

Modulo 2:

Riferimento a linee guida	SCHEMA N: 16 AUTOVALUTAZIONE PROGRAMMA
3	Nome programma: Nuclear Analytical Techniques and Applications
3	Responsabile programma Paolo Rossi
3	Obiettivi specifici del programma <p>Techniques and devices developed for doing basic Nuclear Physics, such as accelerators and detectors, have found wide application in the analysis of materials, samples or structured systems. This program consists of three research lines that address specific issues with increasing practical impact and also have invented and developed new devices and methods. All the research lines have employed instrumentation and know how of the nearby National Laboratories of Legnaro (LNL). Their goals follow.</p> <p><i>Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices</i></p> <p>Ions have been employed to analyze materials and samples for many years. If the ion beam is focused to a micrometric size (Microprobes), one can even locally inspect the sample. A radically new form of nuclear microscopy, the Emission Microscopy, was invented a few years ago to address the need of performing localized single-ion analysis using ions that are difficult or even impossible to focus. It employs a low current, broad ion beam impinging on a sample. When a single ion strikes the sample, the emitted particles, such as electrons, photons or ions, are projected at great magnification onto a position sensitive detector (PSD). Eventually the position is put into coincidence with signals describing the ion effect one wants to inspect. The emission microscopy includes IEEM (Ion Electron Emission Microscopy), IPEM (Ion Photon Emission Microscopy), and HCI-SIMS (Highly Charged Ion-Secondary Ion Mass Spectroscopy).</p> <p>Applications include Ion Beam Induced Charge (IBIC) studies on semi-conducting and insulating materials, and single event upset evaluation on microchips and even biological cells in radiobiological effectiveness experiments.</p> <p>The main interest of this program is the application of IEEM and IPEM to test radiation hard microchips and pinpoint their radiation sensitive components. Current customers for this research are particle physics experiments that need front-end electronics harshly irradiated and satellite programs, but we anticipate much future work with IC industries. Nowadays, IC's tend to have thicker over-layers and are mounted in flip-chip packages, where the electronic features are buried hundreds of microns from the surface. All this requires ultra high-energy heavy-ions as test bullets, which may be provided by high energy cyclotrons. No device with reasonable cost and size can focus such ions and the only way to inspect their effect is an emission microscope.</p> <p>This program aims at both inventing and developing new emission devices and employing them to test IC's.</p>

Research line 2- Civil Security Applications

A first part of this research line is mainly devoted to the application of nuclear techniques in the detection of landmines in Humanitarian De-mining (HD) operations. It is indeed well known that the common tools used in HD operations (i.e. the scanning with metal detectors and than the manual prodding) are scarcely cost-effective because of the large number of false alarms due to metallic clutters. Consequently, there is a continuous search of new tools for improving the efficiency of HD operations. The use of nuclear techniques to detect hidden explosives is one of the field in which R&D projects were launched in past years.

This research started in Padova with the experiment EXPLODET (EXPLOsive DETection, collaboration between research groups from Alessandria-Bari-Legnaro-Padova-Pavia-Torino-Trento) funded by INFN in the years 1998-2002 aiming at applying neutron capture reactions on the nitrogen nuclei contained in the common explosives to detect landmines. The use of fast neutrons for the non destructive analysis of materials by the detection of the characteristic gamma rays emitted by the bombarded nuclei was explored in a project funded by MURST within the PRIN1999 program "Detection of Anti-personnel Landmine by using 14 MeV tagged neutrons" (Bari, Padova-Trento Collaboration) that was working in the years 2000-1. Under this project the use of neutron beams tagged by the associated particle emitted in the D+T reaction was extended to the case of fan beams produced also with portable sealed tube neutron generators (in collaboration with the French company SODERN). Moreover, a specific project was also funded by EU under the IST part of the 5th Framework Project for the development of a hand held de-mining sensor, combining a neutron back-scattering detector with a metal detector. This project, called DIAMINE (Detection and Identification of Anti-personnel Landmines by neutron backscattering) was working in the period 2001-2.

A second part of this research line is devoted to the contrast of Illicit trafficking. In the post September 11 era, the contrast of illicit trafficking is one of the priority in the political agenda to minimize the risk of terrorist actions with the use of Weapons of Mass Destruction. In this respect, the inspection of cargo container in the mayor seaports is an action due to the recent agreements between USA and EU governments under the so-called Container Security Initiative (CSI). The CSI agreement obliges to scan in the EU seaports all cargo container with final destination in US ports of entry. The search of hidden explosives is one of the tasks in this screening and is currently performed by using X-ray scanners. The X-ray inspection provides good quality images of the transported goods but extremely poor information about the nature of the material. This information can be obtained by the use of non destructive interrogation performed by fast neutrons.

The EU has launched under FP6 (IST) a project called EURITRACK (EURopean Illicit Trafficking Countermeasures Kit) aimed a constructing the first prototype of an European portal for neutronic scanning of cargo container. Such system will be installed at LeHavre (France) in the vicinity of a large X-Ray scanner currently in operation. The neutronic portal will be used to inspect those container which resulted suspect after the X-Ray scan. EURITRACK started October 2004 and will run until October 2007. The Padova group is responsible of the entire WorkPackage 3: Tagged Neutron Inspection System. More specifically, Padova is responsible of the detector for the associated particle that is used to tag the neutron beam and, together with CAEN, of the front-end electronics and DAQ, including the development of some

software tools.

The inspection of cargo container with neutrons is also pursued in the Project “Control of illicit trafficking of threat materials” Project n. 980526 funded by NATO under the Science for Peace program. This project is a collaboration between Padova (INFN Sezione di Padova) and the Institute Ruder Boskovic in Zagreb. It is a 3 years project started in April 2004. The Director of the Project is G. Nebbia (INFN Padova). Within this project the possibility of detect and identify radioactive and fissile material will be explored.

