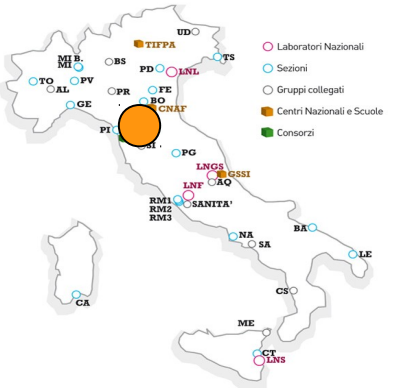
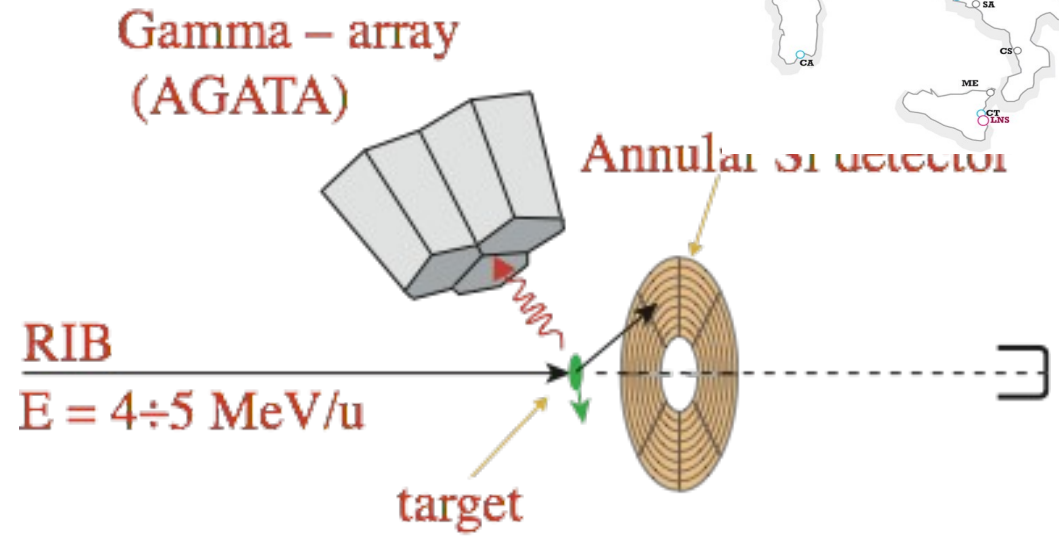
sctructure

The activity in Firenze



EXPERIMENT NAME: GAMMA

CONTACTS:
A. Nannini INFN Firenze



Coulomb excitation: powerful type of experiments to study nuclear levels. First-day SPES experiments (possible even with low currents)

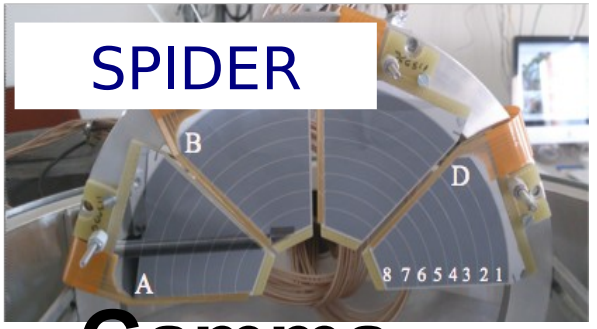
A simple Set-up

- Ge crystals for gammas and
- Segmented Silicon detectors for projectile or target detection

Thesis available:

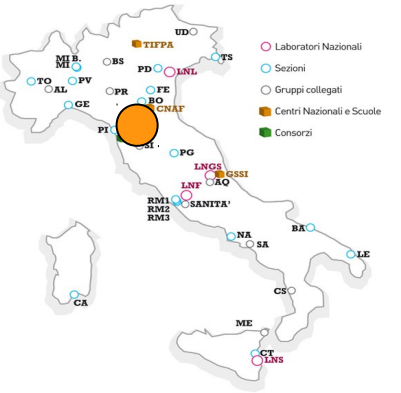
CoulEx setup for SPES experiments

Data analysis and model comparisons



Gamma spectroscopy

The activity in Firenze



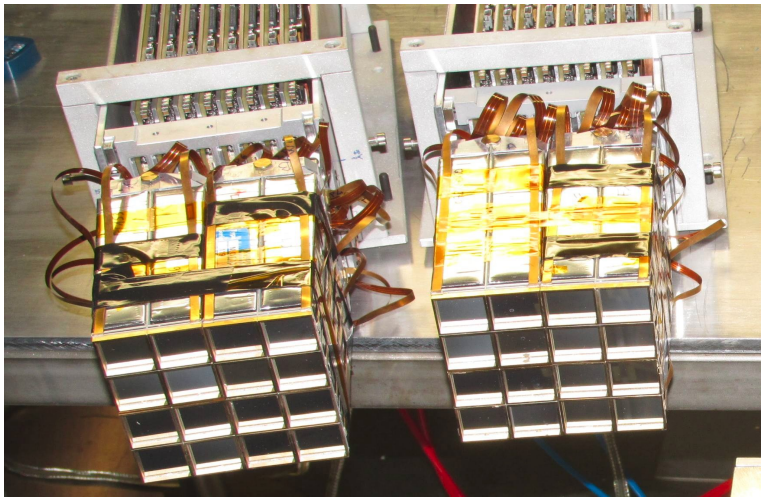
EXPERIMENT NAME: NUCLEX/FAZIA

Strong overlap with LNL, Bologna, Naples

+ International collaborations

CONTACTS:

G.C. INFN Firenze
S. Piantelli INFN Fi
G.Pasquali Uni Fi
S. Barlini Uni and INFN Fi



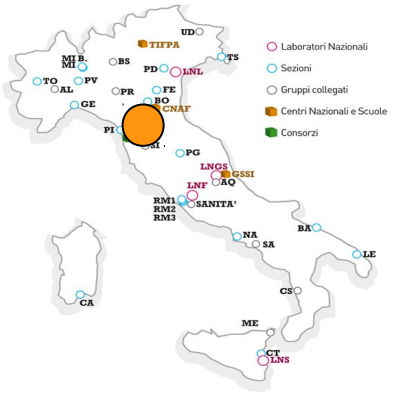
Two modules of the FAZIA array

SHORTLY:

- **Isospin relaxation and nuclear EOS**
- **Clustering in nuclei**
- **From evaporating to multifragmenting systems**
- **Experiments with the GARFIELD array (LNL) and the advanced FAZIA array for ion identification**
- **Fast sampling electronics and ion identification**
- **Advanced detectors for charge particles**

