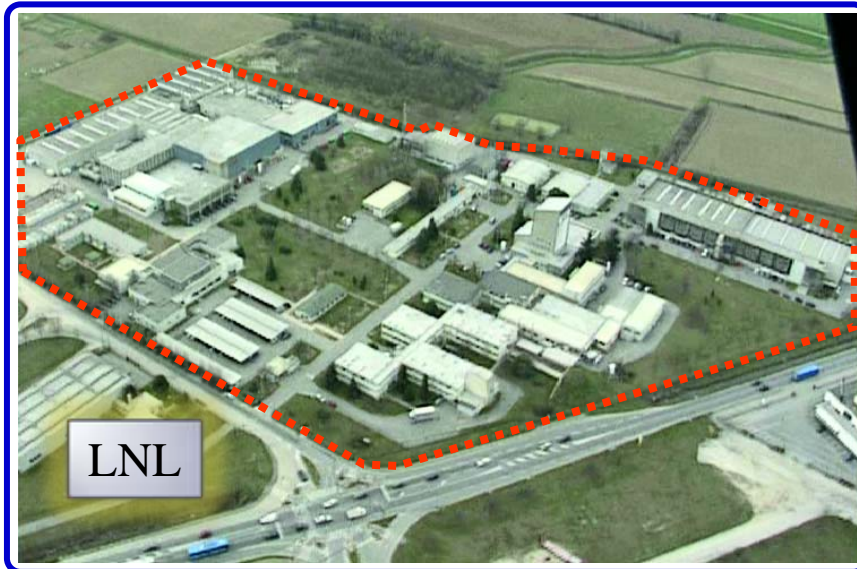


INFN-LNL, Legnaro (Padova), Italy

INFN-LNS, Catania, Italy



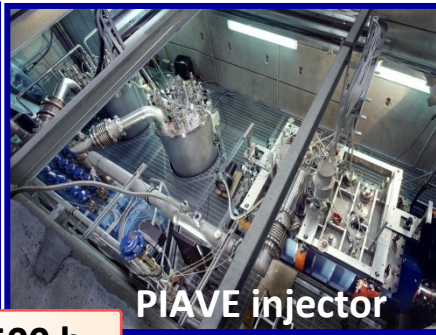
TNA Coordinator : E. Fioretto (INFN-LNL)

Deputy Coordinator : R. Alba (INFN-LNS)

TNA03 – Accelerator facilities



XTU-Tandem



PIAVE injector

3.500 h



SC Booster ALPI

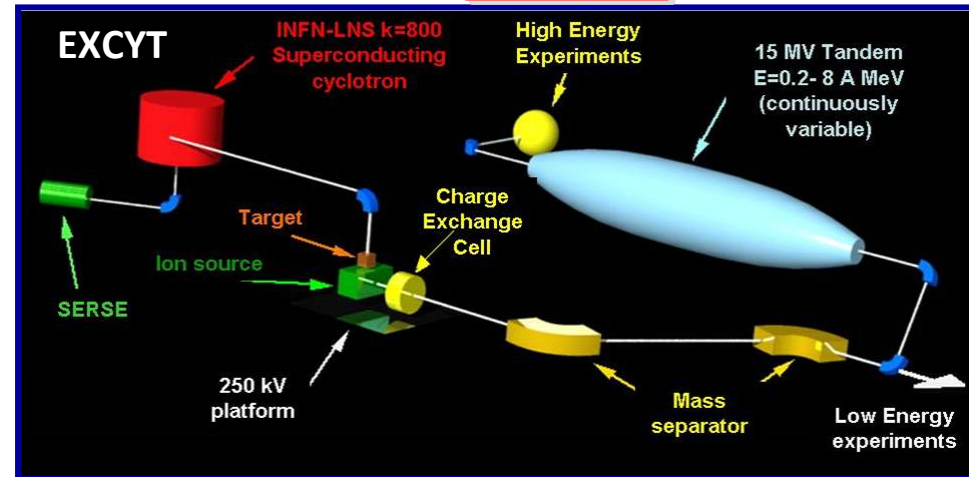


SMP Tandem



SC Cyclotron

5.200 h



12.700 beam-on-target hours

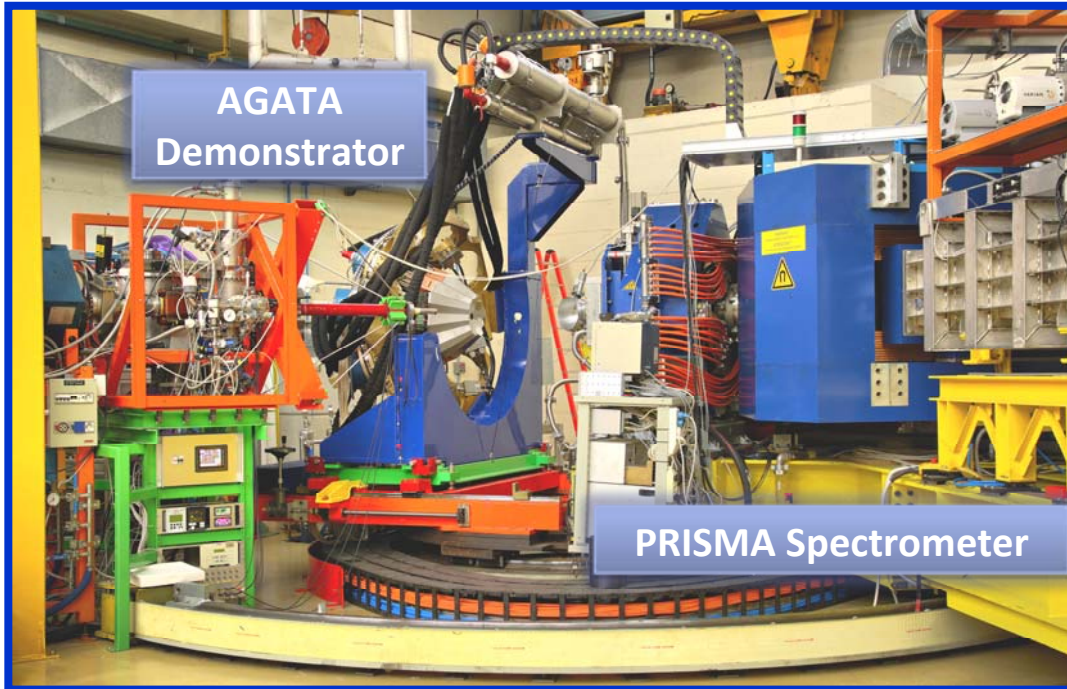


AN2000



CN

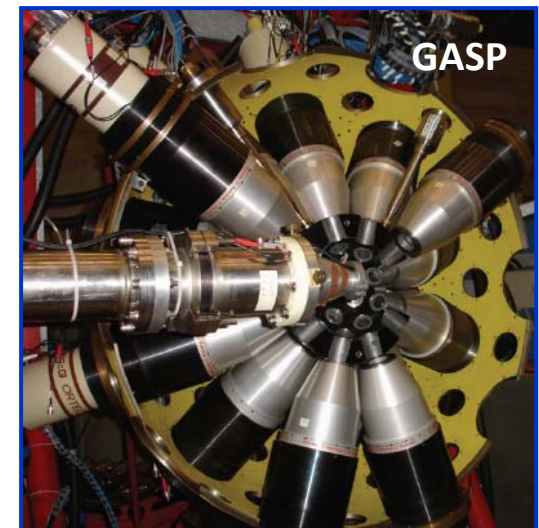
Nuclear Structure and Dynamics Based Facilities

