Center for Isotopic Research on Cultural and Environmental heritage

INNOVA
CENTRO REGIONALE DI COMPETENZA PER LO SVILUPPO ED IL TRASFERIMENTO DELL'INNOVAZIONE APPLICATA AI BENI CULTURALI E AMBIENTALI

SECONDA UNIVERSITÀ DEGLI STUDI DI NAPOLI
SCUOLA POLITECNICA E DELLE SCIENZE DI BASE
DIPARTIMENTO DI MATEMATICA E FISICA

INFN
Istituto Nazionale di Fisica Nucleare

Absolute measurement of the $^{7}Be(p,\gamma)^{8}B$ cross section with the recoil separator ERNA

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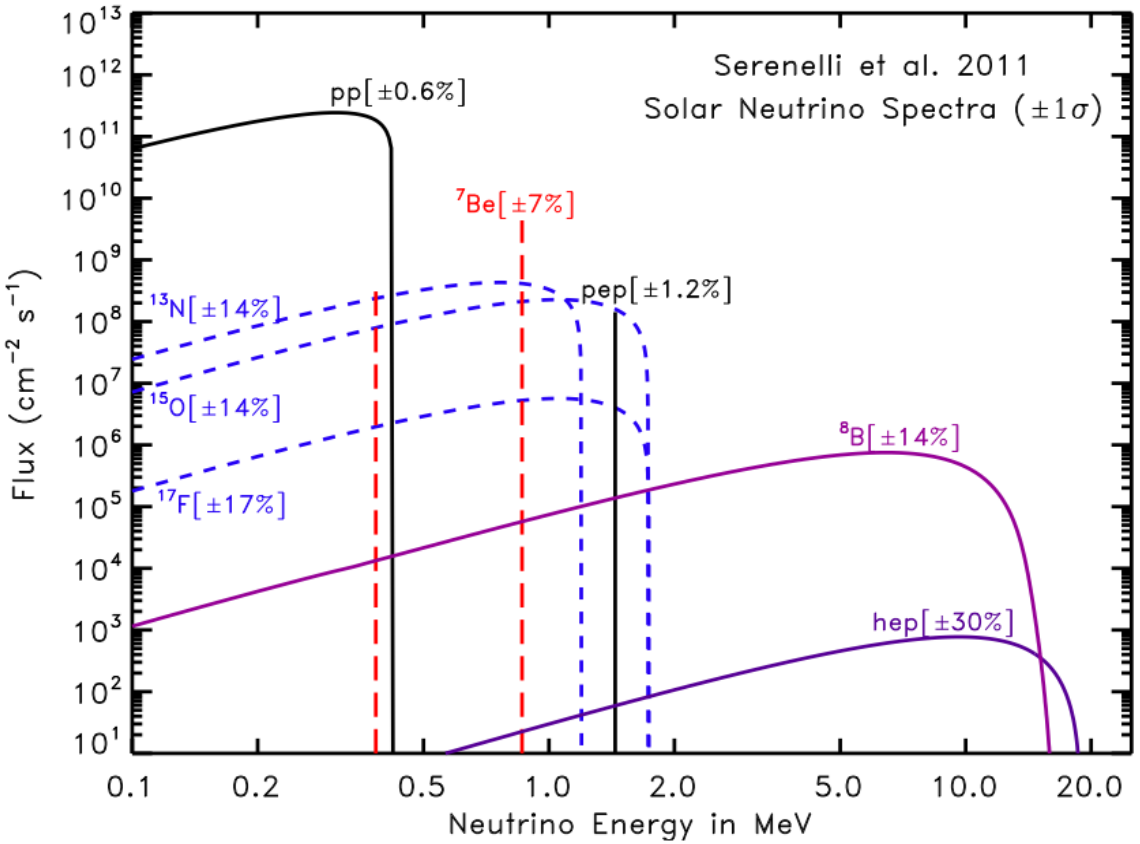
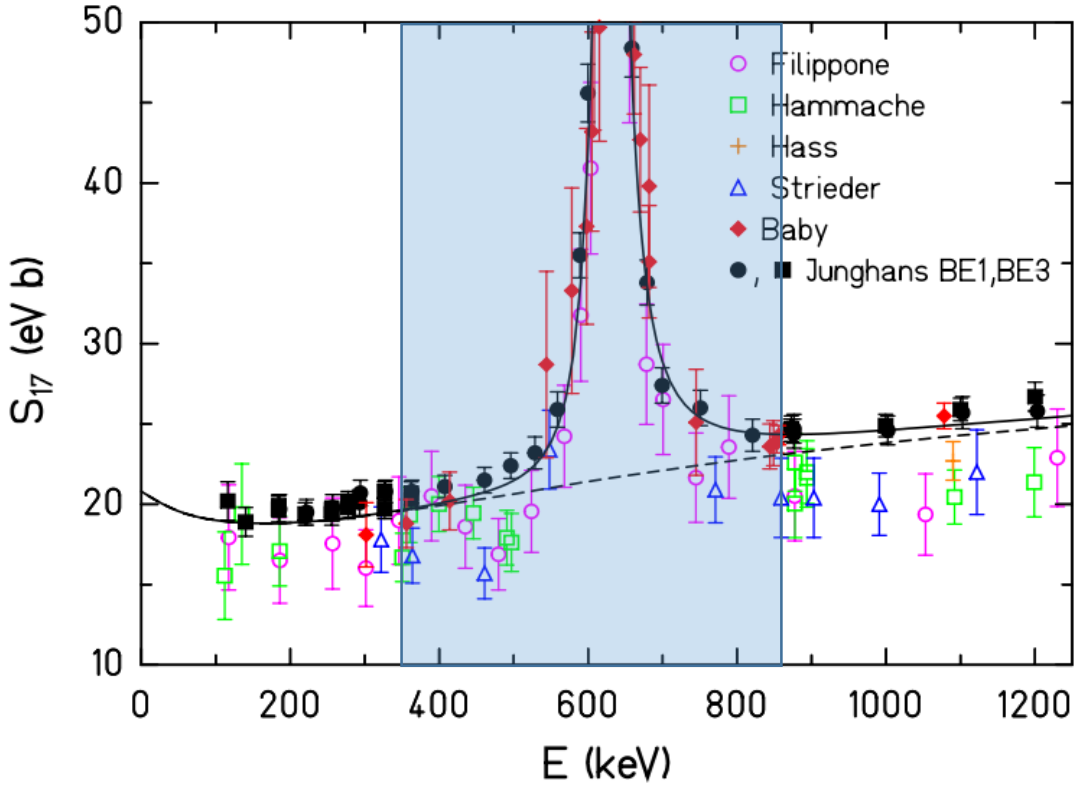
Why $^{7}Be(p,\gamma)^{8}B$?