Charged products and reactions

The activity in Firenze



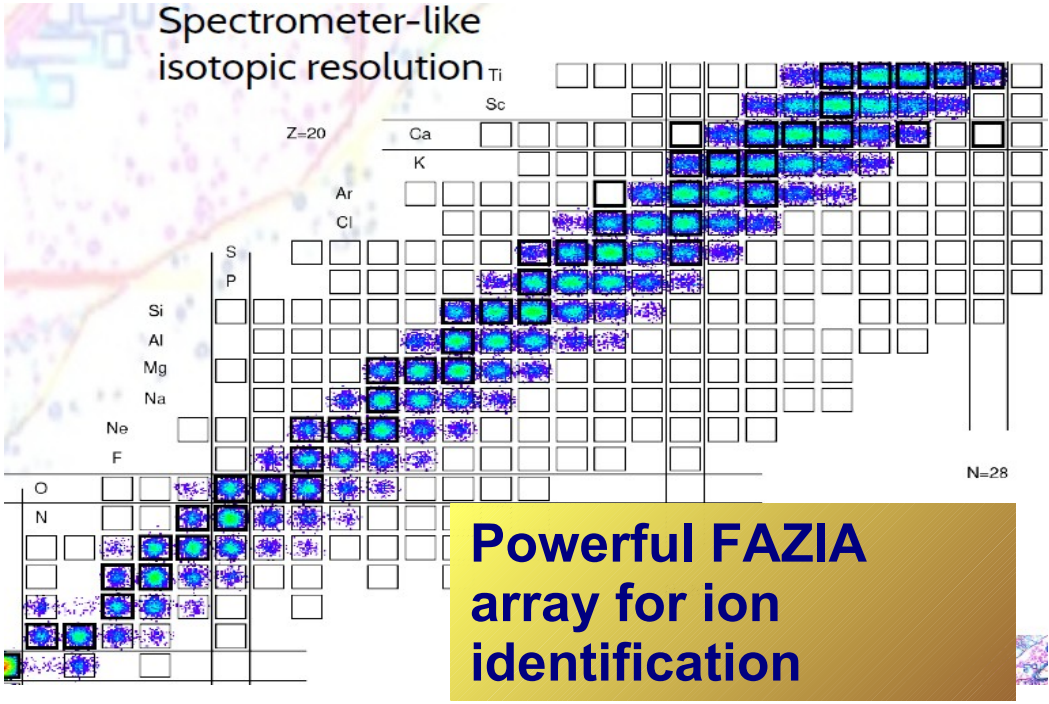
EXPERIMENT NAME: NUCLEX/FAZIA

Strong overlap with LNL, Bologna, Naples

+ International collaborations

SUBJECTS FOR STUDENTS:

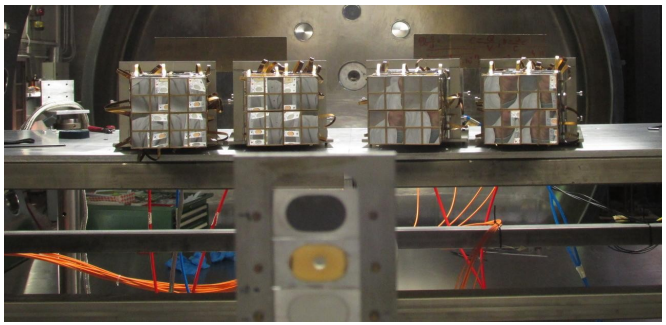
- Experiments in various lab (LNL,LNS, GANIL)
- Detector tests, handling, mounting
- Digital algorithm developments
- Data analysis and MC simulations
- DAQ developments



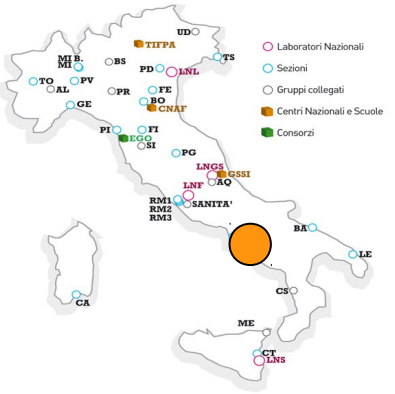
Powerful FAZIA array for ion identification

Thesis available:

- Isospin transport studies
- Clustering effects at LNL and LNS
- Fusion-fission reactions at LNL
- FAZIA experiments at GANIL (France)
- Digital filtering and Pulse shape analysis
- Detector developments and test



The activity in Napoli



EXPERIMENT NAME: NUCLEX/FAZIA

Strong overlap with LNL, Bologna, **Frenze**

+ International collaborations

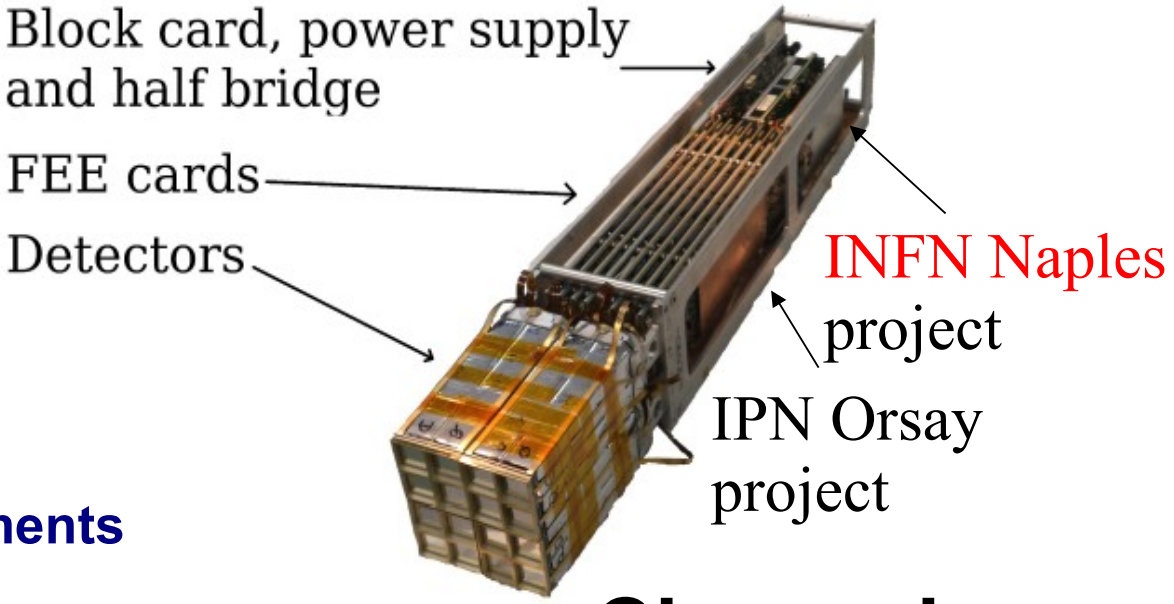
CONTACTS:

M.Vigilante, Uni Napoli

I.Lombardo INFN and Uni Na

SUBJECTS FOR STUDENTS:

- Digital Electronics development
- VHDL
- Hardware construction
- Data Analysis
- Acquisition systems



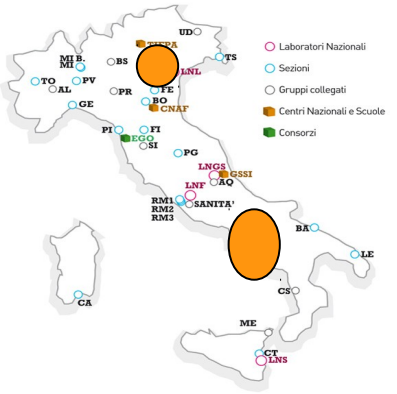
Thesis available:

Data analysis of FAZIA experiments
Electronics developments
DAQ systems
MonteCarlo simulations for particle correlation studies

