Utilizzo dei fasci FRIBS con CHIMERA

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For the EXOCHIM collaboration

Since the first tests of FRIBS the interest of CHIMERA for such BEAMS was very high and some of us collaborated with Giovanni also to test transmission of such beams on CICLOPE and on the new CHIMERA hall

After these tests it was clear that a much better transmission of such beams was possible in the new CHIMERA hall and this was the main reason to move CHIMERA in such hall in 2007-2008

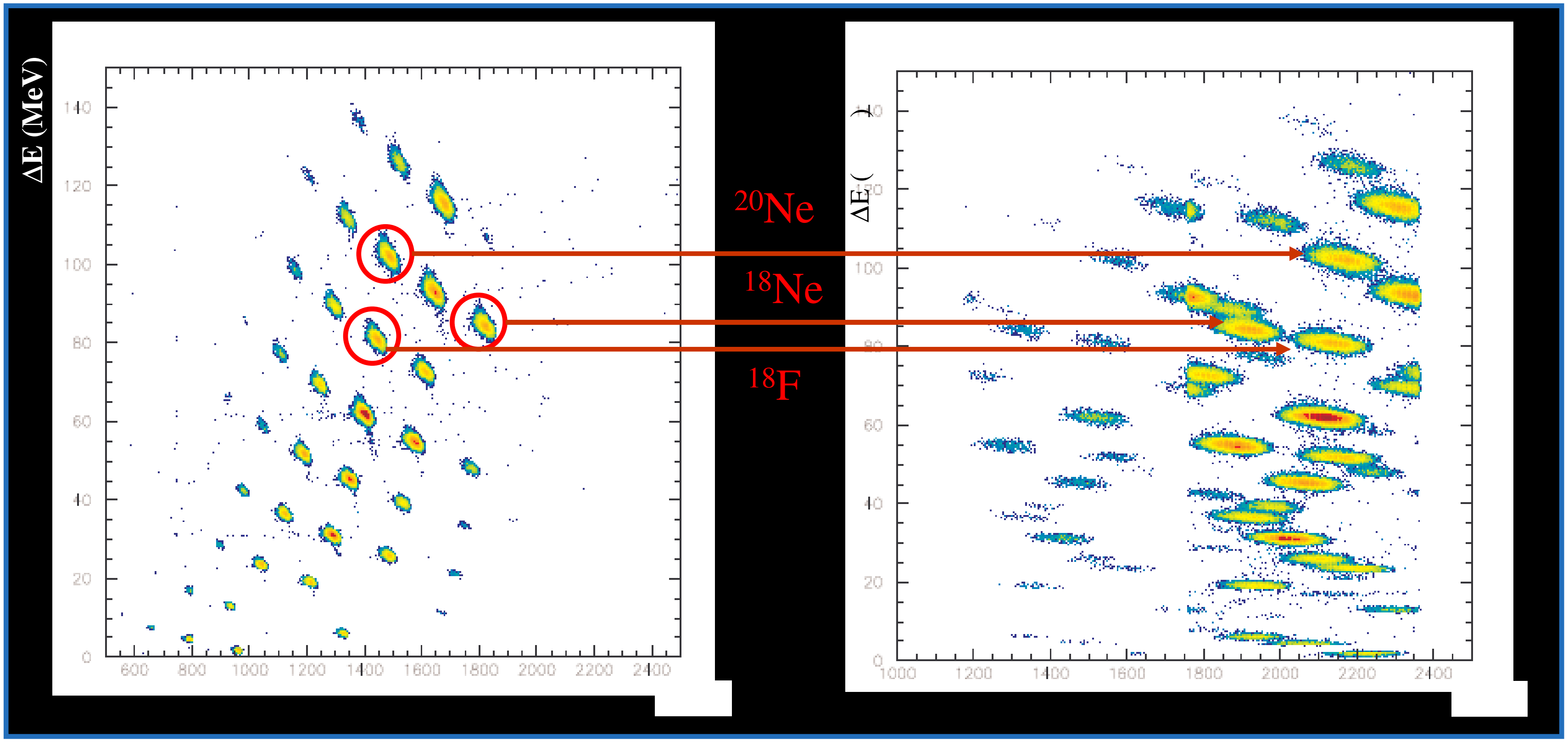
Now the detector is ready to accept such beams and also some work has been done to specialize the tagging system for the needs of CHIMERA

The UNSTABLE proposal was accepted for 30 BTU by the 2008 PAC to study transfer and pick-up reactions in the region of ^{11}Be.

I will briefly speaks about these items and about what we can do with improved beams

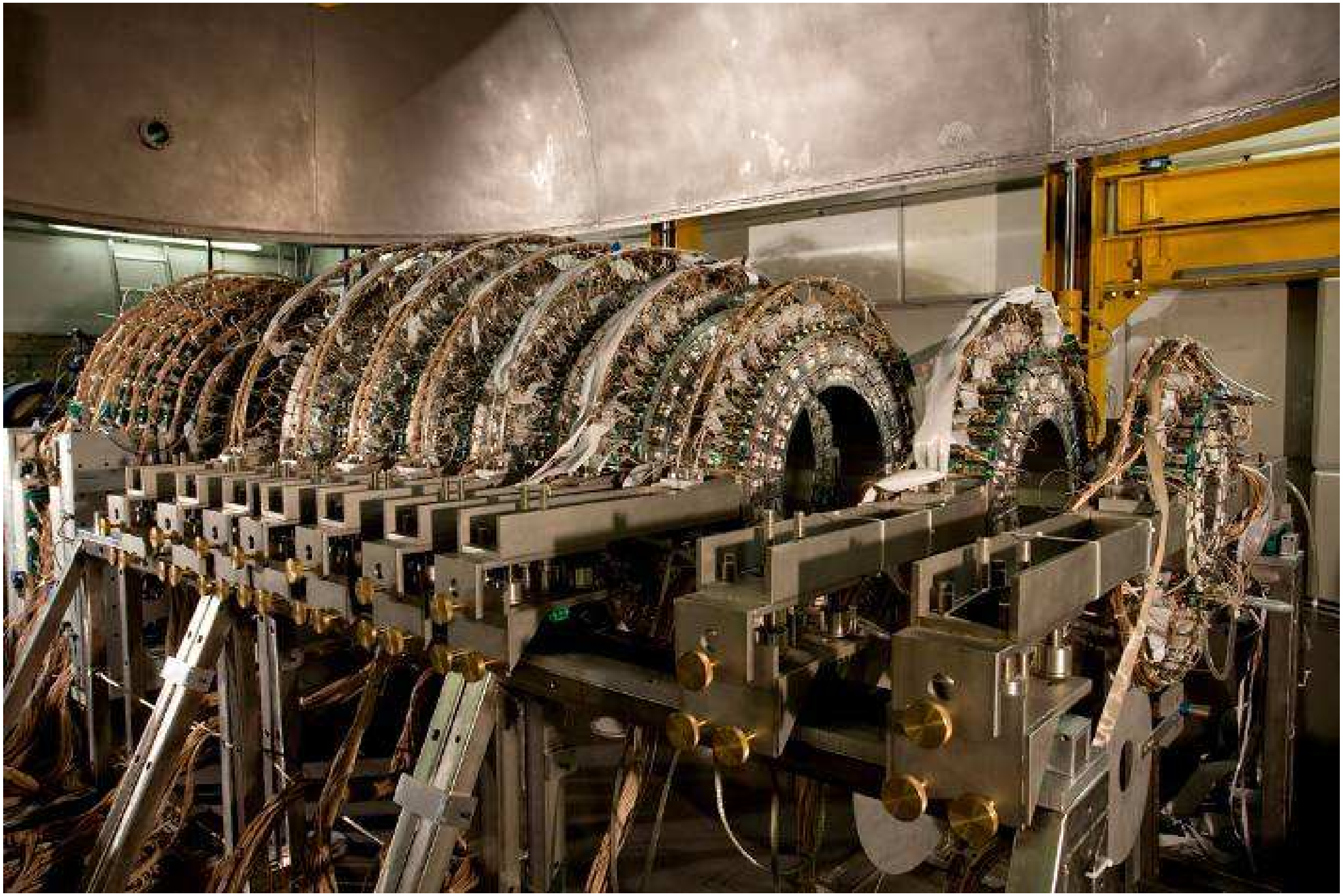
2006 -Transmission test of FRIBS beams to CHIMERA hall

