel.

e) Sinusoidal reactivity oscillator for transfer function studies (from 10^{-3} to 20 Hz).

f) Pulsed source equipment for reactivity calibrations or high frequency pile modulation.

g) Equipments for β and γ
- automatic 8 channels unit for β counting
- automatic single channel for β , β-γ, γ-γ coincidence measurements
- 4 further special counting channels.

Possible areas of application

The reactor may be utilized for experiments in the field of reactor moderated with heavy water and cooled with heavy water, light water, organic liquids (fuel elements with various configuration and composition natural or slightly enriced Uranium, Pu-U and Th-U alloys e.a.).

See next page

Experiments in hot conditions by means of a special loop measurements of void coefficient. Studies with irradiated fuel elements. (By the progressive substitution technique or by oscillation).

References

- ECO-Experience critique pour l'étude de la filière ORGEL
- Design criteria, engineering features and experimental program of the ECO reactor.
  Reprint from "Energia Nucleare" Vol. 9, N. 9, 1962
- The ECO reactor
  Programming and utilization of research reactors, Vol. 2, 1962, 37-44
- Manual on shielding of the ORGEL Critical Experiment
  EUR 149 e
- A measurement of the temperature coefficient of the effective resonance integral for Uranium Carbide
  Energia Nucleare, Vol. 14, N. 5, 1967, 289-294
- Heavy water lattices analyses at Ispra
  Proceedings of the Conference on Physics problems in thermal reactors design.
- The use of heterogeneous methods at Ispra
  Proceedings of the Conference on Physics problems in thermal reactors design
- Spectrum indices measurements
  EUR 3736 e
- A simplified direct reactivity meter for D_2O moderated systems - Nuclear applications, Vol. 3, 1967, 532-539
- Reactivity calibration by a digital analysis of flux transients - Nukleonik, Vol. 11, 1968, 1-4
- First experiments with the zero power facility ECO
  Atomkernenergie (ATKE) 13, 1968, 133-138
- Principi costruttivi e programma sperimentale del reattore ECO -
  Ingegneria Nucleare, 3, 1968, 3-10

Area of activity

Reactor Ispra I

Competence acquired

Operation of Ispra I (5 MW heavy water cooled and moderated research reactor). Maintenance and improvement of the nuclear and non nuclear circuits and components of the whole plant. Operation of in-pile organic fluid loops.

Experimental facilities

- 2 organic liquid cooled in-pile loops (actually out of service), working temperature 300°C and 400°C, serving for irradiation of fissile or non fissile materials, flux 7. 10^{13} nvt and 3. 10^{13} nvt;
- Possibility of in core irradiation of rings with maximum diameter of 4 inches to 6 inches, flux 5. 10^{13} nvt to 10^{14} nvt;
- Possibility of irradiation in vertical irradiation channel of 3, 3 inches diameter, flux 3. 10^{13};
- 8 spectrometers, choppers or diffractometers for basic research on condensed matter using the reactor beam tubes;
- Possibility of use on reactor beam tubes from 4 to 12 inches diameter;
- Irradiations by fast neutrons in a large volume (4,5 m^3) irradiation chamber using the Euracos converter, fast flux= 2. 10^{10} nvt;
- Possibility of using a 12 by 12 inches vertical channel in the thermal column, flux 4. 10^{12} nvt;
- Production of radioisotope or irradiation of capsules for various researches.

The following irradiation facilities exist:

Name of facility	Number of capsules in facility	Volume of capsule cm^3	Thermal flux, nvt	Max temperature °C
PH 2/4 *	2	52,8	$1,7.10^{13}$	80
IPA/B/C	6	15,5	$2,6\text{-}6,3.10^{12}$	113
Epsilon *	14	42,4	6.10^{12}	150 in cost.
Delta *	10	33,4	3.10^{13}	100 in cost.
XCPR-2	1	16,7	10^{11}-10^{13}	20 water cooled
XCPR-3	2	36,1	10^{11}-10^{13}	20 water cooled
Cryostat	1	73,8	$1,5.10^{13}$ fast 10^{11}	- 170
Schuele	1	125	10^{13}	200 elec. heated
DG-65 converter	1	196	fast 10^{11}	40

* These facilities are operated by the reactor personnel; the other facilities are operated by the experimenters.

Possible areas of application

Technological and vasical research using reactor neutron or gamma/beta radiation.
Radioisotope production.
Use of the experimental installation indicated under point 3).

References see next page

References

The indications refer to reports or publications on the reactor and on the experiments. This list is not complete, namely as to publicationsin scientific and technical journals and to patents. Detailed information might be obtained directly from the experimenter concerned.
Some reports on the Ispra-1 Reactor have been issued by the former C.N.E.N. staff.

Contribution to scientific and technical journals

- Euracos, un dispositivo di irradiazione ad elevato flusso di neutroni veloci.
  Energia Nucleare - Vol. 15 no. 11 - novembre 68
- Le attività del C.N.E.N. presso il Centro Comune di Ricerca Euratom di Ispra
  Notiziario del C.N.E.N. - no. 11, novembre 68
- The control System of the Ispra-1 Reactor
  Nuclear Science and Engineering 12, 1962
- Drop Time Measurement Apparatus of Nuclear Reactor Safety Rods
  Energia Nucleare Vol. 7 no. 11, novembre 60
- I dispositivi di controllo di radioattività degli affluenti liquidi e gassosi del Reattore Ispra-1 ed edificio annesso
  Minerva Nucleare - Vol. 4 - no. 10 ottobre 60
- Experimental Determinations of the statistical Dynamics of Ispra-1 Reactor
  Energia Nucleare - Vol. 14 no. 8 agosto 67

External reports

- Irradiation facilities in the Ispra-1 Reactor
  EUR 374.e
- In-pile test of a thermoionic converter
  EUR 485.e
- Operating experience with an experimental nuclear heated thermoionic converter
  EUR 861.e
- In-pile application of strain gauges
  EUR 2120.e
- Gamma heat generation in the 4GV1 beam of the Ispra-1 Reactor
  EUR 2178.e
- Die Meteorologischen Bedingungen der Ausbreitung luftfremder Stoffe in Ispra-1 Italien bei den Reaktoren der Euratom
  EUR 3167.d

See next page

Other reports

- Euratom's Neutron Physics Activity at Ispra
- Il sistema di controllo automatico del Reattore Ispra-1
  CNEN RT/ING. 65.3.
- Il sistema di regolazione del Reattore Ispra-1
  CNEN no. 145
- Descrizione generale del sistema di regolazione
- Calcul d'antiréactivité et étude de la répartition du flux dans la boucle DIRCE
  Vielvoye-1966
- Etude de la variation du Keff du réacteur Ispra-1 en fonction du titre de l'eau lourde
  Vielvoye-1966
- Calcul des doses neutroniques et gamma à la sortie d'un canal IS du Réacteur Ispra-1
  Vielvoye-1965
- Etude neutronique des éléments NUKEM
  Vielvoye-1966
- On non-destructive methods of burn-up determination in irradiated uranium fuel
  EUR/C-IS/814/67 e
- The double chopper neutron spectrometer at Ispra
  EUR/C-IS/444/68 e
- Exploitation de la boucle organique DIRCE II
  IP/0141/N

Area of activity

Post-irradiation examinations of fuel and structural materials.

Competence acquired

Dismantling and examination of UC/SAP fuel rods and thermionic fuel capsules.

Experimental facilities

"Laboratoire de Moyenne Activité" with the possibility to perform the following operations:

- dismantling of fuel elements and capsules
- gamma-scanning
- puncture-test
- dimensional measurements
- determination of density
- determination of expansion coefficient (dilatometry)
- metallography
- hardness measurements
- mechanical properties (tensile test and impact test)
- post-irradiation annealing test.

Possible areas of application

Performance study of reactor materials.

Possible interested industries

Electrical utilities with nuclear power stations
Reactor industry.

References see next page

References

- Rapporto di sicurezza - Laboratorio di media attività dell'Euratom CCR Ispra
EUR/C-IS/1129/67 i

Area of activity

Preparation and execution of irradiation tests.

Competence acquired

- Irradiation tests of UC/SAP fuel rod in an organic loop (reactor Ispra I)
- Capsule irradiations of fuel in Ispra I and HFR (Petten)

Experimental facilities

Laboratory for construction and tests of experimental irradiation devices.

Possible areas of application

Fuel element development.

Possible interested industries

Manufactures of nuclear fuels.
Reactor industry.

References see next page

References

- Description and operation characteristics of the experimental fuel element irradiation loop DIRCE EUR/C-IS/1182/66 e, f

- Final proposal for the irradiation of an Orgel type fuel assembly in WR-I. Exp-WRI-601 Communication 1292

Area of activity

Packaging and transport of radioactive materials

Competence acquired

Several design studies, safety reports for approval by competent Authorities - structural, thermal, shielding, criticality (with TCR support), calculations, drawings and assessment - for type A, B, great source packagings and for capsules.
Modifications, additions and transformations of road-vehicles for transport of radioactive materials.
See references for details.

Experimental facilities

Facilities to test type A packaging for radioactive materials are available.
Calculation on Cetis computers have been done for type B packaging.

Possible areas of applications

Design and development of transport packaging and vehicles for radioactive and/or dangerous materials according to existing regulations, even in collaboration with industries and national organisations.

References see next page

References

External reports

- Sécurité nucléaire du conteneur de transport pour éléments nourriciers Essor irradiés (to be published)
  R. RICCHENA (TCR), P. ROCCO
- Shipping flask for UC/SAP irradiated fuel (to be published)
  J. COSSE, D. PRUESS, P. ROCCO

Patents

- Patent no. 1, 130, 762 of the Patent Office, London
  Carrier for transportation of radioactive materials
  Inventors: G. BONNET, G. MOLLICA, G. BOTTANI

Other references

- Modification of BEI-BEN designs of BR2 and HFR Irradiated fuel transport flasks
  Meeting with UKAEA experts to have British Approval for these flasks (type B . packaging for great source fissile Class II)
  The criticality calculations for these flasks have been done with TCR support
- Preliminary design of ESSOR irradiated feeding fuel transport flask (type B - packaging for great - fissile Class II)
- Criticality calculations for the final design of point 2) flask (in collaboration with TCR) The flask will be built by Robatel-SLPI
- Design of a shock absorbing-structure with aluminium honey-comb for transport flask - To be patented
- Preliminary and final design of a transport flask for irradiated fuel to be shipped from Canada to Ispra (Type B packaging for great source - fissile Class II)
  The flask was built by MAN - Approval of the flask was obtained by the Canadian Authority
- Designs and modifications on capsules and type A packagings for external and internal transport of CCR-Ispra
- Design revisions, modification and addition to road-vehicules for radioactive materials transport
- Some minor tests have been done to have approval for a type A packaging
- Contribution to Euratom/CNEN/Montecatini-Edison contract no. 032-66-IECII Investigations on fission products release from irradiated fuel
- Contribution to Euratom contract no. 024-65-6 ECIC (Le règlement de transport des matières radioactives de l'IAEA)

Area of activity

Instrumentation for irradiation tests

Measurement of high temperatures and neutron flux.
Special types of welding and brazing (without flux)
Resistivity (at cryogenic and room temperatures)

Competence acquired

- Diffusion boundings of sheat of thermocouples and plugs of fuel elements
- Fabrication of composite thermocouples for high and medium temperatures
- Study of the insulation of various ceramics up to 1700° ($BeO-Al_2O_3$)
- Flux detectors "Collectrons": fabrication, calibration, measuring devices
- Calibration of thermocouples up to 1700°C with three reference points (Gold, Antimony, Nickel)
- Brazing wihtout flux of current or refractory metals
- Special types of weldings: TIG - Microplasma - Resistance Welding
- Resistivity

Experimental facilities

- Precision electrical measuring apparatus
- Furnaces for calibrations up to 1750°C (in vacuum or hydrogen)
- Several welding facilities
- Resistivity bench with cryostat

Possible areas of application

- Measurement of high temperatures (up to 1700°C)
- Continuous measurement of neutron flux
- Bonding of refractory metals for high temperature experiments
- Physical properties of materials (Resistivity)

Possible interested industries

Space Industry - Motor Industry - Metallurgical Industry

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References

Contribution to scientific Journals

- Durcissement à basse température dans les alliages type SAP - par P. GUYOT - R. DEBEIR - Acta Metallurgica 1966
- Misure di resistività elettrica a bassa temperatura e di effetto hall nell'alluminio e nel SAP par R. DEBEIR, D. NOBILI, L. PASSARI - 1965 - Supplemento al Nuovo Cemento Serie I, Vol. 3, p.

External Reports

- Les collectrons - M. GRIN - 1967 - EUR 3567.f
- Cryostat en phase gazeuse - R. DEBEIR - M. GRIN 1966 - EUR 2710.f
- Essais de traction à basses temperatures sur SAP 4%, 1966 - D. BOERMAN - R. DEBEIR - EUR 2648.f
- Mesure de flux neutronique par collectrons R. DEBEIR - M. GRIN - O. SIMONI - 1969 (to be published)

Patents

- Modèle d'utilité en Allemagne "Verbindungskapsel für Thermoelemente" déposé le 1.9.67 No. E 25 707/42 i.

Other reports

- Rig rivelatori di flusso neutronico R. DEBEIR - M. GRIN - O. SIMONI - 1967 ISP 1183
- Mesures de résistivité à basse température M. GRIN - R. DEBEIR - 1963 ISP 468
- Dépôts chimiques en phase vapeur de métaux réfractaires F. BROSSA - R. DEBEIR - M. GRIN - G. PIATTI - H. VENKER

  Présenté au Premier Colloque International sur les applications des sciences et techniques du vide aux revêtements et états de surface. DIJON 15 - 19 Octobre 1968.

II) PHYSICS

II/1 Reactor Physics

II/2 Solid State Physics

Area of activity

Theoretical dynamics in general, of nuclear reactor facilities in particular.

Competence acquired

Establishment and treatment of mathematical models for the time behaviour of every nuclear reactor type.
Nuclear part: More-point and more-energy group kinetics. Linear and nonlinear stability, LIAPUNOV theory. Pulsed reactor kinetics.
Conventional part: Non-stationary heat transfer through fuel elments, dynamics of boiling and two-phase flow, heat exchange simulation. Control part: Control philosophies, simulation of components, automation of components and plants.
Direct and indirect nuclear accident analyses.
Design of reactor components by dynamical points of view.

Experimental facilities (disposable at Ispra computation center CETIS)

Analog computer PACE 231 R, 3 consoles approximately with 150 amplifiers and 60 multipliers.
Various important auxiliary components, e.g. SIOUX, a device for automatic scale change.
Digital computer IBM 7090.
Digital computer IBM 360/65.

Possible areas of application

Design calculations, both nuclear and thermohydraulic of fuel elements and coolant circuits. All dynamics and nuclear safety analyses.
Two-phase flow problems (theoretical). Plant automation.

Possible interested industries

All nuclear firms.

References see next page

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- "Die Selbstregelfähigkeit von Leistungsreaktoren", H. Wundt, Nukleonik 5, H. 5 (1963)
- "On the structure of consistent equation sets to describe multiphase flow", H. Wundt, Symp. on Two-Phase Flow Dynamics, Eindhoven (1967), proceedings in press
- "Lösung der instationaren Wärmeleitungsleistung mit zeitabhängiger Umgebungstemperatur und zeitlich veränderlicher und räumlich ungleichmässig verteilter Wärmequelle", R. Palinski, Nukleonik 6, H. 6 (1964)
- "Lösung der instationären Wärmeleitungsprobleme für hohlzylindrische Körper mit zeitabhängiger Umgebungstemperatur und Flächenbelastung", R. Palinski, Nukleonik 7, H. 2 (1965)
- "Zeitliche Reaktivitätsänderung eines mit der Temperatur des Moderators geregelten Reaktors", R. Palinski, Nukleonik 7, H. 5 (1965)
- "Mathematisches Modell zur Beschreibung des Betriebsverhaltens eines Reaktors mit Notstromaggregat", R. Palinski, Nukleonik 9, H. 5 (1967)
- "A mathematical model for the dynamic behaviour of a power reactor with particular regard to non-stationary heat transfer", R. Palinski, Nukleonik (to appear)
- "On ascertaining asymptotic stability in the large of nuclear power reactors by means of Liapunov's second method", D. Schwalm, Nikleonik 8, H. 7 (1966)
- "Asymptotic stability of a coupled reactor with linear power feedback", D. Schwalm, Nukleonik 9, H. 4 (1967)
- "Stability of P_1-dynamical equations", D. Schwalm, Nukleonik 11, H. 6 (1968)
- "Technik und Kosten der Automatisierung von Kernkraftwerken", K. Ditterich, Atomwirtschaft-Atomtechnik Nr. 10, Okt. (1968)

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- "Dynamics and control of the fast pulsed reactor SORA", H. Wundt, EUR-2553.e (1965)
- "Basic relationships in n-component diabatic flow", H. Wundt, EUR-3459.e (1967)
- "The part of thermal non-equilibrium in boiling co-current flow", H. Wundt, EUR-4188.e (1968)
- "On a multigroup kinetics", D. Schwalm, EUR-2285.e (1965)
- "On a derivation of the multigroup kinetic equations of coupled reactors", D. Schwalm, EUR-2416.e (1965)
- "Der Einfluss von Störungen auf das Zeitverhalten von Kernreaktoren unter Verwendung eines Mehrgruppen- und Mehrpunkt-Modells bei Berücksichtigung von Rückkopplungseffekten", D. Schwalm, (to be published)

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Area of activity

System dynamics.

Competence acquired

System identification and mathematical simulation; development and techniques and instruments of measurements; realization of control means and prototypes.

Typical realizations

Transfer function of nuclear reactors; noise analysis in nuclear systems; dynamic behaviour of pulsed reactors; direct spectral method of identification of linear systems; thermodynamics for a digital code for liquid-cooled multi-channel reactors; mathematical model of heat exchangers; analog simulation of the control system of Reactor Ispra I.
Automatic control system for Dragon Reactor (UKAEA); transfer function analyser; statistical dynamics analyser; high resolution Mössbauer effect analiser.
Pile oscillators; development and erection of mock-ups of liquid-rod shut-down systems; fast safety rod for a pulsed reactor; fluidic control system (for pneumatic oscillators, pneumatic driven irradiation facility, level control device).

Possible areas of application

Basic research, traditional industrial processes, nuclear plants, economical systems, bio-engineering.

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- "Noise measurements in a zero power reactor and analysis of its influence on oscillation measurements", A. Garroni, A. Lucia, F. Sciuto, Energia Nucleare N. 2(1967)
- "Experimental determination of the statistical dynamics of ISPRA-I reactor", A. Garroni, A. Lucia, F. Sciuto, Energia Nucleare N. 8 (1967)
- "Sulla sintesi di correttori digitali nei sistemi di controllo a segnali campionati con modulazione di larghezza d'impulso", G. Bressanin, Convegno "ANIPLA" Roma, Ottobre (1967)
- "Problemi relativi ad un metodo digitale diretto per la determinazione di matrici di coerenza", A. Garroni, F. Sciuto, Convegno "ANIPLA" Roma, Ottobre (1967)
- "Un'apparecchiatura digitale per l'analisi di dinamica e dinamica statistica di sistemi", A. Garroni, F. Sciuto, Convegno "ANIPLA" Roma, Ottobre (1967)
- "A liquid-rod shut-down system", A. Agazzi, A. Broggi, S. Galli de Paratesi, L. Ghiurghi, A.N.S. Toronto, July (1968)
- "Development of fluidic systems for nuclear plant control", S. Galli de Paratesi, L. Ghiurghi, H. Musik, Convegno di Fluidica, Torino, Maggio (1968)

Area of activity

Reactor dynamics studies.

Competence acquired

Development of numerical programmes for space and time dependent neutronic and for the thermohydraulics of the cooling channels with boiling and non boiling coolants. These are the series of the Codes COSTANZA in one and two dimensional geometry for the study of the normal operation and for the dynamics of accidents of intermediate gravity.
Problems of stability of the plant are studied with zero-dimensional digital codes and analogical methods.
Xenon stability is treated with the series of COSTANZA codes adapted for long term transient, and also analytical methods for non linear stability were studied.
Normal power excursions of pulsed fast reactors inclusive of Doppler and thermal expansion feed-backs.
Analysis of elastic vibrations induced by pulsing.

Tools

IBM 360/65 digital computer.
3 PACE Analog computers.

Possible areas of application

Stability and intermediate accidents for any type of thermal reactors and pulsed fast reactors.
The extension to the domain of power fast reactors is possible.

Remarks

An Information Center on space dependent dynamics is being organized at Ispra in order to collect, evaluate and distribute through regular bulletins and meetings, world-wide data and codes.

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- "A dynamic model for the cooling channels of a boiling nuclear reactor with forced circulation and high pressure level", G. Forti, EUR-4052.e (1968)
- "FRANCESCA. A dynamic programme for boiling cooling channels", G Forti, EUR-2650.e (1968)
- "Etude de la stabilité axiale du prototype ORGEL", A. Martinet, E. Vincenti, EUR-2651.f (1968)
- "Instabilité Xénon dans un réacteur. Théorie à un groupe de neutrons. Réacteur avec réflecteur", A. Sola, ISP-1262 (1968)
- "Eindimensionale Dynamikuntersuchungen von Kruz und Langzeitvorgängen", K. Friedrich, L. Massimo, E. Vincenti (in collaboration with BB/Krupp), to be presented to the German Atom Forum of April 1969
- "Research of Xenon excursions in boiling water reactor", G. Forti, U. Schmidt, E. Vincenti (in collaboration with AEG), to be presented to the German Atom Forum of April 1969
- "Computing methods in reactor physics", H. Greenspan, C.N. Kelber, D. Okrent, A.N.L. (Editor Gardon & Breach), from page 480 to page 488. The method used in our Codes COSTANZA is discussed.
- "Feedback due to elastic waves and doppler coefficient during the excursions of a pulsed fast reactor", J. Randles, J. Nucl. Energy A/B, 20, 1 (1966)
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- "Theoretical analysis of hypothetical destructive accidents in a pulsed fast reactor", J. Randles, Fast Reactor Phys. II, Vienna (1968)
- "Some problems of stress wave production encountered in the study of pulsed fast reactor dynamics", J. Randles, EUR-3654.e (1967)
- "Analysis of accidents in pulsed fast reactors: Computer programmes DOPPELAS and SOREX 1", J. Randles, EUR-3615.e (1968)
- "Amplification of vibrations due to the repetition of thermal Shocks in a pulsed fast reactor", J. Randles, EUR-4060.e (1968)

Area of activity

Nuclear Data

Competence acquired

Elaboration of scattering kernel models (hydrogen bound in organic molecules and water, crystalline model for carbon) for use in multigroup thermal codes. Development of simplified formulae for the evaluation of resonance integrals of U-238, Th-232 and U-235 in heterogeneous systems for use in multigroup cell calculations. Execution of resonance integral and Doppler effect measurements for uranium carbide rods. Analysis of cross-section formalisms for fissile and fertile nuclei in the resolved and unresolved energy region. Utilisation and development of standard libraries (GAM, GATHER etc.). Processing of nuclear data from ENDF-B files for use in Montecarlo codes. Assessment of experiments in ECO for the evaluation of integral nuclear data of plutonium in thermal systems and their interpretation. Studies of fission product chains and their representation in simplified schemes. Measurements of spectra and integral nuclear parameters (conversion ratio, Doppler coefficient of U-238 etc.) in fast spectra by activation, proton recoil, stilbene and Li^6 - sandwich spectrometers (EURACOS).