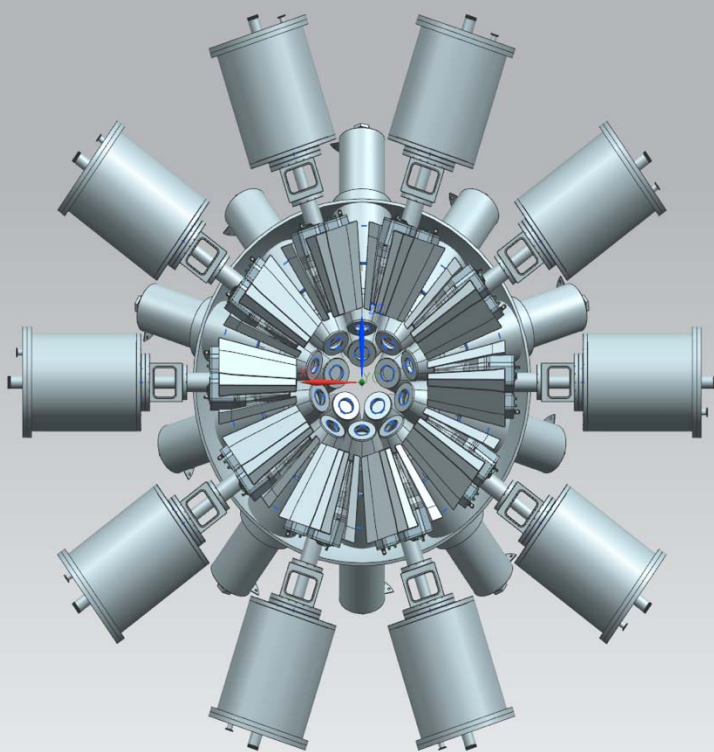


- ✓ Shell structure evolution in neutron-rich nuclei
- ✓ Lifetime measurements
- ✓ Symmetries in nuclei
- ✓ Electromagnetic moments in exotic nuclei

GASP – 1992
4 April 2012
official shutdown

High-spin states populated in
fusion–evaporation reactions





New gamma-ray array at LNL

take advantage of the recent technical developments for AGATA

preamplifiers, digital sampling, preprocessing, DAQ

→ high counting rates (30–50 kHz/det)

use of existing detectors

EB cluster detectors capsules

GASP detectors

→ high photopeak efficiency

use beam facilities at LNL

Tandem/PIAVE, ALPI – stable

SPES – RIB

→ production of new nuclei

30 GASP detectors @ 22.5 cm

5 5 5 5 5 5
29° 51° 59° 121° 129° 151°

10 triple cluster (EB clusters) @ 24 cm

90°

$\epsilon_{ph} \sim 8\%$ P/T $\sim 50\%$

Physics cases and ancillary detectors

GALILEO + Scintillatori LaBr₃ (Milano) + RFD (Kracow):

- Search for Jacobi transition in neutron rich Ba isotopes
- Study of very heavy Th, Rn, Ra nuclei at high spins and $T \neq 0$
- Rapidly rotating nuclei in A=60 region



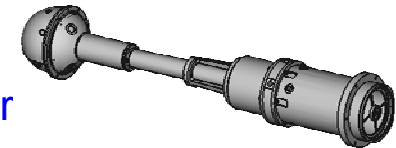
GALILEO + Scintillatori LaBr₃ (Milano) + TRACE (Padova):

- Inelastic scattering of ¹⁷O ions : pygmy dipole states and GQR



GALILEO + Plunger (Koeln) + PPAC:

- In-beam spectroscopy by transfer reactions with Heavy Ions: search for particle-phonon couplings (Ni, Fe, ...)



GALILEO + EUCLIDES (Legnaro) + NWall (Sweden):

- In-beam spectroscopy by transfer reactions with heavy ions: search for particle-phonon couplings (Ni, Fe, ...)



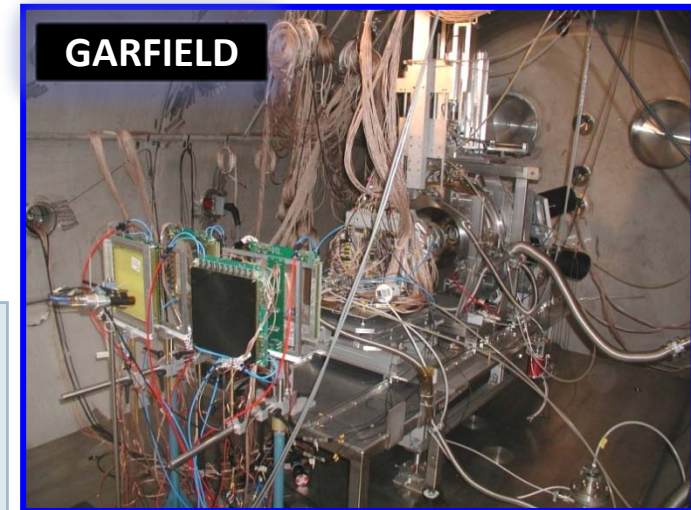
GALILEO + TRACE (Padova):

- Measurement of astrophysical interest (n, γ) reactions cross section through the surrogate nuclear reactions method



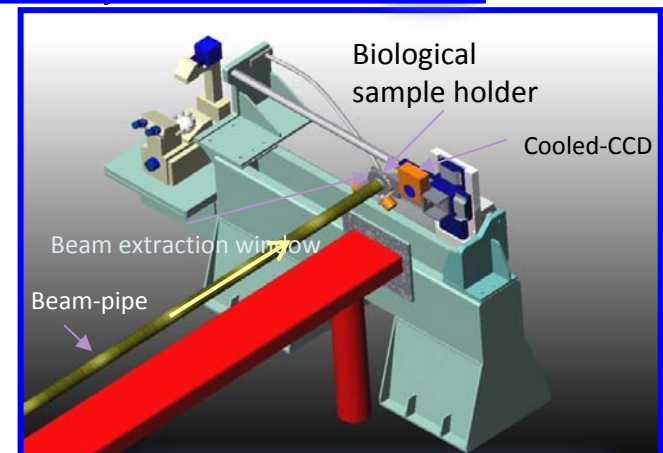
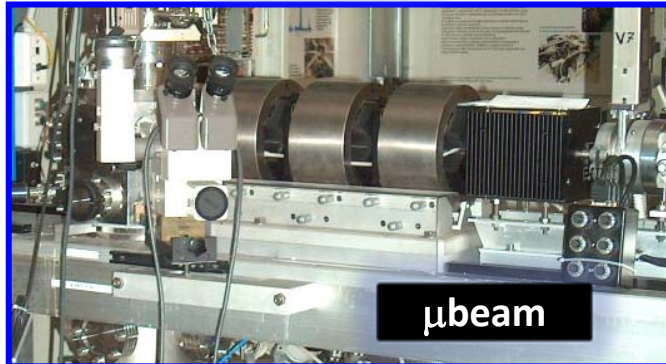
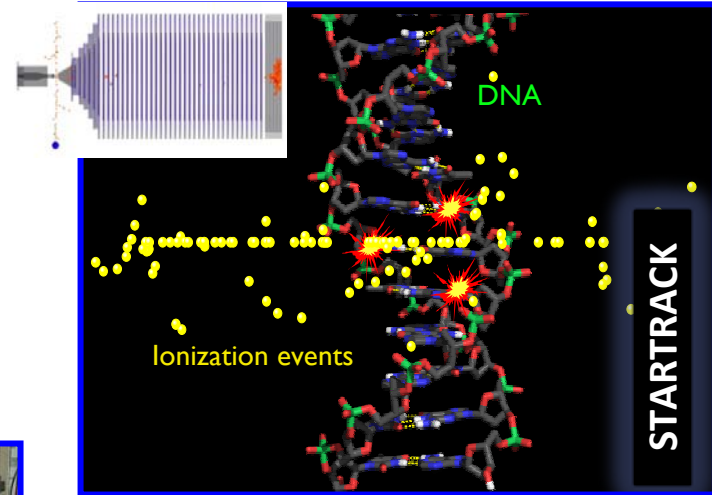
**In-beam commissioning
at the beginning of 2014**