Research line 3. Aerosol Research with nuclear analytical techniques

A) Experimental methods and their development.

The PIXE-FISAMB set-up is a highly reliable device, constantly operational since 1982, measuring absolute elemental areal densities (ng cm^{-2}) with high sensitivity for $Z \geq 11$ (Na). In recent years this device has been extensively used by this group in the study of Antarctic Coastal Aerosol, moreover, an integrated system for systematic aerosol research in this field has and is being developed, including several new important features, among which: (1) development of semi-automatic SAP (Single Aerosol Particle) micro-PIXE analysis of size-segregated aerosol samples, presently covering the full supermicrometric size range and measuring absolute elemental masses (ng); (2) systematic use of various types of PCA (Principal Component Analysis) applied to both PIXE, size-segregated, multielemental data and micro-PIXE, size-segregated SAP data.

A parallel effort has been developed to improve the field aerosol sampling procedures and to perform systematic field aerosol sampling campaigns (4 austral summer campaigns up to now) using (in the last campaigns) two (twin) DEKATI SDI 12 stage ($12. \mu\text{m} \geq \varnothing_{\text{aer}} \geq 47. \text{nm}$) for size-segregated aerosol sampling. This feature allows the simultaneous collection of samples devoted to distinct analytical techniques complementary to PIXE: e.g. LDI-TOFMS (Laser Desorption Ionization Time Of Flight Mass Spectrometry), Ion Chromatography. TSI UCPC (Ultra fine Condensation Particle Counters, sensitivity $\varnothing \geq 7. \text{nm}$) allows detection of contamination or aerosol nucleation episodes.

Reconstruction of backward air mass trajectories (up to ~ 10 days) was also been performed.

B) Scientific research domain and state of the art.

Atmospheric aerosols play a central role in climatology, atmospheric chemistry, cloud physics transport of materials through the atmosphere, sea-air transport processes etc. Study of Antarctic Coastal Aerosol in a clean site (Campo Icaro, on the coast of the Ross Sea) is particularly attractive, due to the almost exclusive presence of three components of natural aerosol, of essential importance everywhere, from all the above points of view: sea-salt aerosol, crustal aerosol and the supermicrometric accumulation mode of S containing aerosol. This group has been active in this field since several years within the framework of programmes approved and financed by PNRA (Programma Nazionale di Ricerche in Antartide), which also gives a complete logistic support at M. Zucchelli Station and at Dôme Concorde. Results concerning bulk PIXE analysis of size-segregated samples of the 1999/2000 campaign are presented in the proceedings of the 2004 Kyoto ICNAA conference. They include: the size distributions of the mass concentration (ng m^{-3}) of up to 12 elements, as well as their representation with lognormal or power law distributions. Moreover, several

	<p>distinct types of (partially unconventional) Principal Component Analyses (PCA) were performed. Results include: the identification and time averaged size distributions of sea-salt aerosol, crustal aerosol and of the submicrometric sulphur accumulation mode; the existence and amount of an internal mixing of the crustal component with sea-salt aerosol; some of the main chemical interactions of the gaseous (or possibly, particle) sulphur and chlorine compounds, with the supermicrometric sea-salt aerosol particles as detected by means of sea-salt aerosol enrichments in S and depletion in Cl, with respect to sea water composition; the increasing importance of these phenomena for decreasing particle diameter; the interpretation of this fact as an evidence favoring the occurrence of the above mentioned interactions on the surface, rather than in the volume of the particles; the evidence of the contribution of crustal materials to the interaction of S compounds with the aerosol particles; an evaluation of the relative importance of, respectively, the super and the submicrometric size domains for the interactions of gaseous S compounds.</p> <p>Micro-PIXE SAP data concerning three samples of the above campaign (2000 particles) were submitted to PCA. Three Principal Components (PC's) were geochemically identified by means of their elemental profile and their correlations with elements, as: sea-salt, crustal and a (unexpected) "P+Ca" component, possibly originated by ornithogenic cryosols. (F. Chiminello et al. Nucl. Instr. & Meth. B, Vol. 219-220, pp. 171-175)</p> <p>C) Objectives</p> <p>Results presented in B, together with significant improvements both in sampling techniques (lower background levels; smaller measurement errors; use of two twin samplers) and in analytical techniques (in particular micro-PIXE), show feasibility and interest of systematic sampling campaigns with the following main objectives: (1) chemical interactions of gaseous S compounds with both the sub and supermicrometric aerosol fractions; (2) chemical interactions involving Cl in the full size-range; (3) detailed study of internal mixing between sea-salt and crustal materials, as an evidence of sea-air transport processes; (4) time dependence of intensity and shapes of the size-distributions of the various aerosol components and of their interactions, and thus, dependence on environmental conditions, etc.; (5) extension of the research domain to components (in particular ions) non-detectable with nuclear techniques.</p>
3	Progetti in corso
	<p><i>Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices</i></p> <p><i>Project 1.1 SIRAD</i></p> <p>The SIRAD irradiation facility at the Tandem accelerator of LNL is dedicated to bulk damage and single event effect studies in semiconductor devices and electronic systems for high energy physics and space applications. Bulk damage is a concern only if the substrate is a sensitive part of the device itself, such as in diodes, particle detectors, solar cells, light-emitting diodes and bipolar transistors. Atomic ionization produces charge accumulation in the thin oxide layer, affecting the device behavior. Single Event Effects (SEE) occur if enough ionization is created at a sensitive node</p>

or is induced in a high electric field region of an active device, e.g. during the passage of a single heavily ionizing particle.