45 MeV/A ^{20}Ne on ^{9}Be (500 μm).
Fragments identified by a standard CHIMERA detector (300 μm Si+CsI)



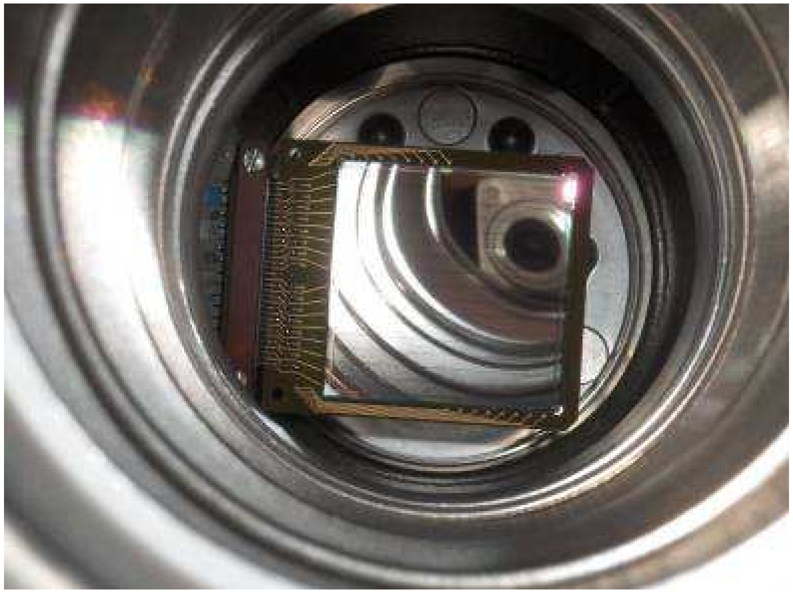
Good resolution and identification obtained - Transmission efficiency ~50% of the produced fragments

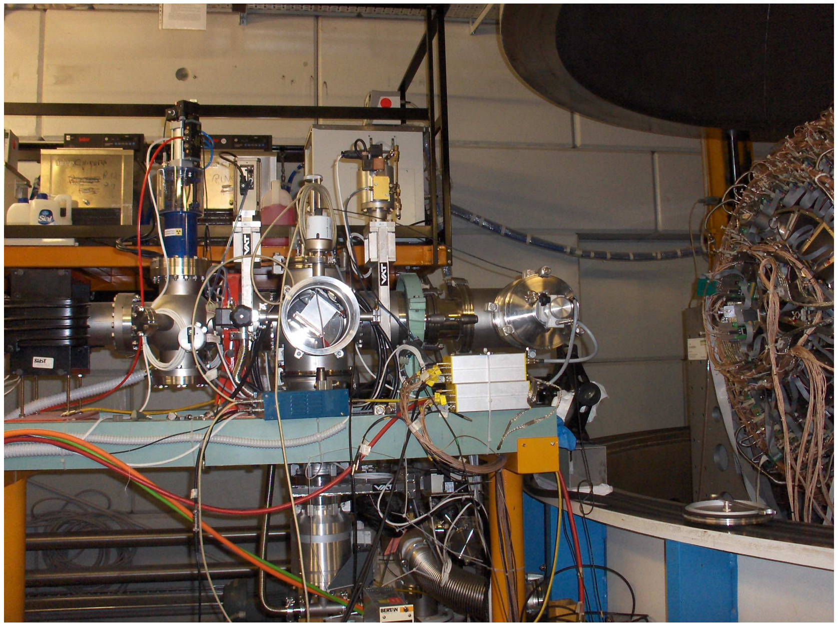
The previous result produced a lot of work from September 2007 until May 2008 to mount CHIMERA in the new scattering chamber – for lack of time I show you only the final result



We decided to specialize the tagging detector for the use with CHIMERA

To reduce the amount of reactions on the tagging detector we decided to use a thinner strip detector, 140 μm for the first test - we will try also 65 micron in future

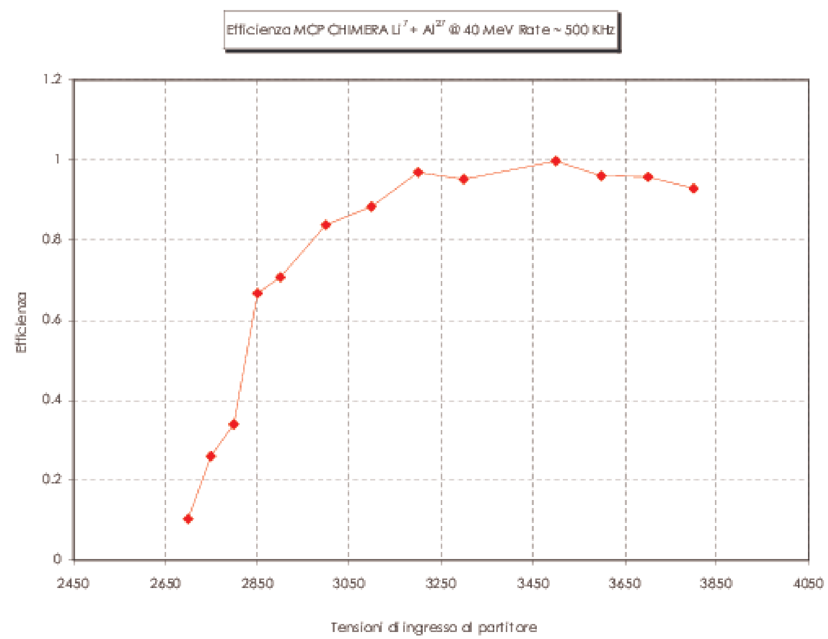




The detector is mounted along the beam line at the entrance of the CHIMERA scattering chamber – The SPHERE act as a natural collimator for particles scattered by the strip – only detectors of ring 1 can be irradiated by such particles – Therefore we can easily discriminate reactions on target from the reactions on tagging detector

We decided to complete our tagging system with a start detector to measure the time of flight independently from the RF of the cyclotron - the choice was a large size MCP