Nuclear Structure and Dynamics Based Facilities



- ✓ Nuclear dynamics
- ✓ Signals of Phase Transition
- ✓ Nuclear reactions for Astrophysics

Applied and Interdisciplinary Physics Facilities

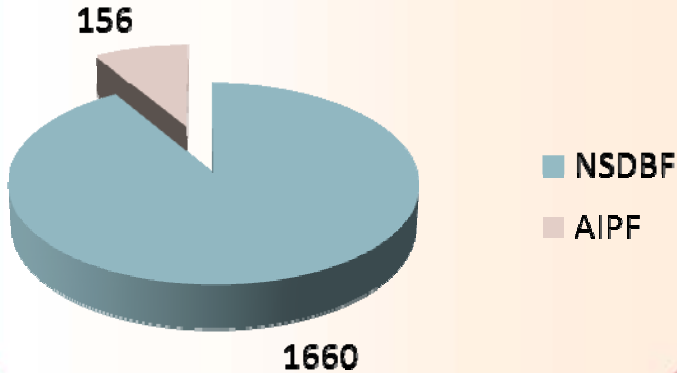


- ✓ Basic and applied research in radiobiology
- ✓ Trace element analysis of geological and archeological samples
- ✓ Measurements for hadrontherapy applications

μbeam facility for single cell irradiation

TNA03 – Deliverables

Person-days



Nuclear Structure and Dynamics Based Facilities (**NSDBF**)
Applied and Interdisciplinary Physics Facilities (**AIPF**)

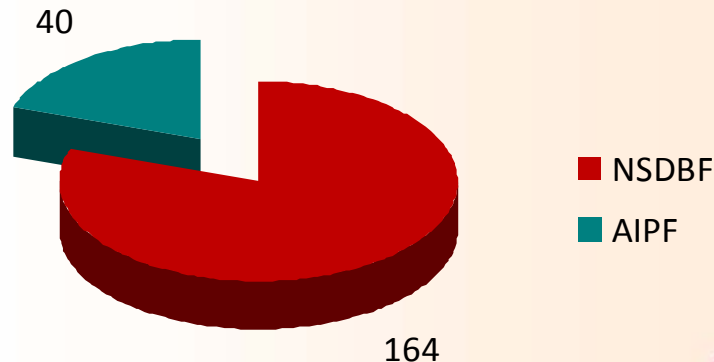
Min. quantity of access to be provided



4424 h / 4y

204 users / 4y

Users



52 projects / 4y

Projects



TNA03 – Budget

G. Estimated Unit cost charged to the proposal = F x (D/E)		86,41
H. Quantity of access offered under the proposal (over the whole duration of the project)		4.424
I. Access Cost = G x H		382.261
J. T&S direct eligible costs ^[2]		234.320
K. T&S indirect eligible costs = 7% x J		16.402
Total budget → 297.862 €	L. Other direct costs = J	234.320
	M. Indirect costs = K	16.402
	N. Access costs ENSAR = I	382.261
	O. Access costs for AGATA	63.542
	P. Total budget = L + M + N + O	696.526

In the preparation phase of the project specific funds have been proposed by the AGATA community to support the experimental campaign of AGATA at LNL, GSI and GANIL. The idea was to use these funds for travel and subsistence expenses, and to hire personnel for AGATA.

Negotiation phase → only travel and subsistence expenses (after USP approval). Experts of the different parts of the apparatus (detectors, electronics, control systems, data acquisition system and so on) involved in maintenance and repairing activities had to be included in the list of users of approved experiments. Other costs for AGATA had to be supported by LNL using Access funds.

TNA03 – PACs and ENSAR User Selection Panel

LNL

Program Advisory Committee and USIP

LNS

Program Advisory Committee

Scientific merit of the proposals

EU support
within ENSAR

Beam time allocation

ENSAR USP

- Prof. A. Vitturi (LNL PAC Chairman)
- Prof. R. Bougault (LNS PAC Chairman)
- Prof. G. De France (LNL PAC member)
- Dr. A. Kacperek (LNS PAC member)
- Dr. E. Fioretto (TNA Coordinator)

24 May 2011

24 September 2012

- Prof. S. Lunardi (LNL PAC Chairman)
- Prof. R. Bougault (LNS PAC Chairman)
- Dr. D. Ackermann (LNL PAC member)
- Dr. A. Kacperek (LNS PAC member)
- Dr. E. Fioretto (TNA Coordinator)

TNA03 – USP meetings and approved projects

LNL

LNS

13 July 2011 at LNL



4 experiments at NSDBF

4 experiments at NSDBF

12 October 2011
via e-mail



5 experiments at NSDBF
2 projects at AIPF

2 experiments at NSDBF
2 projects at AIPF

11 July 2012 at LNS
4 October via e-mail



4 experiments at NSDBF
4 projects at AIPF

2 experiments at NSDBF
3 projects at AIPF

24 Jan 2013 at LNL



4 experiments at NSDBF
1 project at AIPF

13

9 already
performed

1 experiment cancelled
2 exp. 2011 postponed

24

April → 18
May → 21
July → 23

- a) Vacuum leak have occurred especially in the Low Energy section

The first and eighth accelerating tubes will be replaced with new ones

- a) Breaking of the charging belt

The present charging system (belt) will be replaced with the NEC Pelletron in 2014 - in the meanwhile, beam delivery to the approved experiments will be depending upon the performance of the available belts

