

# Breve curriculum vitae del Prof. Giuseppe Russo

Professore Ordinario di Fisica Sperimentale  
Dipartimento di Fisica e Astronomia  
Università degli studi di Catania  
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## Formazione

Giuseppe Russo è nato a Catania il 08 aprile del 1950. Laureato in Fisica, orientamento nucleare, nel 1972 con voti 110/110 e la lode all'Università di Catania. Dopo la laurea è stato titolare di una borsa di studio del Centro Siciliano di Fisica Nucleare e di Struttura della Materia dal luglio 1973 all'ottobre 1974. Ha conseguito le abilitazioni all'insegnamento nelle scuole secondarie superiori nelle classi di concorso: Fisica, Matematica e Fisica e Fisica, Impianti nucleari e Tecnologie Relative" con il massimo dei voti. E' stato vincitore di una cattedra di Fisica per la scuola secondaria. E' stato titolare di una borsa di studio della fondazione Von Humboldt presso il Max-Planck Institut di Heidelberg, di un Contratto Quadriennale presso la Facoltà di Scienze dell'Università di Catania. Ha conseguito, nel luglio 1977, il diploma della scuola di Specializzazione in Fisica, sezione Nucleare, con la votazione di 50/50 e lode. Professore incaricato dall'A.A. 1977/78 al 1981/82; Idoneo al Concorso nazionale per Professore Associato in Fisica Nucleare (SSD FIS/04); Professore Associato (SSD FIS/01) dall'A.A. 1982/83 all'A.A. 2002/2003; Idoneo al ruolo di professore universitario di prima fascia, nel 2002, per il settore scientifico disciplinare FIS/01 e Professore Ordinario (SSD FIS/01, settore concorsuale 02/A1 – Fisica sperimentali delle interazioni fondamentali) dall'A.A. 2003/04 presso il Dipartimento di Fisica e Astronomia dell'Università degli studi di Catania.

## Incarichi Istituzionali

All'interno dell'Università degli studi di Catania è stato:

- Componente della Giunta di Direzione del Dipartimento di Fisica e Astronomia (1995-98)
- Componente della commissione spazi del DFA
- Componente della commissione organici
- Componente della commissione paritetica dipartimentale
- Componente del collegio dei docenti del dottorato in fisica
- Componente la commissione scientifica 02
- Componente del collegio di disciplina della sezione fascia degli Ordinari
- Presidente corso del corso di laurea L-30 dall'A.A. 2012/13 ad oggi
- Responsabile scientifico di progetti di ricerca MURST 60%
- Coordinatore dell'Indirizzo Fisico -Informatico- Matematico della Scuola Interuniversitaria Siciliana di Specializzazione per l'Insegnamento Secondario (SISSIS), sezione di Catania dal Marzo 2001 fino al 30 aprile dell'A.A. 2006/07 e dal 01 novembre dell'A.A. 2006/07 fino alla chiusura delle attività della SISSIS

- Referente TFA per la classe A049- Matematica e Fisica
- Rappresentante del Dipartimento di Fisica e Astronomia presso il Consiglio di Presidenza della facoltà di Scienze Mat., Fis. e Nat.li dell'Università di Catania
- Responsabile del laboratorio Microtrone

E' stato inoltre:

- Componente del Comitato Regionale Ricerche Nucleari e di Struttura della Materia (C.R.R.N.S.M.) per il triennio 1986/89
- Rappresentante dei ricercatori nel consiglio della sezione di Catania dell'INFN
- Responsabile scientifico locale e nazionale di esperimenti presso la sezione INFN di Catania
- Componente di commissione in svariati concorsi e valutazioni comparative per borse e assegni di studio, per ruoli di Ricercatore, Professori Associato e Ordinario nonché componente di alcune commissioni di Conferma dei professori associati per il settore FIS/01-Fisica Sperimentale presso Università italiane
- Coordinatore dei corsi integrativi nei licei ed istituti artistici dall' a.s. 2003/04 al 2006/07
- Componente della Commissione di concorso per il reclutamento dei Supervisor della SISIS
- Presidente della Commissione giudicatrice per l'ammissione alla Scuola Interuniversitaria Siciliana di Specializzazione per l'Insegnamento Secondario (SISIS), sezione di Catania, Indirizzo 2 Fisico -Informatico- Matematico negli A.A. 2001/02, 2002/03, 2003/04, 2004/05, 2005/06, 2006/07, 2007/08
- quale delegato del Rettore dell'Università di Catania, componente la Commissione Interuniversitaria per le modifiche da apportare al regolamento generale ed all'atto costitutivo della SISIS
- Presidente della Commissione Esaminatrice per l'esame di Stato finale della SISIS, sezione di Catania, Indirizzo 2 Fisico -Informatico- Matematico negli A.A. 2000/01, 2001/02, 2002/03, 2003/04, 2004/05, 2005/06 (sessioni ordinarie e straordinarie), 2007/08 e 2008/09 (sessioni ordinarie e straordinarie).
- Presidente di Commissione per la selezione di tutor coordinatori per il T.F.A. classe A049 - Matematica e Fisica
- Presidente di Commissione per la selezione di n. 2 ricercatori a tempo determinato (bando rif. LNS-R3-705) nomina del Presidente INFN con disposizione del 06 dicembre 2017 n. 19540