We know that we can work with MCP with a very high rate, with tandem beams (^{7}Li at 54 MeV) we have measured approximately 100% efficiency with a beam of 10^{6} p/s with a small size MCP detector that we will use for the tagging of EXCYT beams



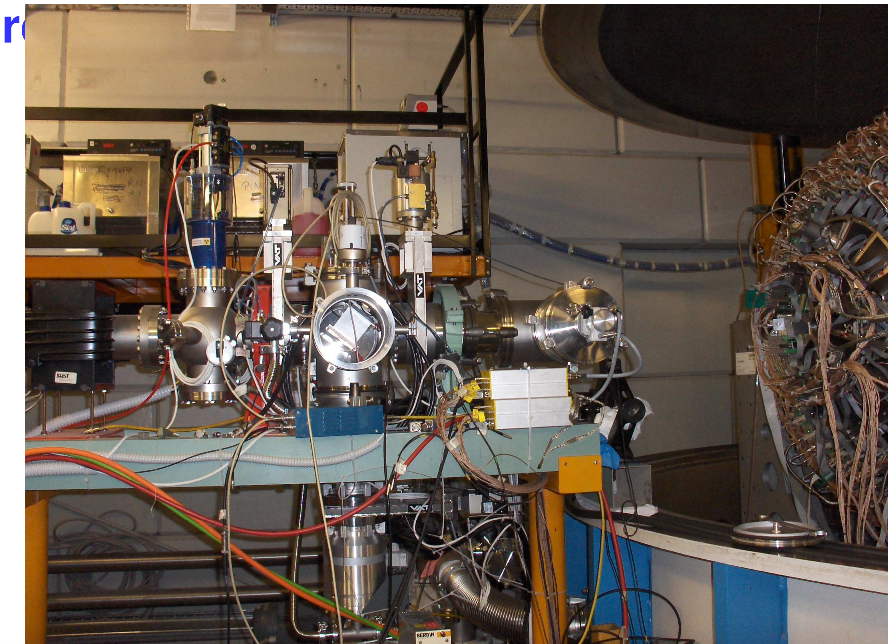
Moreover in 2006 we measured 80% efficiency with another MCP system also at 10^{6} p/s with 36Ar beam 40 MeV/A (TREQIS experiment)

We then built a large size (40*60 mm^2) MCP detector

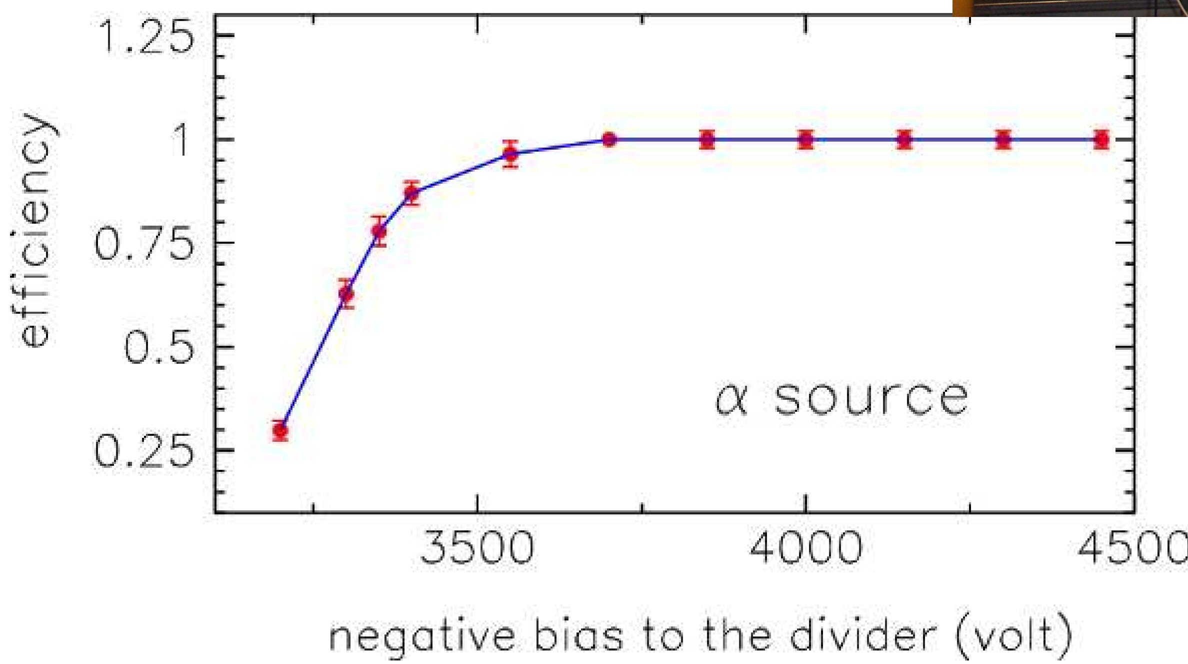
It is mounted 12.9 m far from the ΔE strip tagging detector along the beam line

We use an aluminized mylar foil of 2 μm with LiF evaporated on one side to generate electrons with high efficiency

The performances of MCP and strip detectors where first verified with alpha sour

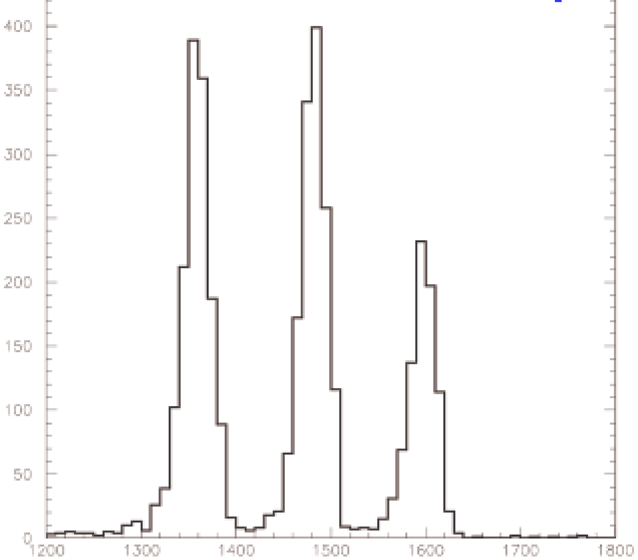


We measured the efficiency of MCP by looking at coincidences with the silicon strip. They were mounted inside the beam line before the CHIMERA scattering chamber at a distance of about 50 cm one from the other