PISA2015 Student week, july20-24

Charged products and reactions

The activity in Napoli



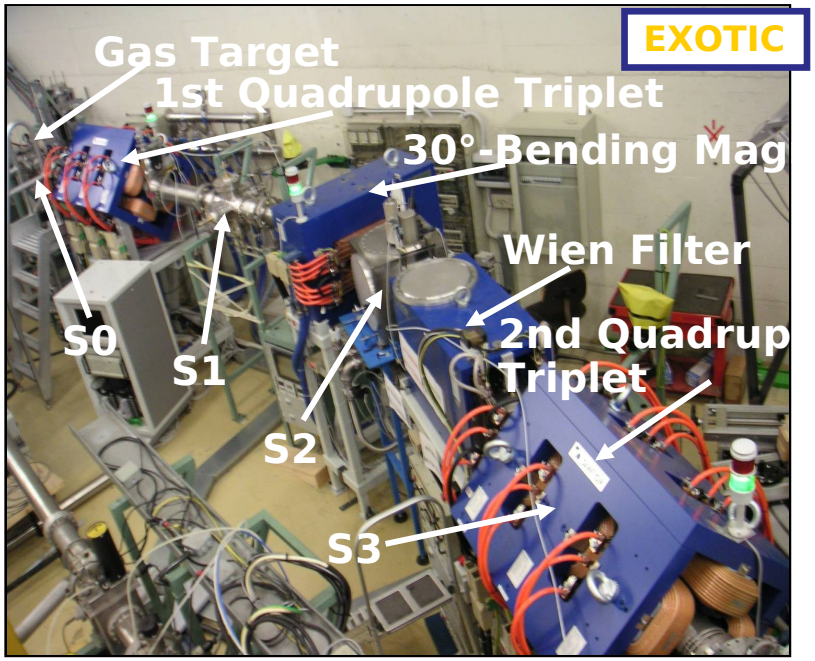
EXPERIMENT NAME: EXOTIC

Strong overlap with LNL, Padova

CONTACTS:

D.Pierroutsakou, INFN Napoli

in-flight inverse kinematics reactions induced by high intensity beams from the Legnaro Tandem on gas targets (p,d,3He).



Production line installed at LNL

SHORTLY:

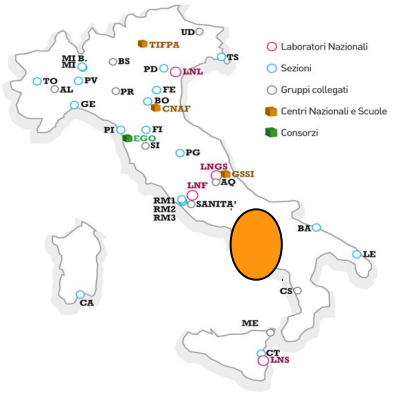
- **Production line for light exotic nuclei**
- **Experiments with these ions Structure and interactions of exotic species around the Coulomb Barrier**
- **Dynamical collective resonances**
- **Light particle segmented detectors**

RIBs: 17F, 7Be, 8B, 8Li, 15O

 (RIB= radioactive ion beam)

Beam production and reactions

The activity in Napoli



EXPERIMENT NAME: EXOTIC

SUBJECTS FOR STUDENTS:
- Computing, simulations
- Beam production
- Gas target
- Nuclear structure and dynamics
- Detectors

Structure and reaction of light-exotic beams

Experimental set up: EXPADES
(8 telescopes: IC+ 40 μm DSSD +300 μm DSSD)

Thesis available:

reaction mechanisms and structure of light exotic nuclei in experiments with the EXOTIC beam line

Dynamical Dipole excitation (DD)

a pre-equilibrium Giant Dipole Resonance excitation in charge asymmetric heavy-ion reactions

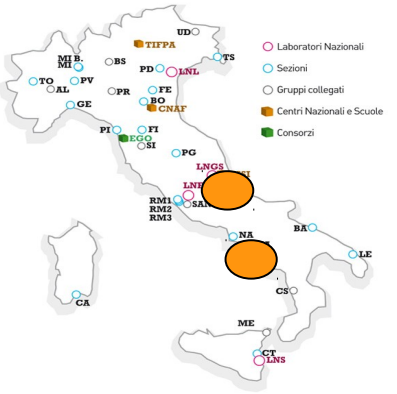
Experimental set up: detectors for high energy γ-rays, gas counters for fusion residue, telescopes for fragments

Thesis available:

In future using SPES n-rich beams

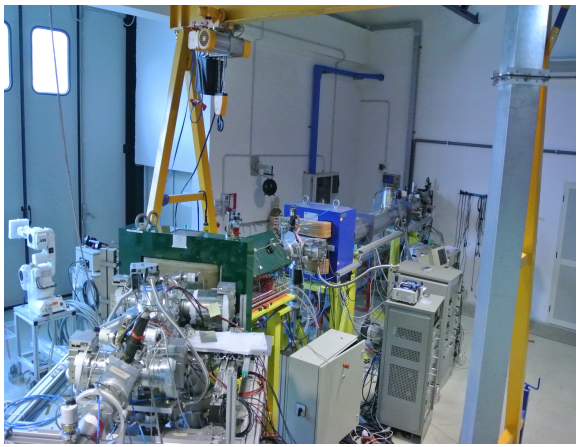
simulation of the best reactions to be studied by employing the SPES RIBs, combined with stable beams on different targets.

The activity in Napoli



Nuclear Astrophysics: to measure extremely low cross sections of the nuclear processes that fuel the stars and characterise the nucleosynthesis.

Maximise S/N is extremely important.



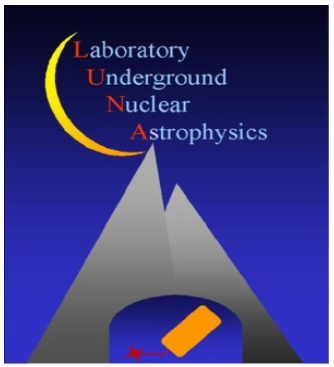
Two approaches may be followed:

Experiment name: ERNA intern. collaboration

METHOD: **Kinematic signature of the events**
➡ **Recoil separator.**

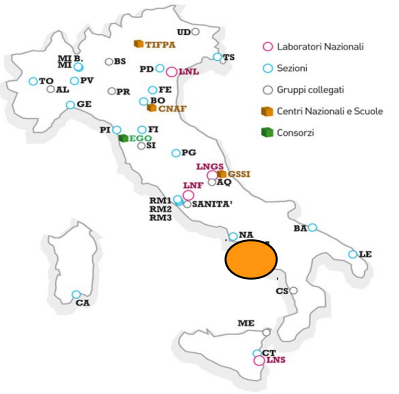
Experiment name: LUNA intern. collaboration

METHOD **Background minimization**➡ Underground exeperiments made under mountains in a silent location at LNGS.