Large uncertanty on the predicted solar neutrino flux.



Adelberger et al. 2011

Discrepancies between existing data sets limits the precision of the extrapolation to solar energy.

^{7}Be beam

ATOMKI
Cyclotron Laboratory.

^{7}Li pills → ^{7}Li(p,n)^{7}Be → ^{7}Li + ^{7}Be pills ≈9GBq

Radiochemical separation

CIRCE laboratory

Source
2mm cathodes

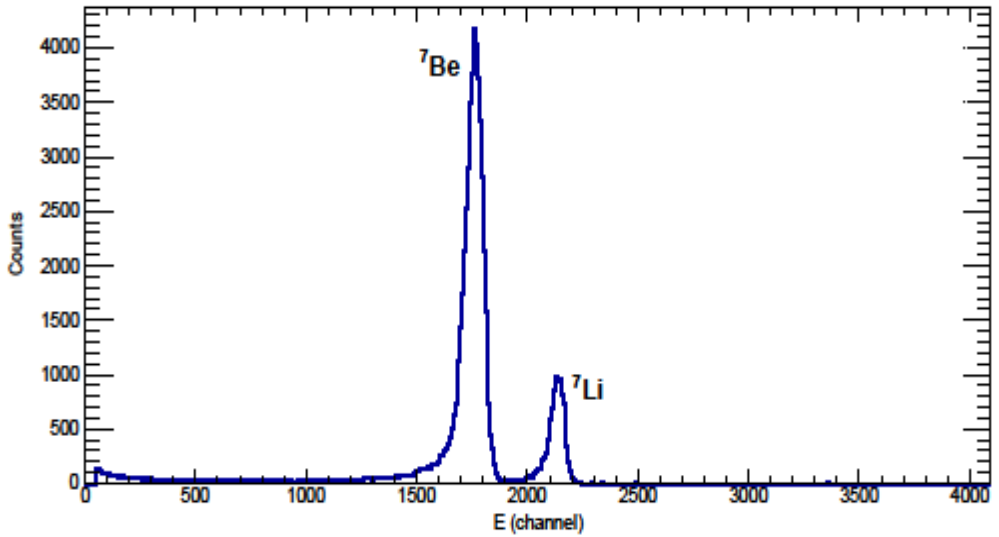
3x≈3GBq

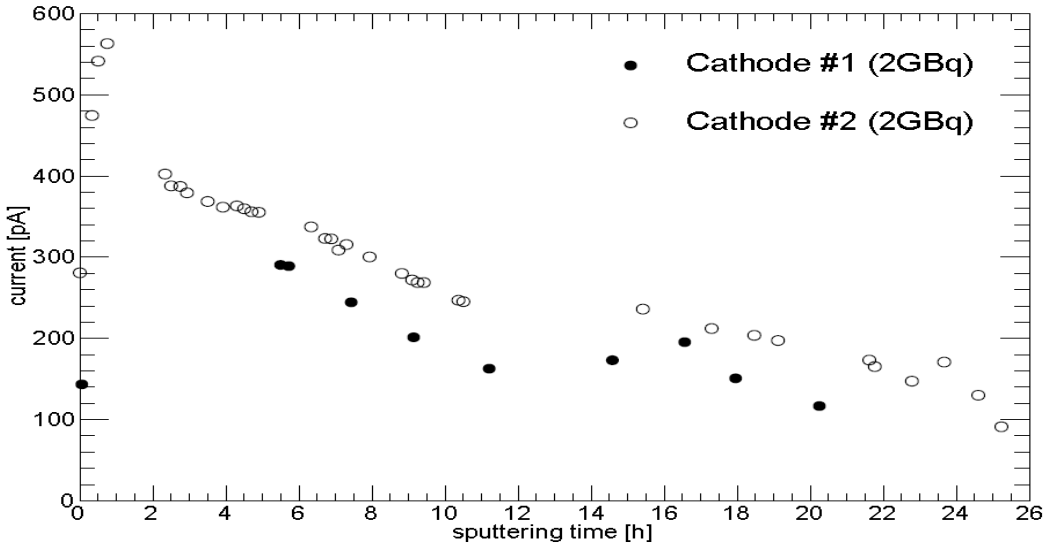
Test and mounting

SNICS-40
ions source.

Intensity up to 10^{9} pps.