At the typical Tandem operating voltage (14 MV) the available surface ion LET and range in silicon well cover the regions of interest for SEE studies, spanning from 0.37 to 81.7 MeVcm²/mg and from 378 to 23.4 μm for ⁷Li and ¹⁹⁷Au ions respectively. Irradiations are performed in vacuum to take advantage of the full beam energy. The insertion in SIRAD of more energetic ion beams coming from the PIAVE+ALPI complex will further increase the maximum LET and range. At present the beam spot size (2-3 mm) permits a millimetric mapping of the SEE sensitivity by a mechanical masking. This value will be soon pushed down to a micrometric level thanks to the IEEM project.

The irradiation chamber houses a new target holder designed to meet the European Space Agency (ESA) specifications in terms of target size and degrees of freedom, making it possible to install big targets and move them with micrometric precision along three linear axis, plus a rotation one, allowing irradiation of a large number of different samples without breaking the vacuum.

Bulk damage studies require penetrating particles (p⁺ and ⁷Li) to allow a constant energy loss along the track. In order to uniformly irradiate a large target, the focused beam is rastered by a system of vertical and horizontal electrostatic deflection plates. Beam diagnostics, performed by a system of Faraday cups or diodes located near the target plane, allows monitoring of beam current and uniformity up to few percent.

The SIRAD set-up has been (and is being) successfully used for studies as heavy ion effects in power diodes, in thin gate oxides, in FPGA devices and floating-gate memory cells, and SEU and latch-up tests on electronic chips for high energy physics and space applications, in collaboration with various Universities, Research Centers and Industrial groups.

SIRAD activities are funded by University and Sezione INFN of Padova.

Research for radiation hard power devices is co-funded by STMicroelectronics within the European Galileo Project.

Project 1.2. A new design IEEM

The feature size of modern electronic devices sets the size of the smaller active cell at the micron scale, and this is consequently the spatial resolution the measuring instrument needs to match. An Ion Electron Emission Microscope, IEEM, aimed to map at the micron level the sensitivity to Single Events Effects of electronic devices has been developed at the SIRAD facility. This novel technique, proposed and pioneered by B. Doyle of SANDIA National Laboratory, uses a broad heavy ions beam to map the response of an electronic device respect to the impinging particle with a lateral resolution equal or better than one micron.

To register the impact position of the incoming particle to the target plane, a commercial Photon Electron Emission Microscope is used to image (with a 160 magnification factor) the secondary electrons emitted by the target surface when the particle strikes on it. Since only a few electrons reach the microscope focal plane, a Microchannel Plate (MCP) is used to multiply this thin signal by a factor ~10⁷. The electron cloud at the output of the MCP hit a phosphor layer (P47) so generating a light signal which is collected outside the chamber by the mean of an optical system by a novel device, developed by the SIRAD group, able to perform two dimensional imaging of the luminous spot with a frame rate of by about 10 kHz and a spatial resolution better than 800*800 points over the 25mm diameter circular FOV. This device uses of a couple of linear pixels array instead of a square one: a specifically

designed optical system makes possible using each one of the linear sensors to read one single spatial coordinate. This arrangement reduces the amount of data to read to the square root of an equivalent dimension pixel square array, speeding up the frame rate of the same factor (the two sensors are read simultaneously), i.e. a factor 1000 respect to a one million pixel square array. An FPGA based signal analysis system analyzes and converts the sensors output signals to a spatial position and directly send it to the control computer via simple USB connection, with the need of no other components/interfaces.

The whole system has been tested to meet the resolution and speed requirements with passive targets. Tests with an active target, a SDRAM, are planned in Spring 2006.

IEEM project is funded by University of Padova and INFN.

Project 1.3. Alpha-IPEM

This device has been recently invented at Sandia National Laboratories, USA, in collaboration with the University of Padova and the INFN.

It employs a low current, broad ion beam impinging on a sample, previously coated or simply covered with a few microns of a fast, highly efficient phosphor layer. The light produced at the single ion impact point is collected with an optical microscope and projected at high magnification onto a single photon position sensitive detector (PSD).

Two particularly attractive attributes of IPEM are (1) its use in ambient air and (2) its practice using alpha particle sources ameliorating the need of an accelerator (Alpha-IPEM). The great advantage of an Alpha-IPEM is low cost and a negligible size, that of a table-top optical microscope. For this invention, one of us has been co-awarded the R&D100 prize for the year 2005 decided by the R&D magazine for the best 100 inventions of the year.

Since early tests indicate a reduced spatial resolution, due to a peculiar blooming effect of the light trapped inside the phosphor, we work to substitute the phosphor sheet with a structured light emitter.

To this purpose, we are developing a “Microscopic Gridded Phosphor” (also called Black Matrix) where the phosphor nanocrystals are confined within the gaps of a micrometer scale opaque grid, which limits the amount of detrimental light blooming. We are employing MeV-energy proton beam lithography, which is ideally suited to lithographically form masks for the grid because its high aspect ratio, pattern density and sub-micron resolution. Our metal micro-grids promise an order-of-magnitude improvement in the resolution of IPEM.

Research line 2- Civil Security Applications

Project 2.1 EURITRACK.

This project has been funded by EU under FP6. Padova is officially participating as Sezione INFN. The Padova group have already delivered the detector for associate particle that will be integrated in a sealed neutron generator by SODERN (France). Test of the neutron generator are planned during 2006. In the same year, the front-end electronics and the associated DAQ and off-line software will be delivered in collaboration with CAEN. Integration of the portal is planned starting from September 2006 at CEN Saclay (CEA-France). During 2007 the portal will be installed at LeHavre and used during a 6 months long demonstration period. The

portal is mainly design to detect the presence of Highly Explosive (HE) material.

