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

Istituto Nazionale di Fisica Nucleare

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

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

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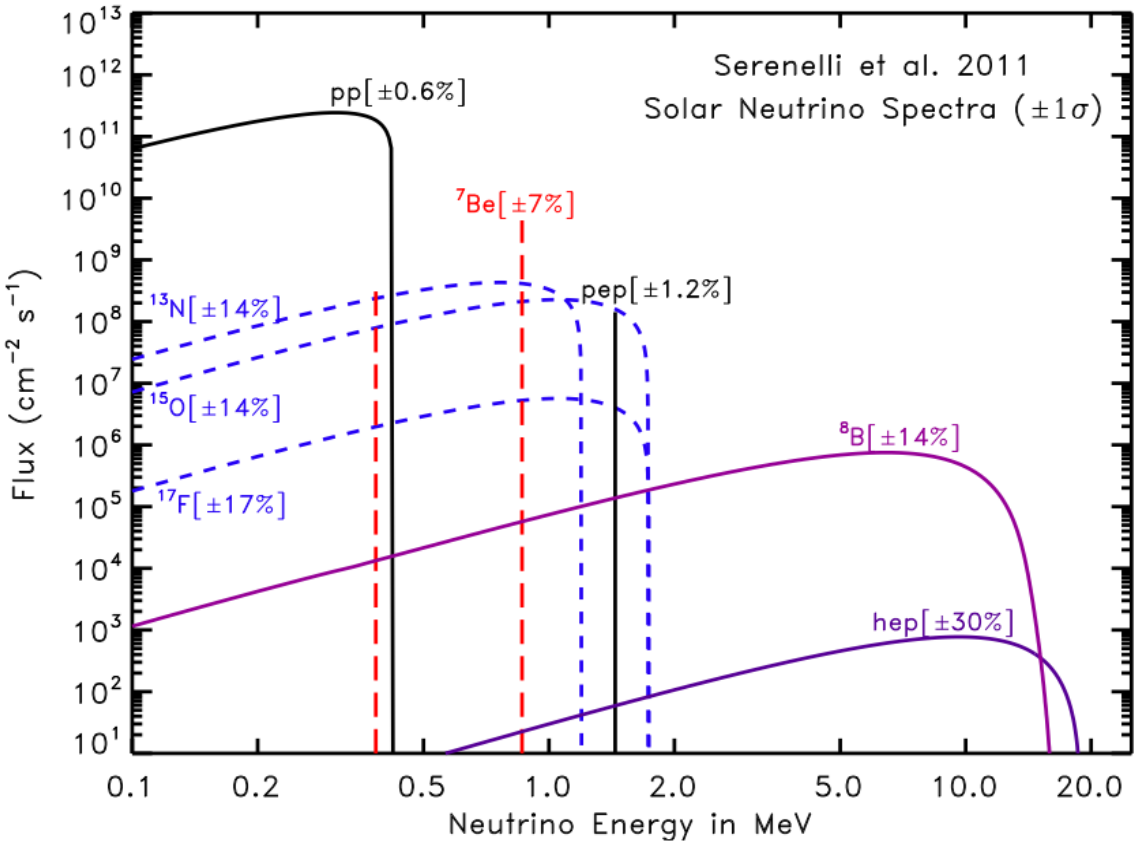
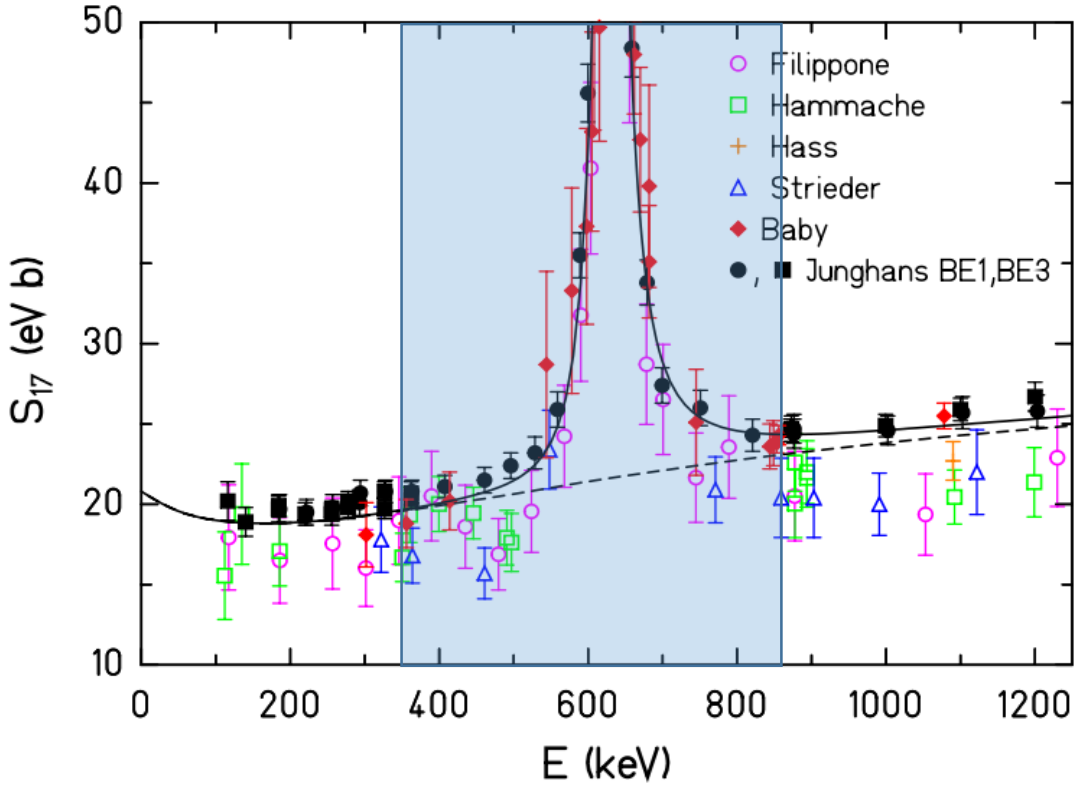
ERNA
European Recoil separator for Nuclear Astrophysics