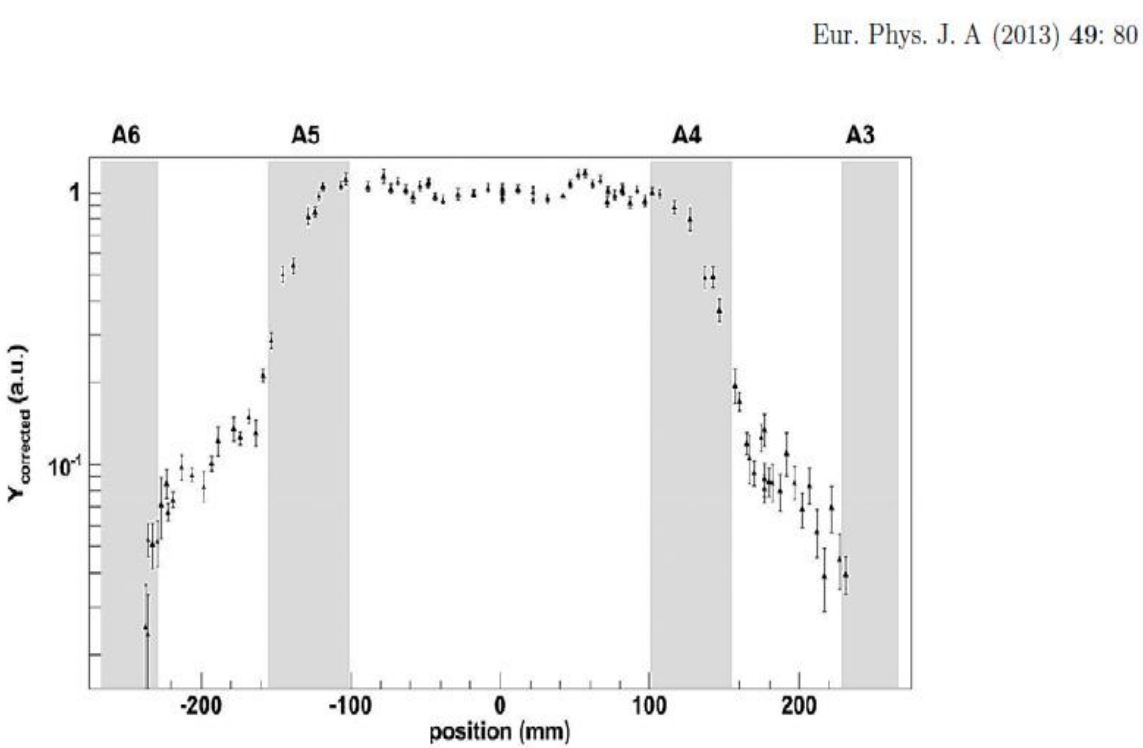
^{7}Be BEAM



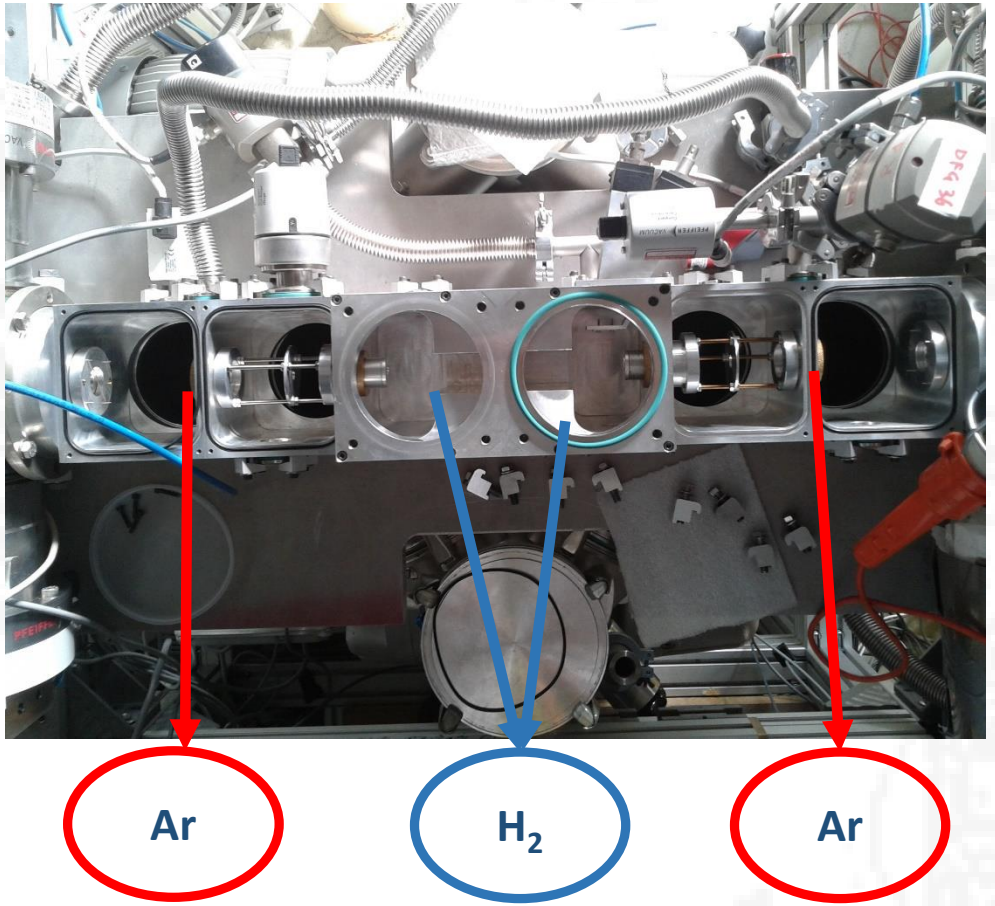


The number of incident projectiles, including lithium contamination, is monitored on line through elastic scattering.