*Project 2.2 Project 980526 Science for Peace
(Collaboration between Italy and Croatia)*

A test site has been prepared at IRB Zagreb and is currently used to test detection scheme for HE as well as radioactive and fissile materials. Development of new detectors to be used for producing tagged neutron beams with the use of sealed neutron generators is planned for the near future.

Research line 3. Aerosol Research with nuclear analytical techniques

*Project 3.1. Marine and Continental Aerosol at Baia Terra Nova (Antarctica):
Chemical Interactions, Mixing and Transport Processes.
PNRA identification name: < MITTNEI >*

The previously mentioned aerosol components and their interactions can be conveniently studied in conditions of little contributions from outside the Antarctic region and of low anthropogenic background (I.4). Use of PIXE and micro-PIXE allows detection of both the soluble and insoluble aerosol fractions. The use of complementary analytical techniques is made possible by the twin samplers procedure

1) Recently available results:

a) Experimental and methodological results

- 3 continuous (2-3 months), summer sampling (48 hr duration) campaigns at Baia Terra Nova; size segregated samples; two samplers now available; lower background levels

- PIXE and micro-PIXE analyses currently going on

- Essential improvements in micro-PIXE SAP analysis concern: extension of SDI size domain; mass measurements; automatization.

b)Scientific results:

- PIXE (bulk) data; substantial methodological improvements allow now a quite satisfactory description of the aerosol system in each individual sample, rather than through average properties of a set of samples. The description includes fitted shapes of elemental size distributions, enrichments, depletions, down to small diameters, together with analyses of correlations between elements. Considerable intersample variability of shapes and intensities is now observed, opening the way to a study of connections with environmental parameters. Preliminary results were presented at the Beijing IAMAS 2005 conference.

- Micro-PIXE SAP data

Substantially improved procedures allow a successful geochemical modeling of new data (3 samples, 4 SDI stages, 2800 particles) within PCA, with 2 Principal Components only. An absolute dominance of internal mixing, IM, of crustal materials with sea-salt materials is found, vs. a possible External Mixing. IM, as described by means of the elemental profiles of the two PC's, displays typical elemental ratios of (strongly enriched) crustal elements. This is a rather strong evidence of sea-air transport processes of crustal materials through sea-salt aerosol formation processes.

	<p>This also implies presence and role of natural surfactants. Preliminary evidence is found of increased enrichments, and thus of stronger interactions, of element S with those particles containing crustal materials. (D. Biancato et al., Nucl. Instr. & Meth. B, accepted for publication)</p> <ul style="list-style-type: none"> •LDI-TOMF analysis (IV1) of some samples at University of California, Davis, display evidence of several distinct N and S compounds, together with distinct C aggregation states. <p>2) Possible extension of Aerosol sampling at the site Dome Concorde. This scientifically very interesting extension is now made possible by the operational conditions of the local laboratory, logistic support by PNRA and collaboration with other groups. Preliminary studies were proposed in the above 2004/2006 program.</p> <p>3) Remarks on other possible developments</p> <p>a) Present use of the PIXE-FISAMB set-up by other research groups The constant operativeness, the reliability and the sensitivity of the set-up make it an ideal instrument to be used by external groups, technically supported by our group. The most important scientific application is, at present, a contribution to the analysis of ice cores collected in Antarctica (EPICA project at DOME C, and possibly other sites), for studies concerning the climates of the past. Such studies widely concern the properties of the aerosol in the past. Possible connection with our present research line can be envisaged.</p> <p>b) Urban aerosol studies. The system is well fit for in-depth studies of this type</p>
4.b	Risorse personale
	<p><i>[professori ordinari, associati, ricercatori e dottorandi, borsisti post dottorato, assegnisti, personale tecnico-amministrativo]</i></p> <p><i>Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices</i></p> <p><i>Staff</i> D. Bisello (PO) M. Nigro (PO) J. Wyss (PA- University of Cassino) P. Rossi (PA)</p> <p><i>Assegnisti & postdoc</i> A. Candelori (INFN, from 2202 to 2005) R. Rando (INFN, since 2005) A. Kaminsky (INFN, since 2002)</p> <p><i>Dottorandi</i> P. Giubilato (from 2002 to 2005) S. Mattiazzo (since 2004) R. Rando (from 2001 to 2004)</p> <p><i>Personale Tecnico</i> D. Pantano M. Tessaro (INFN Sez. Padova)</p>

Research line 2- Civil Security Applications

Staff

G. Viesti (PA)
M. Morando (PO)
L. Lunardon (RU since 2005)
(G. Nebbia INFN Sez. Padova)
(D. Fabris INFN Sez. Padova)

Assegnisti e Post-doc

M. Lunardon (AssRic 01-03)
S. Moretto (BPD04-05, AssRic 05-07)
(S. Pesente INFN Sez. Padova 2004-2005)

Dottorandi

S. Pesente (2001-3)

Personale Tecnico

M. Caldugno

Research line 3. Aerosol Research with nuclear Analytical techniques

Staff

P. Mittner (formerly, until 31/10/2004, full professor; now with a research contract by the Physics Department)

Assegnisti

F. Chiminello (BPD from 2001 to 2002, AssRic from 2003 to 2004)

Personale tecnico

D. Ceccato

5.b

Risorse finanziarie [media quinquennale]

[la somma di finanziamento ordinario d'Ateneo finanziamenti specifici d'ateneo, finanziamenti specifici da enti di ricerca locali, nazionali e internazionali, finanziamenti da contratti con enti privati.]

Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices

Funding Source	Budget 2001-5 (€)
MIUR	0
ATENEO	22.5
INFN	11.5
OTHERS	6.0
TOTAL	40.0
Average per year	8.