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



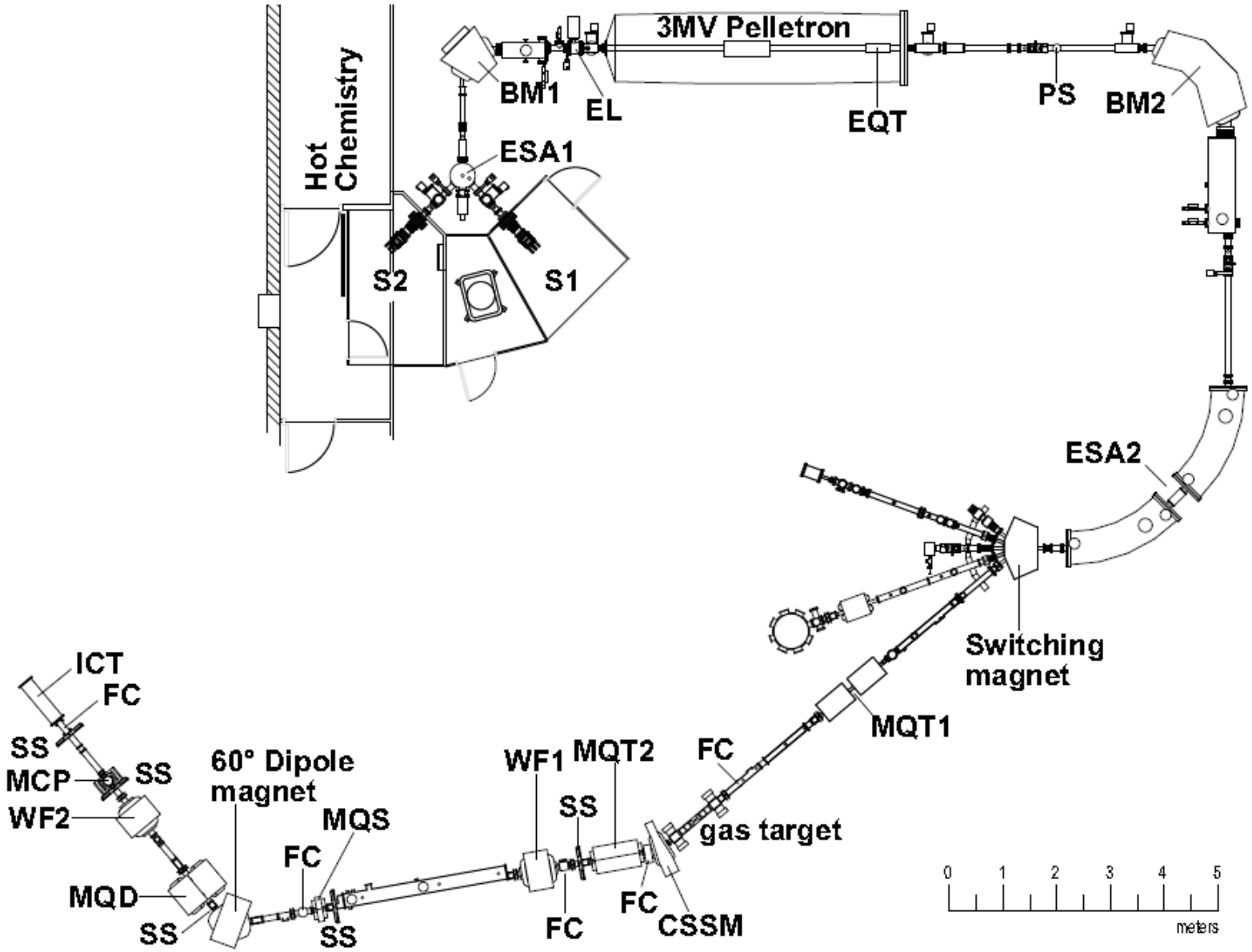
Large uncertanty on the predicted solar neutrino flux.