Windowless gas target



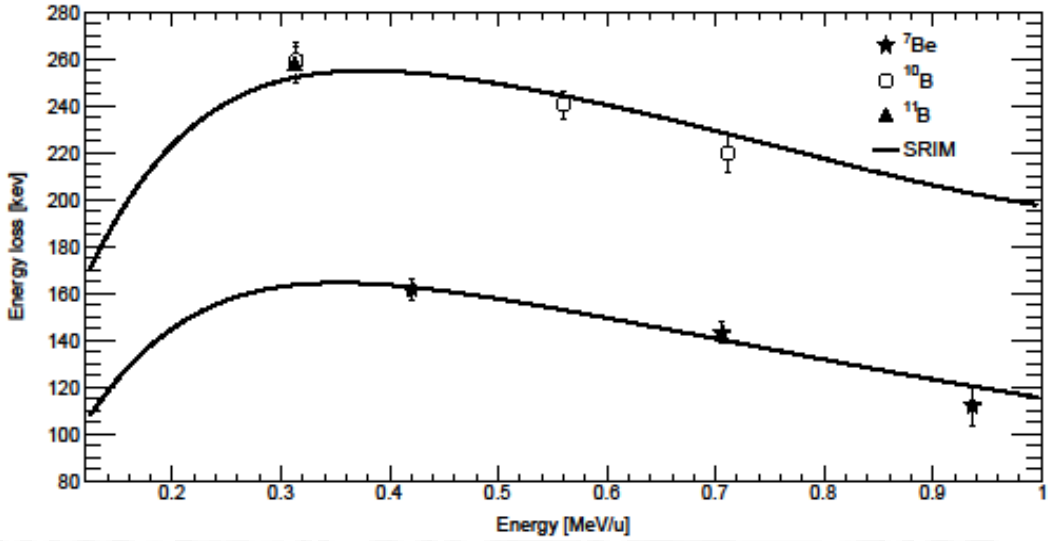
Density profile of the gas target as seen in the yield of the 478 keV γ-ray line from the $^{7}Li(p, p)^{7}Li$



Target density $n = 7.22 \pm 0.15 \cdot 10^{18}$ at/cm^2

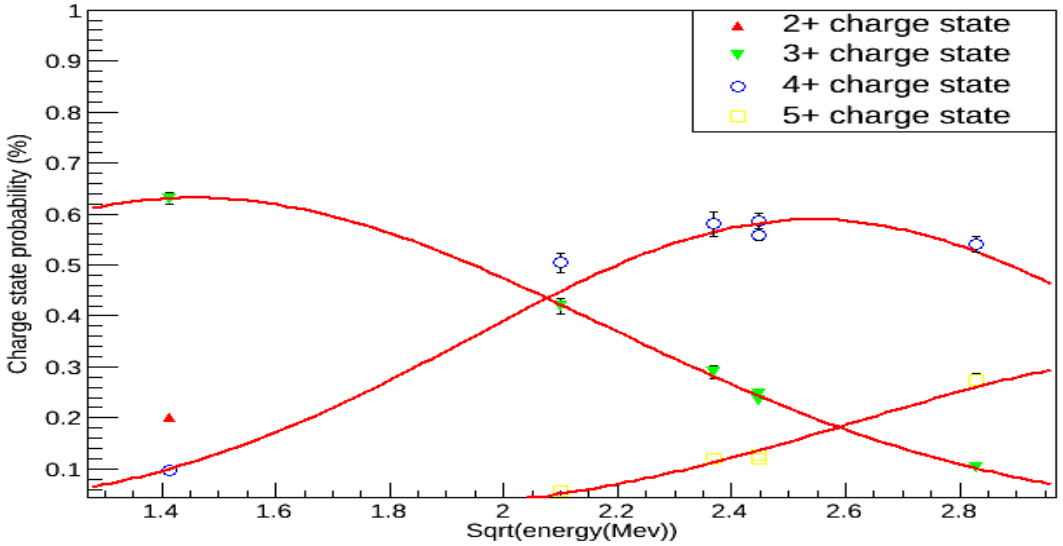
D. Schürmann et al., Eur. Phys. J. A (2013) **49**: 80