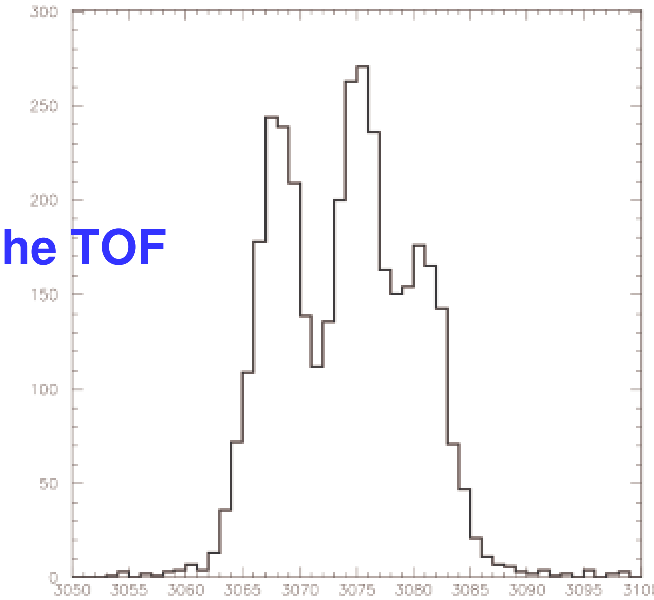


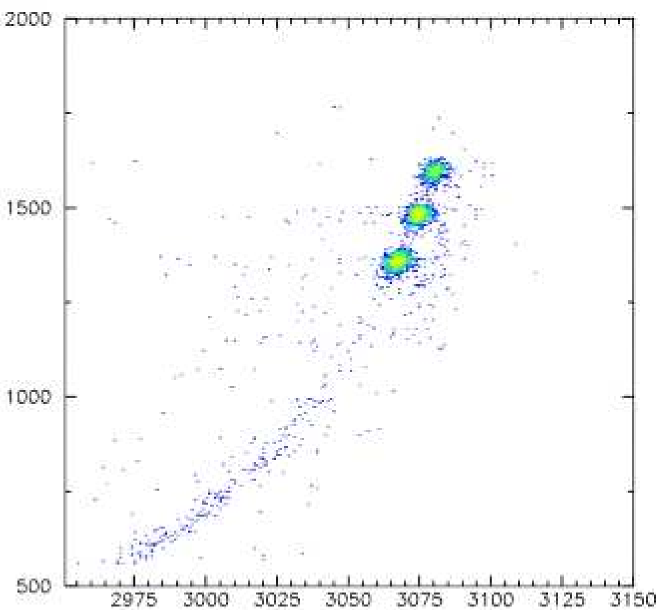
A good efficiency was observed after evaporation of LiF on the mylar foil

This is the energy spectrum measured on one strip



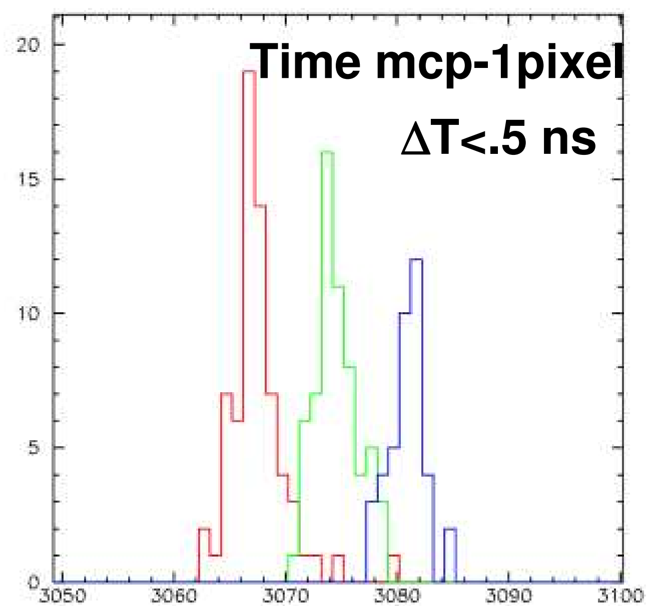
And this is the TOF





You can see the good behavior of TOF

And you can better appreciate it When you select only a pixel of the strip



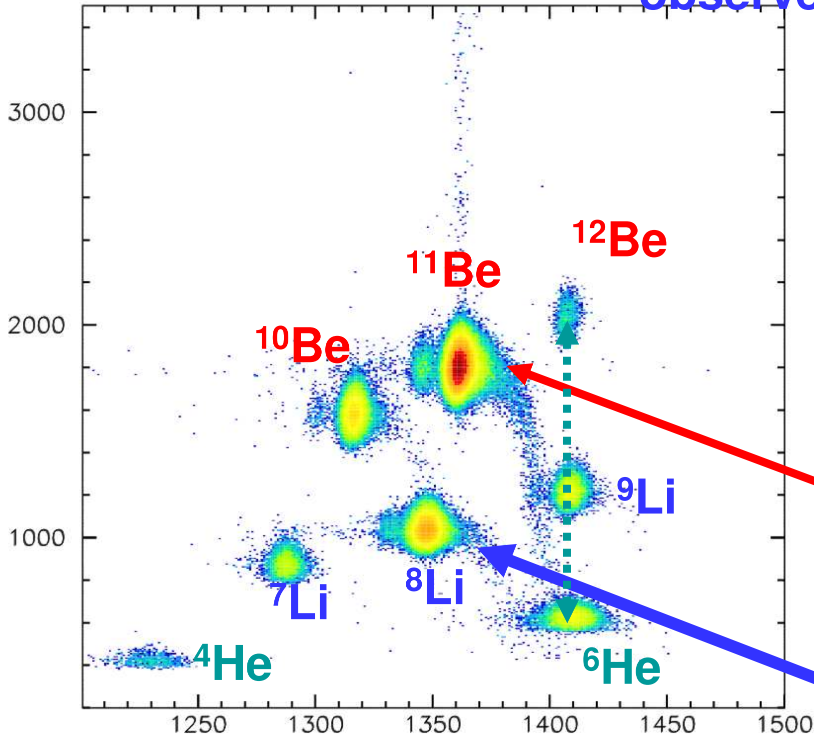
The test on-beam was performed at beginning of March – We tested the production of ions in the region of ^{11}Be necessary for the experiment UNSTABLE that we will perform at the end of July

To produce such beam we use a primary ^{13}C beam 55 MeV/A impinging on a ^{9}Be target 1.5mm thick

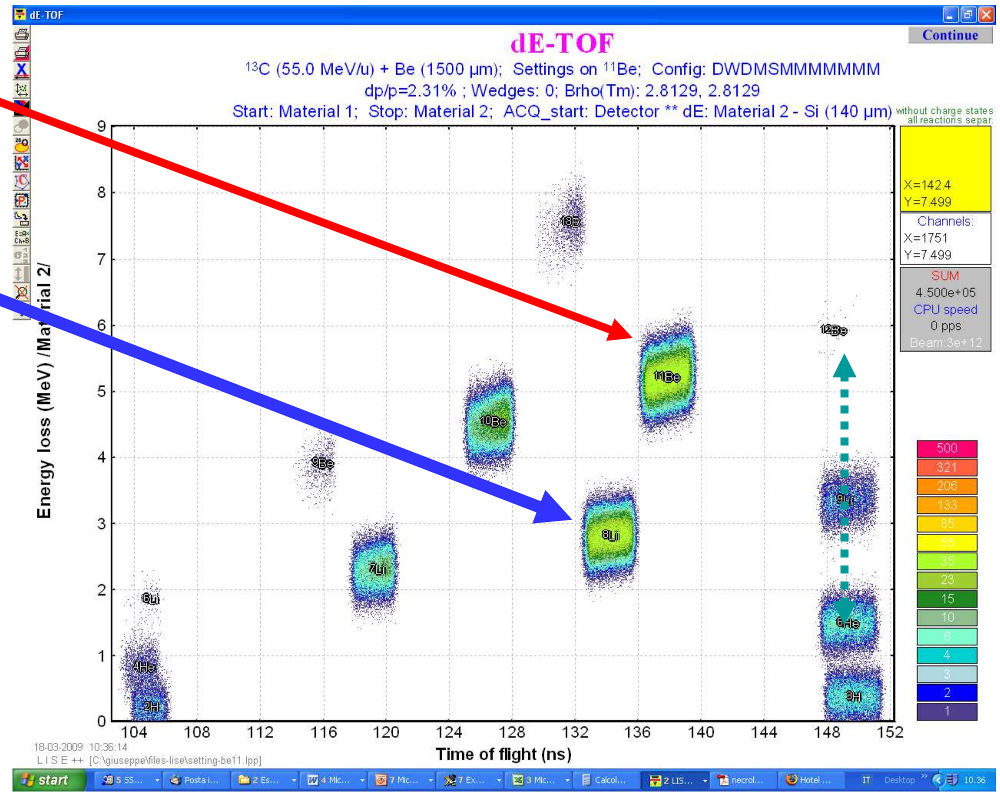
In the future, as you heard from Cosentino, some detectors to monitor the beam transport will be implemented – However for this test we had to use a pilot beam with the same magnetic rigidity of the requested radioactive beam

