Il gruppo di fisica nucleare (GR3) a Firenze

Giovanni Casini
INFN Firenze

- manpower e le richieste
- Le attivita' e le sigle INFN **(GAMMA e NUCLEX)**

SPES: una facility con 4 fasi

Fase α ciclotrone ed edilizia
Gia' finanziata (circa 22Meuro)

Fase β riaccelerazione di fasci radioattivi
Costo 25Meuro

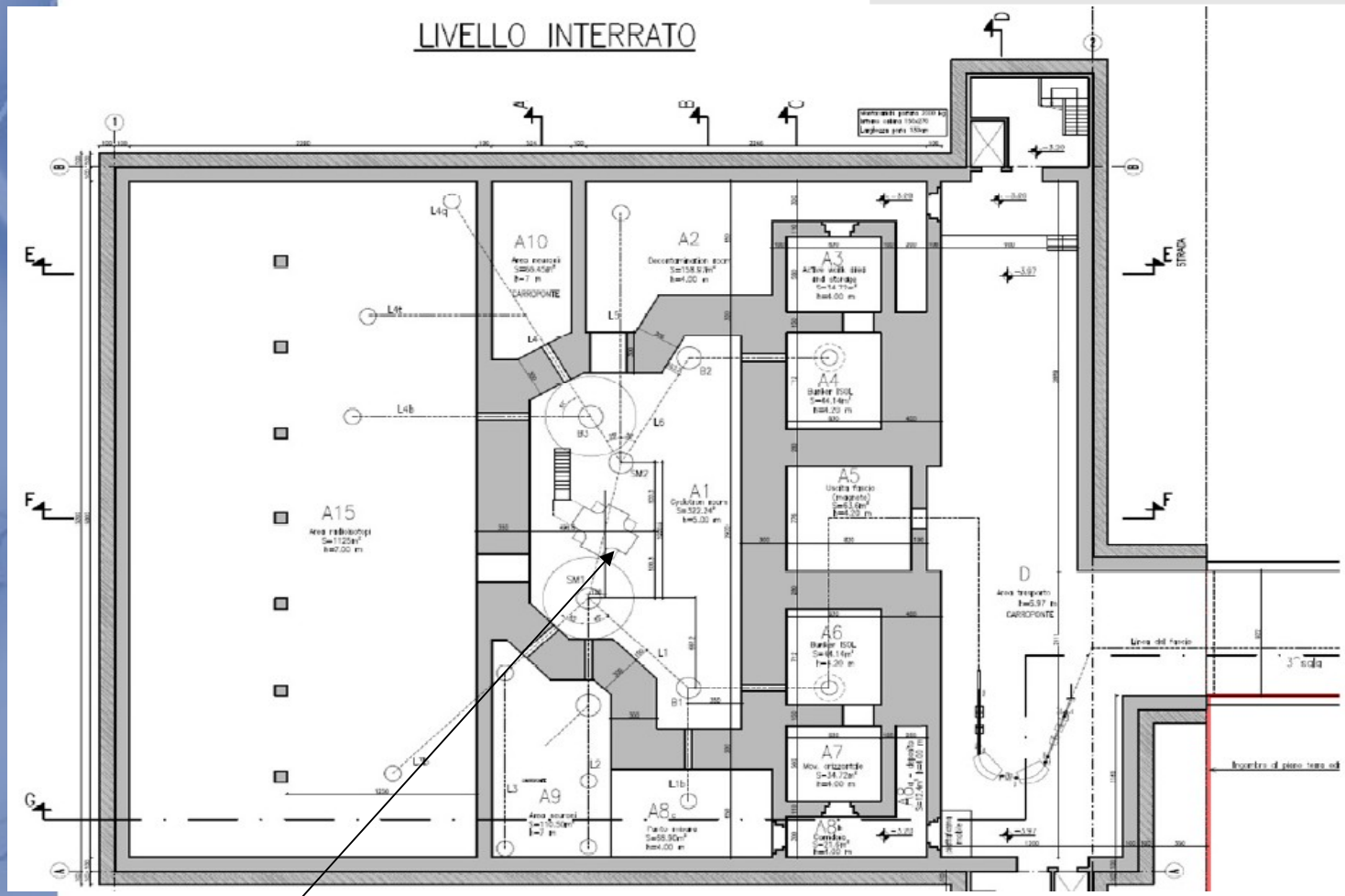
Fase γ radioisotopi per Medicina
Costo 17-20Meuro (NON INFN!)

Fase δ una facility per neutron irradiation
Costo 10Meuro (un po' INFN?)

Il QUADRO

SPES exotic beams for science

Edificio con pianta 50x60m2 Nel febbraio 2013 iniziata la costruzione



Costo dell'edilizia circa 11000ke

8000ke erano residui del finanziamento 2003 mentre altri 3000 sono stati erogati nel 2011

Ciclotrone della BEST B70 (Canada')

Firenze e SPES

Il gruppo III di Firenze e' molto coinvolto in attivita' presso i LNL

Spettroscopia gamma (struttura) e misure di specie cariche (reazioni)

SPES Steering Committee (dal 2008)
Persone di Bo, Mi, Fi, LNL, LNS, Na, Pd

Per Firenze: 2008-2012 G.C. ; da giugno 2012 A.Nannini

SPES instrumentation group (2010) per le interazioni con il Gruppo Supporto Scientifico e come interfaccia (in qualche modo) con la CSN3

Members: G.C., G. DeAngelis, G. LaRana, N.Pollarolo

Gruppo Supporto Scientifico (2010) per la promozione dei casi di fisica e la valutazione delle LoI

DeAngelis* (convener) , S.Pirrone, A.Dipietro, G.Colò, A.Gargano, S.Lenzi, N.Pollarolo, GC

* ha sostituito di recente A.Covello

Firenze e SPES

Nominato ufficialmente il SAC di SPES (per Firenze A.Olmi)
Prima riunione probabilmente inizio 2014
Lavoro principale: revisione delle LoI

Gruppo SPES supporto scientifico organizza una serie di incontri di un giorno (SPES one-day workshop):

Miniworkshop SPES (Na, maggio 2012): Direct (transfer) Reactions
Miniworkshop SPES (Fi, sett 2012): Coulomb Excitation
In programma (Ct, ottobre 2013): Search of isospin effects with RIB

