Fragmentation beam yields in the CHIMERA hall

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For the EXOCHIM collaboration

Little history I

Since the first results obtained by G.Raciti on the production of exotic beams at LNS we were interested on their use with CHIMERA – so on 2003 we proposed the experiment Diproton together with other LNS groups (TRASMA-ISOSPIN-SIS collaboration) to get a first experience with such beams

Search for di-proton decay of 18Ne

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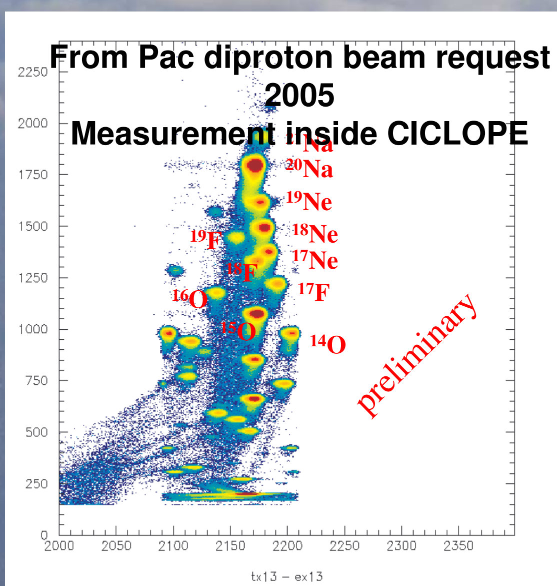
Supported by ISOSPIN collaboration



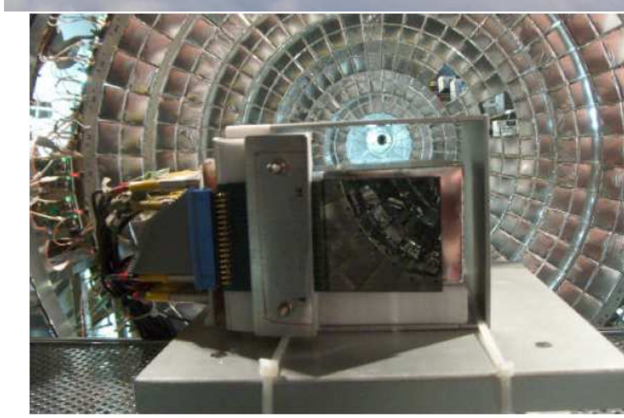
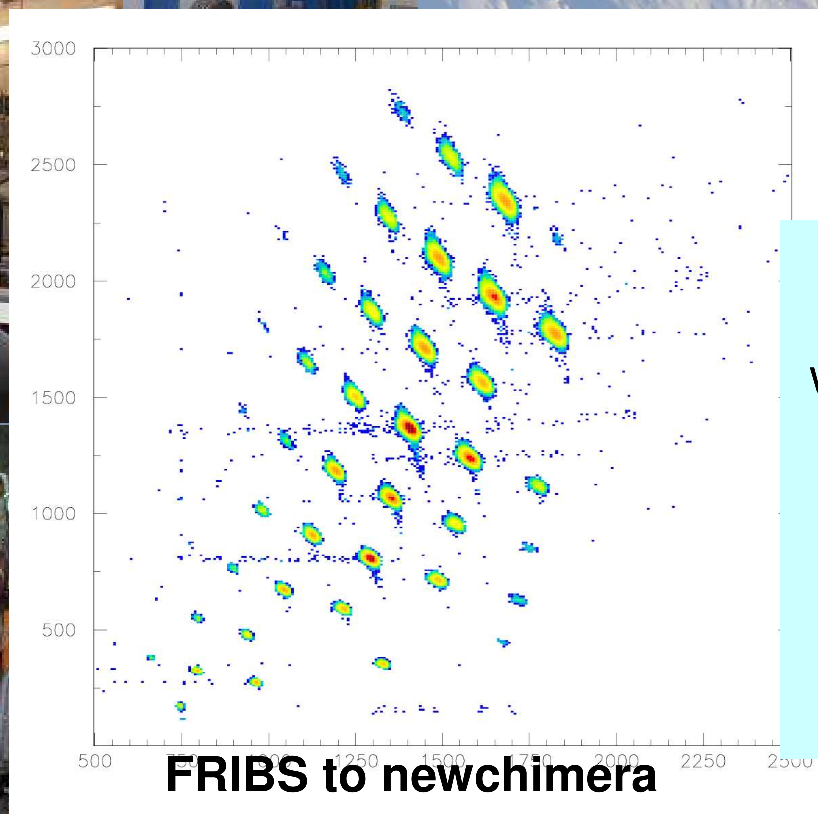


Figure 3: The detectors array mounted inside the Ciclope scattering chamber. Th CHIMERA rings are also visible.

After some attempts we realized that it was impossible to use such beams inside the CICLOPE scattering chamber were CHIMERA was mounted because of a poor beam transmission and we asked some test beam to measure the transmission on the new experimental halls

Little history II

On 2006 we performed a transmission test on the new CHIMERA Hall using a CHIMERA telescope inside the beam line



A rather good and clean transmission was obtained with at least 50% of the beam transported

This was enough to decide the transfer of CHIMERA inside the new chamber

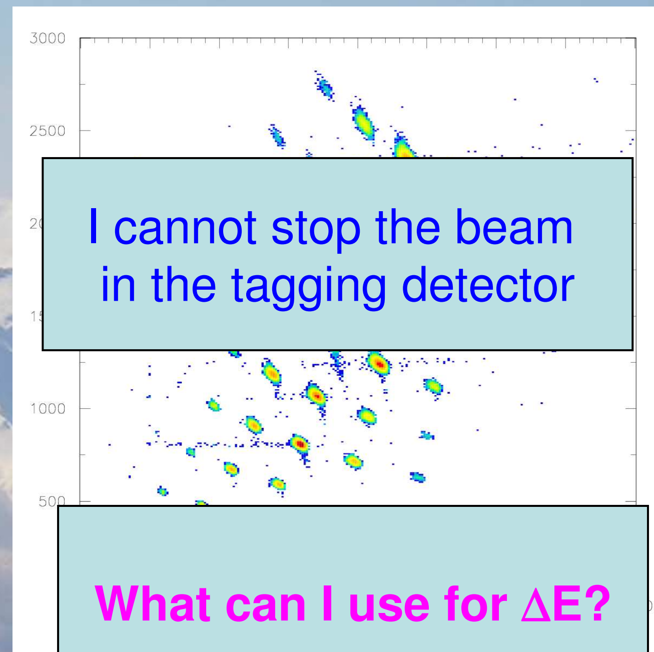
Little history III

We also decided to improve the simple tagging system used in the 20° beam line using a powerful timing device to be independent from RF

Tagging system: flow chart I DSSSD

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

~~ΔE-E?~~

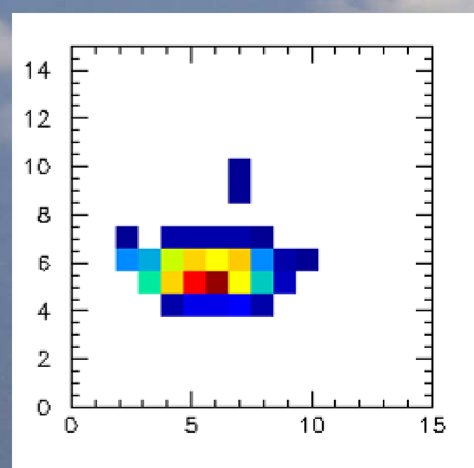


I cannot stop the beam in the tagging detector

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 counting rate larger than a single detector