## **Attività didattica**

Ha ricoperto numerosi insegnamenti presso le facoltà di Scienze, di Ingegneria, di Agraria e di Farmacia dell'Università di Catania:

- Fisica generale I
- Fisica Generale II
- Fisica Sperimentale II
- Esercitazioni di Fisica Sperimentale
- Fisica dei Reattori Nucleari
- Elettrodinamica Classica
- Fondamenti di Fisica Moderna
- Elettrodinamica Relativistica
- Oscillazioni e Onde
- Fondamenti di Fisica II
- Fondamenti di Fisica III
- Istituzioni di Matematica, Statistica e Fisica
- Struttura della Materia

- Radioattività
- Metodi Matematici applicati alla fisica
- Laboratorio di Fisica
- Fondamenti di Fisica sperimentale II
- Fisica I, II e III
- Fondamenti di Fisica Sperimentale I
- Fisica (SSD FIS/07)
- Matematica (SSD MAT/06)
- Temi di struttura della materia
- Esperienze didattiche di fisica II
- Fondamenti ed applicazioni alla fisica della statistica matematica

Ha ricoperto gli insegnamenti di Matematica, Fisica e Logica nei Corsi di Orientamento e preparazione agli esami di ammissione ai Corsi di Laurea a numero programmato, edizioni dal 2007 al 2017

Ha ricoperto, nell'A.A. 2015-16, un modulo dell'insegnamento di Complementi di Elettrodinamica Classica presso la Scuola Superiore dell'Università di Catania

È stato relatore di tesine e di numerose tesi di laurea, tutor di tesi di dottorato e tutor presso la scuola superiore

È stato membro delle Commissioni giudicatrici del concorso di ammissione al Dottorato di Ricerca in Fisica X , XIV e X XVI ciclo e della Commissione giudicatrice per la valutazione dell'esame finale per il conseguimento del titolo di dottore di ricerca in Fisica, XV ciclo- Settore Fisica Nucleare.

## **Attività di ricerca**

Le principali tematiche di ricerca hanno riguardato:

- Studio degli isomeri di forma con la tecnica della fissione in volo;
- Strutture intermedie in processi di fissione sottosoglia;
- Fotofissione sottosoglia con gamma di bresstrahlung;
- Fluidodinamica nucleare;
- Risonanze giganti su stati alto spin;
- Struttura dei nuclei ad alto spin;
- Proprietà dei nuclei caldi;
- Collisioni periferiche tra ioni pesanti;
- Spettroscopia gamma dei residui prodotti in collisioni periferiche;
- Emissioni di gamma di alta energia in reazioni dissipative;
- Produzione di protoni e pioni carichi ad energie intermedie;
- Studio di meccanismi di produzione di gamma di alta energia nelle collisioni nucleo-nucleo ad energie intermedie;
- Studio delle risonanze giganti di dipolo nei nuclei caldi;
- Studio della produzione di pioni neutri sotto soglia ad energie intermedie;
- Interferometria gamma di intensità nelle collisioni nucleo-nucleo ad energie intermedie;
- Produzione di pioni carichi e kaoni in collisioni p-nucleo;
- Fotoreazioni con fasci  $\gamma$  polarizzati, produzione di mesoni e studio delle risonanze barioniche;

- Misure di anisotropia della velocità della luce;
- Fondamenti di relatività speciale e teorie alternative;
- Misure dei fattori di forma elettrico e magnetico del nucleone;
- Misure di violazione della parità nella diffusione elettrone-quark e elettrone-deutone;
- Misura di elementi di matrice per il doppio decadimento beta senza neutrini mediante reazioni a doppio scambio di carica.

