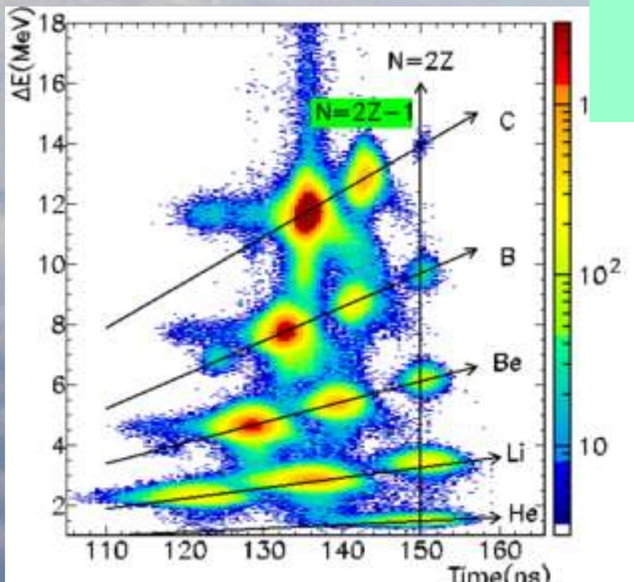
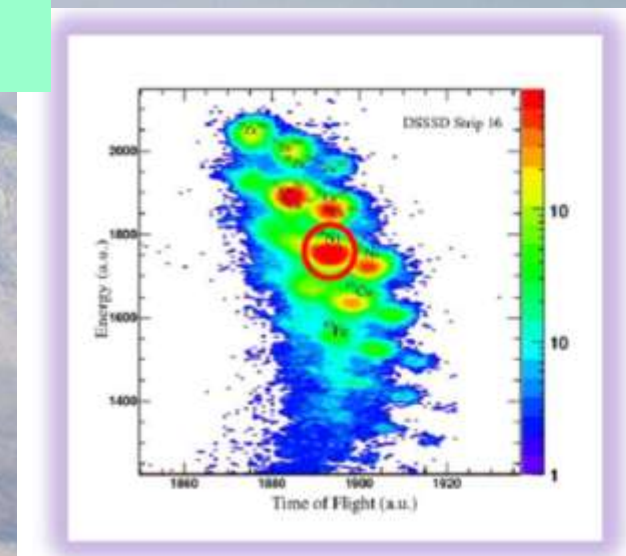
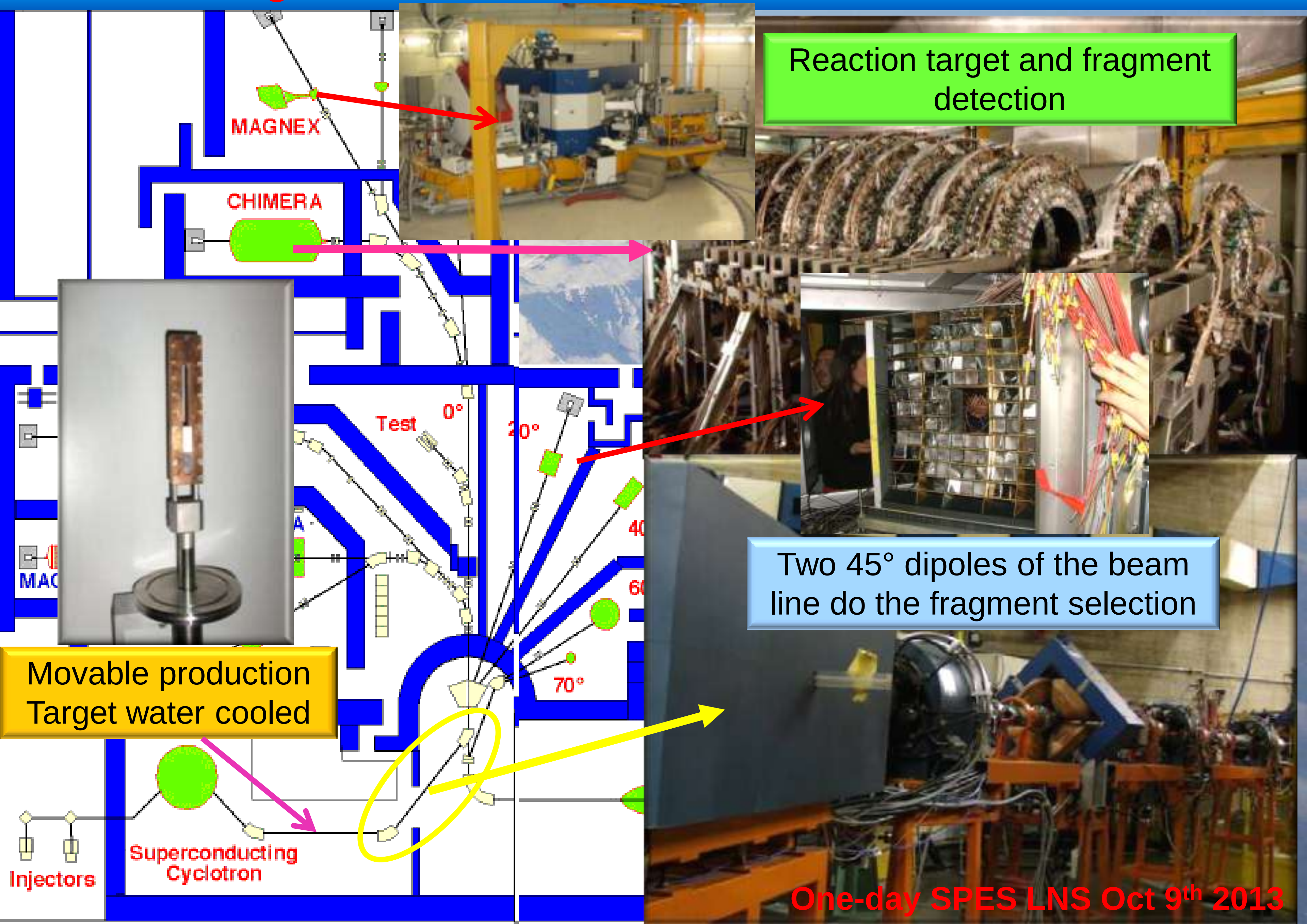
RIB by Fragmentation @ LNS



G.Cardella
&
many others

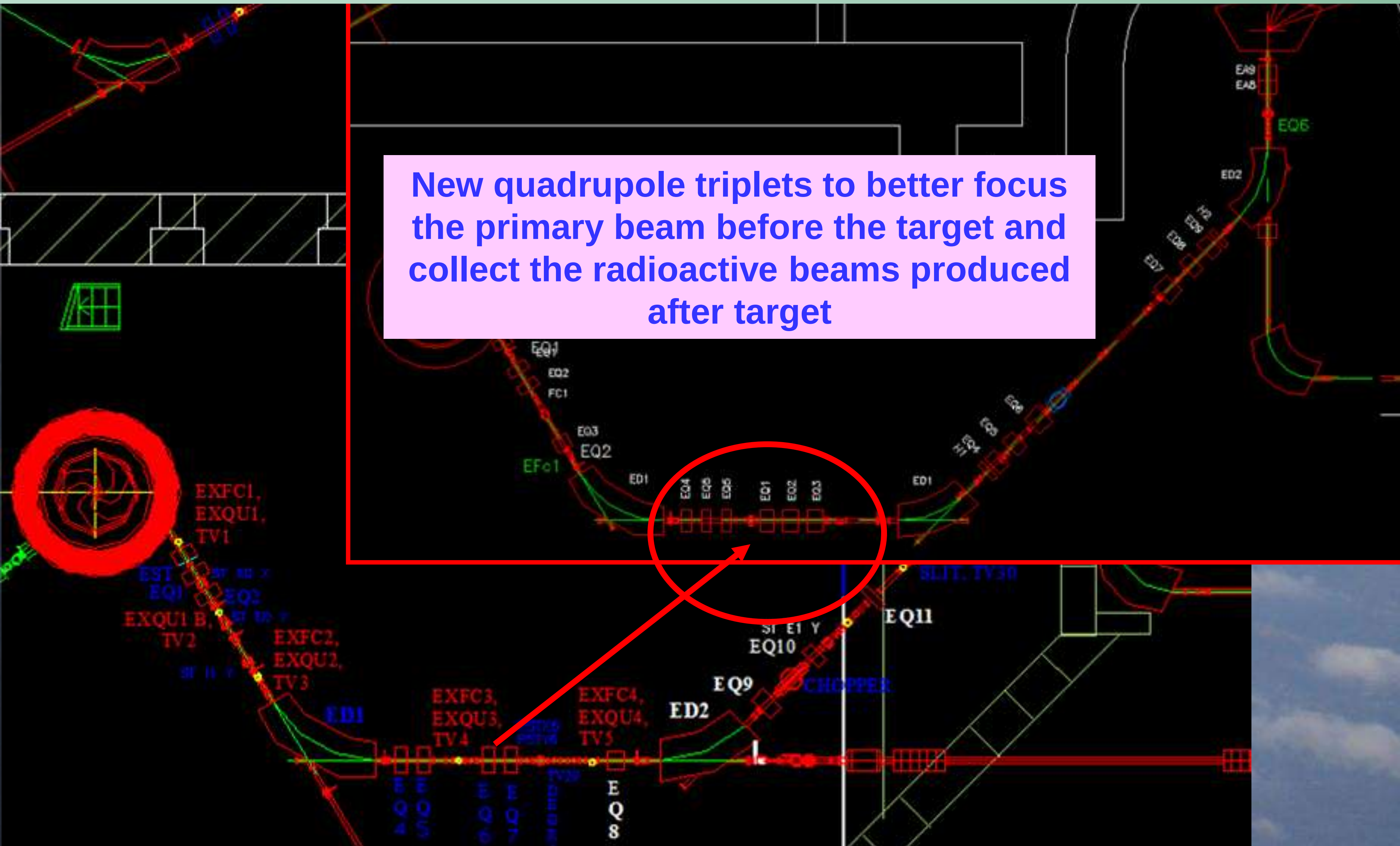


Fragmentation beams at INFN-LNS - Catania



The 2010 upgrading of LNS Fragmentation beam

New quadrupole triplets to better focus the primary beam before the target and collect the radioactive beams produced after target



Beam diagnostic

The EXCYT diagnostic was essential to improve the beam transport efficiency respect to previous transports based on Pilot beams **A.Amato,..G.Cosentino et al LNS report 2009**