Tagging System: flow chart II - RF-timing

~~ΔE-E?~~

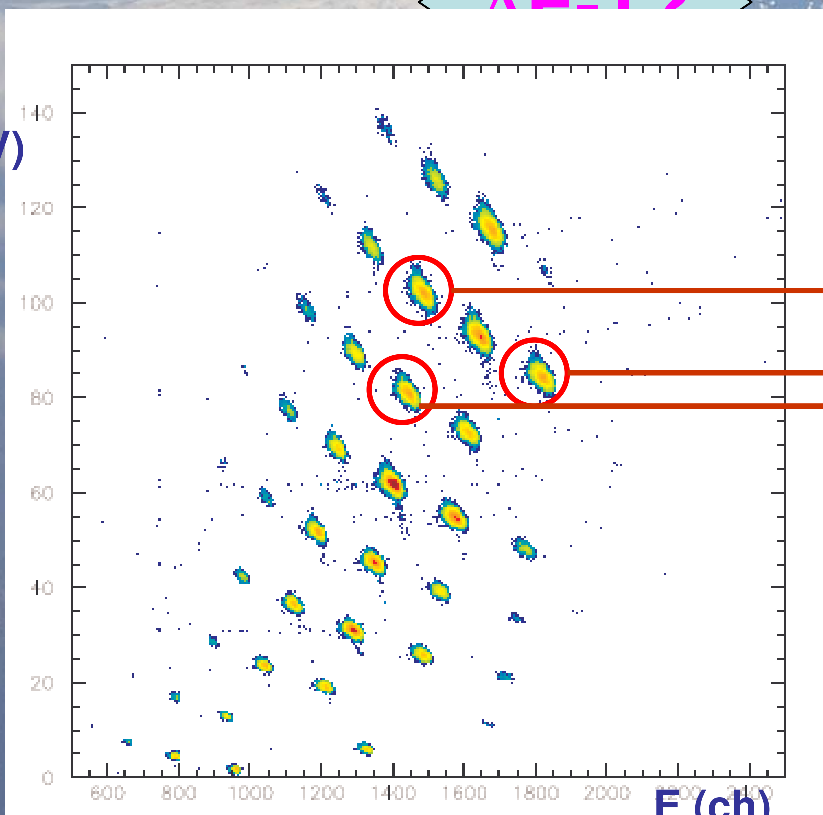
I cannot stop the beam in the tagging detector

ΔE-T?

Possible but how

Ma

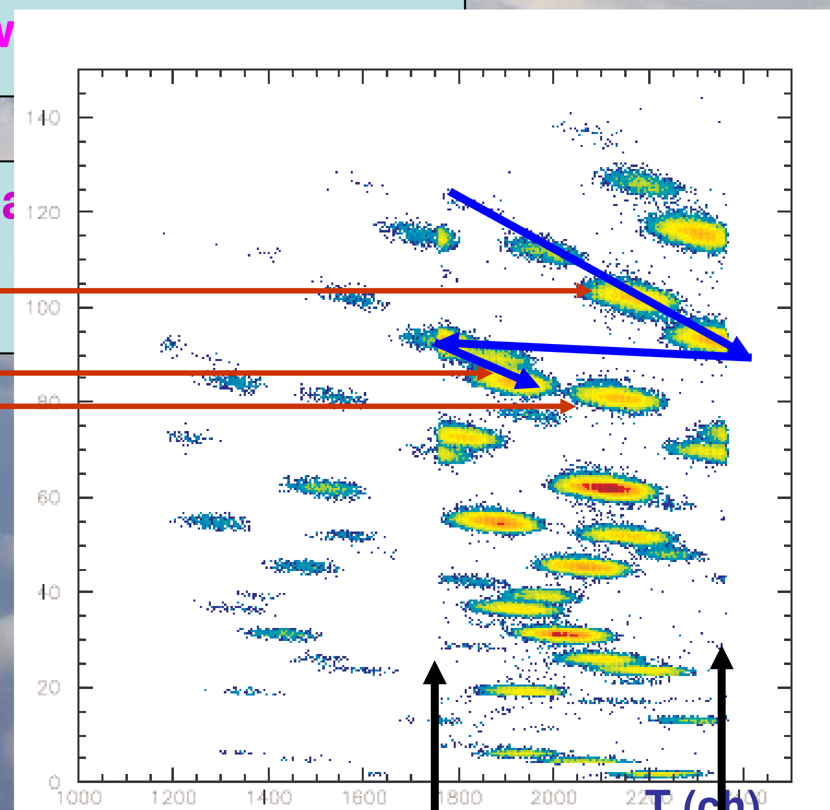
DE (MeV)



^{20}Ne

^{18}Ne

^{18}F



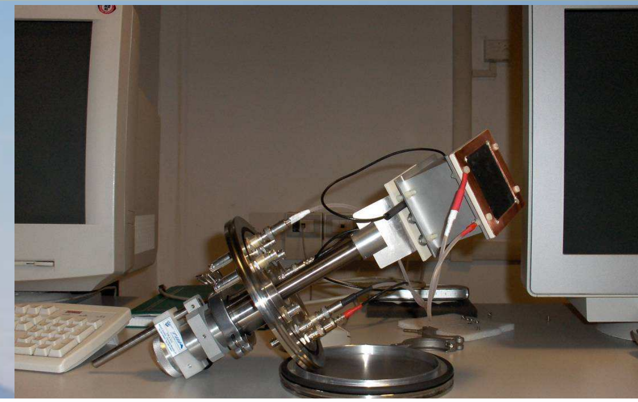
30 ns

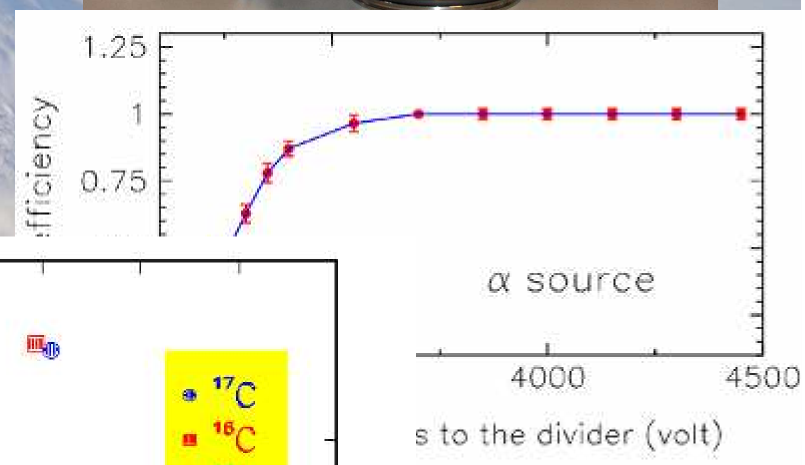
Tagging system : flow chart III MCP timing