### **Elenco di alcune pubblicazioni tra le più recenti:**

- 1) D. Lo Presti ed altri tra cui G. Russo, “The MEV project: Design and testing of a new high-resolution telescope for muography of Etna Volcano”, Nucl. Instr. And Meth. A904 (2018)195, DOI 10.1016/j.nima.2018.07.048;
- 2) F. Cappuzzello ed altri tra cui G. Russo, “The NUMEN project: Nuclear Matrix Elements for Neutrinoless double beta decay”, Eur. Phys. J.A . (2018)54:72, DOI 10.1140/epja/i2018-12509-3;
- 3) V. Kuznetsov ed altri tra cui G. Russo, “New narrow N(1685) and N(1726)? Remarks on the interpretation of the neutron anomaly as an interference phenomenon”, JETP Letters (2017), vol. 105, p. 1-6 ISSN: 0021-3640;
- 4) M. Defume ed altri tra cui G. Russo, “Rosenbluth separation of the  $\pi^0$  Electroproduction cross section”, Phys. Rev. Lett.(2016), vol. 117, ISSN: 1092-0145;
- 5) V. Nedorezov ed altri tra cui G. Russo, “Disintegration of C-12 nuclei by 700-1500 Mev photon”, Nucl. Phys. A (2015), vol. 940, p. 264-278, ISSN: 0375-9474;
- 6) P. Levi Sandri ed altri tra cui G. Russo, “First measurements of the sigma beam asymmetry in eta photoproduction off the proton near threshold”, Eur. Phys. Jour. A (2015), vol. 51, ISSN: 1434-6001;
- 7) V. Vegna ed altri tra cui G. Russo, “Measurements of the Sigma beam asymmetry for the omega photoproduction off the proton and the neutron at GRAAL”, Phys. Rev. C (2015), vol. 91, ISSN: 0556-2813;
- 8) F. Schillaci ed altri tra cui G. Russo, “Calibration and Energy resolution study of high dispersive power Thomson Parabola Spectrometer with monochromatic proton beams”, Jour. of Instr. (2014), vol. 9, p. 1-16, ISSN: 1748-0221;
- 9) D. Wang ed altri tra cui G. Russo, “Measurements of parity violation in electron-quark scattering”, Nature Physics (2014), vol. 506, p. 67-70, ISSN: 1745-2473;
- 10) D. Wang ed altri tra cui G. Russo, “Measurements of parity violation in electron-deuteron scattering in the nucleon resonance region”, Phys. Rev. Lett. (2013), vol. 111, ISSN: 0031-9007;
- 11) S. Abrahamyan ed altri tra cui G. Russo, “Measurements of the Neutron Radius of Pb-208 through parity violation in electron scattering”, Phys. Rev. Lett. (2012), vol. 108, ISSN: 0031-9007;
- 12) Z. Ahmed ed altri tra cui G. Russo, “New precision limit on the strange Vector form-factors of the proton”, Phys. Rev. Lett. (2012), vol. 108, 102001, ISSN: 0031-9007;

# Silvia Monica Lenzi

## Curriculum Vitae

### Personal information

Silvia Monica Lenzi  
Dipartimento di Fisica e Astronomia "Galileo Galilei", University of Padova  
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### Education

PhD in Physics, University of Buenos Aires, 1987  
Licenciada (Master) in Physics, University of Buenos Aires, 1982

### Current academic position

Full Professor at the Department of Physics and Astronomy, University of Padova, Italy

### Brief presentation

My research activity covers different theoretical and experimental aspects of the structure of atomic nuclei, that complement each other. Nuclear-spectroscopy experiments are performed with large gamma-ray spectrometers such as AGATA, EUROBALL, EXOGAM, JUROGAM, GASP, GALILEO, EURICA. My theoretical experience and constant activity have been a fundamental and stimulating background for the experimental activities. Spokesperson of several experiments performed in international laboratories: LNL (INFN), IReS (France), GANIL (France), GSI (Germany), NSCL-MSU (USA), RIKEN (Japan), coordinating international collaborations. My activity consists on proposing and coordinating experiments with advanced gamma-ray spectrometers, data analysis and theoretical interpretation of the results. The main research achievements have been the study of the structure of N-Z nuclei and the theoretical description within the shell model. The study and description of the isospin symmetry in nuclei has given important results and was the object of a recent review article. In parallel, I have studied both experimentally and theoretically the structure of neutron-rich nuclei far from the valley of stability where new magic numbers appear and new regions of deformation develop.

My research activity is documented in more than 300 publications in international journals with almost 5000 citations and an h-index of 38.  
I have given more than 80 invited talks and seminars.

Member of several international collaborations with role of coordination and responsibility. In particular, I am the Scientific Coordinator of the AGATA (Advanced Gamma Tracking Array) physics campaign in GANIL. AGATA is a European collaboration of 41 institutions from 12 countries. I am Work package leader of the Nuclear Spectroscopy Instrumentation Network (NUSPIN) of the Integrated Infrastructure Initiative ENSAR2 (European Nuclear Science and Applications Research, funded by HORIZON2020) and member of the Executive board of ENSAR2. I am Chair of the Program Advisory Committee of the JYFL laboratory (Finland) and member of the Board of Directors of the Euroschool on Exotic Beams.

I have been Coordinator of two European networks funded by the EU in the framework of ENSAR (FP7) and EURONS (FP6). Among other scientific aspects, my activity in these networks was oriented towards the cooperation of different communities, the sharing of valuable instrumentation, the transfer of knowledge and the training of young researchers. I have been Chair, member of the International Advisory Committee and of the Organizing Committee of many conferences and workshops.

I cover and have covered different roles of responsibility in the Physics and Astronomy Department of the University of Padua. Ample teaching experience at the Master and PhD degrees. I am referee of several international journals and evaluator of national and international funding agencies and institutions.

**Current Responsibilities  
and participation in  
Scientific Committees**

Scientific Coordinator (spokesperson) of the AGATA (Advanced Gamma Tracking Array) experimental campaign at the GANIL French National Laboratory - since 2012  
Chair of the Program Advisory Committee of the Jyvaskyla Laboratory - since 2017  
Work Package Leader of the Nuclear Spectroscopy Instrumentation Network (NUSPIN) of ENSAR2 (European Nuclear Science and Applications Research), funded by HORIZON 2020 – since 2016  
Member of the Executive Board of the Integrated Initiative ENSAR2 (HORIZON2020) - since 2016  
Director of the School of Specialization in Medical Physics of the University of Padova - since 2017  
Member of the Board of Directors of the Euro-School on Exotic Beams- since 2008  
Member of the Steering Committee of NUSPRASEN Network of ENSAR2 since 2016  
Member of the International Scientific Advisory Board (ISAB) of the National Authority for Scientific Research and Innovation (Romania) for the Scientific Program FAIR-RO since 2015  
Member of the Euroball Owners Committee - since 2004  
Member of the Study Group of the SPES project of INFN for the development and construction of a radioactive beam facility at the Legnaro National Laboratory - since 2008  
Member of the AGATA Collaboration Council - since 2010