Esperimento nucl-ex

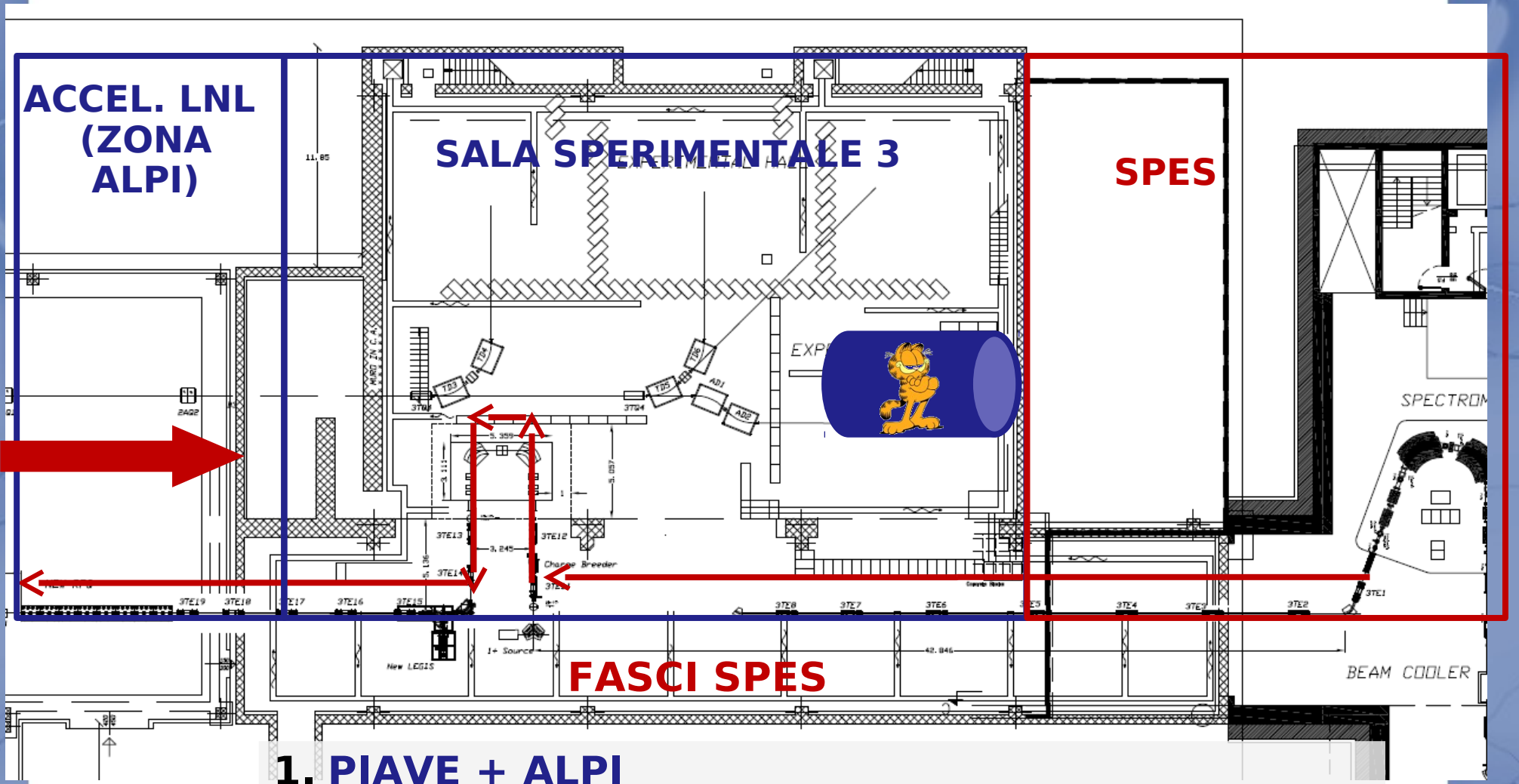
- Caratterizzazione di processi di reazione a vari regimi energetici
- Esplorazione degli effetti di isospin nei processi di eccitazione e decadimento dei nuclei
- Studio dettagliato del processo di fusione evaporazione
- Costruzione dimostratore di FAZIA

FTE 7.3 divisi tra FAZIA e SPERIM

Tecnici di supporto: G.Tobia e E.Scarlini

Esperimenti a LNL (Garfield e RIPEN)
E con FAZIA sia a LNS che a GANIL (negli ultimi due anni)

Esperimento Nuclex (Fi)



1. **PIAVE + ALPI**
2. **TANDEM (+ALPI)**
3. **SPES + ALPI (RIBs)**

Experimental set-up @ LNL-INFN

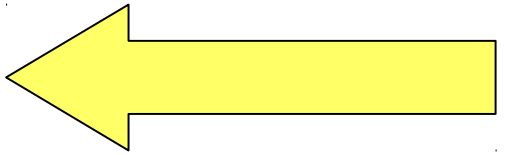
data from ^{12}C(@ 95 MeV)+^{12}C

NUCL-EX collaboration campaign:
STATistical properties of LIGHT nuclei from Fus-Evap.

- low multiplicity evts. & high detection coverage
  → (quasi)complete evt. reconstruction
- high energy and angular resolution
  → global control on the decay mechanism

⇒ GARFIELD+RCo @ LNL, **^{12}C(@95 MeV)+^{12}C**

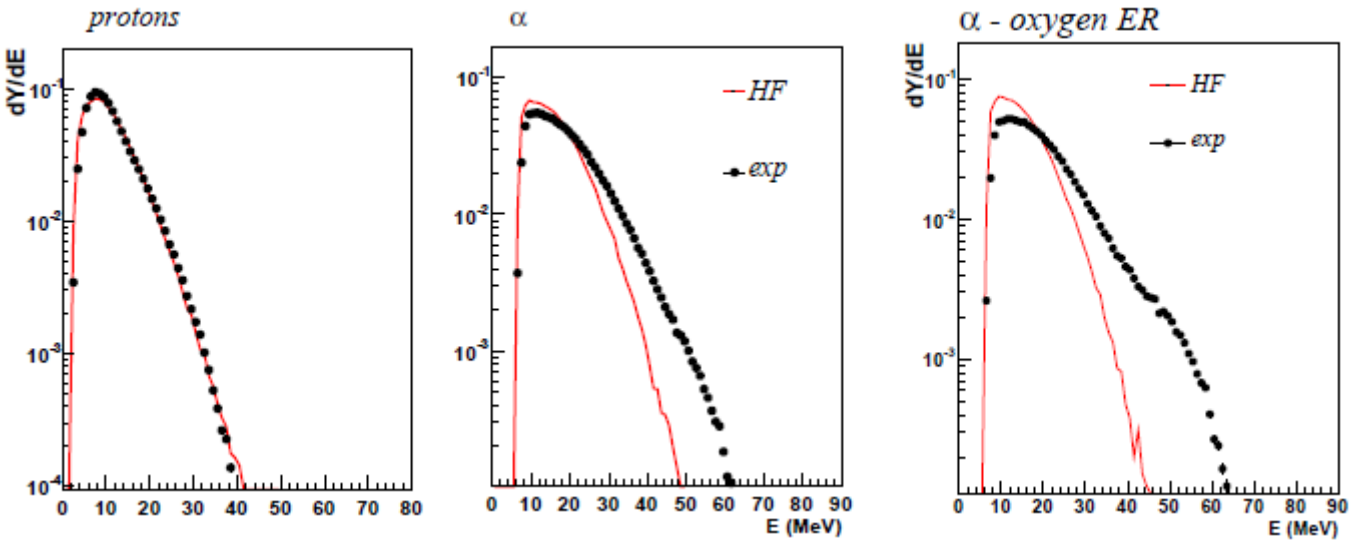
- Compound Nucleus formation and decay
  → Level Density for A∼20, $e^* \sim 3$ A. MeV (few excl.data!)
- signature of *molecular* structure
  → deviation from a statistical behaviour



FusEvap channel selection

- completeness of the detection $Z_{det} \geq 80\%(Z_{proj+targ})$
- coincidence between LCP in GARF $(30^\circ \leq \theta_{lab} \leq 150^\circ)$ and ER in RCo $(5^\circ \leq \theta_{lab} \leq 17^\circ)$