Research line 2- Civil Security Applications

-COFIN99: 2000-2002 Padova Unit funds: 123.433 Euro
 -60 % total 20500 Euro
 -Progetto Ricerca Ateneo 2002: 95000 Euro
 -INFN CSN V (Experiments EXPLODET and AENEAS) Total 2001-3: 91500 Euro
 -EU FUNDS (via INFN)
 -DIAMINE FP5: Padova group: 18000 Euro 2001; 17000 Euro 2002. EURITRACK
 FP6: October 2004-October 2007 Total Budget: 192000 Euro , about 64000 Euro per year.
 Total EU (2001-5): 99000 Euro

Funding Source	Budget 2001-5 (€)
MIUR	61700
ATENEIO	1155000
INFN	91500
EU FP5-FP6	99000
TOTAL	367700
Average per year	73540

Research line 3. Aerosol Research with nuclear Analytical techniques

Funding Source	Budget 2001-5 (€)
MIUR	0
ATENEIO	1000
INFN	0
PNRA	118776
TOTAL	119776
Average per year	23.955

GRAND TOTAL

Funding Source	Budget 2001-5 (k€)
MIUR	61.7
ATENEIO	139
INFN	103.0
OTHERS	223.8
TOTAL	527.5
Average per year	105.5

7 Rapporti con altri istituti di ricerca a livello locale, nazionale e internazionale

7.a [specificare concretamente quanto indicato sotto collaborazioni istituzionalizzate indicate al punto 1 della scheda di Dipartimento]

Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices

1. The research activities in this field are performed at the INFN Laboratori Nazionali of Legnaro (Padova) within the agreement signed between the Physics Department of the Padova University and the INFN Legnaro Laboratory.
2. SIRAD host a research activity funded by STMicroelectronics (Catania) for the validation

	<p>for space applications of electronic power devices in the framework of the ESA Galileo project thanks to an agreement signed between STM and the Physics Department of the Padova University.</p> <p>Research line 2- Civil Security Applications</p> <ol style="list-style-type: none"> 1. The research activities in the field of Civil Security applications of nuclear techniques has been carried out within the agreement between the Physics Department of the Padova University and the INFN Sezione di Padova. 2. A specific Memorandum of Understanding has been signed between the Physics Department of the Padova University and the Institute Ruder Boskovic of Zagreb (Croatia). 3. Participation to the FP5 project DIAMINE Project (Detection and Imaging of Anti-Personel Landmines by Neutron Backscattering techniques) was in collaboration with industries (Laben, Caen, Neuricam, Wiener, Vallon) and research institutes (INFN, IoP-SAS Bratislava, JRC-IRMM Geel, IRB Zagreb). 4. Participation to the FP6 project EURITRACK (EUROpean Illicit TRAfficking Countermeasures Kit) is in collaboration with industries (SODERN, DAPHIMO, CAEN), research institutes (INFN, CEA, IPJ Poland, KTH Stockholm, JRC Ispra, IRB Zagreb) and the French Customs. 5. The COFIN99 project “Detection of Anti-personnel Landmine by using 14 MeV tagged neutrons” was a collaboration between the Physics Departments of Padova, Bari and Trento (National Coordinator G. Viesti). <p>Research line 3. Aerosol Research with nuclear Analytical techniques</p> <ol style="list-style-type: none"> 1. LNL-INFN. Scientific programs involving the use of the PIXE-FISAMB set-up and of the LNL micro-PIXE facility are submitted to the “User Selection Panel” of the LNL. On the other hand, use of the PIXE-FISAMB set-up by external research groups with technical assistance (in particular x-ray detector energy and efficiency calibrations; use of Gupix software), is a usual practice, made possible by the constant presence of a member of this group in our laboratory at LNL. 2. PNRA (Programma Nazionale di Ricerche in Antartide) examines (international refereeing) and funds the research programs, within the framework of the “Physics and Chemistry of the Atmosphere” section. The systematic sampling campaigns of our group are performed with full logistic support of PNRA, concerning installation of sampling devices as well as sample conservation and transport. PNRA members and members of other research teams may partially help during samplings.
7.b	<p><i>[Indicare collaborazioni personali non istituzionalizzate ma rilevanti per il programma]</i></p> <p>Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices</p> <ol style="list-style-type: none"> 1. Collaboration with the Department “Radiation Solid Interactions and Processing”, directed by Barney L. Doyle, part of Sandia National Laboratories (SNL), NM, USA. This Department is committed to assessing radiation hard microchips with nuclear techniques and developing and inventing new devices to this purpose. 2. P. Rossi has been “Faculty Sabbatical” at SNL from Aug/2001 to Sep /2004. 3. Collaboration with the “Ion Beam Modification & Analysis Laboratory”, of the University of North Texas, TX, USA, directed by Prof. Floyd Del McDaniel. This is an outstanding institution as for analytical nuclear techniques. 4. The research activity at SIRAD has been performed in collaboration with:

	<p>[1]Dipartimento di Ingegneria Nucleare, Politecnico di Milano; [2]Istituto Nazionale di Astrofisica – IASF, Milano; [3]CERN, Geneve, Switzerland; [4]Imperial College, London, UK; [5]Dipartimento di Ingegneria dell'Informazione, Università di Padova; [6]ST Microelectronics, Agrate Brianza, Milano; [7]Dipartimento di Ingegneria Elettronica, Università di Roma "Tor Vergata"; [8]Centro per la Ricerca Scientifica e Tecnologica, ITC-irst, Trento; [9]INFN, Sezione di Trieste; [10]Dipartimento di Energetica, Università di Firenze and INFN, Sezione di Firenze; [11]Center for Advanced Research in Space Optics (CARSO), Trieste; [12]DAEIMI, Università di Cassino; [13]ST Microelectronics, Catania; [14]Sanitas EG, Milano; [15]Dipartimento di Informatica e Telecomunicazioni, Università di Trento; [16]INFN, Sezione di Ferrara; [17]Galileo Avionica, Milano; [18]TOPREL, Roma; [19]Galileo Avionica, Campi Bisenzio, Firenze; [20]Dipartimento di Ingegneria Industriale, Università di Bergamo; [21]Clemenson University, South Carolina, USA; [22]IMEC, Leuven, Belgium; [23]Dipartimento di Elettronica, Università di Pavia and INFN, Sezione di Pavia; [24]Dipartimento di Automatica e Informatica, Politecnico di Torino; [25]Philips Semiconductors, Nijmegen, Netherlands; [26]DSM, Università di Cassino; [27]SCIPP, University of California at Santa Cruz, USA; [28]Tecnomare, Venezia; [29]SLAC, Stanford University, Stanford, USA.</p> <p>5. IEEM construction is performed in collaboration with University of Cassino and University of Roma II “Tor Vergata”.</p> <p>Research line 2- Civil Security Applications</p> <p>G. Viesti</p> <ol style="list-style-type: none"> 1. Chief Scientific Investigator of the project "Exploring the limits in the detection of Land-Mine by neutron induced reactions", part of the IAEA Coordinated Research Project “Application of Nuclear Techniques to Antipersonnel Landmines Identification”. 2. Visiting Scientist (2005) at the Institute of Advanced Energy Kyoto as consultant to the Japanese Humanitarian De-mining program. 3. External Collaborator of the Khlopin Radium Institute , St. Petersburg (Russia) in the project ISTC 1050 funded by the International Science and Technology Centre (Moscow) on the application of nuclear techniques in the detection of explosives. 4. Training activities organized by IAEA: training of Egyptians researchers on the use of neutrons for non destructive inspection. Five months training during 2005. Training fee 5000 Euro <p>Research line 3. Aerosol Research with nuclear Analytical techniques</p> <ol style="list-style-type: none"> 1. An informal agreement with the Chemistry Department at University of California – Davis, Prof. P.B. Kelly, allowed (a) the recognition of a very low background level in aluminum blanks in LDI-TOFMS analysis; (b) the successful analysis of some SDI aerosol samples with the same method; (c) the participation of a Davis research fellow to the last sampling campaign in Antarctica; (d) first significant scientific results. 2. Preliminary feasibility tests of micro-PIXE SAP measurements in the sub-micrometric size range were performed at the LIPSION facility of Leipzig University (prof. T. Butz)
9	<p>Altre attività rilevanti per la ricerca, a livello di Programma</p>
	<p>[organizzazione di seminari e convegni, partecipazione a seminari e convegni, ecc..]</p> <p>Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices</p> <p><i>Committee Memberships and Conference organizations</i></p> <ol style="list-style-type: none"> 1. Workshop RADECS, September 19-20, 2002, Padova, Jointly organized by the

Department of Physics and the Department of Information Engineering of the Padova University, in collaboration with INFN, ASI and RADECS. D. Bisello chairman of the Organizing committee.

2. First National Course: "Detectors and Electronics for High Energy Physics, Astrophysics and Spatial Applications", Legnaro 4-8 April 2005. The course dedicated to Italian PhD students, young researchers and engineers from Universities, Research Institutes and Industries (27 speakers, 72 students) was organized by the Department of Physics in collaboration with the Department of Information Engineering of the Padova University, INFN, ASI and RADECS. D. Bisello co-chairman of the Scientific committee; A. Candelori chairman, P. Giubilato and R. Rando members of the Organizing committee.
3. P. Rossi has been member of the Program Committee of the *Ion Beam Analysis Conference*, Albuquerque, NM, June 29 – July 4, 2003

Presentations and invited talks

1. A. Candelori, D. Contarato, N. Bacchetta, D. Bisello, G. Hall, E. Noah, M. Raymond and J. Wyss, "High Energy Ion Irradiation Effects on Thin Oxide p-Channel MOSFETs", RADECS 2001, September 10-14, 2001, Grenoble, France
2. D. Bisello, A. Candelori, P. Colautti, A. Dainelli, P. Giubilato, G. Fortuna, A. Kaminski, S. Lora, D. Pantano, V. Rigato, P. Rossi, M. Tessaro and J. Wyss, "Irradiation Facilities for Electronic Device Testing at the INFN National Laboratory of Legnaro", RADECS 2002, September 19-20, 2002, Padova, Italy
3. A. Candelori, D. Bisello, P. Giubilato, A. Kaminski, D. Pantano, R. Rando, M. Tessaro and J. Wyss, "The SIRAD Irradiation Facility for Bulk Damage and Single Event Effect Studies", RADECS 2003, September 15-19, 2003, Noordwijk, The Netherlands
4. A. Candelori, R. Bainbridge, P. Barrillon, D. Bisello, M. J. French, G. Hall, A. Kaminski, V. Khomenkov, E. Noah, M. Raymond, L. Stefanutti, M. Tessaro, "Radiation Hardness Qualification of the APV25 Chip Production for the CMS Experiment", 10th Vienna Conference on Instrumentations, February 16-21, 2004, Vienna, Austria,
5. P. Rossi, E. Vittone, B.L. Doyle, R. Cherubini, A. Battistella, G. Gennaro, L. Giacomelli, A. Lo Giudice, C. Manfredotti, D. Zafiroopoulos, "ALBA: Alpha Light-Based Analysis. A New Approach to Single-Cell Irradiation", Talk given at the 5th International Workshop on Microbeam Probes of Cellular Radiation Response, Stresa (Lago Maggiore) Italy, May 27, 2001 (Pres. by P. Rossi)
6. P. Rossi, B.L. Doyle, J.C. Banks, A. Battistella, G. Gennaro, F.D. McDaniel, M. Mellon,
7. E. Vittone, G. Vizkelethy, N.D. Wing, "Ion Photon Emission Microscopy", 8th ICNMTA, Takasaky, Japan, Sep. 8-13, 2002 (Pres. by P. Rossi)
8. P. Rossi, D.K. Brice, B.L. Doyle, "Spatial distribution measured by the modulation transfer function", 8th ICNMTA, Takasaky, Japan, Sep. 8-13, 2002 (Pres. by P. Rossi)
9. B. L. Doyle, P. Rossi, F.D. McDaniel, G. Vizkelethy, N.D. Wing, Performance and early application of a ion Photon Emission Microscope (IPEM). 17th CAARI, Denton (TX). 12-16 Novembre 2002 (Invited Talk by P. Rossi)
10. P. Rossi, B.L. Doyle, J.C. Banks, A. Battistella, G. Gennaro, F.D. McDaniel, M. Mellon, E. Vittone, G. Vizkelethy, N.D. Wing, "Single Cell Irradiation Microscopy with a Radioactive Source", 17th CAARI, Denton (TX). 12-16 Novembre 2002, (Invited Talk by P. Rossi)
11. P. Rossi, D.K. Brice, C.H. Seager, F.D. McDaniel, G. Vizkelethy, B.L. Doyle, "Ion Beam Induced Luminescence of Doped Yttrium Compounds", Ion Beam Analysis Conference (IBA2003), Albuquerque, NM, June 29-July 4, 2003 (pres. by P. Rossi)
12. P. Rossi, B.L. Doyle, G. Vizkelethy, D.S. Walsh, F.D. McDaniel, "Ion-Induced Emission Microscopy for Ion Beam Analysis", Ion Beam Analysis Conference (IBA2003), Albuquerque, NM, June 29-July 4, 2003 (Invited talk by P. Rossi)
13. P. Rossi, B.L. Doyle, V. Auzelyte, Floyd D. McDaniel, M. Mellon, "Performance of an Alpha-IPEM", 17th IBA, Sevilla, Spain, Jun 26- Jul 1, 2005, (Pres. by P. Rossi)