**Participation to international  
collaboration and Scientific  
Networks**

Member of NUSTAR of GSI-FAIR, Darmstadt, Germany  
Member of SUNFLOWER Collaboration, Spectroscopy of Unstable Nuclei with Fast and Slow Beam Experiments at RIBF, RIKEN, Japan  
Member of the Network SARFEN (Structure and Reactions for Exotic Nuclei) funded by the European Network of funding agencies in Nuclear Physics (NUPNET) (2012-2014)  
Member of the European Network HOPE (Horizons in Physics Education) of the Life Long Learning Programme of EU.  
Member of the Association of Latin American Nuclear Physics and Applications (ALAFNA)

**Past responsibilities and  
participation in Scientific  
Committees**

Member of the Presidence Council of the Faculty of Ingeneering, Università di Padova (1999-2003)  
Member of the User Selection Panel (FP5), Institut de Recherches Subatomiques, Strasbourg (2000-2003)  
Member of the Programme Advisory Committee of the GANIL French National Laboratory (2005-2009)  
Chair of the Euroball Owners Committee for the administration of resources for gamma spectroscopy research in Europe (2005-2008)  
Member of the Executive Board of the Integrated Initiative EURONS (FP6) (2005-2008)  
Member of the "Giunta del Dipartimento di Fisica dell'Università di Padova" (2006-2011)  
Representative ("Osservatore") of the Scientific Committee for Theoretical Physics (CSN4) at the Scientific Committee for Nuclear Physics (CSN3) of INFN (2007-2012)  
Chair of the Committee for the INFN postdoctoral fellowships (assegni di ricerca) of the INFN, Sezione di Padova (2012-2014) Deputy-chair of the Committee for the LNL-INFN postdoctoral fellowships since 2018.  
Member of the Executive Board of the Integrated Initiative ENSAR (FP7) – 2010-2014

**Publications and presentations at international conferences**

Author and co-author of more than 250 publications in scientific journals, and about 100 papers in proceedings volumes

Citations: 4980

h-factor: 38

Invited talks at conferences: more than 60.

Seminars and Colloquia at research institutions: 16.

Invited Lectures at Summer Schools: EuroSchool on Exotic Beams (2007), - Enrico Fermi School (2007, 2017), Carpathian Summer School (2007), Joliot-Curie School (2010)

**Teaching experience and supervisor duties**

Wide teaching experience since 1984. I have been the supervisor of 17 undergraduate and 5 PhD thesis and member of several evaluation PhD committees in Italy and abroad.

Supervisor of 6 postdocs

**Evaluation activities in international review committees**

- Referee of several funding agencies and research institutions: ERC (European Research Council), ANVUR (Italy), FWO (Belgium), NSERC (Canada), DOE (USA), CNPq (Brazil), BEC.AR (Argentina), ANCSI (Romania)
- Member of the International Scientific Advisory Board (ISAB) for the FAIR-RO Scientific Programme of ANCSI, Romania since 2015
- Member of different committees for the selection of researchers, post-docs and PhD students
- Member of the Committee for the "Habilitation a Diriger des Recherches" of Dr. G.Georgiev (Orsay, 2012)
- Member of the Committee for the selection of an Associate Professor of the University of Oslo, Norway (2009)
- Member of the Committee for PhD thesis at several Universities: Paris Sud, Caen, Atene, Bucharest, Autónoma de Madrid, Copenhagen, Valencia, Milano, Lund, Leuven, Sao Paulo.
- Referee of international scientific journals: Physical Review Letters, Physical Review C, Physics Letters B, Nuclear Physics A, European Physical Journal A, Europhysics Letters.

**Member of Organizing Committee of International Conferences and Workshops  
In the last 5 years:**

- NUSPIN 2018 Workshop, Valencia, 25-29 June, 2018
- SPES-NUSPRASEN Workshop, Pisa, 1-2 February 2018
- OPT9 Workshop, Padova, 22-25<sup>th</sup> May 2018
- NUSPIN 2017 Workshop, Darmstadt, 26-29<sup>th</sup> June, 2017
- NUSPRASEN Workshop, CERN, 7<sup>th</sup> December, 2016
- Third International SPES Workshop, Legnaro, October 10<sup>th</sup>-12<sup>th</sup>, 2016
- NUSPIN 2016 Workshop, San Servolo, Venice, June 27<sup>th</sup>-July 1<sup>st</sup>, 2016 (Chair)
- AGATA@GANIL Workshop 2016, Caen, 10-12 February, 2016 (Chair)
- Nuclear Structure at  $N = Z$  and at the proton drip line with the AGATA and GALILEO arrays, San Servolo, 4 - 5 May, 2015 (co-Chair)
- AGATA@GANIL Workshop 2015, Caen, 11-13 February, 2015 (Chair)
- Interplay of Structure and Dynamics of heavy ion collisions, ECT\*, Trento, 14 -15 May, 2015
- Euroschool on Exotic Beams 2014, Padova, September 2014 (Chair)
- EGAN 2014, GSI, June 23-26, 2014
- SPES Workshop, LNL, May, 2014
- INFN2014, Padova March, 2014
- AGATA@GANIL Workshop, Caen, February 2014 (Chair)
- EGAN 2013 Workshop, Liverpool, June 24-27, 2013
- NSP2013 Workshop, Padova, 10-12 June 2013
- AGATA@GANIL Workshop, Caen, 19-21 February 2013 (Chair)