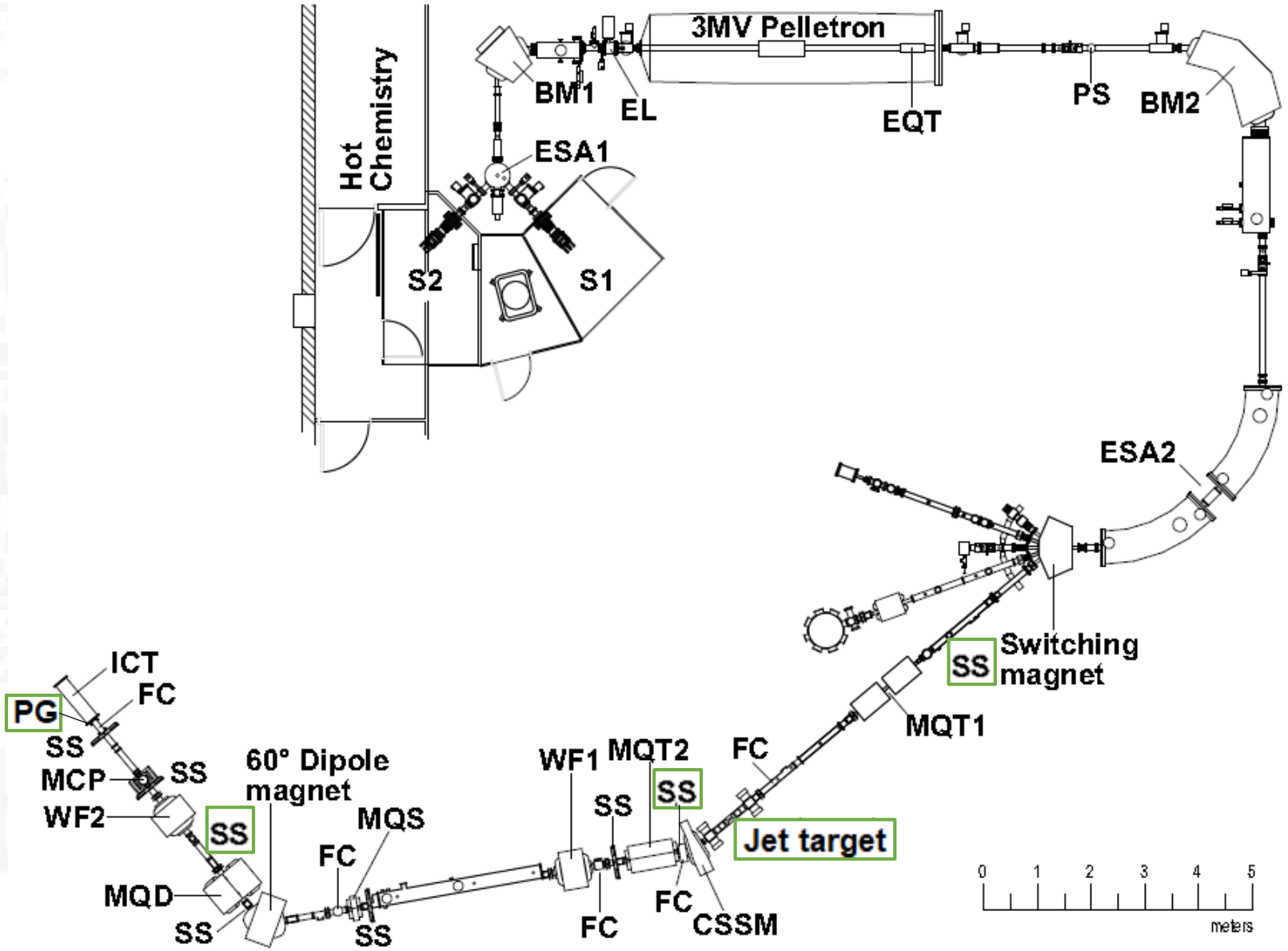
Adelberger et al. 2011

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

Tandem Laboratory @ CIRCE