Tools

IBM 360/65 digital computer - ECO, heavy water critical facility - EURACOS converter facility; analog and digital direct reactivity meter; counting equipment; calibration converter DG65.

Areas of application

Collection and elaboration of multigroup cross-section librairies for nuclear design and operation in thermal and fast systems. Documentation, analysis and execution of clean-geometry integral experiments. Reliability tests of cross section libraries on clean integral experiments. Assessment of the influence of cross-section uncertainties on design parameters. Elaboration of standard sets of cross-section libraries. Nuclear safeguard evaluations.

Remarks

This activity is a part of the proposed INDAC (Integral Nuclear Data Center) activity.

References see next page

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- R.DIERCKX - Use of RDMN for the calculation of differential neutron spectra of fast reactors from foil activation data - memo to the Conf. on "Radiation Measurements in Nuclear Power" - Berkeley England 1966
- R. DIERCKX , A.MARCHAL, A.VAN WAUWE - A simplified direct activity meter for D_2O moderator systems - Nucl. Appl. 3, 1967
- R. DIERCKX , A.HAGE, A.VAN WAUWE - Measurement of small reactivities by the direct reactivity meter method - Nucl. Inst. and Meth. 63-1968
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- R. DIERCKX, W.HAGE, H.HETTINGER et al. - Reactivity calibrations by analog and digital methods used during ESSOR zero power experiments- to be published - Atomkernenergie 1969
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- A. BACCOLINI et al. - Zero reactivity method in nuclear parameter evaluation of heavy water power reactors - Heavy Water Power Reactors IAEA 1968
- W. HAGE et al. - First experiments with the zero power facility ECO Atomkernenergie 13-26 (133-138/1968)
- W.HAGE et al. - Results of the ESSOR zero power experiments - Heavy Water Power Reactors IAEA 1968
- W. DE HAAN - Calculation of the absorption and fission resonance integrals of U-235 by a fitting procedure - EUR 3936 e.
- F. BEONIO-BROCCHIERI et al. - Studies of 240-Pu resonance absorption in heterogeneous systems - ANS Meeting on Reactor Physics, San Diego(1966)
- F. BEONIO-BROCCHIERI - Calcolo dell'evoluzione dei materiali fertili e fissili e di prodotti di fissione in sistemi irraggiati - to be publ.

Area of activity

Radiation Shielding

Competence acquired

Shield design methods and calculations: evaluation of bulk shields; radiation streaming through ducts and voids; heat deposition in reactor components; radiation damage in pressure vessels; activation of components. Development of computer programs for the calculation of neutron and gamma ray attenuation with the removal-diffusion theory (MAC-RAD, SABINE) and transport theory (BIGGI, CINNA); collection and evaluation of computer codes and nuclear data interesting in shielding applications.

Experimental investigations: Mock-up studies for specific shields; neutron dosimetry and spectrometry; assessment of design methods.

Tools

High flux converter EURACOS: Power: 1,5 KW, source strength 10^{14} n/sec; incident fast flux 2.10^{10} n/cm^{2}sec; IBM-computers 7090 and 360/65.

Possible areas of application

Shield design, heat deposit and radiation damage calculations for light, heavy water reactors, HTGR, fast reactors; Shield design for accelerators; Accessibility problems for actived reactor components, etc.; Shielding for spent fuel elements.

Remarks

It is foreseen to establish at Ispra a European Shielding Information Service (E.S.I.S.) with tasks similar to that of the R.S.I.C. operating in the U.S.A. The E.S.I.S. is intended to serve nuclear industries and organizations of the European Community.

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- "Solution of the neutron slowing-down problem via a multiple collision approach", C. Syros, Nucl. Sci. & Eng. 28 (1967) 203-214

- "The space-energy-angle-dependent Fourier solution of the Slab Problem", N. Papmehl, Part I, Nucl. Sci. & Eng. (1968)

- "EURACOS: Un dispositivo di irradiazione ad elevato flusso di neutroni veloci", G. Perlini, Energia Nucleare (1968)

- "Investigation of the accuracy of different shielding codes in water-iron shields", R. Nicks et al., Nucl. Eng. & Design (1968)

- "MAC-RAD, a reactor shielding code", U. Canali et al., EUR 2152 e, 1964

- "Etude expérimentale de la propagation de neutrons monoénergétiques dans l'eau", R. Nicks et al., EUR 2161 f, 1964

- "User's manual for the gamma transport codes BIGGI 3P and BIGGI 4T", H. Penkuhn, EUR 3555 e, 1967

- "SABINE, a one dimensional bulk shielding program", C. Ponti et al., EUR 3636 e, 1967

- "SABINE, a one dimensional shielding program which employs experimental removal cross-sections", C. Ponti et al. Proc. of the Conference on "The Physics Problem of Reactor Shielding", Harwell 1967; Paper RS/1.1/1, AERE-R 5773

- "Today's approaches to reactor shielding problems", R. Nicks et al., paper presented at the ANS Winter meeting 1968.

Area of activity

Reactor safety analysis.

Competence acquired

Theory and calculation of reactor and plant safety; assessment of fission product dispersion resulting from hypothetical extreme accidents; criticality control of fissile materials on the basis of the different national regulations. In particular computer codes were developed and used for: reactor dynamics studies (COSTANZA, SOREX 1, DOPPELAS); associated thermodynamic calculations (EQUSTA); atmospheric diffusion of radioactivity (CLOUD).

Tools

IBM 360:65 digital computer.

Possible areas of application

Analysis of non-destructive accidental transients for: boiling water reactors; pebble bed reactors; heavy water reactors; light water ship propulsion reactors.
Analysis of Xenon spatial oscillations. Analysis of non destructive accidents in fast reactors. Site hazards evaluation following a maximum credible accident. Studies of the storage transport and handling of nuclear fuel.

Remarks

The "Protezione Sanitaria" and "Génie Radioactive" Services are contributing, together with T.C.R. to this activity.

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a) Journals

- "Feedback due to elastic waves and dopler coefficient during the excursions of a pulsed fast reactor", J. Randles, J. Nucl. Energy A/B, 20 (1966) 1
- "Accident and self regulation studies of pulsed fast reactors", J. Randles, J. Nucl. Energy A/B, 20 (1966) 713
- "Theoretical analysis of hypothetical destructive accidents in a pulsed fast reactor", J. Randles, Fast Reactor Physics II, IAEA (1968)

b) External Reports

- "Some problems of stress wave production encountered in the study of pulsed fast reactor dynamics", J. Randles, EUR-3654.e (1967)
- "Analysis of accidents in pulsed fast reactors: Computer Programmes DOPPELAS and SOREX 1", J. Randles, EUR-3615.e (1968)
- "Amplification of vibrations due to the repetition of thermal shocks in a pulsed fast reactor", J. Randles, EUR-4060.e (1968)
- "Primo esame di un reattore ad escursione di potenza da impiegare per la ricerca sulla sicurezza dei reattori nucleari", V. Coen, G. Dondi et al., EUR-271.i (1963)
- "Finite difference method for solving the spatic-temporal diffusion equation in the two-group approximation", R. Monterosso, E. Vincenti, EUR-596.e (1964)
- "COSTANZA. A numerical code for the study of the reactor spatial dynamics in two groups", E. Vincenti, A. Agazzi, R. Monterosso, EUR-2103.e (1964)
- "The code COSTANZA", E. Vincenti, A. Agazzi, R. Monterosso, EUR-2104.e (1964)
- "An advanced power excursion reactor for research in reactor safety". Preliminary studies", C. Rinaldini, V. Coen, EUR-2433.e
- "COSTANZA Cylindrical. A cylindrical one dimensional dynamics code for liquid-cooled multi-channel nuclear reactors", A. Agazzi, G. Forti, E. Vincenti, EUR-3171.e (1966)
- "The code COSTANZA for the dynamics of liquid-cooled nuclear reactors", G. Forti, E. Vincenti, EUR-3633.e (1967)
- "Control rod oscillator tests. Garigliano nuclear reactor", R.T. Lahey, E. Vincenti et al., GEAP-5534.e (1967).

Area of activity

Reactor cell calculations

Competence acquired

Development of analytical and numerical methods for the evaluation of collision probabilities in various geometries (codes SHOCK, PROCOPE). Elaboration, test and use of design lattice calculation schemes, based mainly on integral transport equation, for Uranium Thorium and Plutonium bearing systems, including fuel evolution and point reactivity curve as a function of burn-up and various geometries (rods, clusters)-(codes PLUTHARCO, RABBIT, PINOCCHIO, HEROIC). Development of refined calculation models to rigorously treat the resonance phenomena in heterogeneous systems (code PETARD). Improvement of existing codes for resonance integral calculations to deal with coated particle fuel elements (code ZUT-CP).
Use of one and two dimension S_N (WDSN, DTF-IV, 2DXY) and Montecarlo cell codes (REP, MOCK-UP).

Tools

IBM 360/65 - IBM 7090 computers

Areas of application

Evaluation of core group constants in nuclear design and operation of thermal reactors; calculation of hyperfine distributions in fuel bundles; refined calculations of reactivity temperature coefficients. Extension to fast systems is in progress. Burn-up studies (isotopic and reactivity analyses).

Remarks

This activity is a part of a more general competence in the field of fuel burn-up analysis.

References see next page

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- "CAROLINE 1 - A calculation method for non-irradiated organic liquid heavy water lattices", G. CASINI et al., EUR-134.e (1962)
- "PLUTHARCO - A plutonium, uranium, thorium assembly reactivity code", W. DE HAAN et al., EUR-3141.e (1966)
- "Heavy water lattice analyses at Ispra", L. AMYOT et al., Int. Conf. on the Physics Problems in Thermal Reactor Design, London June 1967,15
- "PINOCCHIO - A new lattice calculation method for D_2O reactors", L. AMYOT et al., EAES Meeting, Karlsruhe (1966)
- "First-Flight collision probabilities in Pu cluster and rod lattices", AMYOT-BENOIST, Nucl.Sci.Eng. 28 (1967) 215-225
- "The fast neutron multiplication factor", L. AMYOT, EUR-1618.e (1964)
- "Anisotropic collision probabilities in general cylindrical geometry", L. AMYOT, EUR-3937.e
- "Refined calculations and comparison with measurements of the thermal neutron hyperfine structure in D_2O moderated 4 and 7 rod UC clusters", B. STURM, Energia Nucleare 13 (1966)
- "Epithermal absorption in an isolated resonance", J. MEGIER, J. of Nucl. Eng. 22, (1968) 417-431
- "Calcolo dell'evoluzione dei materiali fertili e fissili e di prodotti di fissione in sistemi irraggiati", BEONIO-BROCCHIERI, (to be published)
- "Molecular model for polyphenils and its use in calculating reactor parameters", V. ARDENTE, et al. , IAEA Neutron Thermalization and Reactor Spectra-Symposium, Ann Arbor 17/21 July 1967-Vol. 1 p. 467
- "Application of phenomenological thermalization model to irradiate heavy water lattices", A. KIND, G. ROSSI, ANS Meeting on Reactor Physics in the Resonance and Thermal Region, San Diego (1966)
- "Calculation of D_2O moderated lattices by basic methods", B. STURM, EUR-597.e (1967)

Area of activity

Reactor cell measurements

Competence acquired

Critical experiments, activation techniques for detailed parameter measurements and spectral indices as function of temperature; reactivity calibrations of critical assemblies by many different methods. Data processing programs for experiments with critical assemblies (about 20 unpublished data processing codes available). Burn up measurements with pile oscillator techniques.
Operation experience with subcritical D_2O assemblies operated with stationary and pulsed sources. Analysis methods based on 3 group heterogeneous methods in mono and dipol approximation for stationary and pulsed source operation (CODE-ISIS) in order to obtain the material buckling and the migration area anisotropy.

Tools

FCO reactor, fuel element oscillator, loop for hot channel experiments, several automatic and semiautomatic activity counting installations, pile reactivity calibration equipment hot cell for mounting active fuel elements, uranium metal and uranium carbide fuel in form of rods.
Subcritical facility D_2O equipped with fully automatic scanners for global scans axially and radially and cell fine structure in moderator around each fuel element. Stationary and pulsed source analysis equipment. Moderator heatable up to 90°C.

Areas of application

Experiments to test codes for nuclear design of reactors, participation or full charge of power start up experiments with trained persons and equipment.

References see next page

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- A. BOEUF, S. TASSAN - A measurement of the hyperfine structure of the thermal neutron flux distribution in organic cooled UC clustered fuel elements in a D_2O moderated lattice - Energia Nucleare, 13, 2 (1966)
- A. BOEUF, S. TASSAN - A measurement of the effective resonance integral of UC rods - Nucl.Sci. and Eng. 25, 365 (1966)
- P. ARCIPIANI, A.BOEUF, et al. - Measurements of the effective resonance integral of a natural uranium metal cluster containing moderating coolants Energia Nucleare, 13, 6 (1966)
- S. GUARDINI, S. TASSAN, A.BOEUF - Measurement of fast fission ratios in uranium carbide rods - Energia Nucleare, in press (1966)
- S. TASSAN, L. HAEMERS, A.BOEUF - Measurement of the temperature coefficient of the effective resonance integral of uranium carbide - submitted for publication to Energia Nucleare
- S. GUARDINI, S. TASSAN - A technique for the measurement of the fine structure of the thermal spectrum index in clustered fuel elements in a D_2O moderated lattice - Energia Nucleare
- G. MARACCI, F. RUSTICHELLI - Fast fission ratio in natural uranium cluster heavy water lattices - J.Nucl.Energy Vol. 21 pp.857 to 865
- V. AIELLO, G. MARACCI, F. RUSTICHELLI - Single rod fine distribution of the fast fission ratio - Nucl.Sci. and Eng. to be published
- W. HAGE et al. - Heavy water power reactors - Results of the ESSOR zero power experiments - SM-99/43 IAEA Vienna 1968
- A. BACCOLINI et al. - Zero reactivity method in nuclear parameter evaluation of heavy water power reactors - SM-99/23 IAEA Vienna 1968
- R. DIERICKS et al. - Reaktivitatseichungen mit Analoger and Digitaler Datenverarbeitung bei der Essor Nulleistungsphase - Atomforum - Reaktortheorie Tagung 1968 Muenchen
- R. DIERCKX et al. - Measurement of small reactivities by the direct reactivity meter method - Nucl.Instr.and Method. 63(1968) 166-72
- G.BIRKHOFF, L.BONDAR, W.HAGE - Analyse von Exponential-experimenten mit schwerwassermoderierten Stabbündelgittern - Vortrag Deutsches Atomforum München 1968
- G. BIRKHOFF - Experimentelle Bestimmung der neutronenphysikalischen Entwurfsdaten von D_2O-modedierten Reaktoren - Vortrag TH Aachen, Seminar für Reaktortechnik am 28.11.68

Area of activity

Reactor core calculations, fuel cycles analysis.

Competence acquired

Development, test and use of two and three-dimensional (of homogeneous and heterogeneous type) computer codes for reactor design, burn-up and fuel management calculations: MAFIA; (under contract with FIAT-ARS) SQUID, CONDOR, EREBUS, TRITON; (under contract with GAAA) TRIHET, HETROIS; ORACLE. Development test and use of burn-up computer codes for fuel cycles assessment for a continuous charge and discharge of the fuel: BACCHUS, MOGA, BACON. Fuel cycles analysis for High Temperature Gas Cooled Reactors, Heavy Water Moderated Organic or Water Moderated Organic or Water Cooled Reactors, Light Water Reactors: assessment of the once through and of the Plutonium recycle schemes for Uranium fuelled reactors; assessment of the full recycle and of the segregation scheme for Thorium fuelled reactors.

Tools

IBM 360/65 digital computer.

Possible areas of application

Development of calculation methods for design and operation of power thermal reactors. Extension to fast reactors is possible. Comparison and assessment of the various possible fuel cycle schemes for a given reactor type. Comparison of different reactor types, on the basis of their fuel utilization, in view of power reactors strategy studies.

Remarks

This activity is a part of a more general competence in the field of the fuel burn-up analysis.

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- "MAFIA. A one dimensional burn-up code", L. Massimo, presented at the Conference on the Application of Computing Methods to Reactor Problems, Argonne, May (1965)
- "BACCHUS. A burn-up code for continuous charge-discharge fuel cycles", L. Massimo, EUR-3076.e (1966)
- "Fission product chains and their importance in high burn-up fuel cycles", J.J. Devos, L. Massimo, EUR-3119.e (1966)
- "Performances d'un réacteur ORGEL alimenté au Thorium", (F. Lafontaine, C. Rinaldini, C. Zanantoni, SM-99/44, IAEA Symposium on heavy water power reactors, Vienna Sept. (1967)
- "The value of plutonium as a make-up for thorium thermal converters", G. Graziani, C. Rinaldini, C. Zanantoni, presented at the Symposium on the economics of nuclear fuel, IAEA-Gottwaldov, May (1968)
- "Can Thorium compete with Uranium? An assessment of heavy water and graphite moderated reactors", G. Graziani, C. Rinaldini, C. Zanantoni, Panel on the utilization of Thorium in power reactors, IAEA, Vienna June (1968)
- "The use of Thorium in heavy water moderated reactors", G. Graziani, C. Rinaldini, C. Zanantoni, Energia Nucleare, June (1968)
- "The use of heterogeneous methods at Ispra", G. Casini, W. Hage, A. Kind, Conference on physics problems in Thermal Reactor Design, June (1967) (London)
- "Application des méthodes hétérogènes aux réacteurs ORGEL (code TRIHET V), J. Ligon (GAAA), Communication EURATOM 1.6.1950.
- "Oracle II. An operating reactor assembler code for life evaluation", W. De Haan, A. Inzaghi, (to be published as Euratom Report).

Area of activity

Stochastic and analytical methods.

Competence acquired

Development and application of Monte Carlo codes to neutron transport in complex structured reactors, two phase transitions in thermo-dynamics and differential equations of mathematical physics. Analysis of space-energy-time dependent transport problems by variational and integral transformation methods and their application to reactor research and development, electro-dynamics, signal transmission and polymer physics. Mathematical methods of statistical- and continuum-mechanics. Stochastic processes, noise analysis and statistics. Design and programming of computer codes including large scale data handling.

Tools

Computers: IBM 7090 and 360/65

Possible areas of application

Reactor analysis in complex 3-dimensional geometries, optimization of experimental facilities, calculation of differential effects, energy release, space-dependent kinetics, neutron thermalization. Application of stochastic methods to differential- and integral equations of mathematical physics, queuing theory, population evolution, renewal theory. Analysis of the dynamic characteristics of physical processes by statistical methods, regression and variance. Design and optimization of nuclear experiments. Simulation of radiation damage, two-phase transition, fracture mechanics (stress analysis and crack propagation), biophysics.

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- "Reactivity calculations for a periodically pulsed fast reactor by the TIMOC Code", H. Rief, H. Kschwendt, R. Jaarsma, Proceedings for the International Conference on the Utilization of Research Reactor Mathematics and Computation, CNM-R-2, Mexico (1967)
- "Reactor analysis by Monte Carlo", H. Rief, H. Kschwendt, J. of Nucl. Sci. & Eng. 30, (1967) 395-413
- "The expected leakage estimator applied to time-dependent neutron transport", H. Kschwendt, H. Rief, J. of Nucl. Energy 22, (1968) 127-138
- "The application of Monte Carlo to neutron transport and reactor analysis problems at the Euratom Research Center Ispra", H. Rief, Invited paper at the Joint American Canadian Nucl. Soc. Meeting, ANS-CNA Trans. 11,1, Toronto (1968)
- "Model calculations of phase transitions with Monte Carlo", W. Matthes, accepted for publication in the J. of Comp. Phys. (1969)
- "The J_N method for time-dependent neutron transport problems", T. Asaoka, Proceedings of the Int. Conference on the Utilization of Research Reactors and Reactor Mathematics and Computation, Vol. II, Mexico City, May 2/4, 1967 pp. 1059-1085
- "The J_N method for neutron transport problems in a bare sphere", T. Asaoka, J. Nucl. Energy, 22, (1968) 99-121
- "Space-angle-energy-time-dependent neutron transport in a homogeneous slab by the J_N method", T. Asaoka, Nucl. Sci. & Engng. 34 (1968) 122-133
- "Wave properties of linear transport", K.-H. Müller, Atomkernenergie (1969) in press
- "Ein analytisches Verfahren zur Untersuchung der zeitlichen Zerfallskonstanten eines Neutronenpulses in Platten und Kugeln beliebiger Dicke", H. Hembd, Atomkernenergie 12 (1967) 334-336
- "Die Untersuchung von schnellen gepulsten Anordnungen mit der Monte Carlo Methode", H. Kschwendt, EUR-4087.d (1968)
- "Measurement of the Transfer-Function with Statistical Methods", W. Matthes, Nukleonik Vol. 8, Heft 1 (1966) 2
- "Theory of Fluctuations in Neutron Fields", W. Matthes, Nukleonik Vol. 8, Heft 2 (1966) 87
- "Usefulness of Noise Analysis in Reactor Physics", W. Matthes, NPY-Seminar on Noise Analysis in Kjeller (Norway) (1966), Invited Paper

Area of activity

Direct observation of imperfections in crystals by means of X-ray diffraction topography.
Measurements of X-ray diffracted intensities to detect phenomena of impurity clustering.

Competence acquired

Experimental and theoretical knowledge of X-ray dynamical diffraction phenomena. Experience in techniques: a) for X-ray diffraction topography, b) for quantitative measurements of X-ray diffracted intensities.

Experimental facilities

X-ray diffraction equipment (generator, tubes and geniometer).

Possible areas of application

Study of dislocations, segregation and precipitation in semiconductor crystals. Examination of diffusion induced dislocation patterns in semiconductor junctions.

References see next page

References

- "Borrmann topographic investigation on dislocation configuration in well-annealed and lightly deformed copper crystals", A. Merlini, F.W. Young, J. de Physique C-3, Suppl. au no. 7-8, tome 27, (1966) 219
- "A camera for Borrmann Stereo X-ray topographs", F.W. Young, T.O. Baldwin, A. Merlini, F.A. Sherrill, Advances in X-ray Analysis 9, (1966) 1.

Area of activity

Magnetic Resonance Spectroscopy.

Competence acquired

- High-resolution NMR spectroscopy
- Electron spin resonance
- Relaxation and double resonance spectroscopy.