**Member of several  
International Advisory  
Committee of Workshops and  
Conferences**

**In the last 5 years:**

Nuclear Structure 2018, East-Lansing, USA, August 5-10<sup>th</sup> 2018  
XII Latin American Symposium on Nuclear Physics and Applications, La Havana, October 23<sup>rd</sup>-27<sup>th</sup>, 2017  
Nuclear Structure 2016 Workshop, Knoxville, July 24<sup>th</sup>-29<sup>th</sup>, 2016.  
ALTO nu-ball hybrid spectrometer workshop 2016, Orsay, France, May 19<sup>th</sup>-20<sup>th</sup>, 2016  
XI Latin American Symposium on Nuclear Physics and Applications, Medellin, Colombia, November 30<sup>th</sup>-December 4<sup>th</sup>, 2015  
Nuclear Structure 2014, Vancouver, 21-25 July, 2014  
Advances in Radioactive Isotope Science, ARIS 2014, Tokyo, 1-6 June, 2014  
X Latin American Symposium on Nuclear Physics and Applications, Montevideo, Uruguay, 1-6 December, 2013

**Outreach activities**

Representative of the University of Padua in the "Comitato Tecnico Scientifico della Mostra SPERIMENTANDO", 2010-2013, oriented to high school students.  
Promoter and responsible of the organization of "Seminari M5P" at the Department of Physics and Astronomy, University of Padova, seminars on different research activities addressed to students of the Physics, Astronomy and Engineering courses, 2004-2014.  
Responsible for the outreach activities of the Physics Department (Padova), 2006-2011.

In compliance with the GDPR n. 2016/679, I hereby authorize INFN to use and process my personal details contained in this document.

Padova, September 2018



Silvia M. Lenzi



**Curriculum Vitae  
Luciano Calabretta**

**Dr. Luciano Calabretta is a senior scientist of National Institute for Nuclear Physics (INFN). He works at Laboratori Nazionali del Sud (LNS) in Catania since 1981.**

**Positions of responsibilities**

- **July 2017, the design study of SCENT-300, a superconducting cyclotron to deliver carbon beams for therapy, was sold for 150 k€ at ASIPP (Chinese Academy of Sciences Institute for Plasma Physics) of Hefei (China). The design study was performed by the accelerator team of LNS headed by Dr. Calabretta in the 2009;**
- **October 2016 reviewer of the project "Superconducting Cyclotron SC200 for proton therapy in HeFei (China);**
- **March 2016, member of the scientific Advisory Board of IPAC17;**
- **September 2016, He leaves the International Organizing Committee of International Cyclotron Conference and their Applications (ICCA), after twenty-one years of membership in the committee;**
- **January 2016, reviewer for the "RISP ISOL Driver at RISP" Daejeon, South Korea;**
- **January 2016 reviewer for the "Research Activities of the RIKEN Accelerator Group", Wako Campus, Saitama, Japan;**
- **November 2016, is invited as chairman of session "Particle Therapy" at meeting AIME (Academia-Industry Matching Event on superconductivity for accelerators for medical applications) organised by CIEMAT, Madrid, Spain;**
- **from may 2015 to January 2016 He was consultant of the RISP project of the Institute of Base Science (IBS, DAEJEON, Korea)**
- **Since November 2007 up to December 2015, in charge of the INFN-LNS Research Division;**
- **Since December 2014 member of the project group ELIMED, which has to build a therapy beam line for the facility ELI-beamlines of Praga (check republic);**
- **Since may 2015 consultant for the Rare Isotope Science Project (RISP) founded by the Institute of Base Science (IBS, Daejeon, Korea) for a new cyclotron able to deliver 1 mA deuteron beam at 80 MeV;**
- **June 2012 to December 2014, in charge to coordinate the test experiment CAPEN supported by the 5<sup>th</sup> Scientific Committee of INFN, in the frame of the collaboration among the INFN, MIT of Boston and Best Cyclotron Co.;**
- **May 2012, member of a committee to evaluate the private company BEST Cyclotrons Inc. of Vancouver (Canada);**
- **2011/12 and 2012/13, in charge of a 48 hours lesson course on "Particle Accelerators and their Applications" at Physics department of Catania University;**
- **June 2007 to December 2012 in charge of task "Target and Beam Transport and Purification" of SPES project (LNL-INF);**
- **2009 up to now, member of the committee in charge to select the supplier of the 70 MeV proton cyclotron for the SPES project and for the acceptance tests;**
- **November 2008 to December 2011, member of the committee INFN-MED and in charge of the section "Accelerators for Hadron Therapy";**
- **September 2002 to November 2007, LNS coordinator for the activity of 5<sup>th</sup> Scientific National Commission of INFN;**
- **2004 to 2007, chairman of the International Conference on Cyclotrons and their Applications";**