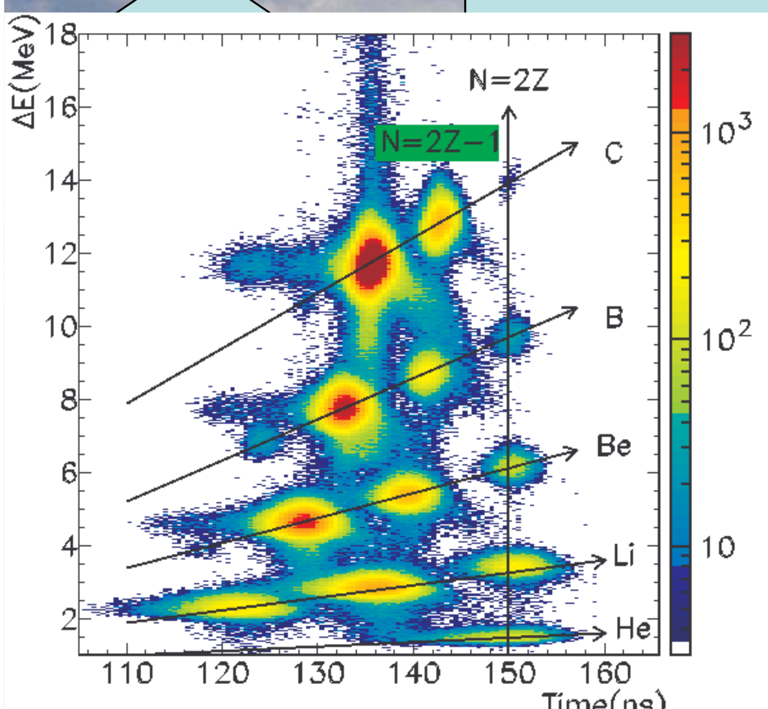
~~DE-E?~~

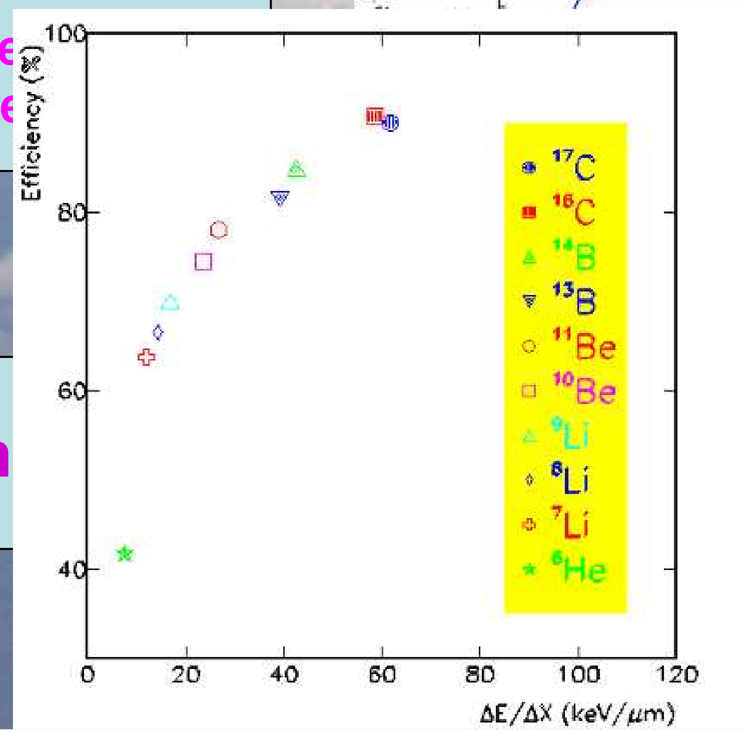
I cannot stop the beam in the tagging detector