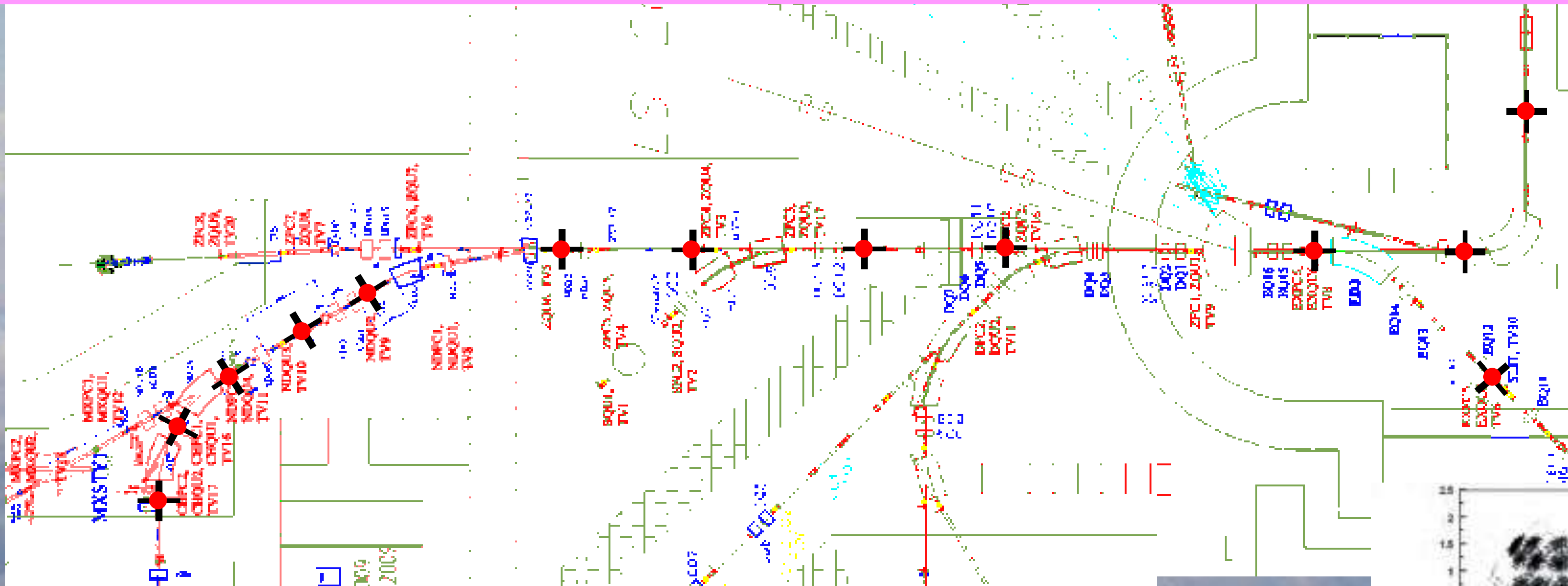


Fig. 2. Beam particle counter, based on a plastic scintillator coupled to a photomultiplier.

Fig. 3. PSSD mounted in a pneumatic actuator. The mask made by brass is 2mm thick.

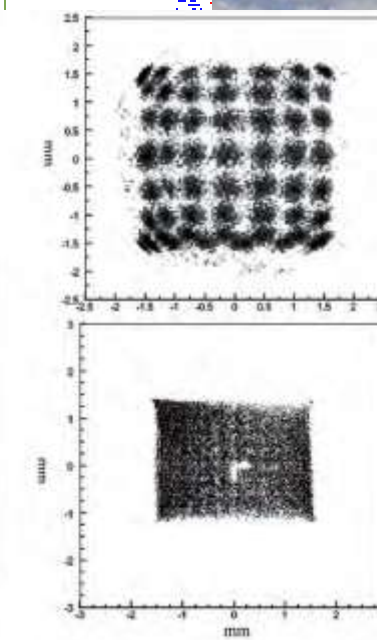
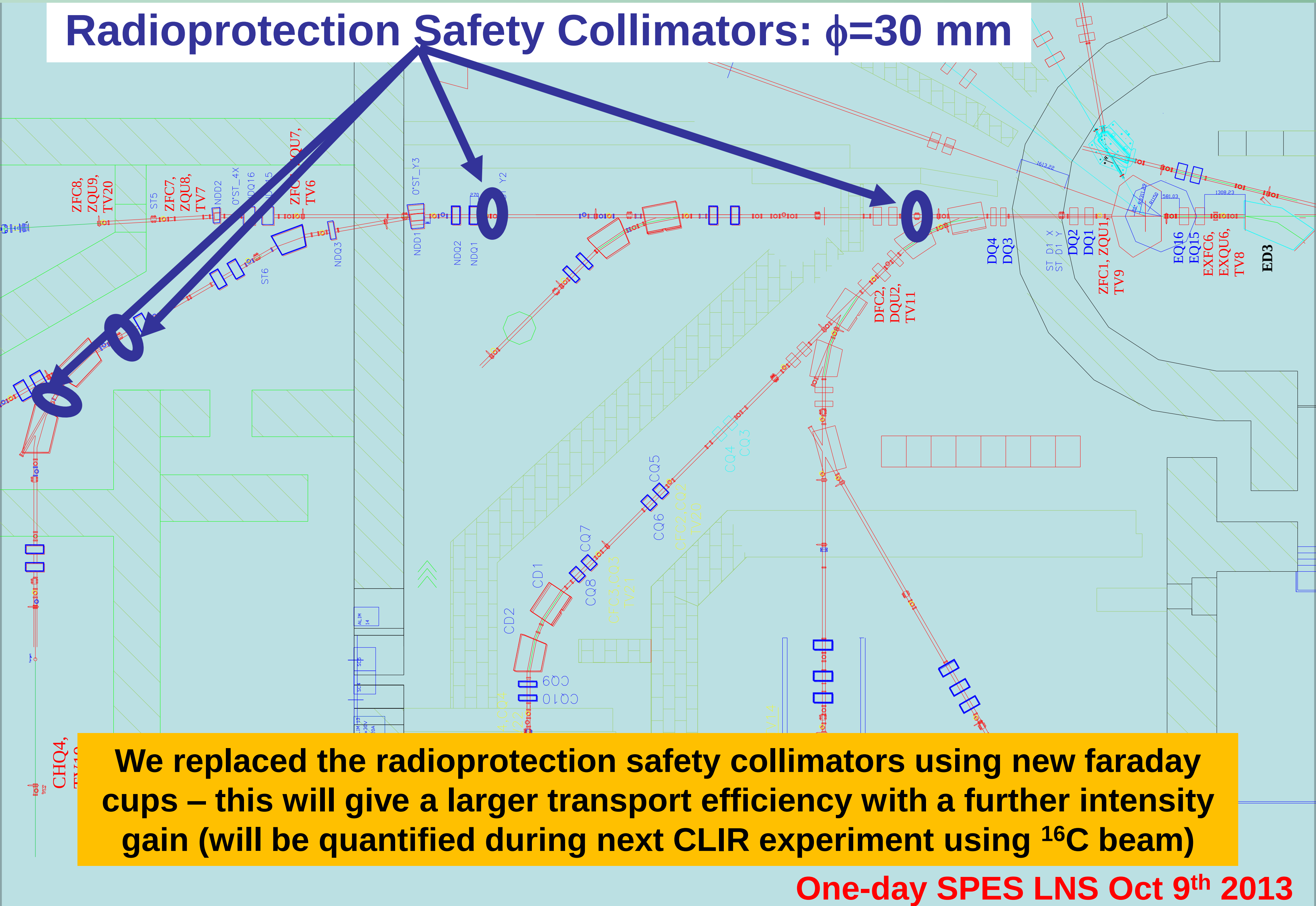


Fig. 4. Corrected beam profiles of a EXCYT (a) and a ... two different masks.

Other improvements done

Radioprotection Safety Collimators: ϕ=30 mm



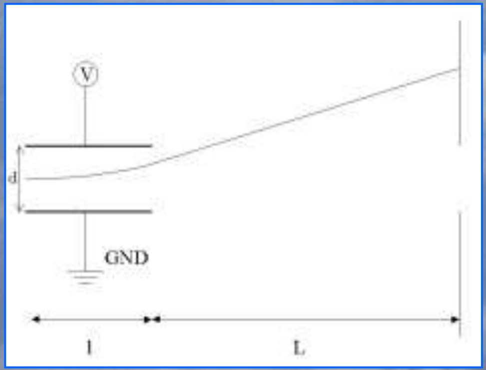
We replaced the radioprotection safety collimators using new faraday cups – this will give a larger transport efficiency with a further intensity gain (will be quantified during next CLIR experiment using ^{16}C beam)

Next improvement

Chopper - 500

The production of consecutive accelerated bunches with a separation time of up to 200 ns and a width of 500 ps FWHM, is the goal of this new chopping beam system. The chopper 500 should cut the present length of the accelerated beam bunches, delivered from the superconducting cyclotron, from 1.5÷2 ns to 0.5 ns.