^{24}Mg ($E^* = 62$ MeV) decay, $J_{CN} = tria(0;12)\hbar$

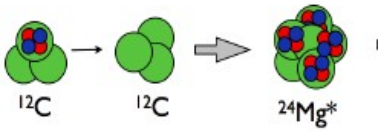


Protoni compatibili solo con CN decay

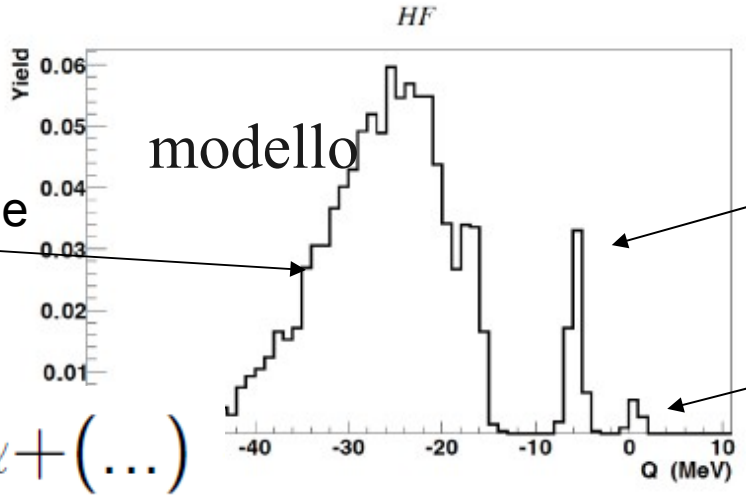
Alfa in eccesso!

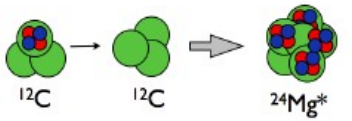
Eccesso di particelle alfa specie di alta energia e associate alla rivelazione di un ossigeno in avanti

ALPHA STRUCTURE?



2 alfa + almeno un neutrone



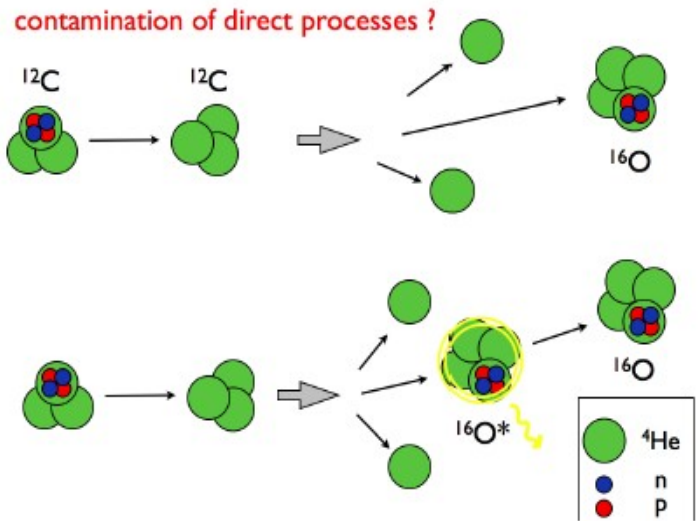


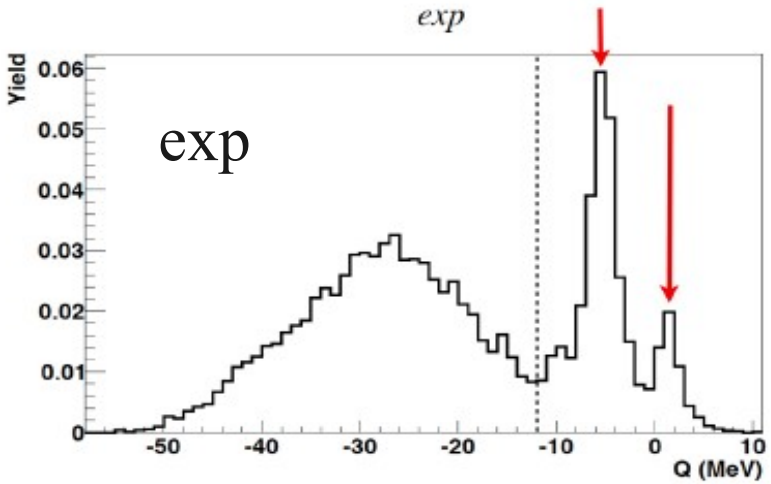
2 alfa e anche gamma

2 alfa

$$^{12}C + ^{12}C \rightarrow ^{x}O + 2\alpha + (\ldots)$$

Garfield at LNL. Baiocco PRC 87 2013

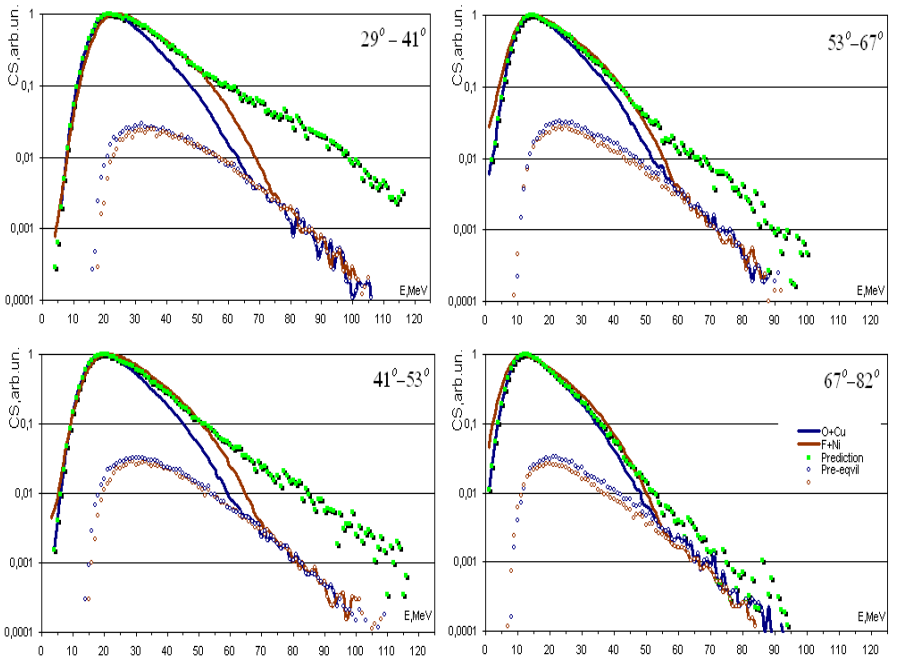




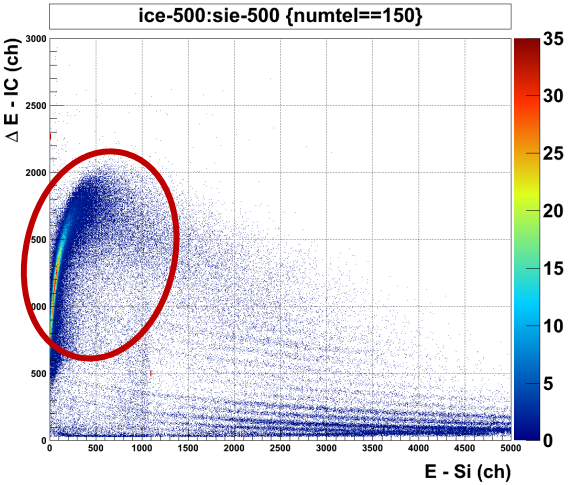
Effettuati altri esperimenti con stesso CN ma diverso canale di REAZIONE 14N+10B = 24Mg. Analisi in corso. Contributo a INPC13

Pre-equilibrium a-particle emission as a probe to study a-clustering in nuclei

- Hybrid model calculation 19F+62Ni
- Hybrid model calculation 16O+65Cu
§ Hybrid model + clustering 16O+65Cu