Tagged beam

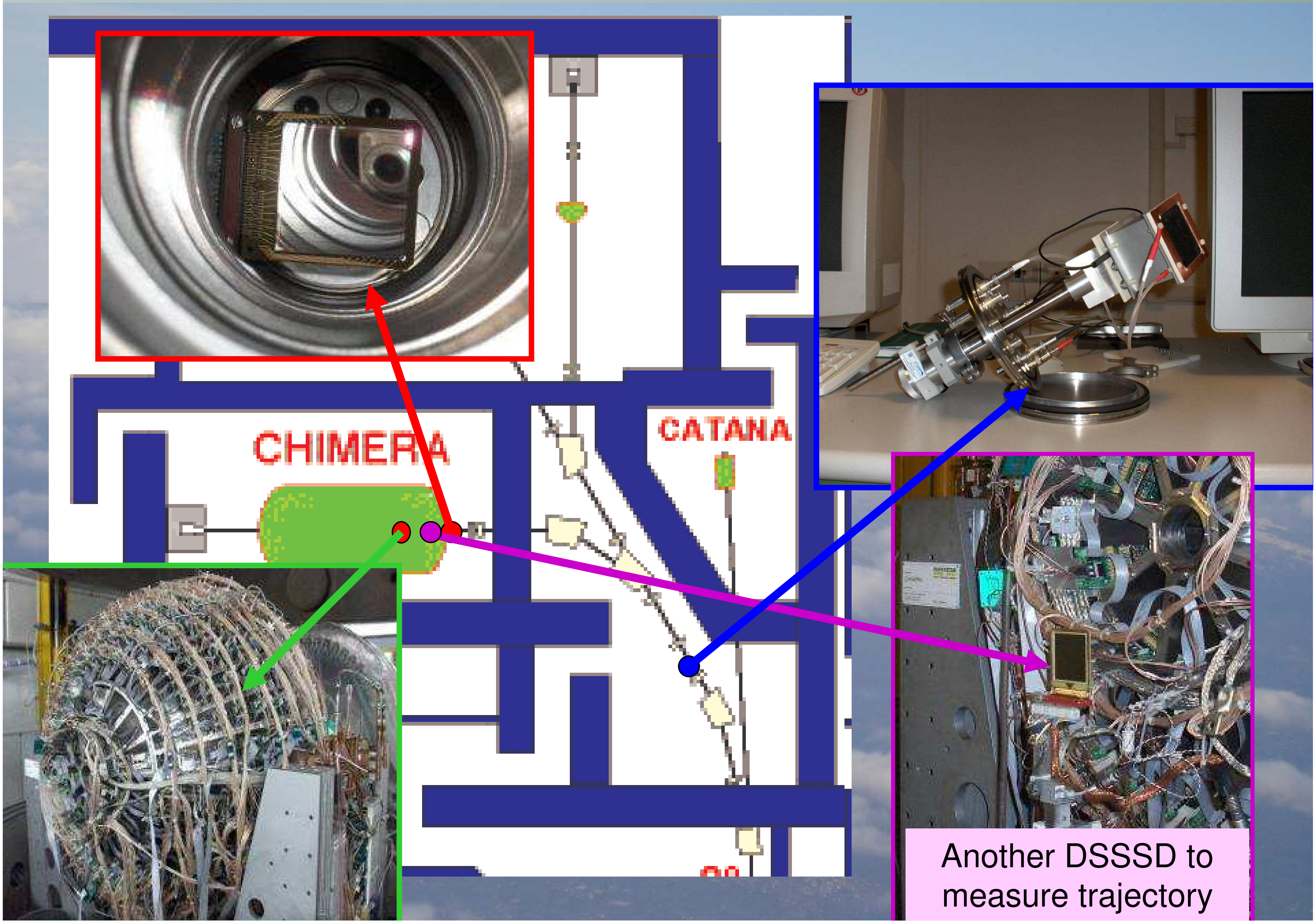








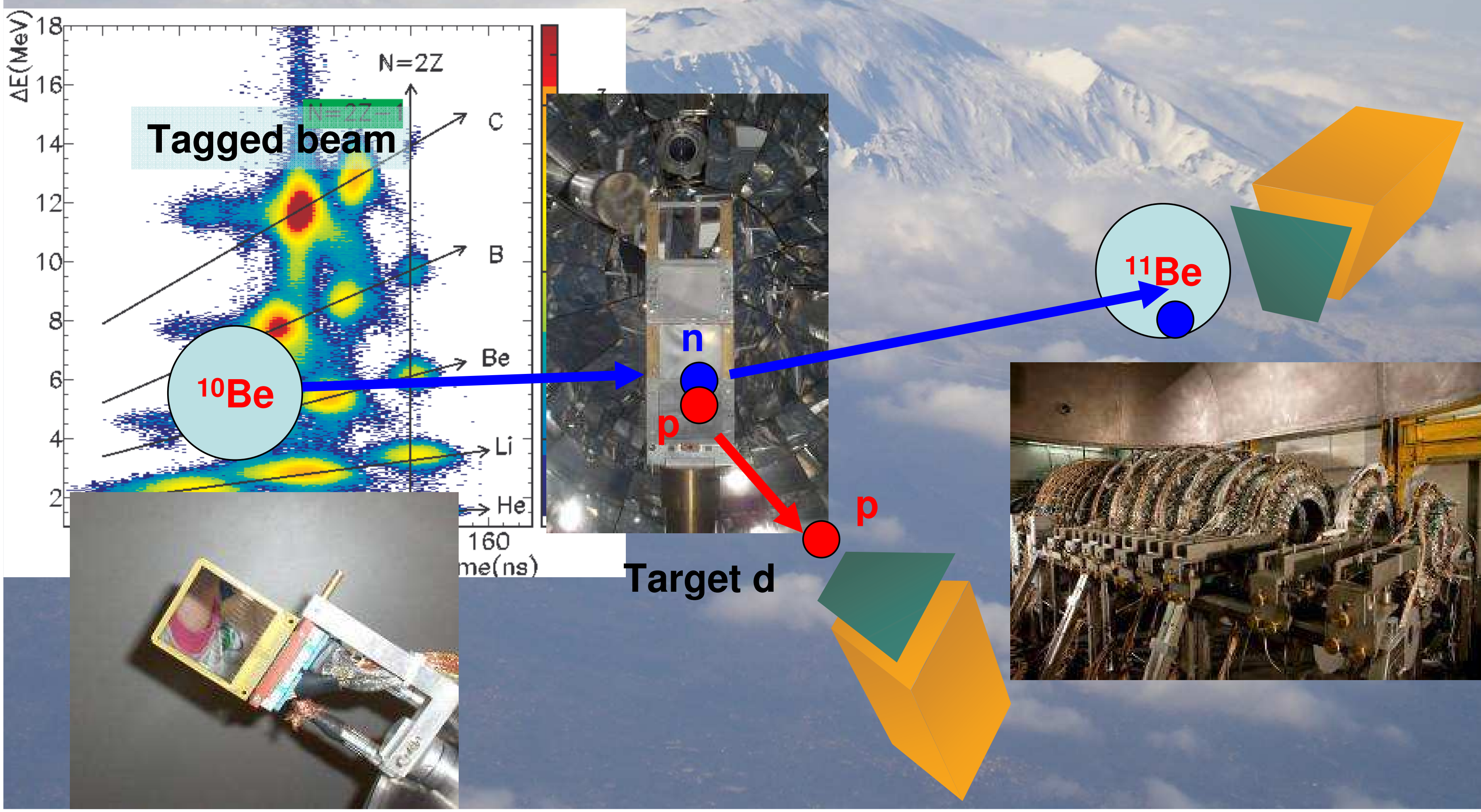
Tagging system: layout



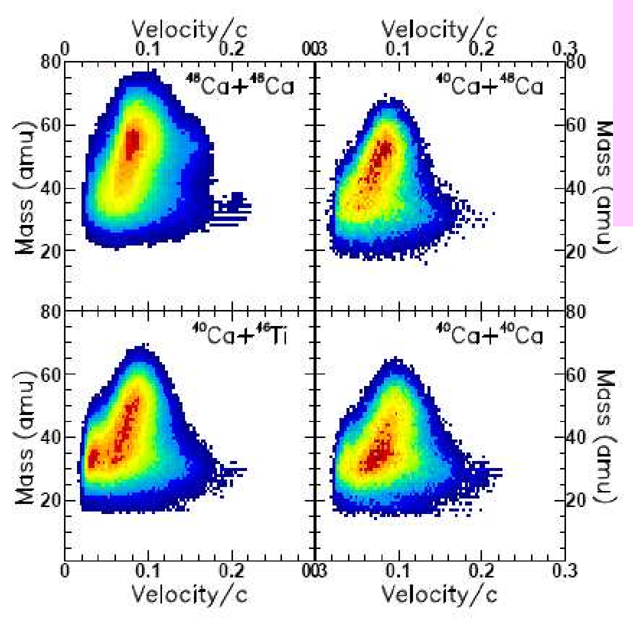
The physics case: I - neutron transfer reactions near halo nuclei -

With CHIMERA 4π detector we want study transfer reactions of light nuclei on p, d targets to search halo or other nuclear structure effects

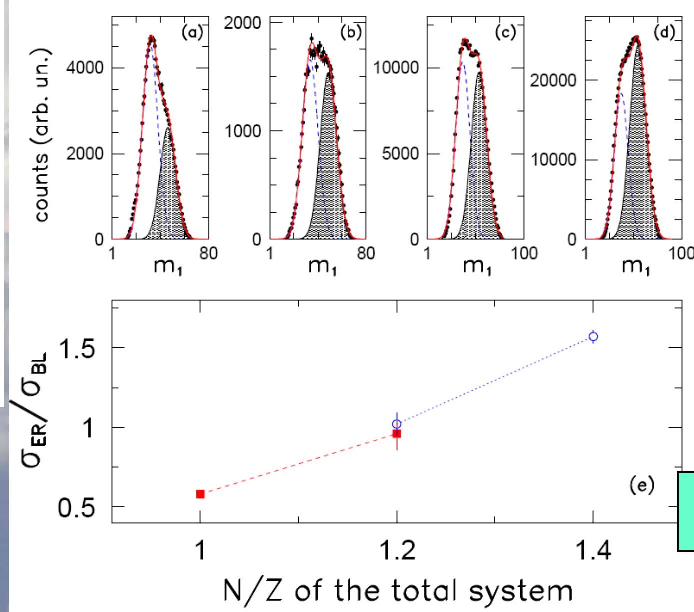
EVENT SELECTION performed with kinematic coincidences – we measure in binary reactions both reaction partners cleaning the events



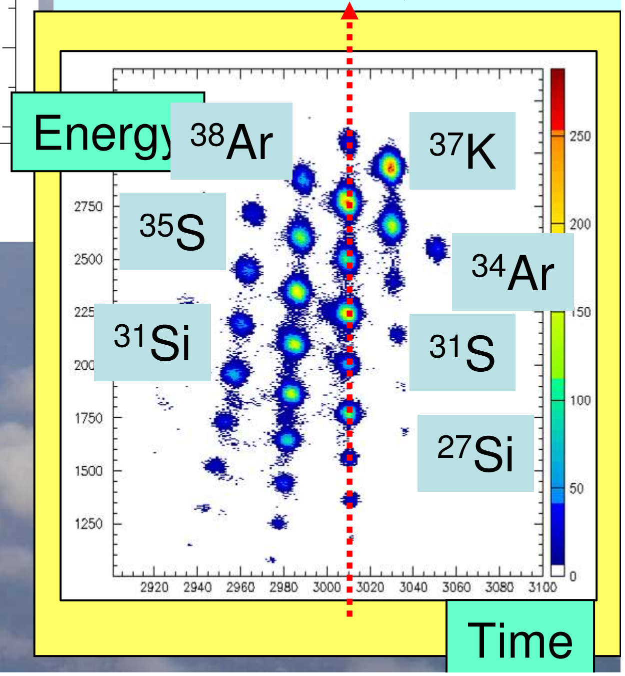
The physics case: II – Isospin dependence of incomplete fusion reactions



In past years we measured with CHIMERA detector reactions induced by ^{40,48}Ca at 25MeV/A on ^{40,48}Ca,^{46}Ti.
The mass–velocity correlations (m_1,v_1) of the largest nucleus emitted show that in the most neutron rich system ^{48}Ca+^{48}Ca heavy residues are more probably populated than in N=Z systems
F.Amorini et al Phys.Rev.Lett 102 (2009) 112701

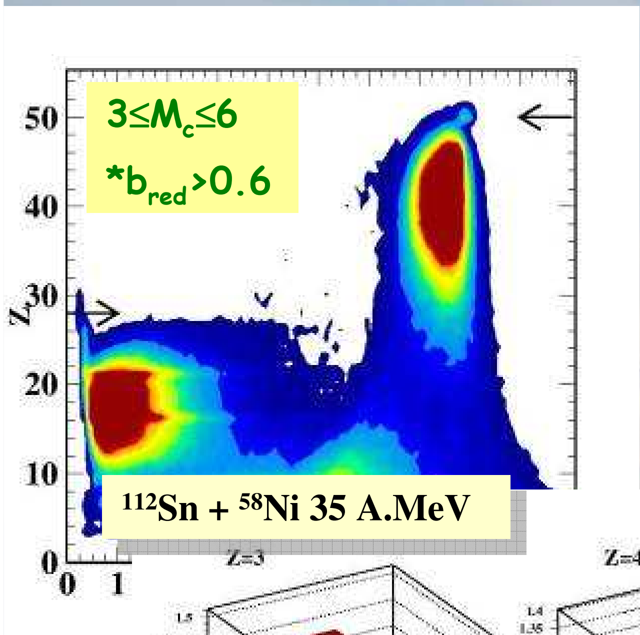


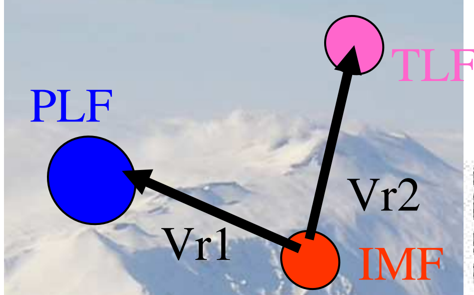
By increasing the N/Z of the entrance channel increases the ratio between ER production and other mechanisms (such as binary-like and multi-fragment emission).