SMP Tandem at LNS



Operation is just restarted

TNA03 – Deliverables up to April – July 2013

April 2013



27 experiments

52%

133 users

65%

112 indiv. users

157 visits

923 person-days

51%

126 k€

42%

July 2013



32 experiments

62%

166 users

81%

161 k€

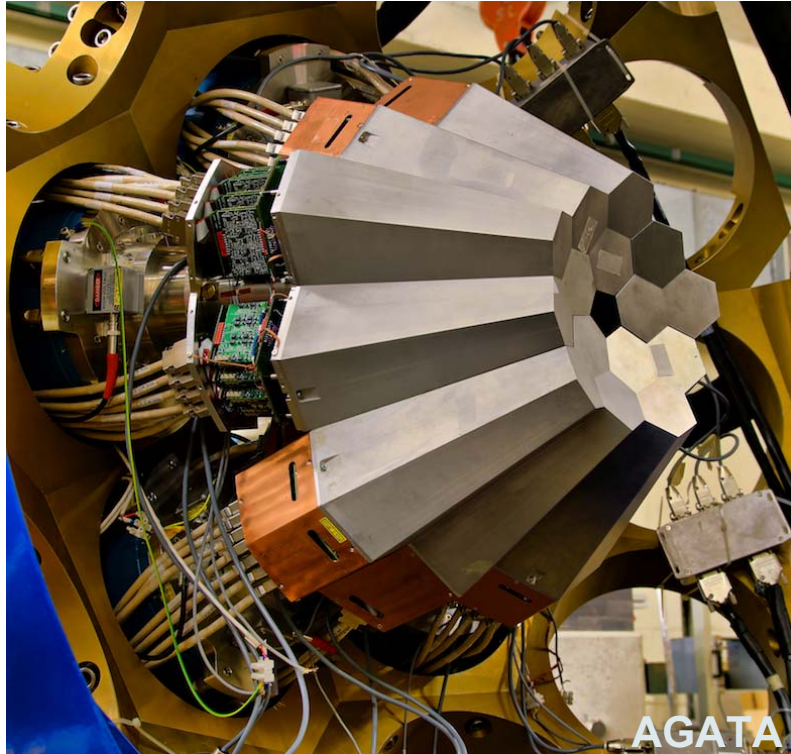
54%

191 visits

1206 person-days

66%

TNA03 – AGATA Demonstrator at LNL



AGATA concluded the physics campaign at LNL at the end of December 2011
~ 50% of the total beam time at the Tandem/PIAVE-ALPI accelerator complex

7 projects

59 users (22 new users)

435 person-days

NSDBF @ LNL

Titles

Lifetimes of intruder states in N=20 sd-pf-shell neutron-rich nuclei

RDDS lifetime measurement in the region of the ^{132}Sn : Lifetime of the 6^+ state in ^{136}Te

Structure beyond the N=50 closure in neutron-rich nuclei in the vicinity of ^{78}Ni : the case of N=51 nuclei

Nuclear structure of neutron-rich isotopes in the Z~38 region populated by heavy-ion induced fission

Spectroscopy of neutron rich Th and U nuclei after multi-nucleon reactions

Collectivity at maximum nucleon valency: investigation of ground-state rotation in the neutron-rich Dy, Er and Yb nuclei

Study of high-lying bound and unbound states in ^{124}Sn and ^{140}Ce via inelastic scattering of ^{17}O ions



AD



PRISMA



Differential
Plunger

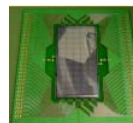
+

+ 10 LaBr3



DANTE

+



+

TRACE + 8 large volume LaBr3

TNA03 – Projects supported up to April 2013

NSDBF @ LNL and LNS

Titles

GPV measurement in Sn and Pb with (p,t) reaction (**LNS**)

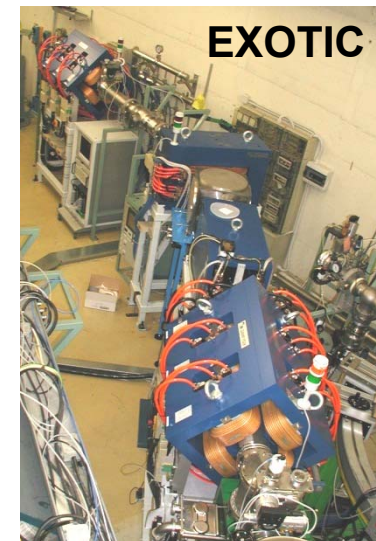
Test of FAZIA prototypes at **LNS**

Sub-barrier transfer measurements (**LNL**)

$^8\text{B}+^{28}\text{Si}$ total reaction cross sections at near barrier energies (**LNL**)

Indirect study of the $^{19}\text{F}(p,\alpha)^{16}\text{O}$ reaction through the THM applied to the $^2\text{H}(^{19}\text{F}, \alpha^{16}\text{O})n$ three-body reaction (**LNL**)

High rate capable detectors for heavy ion tracking (**LNS**)



Diamond
detectors

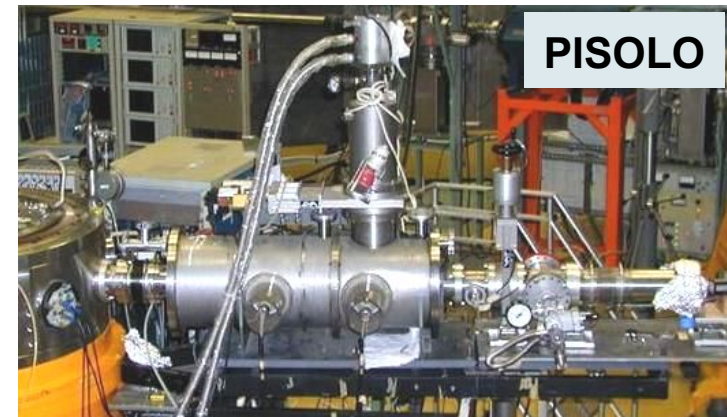
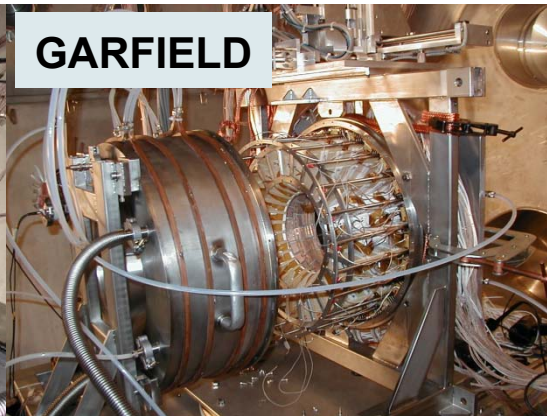
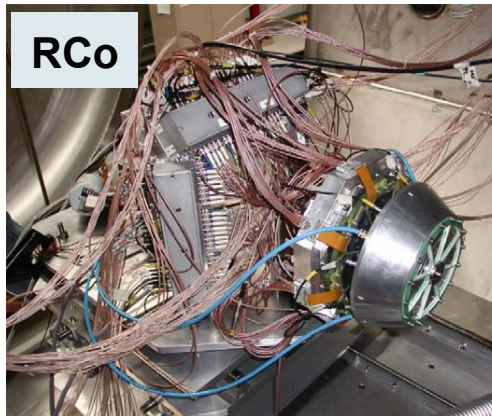
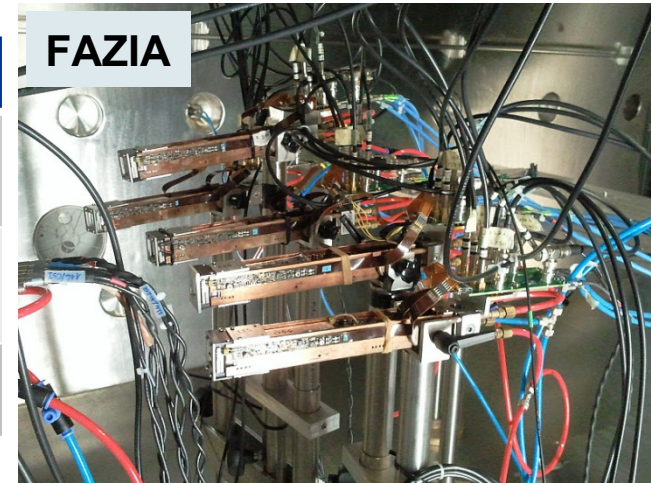
NSDBF @ LNL and LNS