From separation time 20-66 ns
Width of single bunch 1.6-5 ns

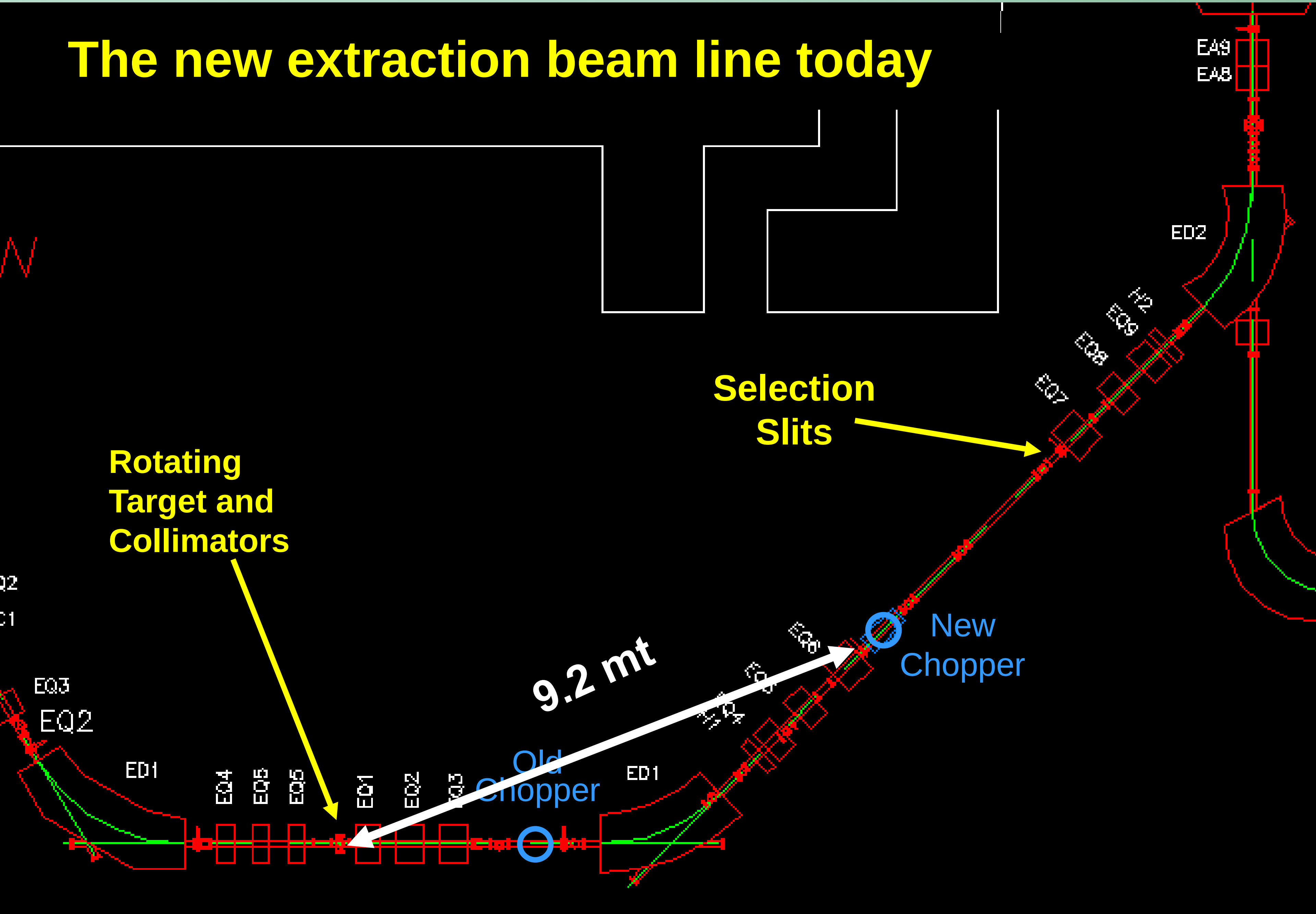


To separation time ≤ 200 ns
Width of single bunch 500 ps

Chopper-500 cavity

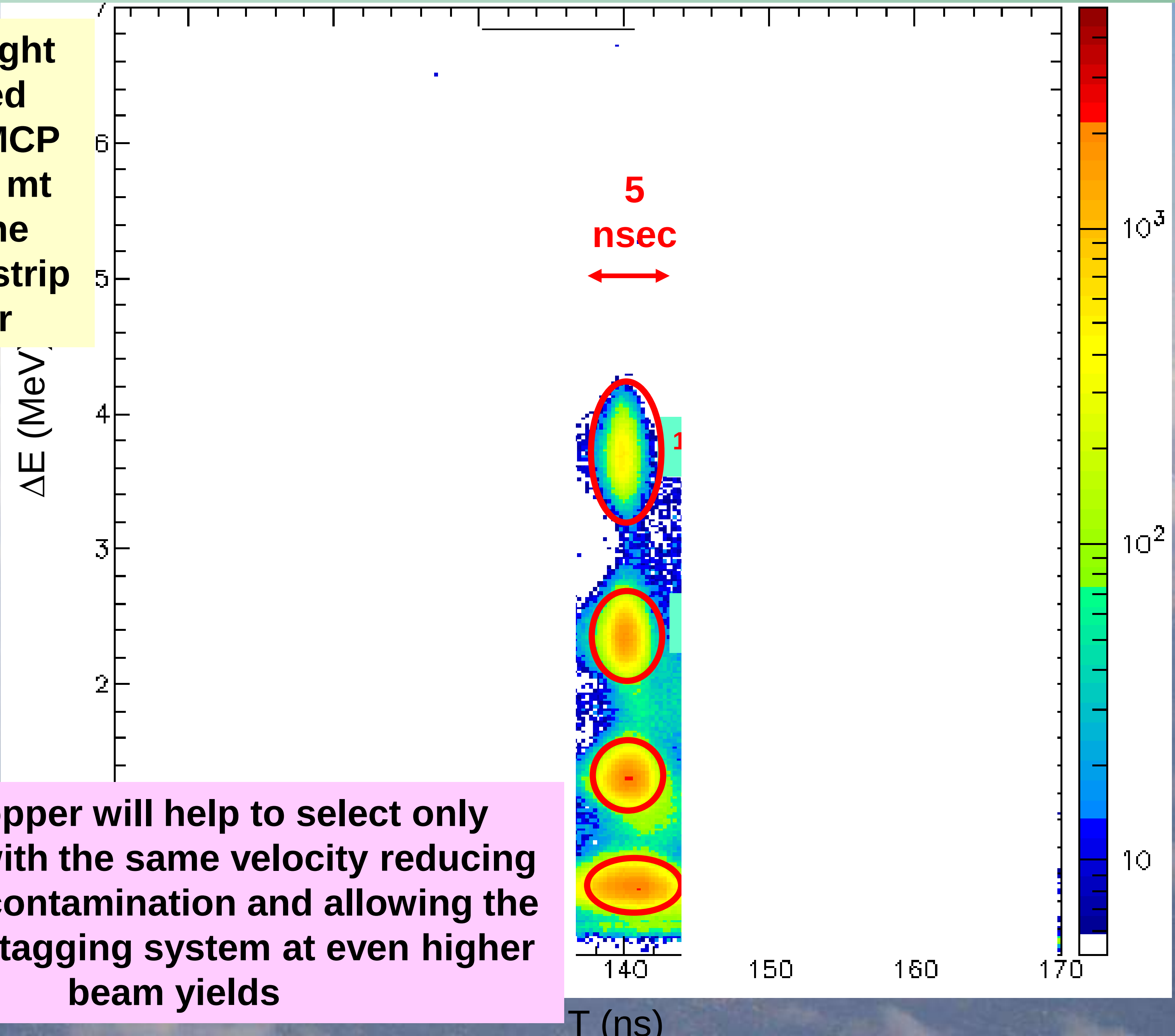
Next improvements

The new extraction beam line today



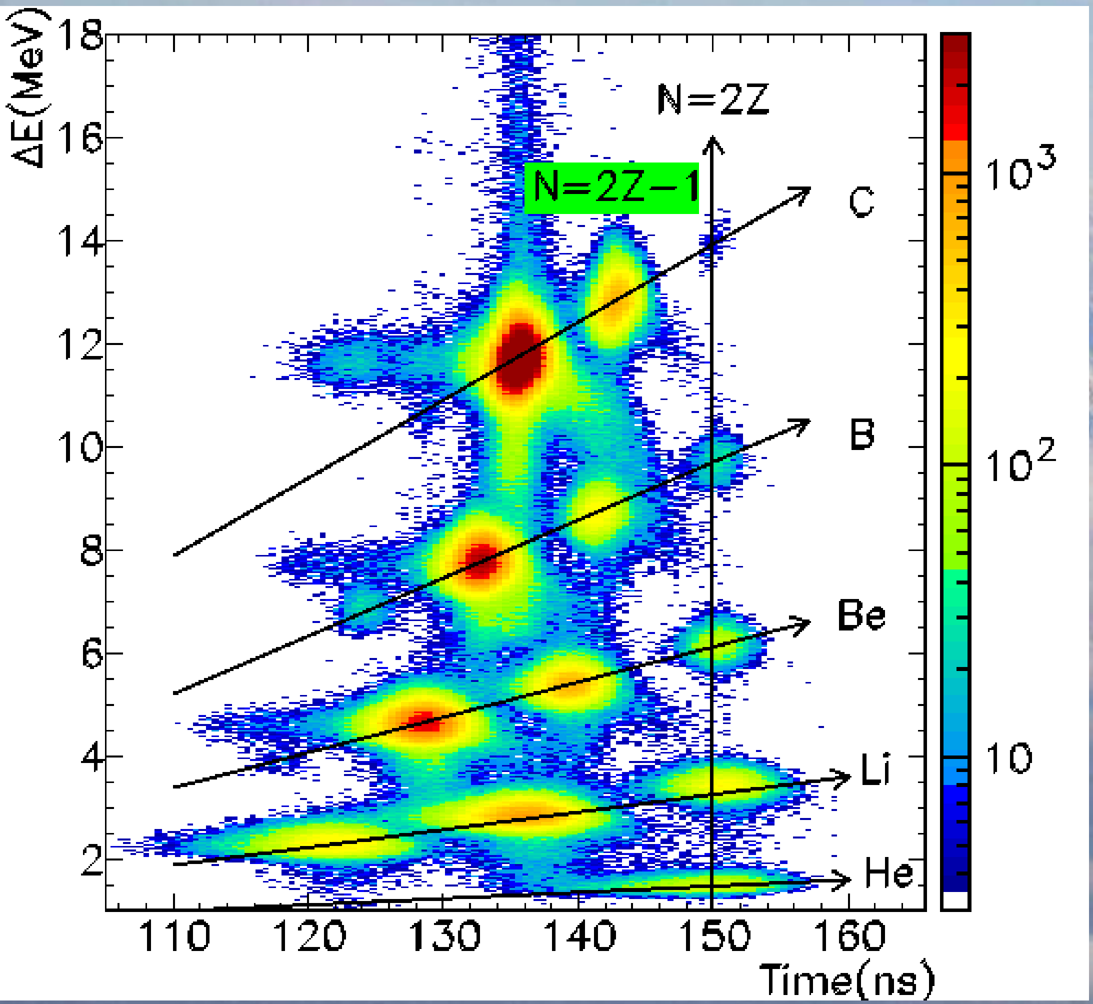
Next Improvvements

Time of flight measured between MCP placed 13 mt before the CHIMERA strip detector



The chopper will help to select only particles with the same velocity reducing the beam contamination and allowing the use of the tagging system at even higher beam yields

Beam identification



A fragmentation beam is generally a mixed beam and many efforts are devoted to improve its purity

In our case we decided to begin with a more simple approach – to identify event by event all beam nuclei performing many experiments at the same time

The tagging system is therefore of fundamental importance

Tagging system: flow chart I DSSSD

I cannot change too much the beam characteristics if I want to use it

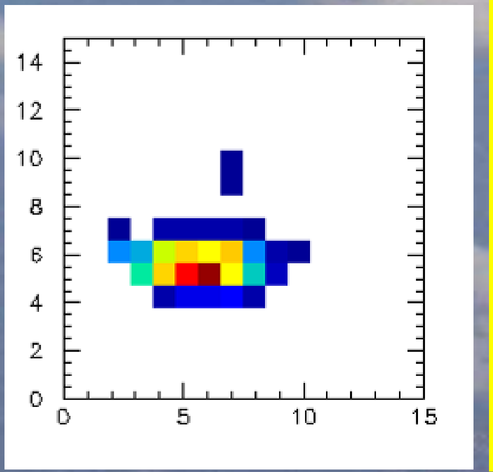
~~ΔE-E?~~

I cannot stop the beam in the tagging detector

ΔE-T?

What can I use for ΔE?