It is quite difficult and sometime impossible to have a pilot beam for a neutron rich beam however this was a lucky case and the pilote beam of ^{11}Be is the $^{13}C^{5+}$ primary beam itself – We started selecting this beam and after we scaled all dipole magnetic fields to search for different beams

This is the ΔE-Tof scatter plot we were able to obtain - we measured a transmission around 50%, on the CHIMERA scattering chamber, respect to what is observed in the FRIBS point

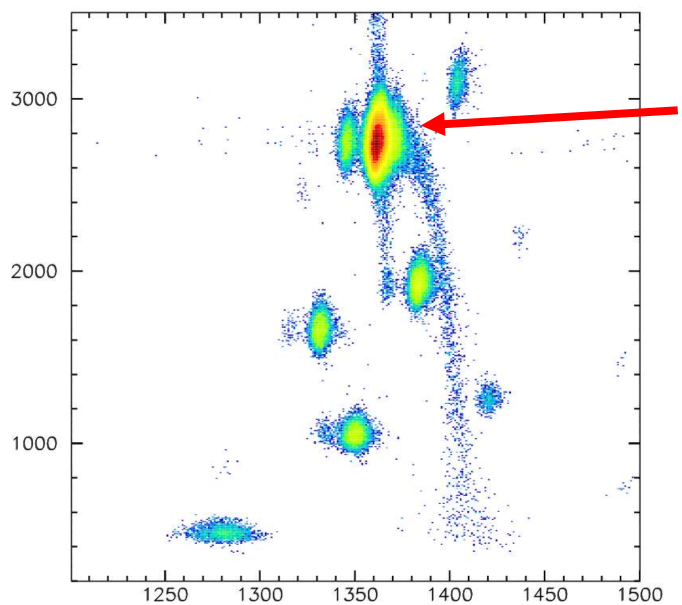


The identification of the particles can be obtained doing a comparison with LISE predictions and can be further confirmed using the TOF and energy calibration



The ^{11}Be was about 50% of the total beam transported on the CHIMERA chamber - with 80 nA from the cyclotron we get a yield of about 1.6 kHz of ^{11}Be – we emphasize that only 50 nA were measured before the ^{9}Be target

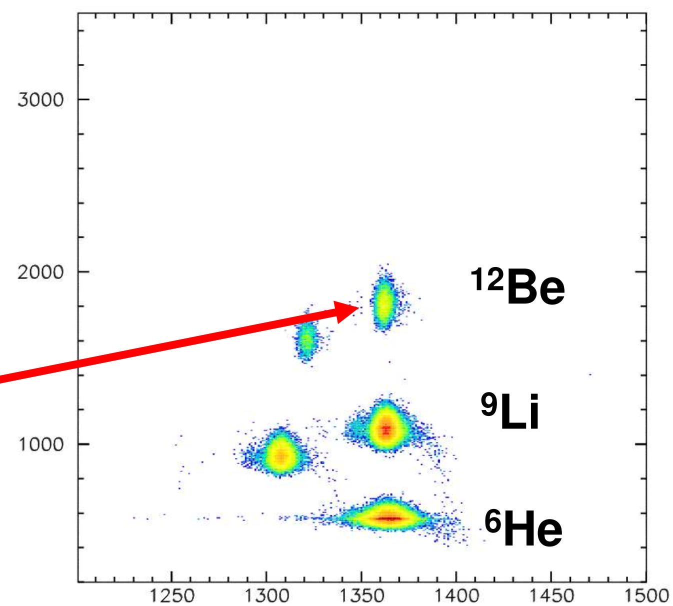
Another very interesting case was obtained setting the magnets to transport the ^{12}B beam – all currents were scaled by -13% - no scaling was done for the quadrupoles



We obtained a relatively pure beam (>85%) and a very high rate – about 8.4 kHz of ^{12}B with 120 nA of beam exctracted from the Cyclotron (only 90 nA before the target)

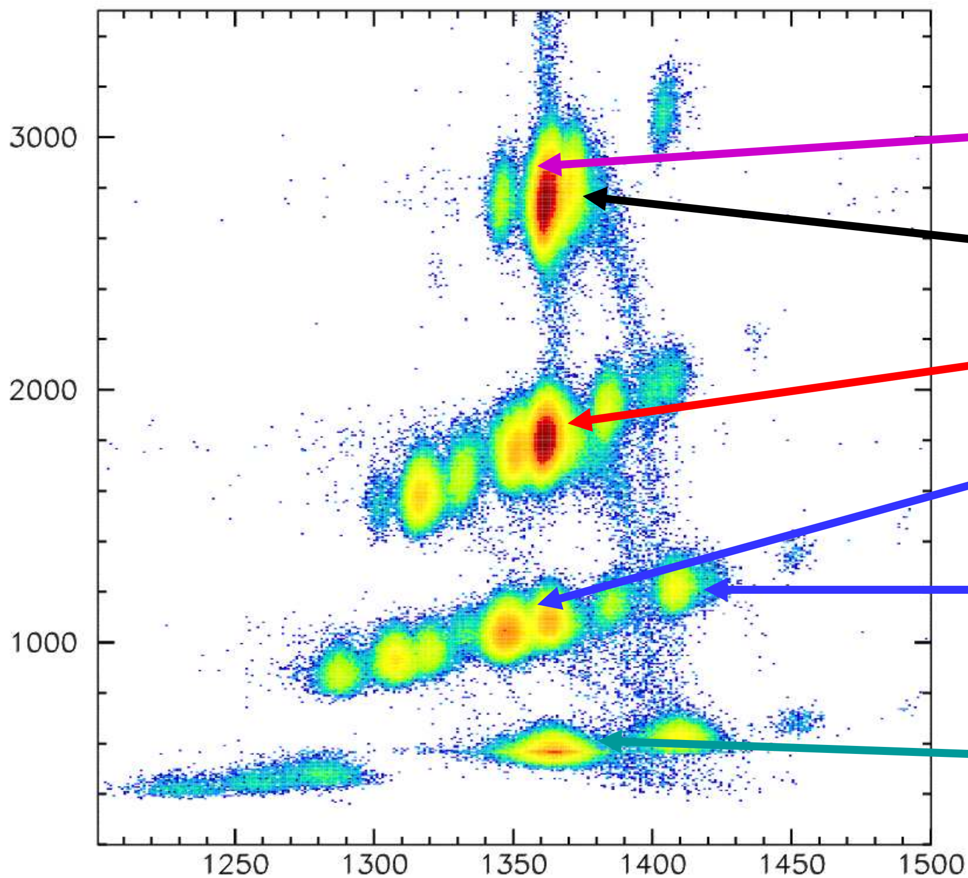
So current for ^{12}B could be at least a factor 2 using a good beam monitor system and increasing the cyclotron current we can go near 10^5 p/s