Energy loss measurements

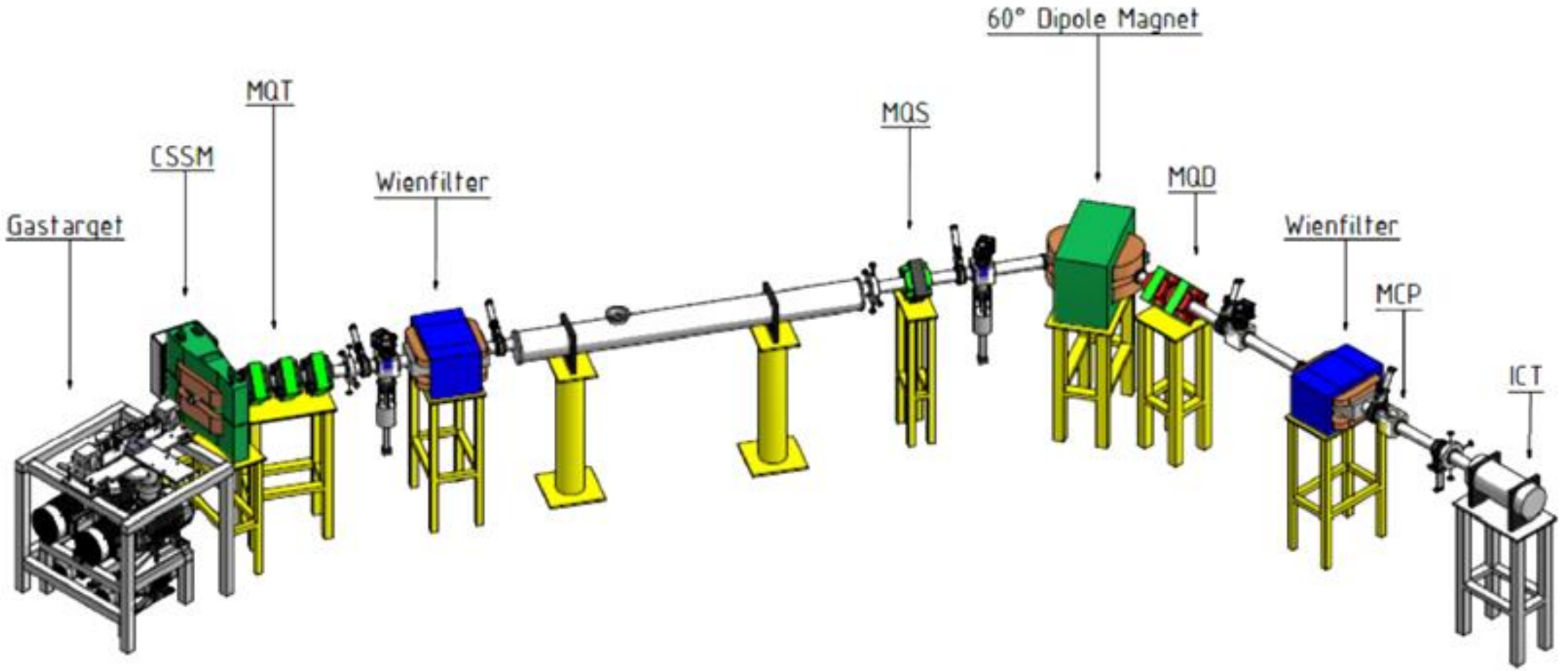


Energy loss of ^{7}Be projectiles and ^{8}B recoils in the target. Significant differences in absolute values are found with respect to SRIM (shown renormalized to data).

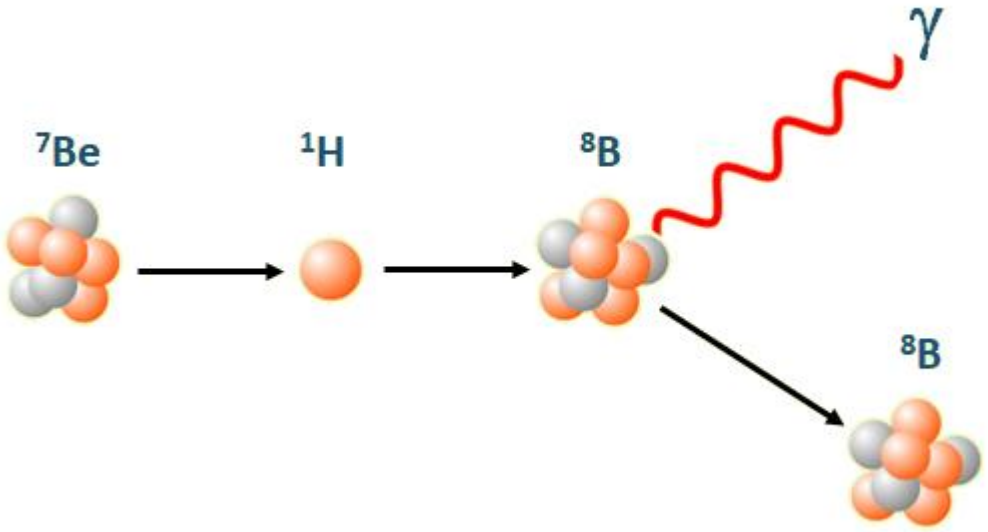
^{8}B charge state probability. The reaction yield measurements are performed selecting recoils in the 3+ charge state.



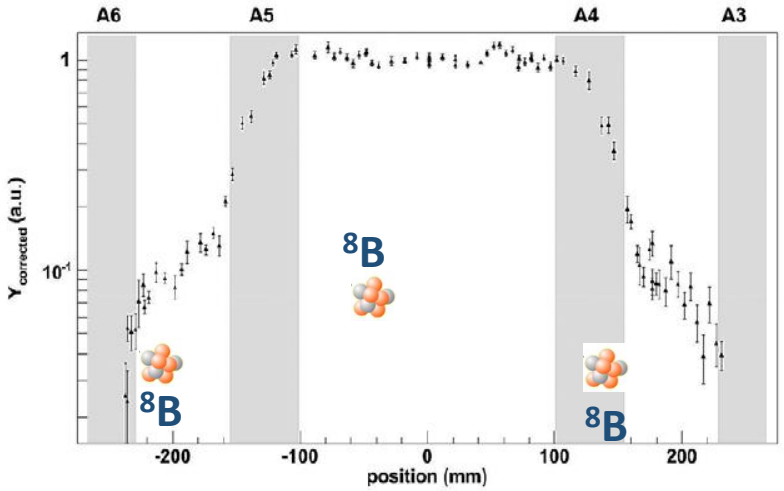
European Recoil mass separator for Nuclear Astrophysics (ERNA)