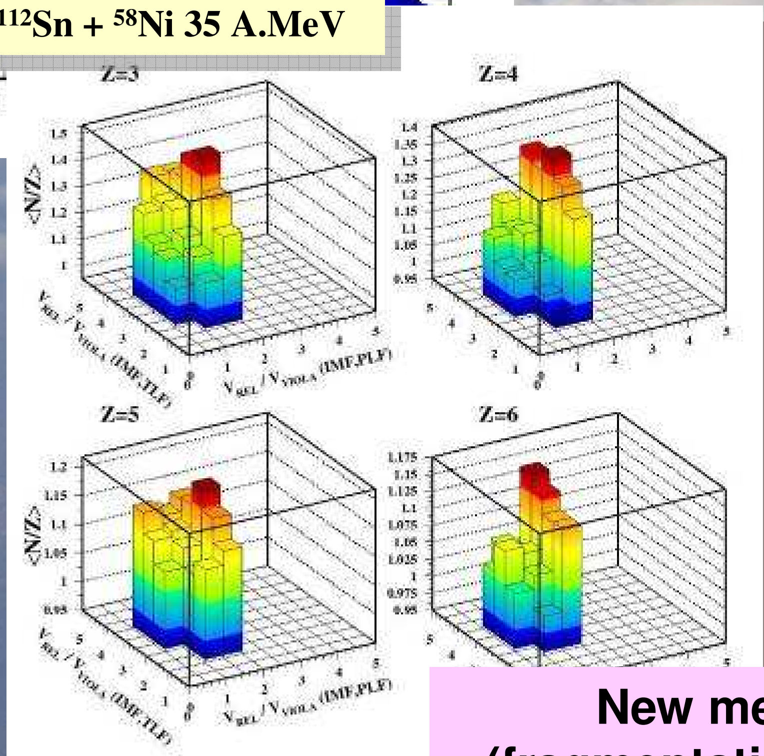


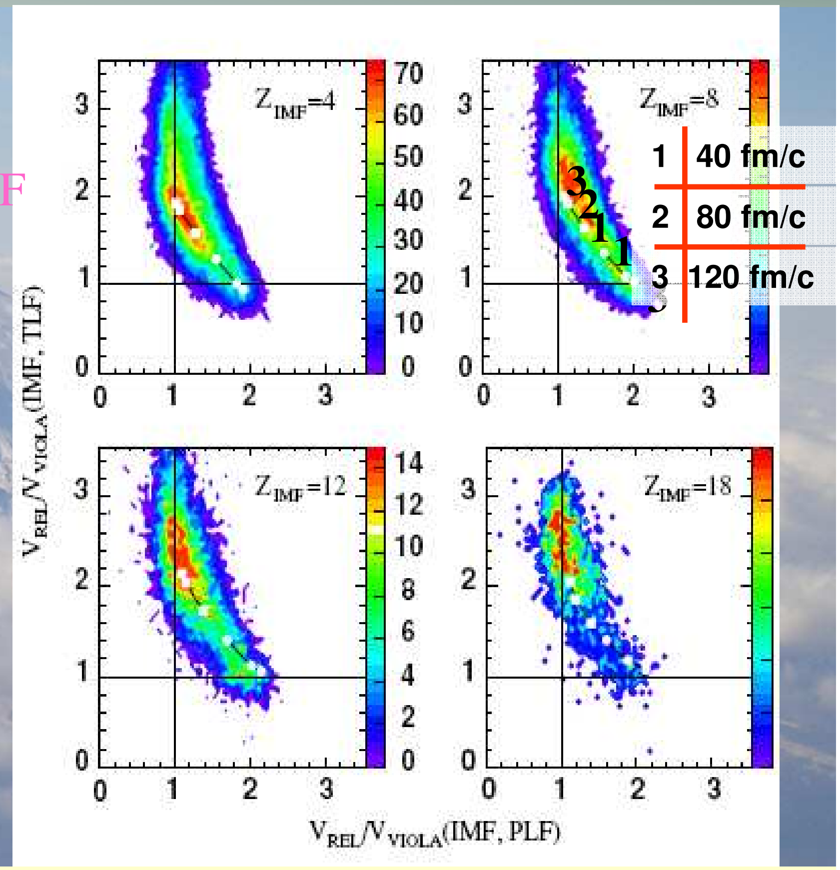
Following these results we decided to extend the investigations to a larger range of N/Z of the total system.
A first attempt was performed on February this year with a production tests of proton rich nuclear systems in the region of Argon by in flight fragmentation at LNS Catania. The exotic mixed beams produced was sent on a ^{27}Al target and reaction products where detected with CHIMERA

The physics case: III – IMF Emission Timescale in reactions induced by Ni ions on Sn – Isospin dependence









Measurements already performed with $^{64,58}Ni + ^{112,124}Sn$ (direct and inverse kinematics)

E.De Filippo et al PHYS. REV. C 71, 044602 (2005)

New measurements request for beams of ^{68}Ni (fragmentation of ^{70}Zn) and ^{56}Ni (fragmentation of ^{64}Zn)

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**

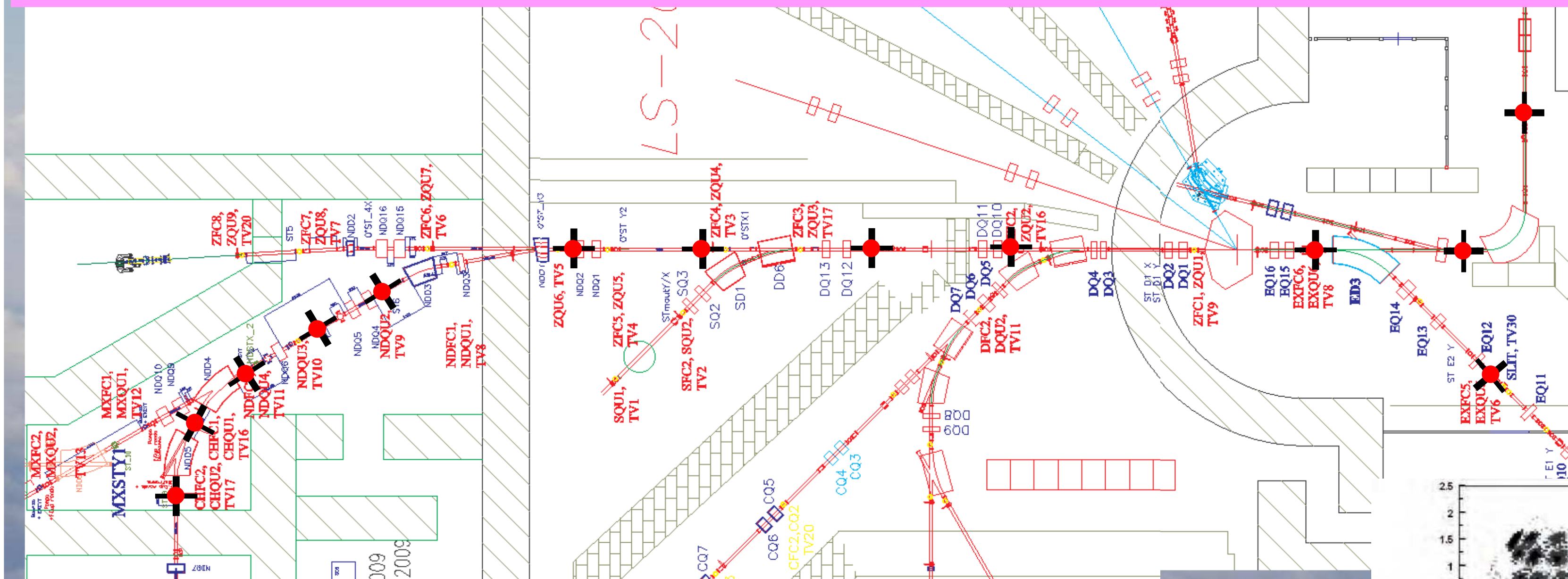


Fig. 2. Beam particle counter, based on a plastic scintillator coupled to a photomultiplier.