This was the beam obtained with a setting for ^{12}Be
The rate was low – 15 Hz with 140 nA primary beam – a factor 3 more current was obtained scaling also quadrupoles in this case



Global results

These were all the beams produced using various settings with different Bρ predicted by LISE to maximize 11Be -12Be – 12B -13B



12B 8.3 kHz (80%) - 70Hz/nA - setting not optimized

13B 0.1 Hz (i=20nA) (20%) 5Hz/nA Not Opt.

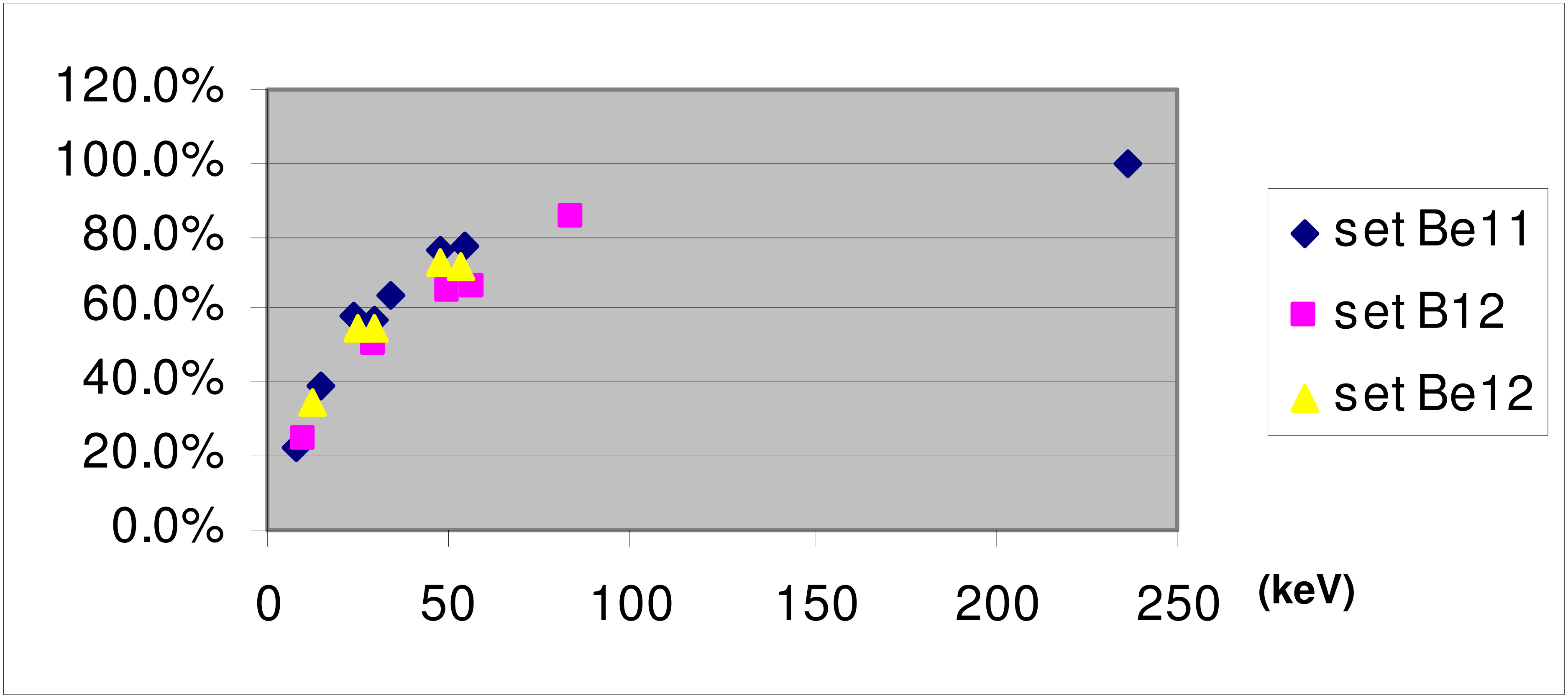
11Be 1.6 kHz (55%) - 20Hz/nA (5+)

8Li 0.6 kHz (21%) - 8Hz/nA (setting be11)

9Li 0.2 kHz (30%) - 1Hz/nA setting be12 Not Opt.

6He 0.3kHz (50%) – 2Hz/nA setting be12 Not Opt.

Going back to the behavior of our MCP - In this first test, we used a quite high threshold, to be sure of its timing - we have observed an efficiency that strongly depend from the energy loss in the mylar foil



We note that the MCP efficiency is smaller for the settings obtained scaling the dipole currents probably due the poor transport

What we will study with such beams?