Experimental facilities

- High-resolution NMR spectrometers at 60 and 100 MHz
- Electron spin resonance spectrometers
- r.f. pulse spectrometer at 4,6,15 and 48 MHz
- double resonance spectrometers
- liquid helium facilities

Possible areas of application

Structure of matter, molecular motions

Possible interested industries

Chemical industry

References see next page

References

- "Kernrelaxation und Spindiffusion in organischen Festkörpern mit paramagnetischen Radikalzentren", J. Haupt, W. Müller-Warmuth, Z. Naturforsch. 22a, (1967) 643
- "Zeeman and dipolar nuclear relaxation by paramagnetic impurities in CaF_2", R. Van Steenwinkel, P. Zegers, Z. Naturforsch. 23a, (1968) 818
- "Nuclear-Electron interactions and molecular motion in fluoro-organic solutions of free radicals", G.J. Krüger, W. Müller-Warmuth, R. Van Steenwinkel, Proceedings of the XIVth Colloque Ampère (1966), North-Holland Publishing Co. (1967), 60

(and 18 other papers).

III) Engineering

III/1 DESIGN
III/2 HEAT TRANSFER
III/3 ELECTRONICS
III/4 FABRICATION METHODS
III/5 COMPONENT TESTING

Area of activity

Mathematical and experimental models for Eng. Problems

- Strength of materials
- Heat transfer

Competence acquired

- Experience in the use of both analogous and digital computers for Engineering problems
- Photoelasticity - Stress loading - Moiré
- Straingage technique
- Electrical analogies

Experimental facilities

Computation facilities of the Ispra Center (CETIS)

- Photoelasticity bank
- Electrical analogy equipment

Possible areas of application

- Stress analysis in graphite and in prestressed concrete structures
- Heat transfer

Possible interested Industries

- Chemical, nuclear, aeronautical, naval, mechanical and automobil industry

References see next page

References

External reports

- "Etude des perturbations circonférentielles et axiales de température dans une gaine cylindrique d'élément combustible.. (Méthode mathématique et Rhéoanalogique)", J. Reynen, E. Labarre, E. Aranovitch, EUR 2480.f (1965)
- "Temperature and thermal stress distribution in smooth and finned cannings due to axial flux variations", J. Reynen, EUR 3557.e (1967)
- "Problèmes thermiques liés à un canal de Zircaloy à ailettes dans un réacteurs ORGEL", J. Fauré, J. Reynen, EUR 3886.f (1968)

Area of activity

Investigations needed for the design of prototype fuel elements and their final realisation

Competence acquired

Design study and realisation of fuel elements applied for physical measurements in ECO and ESSOR

Experimental facilities

- Design office
- Mechanical workship for the manufacture of structural elements
- Workship for the manufacture of fuel pins
- Fuel elements and models
- Other facilities: vacuum furnaces of big dimensions, hydraulical press

Possible areas of application

Design study and construction of fuel pins, fuel elements

Area of activity

Study and development of nuclear reactor components

- design of nuclear reactor channels, of thermal insulation for concrete pressure vessels and of fuel handling devices
- design of a space reactor

Competence acquired

- Design and fabrication of an organic loop for in pile experiments
- Design and fabrication of experimental channels for the ESSOR reactor
- Lay out studies of small thermionic reactors
- Development of integrated space power plant (100 kWe)
- Design and testing of remote handle tube closure
- Measurements of thermal characteristics of materials

Experimental facilities

- Experimental set-up for testing the behaviour of a remote handle tube closure
- Mock-up to test insulation and lining materials under temperature and pressure (300°C, 100 atm)
- High temperature, high vacuum equipment
- Laboratory of thermometry

Possible areas of application

- Nuclear vessels, core of piles
- Pressure tube reactors
- Concrete pressure vessels
- Thermal characteristics of refractory and of insulating materials.

Possible interested industries

Nuclear Industry.

References see next page

References

External reports

- "Determination de la diffusivité thermique des isolants par la méthode du signal très bref", J. Fauré, EUR 1822.f (1964)
- "ORGEL channel" J. Bernard, the paper is presented as: chapter 11.2.3.2 of the Euratom's scientific activities: Orgel program EUR 1830.e part III (1964)
- "Isolement thermique d'un canal Orgel par une lame de gaz stagnant", J. Fauré, E. Labarre, EUR 2175.f (1964)
- "A heat pipe thermionic reactor concept", P. Fiebelmann, H.Neu, C. Rinaldini, Paper presented at: "Second International Conf. on Thermionic Electrical Power Generation", Stresa, Italy, May 27-31, 1968, published by the Euratom Centre for information and documentation as EUR 4210.f.e (1968)

Patents

- "Nuclear reactor cooling duct or pressure tube with solid internal insulation",J. Dufresne, F. Farfaletti-Casali, G.Volta, Int.Clas. G 21 c 15/20, Patent Specification England 1, 119, 469
- "Isolement thermique pour tubes à combustible de réacteurs nucléaires", M. Montagnani, F. Farfaletti-Casali, Int. Clas. G 21 c 3/00, Brevet d'invention France P.V. n° 101.098, N° 1.527.025
- "Heterogeneous nuclear reactor liquid moderated and cooled", J. Bernard, J. Bunge, J. Dufresne, S. Finzi, G. Volta, Int. Clas. G 21 c
- "Isolement thermique", S. Finzi, J. Fauré, J. Lebrun,Dep. in France n° 65.819 - in U.S.A. n° 555.191
- "Heterogener Kernreaktor", P. Fiebelmann, Dep. Germany DT 1281594
- "Nuclear fuel arrangement", P. Fiebelmann, Dep. France 1.500.204
- "Tube calorifique ou de transmissionde chaleur", P. Fiebelmann, Dep. France 1.480.628

Area of activity

Calculation and design of structures subject to dynamic loads

Competence acquired

Calculation of strain and stress in complex structures which are subject to the following loads:

- pulsating forces and/or displacements
- shock

Experimental facilities

Vibration and acceleration measuring and analysing equipment

Possible areas of application

Calculation and design under the special view of dynamic loading of the following devices:

- foundations, lifting appliance, metallic framework in general, shells etc.
- foundations, framework, protection walls against fragments, shock absorbers as honey-comb structures, spring configurations, hydraulic and pneumatic devices etc.

References see next page

References

External reports:

- "Studio dinamico di una struttura a portale" by A. Benuzzi, M. Biggio (to be published)
- "Un metodo di calcolo dei sistemi reticolari di travi", M. Biggio, G. Di Cola (to be published)

Others reports

- "Oscillateur rectangulaire E.C.O. - IV partie: amortisseur - récupérateur" - Category 1,5 - Communication 1935 - Year 1968 by M. Biggio, M. Ceresoli
- Safety report (April 11, 1967) "Contenitore ESSOR", P. Rocco

Area of activity

Calculation and design of fast rotating equipment

Competence acquired

Calculation of flexional, torsional, and axial critical velocities of peculiar configurations, including special effects as gyroscopic, shear and processional effects. Stress analyses within the rotating bodies with special regard to stress concentrations. Application of high velocity bearings. Experimental verification of the systems.

Experimental facilities

Vibration measuring and analysing equipment
Testing pit for fast running machines (under project)

Possible areas of application

Mechanical design of any kind of fast running equipment with high circumferential velocities as p. ex.: Neutron-choppers, centrifuges, angular decoders etc.

See References next page

References

- "Calculating the critical velocities of a Chopper", EUR 3883.e 1968, by M. Biggio
- "The double Chopper neutron spectrometer at Ispra", (K. Krebs) Symposium on "Neutron inelastic scattering, Copenhagen, May 1968

Patents

- "Appareil de sélection de neutrons à l'aide d'un rotor sélecteur tournant", Will, Geist, Krebs. Brevet Français no. 1.476.064 - Patentanmeldung in Deutschland 12.4.1965 Nr. E 29.102

Other reports

- "The calculating of the critical torsional and flexional velocities of a Chopper-Shaft" - No. 556 (December 1963) M. Biggio
- "Calculating of Chopper rotor stresses" - No.623 (April 1964) M. Biggio, H. Geist
- "The calculating of the procession velocities of a Chopper Rotor" - No. 969 (May 1966), M. Biggio
- "Safety Report (July 1966) Double Chopper facility" - H. Geist K. Krebs

Area of activity

Fluid flow and heat transfer studies for thermal design of nuclear fuel elements (rod assemblies and other complex geometries), cooled by fluids in single phase flow.

Competence acquired

The competence acquired has its origin in thermal design studies for ORGEL and SORA fuel elements (bundles made up of finned or smooth rods) and in basic fluid flow and heat transfer studies in rod bundles. The following aspects were dealt with: development of calculation models, distribution of local coolant velocities and subchannel flow rates, coolant mixing, rod bundle temperature distributions, entrance effects.

Experimental facilities

Low pressure water circuit and laboratory facilities.

Possible areas of application

Thermal design of:

- fast-neutron reactor fuel rod assemblies
- compact rod-bundle fuel elements for space power systems
- compact rod-bundle fuel elements for water (heavy or light) cooled reactors.

References see next page

References

- "Heat transfer calculations of organic cooled seven-rod cluster fuel elements", R. Nijsing, W. Eifler, Nucl. Eng. & Design 4, (1966) 253
- "Description of IBM 360 Computer program for the calculation of liquid cooled 7-rod cluster fuel elements", W. Eifler, R. Nijsing, J. Airola, EUR 3733.e (1968)
- "Studies on fluid mixing between subchannels in a bundle of finned tubes", R. Nijsing, W. Eifler, B. Delfau, J. Camposilvan, Nucl. Eng. & Design 5, (1967) 229
- "Der örtliche Wärmeübergang in einem aus spiralförmig berippten und parallel angeströmten Stäben gebildeten Reaktorbrennelements", W. Eifler, R. Nijsing, Nucl. Eng. & Design (in press)
- "Temperature and heat flux distribution in nuclear fuel element rods", R. Nijsing, Nucl. Eng. & Design 4 (1966)
- "Fundamental studies of fluid flow and heat transfer in fuel element geometries", R. Nijsing, I. Gargantini, W. Eifler, EUR 2193.e, Part I, (1964)
- "Analysis of fluid flow and heat transfer in a triangular array of parallel heat generating rods", R. Nijsing, I. Gargantini, W. Eifler, Nucl. Eng. & Design 4 (1966) 375
- "Fundamental studies of fluid flow and heat transfer in fuel element geometries", W. Eifler, R. Nijsing, EUR 2193.e, Part II (1965)
- "Experimental investigation of velocity distribution and flow resistance in a triangular array of rods", W. Eifler, R. Nijsing, Nucl. Eng. & Design 5, (1967) 22
- "Über die turbulente Geschwindigkeitsverteilung und Wandreibung in Strömungskanälen verschiedener Querschnitte", W. Eifler, Dissertation T.H. Darmstadt, (1968)
- "Analysis of liquid metal heat transfer in assemblies of closely spaced rods", R. Nijsing, W. Eifler, submitted to Nucl. Eng. & Design
- "Predictions on liquid metal heat transfer in closely packed fuel rod bundles", R. Nijsing, W. Eifler, to be presented at "Reaktortagung des Deutschen Atomforums", April (1969).

Area of activity

Boiling water heat transfer in the pressure range up to 250 bar.

Competence acquired

Measurement and theoretical investigations of critical heat flux densities on various channel geometries in the indicated pressure range. Influence of turbulent promotors (twisted tapes and artificial roughnesses) on heat transfer and critical heat flux density. Heat investigations in the postcrisis region. Investigations on the heat transfer mechanism at supercritical pressures. Boiling instabilities. Steam-water separation. Visualisation of fundamental boiling phenomena.

Experimental facilities

High pressure water loop:	Pressure max	250 bar
	Power max	2,5 MW
	Mass flow max	100 m^3/h

Low pressure water loops and laboratory facilities.

Possible areas of application

Thermal design of BWR and PWR cores. Heat exchanger and high heat flux "once through" vapour generators development. Reactor safety.

References see next page

References

- "Die Bestimmung örtlicher und mittlerer Wärmeübergangszahlen in Rohren bei hohen Wärmestromdichten", W. Hufschmidt, E. Burck, W. Riebold, Int. J. of Heat & Mass Transfer 9 (1966), 539-565
- "Zur Bedeutung der von Dampfblasen erzeugten Mikrokonvektion auf die Wärmeubertragung beim Sieden", A. Bähr, Chemie-Ingenieur-Technik 38, (1966), No. 9, 922-925
- "Wärmeübergang an Wasser bei erzwungener Strömung im Gebiet des kritischen Druckes unter hohen Heizflächenbelastungen", P. Mörk-Mörkenstein, H. Herkenrath, Chemie-Ingenieur-Technik 39 (1967), No. 5/6, 250-253
- "Der Einfluss temperaturabhängiger Stoffwerte auf den Wärmeübergang bei turbulenter Strömung von Flüssigkeiten in Rohren bei hohen Wärmestromdichten und Prandtlzahlen", W. Hufschmidt, E. Burck, Int. J. of Heat & Mass Transfer 11 (1968), 1041-1048
- "Die Wärmeübergangskrise von Wasser bei erzwungener Strömung unter hohen Drücken, Teil I: Darstellung und Vorausbestimmung der kritischen Wärmestromdichte für Drücke von 170 bis 215 bar", H. Herkenrath, P. Mörk-Mörkenstein, Atomkernenergie 2 (1969)
- "Die Ausbildung der Wärmeübergangskrise in Rohren mit und ohne Wirbelerzeuger", A. Bähr, H. Herkenrath, P. Mörk-Mörkenstein, Nukleonik 11 (1968), No. 6, 261-264
- "Experimentelle Untersuchung des Einflusses der Prandtlzahl auf den Wärmeübergang und Druckverlust künstlich aufgerauhter Strömungskanäle", E. Burck, Diss. T.H. Aachen (Germany), 8.6.1968, to be published in: Wärme-Stoffübertr. (1969)

External Reports

- "Grundzuge der Probleme auf dem Gebiet der Blasen- und Filmverdampfung", H. Herkenrath, P. Mörk-Mörkenstein, EUR 2211.d
- "Messung der kritischen Wärmestromdichte an Wasser im unterkühlten Zustand in Rohren bei erzwungener Strömung", E. Burck, W. Hufschmidt, EUR 2433.d
- "2,4 MW Druck- und Siedewasserkreislauf zur Untersuchung des Wärmeübergangs", H. Herkenrath, P. Mörk-Mörkenstein, EUR 3605.d
- "Der Einfluss künstlicher Rauhigkeiten auf die Erhöhung der kritischen Wärmestromdichte von Wasser in Ringspalten bei erzwungener Konvektion Teil I: Unterkuhlter Zustand am Austritt der Messstrecke", E. Burck, W. Hufschmidt, E. De Clercq, EUR 4040.d
- "Wärmeübergang an Wasser bei erzwungener Strömung im Druckbereich von 140 bis 250 bar", H. Herkenrath, P. Mörk-Mörkenstein, U. Jung, F. Weckermann, EUR 3658.d

Area of activity

Instability and natural convection studies with water in the pressure range 1-250 bars.

Competence acquired

Measurements of local and mean heat transfer coefficients with liquids in different geometries especially at high heat-flux conditions. Indirect and direct heating techniques and dynamic temperature and pressure measurements.

Experimental facilities

High-pressure water loop:	Pressure	: 225 bars
	Power	: 700 KW (total)
	Length of test section (three parallel channels)	: 8 m (one to
	Mass flow	: 30 m^3/h

Possible areas of application

Hydro- and thermodynamic design for BWR and PWR primary circuits. Emergency cooling by natural convection and spray. Stability problems of steam-generators in parallel arranged tubes.

References see next page

References

- "Die Bestimmung örtlicher und mittlerer Wärmeübergangszahlen in Rohren bei hohen Wärmestromduchten", W. Hufschmidt, E. Burck, W. Riebold, Int. J. Heat Mass Transfer 9 (1966) 539-565
- "Der Einfluss temperaturabhängiger Stoffwerte auf den Wärmeübergang bei turbulenter Strömung von Flüssigkeiten in Rohren bei hohen Wärmestromdichten", W. Hufschmidt, E. Burck, Int. J. Heat Mass Transfer 11 (1968), 1041-1048
- "Der Einfluss künstlicher Rauhigkeiten auf die Erhöhung der kritischen Warmestromdichte von Wasser in Ringspalten bei erzwungener Konvektion", E. Burck, W. Hufschmidt, E. De Clercq, EUR-4040.d (1968)

Area of activity

Coolant ejection and unsteady-state water-vapour two-phase flow studies in the pressure range up to 60 bar.

Competence acquired

Studies of coolant ejection phenomena starting from:
- stagnant conditions and without heat addition,
- forced convection conditions and with heat addition

for determining coolant voiding time and mean coolant density variation with respect to time.
Pressure loss, instabilities, sonic velocity of two-phase flow. Expanding behaviour, supersonic phenomena and momentum of two-phase free jets. Vapour suppression phenomena and systems.

Experimental facilities

Large scale "forced convection ejection" installation FORCE with:
- vessel pressure p_K 60 bar
- vessel temperature T_K 270°C
- electrical power supply to test section: Q_h 96 KW (actually)

and special instrumentation for measuring steady-state and rapidly varying pressure, momentum, temperature and velocity.

Possible areas of application

Design information for reactor dynamic behaviour and reactor safety problems for BWR and PWR cores. Flash boiling studies for desalination problems. Fundamental studies on two-phase flow phenomena.

References see next page

References

- "Ausbildung von überhitztem Kühlmittel einem Reaktorkühlkanal", G. Friz, B. Milliot, Ausschuss für Hochtemperaturtechnik (VDI), Düsseldorf (Germany), 11.3.1965
- "Coolant ejection studies with analogy experiments", G. Friz, ANL-7120, Argonne National Laboratory (1965)
- "Coolant ejection experiments with heat excursions for exploding wires", G. Grass, G. Friz, Meeting on Reactor Safety Technology "Rapid Transients", Cadarache (France) April (1966)
- "Ejection experiments by heat excursion from exploding wires", G. Friz, European Two-Phase Flow Group (EURATOM) Ispra (Italy), 14/17.6.1966

Area of activity

Liquid metal heat transfer and pressure loss in various channel geometries (single phase)

Competence acquired

Measurement of temperature distribution in channels of different geometries. Measurement of local and average heat transfer coefficient. Pressure loss in single and multiparallel channel system. Investigation of hydrodynamic stability of parallel channel system.

Experimental facilities

NaK loop:	Liquid temperature (max)	: 600°C
	Power	: 150 KW
	System pressure	: 2 atü
	Pressure head of the pump	: 1,5 at
	Mass flow	: 9 m^3/h
Na loop :	Liquid temperature (max)	: 1000°C
	Power	: 500 KW
	System pressure	: 5 atü
	Pressure head of the pump	: 5 at
	Mass flow	: 6 m^3/h

Possible areas of application

Design of fast breeder core and heat exchanger for liquid metal as coolant.

References see activities III/2/f-h

Area of activity

Liquid metal boiling under forced convection with regard to safety aspects in a fast breader reactor.

Competence acquired

Measurement of superheat during incipient boiling and after incipient boiling. Investigation of flow pattern of boiling liquid metals under forced convection. Investigation of constructial and physical or chemical measures to avoid superheating. Critical heat flux of incipient boiling. Boiling tests in rod bundles.

Experimental facilities

Na-loop :	Liquid temp. (max)	:	1000°C
	Power	:	500 KW
	System pressure	:	5 atü
	Pressure head of the pump	:	6 at
	Mass flow	:	6 m^3/h

Instrumentation to measure transient phenomena at high temperature.

Possible areas of application

Fast breader safety problems with regard to the nuclear feed-back of the void effect in case of an accident which leads to evaporation of coolant.

References see next page

References

- "Beitrag zur Untersuchung der Dampfblase in siedenden Flüssigmetallen", B. Scheiten Peterssen, W. Schulze, G. Grass, AKTE 12 (1967), No. 1/2, 15-19
- "Das Sieden von Alkalimentallen", G. Grass, H. Kottowski, R. Warnsing, AKTE 12 (1967), No. 3/4, 101-110
- "Mesures de la surchauffe et étude de l'ébullition des métaux liquides", G. Grass, H. Kottowski, K.H. Spiller, Bulletin d'Information Scientifiques et Techniques du Commissariat à l'Energie Atomique, no. 12 (1968)
- "Mesures de la fraction de vide dans un écoulement double phase NaK-Argon", B. Milliot, J. Lazarus, J. Ph. Navarre, Proceedings of the "Conference International sur la sureté des reacteurs à neutrons rapides"at Aix-en-Provence 19/22.9.1967
- "Über die Verdampfung und Ausbildung einer Restschicht beim Sieden von Alkalimentallen in Kanälen", H. Kottowski, Diss. T.H. Aachen, Juni (1968)
- "Mesure de la fraction de vide dans un écoulement double phase NaK-Argon par attenuation d'un rayonnement", B. Milliot, J. Lazarus, J. Ph. Navarre, EUR 3935.f

Area of activity

Liquid Metal Boiling Instabilities, formation of Aerosols and condensation.

Competence acquired

Studies of hydrodynamic instabilities in boiling liquid metals systems. Influence of periodical and aperiodical disturbances on the hydrodynamic stability. Propagation of disturbances in a single and two phase systems. Evaporation of Na-aerosols. Condensation on solid and liquid surfaces. Measurement of size and density of droplets in an aerosol.

Experimental facilities

a) Na loops :

Liquid temperature (max)	:	1000°C
Power	:	500 KW
System pressure	:	5 atü
Pressure head of the pump	:	5 at
Mass flow	:	6 m^3/h

b) Na loops :

Liquid temperature (max)	:	1000÷1200°C
Power	:	500 KW
System pressure	:	2 atü
Pressure head of the pump	:	4-6 at
Mass flow (max)	:	9 m^3/h

c) Apparatus for studies of formation of Hg-aerosols. High speed camera.

Possible areas of application

Design of MHD-converter, fast breeder safety.

References see next page

References

- "Beitrag zur Untersuchung der Dampfblase in siedenden Flüssigmetallen", B. Schulten Peterssen, W. Schulze, G. Grass, AKTE 12 (1967) No. 1/2, 15-19
- "Das Sieden von Alkalimetallen" , G. Grass, H. Kottowski, R. Warnsing AKTE 12 (1967) No. 3/4, 101-110
- "Mesures de la surchauffe et étude de l'ébullition des métaux liquides", G. Grass, H. Kottowski, K.H. Spiller, Bulletin d'Information Scientifiques et Techniques du Commissariat à l'Energie Atomique, No. 12 (1968)
- "Mesures de la fraction de vide dans un écoulement double phase NaK-Argon", B. Milliot, J. Lazarus, J. Ph. Navarre, Proceedings of the "Conference International sur la sureté des reacteurs à neutronsrapides" at Aix-en Provence 19/22/9/1967
- "Über die Verdampfung und Ausbildung einer Restschicht beim Sieden von Alkalimetallen in Kanälen", H. Kottowski, Diss. T.H. Aschen, Juni (1968)
- "Mesure de la fraction de vide dans un écoulement double phase NaK-Argon par attenuation d'un rayonnement", B. Milliot, J. Lazarus, J. Ph. Navarre, EUR 3935.f

Area of activity

Liquid metal small scale experiments (specially Na, K, NaK).