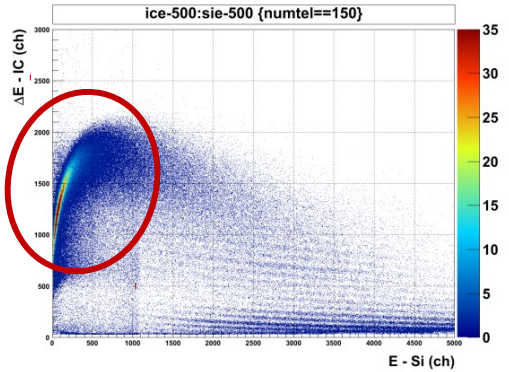


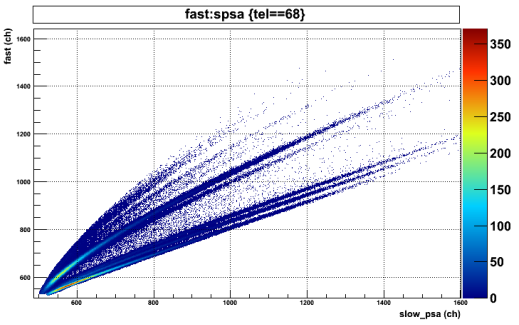
O. Fotina et al. Int.Journ. Mod. Phys. E19(2010)1134
D. O. Eremenko et al. Phys. Atom. Nucl. 65 (2002)18

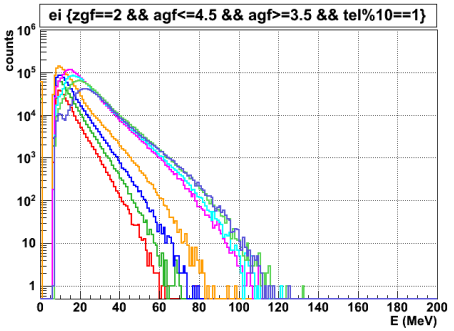


19F + 62Ni
Eb = 256 MeV

16O + 65Cu
Eb = 256 MeV







The basic module

Telescope Si-Si-CsI
Optimization of a standard versatile detector

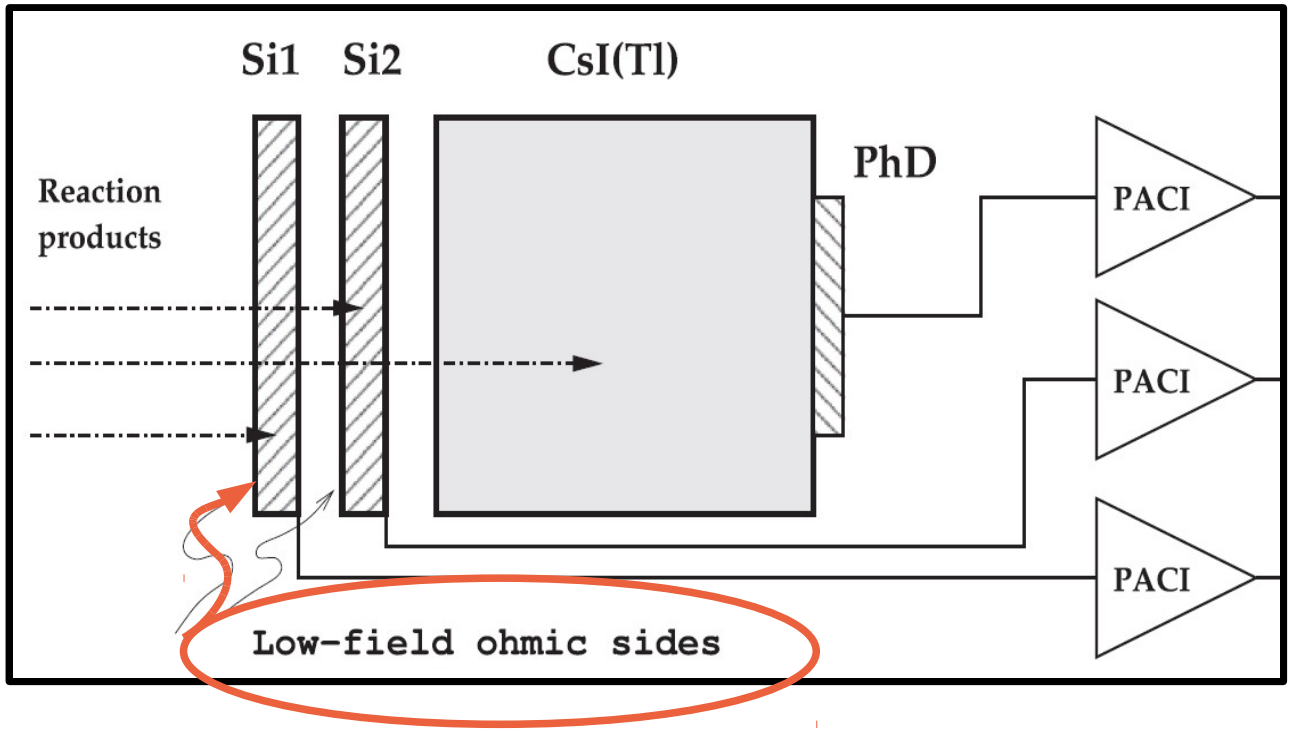
Silicons
20x20mm2
nTD type

300 and 500 μm

CsI(Tl)
20x20mm2
tapered

1500-2000ppm Tl-doping

10 cm thick

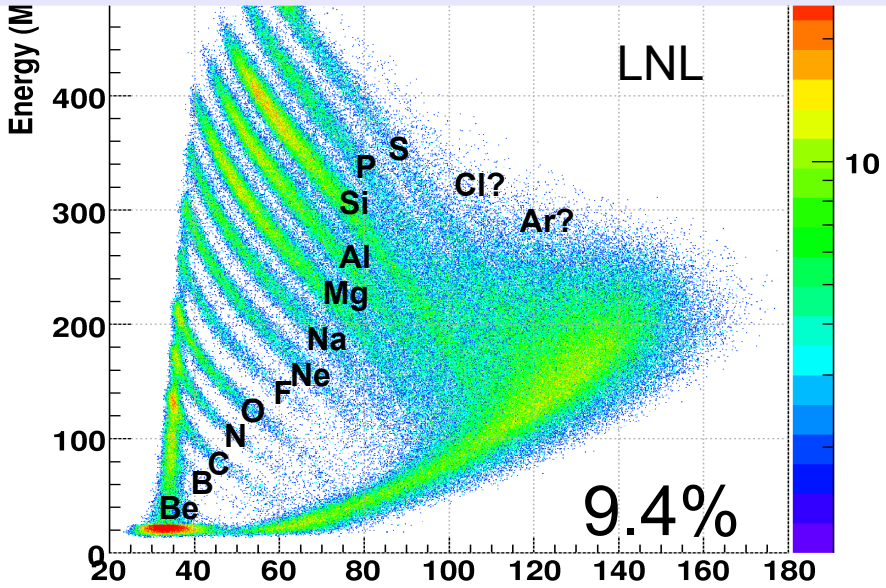


Specific efforts to improve particle identification

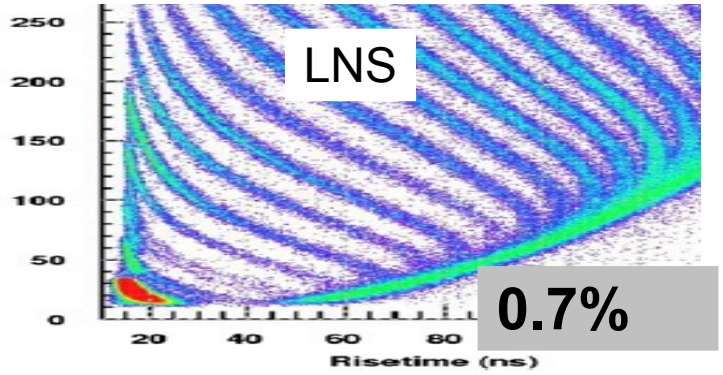
PSA: Homogeneity of Resistivity

Uniformity of the electric field is important to keep the signal shapes constant over the active area of the silicon. This means constant doping homogeneity.