Double side Silicon strip detector



Two main advantages:
From the position of the strip I can also get the XY image of the beam

Many strips can sustain a larger rate than a single detector

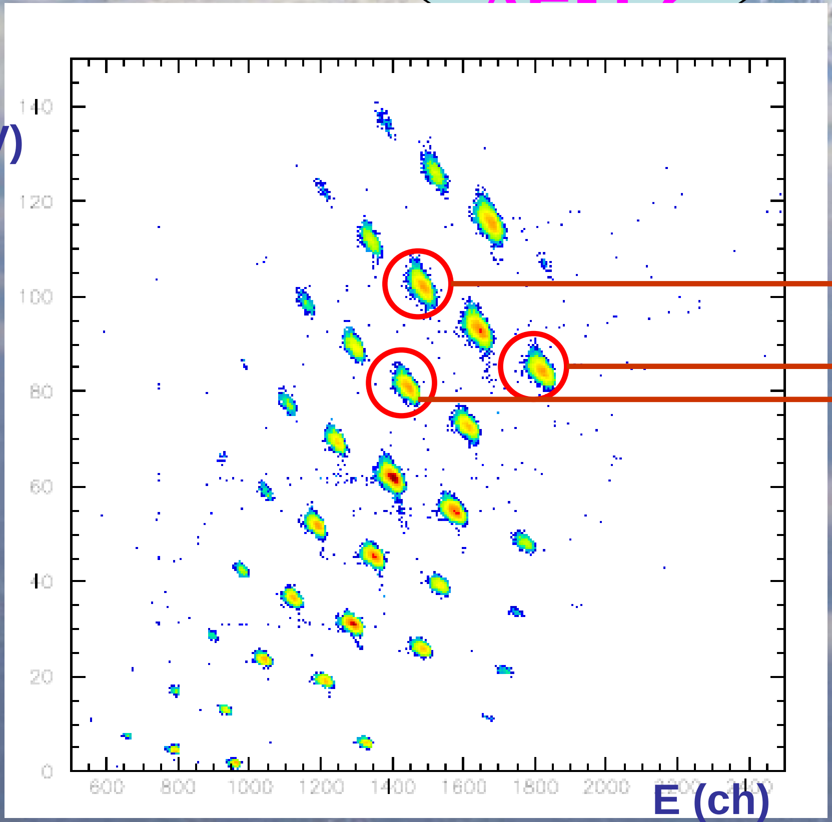
Tagging System: flow chart II - RF-timing

~~ΔE-E?~~

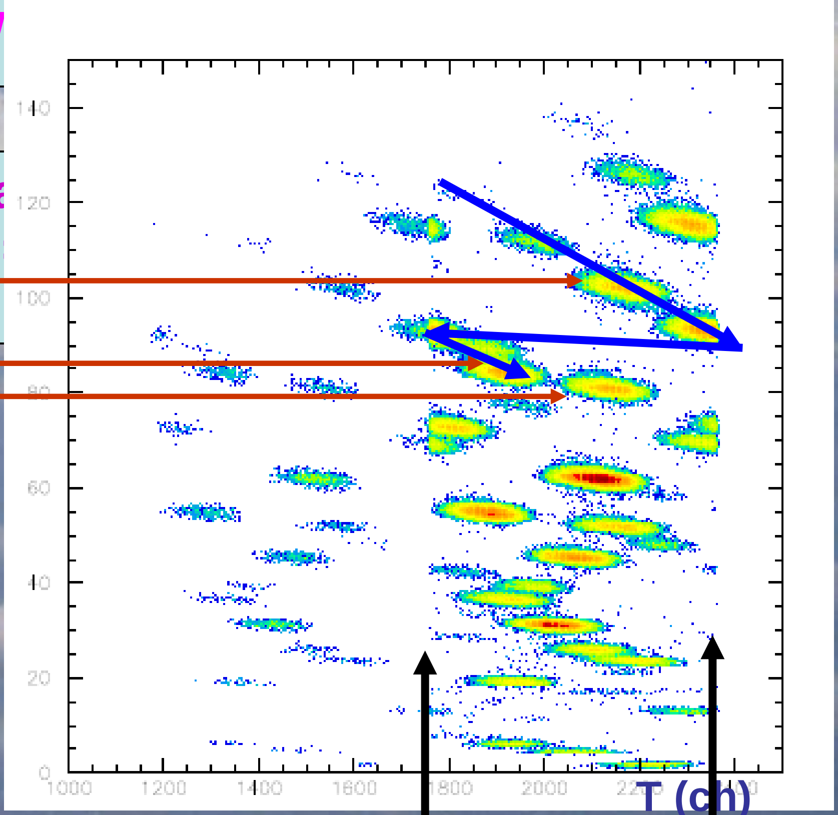
I cannot stop the beam in the tagging detector

ΔE-T?

Possible but how



Ma
^{20}Ne
^{18}Ne
^{18}F

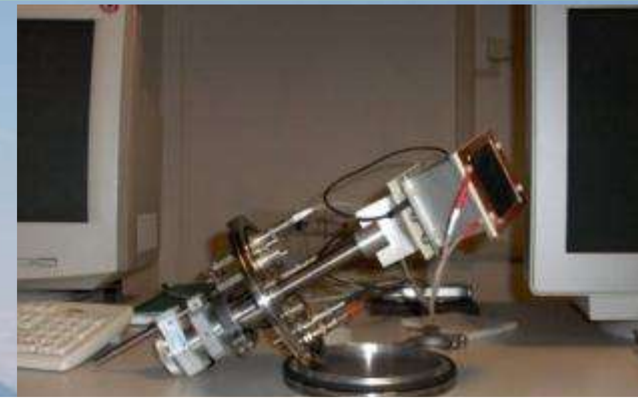


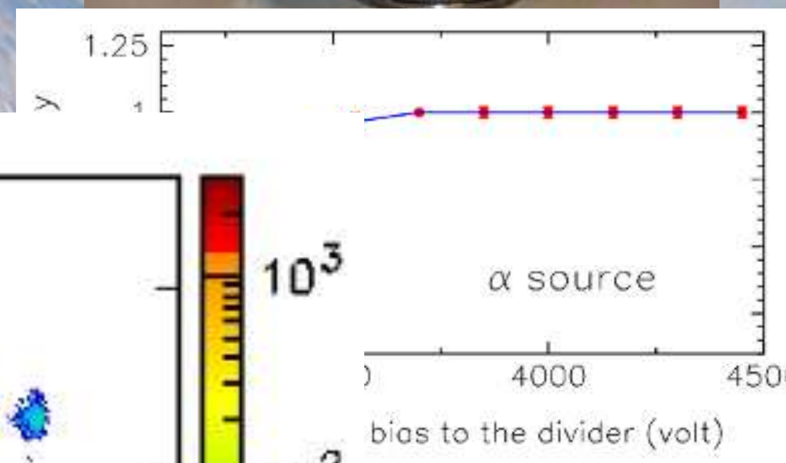
One-day SPES LNS Oct 9th 2013

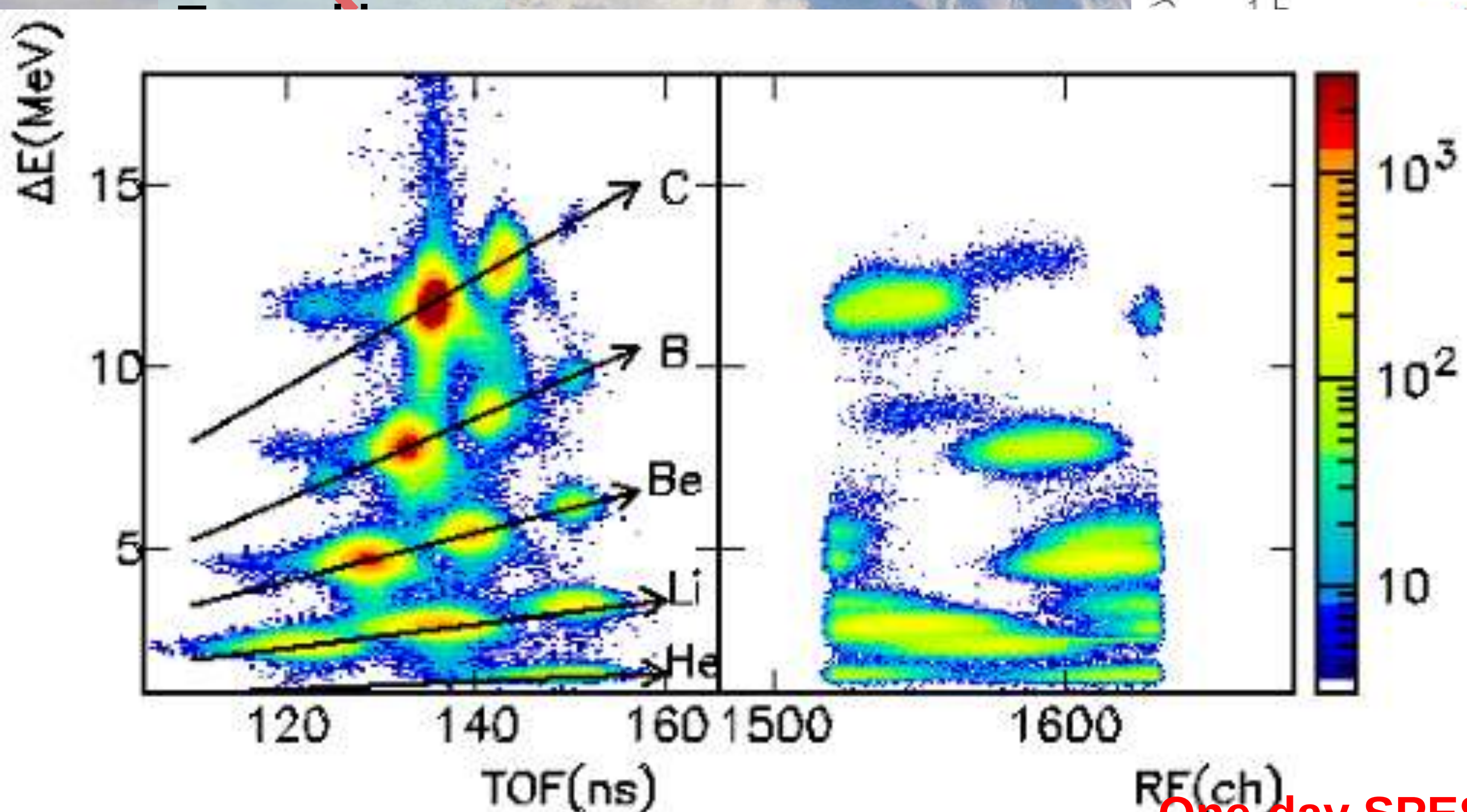
Tagging system : flow chart III MCP timing