LUNA

The activity in Napoli



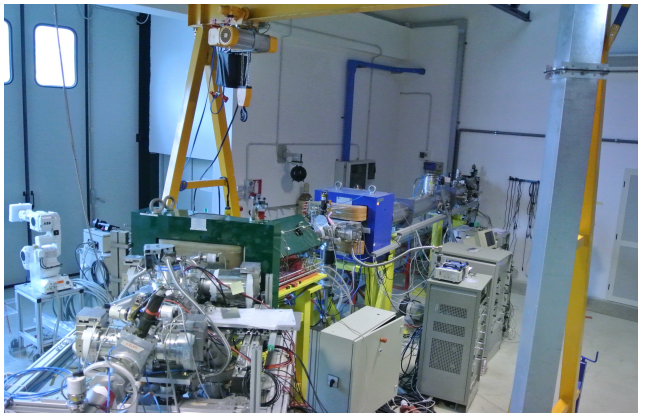
Experiment name: ERNA intern. collaboration

Contacts:

antonino.dileva INFN Napoli

lucio.gialanella INFN Napoli

The **ERNA**
Separator



Thesis available:

- **Kinematic signature of the events**

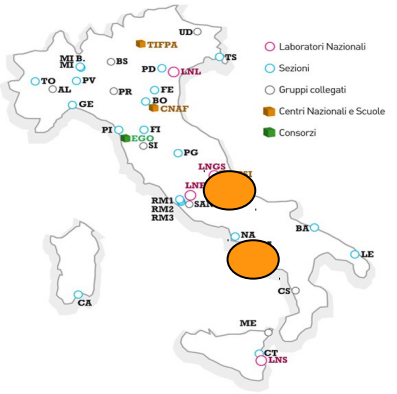
Currently: radiative capture cross section measurements of **7Be(*p*,γ)8B, 14,15N(α,γ)18,19F and 12C(α,γ)16O**

Gamma probe

Another research line uses a dedicated detector assembly for charged particle spectroscopy, at present for **12C+12C and 23Na(*p*,α) 20Ne** reactions.

Alpha probe

The activity in Napoli and LNGS



Experiment name: LUNA intern. collaboration

Contact:

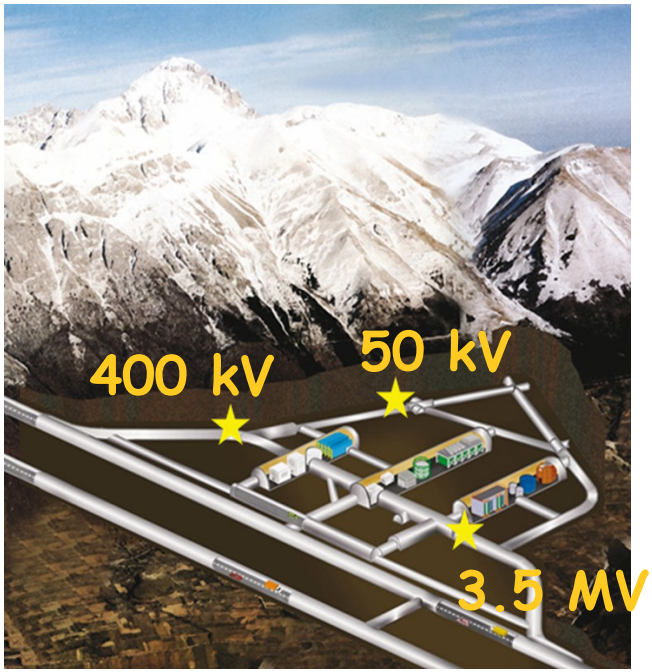
gianluca.imbriani INFN Napoli

Thesis available:

Background minimization➡ underground at LNGS.

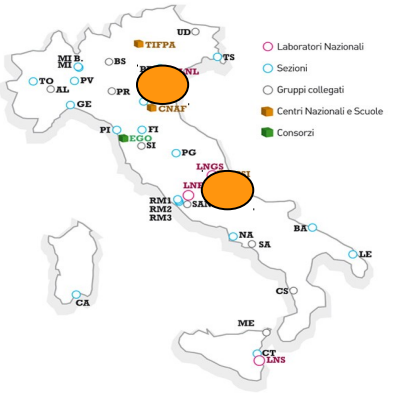
At present the Naples Section is directly responsible for the measurements of

18O(p,γ)19F and 23Na(p, γ) 24Mg, and in the near future other reactions of the CNO, NeNa and MgAl cycles.



Proton beam 0.3mA

The activity in Padova and LNGS



Study of nuclear reactions responsible of the energy production and of stellar chemistry (H-burning)

Contact:

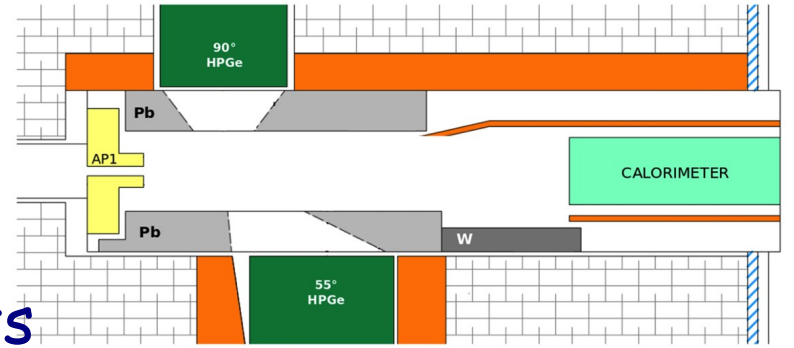
carlo.broggini UNI Padova

In the past most reactions on the typical solar cycle:
- 3He (3He,2p)4He (solar neutrino problem)
- 14N(p,g)15O (CNO neutrinos, Universe age)

Laboratory Underground Nuclear Astrophysics

LUNA

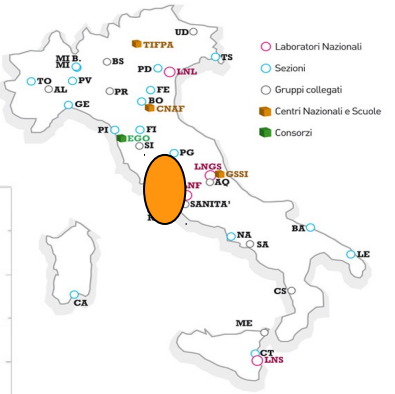
Henceafter: study H-burning at higher Temperatures AGB stars e Novae + BBN



Thesis available:

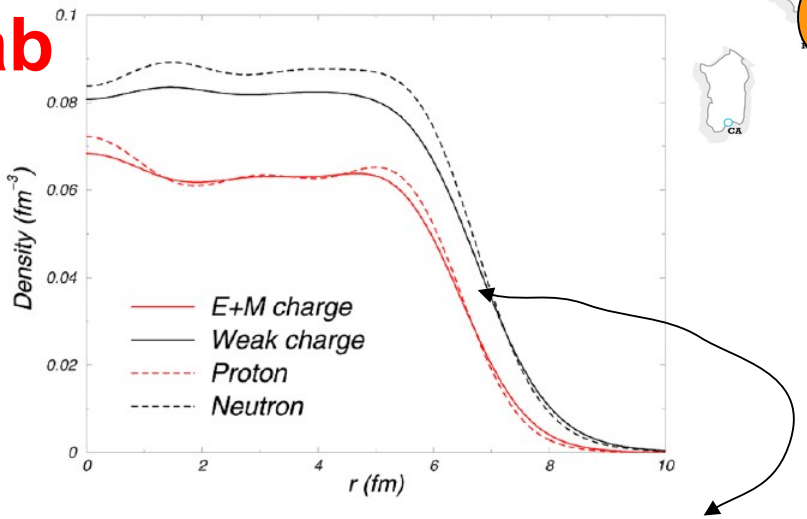
Preparation and test in Legnaro of targets measure @LNGS 6Li(p,γ)7Be.
- Low energy resonance?
- Analysis of previous collected data