Research line 2- Civil Security Applications

Committee Memberships and Conference organizations

G. Viesti:

1. Technical Chair of the International Conference EUDEM-SCOTT on the Humanitarian De-mining (Brussels September 2003).
2. Chairman of the International Program Committee of the EPS Divisional Conference "New Trends in Nuclear Physics Applications and Technology", Pavia September 2005.

Presentations and invited talks

G. Viesti:

1. *Applicazioni di tecniche nucleari nel campo della sicurezza e del contrasto del contrabbando*. Lectures at the Giornate di Studio sui Rivelatori, Villa Gualino (To), February 2001.
2. *Application of nuclear techniques to Humanitarian De-mining*. Seminar JRC IRMN Geel (Belgium) June 2001
3. *The DIAMINE project*. Invited Talk at the IAEA Second Research Coordination Meeting on the Application of Nuclear Techniques to Antipersonnel Landmines Identification, S. Petersburg September 2001.
4. *Reazioni nucleari indotte da neutroni su nuclei leggeri. Sviluppo di sensori per esplosivi nascosti*. Workshop INFN sulla Dosimetria, Roma 5-6 February 2002
5. *The Italian EXPLODET project: advanced nuclear techniques for the detection of hidden explosives*. Seminar BARC MUMBAI, February 2002.
6. *The Italian EXPLODET project: advanced nuclear techniques for the detection of hidden explosives*. Seminar Institute of Physics Bhubaneswar (India), February 2002.
7. *A large area scanning system using 14 MeV neutron tagged beams for non destructive assays*. Talk at the IRMMA-V Conference, Bologna June 2002.
8. *The use of nuclear techniques in counter terrorism applications*. Seminar LNS Catania Settembre 2002.
9. *Detecting landmines by neutron induced reactions: the DIAMINE sensor*. Invited Talk at the International Workshop on Detecting Environmental, Industrial and Biomedical Signals Bari 11-12 October 2002
10. *The DIAMINE - Landmine Detection System*. Invited talk at the CAARI 2002, Conf. on Application of Accelerators in Research and Industry, Denton USA November 2002.
11. *The DIAMINE landmine detection system*. Presentation at the CRP IAEA, Vienna May 2003.
12. *Bulk Explosive Detection by Neutron Interrogation: Results from the EXPLODET Collaboration*. Invited Talk NATO ARW #979920 "Detection of bulk explosives: advanced techniques against terrorism", Saint-Petersburg, Russia, 16 – 21 June, 2003.
13. *Performance and limitations of neutron backscattering sensors*. Talk at the De-mining International Conference EUDEM-SCOTT 2003, Brussel September 2003.
14. *The soil moisture and its relevance to the landmine detection*. Invited Talk, Conferenza SIF Parma, September 2003.
15. *Che fine ha fatto EXPLODET*. Seminar, Università di Bari, October 2003.
16. *Large area scanning system using 14 MeV neutron tagged beams for the detection of hidden explosives*. Relazione su invito al NEMEA (Neutron Measurements and Evaluation for Application) Workshop, Budapest 5-8 Novembre 2003.
17. *The Laboratory for interdisciplinary applications of Neutrons*, Presentation at the SIRAD Workshop, LNL Aprile 2004.
18. Development of Antipersonnel Mine Detection Methods in Italy, invited talk at the Technical Meeting on the Project of the R&D for Supporting Antipersonnel Mine Detection and Removal Activities Program, Kyoto (Japan) 3-4 March 2005.
19. The EURITRACK project, presentation at the IAEA Technical Meeting on "Neutron Generators for Detection of Explosives and Illicit Materials", Vienna, 13-16 June 2005
20. Use of neutrons for the detection of explosives in Civil Security applications, Invited Talk, VI Latin American Symposium on Nuclear Physics and Applications Iguazù, Argentina. October 3 to 7, 2005