Titles

Commissioning of the first complete FAZIA Front-end electronics, detectors and mechanics at LNS (**LNS**)

Search for signatures of transfer channels in the $^{40}\text{Ca} + ^{58,64}\text{Ni}$ fusion reactions at energies below the barrier (**LNL**)

Probing the Statistical Decay of Light Hot $N = Z$ Nuclei (**LNL**)



TNA03 – Projects supported up to April 2013

Titles

Contaminant migration in radioactive waste repositories (LNL) 2

Micro-PIXE studies on archaeological samples (LNL) 3

DNA damage and cellular response along and around the Bragg curve of heavy ions (LNS) 2

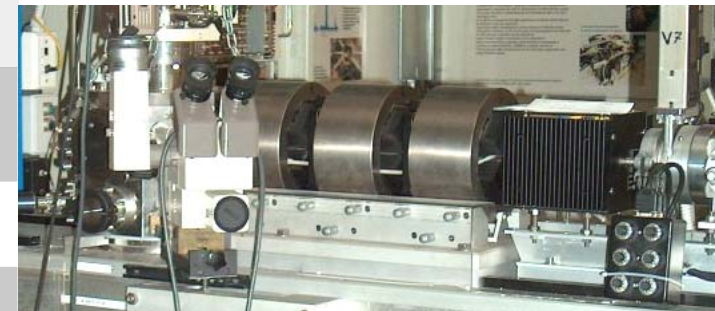
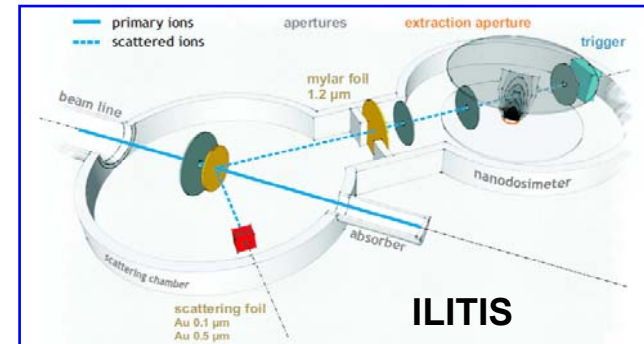
BiOMAS-ARCoR Biochip for Organic Matter Analysis in Space: Antibody Resistance to Cosmic Radiations (LNS)

Radiobiological studies of human malignant cells after irradiation with 62 MeV/u p and ^{12}C ions (LNS)

Investigation of light-ion track structure (LNL)

PIXE from metal targets for dose delivery opt. in p therapy (LNS)