The activity in Roma and US



EXPERIMENT NAME: PREX at Jeff Lab

CONTACTS:
G.M. Urciuoli, INFN Roma 1

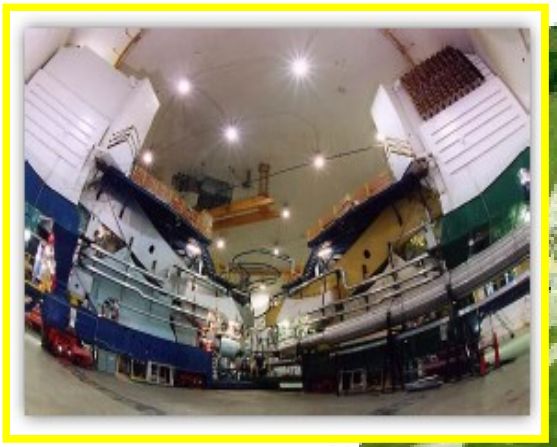


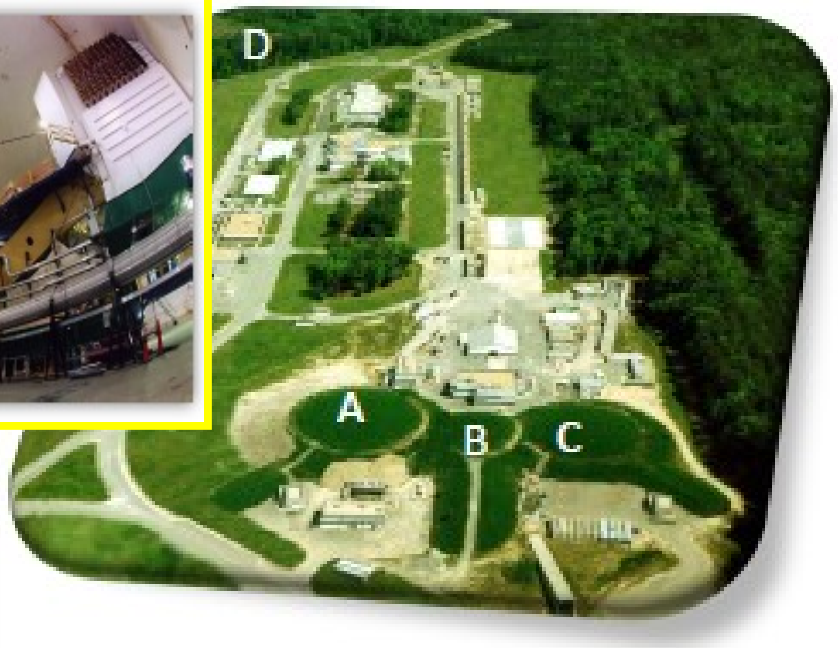
208Pb Neutron skin – PREX experiment

SUBJECTS FOR STUDENTS:
Data Analysis
Polarized beams
Experiments in US

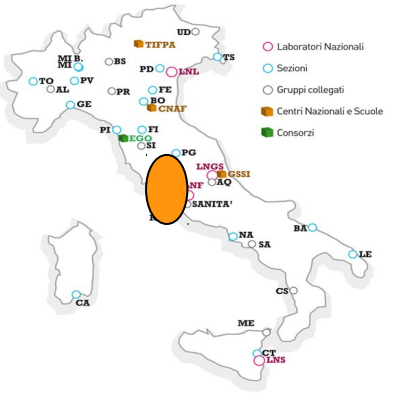
SHORTLY:

- **Experiments at JLAB (USA) with longitudinally polarized electron beams**





The activity in Roma and US



Exps in HallA, using 1 GeV electron beam, (till 70 uA);

highly polarized (90%) on 0.5 mm Pb target

Changing **e-** helicity

part-per-million precision

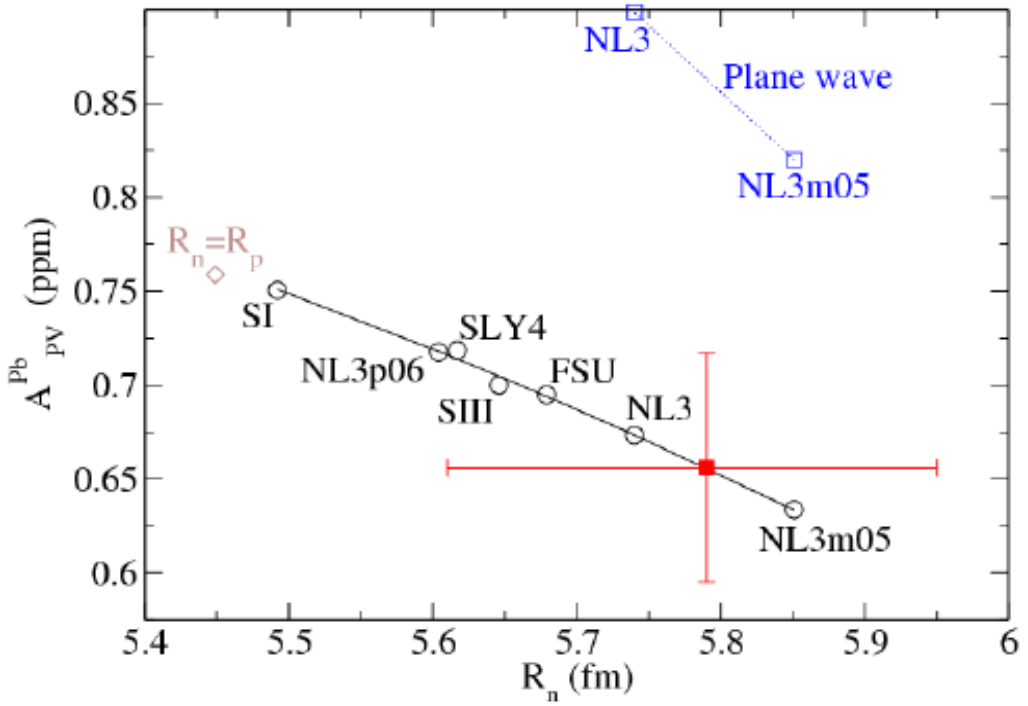
$$A_{PV} = \frac{\left(\frac{d\sigma}{d\Omega}\right)_+ - \left(\frac{d\sigma}{d\Omega}\right)_-}{\left(\frac{d\sigma}{d\Omega}\right)_+ + \left(\frac{d\sigma}{d\Omega}\right)_-} = \frac{G_F Q^2}{2\pi\alpha\sqrt{2}}\left[\underbrace{1-4\sin^2\theta_W}_{\approx 0} - \frac{F_n(Q^2)}{F_p(Q^2)}\right]$$

PWIA

«left»-«right» asymmetry

APV (Z0 exchange) in

e+208Pb elastic scattering



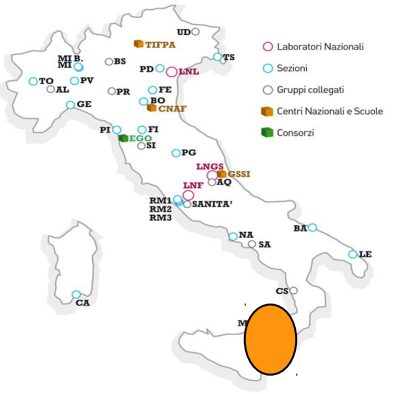
$$R_n - R_p = 0.34^{+16}_{-18}\ fm$$

Thesis available:

New experiments approved to improve statistics and extend to other nuclei.

http://hallaweb.jlab.org/parity/prex/

The activity in Catania



EXPERIMENT NAME: NEWCHIM

CONTACTS:

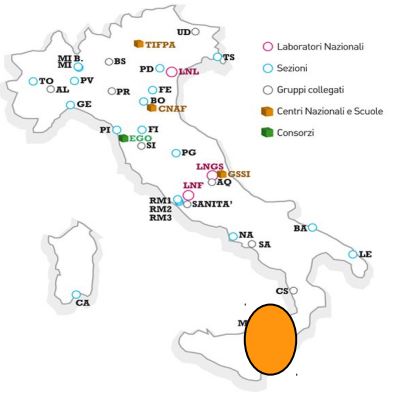
Sara Pirrone and Giuseppe Cardella, INFN Catania
Giuseppe Politi and Ninni Rizzo, Universita' di Catania

SHORTLY:

- **Mulftigramentation, EOS and symmetry energy**
- **Experiments with LNS stable and unstable beams at cyclotron energies**
- **Big detector CHIMERA (almost 1200 “eyes”)**
- **Construction of a powerful sensor for multiparticle correlations (R&D on DETECTORS)**

Charged products and reactions

The activity in Catania



EXPERIMENT NAME: NEWCHIM

SUBJECTS FOR STUDENTS:
- Detector calibrations
- Data Analysis
- Models and Simulations

How a big system is produced and decays by changing the neutron/proton ratio?

E = 10 AMeV $^{78}Kr + ^{40}Ca \rightarrow ^{118}Ba$ and $^{86}Kr + ^{48}Ca \rightarrow ^{134}Ba$

Thesis available:

analysis of an experiment (already done) with stable beams@LNS and on the preparatory phase to SPES experiment

SPES Letter Of Intent

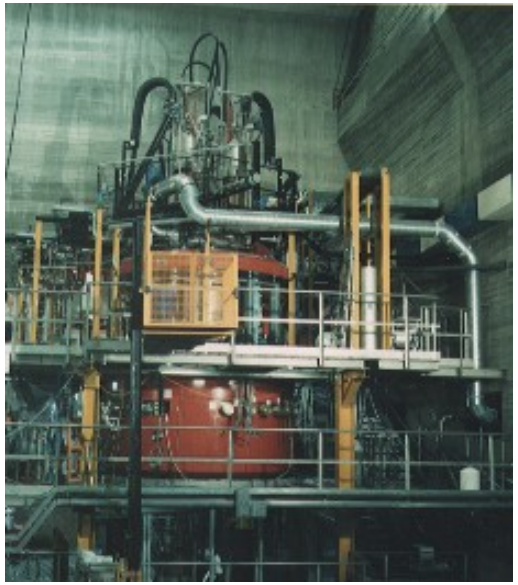
Isospin dependence of compound nucleus formation and decay

systems with higher N/Z

$^{90,94}Kr + ^{40,48}Ca$ 10 AMeV

ISOL (LNL) but not only... in-Flight (LNS) beams

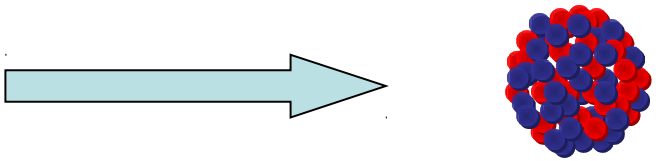
@LNS, Catania



Refer to

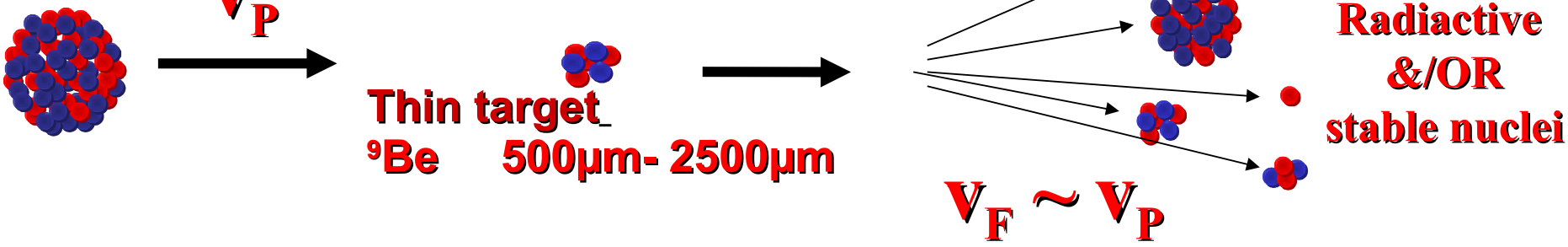
- Lecture by R.Raabe Louven and others

Primary Beam (e.g. from a Cyclotron)



Stable Nuclei
A ~ 10 - 100
E ~ 20 - 60 MeV/A

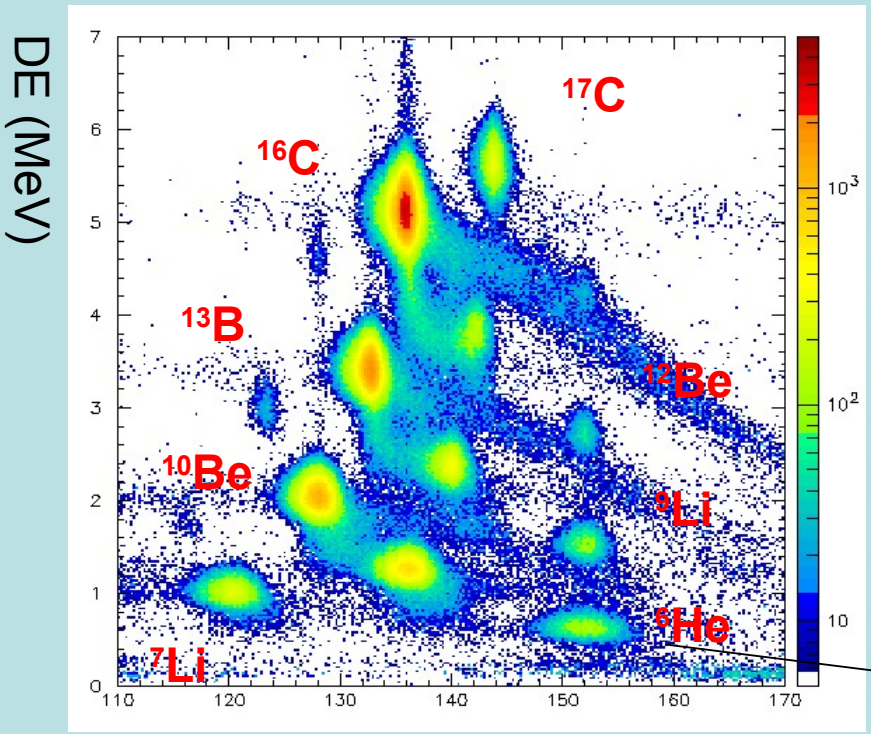
Primary Beam



For more info, among others:
D.Rifuggiato INFN LNS, Catania Accelerator
G.Cardella INFN Ct, Catania, experiments