- 2006-2009, in charge of the SCENT group to design a 300 AMeV cyclotron to deliver protons and Carbon ions for therapy, in the frame of the collaboration agreement between INFN and IBA Company;
- 2003 to 2005, in charge of the project SCENT (Superconducting Cyclotron for Exotic Nuclei production and Therapy) supported by the 5<sup>th</sup> Scientific Committee of INFN;
- 2002, member of evaluation panel of the superconducting cyclotron for the project TRADE of ENEA;
- 1995 to 2001, in charge of INFN-LNS Accelerator Division;
- 1989 to 1995, assistant to the Leader of “Superconducting Cyclotron” project with the charge to coordinate the assembling and commissioning of the superconducting cyclotron of the LNS-Catania.

#### Scientific activities

- December 2015, Expert of the IAEA for the project "Developing Human Resource Capabilities in the Area of Advanced Radiotherapy", Buenos Aires,;
- From 2014, Member of the group in charge to upgrade the Superconducting Cyclotron of the LNS-INFN Catania to deliver beam power higher than 5 kW;
- since 2010 up to now, member of the DAEdALUS collaboration, for the measure of the CP violation in the neutrino sector. He is studying the cyclotron complex to produce a proton beam with maximum energy of 800 MeV and peak intensity of 10 mA. He has studied a 60 MeV/amu normal conducting cyclotron and a 6 sectors superconducting cyclotron ring.
- May 2015, Consultant of the RISP project (DAEJEON, Korea) to evaluate the feasibility of a cyclotron for the production of a Deuteron beam at 40 MeV/amu with intensity of 1 mA. On June 2015 a workshop was organized at RIKEN in Tokyo to evaluate the feasibility of this project.
- October 2007 up to now, on request of the LNS and Laboratori Nazionali di Legnaro (LNL) , He is co-working with the team group for the SPES project and he was the spoken person for the task “Target & Beam Transport” until dec. 2012. He has studied the beam transport line and the High Resolution Mass Separator with a mass resolving power > 40.000.
- 2009-2010, study, design and realization of the new extraction beam line of the LNS superconducting cyclotron to increase of a factor 10 the production and transport of the radioactive beams produced with the in-flight technique.
- 2003 to 2009, study and design of a superconducting cyclotron able to deliver a 300 MeV/n carbon beam and proton beam at energy of 260 MeV. This cyclotron could be used mainly for the hadron therapy. According to the good result of these studies on July 2006 a cooperation agreement was signed between the INFN and Belgian company IBA (Ion Beam Accelerators), world leader in the construction of commercial cyclotron. The IBA company has to promote the INFN cyclotron project and will build the machine when a contract will be signed. The cooperation agreement gives the responsibility of the project and of the commissioning to the INFN. on June 2008, an addendum to the previous cooperation agreement was signed between INFN and IBA. According to this addendum, the working team lead by Dr. Calabretta start the executive design of cyclotron while the IBA company support this project with an amount of money equivalent to three annual contract for scientists. The high scientific level of the project was recognized by the invitation to present the project at the XII International Conference on Cyclotron and their Application, held at Tokyo on October 2004. On the year 2006, Dr. Calabretta was invited by CIAE (Chinese Institute for Atomic Energy) to present the SCENT project at Beijing. On the

year 2007 He was also invited by the University of Valencia and Warsaw to present the SCENT project.

He is patent holder, presented on 2004 August 11th , on the subject “Method to design a radiofrequency cavity, in particular to be used for a cyclotron, and radiofrequency cavity build using this method, and cyclotron using this cavity”.

Since 2007 to 2009 he was involved in the experiments MOBIDIC and FRAG, supported by the scientific commission of INFN 5th and 3rd respectively. The goal of these experiments was to improve the knowledge around the use of carbon ion beam for the oncology therapies. In particular:

- To understand if and how design a beam line to purify a carbon beam after that its energy has been decreased by the crossing through a target absorber;
- To measure the yields for the different fragments produced by the carbon nuclei which strike the nuclei inside the human tissues;

These data are very interesting to improve the simulation code and also the so called TPS “Treatment Planning System” computer code used to define the treatment procedure . The measure of fragmentation cross section are also interesting for the NASA program in the perspective of the future space voyages. The preliminary results have been presented in different international conference.

Dr. Calabretta was “Team Leader” of the LNS group which worked to the project “Dynamic of Fusion-Fission and Fission-Scission Phenomena”, supported by the European Union in the framework of the program INTAS for the period 2005-2007. In the year 2007 an experiment to investigate the superasymmetric fission mode  $A=78$  in  $^{238}\text{U}(d, pf)$  reaction at intermediate energy was performed at the LNS in Catania. With the same group of DUBNA some years before were performed similar experiment to study the fission induced by carbon and Oxygen ions at energy subthreshold of fission in nuclei neutrons deficient  $^{220,224,226}\text{Th}$ , to measure the amount of the contributes of symmetric and asymmetric fission for the thorium and Radium isotopes. The experiment results were useful to validate the nuclear complex model developed by Dubna group.