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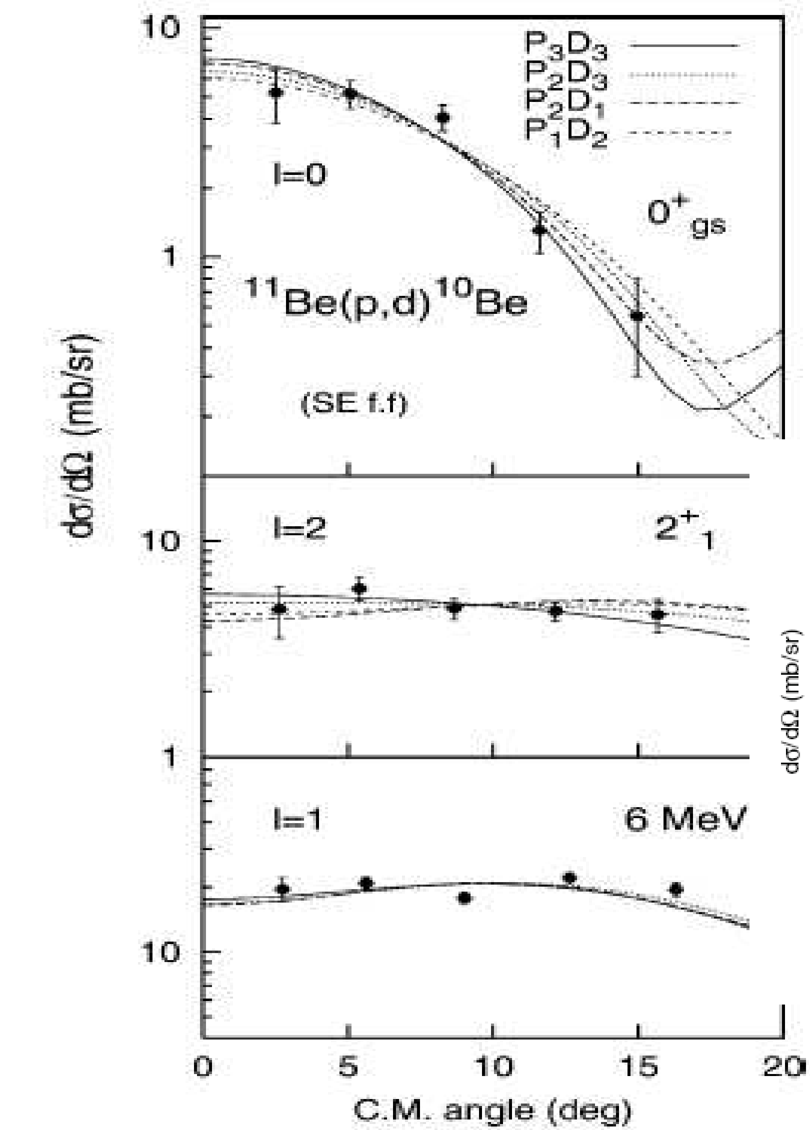
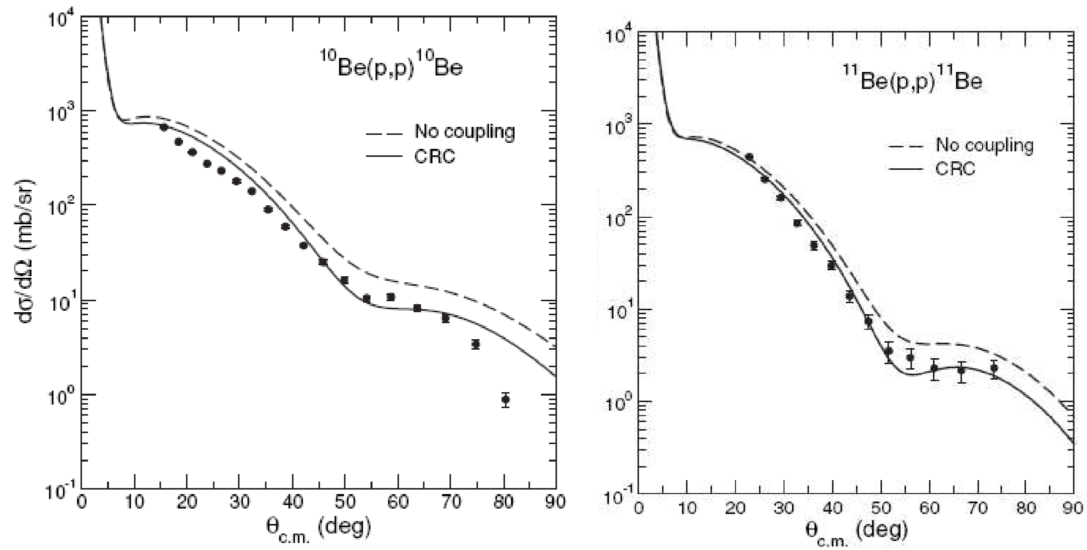


Using both p and d target, we'll be able to measure elastic scattering - transfer/breakup reactions with all the other fragments produced together, for instance: $^{10}Be(d,p)^{11}Be$ - $^{13}B(p,^{3}He)^{11}Be$ - $^{12}B(d,^{3}He)^{11}Be$



40 MeV/A

N. Keeley* and V. Lapoux

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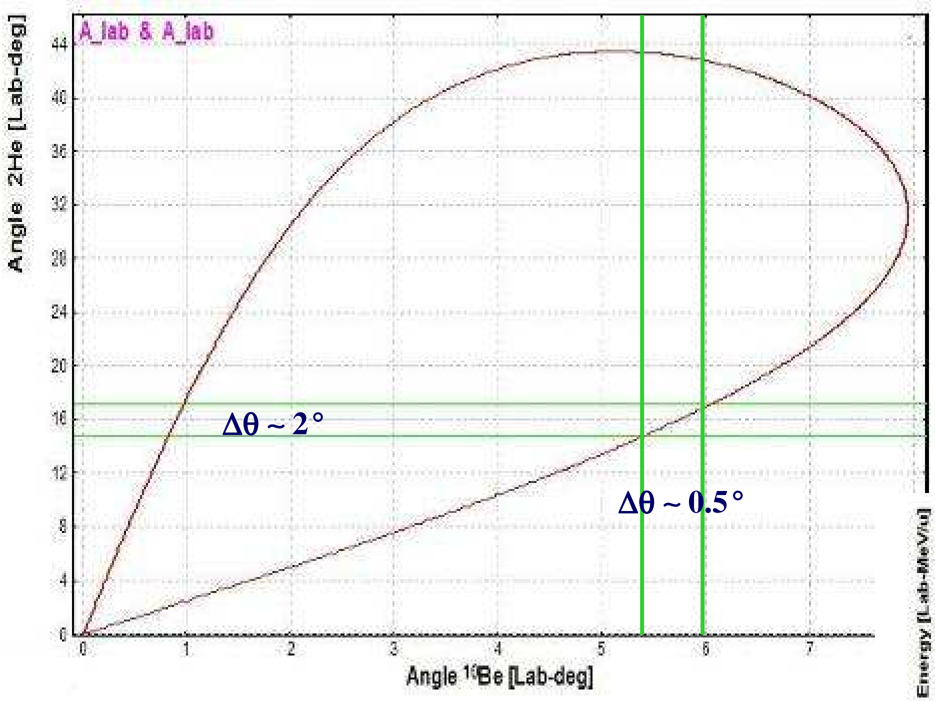
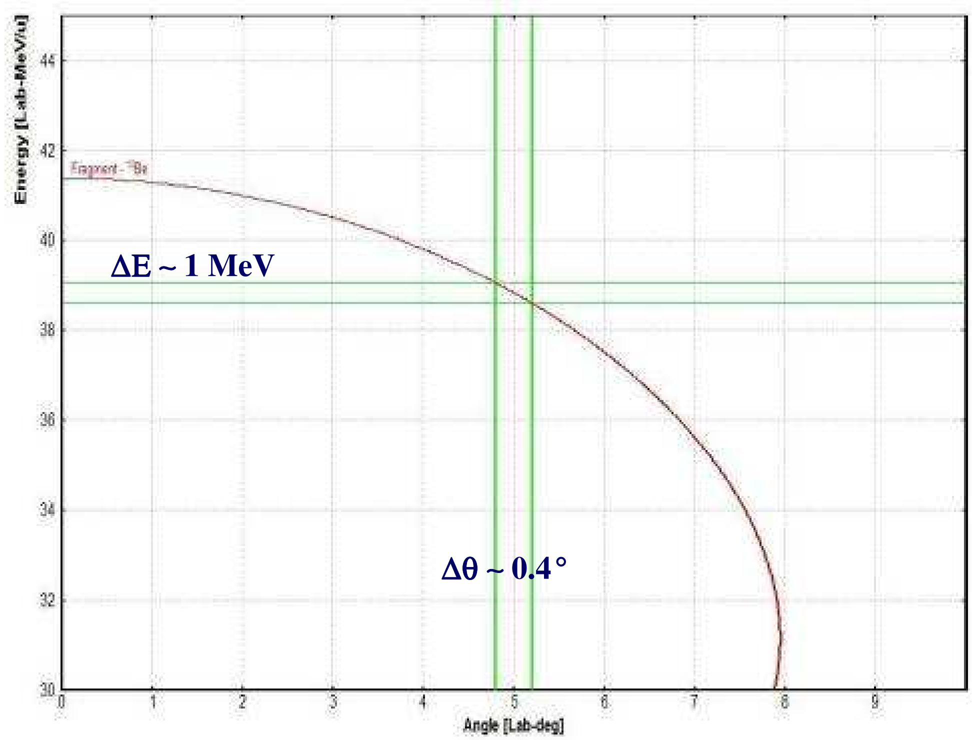
Advantages of using CHIMERA