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

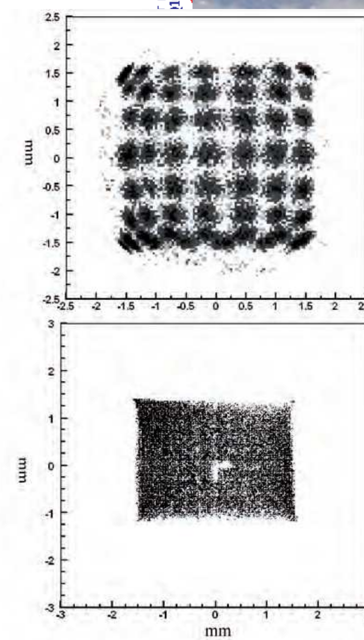
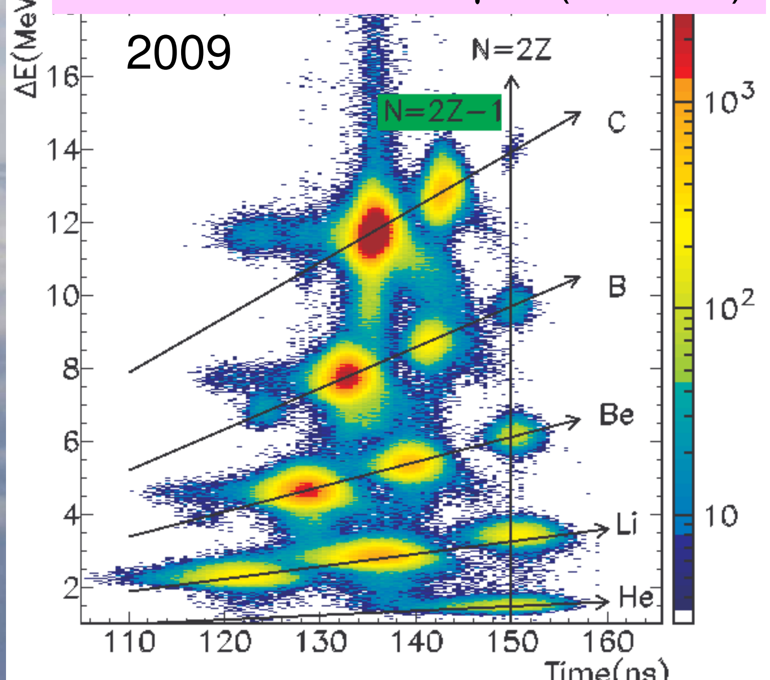


Fig. 4. Corrected beam profiles of a EXCYT (a) and a FRIB (b) beam, acquired by means of the PSSD and using two different masks.

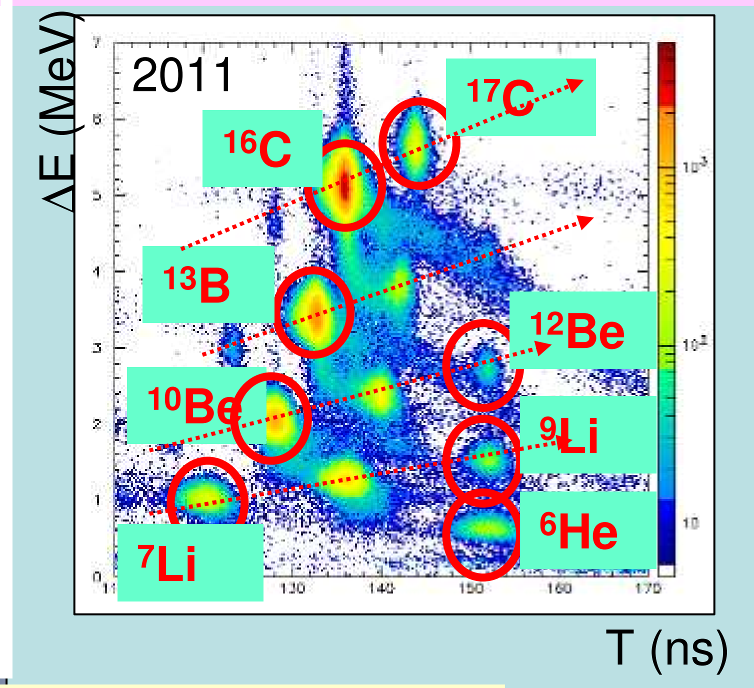
Production and transport test: ^{18}O primary beam

Using a primary $^{18}O^{7+}$ beam (used also as pilot beam to set the Bρ of the dipoles) We have repeated the transport of beams around ^{11}Be performed in December 2009 to test the increase of production after the upgrading of the fragmentation beam

16x16 DSSSD 140μm ($5x5cm^2$)



24x24 DSSSD 62μm ($2.4x2.4cm^2$)

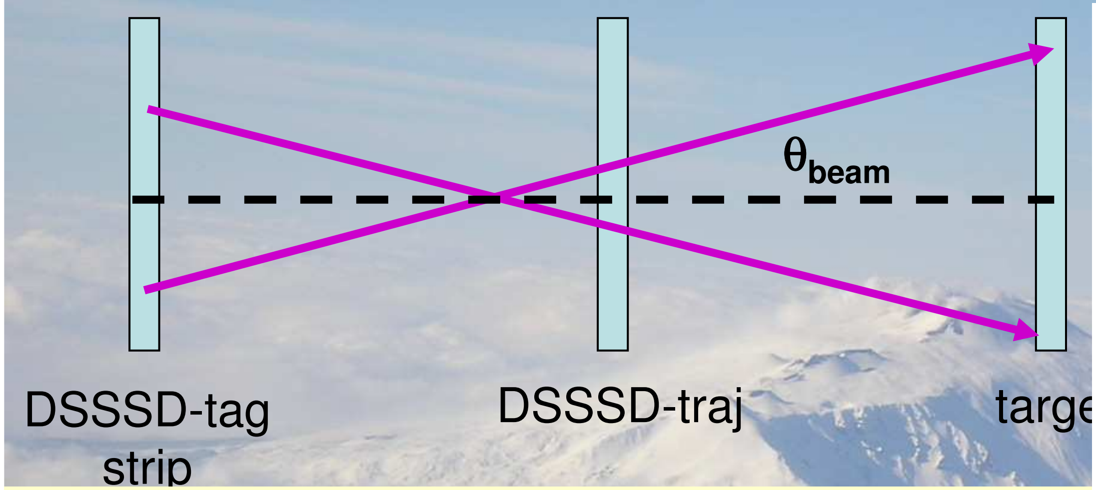


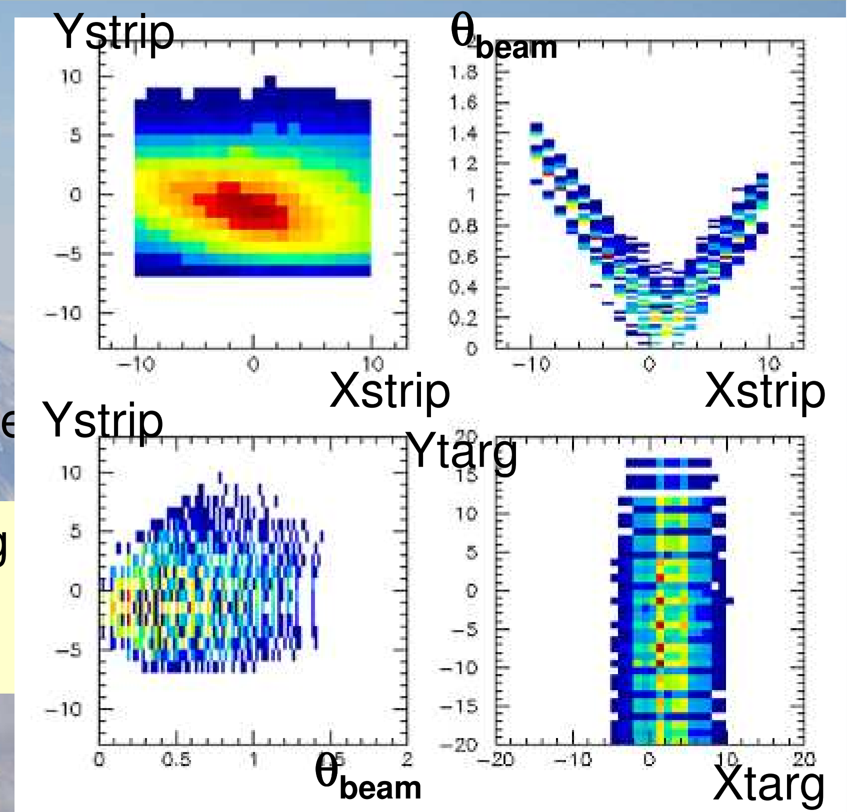
Yields normalized to 100 W beam ($6.3x10^{11}$ p/s)