Neutron Transmutation Doping technology is so far the most effective to give uniform doping in silicons



Ions stopped in 500 micron



Energy versus Charge risetime

DIFFICULT TO OBTAIN VERY HOMOGENEOUS MATERIAL

(2nd Call) ENSAR → A JRA was proposed by FAZIA & others

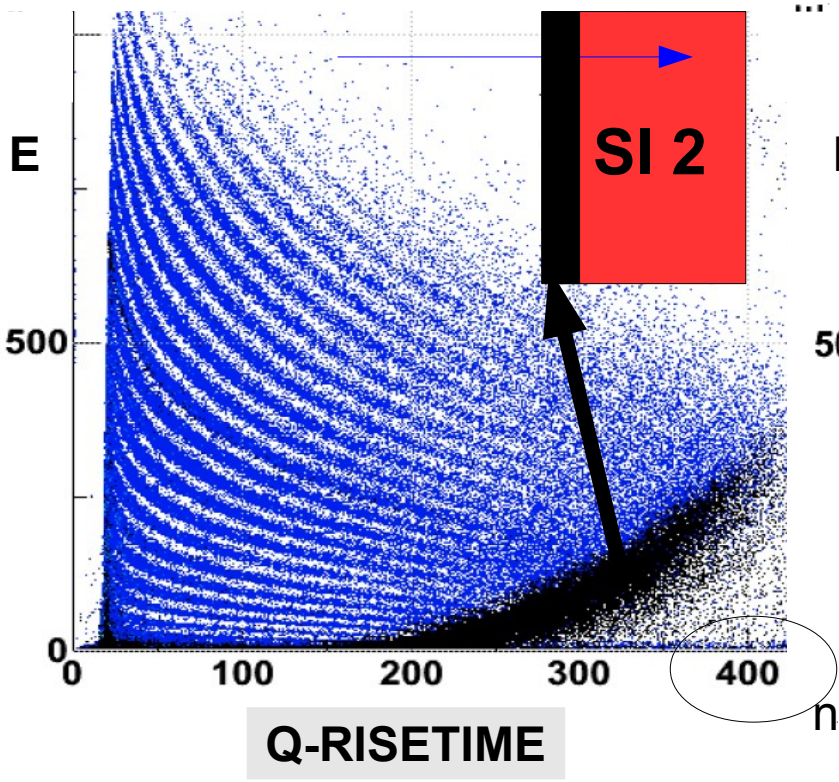
Underdepleted silicons

All ions stopped in Silicon 2

PRELIMINARY

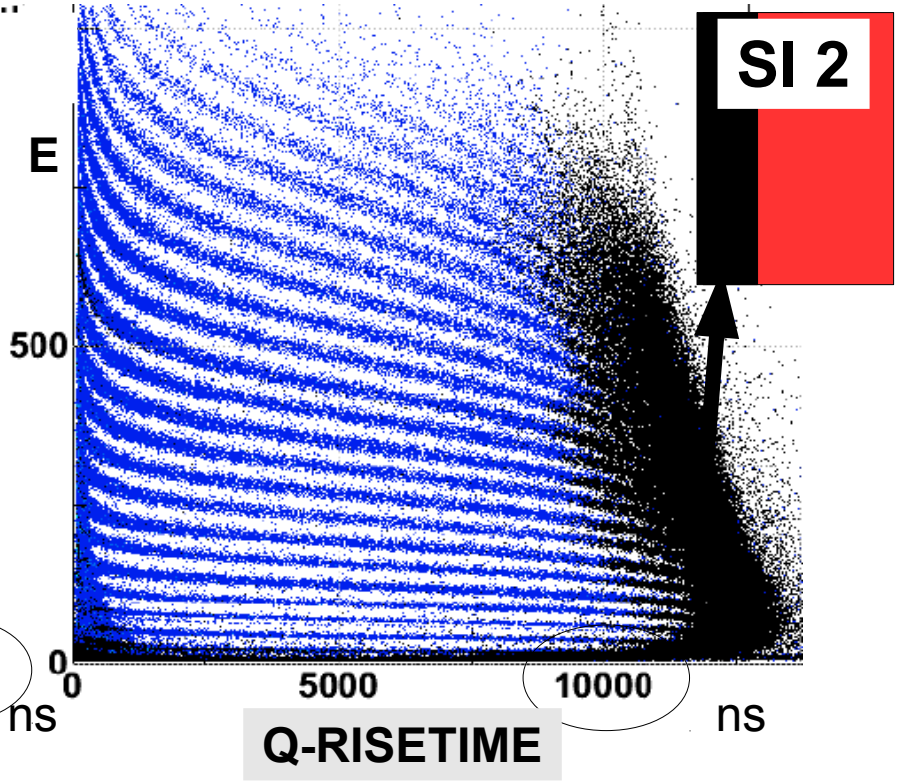
290V full depletion V i.e.
500μm active layer

Black: ions stopped in less than 45μm



105V bias voltage i.e.
300μm active layer

Black: ions stopped in less than 180μm



- Dramatic increase of signal risetime (of course)
- Z identification thresholds increase

BUT....