~~DE-E?~~

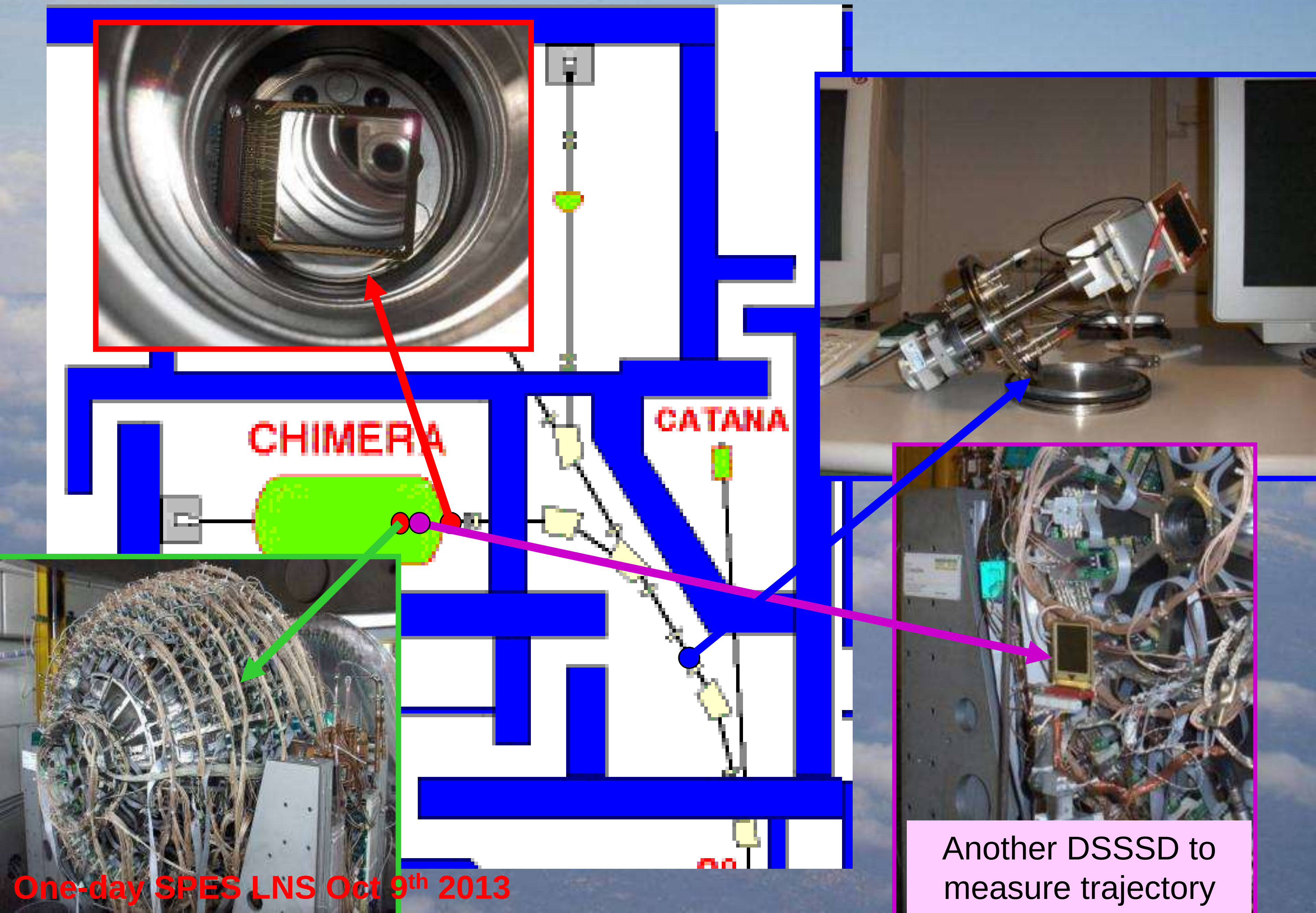
I cannot stop the beam in the tagging detector



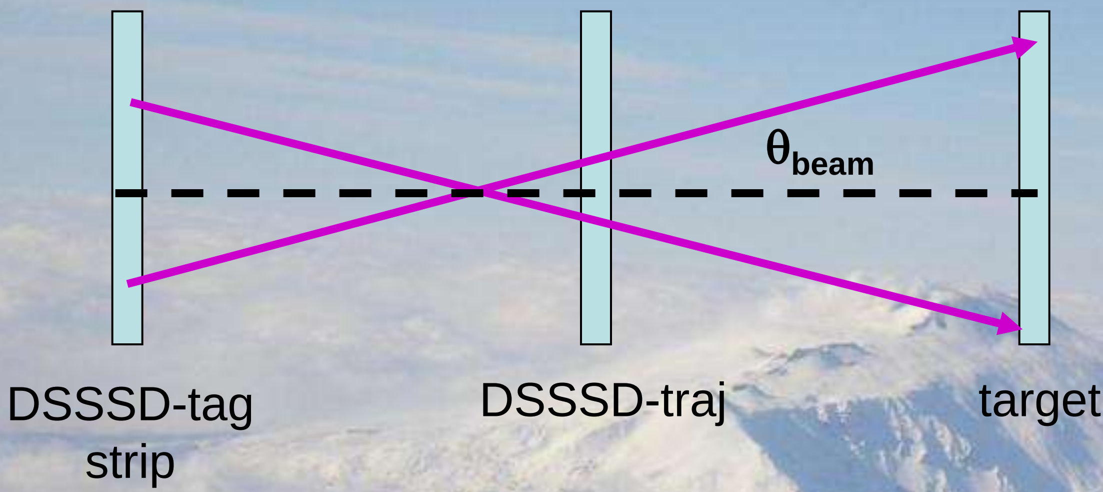


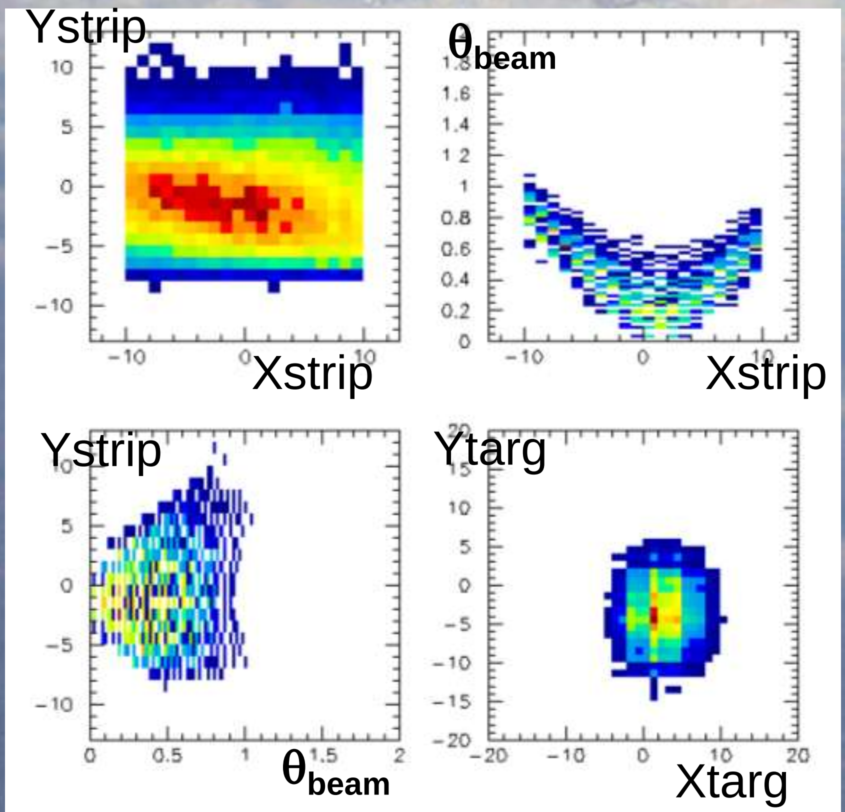


Tagging system: layout



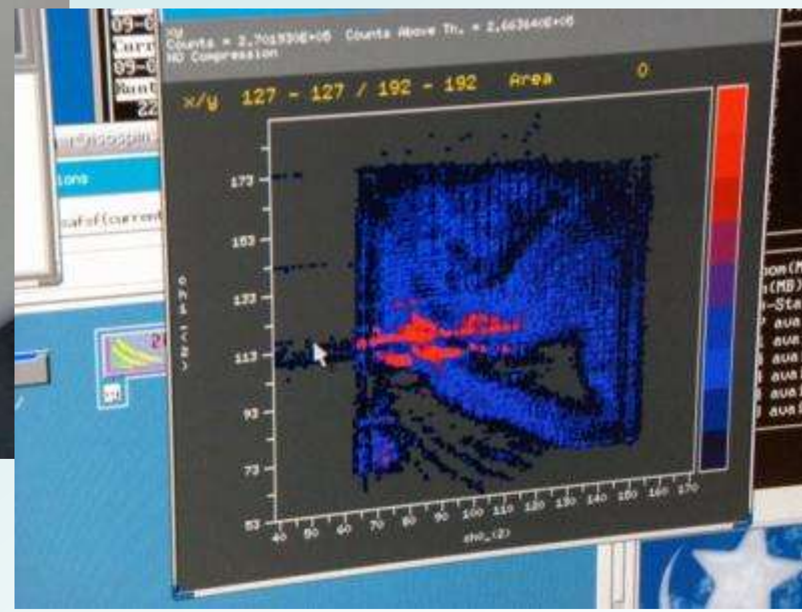
Production and transport test: beam trajectory





It is possible to produce a very beautiful beam on target – with very small divergence

We will use for the trajectory measurement a multiwire gas detector developed by the Exotic group for their LNL radioactive beam



Some pictures showing the tests performed by I.Lombardo and collaborators at Napoli

Intensities available from the most recent beams produced

primary beam	beam	intensity (kHz/100W)
18O 55MeV/A	16C	120
setting 11Be	17C	12
	13B	80
	11Be	20
	10Be	60
	8Li	20
18O 55MeV/A	14B	3
setting 12Be	12Be	5
	9Li	6
	6He	12
13C 55 MeV	11be	50
setting 11Be	12B	100
36Ar 42 MeV	37K	100
setting 34Ar	35Ar	70
	36Ar	100
	37Ar	25
	33Cl	10
	34Cl	50
	35Cl	50
20Ne 35 MeV	18Ne	50
setting ne18	17F	20
	21Na	100
70Zn 42MeV		
setting 68Ni	68Ni	20

New beams to be used during 2014

^{8}He (CHIMERA)

^{14}Be (test experiment) collaboration with Leuven

^{38}S (Magnex)

FRAGMENTATION BEAMS: The first result - Di-proton

Using ^{18}Ne beam we have studied the excitation and decay of a special state that can decay emitting a diproton

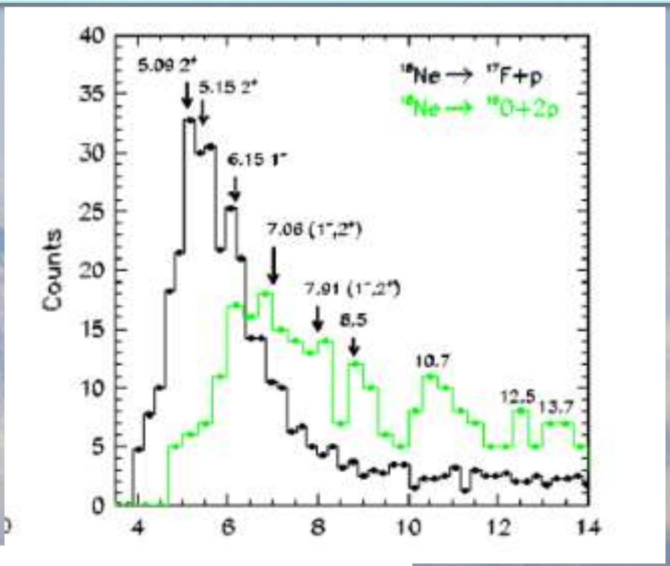
PRL **100,** 192503 (2008) PHYSICAL REVIEW LETTERS week ending 16 MAY 2008