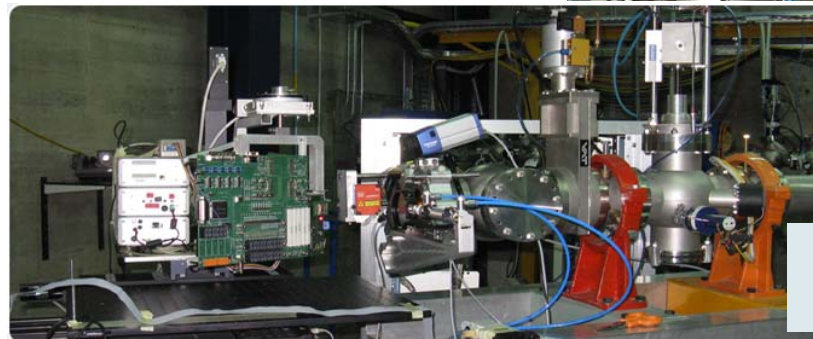
AIPF @ LNL and LNS



Micro-beam and RBS set-up @ LNL



CATANA



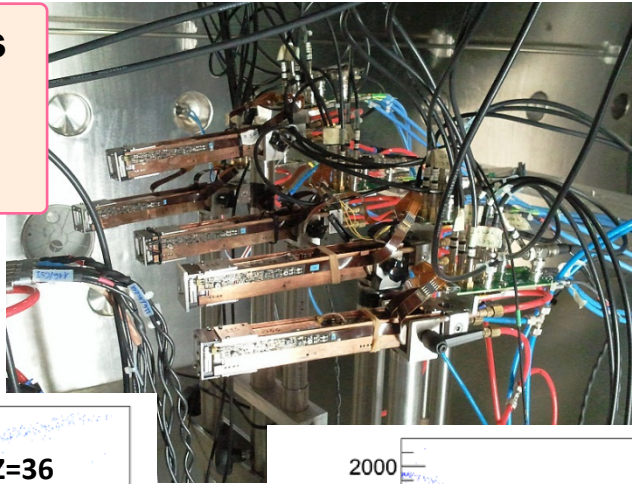
Irradiation facility
0° beamline @ LNS

TNA03 – News from the supported experiments

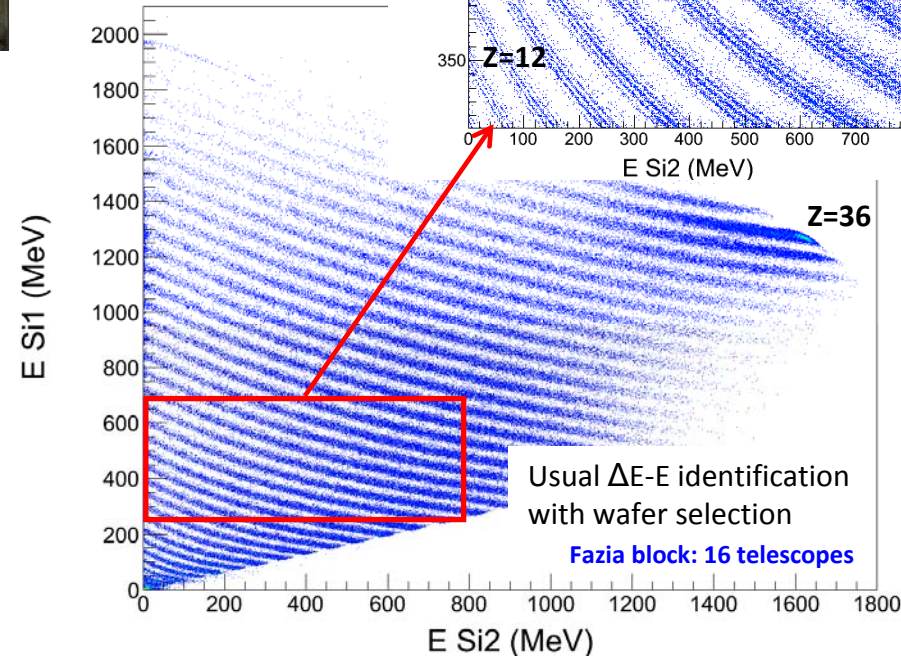
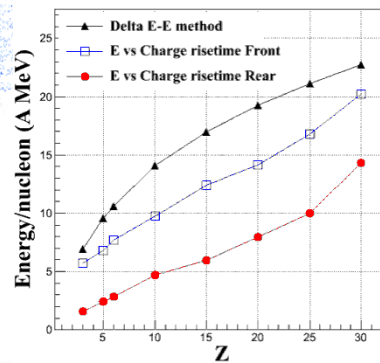
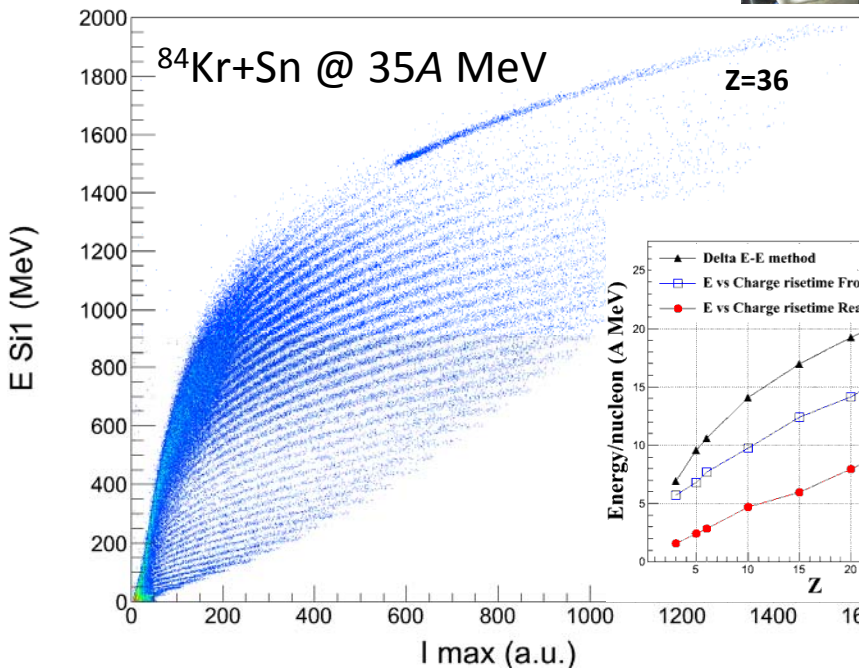
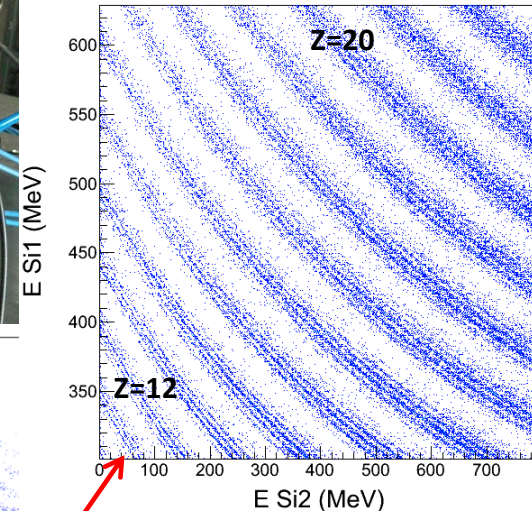
Commissioning of FAZIA modules

2 experiments : LNS FAZIA

N. Le Niendre - LPC, Caen, France



Isotopic resolution up to $Z \approx 25$



Z identification up to the beam charge for stopped particles by PSA

Nucl. Instr. and Meth. in Phys. Res. A 701 (2013) 145

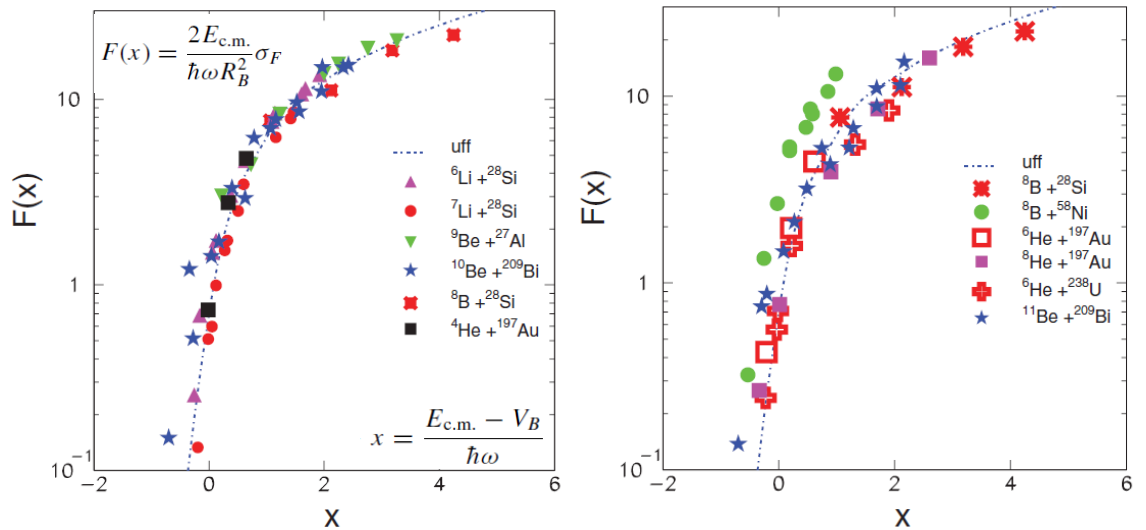
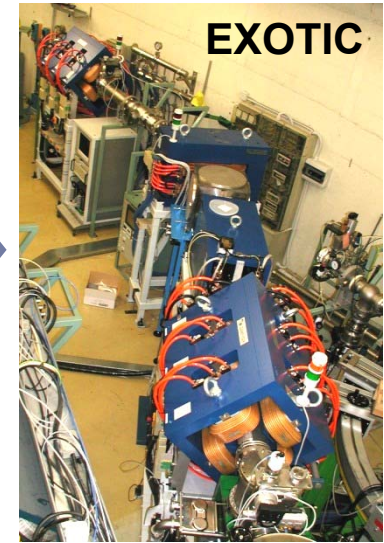
TNA03 – News from the supported experiments