Promising perfomances

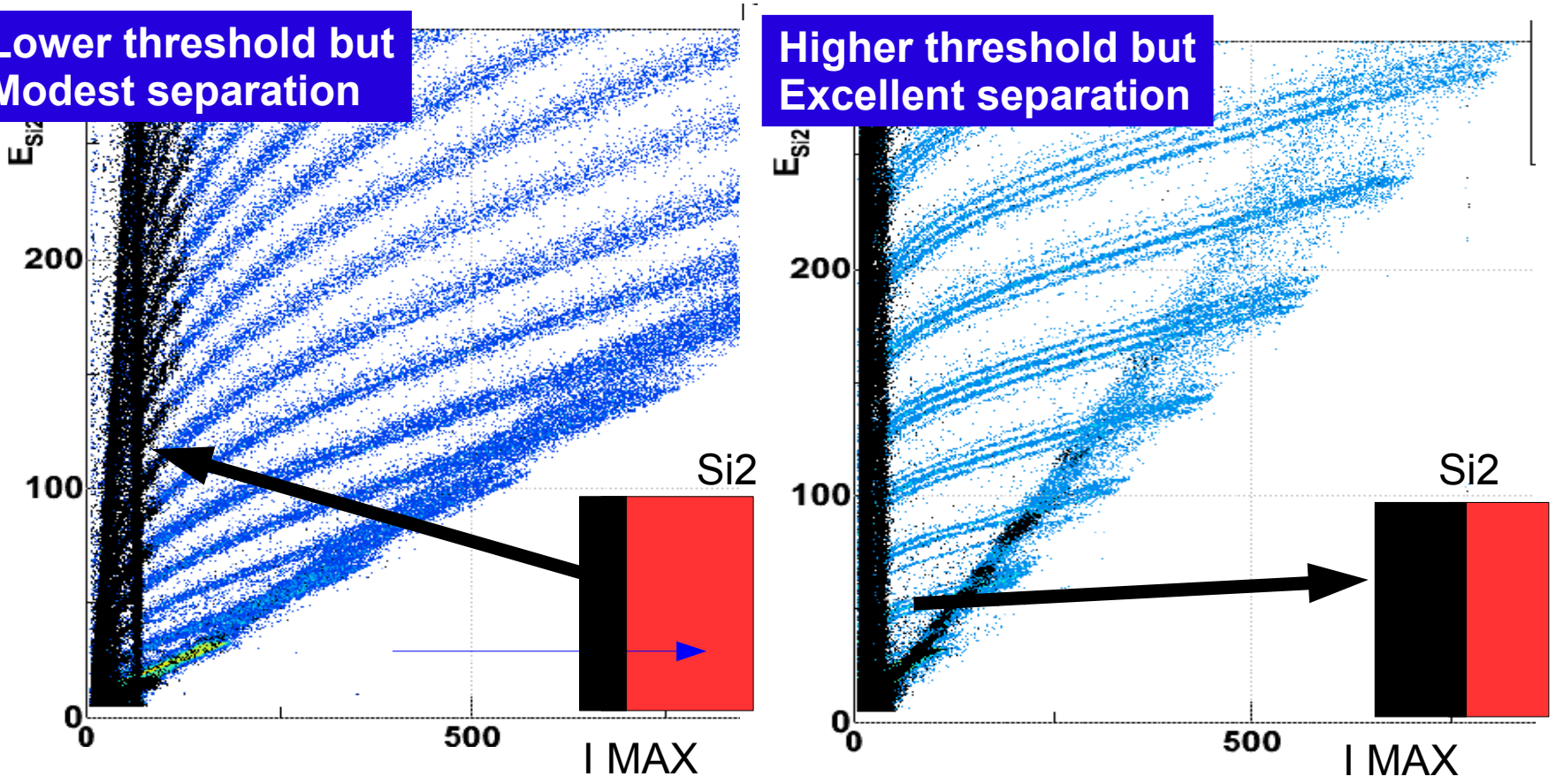
PRELIMINARY

Black: ions with Range <100µm

Black: ions with Range < 250µm

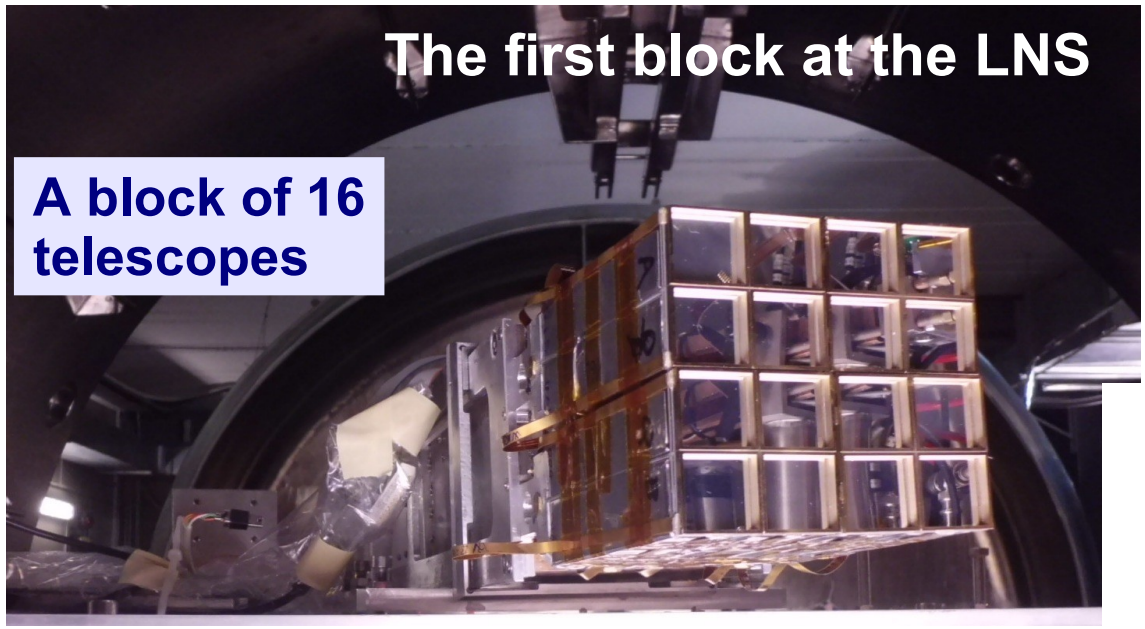
Lower threshold but Modest separation

Higher threshold but Excellent separation

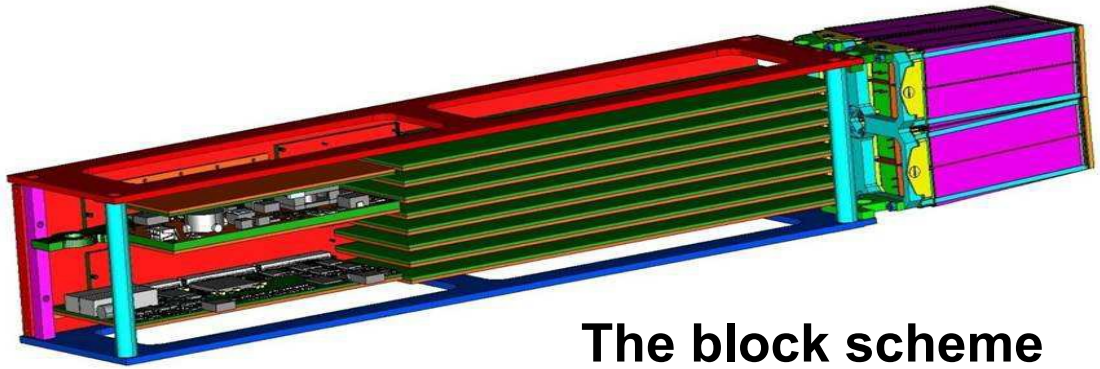


- **Masses are very well separated at 105V**
- **Current max is much better than Qrisetime**
- **Thresholds are higher than for full depletion**

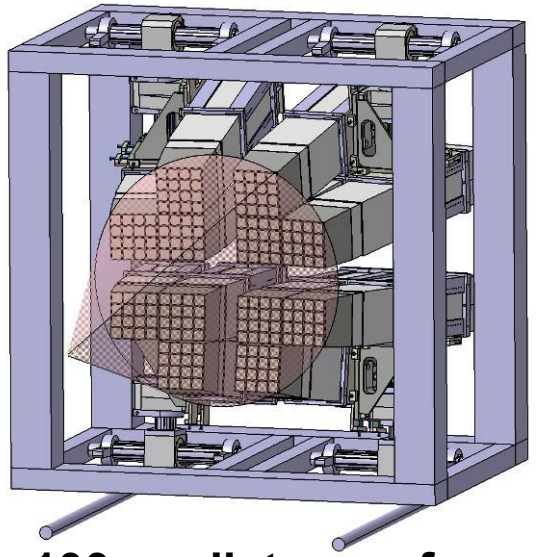
Towards the Demonstrator



192 telescopes
12 Blocks
16 telescopes /block
48 channels /block
Around 11kg /block