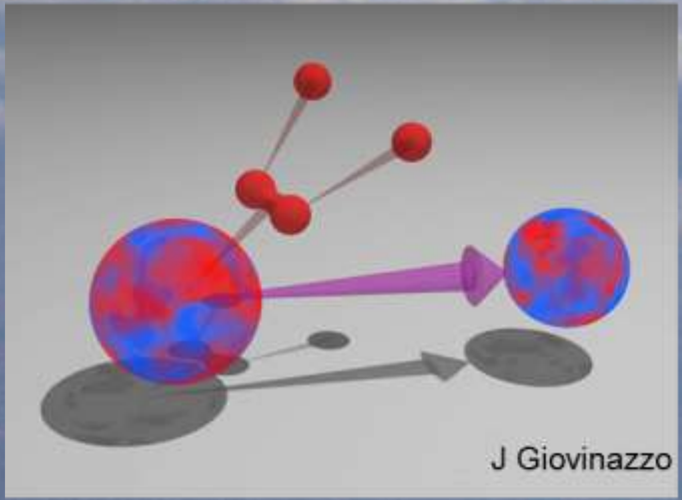
Experimental Evidence of ^{2}He Decay from ^{18}Ne Excited States

G. Raciti,* G. Cardella, M. De Napoli, E. Rapisarda, F. Amorini, and C. Sfienti
Dipartimento di Fisica e Astronomia, Università di Catania Via S. Sofia 64, I-95123, Catania, Italy
INFN—Sezione di Catania, Via S. Sofia 64, I-95123, Catania, Italy
(Received 21 December 2007; published 15 May 2008)

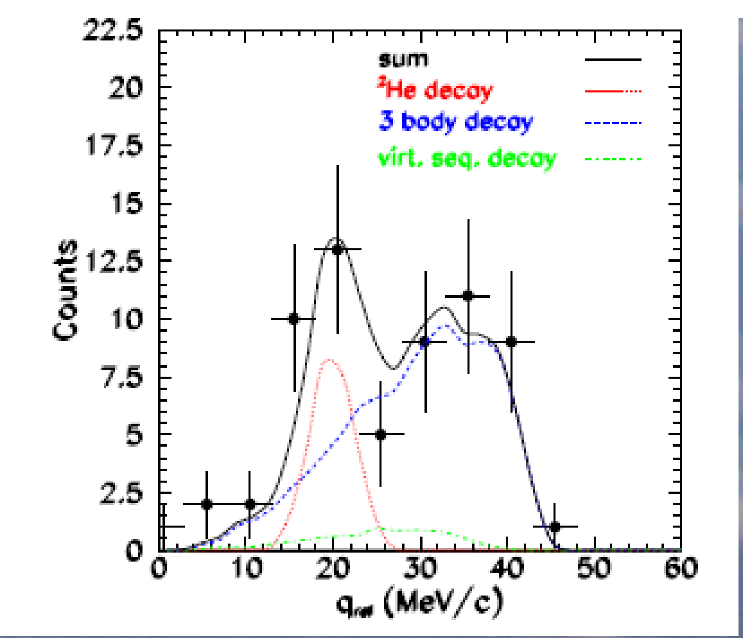
Two-proton decay from ^{18}Ne excited states has been studied by complete kinematical reconstruction of the decay products. The ^{18}Ne nucleus has been produced as a radioactive beam by ^{20}Ne primary projectile fragmentation at 45 AMeV incident energy on a Be target. The ^{18}Ne at 33 AMeV incident energy has been excited via Coulomb excitation on a ^{nat}Pb target. The obtained results unambiguously show that the 6.15 MeV ^{18}Ne state two-proton decay proceeds through a ^{2}He diproton resonance (31%) and democratic or virtual sequential decay (69%). The quoted branching ratio has been deduced from relative angle and momentum correlations of the emitted proton pairs.

^{2}He decay





V. I. Goldansky, *Nucl. Phys.* 19 (1960) 482



Recent results from CHIMERA

Nuclear Instruments and Methods in Physics Research A 715 (2013) 56–61

Contents lists available at SciVerse ScienceDirect

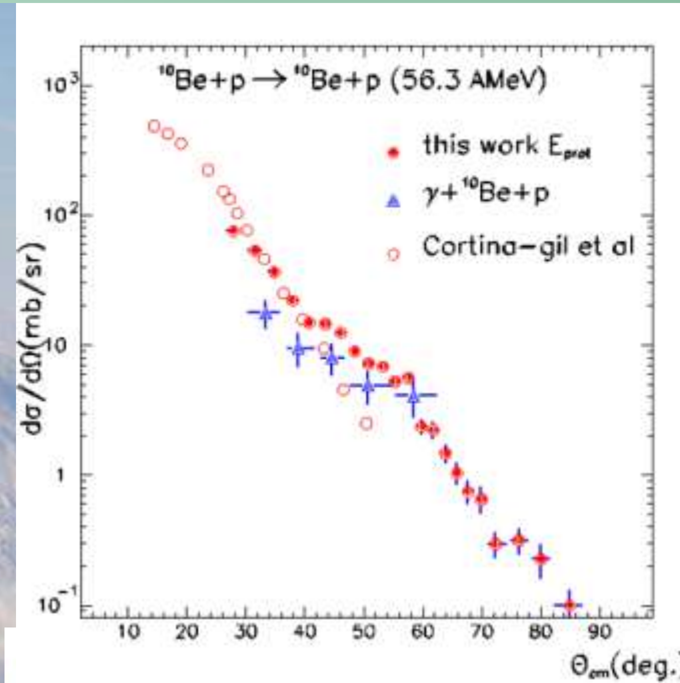
Nuclear Instruments and Methods in Physics Research A

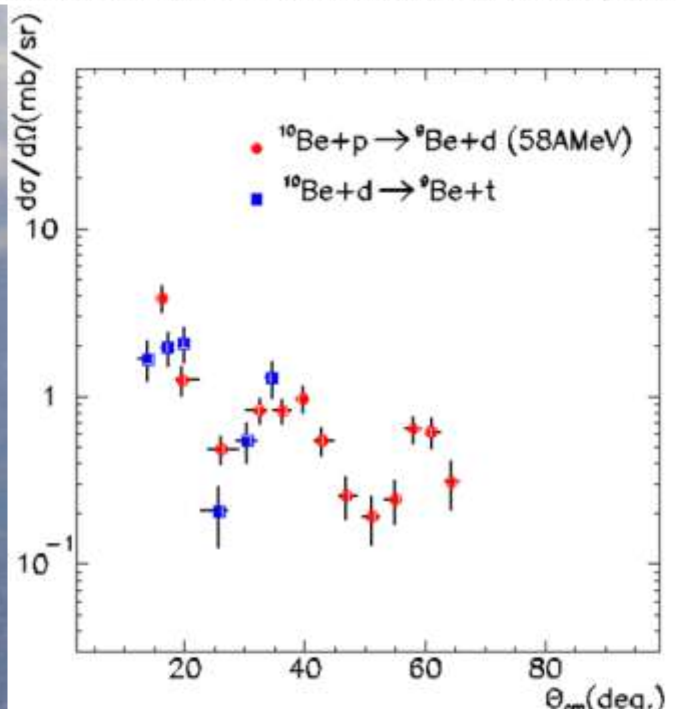
journal homepage: www.elsevier.com/locate/nima

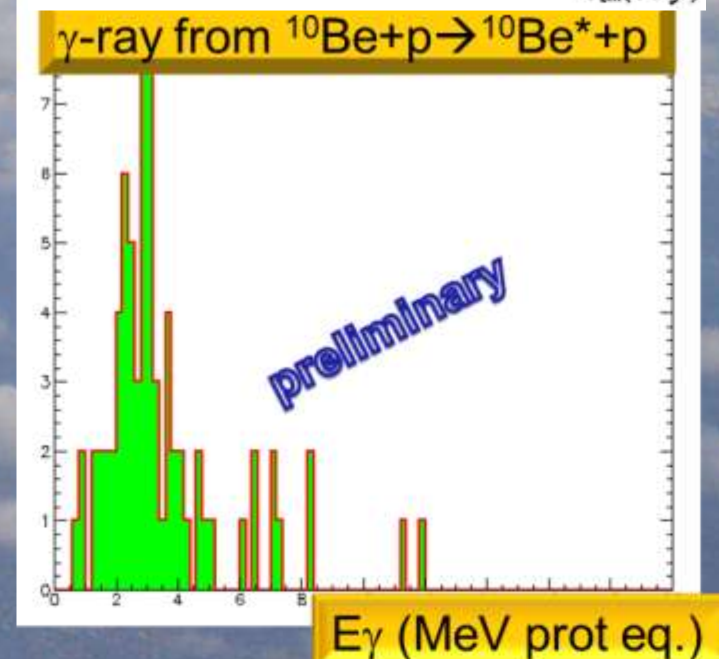
ELSEVIER

Kinematical coincidence method in transfer reactions

L. Acosta[b], F. Amorini[b], L. Auditore[d], I. Berceanu[h], G. Cardella[a,*], M.B. Chatterjiee[i], E. De Filippo[a], L. Francalanza[b,c], R. Gianì[b,c], L. Grassi[a,k], A. Grzeszczuk[j], E. La Guidara[a,g], G. Lanzalone[b,e], I. Lombardo[b,f], D. Loria[d], T. Minniti[d], E.V. Pagano[b,c], M. Papa[a], S. Pirrone[a], G. Politi[a,c], A. Pop[h], F. Porto[b,c], F. Rizzo[b,c], E. Rosato[f], P. Russotto[b,c], S. Santoro[d], A. Trifirò[d], M. Trimarchi[d], G. Verde[a], M. Vigilante[f]