CHIMERA offers a full coverage of the solid angle with an angular resolution of ~1° on most forward angles

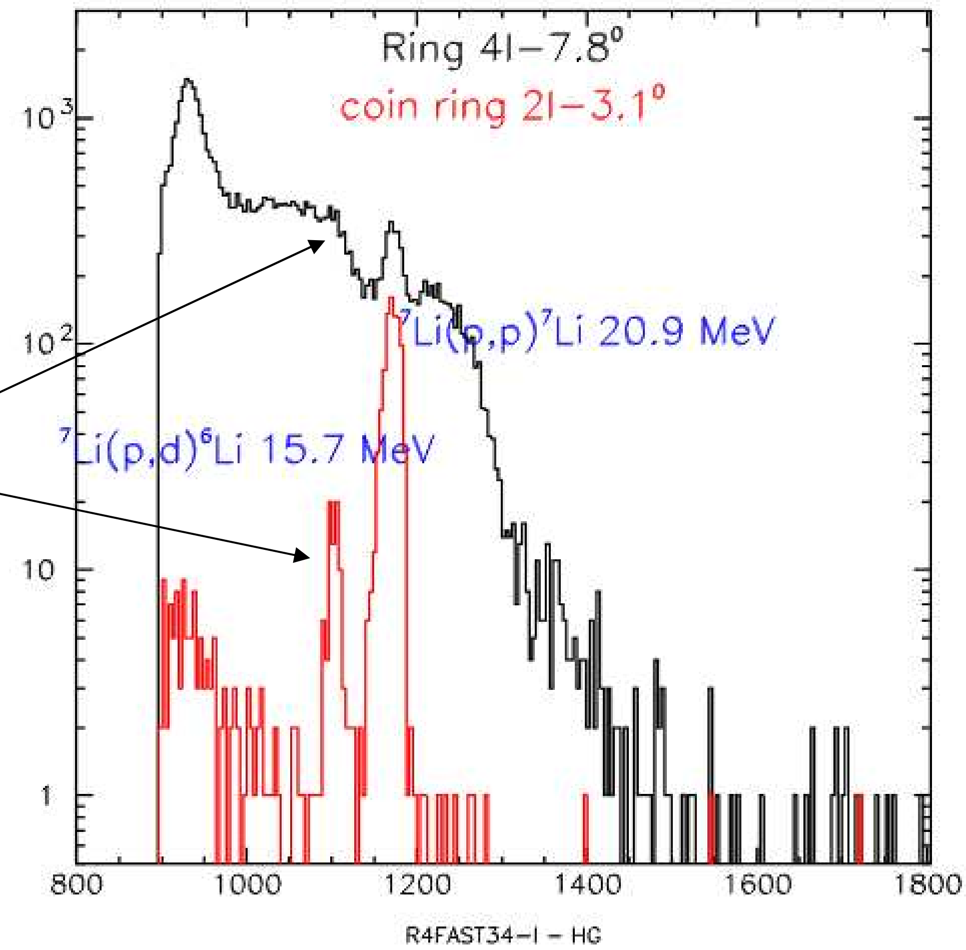
The possibility to detect all the reaction products allows kinematical coincidence measurements

Angular measurements can be refined also selecting as narrow energy windows as the energy resolution – a good timing of the tagging system is fundamental to measure the beam energy



Goodness of kinematical coincidences

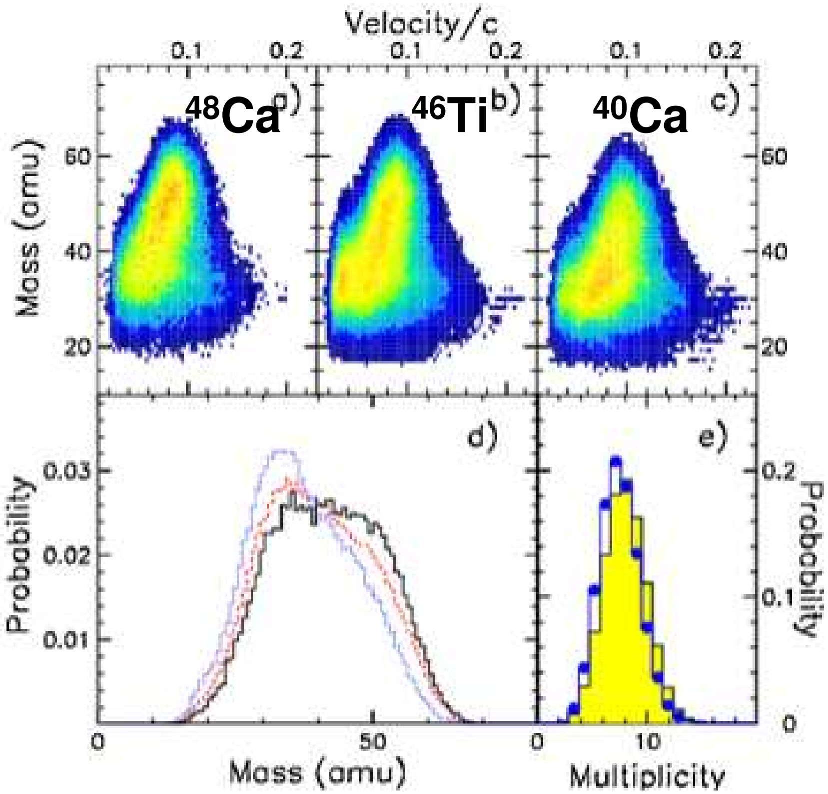
Kinematical coincidences enable us to well measure peaks covered by background as the d peak in this spectrum



Do we need higher current?

Obviously yes

With present configuration we can get 10^4 ^{11}Be/s but only 100 Hz for ^{12}Be a factor 10 or more would allow measurements also on this nucleus
You have seen that we can produce also $^{9,8}Li$ – ^{6}He even if with intensities not too high - a factor 10 would allow the availability at LNS of $^{8,9}Li$ beams from 10 MeV with Excyt up to 40 MeV/A and also ^{11}Li would be available



F.Amorini et al PRL 102(2009)112701

With higher intensities we can also measure isospin dependence of reaction mechanisms - as also suggested by the presentation of C.Rizzo and as we have recently shown in reactions with ^{40}Ca beam at 25 MeV/A on various targets

thank you