Competence acquired

Measurement of physical properties, wetting and void fraction. Studies of boiling, superheat and ejection. Visualisation of liquid metal boiling.

Experimental facilities for pool boiling experiments. Set up for purification and distillation of liquid metals, for boiling, superheat and ejection studies. High frequency generator (MHz, 15 KW_{HF}). Film camera with accessories included densitometer for temperature determination out of black and white or colour films. Electrical recording vacuum balance. Apparatus for the measurements of surface tension of liquid metals. Differ-Thermo-Analyses Apparatus. Equipment for swift or slow recording of mechanical and electrical data.

Possible areas of application

Experiments in the frame work of liquid metal cooled reactor safety (fast breeders). Studies for heat exchanger design for liquid metals. Physical properties measurements. Direct energy conversion heat pipes.

References see next page

References

- "Messungen zur Füllstandanzeige, zur Benetzung und zum Blasennachweis bei flüssigem Na in einem Behalter aus nichtrostendem Stahl", K.H. Spiller, D. Perschke, EUR 1823.d
- "Elektrische Schaltung zur Füllstandsüberwachung, zur Feststellung des Siedens und zur Verwendung bei Benetzungsuntersuchungen in Metallbehältern mit Flüssigmetall", D. Perschke, K.H. Spiller, Deutsche Patenschrift Nr. 1232762 (Kl. 42e - 34)
- "Zur Kenntnis der physikalische Stoffeigenschaften von Flüssigmetallen Teil I: Temp. Bereich zwischen Schmelz- und Siedepunkt", K.H. Spiller, Atomkernenergie 10 (1965) H. 3/4, 127-138
- "Zur Kenntnis der physikalischen Stoffeigenschaften von Flüssigmetallen, Teil II: Temp.-Bereich zwischen Siedepunkt und etwa 1300°C, K.H. Spiller, Atomkernenergie 10 (1965) H. 5/6, 215/227
- "Beitrag zur Untersuchung von Benetzung, Blasenbildung und void fraction in Flüssigmetallen", K.H. Spiller, D. Perschke, G. Grass, Atomkernenergie 11 (1966) H. 11/12, 447-456
- "Besondere Aspekte des Siedens in Flüssigmetallen", G. Grass, H. Kottowski, K.H. Spiller, Thermodynamik Kolloquium (1966), Bad Margentheim
- "Überhitzung und Einzelblasenejektion bei der Verdampfung von stagnierenden Flüssigmetallen", K.H. Spiller, G. Grass, D. Perschke, Atomkernenergie 12 (1967) H. 3/4,111-114
- "Mesure de la surchauffe et étude de l'ébullition des métaux liquides", G. Grass, H. Kottowski, K.H. Spiller, International Conference on the Safety of Fast Reactors 19/22.9.1967, Aix-en-Provence, Proceedings II b-4
- "Uberhitzung und Einzelblasenèjektion von stagnierendem Natrium", K.H. Spiller, D. Perschke, G. Grass, Atomkernenergie 13 (1968) H.4, 245-251
- "Messungen der Restfilmdicke bei der Einzelblasenejektion von flüssigem Na in einem Rohr", K.H. Spiller, D. Perschke, G. Grass, Atomkernenergie 14 (1969) H. 2, (im Druck)
- "Sichtbarmachen von Natriumsieden im Modell eines Reaktorkühlkanales", K.H. Spiller, D. Perschke, G. Grass, Chemie-Engenieur-Technik (angeboten)

Area of activity

Experimental and theoretical determination of thermodynamic and transport properties.

Competence acquired

Measurements of the:

thermal conductivity of gases, vapors and liquids,
viscosity of liquids,
density of vapors and liquids,
molar heat of vapors and liquids,
latent heat of vaporization,
latent heat of fission,
surface tension,
critical data,
vapor pressure,
flash-,fire-and auto-ignition-temperature,

calculations of transport properties (thermal conductivity, viscosity, diffusion) using the theory of intermolecular forces and different potential models.

Experimental facilities

Apparatus for the measurements of the a.m. properties.

Possible areas of application

Heat transfer calculations of non-boiling and boiling liquids and of gases, safety problems, combustion and explosion calculations, intermolecular forces.

Possible interested industries

Chemical and Nuclear Industries.

References see next page

References

- "Bestimmung des absoluten Wärmeleitvermogens von Gasen bis 1100°C", K. Schäfer, F.W. Reiter, Naturwissenschaften 43, (1956) 286
- "Eine Messmethode für die Ermittlung des Wärmeleitvermögens bis 1100°C", K. Schäfer, F.W. Reiter, Ber.d. Bunsen - Ges. f. Phys. Chemie 61 (1957) 1230
- "Über das Wärmeleitvermögen von organischen Reaktorkühlmitteln im flüssigen und dampfförmigen Zustand", F.W. Reiter, Ber. d. Bunsen - Ges. f. Phys. Chemie 70 (1966) 686
- "Bestimmung der Zähigkeit von Polyphenylen mit Hilfe einer Methode für kleine Substanzmengen", G. Fritz, EUR 594.d (1964)
- "Density and surface-tension measurements of pure Polyphenyls and Polyphenyl mixtures", G. Fritz, H. Vossen, EUR 165.e (1963)
- "Vergleich dreier Methoden zur Messung der Oberflächenspannung von Polyphenylen", G. Fritz, R. Nehren, EUR 209.d (1963)
- "Über die Molwärme von dampfförmigen Benzol, Diphenyl, c- und m-Terphenyl", F.W. Reiter, Ber. d. Bunsen - Ges. f. Phys. Chemie 71 (1967) 629
- "Verdampfungswärme von Diphenyl, Naphthalin, o-, m- und p-Terphenyl", F.W. Reiter, EUR 301.d (1963)
- "Bestimmung der Schmelzwärme von o- und m- Terphenyl", G. Friz, E. Krayer-Boullet, R. Nehren, EUR 2223.d (1965)
- "Kritische Daten von Diphenyl und den Terphenylisomeren", F.W. Reiter, EUR 302.d (1963)
- "Transportphänomene und zwischenmolekulare Kräfte in dampfförmigen Benzol, Diphenyl, o-, m- und p- Terphenyl", F.W. Reiter, Forschung im Ingenieurwesen, (in press).

Area of activity

Determination of accomodation coefficients by thermal conductivity measurements at very low pressures.

Competence acquired

Thermal conductivity measurements in dilute gases up to 1100°C. Experience in UHV-technique. Exact studies of radiation and thermal conductivity losses of a hot thin wire in a ultrahigh vacuum. Determination of radiation properties of solid surfaces.

Experimental facilities

Apparatus, instruments and regulating circuits for accomodation coefficient measurements.

Possible areas of application

Heat transfer between solid surfaces and gases, temperature distribution in a fuel element and heat transfer from the fuel to the cladding. Catalysis of gas reactions.

Possible interested industries

Nuclear Industry, Chemical Industry.

References see next page

References

- "Bestimmung des absoluten Wärmeleitvermogens von Gasen bis 1100°C", K. Schäfer, F.W. Reiter, Naturwissenschaften 43 (1956) 286
- "Ein Messmethode für die Ermittlung des Warmeleitvermögens bis 1100°C", K. Schäfer, F.W. Reiter, Ber. d. Bunsen - Ges. f. Phys. Chem. 61 (1957), 1230
- "Bestimmung der Wärmeleitfähigkeit der gesattigten Dämpfe von Benzol, Diphenyl, o-, m- und p- Terphenyl", F.W. Reiter, W. Link, EUR 2282.d (1965)

Area of activity

Heat-Transfer studies with gases.

Competence acquired

Measurements of heat-transfer coefficient and pressure-drop in gas heat-exchangers. Techniques for stationary and transient measurements at high temperatures, and heat-fluxes. Knowledge in the design of leak-tight gas loops. Cooling problems with water under high pressures (up to critical point).

Experimental facilities

Blower for 20 bars, 450°C for air, CO_2, N_2 (he) with variable flow-rate (2400-18000m^3/h) with frequency transformer (990-3000 routes /min), power 240 KW. Different tubes, valves, venturi-tubes with ring-joint flanges (NW 500) for 20 bars, 450°C. Different blowers for atmospheric pressure (air).

Possible areas of application

Heat-Transfer in fuel-elements for gascooled reactors. Inlet effects. Spacer influence on heat transfer. Hot channel factors. Influence of geometrie on heat transfer.

References see next page

References

- "Wärmeübergang an turbulent stromende Gase im Rohreinlauf", G. Grass, Allg. Wärmet. H. 3 (1956), 58-64
- "Wärmeübergang von Querrillenrohren", G. Grass, Allg. Wärmet., H. 5/6 (1956), 104-108
- "Die Eigenschaften von Rippenrohrluftkühlern im Arbeitsbereich der Klimaanlagen", W. Hufschmidt, Forsch. Ber. des Landes Nordrhein-Westfalen, Nr. 889 (1960)
- "beitrag zur Untersuchung über wertschaftliche Abmessungen von Kreisrippen bei der Konstruktion luftgekühlter Wärmeaustauscher", E. Burck, Chemiker-Zeitung Chem. Apparatur 85 (1961), 512-514
- "Die Bestimmung ortlicher und mittlerer Wärmeübergangszahlen in Rohren bei hohen Wärmestromdichten", W. Hufschmidt, E. Burck, W. Riebold, Int. J. Heat Mass Transfer 9 (1966), 539-565
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- "Messung der kritischen Wärmestromdichte von Wasser im unterkühlten Zustand in Rohren bei erzwungener Strömung", E. Burck, W. Hufschmidt, EUR 2432.d (1965)
- "Der Einfluss künstlicher Rauhigkeiten auf die Erhöhung der kritischen Wärmestromdichte von Wasser in Ringspalten bei erzwungener Konvektion", E. Burck, E. Hufschmidt, E. De Clercq, EUR 4040.d (1968)

Area of activity

Electronical measurements and analysis of physical phenomena related to stationary and transient heat transfer. Studies, construction and adaption of apparatus for these measurements. Visualisation of rapid phenomena.

Competence acquired

Different methods controlling temperature and pressure in the dynamic region. Construction of pressure pick-up. Visualisation of boiling and condensation simultaneous with the physical measurements. Boiling detection by means of spectral analysis using the frequency caused by the pressure pulses during condensation. Detection and localisation of burn-out phenomena in channels of different geometries. Electronical equipment for measurement of the viscosity of liquids under high pressure and high temperature. Static and dynamic measurements of two phase flow phenomena in liquid metals with high time resolution using carrier frequencies. Development of electronical apparatus for measurement and regulation. Realisation and studies for statical and dynamical measurements of local temperature.

Experimental facilities

Electronical, thermical, and optical laboratories for studies and realisationof prototypes of special instruments for the above mentioned investigation.

Possible areas of application

Reactor industries and other special measurements. Studies and realisation of test sections.

Possible interested industries

Nuclear and research industries.

References see next page

References

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- "Visualisation "direct condensation", M. Hardy, L. Rigolini, Film presenté à la Conference de Grenoble (1969)
- "Beitrag zum Problem der Burn-out Detektion", P. Herzberger, R. Morin, Zeitschrift ATM, April (1966) N. 363
- "Elektronische Messanordnung zur Bestimmung der Fallzeiten in einem Fallkörperviskosimeter für hohe Temperaturen und Überdruck", P. Herzberger, H. Kuhlbörsch, Zeitschrift ATM (1969)
- "Gerät zur Burn-out-Detektion mit Ortungsmöglichkeit für gleichstrombeheizte Einzelrohre und Rohrbündel", P. Herzberger, Externer Bericht
- "Trägerfrequenz-Absorptionsmessgerät zur Blasenbestimmung in Flüssigmetallen", P. Herzberger, B. Milliot (in Erscheinung)
- "Visualisation de l'ébullition nuclée de l'eau à pression atmosphérique et mesure simultanée des variations de température de surface", G. Bonnet, E. Macke, R. Morin, EUR 1622.f et EUR 1622.e
- "Fluctuations de température dans la paroi chauffante et dans le liquide au cours de l'ébullition nuclée", G. Bonnet, E. Macke, R. Morin, EUR 3162.f

Patents

- "Detecteur de Burn-out", P. Herzberger
- "Transducteur rhéoélectrique à liquide", P. Herzberger, (läuft noch)
- "Trägerfrequenz-Absorptionsmessgerät zur Blasenbestimmung in Flüssigmetallen", P. Herzberger, (läuft noch).

Area of activity

Applications of Radiotracers in fluid flow measurements.

Competence acquired

- Fluid flow measurements and time of residence in different fluids (water, terphenyl, gasoil) with different radio-tracers.
- Leak-detection.

Experimental facilities

- Electronic apparatus to measure and to count the radiation with scintillation counters.
- Preparation of radiotracers.
- Water loop.

Possible areas of application

- Study of fluid flow, flow distribution, time of resistance of a liquid or gas in a mock-up or in industrial plants.
- Leak detection and measurement in industrial plants.

Possible interested industries

Nuclear, chemical, petrochemical industries.

References see next page

References

- "Messung der Verweildauer von Flüssigkeitspartikeln in einem durchströmten Ringspalt,- Untersuchungen mit einer radiomarkierten Wasserstömung", E. Ohlmer, Atomkernenergie 13-65 (1968) 387-393
- "Rivelazione di fughe nell'impianto "Hydrotreater" della Raffineria SHELL di RHO mediante traccianti radioattivi", F. Girardi, R. Lopes Cardozo, E. Ohlmer, IL CALORE No. 10 (1968) 3-8.

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Contributions to scientific and technical journals:

- "Some particular solutions for a nuclear counting chain", G. Colombo, L. Stanchi - Nucl. Instr. and Meth. 42(1966) pag. 104
- "A new method of ADC for improving resolution", G. Colombo, L. Stanchi - IEEE Trans. on Nuclear Science 15, 291 (feb. 1968)

External report:

"Sistema modulare di conteggio della sezione elettronica" - report EUR 2444 i. (may 1965)

Patents:

"Metodo per digitalizzare una grandezza analogica di breve durata", G. Colombo

"Noise reduction in AD-Converters", L. Stanchi

Other reports:

"Quantizzazione dei segnali casuali nelle misure di fisica nucleare", A.G. Colombo - Thesis of Laurea - University of Rome - July 1968

Area of activity

Fast electronics techniques in the subnanosecond range

Competence acquired

- Development of advanced techniques employing fast components
- Use of these techniques in equipment design and construction for nuclear measurements (discriminators, time to height converters, single-channel analyzers, etc.) and for the detection and display of fast events (spatial sampling oscilloscope)

Experimental facilities

Laboratory equipment including fast phototube assembly

Possible areas of application

- Conventional nuclear electronicsequipment transported into the subnanosecond range
- Components layout and assembling techniques for high speed networks, presently very interesting for fast computers
- Radar equipment with very high time (space) resolution, applied to traffic security problems

References see next page

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- "Tunnel diode as tristable element of circuit", L. Stanchi - Proc. IEEE Vol. 54 No. 1 Jan. 1966 pag 68-69
- "A very fast discriminator using the tristable characteristic of tunnel diodes", A. Pedrini, L. Stanchi - Alta Frequenza N.2, vol. XXXV-1966, pag. 138-43
- "Apparent changes of the static characteristic of a tunnel diode when oscillating and their utilization", I. De Lotto, E. Gatti, L. Stanchi - Alta Frequenza N.5 Vol. XXXV-1966 pag. 103-110
- "Time to pulse-height converter using bitripoles", L. Stanchi - IEEE Trans. on Nuclear Science 15, 315 (feb. 1968)
- "Spatial sampling for fast single events", L. Stanchi - will be published on IEEE Trans. on Nucl. Sc. Feb. 1969

External reports

"Preliminary results on timing with photomultipliers and solid state detectors", G. Bertolini, V. Mandl, A. Pedrini, L. Stanchi - report EUR 2274.e (1965)

Patents

"Electrical discriminator unit", L. Stanchi

Area of activity

Automatic design of printed circuits and masks for integrated circuits

Competence acquired

- On-line connections with small computers (PDP-8)
- Digital control by punched tape
- Automatic nuclear experiments
- Equipment design for photo-engraving processes

Experimental facilities

- Possibility of access to CETIS computers for off-line processing with punched cards and magnetic tape equipment
- Facilities for the production of printed circuits by photo-engraving

Possible areas of application

- Printed boards for digital integrated circuits, the operation of which is identified with a synthesis of simple arithmetical and geometrical rules
- Design of masks for semiconductor devices made by ion implantation

References see next page

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- "A twelve inputs time-of-flight converter for use with a PDP-8 computer", G. Colombo, N. Coppo, L. Stanchi - Nucl. Instr. and Method - Vol. 56, 86 (feb. 1968)
- "Software controlled multiple scanner for nuclear experiment", G. Colombo, N. Coppo, L. Stanchi - To be published on Nucl. Instr. and Method

Area of activity

Numerical position control, special purposes computers and recorders for acquisted data

Competence acquired

Design and realisation of the following digital electronic systems:

- position control (stepping motor, shaft encorders)
- computing systems (reactor periodmeter, linearizer, digital mode control for analog computers (SIOUX)
- control units for measurements equipment (timing-generator, read-out of "Instron" tensil test machine)
- control units for recorders (printers, card and tape perforators, tape readers)

Experimental facilities

- Data acquisition and processing equipment available in the center
- Electronic laboratories for research, design and maintenance; production facilities for designed equipments

Possible areas of application

Systems requiring high precision mechanical positioning, computation, automatization of measurements, input and output of data acquisition systems

References see next page

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Contributions to scientific and technical journals

- "Computation of the base two logarithm of binary numbers" IEEE Transactions on electronic computers, Dec. 1965
- "Périodimètre numérique" - Onde Electrique, Nov. 1966
- "The SIOUX-system and hybrid block diagrams" - Simulation, Vol.5, No.1, July 1965

External report

"The SIOUX-system" - EUR 1917

Other reports

"Period Meter for adjacent time intervals" - Internal report EURATOM Ispra 910

Area of activity

Levelmeters of high precision for liquids (radioactive, corrosive a.s.o.)

Competence acquired

Studies and design of two different measuring systems of the D_2O - level in the reactor tank. The first is based on a servo-mechanism which commands a positioning head including a pressure detector. When the moving head in the reactor tank is reaching the liquid level, the pressure detector gives a signal and the head position corresponding to the level is visualized (precision 0,1 mm, indication on request).

The second system consists of a differential pressure gage measuring by means of two tubes in the reactor tank the liquid column pression and an electronic equipment converting the pressing indication in the numerical level display (precision 1 mm, permanent indication).

Experimental facilities

D_2O reactor tanks ECO and ESSOR

height : 2.500 mm
temperature : 20-80 °C
liquid flow : 3-400 m^3/h

Electronic laboratories for research, design and maintenance; production facilities for design equipments.

Possible areas of application

Measurements and visualisation of level for all liquids, e.g. radio-active, corrosive, high viscosity.

References see next page

References

External report

"Les erreurs dans la détermination du niveau d'un liquide par différence de pression" - EUR 2958 f.d.

Area of activity

- Analog techniques - digital techniques - power electronics
- Detector systems

Competence acquired

- Design of an analog computing direct reading reactivity meter with associated peripheral equipment. Reactivity measurements of the control rods of Ispra-1 and ECO
- Development of a standard thyristor power for electrical drives with control circuits to achieve the characteristics of DC, AC and synchronous motors. Realisation of double chopper drive - crystal spectrometer drive - slow neutron chopper drive
- Non nuclear detectors: multiple D_2O detector systems (50 positions) - smoke detectors for organic loops - liquid detectors for organics

Experimental facilities

Laboratory equipment for design and production of electronic instruments for a staff of about 10 technicians

Possible areas of application

- Control and safetyrod adjustment, measurement of small reactivity variations during flux kinetics experiments, reactor instrumentation
- Electrical drives with high frequency stability requirements and/or phase lock properties. Industrial applications in the paper or textile industries
- General application of smoke detectors for plants where the output of vapours and smoke must be detected

Area of activity

Magnetic forming shaping

Competence acquired

More years of experience in this field

Experimental facilities

1 apparatus "Magneform" of 6 KJ
1 apparatus "Magneform" of 12 KJ

Possible areas of application

Direct shaping of construction elements consisting of good conductive materials (aluminium, copper and their alloys)
In the case of bad conductive materials, the same technique may be applied using and intermediate of aluminium or copper.

References see next page

References

Patents

- M. VEAUX - F. MARCHAL

Procédé pour le formage de gorges profondes sur des pièces en matériaux conducteurs, particulièrement tubes métalliques ou en matériaux céramique-métal, à l'aide d'un appareil de formage magnétique et dispositif pour la mise en oeuvre de ce procédé.
Brevet belge No. 518.374 (1964)

- F. MARCHAL

Dichtung für die Befestigung einer Brennstoff-Elementhülle für Kernreaktoren aus einem Verschlusstopfen
Brevet allemand 1.937.790 (1966)

Area of activity

Working by electroerosion of all conducting materials and alloys, allowing the realisation of very complicated forms or the machining in inaccessible places, by conventional methods

Competence acquired

Machining of very hard, refractory or sintered metals (hardened steel, stainless steel, carbide, tungsten, molybdenum)
Complex machining of conductor materials
Grate construction, microholes, dies ...
Particular experience in deep boring and long holes of very small diameters.

Available equipments

1 machine 6 kw material removed : 150 mm^3/mm
1 machine 18 kw mateiral removed : 1200 mm^3/mm
1 worktable for every long holes (with dimensions ranging from Ø 4 mm to greater than 2 m)

A technique, which to our knowledge did not exist , has been put into practice after fruitless research under the European Market

Possible area of application

- on machine : all complex forms of machining; all conducting materials
- on work-table : obtainment of high precision tubes with large wall thickness and of extreme lengths (application to test section)

Possible interested industries

High precision mechanique
All the latest technological development

Area of activity

Welding

Competence acquired

- Welding of sintered aluminium SAP
- Welding of light alloys
- Welding of refractory materials
- Welding of Zirconium alloys

Experimental facilities

- 3 welding sets applying electronic bombardment (1 gun of 1,5 Kw, 1 gun of 3 Kw and 1 gun of 10 Kw)
- 1 apparatus for flash welding
- 2 sets of argon arc welding
- 2 apparatus "magneform" allowing to perform welds by magnetical impulses (of the same type but more flexible than with welding by explosion)
- different welding sets for welding by diffusion
- brasing furnace under vacuum conditions of high capacity
- metallographic laboratory
- helium leak tightness control at room temperature and at high temperature
- 1 horizontal press of 150 tons (welding by coextrusion)
- 1 high frequency heater

Possible areas of application

All types of welding, especially welding of fuel elements and of non conventional material.