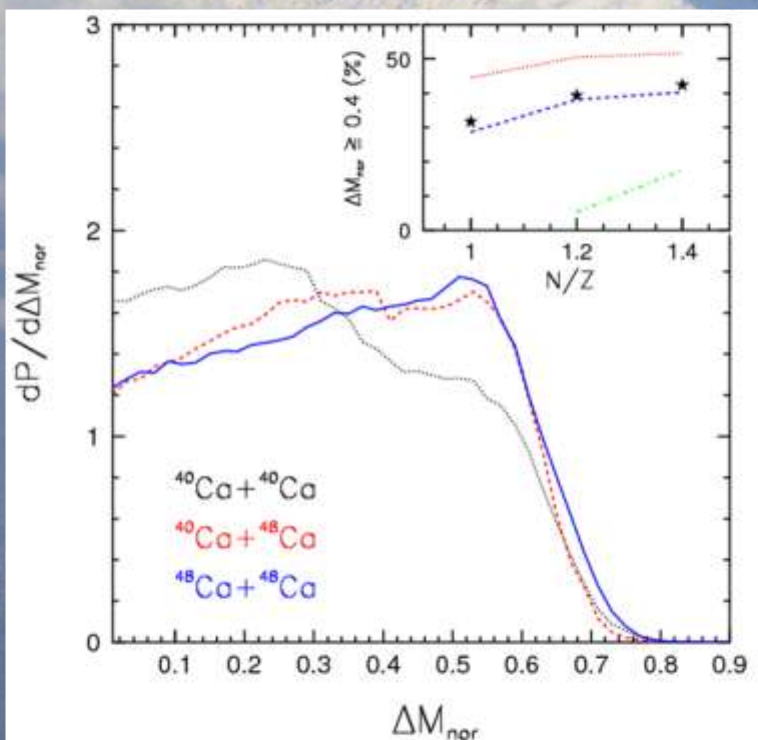


Isospin physics

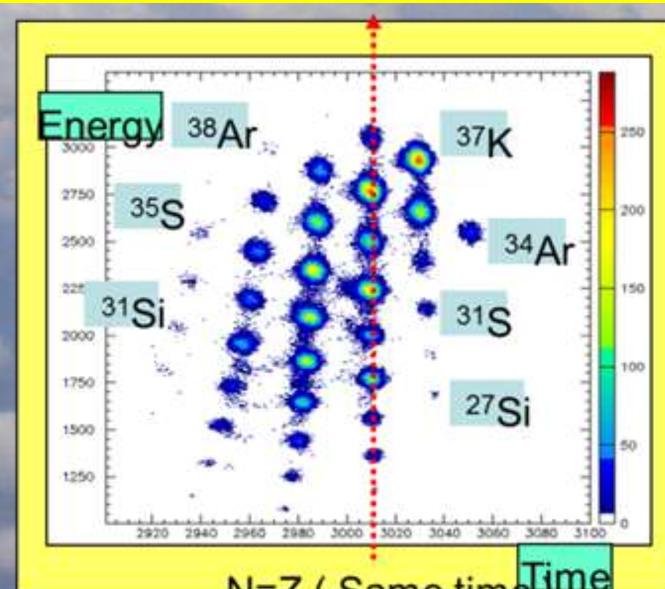
PHYSICAL REVIEW C 00, 004600 (2012)

Effects of neutron richness on the behavior of nuclear systems at intermediate energies

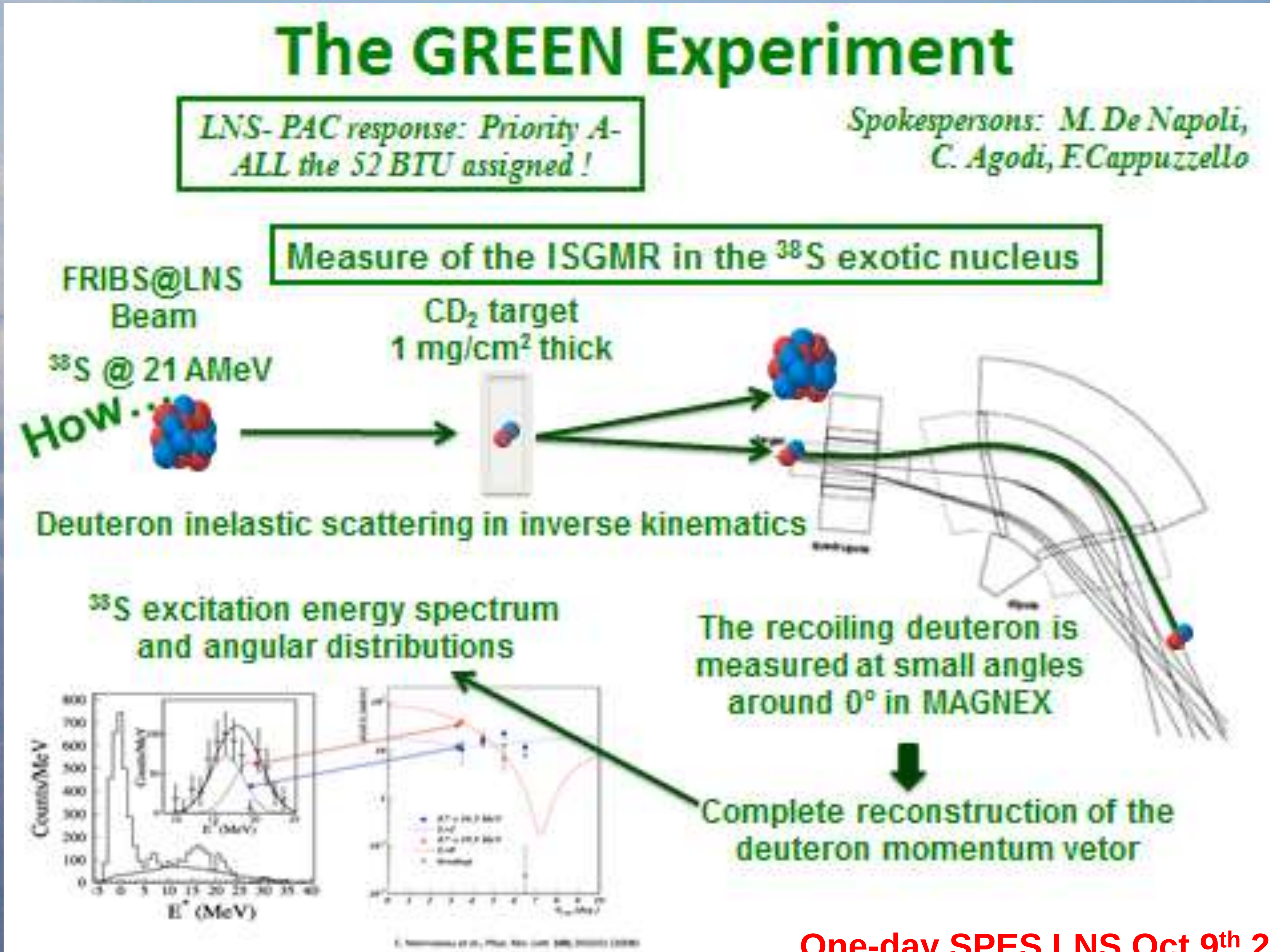
G. Cardella,[2] G. Giuliani,[2,3] I. Lombardo,[4,*] M. Papa,[2] L. Acosta,[1] C. Agodi,[1] F. Amorini,[1] A. Anzalone,[1] L. Auditore,[5] I. Berceanu,[8] S. Cavallaro,[1,3] M. B. Chatterjee,[9] E. De Filippo,[2] E. Geraci,[2,3] L. Grassi,[2,3] J. Han,[1] E. La Guidara,[2,7] D. Loria,[5] G. Lanzalone,[1,6] C. Maiolino,[1] T. Minniti,[5] A. Pagano,[2] S. Pirrone,[2] G. Politi,[2,3] F. Porto,[1,3] F. Rizzo,[1,3] P. Russotto,[1,3] S. Santoro,[5] A. Trifirò,[5] M. Trimarchi,[5] G. Verde,[2] and M. Vigilante[4]



Competition between fusion and binary-like reactions as a function of N/Z using beams in the region of Ar



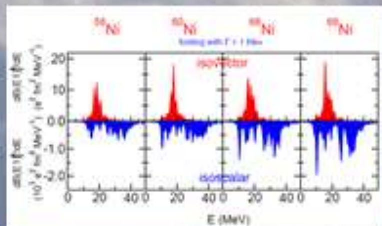
Experiments to be done - MAGNEX



Experiments to be done – PIGMY with CHIMERA/FARCOS

Search for iso-scalar excitation of the PIGMY resonance in ^{68}Ni nuclei

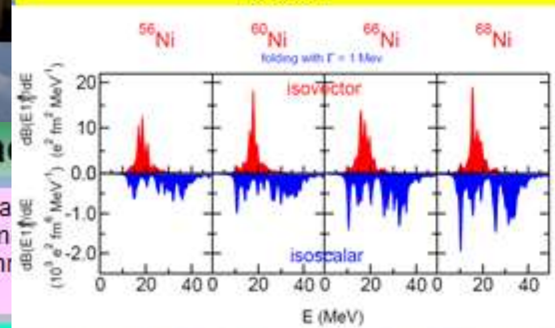
Spokes: G.Cardella, E.G.Lanza
for the
EXOCHIM collaboration

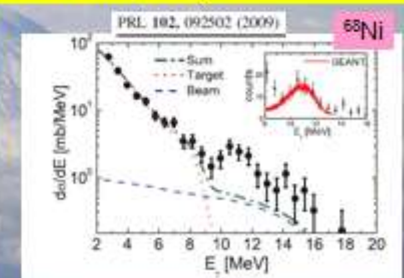


The Pigmy resonance

The search for population and decay of the Pigmy resonance was particular stressed in the last years especially due to the results obtained with neutron rich nuclei at GSI. The interest was high also because its sensitivity to the symmetry term of the nuclear equation of state - A recent revue can be found in Progress in Particle and Nuclear Physics 70 (2013) 210 by D. Savran , T. Aumann, A. Zilges

Experiments at GSI were performed using ^{132}Sn and ^{68}Ni – The resonance was excited by virtual photons generated by the Coulomb field of heavy target nuclei, so probing its isovector response function





However various calculations show that this resonance can be excited also using isoscalar probes

The Pigmy resonance: Beam chara…

The need of new investigations of the isoscalar response of the pigmy resonance well match with the recent production at LNS of ^{68}Ni beams in the framework of the TIMESCALEZN experiment

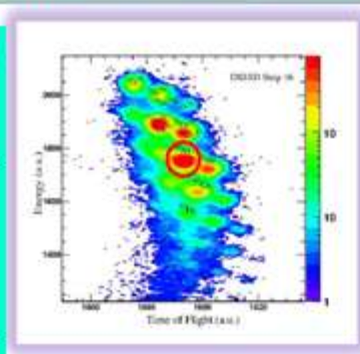
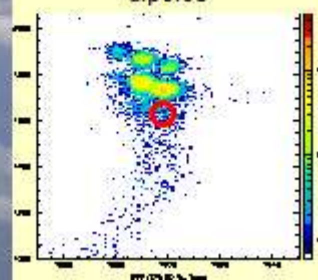


Fig.4 Identification scatter plot of ^{68}Ni fragmentation beam

The bea… via fragm… a 0.25 mı…

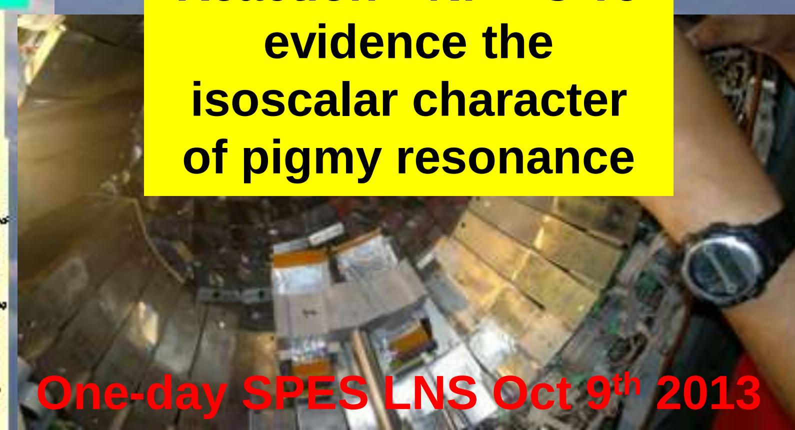
A beam intensity of about $2x10^4$ part/sec/ 100 W primary beam was obtained