Fascio	Khz	
^{16}C	9	59
^{13}B	4.5	37

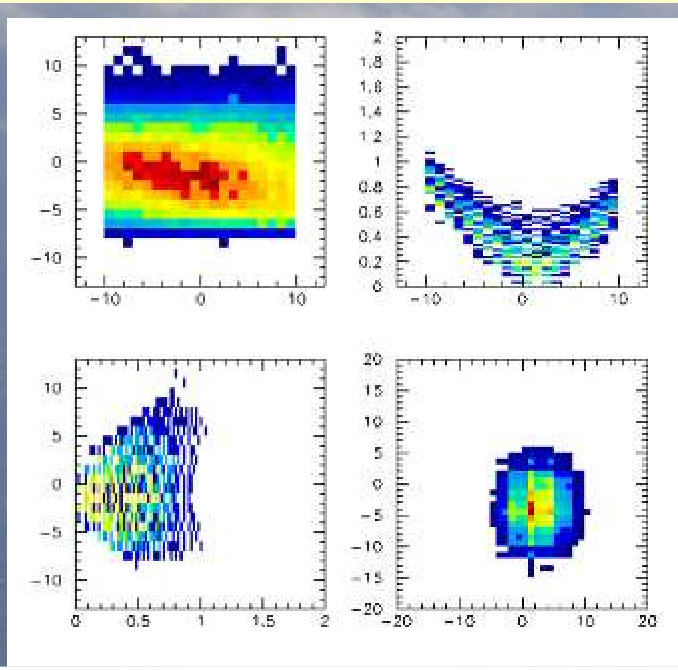
E~50 MeV/A ΔP/P <1%

Production and transport test: beam trajectory



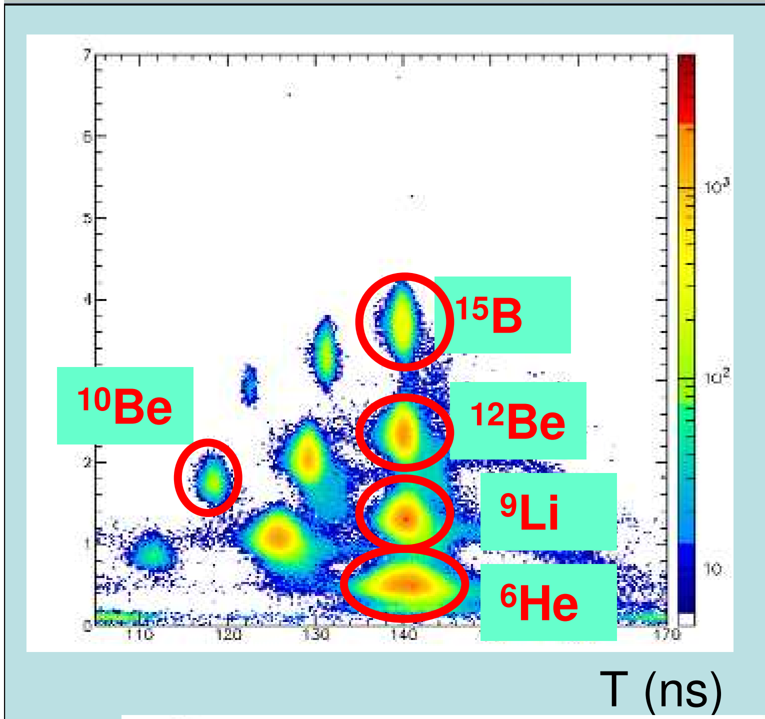


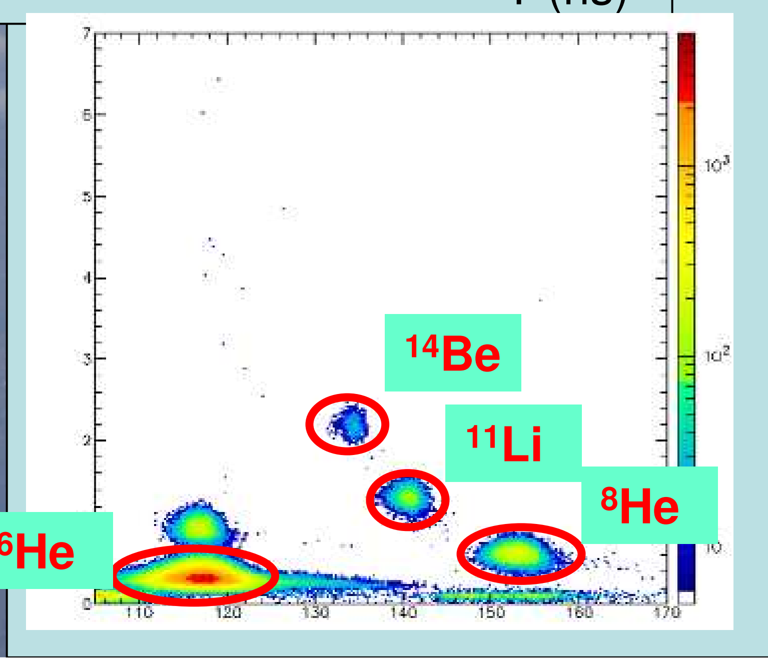
Unfortunately due to the small size of the tagging detector that was too near to last quadrupole a good focus on tagging get a bad focus on target



It is possible to produce a very beautiful beam on target – with very small divergence - but loosing the tagging of many particles – next experiment we will use a new DSSSD 32X32 strips 6.4x6.4cm^2