Remark:

This activity is strength related to the laboratories of classical metallurgy (studies of diffusion, mechanical tests, delatation research, determination of the points of transformation, non-destructive testing) and in thus well adapted to the study of weldability.

References see next page

References

Contributions to scientific and technical journals

- "Das Schweissen von SAP"-"Kerntechnik, Isotopen und Chemie", R. Klersy, G. Musso 9 67 p.152-157
- "The welding of SAP - Canning Tubes by Magnetic Pulse" M. Grin, D. Prüss, F. Marchal - To be published in the Welding Journal
- "Contribution à l'étude du soudage du SAP dans le cas des éléments nucléaires", C. Dumont, Julien, Moneyron, Savornin En cours de publication dans "Mémoires de la révue de Métallurgie"

External reports

- "Das Verschweissen von Brennelementen aus SAP durch Diffusion" W. Worner, Communication 13 1520 - 1967
- "Réalisation de crayons combustibles en carbure d'uranium gainé pour irradiation dans le réacteur NRX (Expérience NRX 716)" R. Klersy, C. Musso, G. Detiffe, J.P. Lecoq Bericht EUR 2158 f (1964)

Patents

- R. Klersy, G. Musso - Procédé pour la soudure de tubes en matériaux composites métal-oxyde, particulièrement destiné à la fermeture de gaines d'éléments combustibles pour réacteurs nucléaires Brevet belge 509.480
- M. Grin, D. Prüss - Procédé de magnésoudage sous atmosphère spéciale Brevet belge - Dec. 1968
- R. Klersy, G. Musso - Procédé pour la soudure de tubes en matériaux composites métal-oxydes particulièrement pour la fermeture de gaines d'élements combustibles pour réacteurs nucléaires Brevet belge N. 29513
- G. Musso, M. Portal - Procédé pour le soudage de matériaux frittés Brevet belge N. 32844

Area of activity

Welding and joints

- study of special welding problems
- explosive weldings
- heterogeneous tube to tube rolled joints

Competence acquired

- Refining of the crystal grain
- Measurements to study the welding performance (fracture toughness, measure of thermal electromotive force)
- Evaluation of the welding goodness as a function of the thermal compatibility of the materials
- Adjustment of explosive welding techniques
- Development of heterogeneous rolled joints

Experimental facilities

- Semi-automatic facility for fabrication of rolled joints
- Laboratory equipment for rolled joints control (leak-tightness, strain measurements, thermal shocks, pull-out tests)
- Set-up for explosive welding
- Facility for remote welding of pressure tubes in nuclear reactors

Possible areas of application

- Control of weldings in place
- Pressure tubesand calandria tubes joints (nuclear reactors)
- Plating of different metals
- Weldings of tubes in heat exchangers
- Welding of plugs on fuel elements cannings
- Cryogeny

Possible interested Industries

- Large vessel constructors
- Vacuum industry
- Nuclear and mechanical industry

References see next page

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Contributions to scientific and technical Journals

- "Das Schweissen von S.A.P." R.Klersy, G.Musso
  Kerntechnik, Isotopentechnik und Chemie,9,Jg.1967,Heft 3/4
  S. 152-157
- "Proprietà meccaniche e controllo non distruttivo mediante misure di potenziale termoelettrico di saldature su tubi di forza in Zr-Nb 2,5 %" G.Musso, G.Volta.
  Ingegneria Nucleare n. 4,1968

Reports and Meetings

- "SAP-Steel channel connections" by J.Bernard
  Paper presented as chapter 6.6 of the "Euratom's Scientific Activities Orgel Program" EUR 1830 e, part II (1964)
- "Explosive welding of nuclear materials" by G.Verzeletti, M.Montagnani, P.Golinelli, G.Beghi.
  Paper presented at "Conference on explosive welding" Hove 18-19 September 1968
- "Applicazione della saldatura per esplosione nel campo delle leghe di Alluminio" G.Verzeletti, M.Montagnani, P.Golinelli, G.Beghi
  Paper presented at "Giornate sulla tecnologia delle leghe di Alluminio" Milano, 14-15 novembre 1968
- Metodi per ridurre l'ingrossamento del grano nelle saldature di leghe di Zirconio. F.Brossa,G.Musso.
  Paper presented at "XIII Congresso dell'Associazione Italiana Metallurgia" Milano, 17-20 Giugno 1968.
- "Valutazione dell'affidamento di materiali fragili ed in particolare di strutture saldate" D.Basile,G.Musso,G.Volta.
  Paper presented at: "XIII Congresso dell'Associazione Italiana Metallurgia" Milano, 17-20 Giugno 1968

Patents

- "Procedimento di saldatura di Zirconio e sue leghe"
  F.Brossa, G.Ferrari, G.Musso
  Dep. in Italia 35941 A/68
- "Ramatura dello Zirconio e sue leghe per spostamento chimico"
  F.Brossa, G.Ferrari, G.Musso. Dep. in Italia 35942 A/68
- "Procédé de réalisation d'un raccord étanche entre deux tubes hétérogènes et joint en faisant application"
  J.Bernard, A.Faraoni - Dep. Germany P 1675207.9
- "Sistema e dispositivo di saldature per esplosione tra un tubo ed un tappo e tra due tubi"
  G.Verzeletti.
  Dep. Germany n. 35 301 1b/49 h

Area of activity

Welding by electron beam of metals and alloys realizing a high quality quite impossible to obtain by other fusion welding systems

Competence acquired

Welding of linear and circular shapes of refractory materials, zirconium alloys, stainless steel, for very thin thicknesses ranging from some tenths up to several millimeters.
Welding with or without supports on machined pieces

Available equipment

- Generator of 10 kw - 60 kv (electron beam)
- Penetration power of greater than 20 mm into stainless steel
- Polyvalent tank of large capacity operating under vacuum (or controlled atmosphere), allowing the welding of micro-pieces, up to a diameter of 200 mm, and a length of 7000 mm.
- A device for particularly flexible movements of translation and rotation allows for several combinations

Possible area of application

Applications of development of various industrial types of weldings materials and refractory alloys, direct assembly of differential materials, geometry and precision, vacuum sealing, contamination risks ...)

Possible interested industries

Sheet metal and high precision mechanical
All the latest technological developments

Area of activity

- Surface treatments by chemicals, destined to form or reform an external layer, for metal protection against other etchings operations (pickling, passivation ,polishing)
- Extension of chemical etching, consisting of the removal of material from prefixed areas by chemicals

Competence acquired

- Surface treatments:
  - normal process for stainless steel and aluminium
  - acquired process for zirconium alloys and sintered aluminium
- Chemical treatment:
  - chemical boring for enlarging of aluminium tubes (canning of combustible elements)

Available equipment

- Complete equipment for surface treatment allowing the treatment of tubes up to 7 m long
- Containers complete with temperature setting devices

Possible areas of application

- Establish and coordinate all known processes
- Working out and setting up of new processes, covering all alloys and etching, according to latest technological developments
- Extensive and far reaching use of chemicals to obtain the required shapes of metals and alloys, the mechanical properties of which cause extreme difficulties for all common cutting, milling and boring operations

Possible interested industries

All industries working metal alloys, according to the latest technological developments

Area of activity

Thin evaporated films

Competence acquired

- Evaporation of metals or semiconductors in high vacuum on substrates of glass and monocrystals of CaF_2(111) at temperatures between 20 - 650°C.
- Measurements of the film thickness and velocity of evaporation
- Ultra high vacuum techniques
- Examination of the structure of the films

Experimental facilities

- Vacuum evaporator with electron gun and resistance heating, with the possibility of heating also the substrate
- Apparatus for mechanical treatment of single crystal surfaces
- Film thickness monitor (quartz oscillator)
- Gas-analyser "Atlas", type Massenfilter AMP 3
- Metallographic microscope "Reichert",
- Electronic microscope "Siemens ELMI II"
- X-ray equipment
- Magnet, type B-E20-E8 "Brucker-Physik AG"

Possible areas of application

Studies in the field of catalyzators corrosion and new semiconductors, microcircuits obtained by evaporation.

Area of activity

Metallic film deposition

Competence acquired

Film deposition on metallic or ceramic supports using the following techniques:

- Electrolytic deposition in acqueous solutions or in molten salts
- Chemical deposition in acquaeous or in molten salts
- Immersion deposition in molten salts
- Vacuum evaporation by Joule effect heating or electron beam
- Refractory metals deposition (W, Mo, Ta, Nb) by chemical reduction of the volatile salts in vapour phase
- Specially oriented films deposition

Experimental facilities

- Equipment for vacuum deposition
- Equipment for electrolytic deposition
- Thermostat and cryostat
- Melting furnaces for salts and metals
- Equipment to deposite refractory metals by chemical reduction
- Control tests equipment for the deposited films

Areas of application

The metallic deposits may have many applications. Examples are

- corrosion protective layers
- wear and diffusion layers
- films improve the brazing between metallic or ceramic-metallic components
- the oriented films can find useful application in the direct conversion

References see next page

References

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- "Etude de la comptabilité dans les systèmes zircaloy 2/Al, zircaloy 2/Cu, zircaloy 2/Ni", F. Brossa, A. Hubaux, D. Quataert, H.W. Schleicher - Mém./Sci. Rev. Métallurg. LXIII, 1 (1966)
- "A computer program for the description of diffusion kinetics in metals", F. Brossa, R.F. Gloden, A. Hubaux, H.W. Schleicher - Z. Metallkde, Bd. 58, 1967, H.5
- "Über die Abscheidung von Nb, Ta, Mo, und W durch Reduktion der entsprechenden Chloride mit Zinkdampf", F. Brossa, H.W. Schleicher, H. Venker - Metalloberfläche 21, J . 1967, Heft 6, S. 175-176
- "Metodi per ridurre l'ingrossamento del grano nelle saldature di leghe di zirconio", F. Brossa, G. Musso, G. Volta - Congresso "Associazione Italiana di Metallurgia", Milano, 17-20 giugno 1968
- "Studio della diffusione tra Al e Nb", F. Brossa, G. Musso, H.W. Schleicher - Congresso "Associazione Italiana di metallurgia", Milano, 17-20 giugno 1968
- "Dépôts chimiques en phase vapeur de métaux réfractaires" F. Brossa, R. Debeir, M. Grin, G. Piatti, H. Venker - Presentato al Congresso di Digione - Ottobre 1968
- "Legierungsbildung zwischen niedrig- und höchstschmelzenden Metallen durch Reduktion flüchtiger Metallhalogenide und Klärung des Aufbaus der so erhaltenen Legierungen", Th. Heumann, H. Venker - Report EUR 4041.d

Patents

11 patents

Area of activity

High temperature techniques

- Testing of materials at very high temperatures (above 1000°C)
- Ceramic-metal soldering; fabrication of metal-ceramic sandwich
- Surface blackening
- Chemical vapor deposition

Competence acquired

- Soldering of Al_2O_3 to Nb 1% Zr and of fused quartz to Kovar
- Improvement and development of new methods for surface blackening
- Deposition of Nb on Al_2O_3 for working temperatures in the 1000 → 1500°C range

Experimental facilities

- Plasma generator – power 100 KW
  temp. 1000 → 15000°k
- Furnace of high temperatures (1000 → 4000°k)
- High vacuum furnace for soldering by high frequency induction heating or by infra red radiation heating
- Thermal cycling facility and test facilities for endurance tests at very high temperatures
- Chemical vapor deposition plating equipment
- Plasma flame spray system METCO type 2M

Possible areas of application

- Direct energy conversion
- Refractory materials
- Test sections with quartz tubes; quartz window
- Insulator in corrosion environment
- High temperature insulations
- Thermionic converters; diffusion barriers; nuclear fuel cladding
- Thermal control surfaces for space power plants

Possible interested industries

Nuclear, Chemical, Space, Aeronautical Industries, Industry of refractory materials;

References see next page

References

Contributions to scientific and technical Journals

- "A bakeable quartz-metal sealed window", L. Verheyden, J.Sci. Instr. 44 (1967), 174-176
- "A bakeable and direct joint between a fused quartz tube and a metal tube", L. Verheyden, J.Sci.Instr. 1, Series 2, (1968) 145-147

External reports

- "Fabrication and properties of chemical vapor deposited Nb layers on Al_2O_3 bodies for thermionic application", P.Fiebelmann, EUR 3743.e (1968)
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Patents

- "Quarzlinsenverbindung in Anlagen zur quantitativen Bestimmung der Konzentration von Dämpfen in einem Trägergas, und Verfahren zur Herstellung der Verbindung", L. Verheyden, K. Klein, C.M. Cappelletti, Dep. Germany N° E 30702 IX b/42 1
- "Lötverbindung zwischen Quarz- und Metallrohr", H. Kind, K. Klein, L. Verheyden, Dep. Germany N° E 35916 XII/47 f

Area of application

Preparation and testing of high temperature materials

Competence acquired

Preparation and testing of UC

Experimental facilities

- High temperature resistance furnaces up to 2500°C
- Electron-beam furnace
- Hot press
- Induction furnaces
- Arc melting furnace
- Glove-box lines
- Metallurgical testing equipment

Areas of application

Development of nuclear and non nuclear ceramic materials

Possible interested industries

- Reactor industry
- Space industry

Area of activity

Sealing and Leak-detection
- Static and reciprocating seals (metallic, asbestos organic sealings)
- Rotating mechanical seals
- Leak measurements and detection in all kind of seals and joints, in pressure or vacuum systems
- Leak detection by radioactive tracers.

Competence acquired

- Seals testing criteria and leak measurements
- Development of new metallic seals
- Development of a leak detector for organic vapors
- Behaviour of mechanical seals at elevated temperature
- Study of wear of mechanical seals
- Study of pressure distribution in a lubricant layer for rotating seals
- Preparing of radioactive tracers

Experimental facilities

- Test device for static and reciprocating seals
- Test set-up for load cycling with hydraulic clamping system and leak-detection facility
- Installation for testing metallic sealings
- Vacuum plant with He mass spectrometer
- Test device for mechanical seals at elevated temperature
- Test device to study wear in different materials
- Electronic chains to measure radiation by scintillation counters

Possible areas of application

- Vacuum and pressure seals
- Seal between nose unit of refuelling machine and pressure tube in nuclear reactor
- Sealing of valves, pumps and compressors
- Leak detection in industrial plants

Possible interested industries

- Vacuum industries; Constructors of valves and joints
- Nuclear and Chemical Industries
- Petrolchemical Industries

References see next page

References

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- "Equipment for producing calibrated leaks especially adapted for substances with melting points above room temperature", L. Verheyden, K. Klein, J. Sci.Instr. 44 (1967)
- "Phenomena occurring in the detection of very small leakages of gas and liquids", L. Verheyden, K. Klein, Vacuum (1968), 457-460
- "Rivelazione di fughe nell'impianto "Hydrotreater" della raffineria SHELL di Rho mediante traccianti radioattive", F. Girardi, R. Lopes-Cardozo, E. Ohlmer, Il Calore N° 10, (1968), 3-8

External reports

- "Conversion of leak flow rates for various fluides and different pressure conditions", J. Amesz, EUR 2982.e (1966)

Patents

- "Apparecchio per la campionatura di fughe", L. Verheyden, K. Klein, Dep. in Italy N° 36173 A/67
- "Dichtungsring", L. Verheyden, K. Klein, Dep. in Germany N° E 34882 XII/47.f

Meetings

- "Mesures en contenu de concentrations de vapeur d'organique dans un gaz porteur", L. Verheyden, K. Klein, Mesucora, Paris 17-21 avril 1967
- "Joint métallique étuvable dont le profil représente une combinaison de différents profils existants. Description et performances", L. Verheyden, K. Klein, Journées de Vide, Versailles 20-24 mai 1967

Area of activity

Testing of components and prototypes
- Testing of components of organic liquid loops
- Testing of entire channel sections
- Testing of fuel bundles fixation systems in nuclear reactors
- Testing of components of a refuelling machine
- Testing of components for P.W.R.

Competence acquired

- Testing of channels and fuel elements in normal operating conditions of ORGEL reactor (organic liquid - 400°C - 20 Atm)
- Techniques for performing measurements at elevated temperatures in organic liquid
- Operating tests of fuel elements loading and unloading for nuclear reactors with vertical channels

Experimental facilities

- Organic liquid loop allowing for thermal shocks on entire channel sections (400°C, 40 Atm, 90 m^3/h)
- Organic liquid loop allowing endurance and reliability tests (400°C, 60 Atm, 15 m^3/h)
- Facility for operating tests of fuel elements loading and unloading

Possible areas of application

- Testing of channels and fuel elements for heavy water moderated nuclear reactors
- Testing of loading and unloading operations for heavy water moderated nuclear reactors
- Testing of valves, flow meters, pumps, seals, etc.

Possible interested industries

- Nuclear, petrochemical industries

- Industries interested in P.W.R.

Area of activity

Behaviour of reactor components under irradiation conditions. (For instance: creep under irradiation of pressure tubes, joints and welds behaviour under irradiation etc ...)

Competence acquired

- Irradiation of different types of graphite and carbons for the core structures of a nuclear reactor
- Preparation of pressure tubes to be irradiated in the ESSOR reactor
- Development of the correspondent hot cell apparatus

Experimental facilities

- Availability of ESSOR Reactor (Ispra)
- Availability of H.F.R. Reactor (Petten)
- Availability of Hot Cells in Ispra and Petten
- Workshops and laboratories for fabrication and instrumentation of the irradiation rigs

Possible areas of applications

Nuclear reactor development

Possible interested industries

Nuclear industries

References see next page

References

External reports

- "Comportement sous rayonnement d'un graphite à basse porosité, d'un pyrocarbone et de deux carbones vitreux"
  B. Henry 1969 (to be published)

Other reports

Several internal reports and notes on the ESSOR pressure tubes construction and irradiation programme.

Area of activity

Hydrodynamics and vibrations.
- Hydrodynamic measurements
- Theoretical and experimental study of vibrations of mechanical components.

Competence acquired

- Determination of friction coefficients, pressure drop in complex structures, and of fine velocity distribution
- Measurement of very small velocities and of turbulence
- Flow induced vibrations in complex structures.

Experimental facilities

- Water loop (monophase and biphase water flow with gas injection)
- Instrumentation to measure pressure, velocity, and turbulence
- Electronic measuring device to measure vibration parameters
- Analyser of frequencies and of amplitudes (frequency spectrum)
- Organic liquid loop for tests under thermal flux conditions.

Possible areas of application

- Hydrodynamic behaviour of nuclear reactor components
- Analysis of complex structures vibrations

Possible interested industries

Industries working in the Nuclear, Chemical, Naval, Space, and Automobile fields.

References see next page

References

Contributions to scientific and technical Journals

- "Experimental study on the vibrations of various fuel rod models in parallel flow", D. Basile, J. Fauré and E. Ohlmer, Nuclear Engineering & Design 7 (1968) 517-534
- "Analisi spettrale di vibrazioni meccaniche di componenti del reattore ESSOR", D. Basile (Euratom), L. Cimorelli (CNEN), A. Federico (CNEN), Energia Nucleare (to be published).

Area of activity

Safety

- Rupture of a channel in reactors with pressure tubes
- Consequences of the rupture of components in a pressurized loop

Competence acquired

- Experimental study on full scale models of thermal and mechanical phenomena, caused by the burst of a pressurized structure

Experimental facilities

- Experimental loop, volume 5 m^3 for tests at high pressure (50 atm) and at high temperature (450°C), connected to a reservoir (12 atm, 12 m^3)
- Pressurization systems for liquids or for gas up to 2000 atm

Possible Areas of application

- Propagation of bursts in a beam of tubes (heat exchangers, reactors with pressure tubes)

Possible interested Industries

- Nuclear, Chemical industries

References see next page

References

- "Full scale experiments on the consequences of a pressure tube rupture in ESSOR reactor vessel", H. Holtbecker, M. Montagnani, G. Verzeletti, EUR 4101.f.e. (1968)

Area of activity

- Reliability analysis of mechanical structures and of various systems

Competence acquired

- Knowledge of statistical methods for reliability analysis
- Analysis of brittle materials

Experimental data

- Data from tests on weldings and of rupture tests
- results from tests performed on components mounted in experimented loops

Possible areas of application

- Analysis of conventional nuclear structures
- reliability study of welded structures

Possible interested industries

- Industries fabricating complex structures (reactors, ships
- Constructors of electric power stations

References see next page

References

- "Metodi statistici parametrici e non parametrici per la stima dell'affidamento di componenti meccanici", D. Basile, G. Volta, (to be published)
- "Collection and analysis of data on the life expectancy of Organic plant components", S. Capobianchi, J.P. Rougeau, G. Volta, EUR 2984.e (1966)
- "Valutazione dell'affidamento di materiali fragili ed in particolare di strutture saldate", D. Basile, G. Musso, G. Volta, Paper presented at: XIII Congress of "Associazione Italiana Metallurgia" Milano, June (1968)
- "An integrated system for optimal management and reliability evaluation based on plant operation data", A. Schweitzer, G. Volta, Paper presented at: "Meeting Crest on reliability of electrical supply systems for Nuclear Reactors", Ispra, June 27-28.1968.

IV) Materials

IV/1 Material Testing
IV/2 Material Development

Area of activity

Testing of Materials and structures

- thermal and mechanical fatigue
- creep and creep damage
- tensile and charpy tests
- metrology and non destructive testing
- wear
- study of the dynamic behaviour of materials (prestressed concrete)
- effects of combined mechanical and thermal stresses

Competence acquired

- Determination of parameters influencing the thermal fatigue behaviour of materials
- Study of mechanical fatigue of bellows
- Creep rupture and creep damage for S.A.P.; analysis of experimental data with statistical methods
- Ultrasonic controle of pressure tubes and of Zy-SS joints
- Methods to test wear and fretting corrosion at elevated temperatures
- Behaviour of materials under dynamic sollicitations produced by explosives or by magneforming
- Computer codes to calculate dynamic behaviour of structures
- Buckling under thermal cycling of fuel elements

Experimental facilities

- Mock-up allowing for fast thermal cycling; maximum temperature: 1000°C, max. cycling velocity 30 cycles/min
- Facility permitting mechanical fatigue tests on very big structures (reactor vessels)
- Apparatus to perform fatigue tests on metallic bellows at elevated temperatures.
- Creep furnaces and measurement devices
- 3 tensile machines (50 tons, 20 tons, 2 tons)
- 2 Charpy machines (30 kgm - 5 kgm)
- Ultrasonic device to detect defects and to mesure the thickness of pressure tubes
- X rays apparatus, röntgen apparatus
- facilities to perform fretting corrosion in water (250°C), friction tests combined with vibrations (350°C,25 Hz), measurements of friction coefficients
- Instrumentation for measurements of fast phenomena (10^4 to 10^6 Hz) pressure transducers, shock-tubes, fast film camera (up to 1, 2 10^5 foto's/sec.), Hopkinson bars,
- Device to produce dynamic sollicitations by hydraulic means.