RIB @ Intermediate Energy

The activity in Catania



EXPERIMENT NAME: NEWCHIM

In-flight fragmentation beams @ LNS with CHIMERA

^{18}O + ^{9}Be (1.5 mm) at 55 MeV/A

18O beam, 88W, 5.5×10^{11} p/s

Among the various produced nuclides

^{8}He 3 kHz

secondary beam 40-50 MeV/A

SUBJECTS FOR STUDENTS:

- Detector calibrations
- Data Analysis
- Models and Simulations

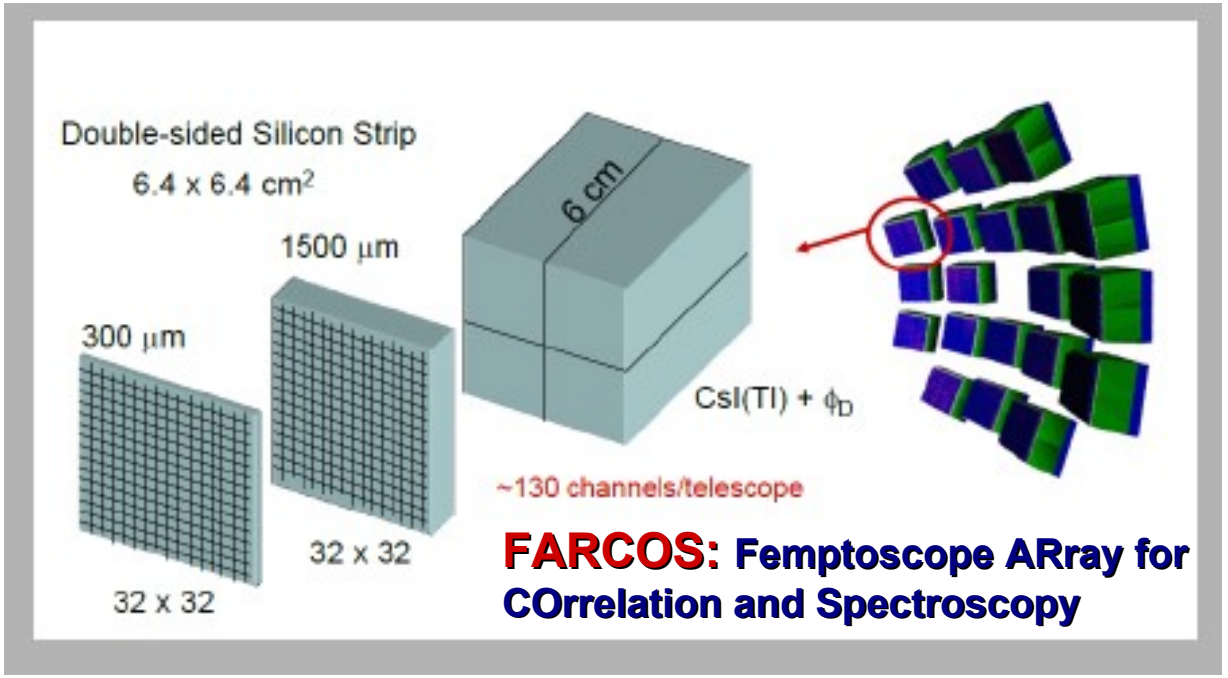
Thesis available:

Study of the ^{9}He structure in one neutron trasfer reactions ^{8}He +d → ^{9}He+p

The activity in Catania

EXPERIMENT NAME: NEWCHIM

SUBJECTS FOR STUDENTS:
DETECTORS
ELECTRONICS
LAB TESTS



Telescopes for fragments with High angular resolution (Δϑ<1°) and low thresholds (<1 MeV/A)
Pulse-shape analysis in Silicon
wide Dynamic range (>>20MeV)
Modularity and Transportability
Coupling to 4π detectors or spectrometers
Integrated Electronics (GET)

Thesis available:

20 modules under CONSTRUCTION 2015-2019

reactions

The activity in Catania (and Canada)

EXPERIMENT NAME: LNS-STREAM

Thesis available:

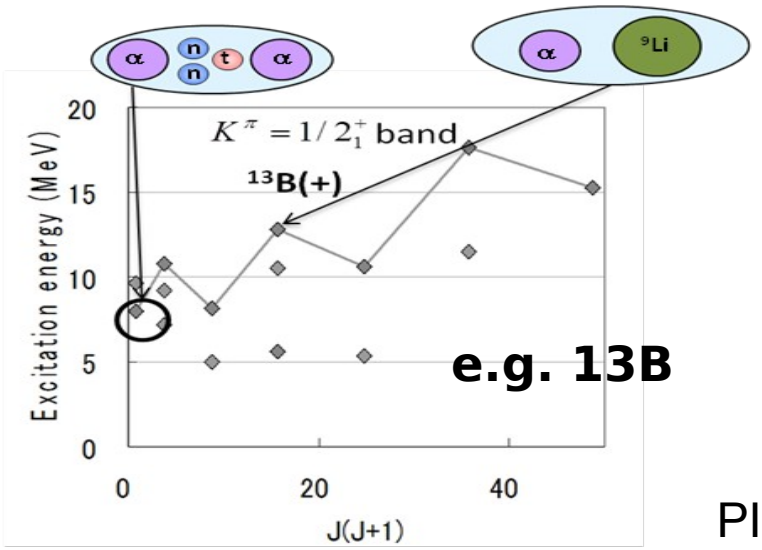
Contacts:

A.Di Pietro INFN LNS Catania

9,11Li-α cluster states in 13,15B

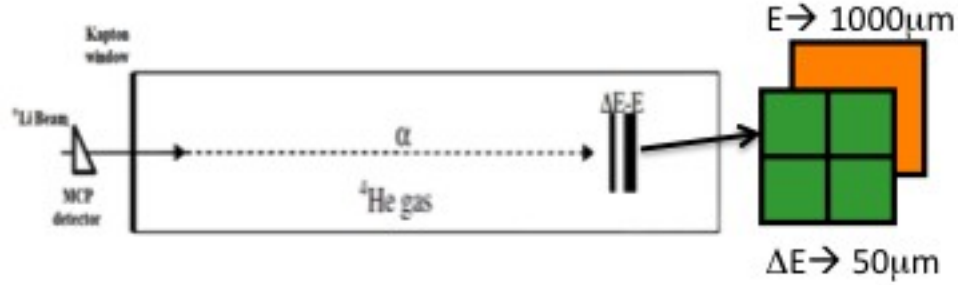
Experiment approved @ TRIUMF Canada

In many light N=Z nuclei clusters are formed by tightly bound nucleons (alpha particles). In n-rich nuclei clusters coudn't be stiff particles and Exotic cluster configurations may appear.



e.g. 13B

Resonance Scattering Technique: a beam hits an extended gas target (also it is an energy degrader). Elastic excitation functions are measured in a broad energy range in a single run. Very useful with RIBs to minimise the beam time requests.