Recoils emittance



Eur. Phys. J. A (2013) 49: 80



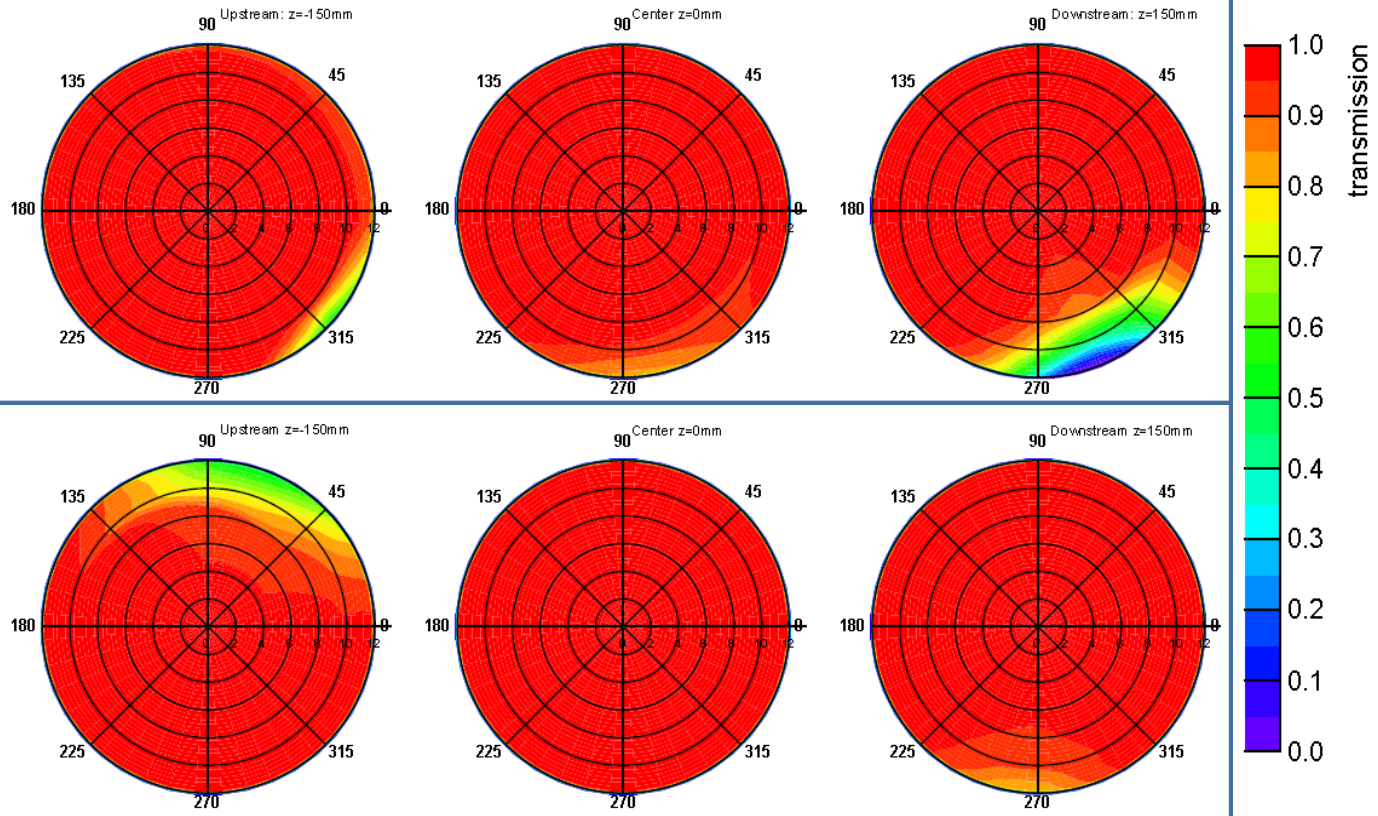
Recoils emittance is determined by reaction kinematics and straggling due to interaction with target gas.
E.g. at Ec.m.=350keV maximum angle is 12 mrad and energy broadening is 90 keV

The ^{8}B can be produced in different part along the gas target.

In all conditions 100% transmission to the end detector of the recoils in the selected charge state is mandatory.