Research line 3. Aerosol Research with nuclear Analytical techniques

Presentations and invited talks

1. F. Chiminello, D. Ceccato, P. Mittner, “Single Particle Micro-PIXE Analysis of Size Segregated Aerosol Samples Collected at Terra Nova Bay (Antarctica) Preliminary Results”, Proceedings of IAC 2002 (Sixth International Aerosol Conference), September 9-13, 2002 Taipei Taiwan, Editor: Chiu-Sen Wang, ISBN 986-80544-1-9 (Pres. by Francesco Chiminello)
2. F. Chiminello, P. Mittner, A. Trevisiol and D. Ceccato, “Three Major Components of Natural Aerosol and Their Interactions at an Antarctic Coastal Site”, Proceedings of 16th International Conference on Nucleation and Atmospheric Aerosols (ICNAA), Kyoto July 26-30, 2004, Kyoto University press, editors: Mikio Kashara, Markku Kulmala ISBN 4-87698-635-5, pp.649-652 (Pres. by Francesco Chiminello)
3. F. Chiminello, D. Ceccato, P. Mittner, “Single Particle Micro-PIXE Analysis of Size Segregated Aerosol Samples Collected at Baia Terra Nova (Antarctica)”, Proceedings of EAC 2003 (European Aerosol Conference 2003), August 31 – September 5, 2005 Madrid Spain, Journal of Aerosol Science, Vol. 1, pp.s25-s26, ISSN: 0021-8502 (Pres. by Francesco Chiminello)
4. D. Biancato, D. Ceccato, F. Chiminello, P. Mittner, “Aerosol Internal Mixing Phenomena At An Antarctic Coastal Site”, Proceedings of IAMAS 2005 Conference, (International Association of Meteorology and Atmospheric Sciences), August 2-11, 2005, Beijing, China, p. F-3 (Pres. by Paolo Mittner)
5. P. Mittner, D. Ceccato, F. Chiminello, V. Trovo, “Size Distributions Of The Elemental Volume Concentration Of Some Major Coastal Antarctic Aerosol Components: Preliminary Results”, Proceedings of IAMAS 2005 Conference, (International Association of Meteorology and Atmospheric Sciences), August 2-11, 2005, Beijing, China, p. F-4 (Pres. by Paolo Mittner)

11

Prodotti della ricerca

11.b

[per ogni anno del quinquennio la quantità totale dei prodotti del programma secondo la tipologia CINECA, indicare anche eventuali prodotti che non rientrano in questa tipologia.]

Legenda:

J-ISI: papers on international journals with ISI classification

J: other journals

C: Congress Proceedings

IR: Internal Reports

B: Books or chapters of a book

P: Patents

O: Other products

Research line 1. Emission Microscopies and Assessment of Radiation Hard Electronic Devices

Year	J-ISI	J	C	IR	B	P	O
2001	4						
2002	4		1				
2003	9	4	4				
2004	6		2				
2005	4		2				1

Research line 2- Civil Security Applications

Year	J-ISI	J	C	IR	B	P	O
2001	3						
2002							
2003	5						
2004	8						
2005	3						

Research line 3. Aerosol Research with nuclear Analytical techniques

Year	J-ISI	J	C	IR	B	P	O
2001				2			
2002	1		2	1			
2003		1		2			
2004	1	1	4	5			
2005			3	5			

GRAND TOTAL

Year	J-ISI	J	C	IR	B	P	O
2001	7	0	0	2	0	0	0
2002	5	0	3	1	0	0	0
2003	14	5	4	2	0	0	0
2004	15	1	6	5	0	0	0
2005	7	0	5	5	0	0	0
TOT	48	6	18	15	0	0	0

11.c

[indicare i prodotti più rappresentativi con un massimo di 5 per l'intero quinquennio]

1. S. Pesente , G. Nebbia, M. Lunardon, G. Viesti, D. Sudac, K. Nad, S. Blagus, V. Valkovic, "Detection of hidden explosives by using tagged neutron beams with sub-nanosecond time resolution", Nuclear Instruments and Methods in Physics Research, Section A-Accelerators, Spectrometers, Detectors and Associated Equipment, 531 (3): 657-667 OCT 1 2004
2. AWARD R&D100 for the year 2005, decided by the R&D Magazine. The prize has been given to the Sandia NL (NM, USA), the Università di Padova e INFN, the Università del North Texas (TX, USA) and the company Quantar Technology (Ca, USA) for inventing the Ion Photon Emission Microscope – IPEM (authors B.L. Doyle, P. Rossi, F.D. McDaniel, M. Mellon), as one of 100 most technologically significant new products of the year.
3. F. Chiminello, D. Ceccato and P. Mittner, "Micro-PIXE study of tropospheric aerosols in an Antarctic coastal environment", Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Volumes 219-220, June 2004, Pages 171-175
4. E. Noah, T. Bauer, D. Bisello, F. Faccio, M. Friedl, J. R. Fulcher, G. Hall, M. Huhtinen, A. Kaminsky, M. Pernicka, M. Raymond and J. Wyss: "Single event upset studies on the CMS tracker APV25 readout chip", Nuclear Instruments and Methods in Physics Research, Section A-Accelerators, Spectrometers, Detectors and Associated Equipment, 492 (3): 434-450 OCT 21 2002

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| | <p>5. A. Candelori, D. Bisello, P. Giubilato, A. Kaminsky, S. Mattiazzo, M. Nigro, D. Pantano, R. Rando, M. Tessaro and J. Wyss, "Ion Electron Emission Microscopy at SIRAD", Nuclear Instruments and Methods in Physics Research, Section B – Beam Interactions with Materials and Atoms, 231 (1-4): 65-69 APRIL 2005</p> |
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