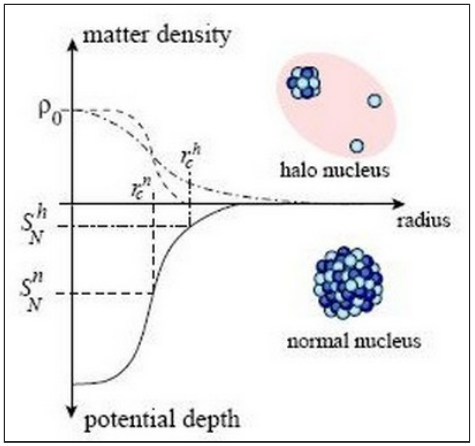
gas target (1.5 m)

ΔE-E for He,H separation

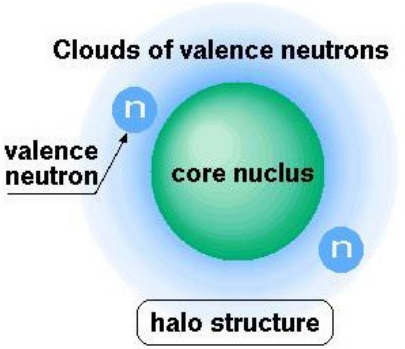
Tof between MCP detector and ΔE-Si-detector

The activity in Catania (and Canada)

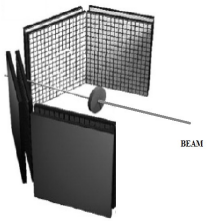
halo *vs* normal nucleus



ELASTIC SCATTERING AND BREAK-UP IN THE 9,11LI+64Zn reaction



- Weakly bound (easy to break-up)
- Easy to polarise (large B(E1) low energy strength)
- Suffer lower Coulomb barrier
- Higher transfer probability of valence nucleons



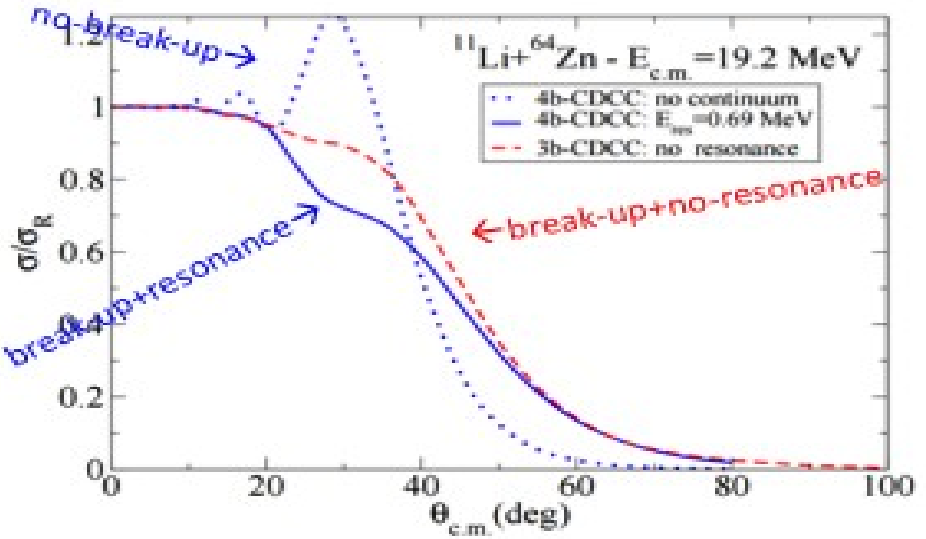
Experiment approved @ TRIUMF Canada

Thesis available:

Understand the dynamics of the reactions induced by halo nuclei (11Li)

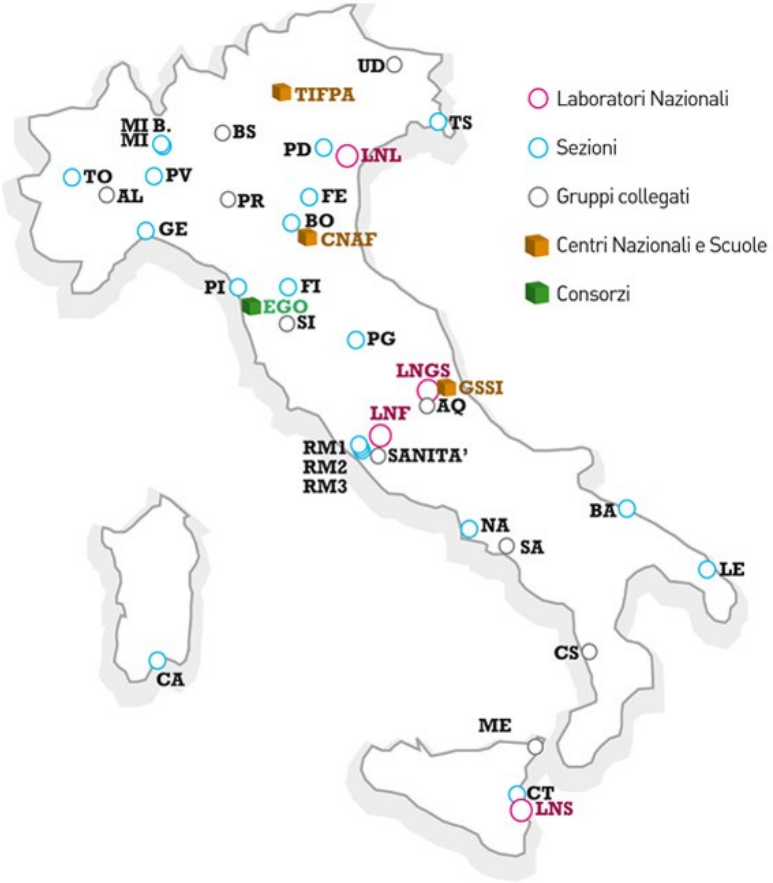
Due to the low binding-energy of halo nuclei, g.s. lies close to the break-up threshold. Coupling to break-up states (continuum) affects the dynamics of the collisions. Also soft-resonances can occur

Elastic-scattering angular distribution



To keep in mind

People we have met!



camera @mi.infn.it GAMMA detectors
Leoni @mi.infn.it GAMMA experiments
Benzoni @mi.infn.it GAMMA and beta-decay
Bracco @mi.infn.it GAMMA experiments
Wieland @mi.infn.it GAMMA experiments
Andrighetto @lnl.infn.it SPES beam develop.
Fioretto @lnl.infn.it PRISMA spectrometre
Corradi @lnl.infn.it PRISMA specttometre
Montagnoli @pd.infn.it PISOLO separator
Valiente-dobon @lnl.infn.it GAMMA array
Mengoni @lnl.infn.it GAMMA particle array
Recchia @pd.infn.it GAMMA experiments
Lenzi @pd.infn.it GAMMA theory
Pierroutsakou @na.infn.it EXOTIC exper.
Morellil @bo.infn.it DYNAMICS experiment
Igialanella @na.infn.it ASTROPHYSICS exps
Dileva @na.infn.it ASTROPHYSICS exps
Broggini @pd.infn.it ASTROPYSICS exps
Casini @fi.infn.it DYNAMICS FAZIA exp.
Piantelli @fi.infn.it DYNAMICS exp
Pasquali @fi.infn.it PARTICLE detectors
Pirrone @ct.infn.it DYNAMICS CHIMERA exp
Cardella @ct.infn.it DYNAMICS CHIMERA exp
Dipietro @lns.infn.it DYNAMICS halo nuclei
Urciuoli @roma1.infn.it neutron SKIN exp.