The block scheme



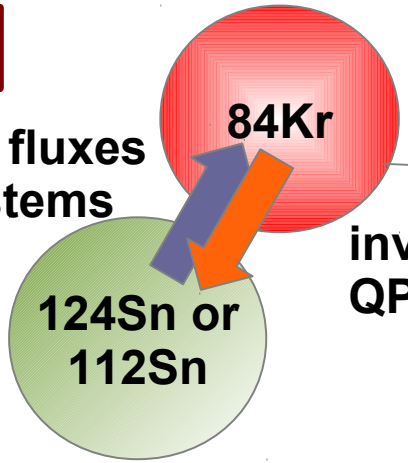
100cm distance; forward cone 3 to 14 degrees

Starting physics with FAZIA

Isospin dynamics

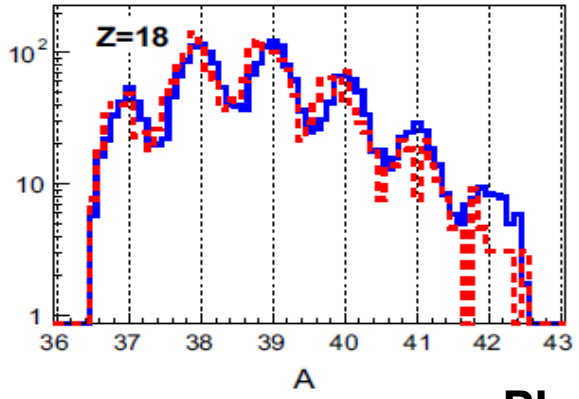
Different neutron-proton fluxes from/to different sub-systems during the interaction

84Kr+ 112,124Sn reactions at 35 MeV/u LNS

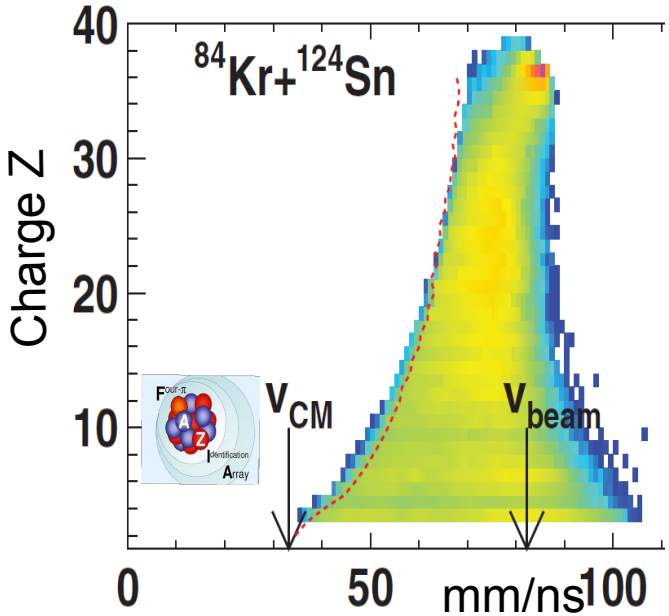


investigating QP decay

Barlini PRC 87 2013 054607

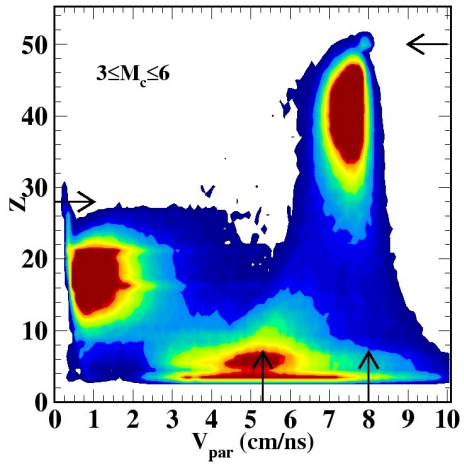


PI



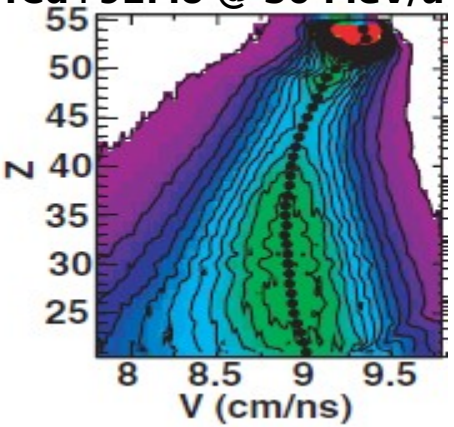
Other experiments...