Production and transport test: other settings with ^{18}O primary beam





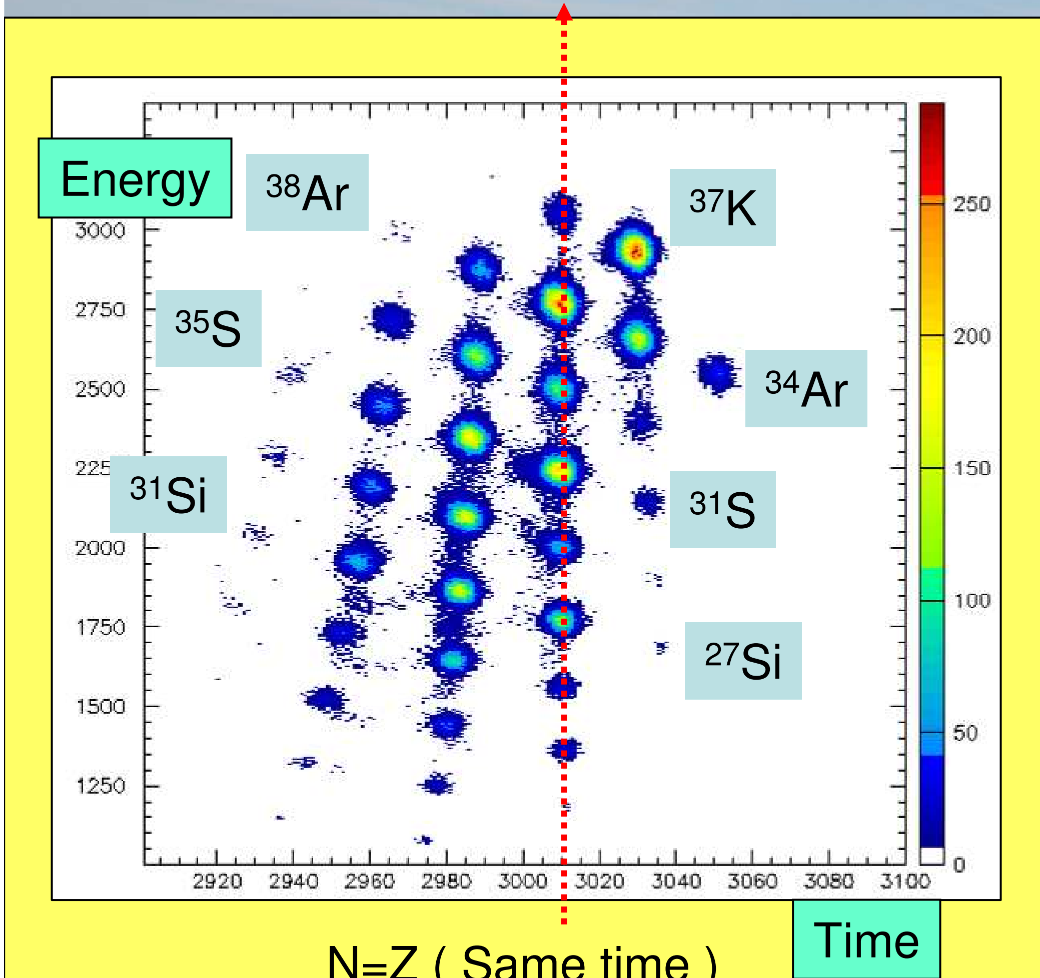
Yields normalized to 100 W

beam	Khz
^{15}B	0.4
^{14}B	1.2
^{12}Be	2
^{11}Be	0.9
^{9}Li	2.7
^{8}Li	2
^{6}He	4.7

Primary beam 100W (4.4×10^{11} p/s)

beam	hz
^{14}Be	6
^{11}Li	27
^{9}Li	55
^{8}He	115
^{6}He	1300

Production and transport test: primary beam ^{36}Ar



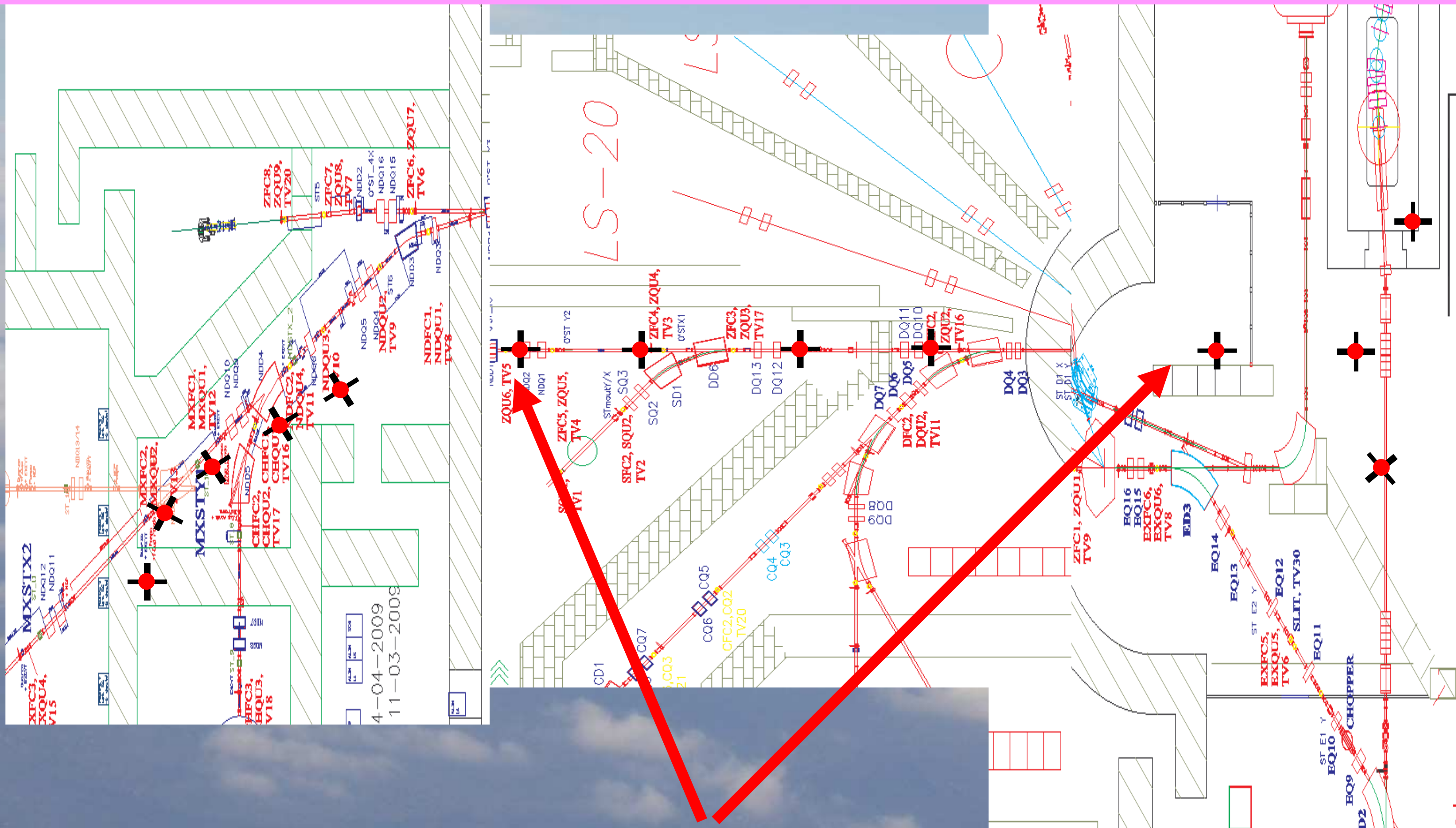
^{36}Ar 42 MeV/A – only 25W were available for some source problems

Beam	Khz
^{37}K	14
^{36}Ar	12
^{35}Ar	8.5
^{34}Ar	1.8
^{33}Cl	1.5
^{34}Cl	6.5
^{31}S	0.8
^{32}S	10
^{28}Si	5
^{29}Si	6.5

Energy ~ 20-25 MeV/A

Production and transport test: new possible beams

Using the EXCYT diagnostic we know were are the bottlenecks for the beam transport



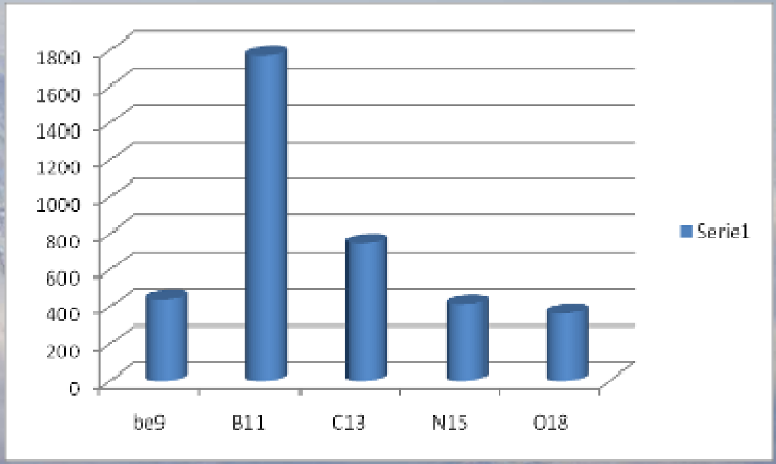
There are collimators ϕ=3cm in correspondence of the radioprotection faraday cups

These collimators are going to be dismounted this will surely increase the beam intensity of at least a factor 2 - hopefully 4 -

Production and transport test: new possible beams

Beam request for this PAC $^{64,70}Zn$ to produce $^{56,68}Ni$ –
LISE predictions 10^5 ^{68}Ni $2x10^4$ ^{56}Ni
We must however do some test because our reproduction of the spectrometer with Lise is not complete and moreover LISE is not fully reliable at these energies

Another beam request is to improve the production of ^{8}He using as primary beam ^{11}B
Lise predictions - quite reliable for this ion with ^{18}O - give a rate of about 2kHz enough for some smart experiments



Open problem: INCREASE the primary beam intensity – possible with the new cooled and movable target holder
but
Electrostatic deflector ??

Problems of radioactivity in the CS hall – During the last tests we had frequently beam stops to reset instruments inside the cave for malfunctions due to the high level of radioactivity

Problems with sources (impossible to use SERSE in these tests due to helium cooling problems)

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