Possible areas of application

- thermal fatigue(fuel element cannings,heat exchangers)
- quality and dimensional control
- contacts between different materials in nuclear reactors
- safety studies on structures
- study of fast phenomena (water-hammer, collapse of vapor bubbles, explosive evaporation)

Possible interested industries

- Nuclear, chemical, mechanical industries

References

External reports

- "Equipment for investigating the thermal stress fatigue behaviour of SAP", R.H. van Erik, EUR 3899.e (1968)
- "Non destructive and destructive testing of reactor pressure tubes in SAP", C. Albertini, M. Montagnani, P. Weltevreden, EUR 3929.e (1968)
- "The response of a Vessel to an internal blast loading", H. Holtbecker, A. Maserati, M. Montagnani, G. Verzeletti, EUR 4101.f.e (1968)
- "Full scale experiment on the consequence of the rupture of a pressure tube in ESSOR reactor vessel", H. Holtbecker, M. Montagnani, G. Verzeletti, EUR 4101.f.e (1968)

Meetings

- "A correlation of non destructive with destructive testing of Zircaloy-Steel welded joints for reactor pressure tubes", C. Albertini, J. Jung, M. Montagnani, G. Verzeletti, Paper presented at: "28th national conference of the American Society for non Destructive Testing", Detroit (Mich.) October 14-17. 1968
- "Statistical interpretation of Creep data for the evaluation of design criteria for pressure tubes in a heavy water moderated reactor vessel", M. Montagnani, J. Putzeys, to be presented at "International conference on pressure vessel Technology", Delft, September 29- October 2, 1969

Area of activity

- Mechanical properties of structural materials
- Technological tests on assemblies and parts of fuel elements

Competence acquired

- Tensile testing between - 196 still 1000°C (in air or under vacuum)
- Micro-hardness measurements till 1000°C in vacuum
- Technological tests on tube material at 450°C (burst test, fatigue, creep)
- Development of computer program CATT (computer analysis of tensile tests)
- Creep and fatigue tests on specimens of bars or tubes and assemblies or subassemblies of fuel elements

Experimental facilities

- 2 Instron tensile testers (1 gr to 5 tons)
- Automatic processing of tensile data (digital voltmeter, puncher, timer)
- 1 SEAVOM prototype micro-hardness tester (1 g to 1000 gr) in vacuum till 1000°C
- Other apparatus: Leitz Durimet micro-hardness, 2 Wolpert macro-hardness, 2 Wolpert impact testers, basic metallographic equipment, 3 burst units
- Creep machines: 36 Adamel creep machine (900°C)
  2 creep machines for tests on fuel elements (test chamber - diameter 100 mm, height 1 m)
- Fatigue machines:
  18 rotative bending machines (room temperature)
  2 Universal fatigue machines (vibrating tables) from 200 kg to 2 tons at 600°C

Areas of application

Mechanical properties of all types of materials in the range of 196°C to 1000°C.

Possible interested industries

All industries working for: nuclear research, space research, special metallurgy, etc.

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Contributions to scientifique and Technical journals

- "Contribution de la fragilité à chaud du composite Al-Al_2O_3"- P.Bonnet, M.Grin - Rev. Met. 63
- "Contribution à l'etude de la plasticité du SAP", P. Guyot - Rev.Met. 64
- "Activation Energy and Activation Volume in SAP" P. Guyot - Acta Met. 64
- "Contribution à l'étude des alliages Al/Fe" C. Becchi, D. Boerman, M. Grin, B. Piatti - Rev.Met. 65
- "The influence of the Deflection of an Electromechanically Operated Tensile Machine", D. Boerman - Mat. Prüfung, Bd. 7, No.5, S. 159/164
- "On the Mechanismus of Plastic Deformation of SAP" P. Guyot - Plenum Press
- "Activation thermique des réactions entre dislocations attractives" - P. Guyot - Acta Met. 66
- "Struttura proprietà leghe Al-$FeAl_3$", C. Beghi, D. Boerman, M. Grin, Nasi, G. Piatti, en cours de publication
- "Deformation Mechanism of Metals Hardened by a Dispersed Incoherent Second Phase", P. Guyot, J. of. Mat.
- " Contribution à l'étude de l'influence de divers traitements thermomécaniques sur la structure d'alliages de Zr résistant à la corrosion en milieu organique", Barigozzi, D. Boerman, P. Bonnet, - En cours de publication dans la Rev. de Métallurgie

External Reports

- "Influence du revenu et de la dimension de grain sur les proprietes mecaniques du SAP", P. Guyot - EUR 2124
- "Computer Analysis of Tensile Tests", Boerman, P. Bonnet, M. Grin, A. Hubaux - EUR 2514.e
- "Essais de traction à basses températures sur SAP 4%", D. Boerman, R. Debeir - EUR 2648.f
- "Al-Al_2O_3 composites. Part 1 : Mechanical properties of SAP", ISML, - D. Boerman, M. Grin, M. Veaux, (en cours de publ.)
- "Mechanical Properties of Al-Al_2O_3 composites. Part 2 : Frittoxal", - D. Boerman, M. Grin, M. Veaux, (en cours d'impr.)

Patents

"Machine de microdureté à chaud sous vide", P. Bonnet, M. Grin, (1966)

Area of activity

Non-destructive testing and dimensional control of nuclear fuel element components.

Competence acquired

Development and use of the non-destructive testing techniques for:

- visual inspection . liquid penetrants, endoscopy
- sheath contour measurements and surface-state control
- special dimensional control: f.i. inside diameter measurement without contact; wall thickness measurement by beta-absorption
- radiography
- ultrasonics, resonance and pulse-echo techniques, attenuation measurements;
- Eddy-currents
- Tightness control; Helium leak test

Experimental facilities

- dimensional control laboratory:
  - automatic vertical bench for deflection and outer diameter measurements;
  - automatic vertical bench for inner diameter measurements,
  - horizontal measuring benches;
  - contour measuring projector;
  - beta-gage wall thickness measurements bench,
- radiography laboratory:
  - 150 KV and 50 kV generators
  - semi automatic radiography bench
- ultrasonics laboratory:
  - SPERRY, KRAUTKRAMER and BRANSON apparatus
  - semi-automatic bench
- Eddy-currents laboratory:
  - BUDD-FORSTER and CNS apparatus
  - vertical exploration bench
- tightness control laboratory:
  - 3 immersion chambers: P = 30 kg/cm^2 - diameter: 120 mm length 3 m
  - detection chambers
  - 2 helium leak detectors

Areas of application

- Nuclear fuel element components, particularly:
  - rods in the course of fabrication, sheating, plugs, welding, thermocouples,
  - experience easely transferable to non-nuclear fields

Possible interested industries

- Light metals
- Nuclear Engineering
- Precision Engineering

References see next page

References

Publications

- "Application de différentes méthodes d'essais non destructifs aus éléments combustibles type ORGEL", P. Bonnet, J. Jansen, - Bucarest 1965

Brevets

-" Appareil pour la radiographie de tubes et plus particulièrement de tubes pour applications nucleaires", J. Jansen, P. Mandrier (1964)

- "Appareil pour la confection de défauts artificiels", H. Mahler (1967)

- "Caméra pour la radiographie d'éléments irradiés", F. Gadda, J. Jansen, A. Wilhelm (1967)

External Reports

- "Réalisation de crayons combustibles NRX 716 - Contrôle non destructif des tubes de gaine", Annexe 1, R. Klersy et al., P. Bonnet, E. Borloo, J. Jansen EUR 2158.f

Area of activity

In and out-of-pile measurements of thermal and mechanical behaviours of solid materials

Competence acquired

Heat transfer coefficient measurements between room temperature up to 2000°C of structural and solid nuclear fuel materials.
In-pile creep measurements up to 400°C.

Design of irradiation devices - Nuclear calculations - After-irradiation works - Hot laboratories equipment - Capsules construction and testing techniques

Experimental facilities

- Apparatus for heat transfer measurements between 100°C and 2000°C (steady state, calorimetric, comparative and unsteady methods. electron beam)
- other facilities to assemble for other required measurements
- In-pile rigs for creep measurements up to 400°C
- 2 in-pile rigs in Ispra-1 reactor for irradiations at 20-30°C

Possible areas of application

Engineering applications for general purposes,
Nuclear design and new materials evaluation

Possibly interested industries

Nuclear, mechanical and engineering industries

References see next page

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Contribution to Scientific and Technical Journals

- "Apparecchiatura per la misura rapida della conducibilità termica di solidi a temperatura ambiente",- Energia Nucleare No.7, Vol.14, Luglio 1967
- "The dependence on microstructure of the High temperature properties of Uranium Oxid" -"Molybdenum and Uranium Oxide Tungsten cermets; II Heat Transfer Properties", - Rev.Int. Hautes Températures et Réfract. T.4, 1967

External Reports

- "Development of Methods for the Determination of the High Temperature Thermal Diffusivity of UC", - EUR-337.e (1963)
- "Heat Transfer in a Fuel Element Gas Gap", - EUR-521.e (1964)
- "Thermal and Mechanical Studies of Solid-Solid Contacts",- EUR-2486.e (1965)
- "Misura della conducibilità termica di materiali di interesse nucleare entro 100°C e 500°C", - EUR-3644.i (1967)
- "Calcul numérique des contraintes mécaniques et thermiques dans un cylindre creux de section droite irrégulière", - EUR-4181.f (1968)

Other reports

- "Esperienze d'irraggiamento in CIRO di un elemento inguainato di grafite impregnata di leghe di magnesio", Daniele, Donea, Lanza, presented in a CNEN Commitee over the CIRO-Program, 4-5 July, 1968

Area of activity

Experimental Stress Analysis through Photoelasticity, Strain-gages (up to 600°C) and Moiré

Competence acquired

Stress analysis of various parts of fuel elements: grids, finned tubes, weldings, stresses around inclusions, strain-gages bonded with Rokide process

Experimental facilities

- Chapman photoelastic bench
- Stress-freezing furnace
- High-speed milling machine for fabrication of models
- Various Strain Indicators
- X-Y Strain Recorders
- Flame spray gun for Rokide Process
- Furnaces for calibration of strain-gages

Areas of application

- Determination of the stress field in mechanical parts (through photoelastic models)
- Verification of the state stress in several points of mechanical part up to 600°C (true part under real loading conditions)

Possibly interested industries

- Motor industry
- Space industry
- Machine Tools

References see next page

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External Reports

- "Mise en oevre et étude des jauges d'extensométrie fixées, par le procédé Rokide", R. Antoine, 1968 (100 pages, 41 fig. 38 réf.) en cours d'impression
- "Propriétés et mise en oeuvre des Araldites utilisées en photoélasticité", M. Veaux, 1967 (105 pages, 32 fig. 32 réf.) EUR-3604 f
- "L'emploi des jauges de déformation, à haute température", B. Legrand, Tout (Sexta-Bagneux), P. Bonnet, M. Grin, EUR-2473 f
- "Répartition des contraintes dans un tube aileté soumis à une pression hydrostatique", G. Evrard, M. Veaux, 1967 (144 pages, 52 fig., 37 réf.) Communication No. 1.5.-1515
- "Orgel type fuel element for the MR-1-906 Experiment", P. Bonnet, C. Dumont, M. Grin, 1966 (étude photoélastique réalisée dans le cadre de ce rapport: "Two Dimensional Photoelasticity: A Method of Approximation to the Stresses in the End Plugs of Elements", G. Evrard, M. Veaux

Other reports

- "Contribution à l'étude de la nocivité des defauts dans les tubes ailetés", P. Bonnet, J. Jansen M. Veaux, 12ème Colloque de métallurgie, SACLAY, 24-26 Juin, 1968
- "Vérification Photoélastique des contraintes dans la grille de l'elément combustible C-2", G. Evrard, M. Veaux, 1966-Ispra-953
- "Répartition des contraintes dans un bouchon de barre combustible soudé à une gaine ailetée", G. Evrard, M. Veaux 1967 - ISPRA-1165
- "Analyse des déformations par la méthode de Moiré. Mise en oeuvre et première application", J.F. Imbert, M. Veaux, 1968 - ISPRA-1268

Area of application

- Zirconium Corrosion in water, steam or organic environments at high temperature, in-pile and out-pile,
- Studies on ZrO_2 layers, catalysis on surface

Competence acquired

- Corrosion measurements on different Zr-alloys on the above environments. Topical alloy design
- Thin film techniques; measurements of electrical parameter and specific apparatus development; measurements on catalysts

Experimental facilities

- No. 8 thermosyphon loops for high temperature terphenyl (420°C max; $p \leq 20$ kg/cm^2) - 1 in-pile loop (KID),
- No. 10 autoclaves for water, steam or gas corrosion measurements at high temperature and pressure: $P \leq 150$ kg/cm^2, $T \leq 750$°C (at lower temperature the pressure may be higher)
- High vacuum metallizing facilities and specialized apparatus for electrical measurements
- Hot laboratory facilities

Possible areas of application

- Development of Zr-alloys for higher temperature use in steam (400°C) or gases, or organic
- general corrosion testing and material reception
- corrosion measurements in general
- studies on corrosion mechanisms
- studies of surfaces

References see next page

References

Publications

- "I Fluoruri doppi di uranio tetravalente nella metallurgia dell'uranio", G. Imarisio, R. Sesini - Energ.Nucl. Vol.5, No.8
- "Sulla corrosione sotto sforzo", A.Bassi, E. Brutto, C.Imarisio, G. Perona, R. Sesini, Energia Nucl.Vol.8, No.5
- "Zircaloy-2 and Stainless Steel Corrosion in Flowing Wet Steam", A. Bassi, E. Brutto, G. Camona, G. Imarisio, G. Perona, R. Sesini - Energ. Nucl. Vol.10, No.4
- "Research Program and Choice of Specific Zirconium Alloys for High Temperature Terphenyl Use", G. Imarisio, EUR-1162(65)
- "Selection of New Zirconium Alloys for high temperature Terphenyls", G. Imarisio, M. Cocchi, G. Faini - Presented to J. Nubl. Mat. - for publication
- "Influence of Thin Noble Metal Films on Zirconium Oxidation", J. Electrochem. Soc. 115, 369-371 (1968)

External Reports

- "Zirconium Alloys in Terphenyls", G. Imarisio - EUR-2649 e
- "Statistical Techniques and Analysis in Corrosion Measurements of Zr-Alloys in Terphenyls", G. Imarisio, M. Cocchi, EUR-2999 e
- "The Compatibility of Zirconium Alloys with High Temperature Polyphenyls", G. Imarisio - EUR-722

CISE reports

- "Design and Assembly of a Loop for Experiments on Corrosion and Erosion Properties on Flowing Wet Steam", E. Brutto, J. Cihi, G. Imarisio, G. Palladino, G. Perona, R. Sesini, - CISE No. 34
- "Results of Corrosion and Erosion Experiments with Steam-Water-Spray", A. Bassi, E. Brutto, G. Imarisio, G. Palladino, G. Perona, R. Sesini, - CISE No. 40
- "Progettazione e conduzione di una batteria di autoclavi", G. Imarisio - CISE No. 92

Patents

- "Process and Plant for the Purification of Terphenyl and/or Analogous Organic Materials", G. Imarisio
  Ref. EUR: 1/692 UK deposited 17.8.65 Great Britain No.35278/65
- "Verwendung von Zirkoniumlegierungen des Zr-Fe-V-Zr-Fe-Cr- und des Zr-Cr-Typs", G. Imarisio
  Ref. EUR I/983 GF deposited 27.7.66 Germany No. E 32 153
- "Zirkoniumlegierungen", G. Imarisio
  Ref. EUR: I/954 deposited 27.7.1966 Germany E 32 152

Area of activity

Compatibility and Corrosion

Competence acquired

- Compatibility and diffusion studies between different materials (solid-solid, solid-fluid metal and solid-gas systems)
- Corrosion tests in organic liquids, water and water-vapour,
- Huey and Strauss tests,
- Salt spray tests and artificial industrial atmosphere tests stress-corrosion tests,
- Electrochemical kinetics, intensiostatic and potentiostatic polarizations,
- Measurements of equilibrium e.m.f.
- Studies of transport phenomena in ionic solids,
- Thermodynamics of many components systems

Experimental facilities

- Furnaces for heat treatments under vacuum and controlled atmospheres,
- Apparatus for purification and filling of liquid metals with low melting points,
- Autoclaves,
- Salt spray and industrial atmosphere boxes
- High and low temperature stress-corrosion device,
- Thermobalance,
- Apparatus for e.m.f. determination on cells with very high impedance
- Polarization unit
- Potentiostat

Area of application

- Qualitative and quantitative evaluation of corrosion and compatibility problems between different materials
- Study of the possibilities of preventing and neutralizing them

Possibly interested industries

Metallurgical and electrochemical industries

References see next page

References

- "Compatibility Studies Concerning the Use of a Liquid Lead Joint in an Uranium-Carbide/Sintered Aluminium (SAP) Fuel Element", P.L. Lensi, H.W. Schleicher, J.of Nucl.Mat. to be published
- "Comportamento alla corrosione dell' aluminio e sue leghe in liquido organico (terphenile) a 400°C, F. Coen-Porisini, G. Piatti, H.W.Schleicher, - Convegno "Associazione Italiana Metallurgia", Milano 17-20 Giugno 1968
- "Determination of Water Content in Potassium Difluoride", G.B. Barbi, S. Pizzini, - Anal.Chem. 35, 409 (1963)
- "Hydrogen Evoluation from KHF_2 Melts at Platinum Electrodes", S. Pizzini, G. Sternheim, G.B. Barbi, - Electrochimie Acta, 8, 227 (1963)
- "Thermodynamic functions and Those Stability Limits by e.m.f. Measurements or Solid Electrolytic Cells", G.B. Barbi, - J.Phys.Chem. 68, 2912 (1964)
- "Funzioni termodinamiche di soluzioni solide Cu-Ni con Misure di f.e.m.", G.B. Barbi, - Ann.Chim. 56, 992 - 1966
- "Thermodynamics Functions by e.f.m. Measurements on Solid Galvanic Cells in Non-Stationary Conditions: System Al + Al_2O_3", G.B. Barbi, - Trnas. Far. Soc. 62, 1589 (1966)
- "Non-Stationary e.m.f. Measurements after Polarization of Solid Galvanic Celles. The Stability of NbO", G.B. Barbi,- Zeitschrift für Naturforschung 23a, 800 (1968)
- "The Stability of Wüstite by Electromotive Force Measurements on all Solid Electrolytic Cells", G.B. Barbi - J. Phys. Chem. 68, 2912 (1964)

Area of activity

Elaboration on laboratory scale of metallic and metallocera-mic materials

Competence acquired

Elaboration of dispersed phase alloys by:

- Sintering of metallic powders
- Chemical Reaction between solid powdered phase and vapour phase
- Ultra high cooling from the liquid phase

Elaboration of composite fiber reinforced materials by:

- Unidirectional solidification
- Dispersion of ceramic fibers in a liquid metallic matrix

Experimental facilities

- ARC-furnace
- Induction-furnaces
- Electron-bombardment furnaces
- Sintering press
- Extrusion-press
- Plasma-jet swaging facility
- Several resistance furnaces for heat treatment,
- Splat cooling apparatus,
- Rolling mill

Possible areas of application

Elaboration of experimental alloys, especially dispersed phase alloys and fiber reinforced alloys

Possibly interested industries

Metallurgical and mechanical industries

References see next page

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- "Quelques observations relatives à l'effet sur les composites Al-Al_2O_3 d'une fusion contrôlée", G. Beghi, G. Piatti,- J. of Nucl. Mat. 15, 1 (1965) 117-120
- "The Maintenance of the Properties of SAP after a Treatment of Fusion of the Matrix", G. Piatti, g. Beghi, - Energia Nucl. Vol.12, No. 10 (1965)
- "Contribution à l'étude des alliages aluminium-fer", G. Beghi, D. Boerman, P. Bonnet, M. Grin, G. Piatti, Mem. Sci. Rev. Metallurg. LXII, No.6, 1965
- "Influence des traitements thermiques de longue durée sur les propriétés des composites Al-Al_2O_3", G. Beghi, M. Grin, G. Piatti, - Mem. Sci. Rev. Metall. LXIV, No.4, 1967
- "Struttura e proprietà meccaniche di leghe in fase dispersa Al-$FeAl_3$ a basso tenore in ferro elaborato per impieghi nucleari", G. Beghi, D. Boerman, M. Grin, M. Nasi, G. Piatti, La Metallurgia Italiana, No.5, 1967
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- "Possibilité d'élaboration d'un alliage en phase dispersée Al-$NbAl_3$ par trempe rapide et à l'état liquide", G. Beghi, R. Matera, G. Piatti, - J. of Nucl. Mat. 26 (1968), 219-222
- "Caratteristiche e applicazioni della solidificazione ultra rapida di leghe metalliche", G. Beghi, R. Matera, G. Piatti, - La Metallurgia Italiana, No. 5, 1968

Area of activity

Structural and physical metallurgy

Competence acquired

- Application of the electron-microanalyzer in the field of metallography and solid state diffusion applications of X-ray microradiography
- Ion-analyzer (same as above)
- Structural analysis (phase identification, preferred orientation, parameter measurements ect.) with the aid of an X-ray diffractometer,
- Dilatometry
- Optical micrography (aluminium-alloys, zirconium-alloys, carbides, pyrolytic graphite etc.)
- Electron microscopy (dispersed phase alloys)

Experimental facilities

- Electron microprobe CAMECA
- Ion analyser CAMECA
- X-ray diffractograph SEIFERT-PHILIPS
- Electron-microscope PHILIPS EM 100,
- Optical microscope REICHERT, LEITZ, ZEISS and metallographic preparation chain
- Ion-microscope TRUB TAUBNER
- ADAMEL Dilatometer (up to 1500°C under high vacuum 10^{-5})
- Laboratory furnaces for thermal treatment under high vacuum up to 1200°C

Possible areas of application

- Study of metal alloys
- Microstructure
- Study of phase transformations
- Study of dispersed phase alloys

Possibly interested industries

Non-ferrous metallurgical industries in general

References see next page

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- "Evolution micro- et macrostructurale des composites Al-Al_2O_3 sous cyclage thermique", G. Beghi, P. Guyot, G. Piatti, - Lém. Sci. Rev. Metallurg. LXI, No.3, 1964
- "Contribution à l'étude des transformations structurales dans le S.P fondu", G. Piatti, G.B. Barbi, G. Beghi, Mem. Sci. Rev. Metallurg. LXIII, No.5, 1965
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- "Esame della resistenza e stabilità a caldo di tubi di lega Al Mg 3% destinati ad applicazioni nucleari", G. Beghi, B. Henry, L. Nasi, - Memoria presentata al XII Convegno AIM, Milan, 17-20 June 1968
- "The Time Temperature Dependence of the Hardness of Dispersion-Strengthened Aluminium Alloys", H. Kellerer, G. Piatti, - J. of Nucl. Materials 27, 1968, 245-256
- "Crack Formation in Sintered Two-Phase Alloys", H. Kellerer, G. Piatti, - J. of Mat. Sci. 3, 1968, 486-497

Area of activity

Dispersion hardened materials and particularly aluminium hardened with dispersed alumina

Competence acquired

- Production of dispersions of very fine sized alumina in aluminium,
- Measurements of mechanical properties: Stress strain, creep,
- Observation of plastic phenomena on sample surfaces,
- Electron microscope observation of dislocations,
- Influence of plastic deformation on internal friction

Experimental facilities

- Instron, tensile testing machine,
- 2 machines for creep,
- 3 equipments to measure internal friction (frequency of 1 cycle to 50 kilocycles),
- 2 electron microscopes

Possible areas of application

- Heavy water reactors
- Aeronautic industry
- High temperature materials

...