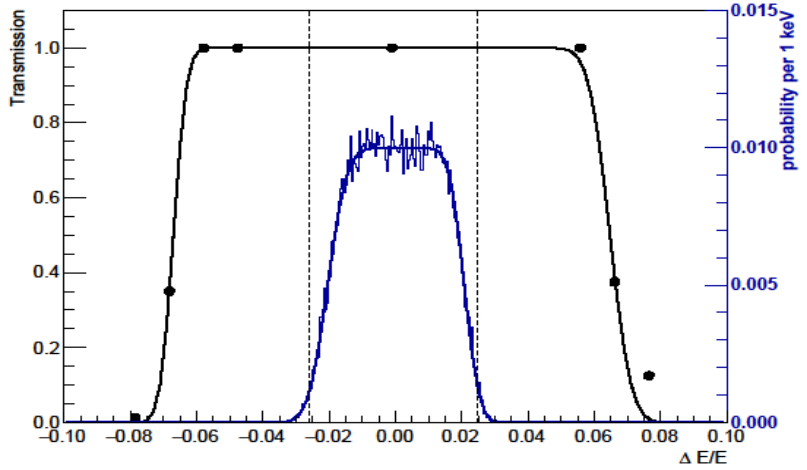
Recoils Acceptance

350 keV angular acceptance

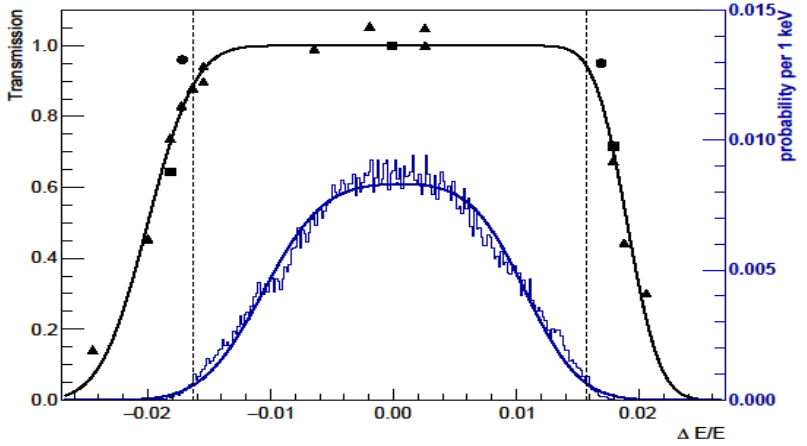


800 keV angular acceptance

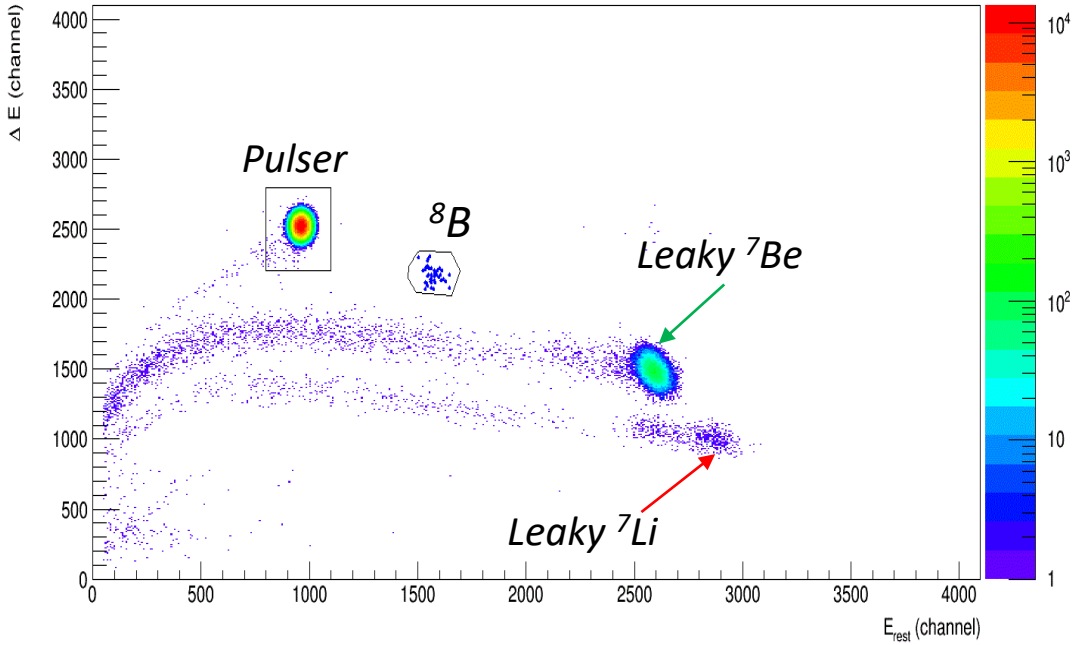
350 keV energy acceptance



800 keV energy acceptance

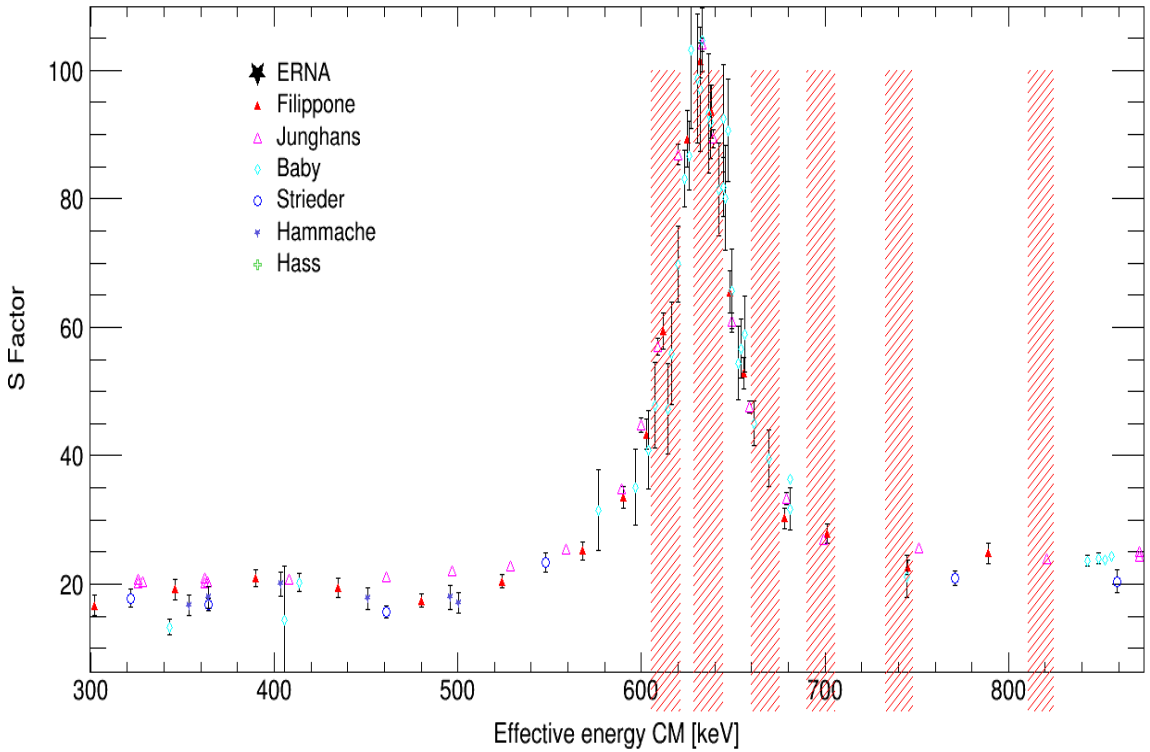


Preliminary results



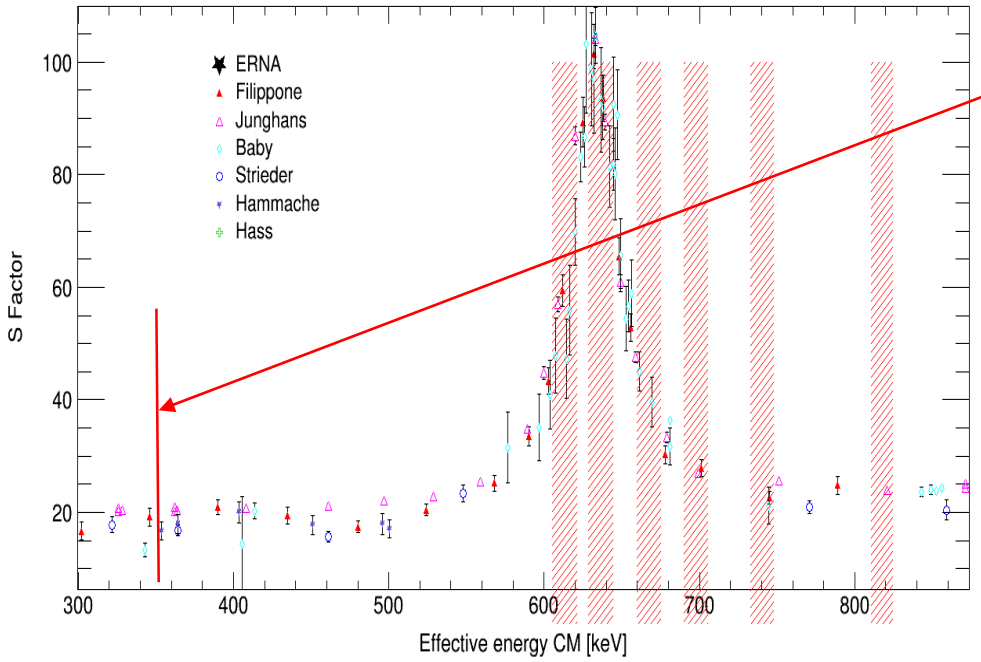
Typical ionization chamber telescope E-DE spectrum.
The 8B recoils are well separated from the leaky.

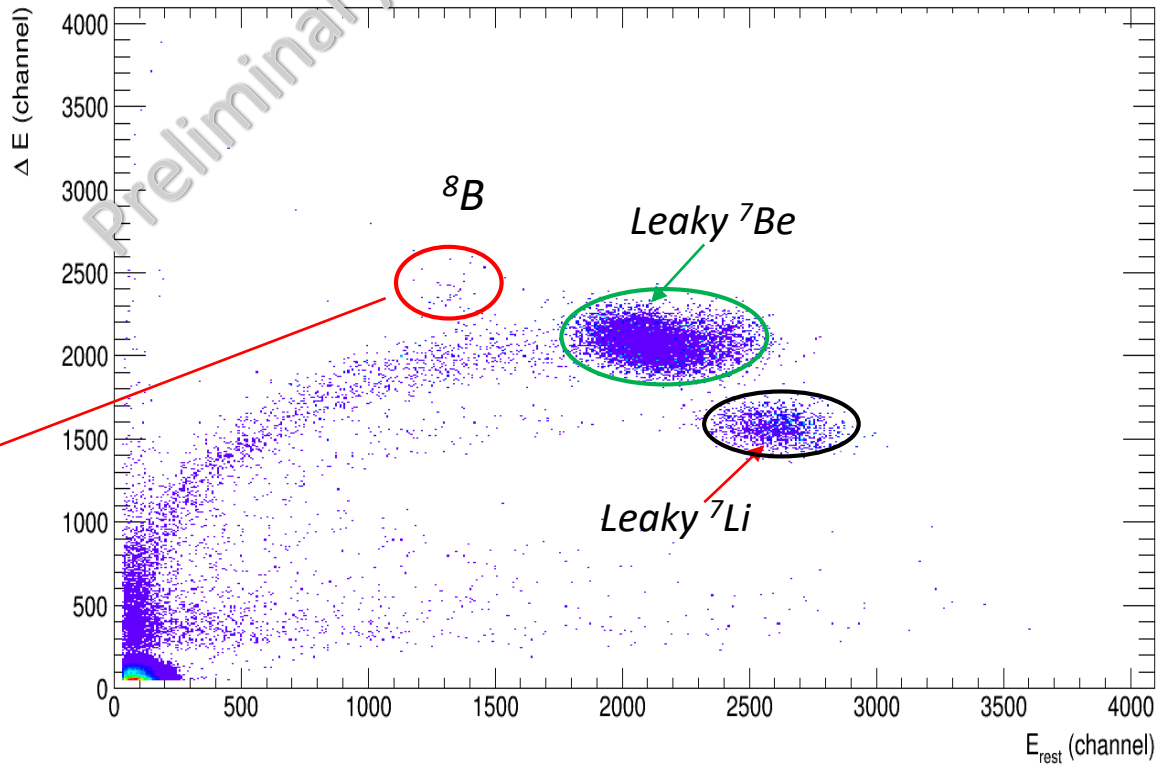
Comparison from the literature data and the energy range (corresponding to the energy loss in the H target) of the measurements already performed at E> 600keV center of mass effective energy.



Ec.m.= 350 keV measurement

Reaction yield measurement performed over 4 days of beam time, analysis ongoing.
The result will allow to evaluate the slope of the astrophysical S-factor.





E-ΔE spectrum with ionization chamber telescope. The ^8B recoil, in the red ellipse.

Conclusion

- A very intense ^{7}Be beam, up to 10^{9} pps, is routinely produced and characterized at CIRCE laboratory.
- The characterization of the extended gas target and the tunings of the separator has been completed at 800 keV, 600 keV and at 350 keV ;
- The measurements of absolute cross section, of the $^{7}Be(p,\gamma)^{8}B$ reaction trough the 629 keV resonance and up to the 800 keV has been performed.
- A new measurements at 350 keV has been performed, and the analysis data is ongoing;
- The preliminary results of the data after the 629 keV resonance up to 800 keV shown a better accord with the data sets with high value;
- The analysis of the data can be completed in the next months, including the 350 keV point, and the impact in the extrapolation of the astrophysical factor will be evaluated.

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Thanks

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