On 1998 the INFN management asked to Dr. Calabretta to work with the Italian company Ansaldo Energia to develop a project to build an accelerator complex cyclotron based, able to feed a subcritical reactor of about 80 MW. This preliminary design was a preliminary step towards the executive project for an Accelerator Driven system full scale dedicated to the transmutation of the nuclear waste and/or to the energy production. On the years 1998 and 1999 He joint the 1<sup>st</sup> and 2<sup>nd</sup> workshop on “Utilisation and reliability of high Power Proton Accelerators” organised by NEA-OECD (Nuclear Energy Atomic – Organization for Economic Co-operation and Development) and he presented oral contributions which were published in workshop proceedings. Triggered by this activity He studied the opportunity to use superconducting cyclotrons to accelerate molecular beam of  $\text{H}_2^+$ . Indeed, in this case is possible to extract the beam from the accelerator using the so called stripping method. This method being generally used in commercial cyclotron and also in research cyclotrons to extract the H- beams. The studies preformed have underlined the feasibility to deliver high proton current beam up to 10 mA at energies in the territory 110–150 MeV using compact superconducting cyclotrons. Was also investigated the feasibility of a superconducting ring cyclotron, separated sector, to achieve energies up to 1 GeV.

In the year 1999 He asked at the AIMA company (Accelerators for Industrial and Medical Application) a preliminary study and a budgetary quotation to build a superconducting cyclotron for the acceleration of ion beam with charge to mass ratio  $q/A=0.5$  up to the energy of 110 MeV/amu. This cyclotron should be a good driver for the EXCYT facility of LNS. On the 2002 Dr. Calabretta was called by the General Director of ENEA, Prof. Carlo Rubbia, to be member of a scientific committee in charge to evaluate the project of AIMA for a superconducting cyclotron for the project TRADE.

Since the 1997 Dr. Calabretta was involved in the study, design, realization and commissioning of the EXCYT (EXotic ion beams at CYclotron and Tandem) facility for the production and acceleration by the tandem accelerator of the exotics beam produced by fragmentation of the beam delivered by the cyclotron of the LNS. The EXCYT project is based on the production of radioactive ions by fragmentation induced by ions beam with medium-light mass delivered by the LNS cyclotron at energy 50-70 MeV/amu on a graphite target. The radioactive nuclei are then extracted by the target and ionized inside a proper source to be accelerated by the LNS tandem accelerator. In the framework of the EXCYT project Dr. Calabretta has coordinate the assembling and the commissioning of the axial injection line for the cyclotron, the so called beam line for the primary beam and the system for the beam attenuation by pepper pot collimator and by the low energy chopper. In particular in the year 2003-2005 he has also studied a diagnostic device to monitor the right beam position and current intensity of the beam on-line and of the commissioning of the transport line from the cyclotron to the EXCYT target. He participated at the beam extraction with power of about 100 W. This result was also achieved thank to the low energy chopper designed just by Dr. Calabretta and which allow to change the beam intensity with continuity and without change the beam space charge density and without the insertion of physical object that often modified the beam features.

In the years 2000-2006 he designed a new transport optic for the extraction beam line to use this line like a Fragment separator for Radioactive Ions Beam (FRIB) produced at an intermediate target station. This new configuration joint with a tagging detector allow the experimental group to perform experiment using radioactive nuclei in flight selected. With this technique was performed an experiment which has demonstrated the existence of a new kind of nuclear de-excitation by the emission of two strongly correlated proton.

In the years 2000-2003 he participated to the study and realization of the experimental device to perform the experiment called "Big Bang". The experiment goal was to measure the cross section of the process  $8\text{Li}(\alpha, n)11\text{B}$  to have indication on the two model of homogeneous and inhomogeneous Big Bang. The measure performed by the experiment were in agreement with other data already measured and thanks to a lower statistical error our experiment help to discriminate between the two model.

In the years 2000-2001 he was involved in the working test and characterization of the accelerator prototype module LIBO (LInac BOoster). The working test of the module demonstrate its ability to increase the beam energy of the 62 MeV proton beam up to 72 MeV, [16]. A useful tool for the working test was also the use of a low energy chopper designed and realized by Dr. Calabretta some year before. This chopper allows to fit the duty cycle of the cyclotron to the duty cycle of the LIBO module and to synchronize the two accelerators.

In the years 1999-2000 he studied a new chopper for the cyclotron beam, called "Chopper-500", to reduce the beam bunch delivered by the cyclotron from the original length of 1-3 nsec to the short length of 500 psec, according to the request of the multi array detector CHIMERA and by other experimental set-up.

In the same period, he has designed a new beam line called "By-Pass" which allow the operators to deliver the tandem beam to two experimental beam line at the same time that the cyclotron beam is delivered in other experimental rooms. The By-Pass line is in operation since the 2003.

In April 1998 he was invited to present a talk on "Effects of INFN Scientific Activities on Technological Advances of Small & Medium Industries" at the convention "R&D INDIA'98" on the item "Converting Research into Development" which was held in Kolkata. It is relevant that the other only two foreign peoples invited to participate to convention were the Director of the IN2P3, at that time Prof. Claude Detraz, and Dr. David Jacobs, at that time deputy leader of the CERN Technological information division.