124Sn+64Ni @ 35 MeV/u



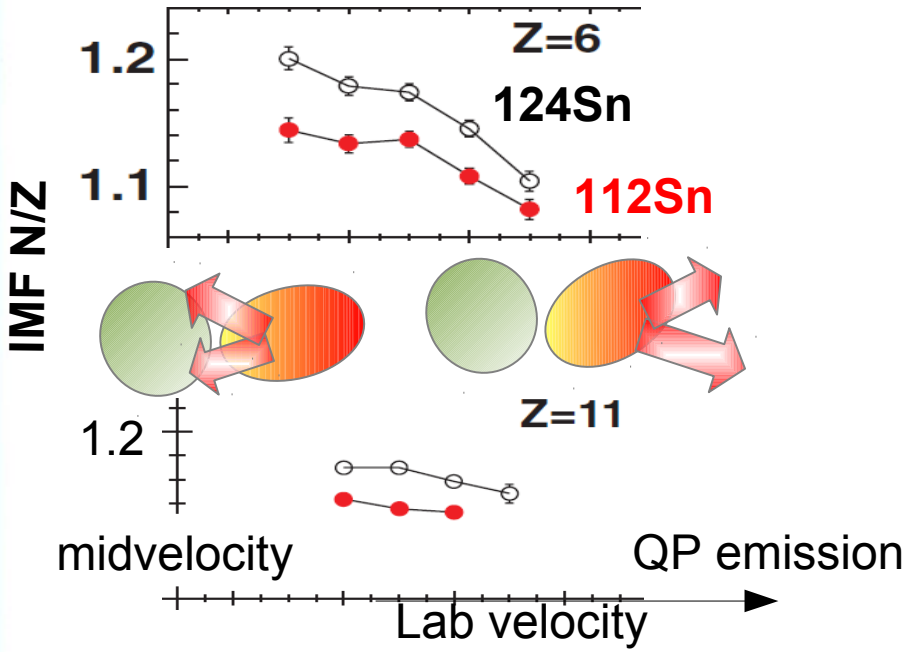
DeFilippo APP40, 2009

114Cd+92Mo @ 50 MeV/u



McIntosh,PRC 81 2010

Starting physics with FAZIA



S.Barlini PRC 87 2013 054607
S.Piantelli at INPC13

84Kr at 35 MeV/u

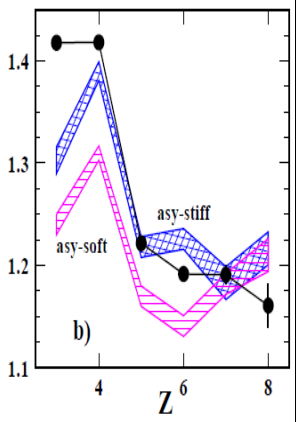
Isospin dynamics

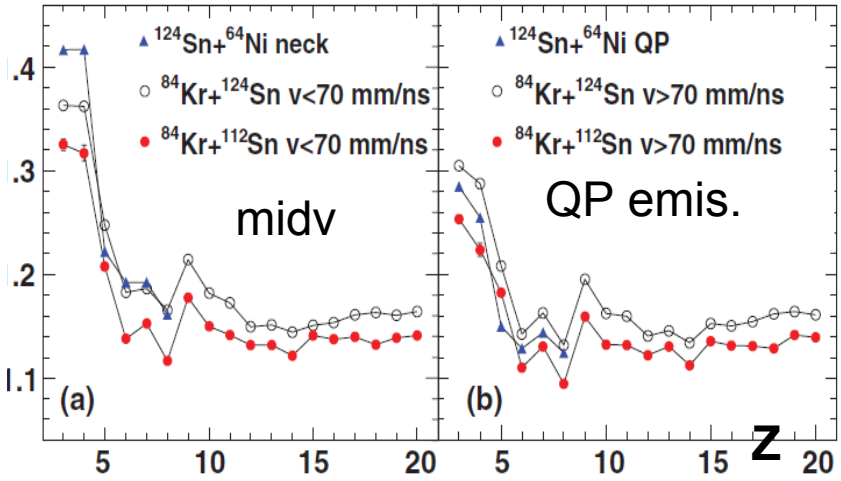
1) isospin diffusion is observed
2) more n-rich light fragments emitted at midvelocity in a diluted neck region (isospin drift according to Baran,Colonna PRC85 2012)

DeFilippo PRC86, 2012

Similar results from CHIMERA coll compatible with an asy-stiff EOS (blu belt)

Many other evidences, e.g.
Theriault PRC74 2000
Hudan PRC86, 2012
Galichet PRC 79 2009



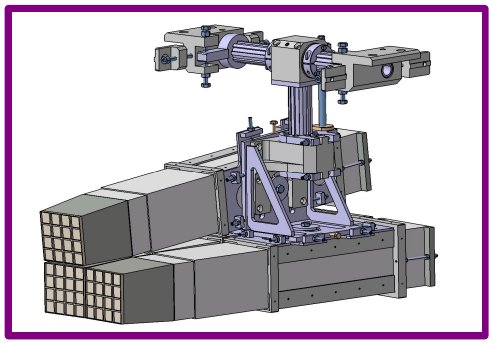


The Demonstrator: experiments

2014-5: 4 FAZIA blocks in a stand-alone configuration. Partial covering of forward angles from 2 to 16 degrees
MAIN PHYSICS: QP features, QP fragmentation cross section

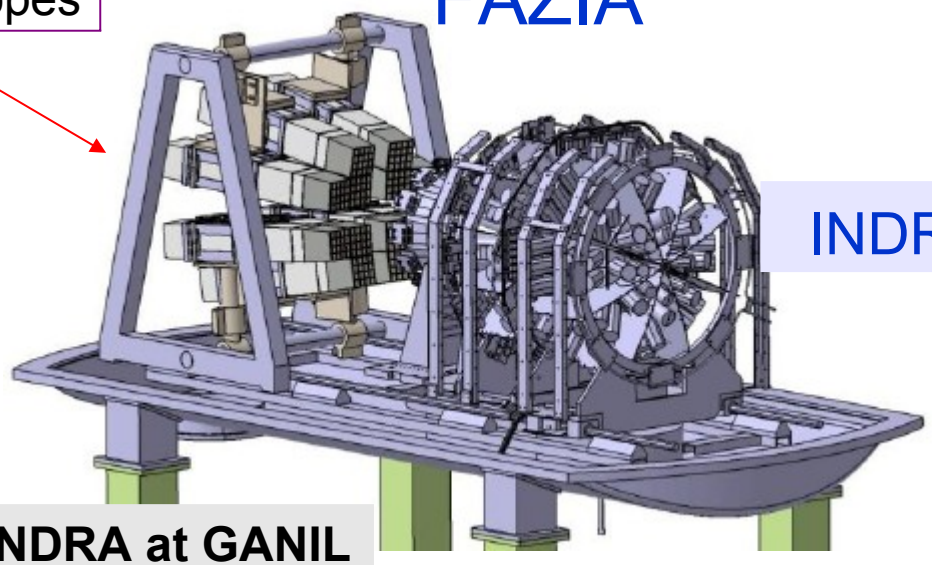
Two experiments ***APPROVED by LNS-PAC*** (2 weeks ago)
1. 40,48Ca+40,48Ca at 35AMeV to refine VAMOS-INDRA data and to accurately determine fragment cross sections
2. 78Kr+46,50Ti at 35AMeV in reverse kinematics, to investigate the role of isospin diffusion on QP sequential fission

>2014
:
3-block supporting arm



192 telescopes

FAZIA



INDRA

Campaign with the multidetector INDRA at GANIL

Richieste 2014

FTE 10.1 RICERCATORI

E 2 tecnici

SERVIZI

Impiego intenso della Camera Pulita di Sezione per bonding Si FAZIA
E in piccola parte per GAMMA per il bonding di Silici per SPIDER

GAMMA officina meccanica 1.5mu
NUCLEX officina meccanica 1mu servizio elettronica 0.5mu
servizio tecnico 0.5mu

GIOVANI

2 assegni, 1 dottorato, 3 lauree magistrali (stima totale in 2013), 2-3 lauree triennali

Esperimento Nuclex (Fi)

Consumo 3ke di cui 1.5ke FAZIA, 1.5 Sperim

Apparato 120ke e' la richiesta per completare produzione silici dopo il diniego di FBK. 24 sono un s.j. per le schede di FEE

Missioni 21.5 ke +10.5 ke s.j perlopiu' per misure da decidere
Piccolo contributo per lo studio di fattibilita' per un bersaglio attivo per SPES

Servizi SEZIONE: 1 servizio di officina meccanica, 3 mesi Camera Pulita (Scarlini), 0.5serv tecnico

		s.j	totale	GRAN TOTALE
missioni	21500	10500	32000	
Consumo	3000		3000	
apparati	120000	24000	144000	179000

Esperimento Gamma (Fi)

2.8 FTE a Firenze

Consumo 9ke di cui 6ke per 2 segmenti del rivelatore SPIDER per CoulEX

Inventario 12ke di cui 4.5ke per CFD e 7.5ke per 2 preamplificatori (conclusione acquisto elettronica)

Missioni 5ke per attivita' a LNS +16ke s.j per misure in Italia e a GANIL

Servizi SEZIONE: 1.5 servizio di officina meccanica

		s.j	totale	GRAN TOTALE
missioni	5000	16000	21000	
Consumo	9000		9000	
inventario	12000		12000	42000

Gruppo III: AZIONI EXTRA-INFN

Nuclear reaction measurements at the Laboratori Nazionali di Legnaro for 26Al determinazion in the Milky Way Galaxy

PI L.Caciolli Pd

Sandro Barlini UNIFI Assegno

Partecipazione S.Piantelli e G.C,

FIRB

Progetto Premiale INFN: partecipazione entro il maggiore premiale SIDENET

Coordinatore A.Vacchi

Sviluppo e integrazione di rivelatori per esperimenti di fisica nucleare avanzata ***(approssimativamente....)***

VINTO

PRIN

PI A.Bracco UNIMI

Coinvolte UNINA, UNIFI (G.Poggi), UNICT, LNL, LNS

Partecipazione a call per una JRA ENSAR-2

HIGRASIL

Coordinatore G.C G.Poggi e R.Bougault

Progetto di cooperazione Ministero Affari ESTERI per favorire la ricerca di base fra Italia e Polonia "Progetto Canaletto" INFN LNL, Fi

Promozione di un accordo tipo COPIGAL (F-Polonia) anche tra I e Polonia