$^8\text{B} + ^{28}\text{Si}$ fusion cross sections at near barrier energies

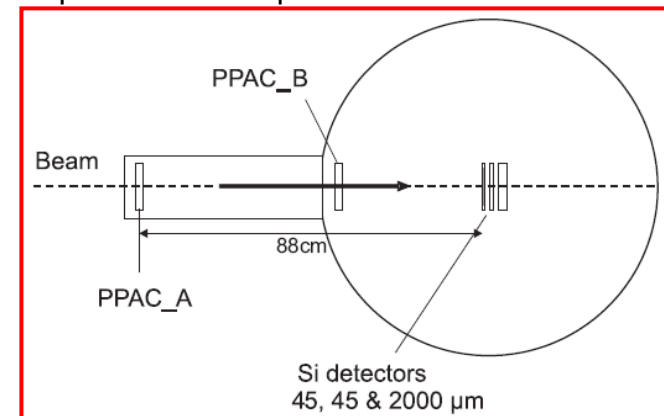
LNL 11.24

A. Pakou – U. Ionnina, Greece

^8B was produced in flight at EXOTIC facility at the rate of 200 pps
 $^3\text{He}(^6\text{Li}, ^8\text{B})n$ Gas target : ^3He , 5 cm long, 1 bar, 90 K, 2 mg/cm²



Experimental setup



1st Workshop on New Aspects and Perspectives in
 Nuclear Physics – 8 Sept 2012, Ioannina, Greece
 IEEE Conference 29 Oct – 3 Nov 2012 Anaheim,
 California, USA

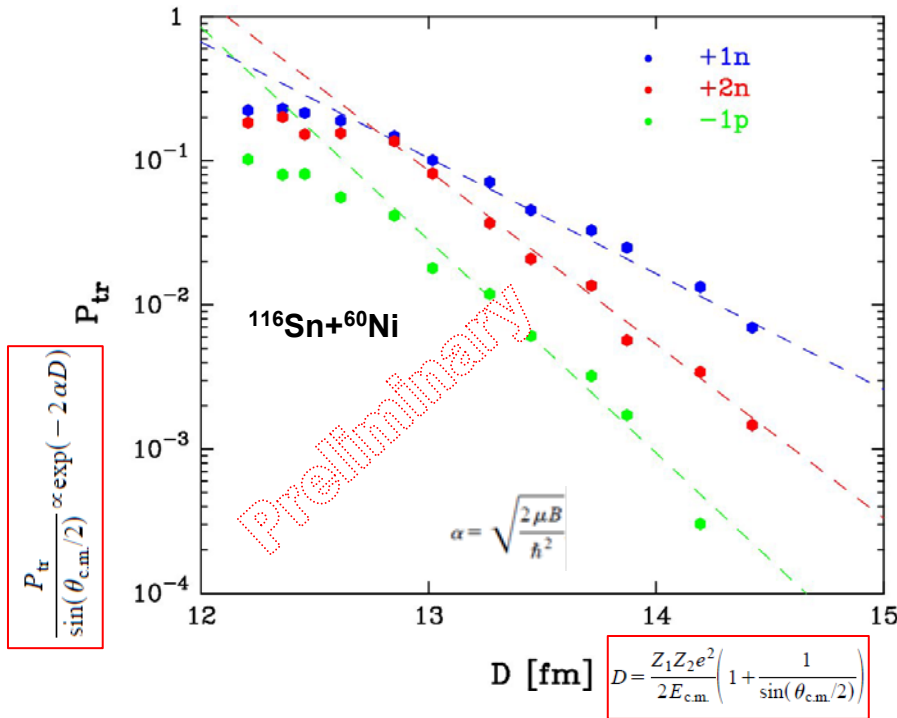
Physical Review C 87, 014619 (2013)

TNA03 – News from the supported experiments

Transfer reactions in $^{116}\text{Sn}+^{60}\text{Ni}$ and $^{92}\text{Mo}+^{54}\text{Fe}$ at deep sub-barrier energies

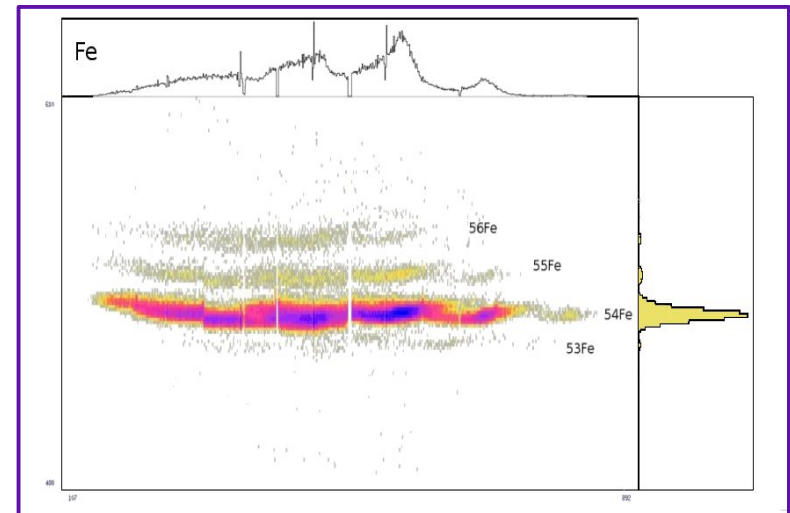
LNL 11.33 and LNL 12.05

S. Szilner - Ruđer Bošković Institute, Croatia



Excitation functions for MNT channels in the $^{116}\text{Sn}+^{60}\text{Ni}$ and $^{92}\text{Mo}+^{54}\text{Fe}$ reactions by using the PRISMA spectrometer working in inverse kinematics

To probe nucleon-nucleon correlations via transfer of (nn), (pp) and (np) pairs



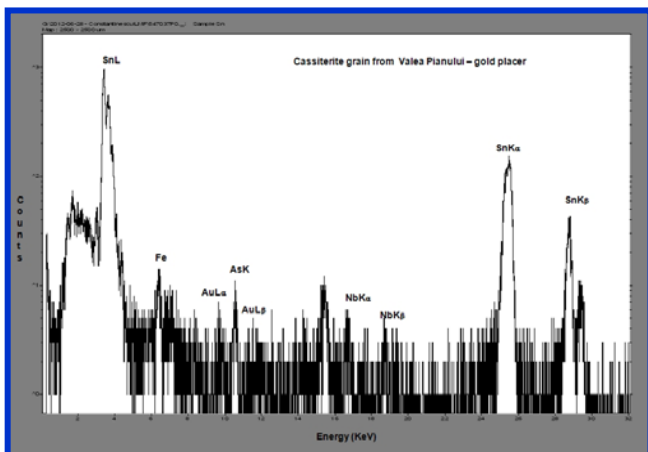
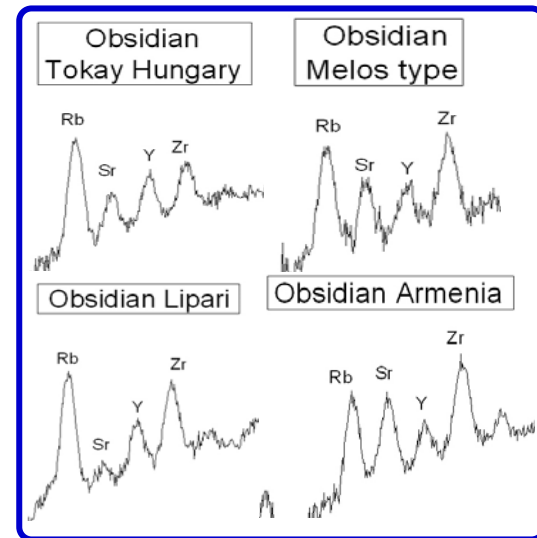
INPC 2013 - 2-7 June 2013, Firenze, Italy