In the years 1997-1998 he participated to the design study of the injection beam line and of the central region of the cyclotron. These improvements allow to operate the cyclotron in the stand alone mode avoiding the beam injection from the tandem. He proposed also the insertion of moveable slit placed inside the RF cavity to perform a roughly longitudinal cut of the beam.

On July 1997 on behalf of the LNS Director, presented to the INFN management the proposal of the LNS development for the years 1999-2003.

Dr. Calabretta together with Dr. Cuttone proposed on the 1996 to start the project CATANA (Center for Applied Therapy and Advanced Nuclear Application), to use the proton beam accelerated up to 62 MeV by the LNS Cyclotron to treat the ocular melanoma and other similar pathologies.

From 1995 up to 2002 he designed and commissioned the new beam line complex to deserve the beam at the new experimental area of the LNS. Moreover, he designed and commissioned a new bunching system for the axial injection of the cyclotron and a chopper device to satisfy the request of the experimental users.

From 1992 up to the 1996 he has designed and commissioned the superconducting solenoid SOLE. This solenoid is used to collect the reaction products emitted inside a solid angle of 30 mster., with momentum dispersion of  $\pm 10\%$  and with magnetic rigidity up to 4.5 Tm inside a detector placed at a distance of 15 m ahead. The simulation shown that it is possible to achieve a precision of impulse measurement of about 0.2%.

From 1987 to 1991 he designed and commissioned the magnetic spectrometer for charged pions CLAMSUD. This spectrometer have a big solid angle of about 35 mster, a good energy resolution of about 0.1% and a large momentum acceptance  $\pm 30\%$ . The optical properties of the spectrometer were measured using alfa source and the tandem beam of the LNS. The CLAMSUD spectrometer was transported in different European laboratories to perform many experiments. An important role in the use of the spectrometer was the develop of the code CARO (Computer Aid for Reconstruction and Optimization) which allow to optimize the reconstruction function on the base of a preliminary experimental measurement data. The reconstruction

function allow to fix the energy of a particle from the parameter (x,theta,y, phi) measured on the focal plane of the spectrometer.

From 1984 to 1995 He also studied, designed and commissioned:

- the injection and extraction beam line for the LNS superconducting cyclotron;
- the system of beam transfer line from the accelerators room to the experimental rooms;
- the bunching system for the proper injection of the tandem beam into the cyclotron.

From 1977 to 1988 he worked both in the fields of nuclear physics and of accelerators. In particular, he participated to the experimental measurement of the:

- photo-fission cross section of  $^{238}\text{U}$  with the goal to put in evidence the effects due to a second minimum in the fission barrier of  $^{238}\text{U}$ ;
- photo-fission cross section of  $^{232}\text{Th}$ , more difficult of the previous due to the lower yield, but scientifically very appealing due to the theoretical indication for a triple bump fission barrier;
- gamma radiation emitted by nuclei highly deformed at high spin using a multiplicity filter in the reaction  $^{124}\text{Sn} ( ^{28}\text{Si} ,n) ^{147}\text{Gd}$ .

Dr. L. Calabretta started his working activity on January 1979 as fellow of EURATOM at the BCMN (Central Bureau of Nuclear Measurements) of Geel, Belgium, where he worked up to march 1980. In that period he made a measure of cross section of neutron capture and fission in the reaction  $n(235\text{U}, \gamma), n(235\text{U}, f)$ .

Dr. L. Calabretta has been member of many examiner boards for public employments for senior scientist, scientist and technicians of INFN;

He has been invited to present the results of his studies in many national and international conferences;

He was co-examiner of 17 thesis for Physics or Engineer degree and for 2 Ph.D. thesis;

He hold lesson courses on accelerators for the Physics Specialization school of Catania University and for the INFN scientist and technicians.

#### Past Students of Luciano Calabretta:

- Dott. Cuttone is now director of National laboratory of South, this is the laboratory where I work.
- Dott. Tuvè is a scientist of INFN she works at the physics department of Catania, near to LNS-INFN laboratory
- Dott. Santo Gammino and Ing. Luigi Celona are experts in ECR ion source, they both work at LNS-INFN laboratory Catania. Gammino is in charge of the LEBT and Ion source for the European Spallation Source (ESS).
- Celona is in charge for the construction of a new ECR ion source for Hadron therapy center called AISHA.
- Alberto Rovelli, is work in the research division as responsible of the service submarine infrastructures.

Other two past students, Mario Maggiore and Daniela Campo, are now working in Legnaro Laboratory INFN, for the installation and commissioning of the 70 MeV proton Cyclotron build by company BEST cyclotron.

**Another engineer, Leandro Piazza, now work with a permanent position at Best Cyclotron company in Vancouver.**

**Alessandra Calanna, has worked at IBA company, and in the last 6 years she has worked with me to design the Daedalus superconducting cyclotron and now she is involved in the design of the new superconducting magnet for the upgrading of Catania Cyclotron. Alessandra left LNS for a permanent position on February 2018.**

**Grazia D'Agostino is a Ph. D. Student, at Catania University and She is working with me at the project to upgrade the LNS-INFN Superconducting Cyclotron.**