Examples of Ions 27+ stripped to 28+ by the MCP mylar foil observed changing the field of last dipoles

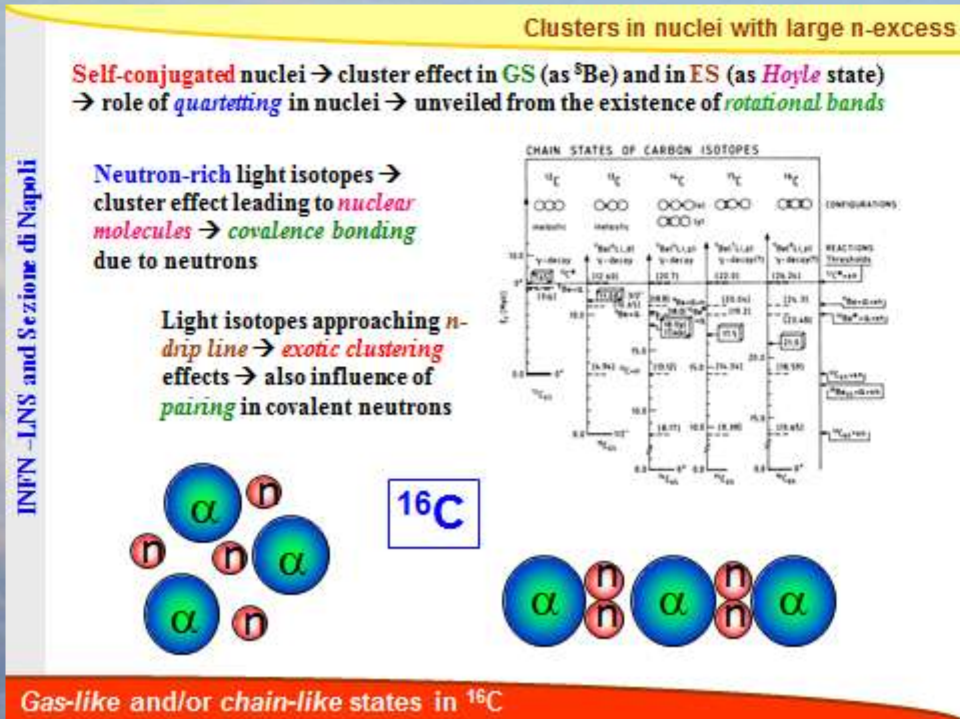


^{68}Ni is the most intense beam transported In our system we can in fact clean quite well not fully stripped ions that could be a source of intense background
The mylar foil of the tagging MCP is a stripper foil cleaning most of such contaminants

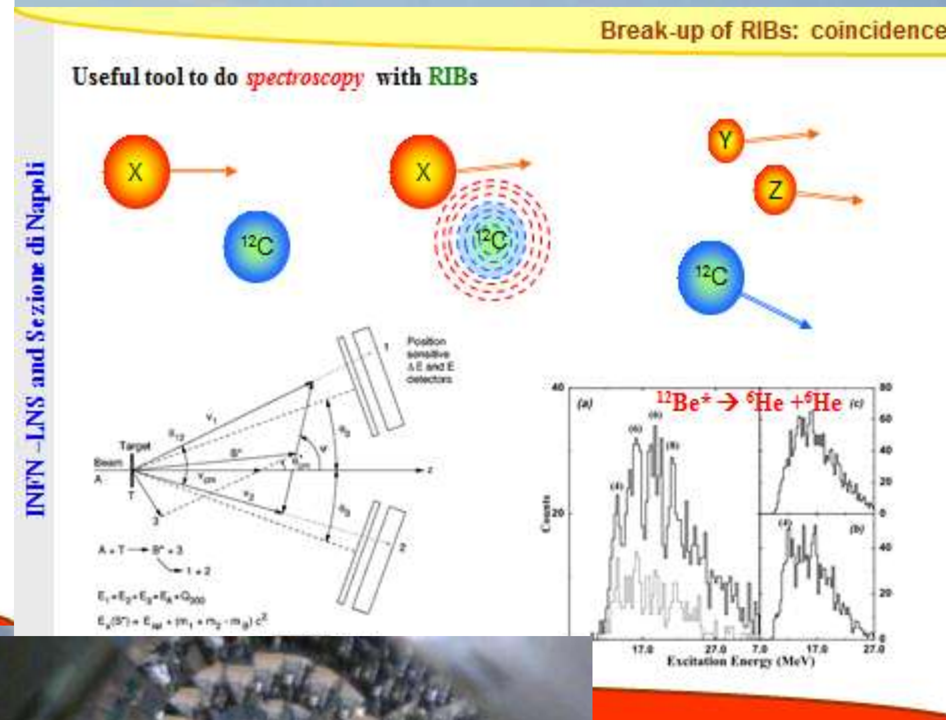
Reaction ^{68}Ni+^{12}C To evidence the isoscalar character of pigmy resonance



Experiments to be done – CLIR with CHIMERA/FARCOS

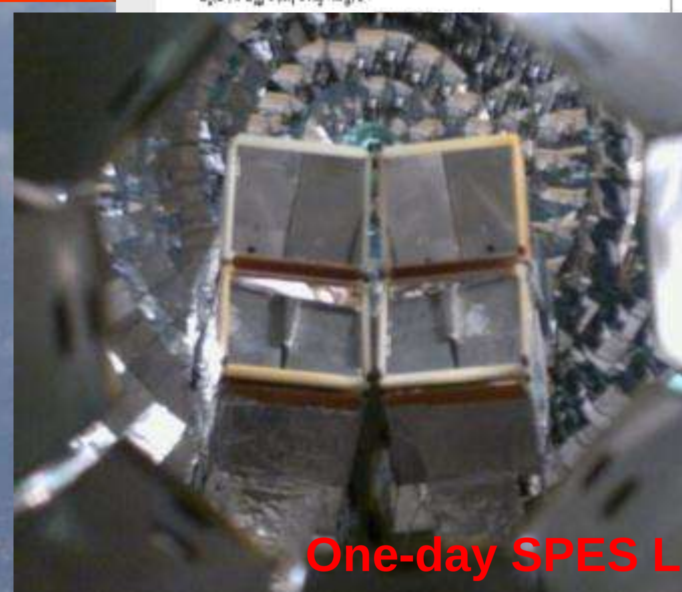


(Custers in Light Ion Reactions)



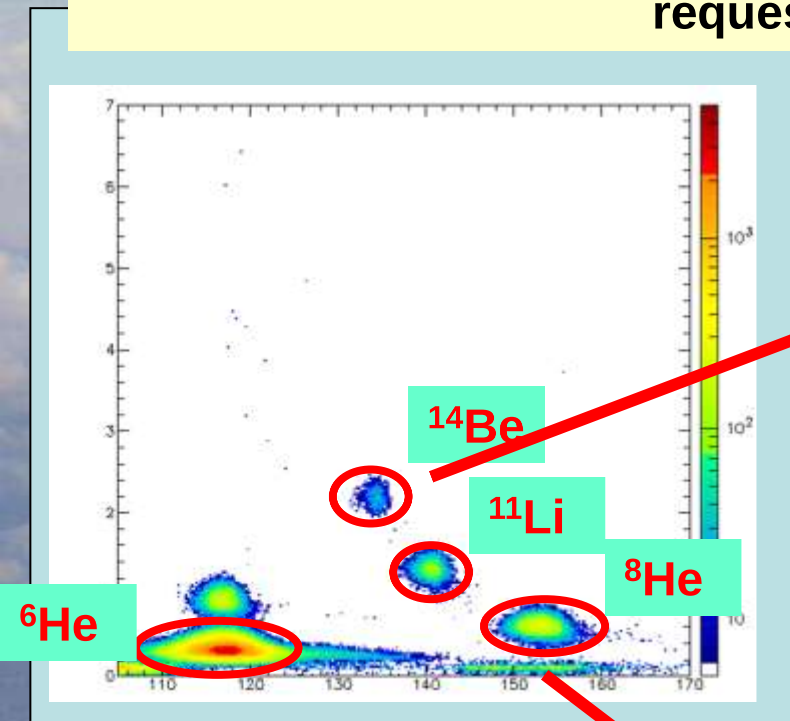
$^{16}C+^{12}C$

Search for exotic decay of ^{16}C (and the other available beams $^{10,11}Be$ ^{13}B …..)



Other test experiments coming

Another experiment in program approved by the PAC is the ^{8}He production by using a ^{11}B primary beam – while with ^{18}O primary beam there is a request for the ^{14}Be study



Implantation and beta delayed decay study of ^{14}Be
By Leuven group
R. Raabe and G.Randisi

^{8}He+d - study of ^{9}He resonance with CHIMERA+FARCOS


Side view of a FARCOS telescope

Conclusions

❖I hope I was able to convince you that at LNS we have now enough intense intermediate energy radioactive beams that can be used for various kind of experiments

❖We already did various experiments and we are planning new ones both on structure and reaction mechanisms

❖Fragmentation beams at LNS and SPES are complementary beams we can do very good physics using them

Some of the collaborators list to be completed

L.Acosta[1], C.Agodi[1], A.Amato[1], F.Amorini[1,3], A.Anzalone[1], L.Auditore[4], I.Berceanu[9], L.Calabretta[1], C.Calì[1], G.C.[,*], S.Cavallaro[1], M.B.Chatterjee[10], L.Cosentino[1], M.D'Andrea[2], B.Diana[1], A.Di Stefano[1], E.De Filippo[2], N.Giudice[2], L.Grassi[2,3], A.Grimaldi[2], N.Guardone[2], E.La Guidara[2,5], F.Ferrera[1], E.Furia[1], G.Lanzalone[1,6], P.Litrico[1], I.Lombardo[1,6], D.Loria[4], S.Marino[1], A.Maugeri[1], T.Minniti[4], A.Pagano[2], M.Papa[2], A.Pappalardo[1], S.Passarello[1], G.Passaro[1], S.Pirrone[2], G.Politi[2,3], F.Porto[1,3], S.Pulvirenti[1], C.Rapicavoli[2], D.Rifuggiato[1], G.Rizza[2], F.Rizzo[1,3], A.Rovelli[1], P.Russotto[1,3], G.Saccà[2], S.Salamone[1], S.Santoro[4], F.Sarta[1], A.Seminara[1], A.Trifirò[4], M.Trimarchì[4], G.Verde[2], M.Vigilante[8]

P.Figuera[a], A.Di Pietro, C.Maiolino[a], M.De Napoli[b,c], I. Pawelczak[d], M. Quinlan[d] , G.Raciti[b,c], E.Rapisarda[b,c],C.Sfienti, D.Santonocito[a], W. U. Schröder[d] , J. Tõke[d]