Enhancement of P_{tr} for pair transfer with respect to the predicted one by an independent particle transfer mechanism

TNA03 – News from the supported experiments

Micro-PIXE studies on geological and archaeological samples (MicroArchaeoStudy)
LNL USP11.71 and LNL USP12.15 B. Constantinescu - NIPNE Bucharest, Romania

Elemental analysis of obsidian archaeological and geological samples was carried out using the proton micro-PIXE facility at LNL to determine their individual pattern: Ti, Mn, Zn, Pb, Rb, Y, Sr, Zr contents and especially the ratios Ti/Mn, Rb/Zr, Rb/Sr. Preliminary results suggest a model of populations movement based on obsidian sources used: from Central Europe (Tokay Mts.) to South in Mesolithic, from Balkans (Melos-Egean Islands) to Central Europe in Early Neolithic.



Micro-inclusions of a Sn mineral in alluvial gold grains

B. Constantinescu *et al.* Proceedings of the Romanian Academy, Series A, 13(1), (2012) 19-26.

B. Constantinescu *et al.*, Journal of Analytical Atomic Spectrometry, Vol. 27. No. 12, (2012) 2076-2081.

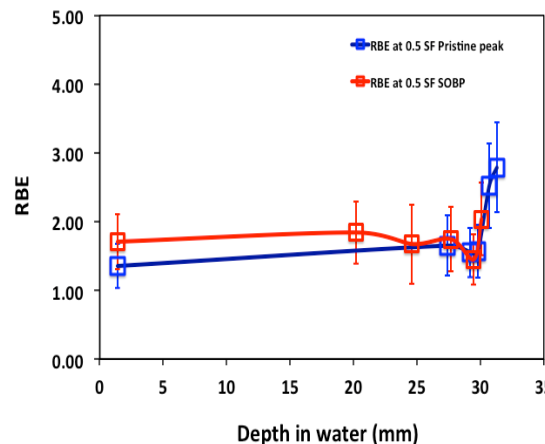
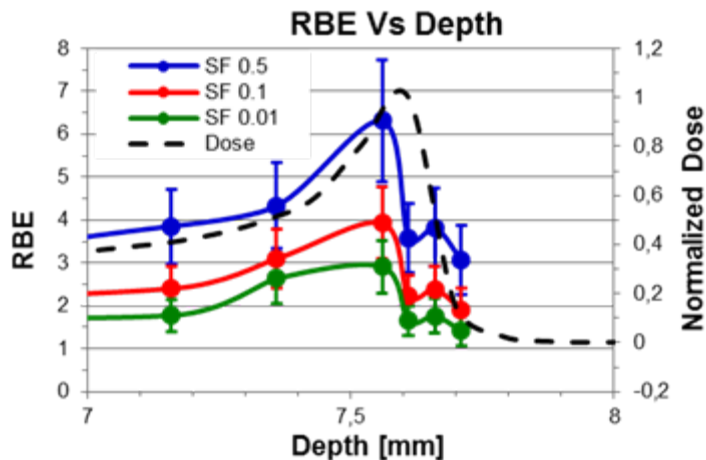
TNA03 – News from the supported experiments

DNA damage and cellular response along and around the Bragg curve

2 experiments : **LNS DNA-BRAGG**

G. Schettino - Queen's University Belfast, UK

- ✓ Beam: 62 MeV/u protons and carbon ions
- ✓ Cell lines: Glioblastoma, Fibroblasts, breast cancer cells, Human Umbilical
- ✓ Assays: Clonogenic cell survival and chromosomal aberrations



Relative biological effectiveness has been evaluated as a function of depth and dose for clinical configurations. Data used to evaluate the effective dose and assess how this changes with depth and beam configuration for possible clinical improvements.

ARR (June 2012) and ERRS (Oct 2012) Conference

Dr. Joy Kavanagh PhD thesis (official graduation June 2012)

Manti et al., 2012 in Journal of Physics: Conference Series 373 (1)

Kavanagh et al, submitted to Nature Communication Oct 2012

TNA03 – Beam time requests (2013)

October 2013 - February 2014

October 2013 - July 2014

Tandem/PIAVE-ALPI
NSDBF and AIPF

LNL

Call – 2 May 2013
Deadline – 10 June 2013
PAC meeting – 15-16 July 2013

Superconducting Cyclotron
NSDBF and AIPF

LNS

Call – 25 February 2013
Deadline – 31 March 2013
PAC meeting – 19-21 June 2013

October 2013 - February 2014

AN-2000 and CN V.d.G.
AIPF

LNL

Call – 2 May 2013
Deadline – 10 June 2013
USIP meeting – 9 July 2013

TNA03 – Outlook

LNL October 2013 - February 2014
LNS October 2013 - July 2014

ENSAR : TNA03

USP meeting – 19 July 2013 at LNS

Total num. of applications **13**
Number of NSDBF projects **6**
AIPF projects **7**

if approved

45 experiments

86%

238 users

+16%

1906 person-days

+5%

268 k€
90%

**Next Call for proposals (only LNL, March – July 2014)
by the end of 2013**

- ✓ The activity started at the end of May 2011
- ✓ 37 experiments approved by the ENSAR USP
- ✓ 27 experiments carried out up to April 2013
 - 6 → PRISMA+AGATA Demonstrator (LNL)
 - 1 → AGATA Dem + 8 large volume LaBr3 scintillators (LNL)
 - 2 → PRISMA (LNL)
 - 1 → MAGNEX (LNS)
 - 1 → Electrostatic deflector (LNL)
 - 1 → GARFIELD (LNL)
 - 2 → In-beam tests of FAZIA prototypes (LNS)
 - 10 → Applied and Interdisciplinary Physics projects (LNL-LNS)
 - 1 → EXOTIC (LNL)
 - 1 → Sliding-seal chamber – Nuclear astrophysics - THM (LNL)
 - 1 → In-beam tests of diamond detectors (LNS)



- ✓ 133 users (**112** individual users)
- ✓ 923 person-days

- ✓ Two experiments at LNS postponed due to the breaking of the charging belt of the SMP Tandem
- ✓ An experiment at LNS has been cancelled by the user group leader because new experimental results (published after the PAC meeting at LNS in June) made it irrelevant.
- ✓ Additional 5 experiments will be performed at LNL by July 2013
 - ✓ 166 users
 - ✓ 1206 person-days
 - ✓ 191 visits
- ✓ Dates of the next PAC meetings
 - ✓ LNS PAC, 19-21 June 2013
 - ✓ LNL PAC, 15-16 July 2013
 - ✓ LNL USIP, 9 July 2013
- ✓ Next meeting of the ENSAR USP
 - ✓ 19 July 2013 at LNS
- ✓ Next call for proposals

End of 2013 @ LNL (Call 2014)