References see next page

References

Publications

- "Internal Friction and Young's Modulus Measurements on SAP", A. Schneiders - Nuova Metallurgia Vo.XXXIII anno 1964 p. 571-573
- "Le mécanisme d'Orowan dans l'aluminium fritté, recristallisé", P. Schiller - Mem. Sci. Rev. metallurg. LXIV No.9, p. 791-794 (1967)
- "On the Ductility of SAP alloys", P. Schiller, A. Schneiders, - J. Nucl. Mat. 27, 115-117 (1968)
- "Ein Korngrenzenmaximum der inneren Reibung in Sinteraluminium", A. Schneiders, P. Schiller - Acta Met. 16, 1075-1079 (1968)
- "On the Origins of the Strain Fields Around the Alumina Particles in Al-Al_2O_3 SAP Foils", E. Ruedl, E. Staroste, - J. Nucl. Mat. 16, 103, 1965
- "Damage and Diffusion in Ion Bombarded Al and Al-Al_2O_3 Alloy", E. Ruedl, Kelly, - Modern Developments in Powder Metallurgy (Plenum Press 1962), Vol.2, pag.131
- "Electron microscopy of SAP Following Tensile Deformation or Quenching", E. Ruedl, P. Guyot, - Modern Developments in Powder Metallurgy (Plenum Press 1966) Vol.2, p.145
- "Observation directe des défauts structureux du SAP", P. Guyot, E. Staroste, E. Ruedl, - Mem. Sci. Rev. Met. 63, (9), 1966, 773
- "On the Behaviour of Vacancies in Quenched Al-Al_2O_3 Alloys", E. Ruedl, E. Staroste, - Mat. Res. Bull. 1, 1966, 215
- "Evidence for Trapping of Bubbles by Alumina Particles in alpha-Bombarded Al-Al_2O_3 alloys", E. Ruedl - Mat. Res. Bull. 2, 1967, 389
- "Deformation Mechanisms of Metals Hardened by a Dispersed, Incoherent, Second Phase", P. Guyot, Ruedl, - J. Mat. Sci. 2, 1967, 221
- "On the stability of the Al_2O_3 Dispersion in Al-Al_2O_3 Alloys", E. Ruedl - Electron Microscopy 1968, Rome 1968, Vol.I, P. 383

Patents

- "Werkwijze voor het bereiden van een dispersielegering", G. Hollebeck, H. Nijman, P. Schiller, A. Schneiders, Registered in the Netherlands: No. 67.16230, 29.11.1967

Area of activity

Impervious impregnated graphite

Competence acquired

- Impregnation of graphite by Mg and its alloys, by Al-Si(13%Si), By Bi and other materials.
- Measurements of mechanical and thermal properties
- Preparation of test fuel elements for irradiation experiments and for special mock-up

Experimental facilities

Furnaces impregnation

F_1 P_{max} 100 kg/cm^2
T_{max} 950°C

maximum dimension of samples: Ø 20 mm, h 60 mm

F_2 P_{max} 40 kg/cm^2
T_{max} 800°C

maximum dimension of samples: Ø 200 mm, h 1000 mm

F_3 P_{max} 40 kg/cm^2
T_{max} 1500°C

Possible areas of application

- Cladding of fuel elements and material for core structure
- Heat exchanger, chemical industry
- Brushes and special electrodes

References see next page

References

Contributions to Scientific and technical Journals

- "Proprietà meccaniche di una grafite impregnata con metalli", F. Lanza - La Meta. It. No.5, 1967

External Reports

- "Obtention d'un graphite imperméable par imprégnation de métaux fondus", H. Burg, F. Lanza, G. Marengo EUR-2988 f
- "Effects of Thermal Annealing and Cycling on Light Metal Impregnated Graphite", H. Burg, F. Lanza, G. Marengo - (to be published)
- "Evaluation of a Graphite Reflector in a Heavy Water Moderated Reactor", F. Lanza

Patents

- "Procedimento per effettuare giunti con corpi in grafite impregnata, particolarmente grafite impregnata con metalli o leghe leggere fusi", Marengo.G. - Dep. 9.3.1966, No. 15358
- "Procedimento di fabbricazione di elementi combustibili nucleari con incamiciatura di grafite impregnata con metalli o leghe leggere fusi ed elemento di combustibile ottenuto", H. Burg, F. Lanza, G. Marengo

Other reports

- "Esperienze di irraggiamento in CIRO di un elemento inguainato di grafite impregnata di leghe di Magnesio", F. Daniele, J. Donea, F. Lanza - presented to a Symposium at Rome on CIRO program, July 1968 (to be published)

V) CHEMISTRY

V/1 ORGANIC CHEMISTRY
V/2 NUCLEAR AND RADIATION CHEMISTRY
V/3 HIGH TEMPERATURE CHEMISTRY
V/4 CHEMICAL ENGINEERING

Area of activity

Organic synthesis
Organic labeled compound synthesis
Structure determination and theorical model evaluation

Competence acquired

- Synthesis of several quinqua, hexa and higher polyphenyls compound
- Synthesis of substituted aromatic compounds
- Synthesis of deuterated (partial and total) compound
- Synthesis of C_{14} labeled hydrocarbons
- Electronic configuration studies of these molecules

Experimental facilities

Laboratory equipped for organic synthesis and purification
Existing programs for theoretical evaluation

Possible areas of application

- Synthesis of pure reference compound for industry and biology
- Structure determination

Possible interested industries

Chemical industry and biology

References see next page

References

- Synthesis of Tritiated Biphenyls Labelled at Specific Positions
(In Coll. with P.Ph. H.L.Otto)
J.Lab.Compds. 2, 349 (1966)

- Abbau von [1 - ^{14}C]-p-Terphenyl und [4 - ^{14}C]-p-Terphenyl zum Nachweis der spezifischen Markierung
(In Coll.with W.Hafferl and K.H.Bloss)
Chem.Ber. 101, 1917 (1968)

Area of activity

Inorganic and organic analytical chemistry, radiochemical methods of analysis (production of radioisotopes).

Competence acquired

Qualitative and quantitative analysis of various materials (organic coolants, Uranium and its compounds, metals alloys, gases, pesticides, biological materials etc..)
Trace analysis - Isotopic analysis - Structural studies and analysis of organic molecules - Organic microanalysis - Synthesis of reference products or standard - Researches and developments of a new analytical procedure and instrumentation - Techniques of automation and computer applications - Techniques of fast and thermal neutron activation - Radioactivity measurements techniques - Chemical and radiochemical separations - Radioisotopes production - Basis studies on ionization potentials, bonding energy, radiolysis, reaction kinetic, excitation processes in flames.

Experimental facilities

14 MeV neutron generator - Irradiation channels in Ispra I reactor - x- ray spectrometers and counting equipments - Radiochemical laboratory facilities - Ultraviolet, Infrared and Raman spectrometers - Gas-chromatographes with electronic integrators and computer - Mass spectrometers with associated facilities (leak detector, nitrogen liquifier, mass spectrum digitizer with punger, power generator, microphotometer) - X-ray fluorescence spectrographs - X-ray diffractograph - X-ray spectrograph with electron excitation - High temperature diffraction chamber - Optical emission spectrographs - Optical emission spectrometer with associated electronics - Arc and spark sources - Flame analysis spectrometers with associated electronics - Optical emission accessory equipment (microphotometers, spectrum projectors, dark room facilities)- Vacuum hot extraction gases in metals analyzers - Electroanalytical facilities including coulometers, polarographs and potentiometric instruments - Ultraviolet and visible spectrophotometers - Elemental microanalyzer for C, H and N in organic compound - Carbon and Sulfur analyzer in metals - Low temperature dry asher - Special equipments for organic synthesis and microanalysis.

Possible areas of application

Analytical programs in any industrial and research activity

References see next page

References

- Mass spectrometric studies on : o-terphenyls-2-^{13}C : identification of compounds related to its synthesis and fragmentation processes
A. Copet, S. Facchetti
Organic Mass Spectrometry 1968 vol.1 pag.881-90 (1968)

- Dosage de l'Hydrogène, de l'Azote, de l'Oxygène dans le monocarbure d'Uranium
A.Colombo, G.Serrini
Anal.Chim.Acta 35 (1966) 169-180

- A demountable water-cooled hollow cathode lamp for atomic absorption spectroscopy
G.Rossi, N.Omenetto
Applied Spectroscopy, 21, 329 (1967)

- The application of X-ray diffraction analysis to uranium ceramic
R.Conti, C.Toussaint, G.Vos
Part I and II
Anal.Chim.Acta No. 37 (1967) 277-283
Anal.Chim.Acta No. 41 (1968) 83- 91

Area of activity

Electron and X-rays irradiation
Use of labeled compounds

Competence acquired

Irradiation of organic and inorganic molecules with a 2 MeV accelerator. Dosimetry well known
Irradiation with a X-ray machine
Irradiation and analysis of C_{14} labeled compounds

Experimental facilities

2 Mev electron accelerator (horizontal)
Power 0,5 kW with a 90° beam deflector and scanning possibility
Vessels and loopes for high temperature experiments
(4 W) X-ray machine
Packard counting equipment for C_{14} compounds

Possible areas of application

All kinds of irradiation with X-rays and electrons

Possible interested industries

Chemical and petrochemical industries

References see next page

References

- The formation of Bitrophyl in the Radiolysis of Carbon-14 Labeled Cycloheptatriene
G. Juppe
(in Coll. with A.P.Wolf)
Chem.Ber. 94, 2328 (1961)

Area of activity

Ion Implantation Techniques for Semiconductor Doping

Competence acquired

- Methods and Techniques for development of P-N junctions in silicon and germanium for radiation detectors
- Measurements techniques for evaluation of electrical characteristics of the semiconductor devices

Experimental facilities

- Laboratory for mechanical and chemical treatment of semiconductors
- Electronic laboratory, 100 keV ion accelerator in construction

Possible areas of application

Construction of semiconductor electronic devices: diodes and rectifiers, bipolar transistors, MOSFET, solar cells , integrated circuits, radiation detectors

Possible interested industries

All the manufacturers of semiconductor devices

Area of activity

Pyrochimie et Pyrometallurgie

Competence acquired

Electrolyse igné "Process chemistry"
Etudes thermodynamiques chimiques à haute temperature
(mesures de potentiel d'électrode en sels fondus -
mesure de solubilité dans les métaux liquides)

Experimental facilities

- Fours à haute température (H.F. 12 kW; H.F. 50 kW et 6 KW)
- Appareils de mesures classiques
- Possibilité de travailler avec radiotraceurs

Possible areas of application

- Procédés de métallurgie extractive
- Etude des piles ou accumulateurs à haute température
  (voir. Recherche en phase d'exploration)

Area of activity

High temperature pyrolysis of organic compounds
Degradation studies

Competence acquired

- Elaborated degradation studies of organic coolants
- Determination of the kinetic laws and calculation of the Arrhenius thermodynamic constants

Experimental facilities

An important set of ovens for operations up to 700°C

Possible areas of application

Testing of organic and inorganic compounds

Possible interested industries

Chemical industries interested in decomposition studies of high temperature resistant compounds

References see next page

References

- The thermal decomposition of o-, m-, and p-Terphenyls in the Presence of clay minerals (in Coll. with H.Rau)

- Paper presented before the division of petroleum chemistry, American Chemical Society, - Miami Beach Meeting, April 9.-14. 1967

Area of activity

Control, study and treatment of active and non-active effluents

Competence acquired

- Decontamination and purification of polluted water
- Combustion of high molecular weight compounds
- Flocculation-basic and applied studies

Experimental facilities

α, β, γ detectors
thin layer distillation column 20 kg/h
pilot flocculation - sedimentation installation 5 m^3/h
ζ potential-meter
submerged combustion installation 50 kg/h

Possible area of application

Water purification method "cascade" (pollution)
Deposition aspect in desalination

Possible interested industries

All industries concerned with water pollution

References see next page

References

- Gas-Phase controlled mass transfer of packed columns correlated to the loading point
R.Lopez Cardozo
Chem.Eng.Sci. 17, 783/796, 1962

- The decontamination of synthetic effluent by floating
Nature 199, 687/8, 1963
R.Lopez Cardozo and P. Dejonghe

Area of activity

Purification by distillation, liquid extraction and catalytic experiments

Competence acquired

- Distillation of organic coolants on pilot scale
- Purification by liquid extraction of high molecular weight compounds for organic coolants
- Catalytic elimination of chlorine and oxygenated compounds in organic coolants

Experimental facilities

- Distillation columns; liquid-liquid extraction laboratory plant 450°C, 10 mm Hg
- Loop and auto-claves and columns for catalytic experiments 450°C, 25 atm.
- Advanced equipment for basic catalyst studies (BE.T, DTA thermobalance, microscope, ultracentrifugation (50.000 rpm).

Possible areas of application

Catalytic studies - Particle size determination
Adsorption and desorption studies

Possible interested industries

Oil refining plant - catalytical processes

References see next page

References

- Minox, a catalytic Deoxygenation process for irradiated organic reactor coolants

  H. Langenkamp, R. Lopez Cardozo and H. Nordmeyer
  Euratom Ispra - Internal Report No. 1011/1966

VI) INFORMATICS

VI/1 BASIC SOFTWARE

VI/2 APPLICATION SOFTWARE

VI/3 TRANSMITTING SYSTEMS

Area of activity

Systems of coordinated subroutines to facilitate efficient use of peripherical devices or solution of special problems.

Competence acquired

CALCOMP routines - Set of Fortran oriented routines allowing a very easy preparation of a tape which will be used by a CALCOMP DATA PLOTTER. Although individual subroutines may be used for special purpose design, the realisation of a graphic with scaling data, axis graduation and labelling, plotting of several curves may be run with a simple call of a subroutine. Written for IBM 7090; then translated and adapted to IBM 360.

FIOT FORTRAN compatible input output package working in trap mode allowing complete overlapping of CPU and channel time.
(2 versions corresponding respectively to version 2 and 3 of Fortran II on IBM 7090)

LISTPROCESSING System of FORTRAN oriented subroutines allowing creation and manipulation of very complex lists of variable length data. Developed for IBM 360 and used in Hybrid Apache.

SAHYB Program running on IBM 7090 or IBM 360 under control of respective systems. Allows direct solution of systems of first order differential equations.
The evaluation of the derivates is expressed in a Fortran subroutine. Facility for use of tabulated functions, delay functions and automatic printing or plotting of results are provided.

Computing facilities

IBM 7090, IBM 360/65

Possible areas of application

General support to problem programming

Possible interested industries or organizations

All computing centers and European computer manufacturers

References see next page

References

External reports

P. Moinil, J. Pire : "Programmation relative au CALCOLP"
EUR 2280.f (1965)

P. Moinil, J.Pire : "Contour Map subroutines"
EUR 2241.f (1965)

J. Pire, L. Sangermano : "Fortran Input-output Package in Trap-Mode" EUR 2760.f (1966)

H. D'Hoop, R. Monterosso : "SAHYB-2: A Programme for the Solution of differential equations using an analogue oriented language"
EUR 3622.e (1967)

Area of activity

Simulation of computers on complex systems

Competence acquired

- Simulation of IBM 1401 on IBM 7090
- Simulation IBM Disks units 1301 of IBM 7090 computer on IBM 2311 dispacks units of 360/65 computer. Complement to IBM Emulator
- Simulation on IBM 360/65 of CAE 510 with console typewriter, paper tape reader and punch units, printer and card reader, drum with decentralisation unit. Simulation of special cadencers analog input, digital input and output, control console and teleprinters is implemented to take care of special needs of T.I.S. control system of reactor ESSOR. Simulation is developed with special regard to program debugging aid.

Computing facilities

IBM 7090, IBM 360/65

Possible areas of application

- Test and evaluation of new computer logic or other equipment at design level, system testing or evaluation, debugging
- Elimination of obsolated computers without need of reprogramming

Possible interested industries or organizations

All computing centers, european computers manufacturers

References see next page

References

External reports

A.F.R. Brown: "The Compilation and processing of IBM 1401 programs on the IBM 7090"
Vol. I : The compiler language programming manual
Vol. II : The compiler program description
Vol. III : The simulator program
Vol. IV : Flow charts of the compiler and of the simulator
EUR 2637.e (1966)

Area of activity

Definition of problem-oriented languages and development of corresponding compilers

Competence acquired

Special language for expression of problems depending on resolution of sets of differential equations.
The solution may be obtained by means of digital or analog computers. In this last case the compiler gives pannel connections and static check values (written for IBM 7090)(APACHE).

Development of previous language to take account of new possibilities as conditional assembly, use of external subroutines, logical variables etc., oriented versus more modern hybrid analog computers (Being developed on IBM 360)(Hybrid Apache)

Little "Fortran-like" language, giving immediate diagnostic and allowing immediate execution on statement basis; designed for remote console conversational use with IBM 360 (LICE).

A COBOL-like programming language which permits to compile programs on IBM 7090 which can be run on IBM 1401. Part of the system is a 1401 simulator on IBM 7090 which permits to run the problem directly.

Special purpose programming language for automatic processing of texts in natural language (SLC = Simulated Linguistic Computer). An operational version exists for IBM 7090. A new improved version is being developed for IBM 360 under O.S.

Computing facilities

IBM 360/65, IBM 7090

Possible areas of application

All fields (numerical or non numerical) of application where special problem-oriented programming language is advantageous.

Possible interested industries or organizations

All computing centers and european computer manufacturers

References see next page

References

A. Brown: "The SLC Programming language and systems for machine Translation"
Vol. I : Programming Manual (Revised Edition)
Vol.II : Utility programs
EUR. 2418.e (1965)

S. Perschke: "The compilation and processing Of IBM 1401 programs on the IBM 7090"
Vol. I : The compiler language programming manual
Vol. II : The compiler program description
Vol. III : The simulator program
Vol. IV : Flow charts of the compiler and of the simulator
EUR 2637.e (1966)

J. Annino, G. Buccari, A.Debroux, G.P. Del Bigio, H.D'Hoop, A.Geranzani, C.Green, C.Pigni, P.Wood:
"Internal structure of the Apache system and the procedure to use it on the digital computer"
EUR 2278.e (1965)

- "APACHE: Analog Programming and checking programmers manual"
EUR 2437. e (1965)

G. Buccari, G.P.Del Bigio, A.Geranzani, P.Sangermano - Wood:
"APACHE: Analog Programming and Checking - System programmers Guide"
EUR 3052. e (1966)

C. Bona: "An Apache subroutine for generating Pade's circuits"
EUR 3559.e (1967)

A. Caracciolo, I. Galligani: "Sulla soluzione di alcuni problemi relativi alla traduzione di un programma Fortran per la CEP"
Il traduttore Fortran per la CEP
Automazione e Strumentazione vol.X,1, 1963

Area of activity

Methods in Automatic Documentation

Competence acquired

- A project was started with the principal objective of automatic indexing within the framework of the EURATOM Nuclear Documentation System. Many tests had been performed which pointed out that with the approaches adopted automatic indexing can reach the level of routine work in manual indexing. An experimental system is being prepared with facilities for improvements. Experiences had been gained in text manipulations and association methods.
- The problem of association factors has been studied and some new approaches introduced for further research.

Computing facilities

IBM 360/65 and IBM 7090,
Text collections in machine readable form,
glossaries

Possible areas of application

- All kind of information retrieval systems (e.g. Documentation, Management Information)
- Information Retrieval, Automatic Indexing, Machine Translation

Possibly interested industries or organizations

Documentation Centers

References see next page

References

Contributions to congresses and meetings

Lustig, G.: Probleme der automatischen Schlagwortzuteilung
16. Jahresversammlung der Deutschen Gesellschaft für Dokumentation, Oktober 1964, Bad Dürkheim

Lustig, G.: Statistische Beziehungen zwischen Schlagwörtern und ihre Verwendung im Information Retrieval
17. Jahresversammlung der Deutschen Gesellschaft für Dokumentation, September 1965, Konstanz

Lustig, G.: A new Class of Association Factors
Proceedings of the FID-IFIP Conference on Mechanized Information Storage Retrieval and Dissemination
Rome 1967
North Holland Publishing Company, Amsterdam

Lustig, G.: The Development of a Automatic Indexing System at EURATOM. Proceedings of the 5th EURATOM-sponsored meeting of librarians working in the nuclear field, Ispra (Italy), April 1968 (in press)

Fangmeyer, H. and Lustig, G.: The EURATOM Automatic Indexing Project
Proceedings of the IFIP congress 68, Edingburgh

Contributions to scientific and technical journals

Lustig, G.: Die automatische Zuteilung von Schlagwörtern des EURATOM-Thesaurus,
NEUE TECHNIK 1968 (in press)

Area of activity

Machine Translation (MT), Machine-aided Translation (MAT)

Competence acquired

- Machine Translation: Operational Russian to English MT service for scientific and technical publications. Current awareness with the MT system (New Titles). MT of Russian abstacts and SDI in preparation. Experimental application of MT system in documentation (automatic assignment of English keywords to Russian abstracts). New Russian-English MT project in course of implementation.
- Machine-aided translation: Automatic compilation of multilanguage terminology glossaries (EUROTERM) in cooperation with the terminology office of the EEC.

  Automatic dictionary search facility for translators (DICAUTOM) developed by the University of Brussels under contract of EURATOM

Computing facilities

Special-purposes programming langauge SLC for natural language text processing operational with IBM 7090; in course of implementation in a modified and improved version (SLC-II) for IBM 360 under OS control
Machine dictionaries (Russian-English, 150.000 entries for science and technology). Concordances, Russian text collections on magnetic tape.

Keypunch service for Russian texts with IBM 026/029 and Russian keyboard Flexowriter

Possible areas of application

Scientific and technical information
Documentation

Possibly interested industries or organizations

Research offices and translation and documentation services

References see next page

References

Contributions to congresses and meetings

Perschke, S.: Der Stand der automatischen Sprachübersetzung; 17. Jahresversammlung der Deutschen Gesellschaft für Dokumentation, Konstanz, September 1965

Perschke, S.: The Use of The "SLC" System in Automatic Indexing. Proceedings of the FID-IFIP Conference on Mechanized Information Storage Retrieval and Dissemination, Rome 1967
North Holland Publishing Company, Amsterdam

Perschke, S.: The Use of Machine Translation in Documentation. Proceedings of the 5th EURATOM-sponsored meeting of librarians working in the nuclear field, Ispra (Italy), April 1968 (in press)

Contributions to scientific and technical journals

Perschke, S.: Machine translation - The second phase of development, Endeavour, Volume XXVII, No. 101, May 1968

Perschke, S. and Lustig, G.: Automatische Sprachübersetzung- Fünf Jahre praktischer Übersetzungsdienst Russisch-Englisch bei EURATOM, ATOMPRAXIS, Heft 4/5, 1968

Perschke, S.: Automatic language translation; its possibilities and limitations, EURATOM Bulletin No.2, 1967

External reports

Brown, A. :"The SLC Programming Language and System for Machine Translation" (2 volumes)
EURATOM Report EUR. 2418.e (1965)

Perschke, S.: Operational Analysis of Verbs
EURATOM Report EUR. 297 e (1963)

Perschke, S.: The Computer Programs of the SLC Systems for Machine Translation
EURATOM Report EUR.2583 e. (1965)

Area of activity

All kinds of administrative data processing (A.D.P.) comprising integrated systems and data collection

Competence acquired

Many kinds of A.D.P. problems, comprising library and documentation problems, statistical and management problems, have been solved for the European Communities.
The advanced type of data handling as intended by the term "integrated systems" has been undertaken:

- an integrated library system destined to handle all aspects of library management: acquisition, cataloguing, loan and bibliographical information. Various functions in this system are treated in real time (see ref.1)
- an integrated system performing maintenance planning, accounting of various disposable resources, financial accounting and the collection of reliability data for the ESSOR reactor (see ref.2)
- an integrated system covering planning, control of progress in production, cost, stock and personnel accounting for the mechanical fabrication department.

An analysis is going on for the construction of a management information system covering the Communitarian research.

Computing facilities

IBM 7090, IBM 1401, IBM 360/65(512K), IBM 360/30 (16K)
IBM display 2260, IBM 357 data collection system.

Possible areas of application

Various realised procedures are of a general interest and might be used by others with only minor modifications.
The vast experience acquired in different fields guarantees adequate solutions for all kinds of A.D.P. and management applications which might be required. Also an experience in teleprocessing use is available.

Possibly interested industries or organizations

In principle all governmental institutions, enterprises and libraries might be interested.

References see next page

References

Contributions to Congresses and Meetings

- Communication to the 5th Euratom Sponsored meeting of librarians working in the nuclear field - 24-25 April 1968, Ispra
  A.Petrucci, S. Capobianchi

- An integrated system for optimal management and reliability evaluation based on plant operation data
  Paper presented at the Meeting of the Specialists on the Reliability of electrical Supply Systems and related electro-mechanical components for nuclear reactor safety.
  27-28 June 1968, Ispra
  A. Schweitzer

Others

- Statistical Office of the European Communities - Foreign Trade - Analytical Tables

Area of activity

Analysis of Complex systems by means of mathematical models and computer aided simulation

Competence acquired

Detailed analysis of the behaviour of such physical or physico-chemical systems as photomultipliers, semiconductor detectors with special devices (diodes), multistage distillators, cracking furnaces. Macro-economical studies on the nuclear fuel consumption for the production of electric energy.

Computing facilities

Digital: IBM 7090, IBM 1401, IBM 360/65 (512K), IBM 360/30 (16K)

Possible areas of application

Econometrics, ecology, biological or biophysical studies, technical systems design

Possibly interested industries or organizations

Electronic, chemical, pharmaceutical industries, government administration

References see next page

References

Contribution to Congresses and Meetings

Cocchi et al.:"On the Use of a Ge(Li) detector for time measurements". International Symposium on Nuclear Electronics, Versailles 10-13 September 1968

Bertolini et al.: "Photofraction enhancement in Ge(Li) detectors", International Symposium on Nuclear Electronics, Versailles 10-13 Sept. 1968

Contributions to scientifique and technical journals

Bertolini et al.: "Time resolution measurements with fast photomultipliers", IEEE Trans. on N.S. October 1966

Cocchi et al.: "Light collection on a photocathode from a cylindrical scintillator", Nucl.Instr.and Methods, 46 (1967) 136-140

Rota et al.: "Time resolution measurements with XP 1020 photomultipliers", Nucl.Instr.and Meth.42 (1966) 109-117

Cocchi et al.: "Sulla simulazione, mediante techniche di Montecarlo, del comportamento di uno scintillatore cilindrico", Calcolo 3 N.2 (1966) 63-74

Cocchi et al.: "A new approach to high resolution timing with photomultipliers", IEEE transactions on N.S., February 1967

Rota et al.: " Some remarks on the scintillator PM system analysis for timing", Nucl.Instr.Meth. 55 (1967) 365-371

Caligiuri et al.: "L'analisi e il controllo ottimale di un forno per piroscissione", Automazione e Strumentazione, N° 7, 1967

External reports

Berg et al.: "Statistical criteria and data processing procedures adopted in a biological study of two fish species"
EUR 2545, Nov. 1965

Area of activity

Reactor Calculation

Competence acquired

Multigroup calculations of flux averaged cross-sections in heterogeneous systems. Multigroup diffusion and transport calculations for one and two dimensional systems. Burn-up calculations and analysis of the performances of different fuel management techniques in power reactors. Point and space dependent neutron-kinetics. Calculation of the thermohydraulic performances of reactor cooling systems. Dynamic simulation of power plants by means of digital or analogical techniques.

Computing facilities

Digital: IBM 360/65 (512K bytes), IBM 360/30 (16K bytes)
IBM 7090 (32K words), IBM 1401
Data plotter Calcomp
Nuclear Programs library (about 300 programs)

Analog: EAI-PACE 231 R (3 consoles)
Control Console ADIOS
SATANAS (semi-automatic analog patching device)
APACHE Compiler

Possible areas of application

Theoretical support to reactor design and analysis

References see next page

References

External reports

C. Tamagnini : "Basic Concepts of Lyra System" EUR 2778.e 1966

H. D'Hoop, R. Monterosso: "SAHYB (Simulation of Analogue and Hybrid Computer). A general purpose program for the solution of initial and boundary value problems", EUR 2519.e (1965)

A. Inzaghi, B. Montagnini, T. Pomentale: "Risoluzione numerica dell'equazione integrale del trasporto nella approssimazione ad una velocità e scattering isotopi in simmetria piana e cilindrica"

G. Gaggero, Gerini, Leoni, Van Erp: "MACACO-PREST: An analog model and a digital code for containment studies" EUR 3927.e, 1968

C. Tamagnini: "AIREK-MOD, A modified version of the kinetic code AIREK-II", EUR 1914.e

B. Dorpema, C. Ponti, C. Tamagnini: "CRE-An IBM 7090 code for the determination of the reactivity changes and flux shape due to control rod insertion in a reactor", EUR 2162.e

B. Borella, G.di Cola, G. Pozzi: "HYTHEST. A Monto Carlo program for the evaluation of correction factors in a BWR and PWR core" EUR 1587.e, 1964

Contributions to scientific and technical journal

T. Mongini, C. Mongini-Tamagnini: "Graduale invecchiamento delle barre di uranio durante il funzionamento di un reattore termico eterogeno ad uranio naturale" - Energia Nucleare No. 17, 1955

References

Contributions to congress and meeting:

T. GALLIGANI, C. MONGINI-TAMAGNINI, C. PONTI: "Some Nuclear Codes Developed at the Computing Center of Ispra", Winter Meeting of A.N.S., San Francisco 1964

C. MONGINI-TAMAGNINI, C. BONA: "PINETO - A Fortran code designed for the solution of non-linear differential equations in neutron dynamics", Conference on "Application of computing methods to reactor problems", Argonne May 1965

G.P. CALIGIURI, N. CLAES, H. D'HOOP, R. VINCHEVETSKI: "Recherche sur la simulation tridimensionelle des réacteurs nucléaires", Third International Analogue Computation Meeting, Opatija 5-8 Sept. 1963

S. ALBERTONI, G. BORTONE, B. FALESCHINI, C. TAMAGNINI: "A one dimensional time saving code for parametric studies on a slow digital computer", Geneve Conference 1958, A/CONF. 14/P

A. DE MATTEIS, P. GIACOBBE, C. MONGINI-TAMAGNINI: "A two groupe calculation for a finite asymetrical reactor", Vienna Seminar on Nucl. Codes 1960

G. GAGGERO, C.A. ARNEODO et al.: "The oscillation onset in a pressurized water natural circulation loop", Meeting on Two Phase Flow Dynamics, Eindhoven Sept. 4-8 1967

A. RICCI, C. MONGINI-TAMAGNINI: "THESIS, un codice per il calcolo iterativo di spettri termici", Giornate dell'Energia Nucleare, Dicembre 1961

C. MONGINI-TAMAGNINI et al.: Un programma di calcolo neutronico-termico per reattori moderati ad organico", VII Congresso Nucleare Roma, Giugno 1962

G. FATTORI: "GATHET and GAMET, two programs for calculation of energy and space dependent neutron spectrum in heterogeneous media", Reaktortagung 1968 of Deutschen Atomforum, München.

Area of activity

Theoretical support to experimental techniques

Competence acquired

Calculation of potential distribution and ion trajectories in complex electrostatic and magnetic lens systems. Optimization of gamma-ray and neutron detectors by means of Montecarlo and S_n transport techniques. Design of abacus for a variety of problems: gammagraphy of concrete, geological prospection, leak-rate conversion.
Calculation of transmutation in irradiated materials. damage in thermocouples and fission fragments production in fuel elements.
Calculation of neutron energy spectra for the interpretation of activation measurements.

Computing facilities

Digital: IBM 360/65 (512K bytes), IBM 360/30 (16K bytes),
IBM 7090 (32K words), IBM 1401,
Data Plotter Calcomp
Nuclear Programs library (about 300 programs)

Possible areas of application

Support to the design of technical facilities: charged particle accelerators, detectors. Aid to the analysis of experimental measurements.

References see next page

References

Contribution to Congresses and Meetings

G. Gaggero: "Monte Carlo Calculations of Ge(Li) Detector Efficiencies", Meeting on Fuel Burn-up Determination, Ispra, May 14-15 (1968)

Contribution to scientific and technical journals

G. Gaggero; L. Lesca et al.: "Determination of the Neutron Capture Resonance Integrals of Mn 55, I_n 115, Sb 121, Sb 123 and La 139."
Journal of Inorganic and Nuclear Chemistry

V. Cotecchia, A. Inzaghi, E. Pirastru, R. Ricchena : "Influence of the Physical and Chemical Properties of Soil on Measurements of Water-Content using Neutron Probes"
Journal of Geophysical Research (1967)

A. Malvivini, C. Tamagnini: "Sezioni d'urto e strumentazione per la loro misura". Energia Nucleare N. 18-1955

External Reports

G. Gaggero, L. Lesca, A. Bresesti, M. Bresesti, E. Orvini : "Calculations of the Epithermal Neutron Spectra in the Lena (TRIGA MARK II) Reactor and Determination of the Cobalt Resonance Capture Integral
EUR Report to be used

H. Ehringer, C. Mongini-Tamagnini, C. Ponti: "Thermocouple Composition Changes due to Neutron Irradiation"
EUR 3156.e (1966)

C. Tamagnini: "Burn-up determination of nuclear fuel"
EUR 3123.e (1966)

Patents

Circular calculator for the determination of the exposure time for concrete gammagraphy
(Deposed November 8, 1968, N° 53097 - England)

Area of application

Numerical Analysis

Competence acquired

Development of numerical methods for particular classes of scientific problems, construction of a library of scientific routines of general utility; evaluation of different algorithms in order to establish their "efficiency" and their "domain of validity".

Computing facilities

Digital: IBM 7090, IBM 1401, IBM 360/65 (512K), IBM 360/30 (16K), Data Plotter - Calcomp

General purpose scientific program Library (about 200 programs)

Possible areas of application

Development of programs for solving "time-independent and time-dependent" "diffusion" problems
Construction of general purpose scientific routines for different computing machines

References see next page

References

Publications

I. Galligani: Sui metodi di soluzione delle equazioni della diffusione neutronica - "Fisica del Reattore", edited by CNR (1966)

I. Galligani, M. Giorcelli: Numerical solution of diffusion equations with the Kantorovith method. - "Energia Nucleare", 13,2 (1966)

I. Galligani: Variational methods for the solution of problems of reactor kinetics. - A.N.I. 7050 (1965)

I. Galligani: Numerical solution of the time-dependent diffusion equations by using the alternating method of Saul'yev. - "Calcolo" II, 1 (suppl.). (1965)

I. Gargantini, T. Pomentale: Rational Chebyshev approximation to the Bessel functions integrals $Ki_s(x)$. - Comm. A.C.M.7, 12 (1964)

I. Galligani: Numerical experiments with direct and iterative methods for solving the algebraic eigenproblem. - Latmsckole Bezdruzice CSSR (1968)

External reports

I. Galligani: Soluzione numerica di alcuni problemi bidimensionali della diffusione neutronica col metodo variazionale di Ritz. EUR 2174.i (1964)

I. Galligani: Il metodo variazionale di Kantorovich-Ritz per risolvere numericamente alcuni problemi tridimensionali della diffusione neutronica. - EUR 2173.i (1964)

J.P. Ross: Some numerical schemas for neutron diffusion problems. EUR 3262.e (1967)

A. Daneri, I. Galligani: A numerical approach to the time-dependent diffusion equations. - EUR 3742.e (1968)

M.L. Demuru: Applicazione del metodo delle caratteristiche all'equazione integro differenziale lineare di Boltmann. - EUR 3632.i (1967)

A. Inzaghi, B. Montagnini, T. Pomentale: Risoluzione numerica della equazione integrale del trasporto. EUR 2410.i (1965)

R. Monterosso, E. Vincenti: Finite difference method for solving the spatiotemporal diffusion equation. - EUR 596.e (1964)

R.F. Gloden: Recherches de la meilleure approximation pour l'evaluation d'une fonction donnée. - EUR 282.f (1963), EUR 282.f (addendum) (1964)

R.F. Gloden: Calcul des fonctions de Bessel I_n moyennant les fractions continues. - EUR 2163.f (1965)

R.F. Gloden: Calcul des fonctions de Bessel I_n, J_n, K_n et Y_n moyennant les fractions continues. - EUR (1969)

G. Bassone, S. Orthmann: A test-program for pseudorandom numbers with uniform distribution. - EUR 3464.e (1967)

I. Galligani: A comparison of methods for computing the eigenvalues and eigenvectors of a matrix. - EUR 4055.e (1968)

S. Orthmann: A comparison of methods for polynomial curve fitting of discrete data. - EUR (1969)

G. Cuomo-Uolla: A comparison of methods for solving polynimial equations. - EUR (1969)

Area of application

Experimental data analysis and reduction

Competence acquired

Analysis and development of numerical and statistical methods to process experimental data. General procedures of data analysis; estimation and fitting problems; error analysis; identification and inverse problems.

Experimental and computing facilities

IBM 360/65, IBM 360/30 Data Plotter Calcomp
Curve-follower D-MAC
On line terminals (IBM 1050, 1070)
Remote sensors

Possible areas of application

Neutron, gamma, Beta, X-ray, mass spectrometry etc.

Possibly interested industries or organisations

Chemical, metallurgic and nuclear industries

References see next page

References

Contribution to Congresses and Meetings

A. Di Cola, A. Rota: Analysis and Development of the series expansion methods in threshold detector activation data handling. - Symposium on Fast and Epithermal Neutron Spectra in Reactors, Harwell, Dictot (G.B.) December 11-13 (1963)

G. Di Cola, A. Rota, G. Bertolini: Analysis of Numerical methods for theunfolding of Beta Spectra obtained by integral detectors. - 13th Nuclear Science Symposium Instrumentation in Space and Laboratory, Boston. Mass. - October 19-21 (1966)

F. Girardi, G. Guzzi, G. Di Cola, W. Becker, A. Termanini: Development of a direct connection between an activation analysis laboratory and an IBM 360/65 computer.- The 1968 International Conference Modern Trends in Activation Analysis National Bureau of Standards, Gaithersbury, Maryland october 7-11 (1968)

Contributions to Scientific and Technical Journals

J. Pauly, G. Guzzi, F. Girardi, A. Borella: Application of j-ray spectrometry and computer techniques to the determination of the minimum detectable content of trace elements in neutron activate materials. - Nucl. Instr. and Methods, 42, 15 (1965)

G. Di Cola, A. Rota: Calculation of differential Fast-Neutron spectra from threshol foil activation data by least-squares series expansion methods. - Nucl. Science and Engineering, 23, 344-353 (1965)

G. Di Cola, H. Matzke: The determination of rare gas diffusion following recoil labelling of plane or spherical solids. - Nucl. Instr. and Meth. 57 (1967)

External Reports

G. Guzzi, J. Pauly, F. Girardi, B. Dorpema: Computer program for calculations of specific activities of radioisotopes formed by (u,j) reaction. - EUR 3154.e (1966)

G. Guzzi, J. Pauly, F. Girardi, B. Dorpema: Computer program for activation analysis with germanium lithium drifted detectors.

M. Cocchi, G. Di Cola: Statistical study of the effects of measurements errors on the extrapolated radius and height calculation for a cylindrical reactor, - EUR 1624.e (1964)

G. Di Cola, A. Rota: RDMM- a code for fast netron spectra determination by activation analysis. - EUR 2985.e (1966)

A. Borella, G. Guzzi: Computer program system for a quantitative analysis by neutron activation and gamma-ray spectrometry. - EUR 531.e (1964)

Area of activity

Fluid and Magneto-Fluid-Dynamics

Competence acquired

The main source of problems in fluid- and magneto-fluid-dynamics has been in the domain of plasma physics and reactor safety.
Particularly phenomena of shock waves propagation and interaction have been studied.
The main effort has been done in the development and application of numerical methods for the solution of one and two-dimensional problems.

Computing facilities

IBM 7090, IBM 360/65
Data Plotter - Calcomp

Possible areas of application

Plasma physics, nuclear and aerospace engineering

Possibly interested industries or organizations

Nuclear and aerospace industries

References see next page

References

Contribution to Congresses and Meetings

S. Albertoni, C. Cercignani, P. Stella, A. Taroni: "Tecniche di simulazione e loro applicazione a certi problemi di fluidodinamica"- Convegno sulla simulazione, Venezia 27-28.5.1966
Supplemento Rivista Calcolo N°2 al Vol.III (1966)

S. Albertoni, C. Cercignani, A. Taroni, L. Guerri:" Numerical Computation Methods of Implosion Processes", Conference on Megagauss Magnetic Field Generation by Explosives and Related Experiments, Frascati Sept.1966
EUR 2750.e(1966) p.203-233

External reports

L. Guerri, P.Stella, A. Taroni:"Computation of the motion of a liner under the impact of a uniform gas flow".
EUR 3157.e (1966)

L. Guerri, P. Stella, A. Taroni: "Computation of the compression of a magnetic field by means of a liner driven by an explosion" - EUR 3288.e (1967)

P. Fasoli Stella, L. Guerri: "Propagazione e riflessione di impulsi di pressione in presenza di ostacoli piani e cilindrici".
EUR Report to be published

L. Guerri, A. Taroni: "Numerical experiments on the propagation of shocks in a polytropic gas"
EUR 2300.e (1965)

Others

B.V. Robouch, G. Di Cola
" Sur quelques actions noncylindriques de Z-pinch en chasse neige"
LGI 69/9 (1968)

Area of activity

Elasticity (Structural Dynamics and Stress Analysis)

Competence acquired

Various problems in structural dynamics and stress analysis have been solved analytically or numerically with the aid of a computer. A good experience has been acquired in the application of numerical methods. In particular a general code of structural dynamics has been developed which makes it possible to analyse a wide class of structures.

Computing facilities

IBM 7090, IBM 360/65, Data Plotter - Calcomp

Possible areas of application

Nuclear and mechanical engineering

Possibly intersted industries or organizations

Nuclear and mechanical industries

References see next page

References

External reports

A. Benuzzi, P. Fasoli Stella
"Studio numerico e analitico di un problema vibratorio con condizioni al contorno variabili nel tempo"
EUR report to be published

A. Benuzzi, L. Guerri, A. Verrini
"Analisi numerica di caratteristiche dinamiche di sistemi a numero elevato di gradi di libertà"
EUR report to be published

Area of activity

Independent or dependent supervisor systems for problem programs scheduling and libraries systems gestion with special control languages

Competence acquired

1401 system: independent system allowing quick look-up and loading of problem programs written on a library tape

GLEE system for IBM 7090. Allowing loading from disks programs and related data libraries, used in conjunction with Fortran II monitor and/or IBSYS system

EULPSS: independent system for IBM 360/30; allows use of tape program library or card read programs to be run in a multiprogramming environment

CARONTE System: through its control language allows the automatic execution of sequences of programs (both scientific and commercial oriented) in which automatic transfer of data is required. The system runs under O.S. of IBM 360. Programs and data are stored in auxiliary memories.

Teleprocessing system: extension and adaptation of H.A.S.P. system to allow use of automatic remote stations for data acquisition control of process etc. and/or conversational stations

Computing facilities

IBM 7090, IBM 360/65

Possible areas of application

All areas where more scientific specific control or facilities on computers, than those delivered by the manufacturers, are required.

Possibly interested industries or organizations

All computing centers and european computer manufacturers

References see next page

References

Contribution to Congresses and Meetings

Caronte: accepted for presentation at "The Effective use of Computers in the nuclear industry", conference at Knowville, Tennessee, April 21-23, 1969, and for publication in the Proceedings of the Tropical Meeting

External Reports

J. Pire, L. Sangermano: "EUMPSS 16K bande" multiperipheric supervisor system". Description et mode d'emploi EUR 3295.f (1967)

J.S. Annino, L. Sangermano: "GLEE Generalized library editor and executor". EUR 1843.e

Area of activity

Transmitting systems

- Telecommunication and teleprocessing
- Digital high speed data transmitting systems using cables

Competence acquired

- A frequency-multiplex-system for twenty channels providing a total data flux of 2. 10^3 Bauds has been developed (DATRAC).
- A bipolar - DC-pulse transmission system performing a data flux of 2.10^6 Bauds has been investigated, two prototype-stations (transmitters, receivers) have been realized. Half or full duplex mode can be achieved. Transmission distances are up to 3 km using a coaxial cable with 8 mm outer diameter. Special advantage of the system: damping-free ramifications allow connection of various remote stations and computers to one cable (ORLOC).
- A data link using the transmission modes of point 2) is operating for on-line connection of analyzers with the central computer 360/65 in the research center of Ispra.

Experimental facilities

Central computer IBM 360, terminals peripheral units IBM 1070, digital data sources (analyzers, digital voltmeters. etc.). Electronic laboratories for research, design and maintenance.
Production facilities for developed equipments.

Possible areas of application

Tele-processing, data transmission between f.i. central computer and remote stations.

References see next page

References

- Methode für die Auswahl der Trägerfrequenzen im DATRAC-System
EUR 2969.d
- Studie einer generellen technischen Lösung des Datenübertragungsproblems in einem Kernforschungszentrum
EUR 3470 d.