Tandem Laboratory @ CIRCE



^{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

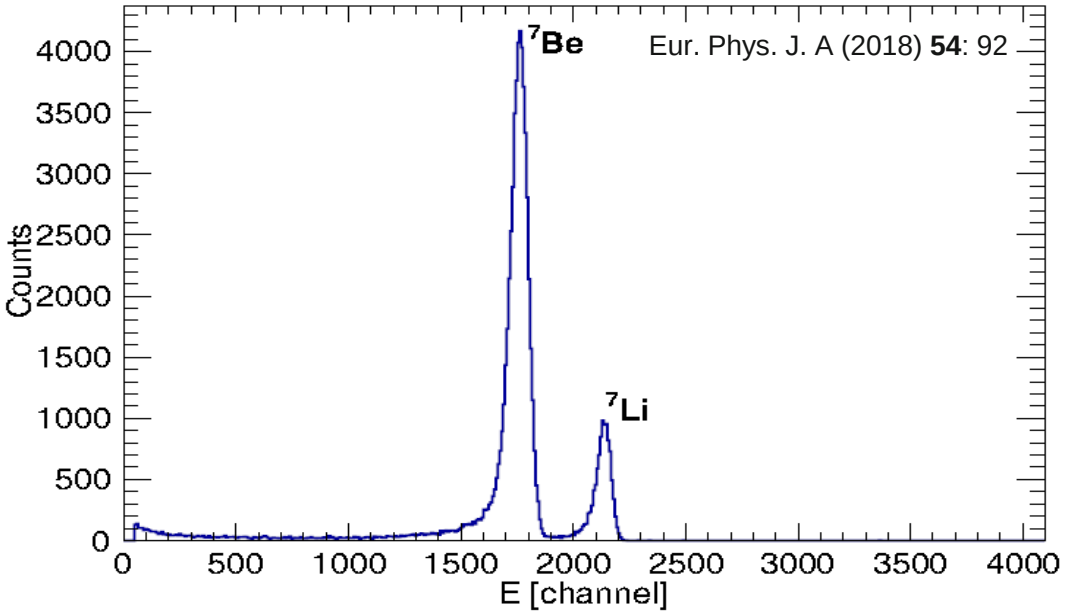
3x≈3GBq

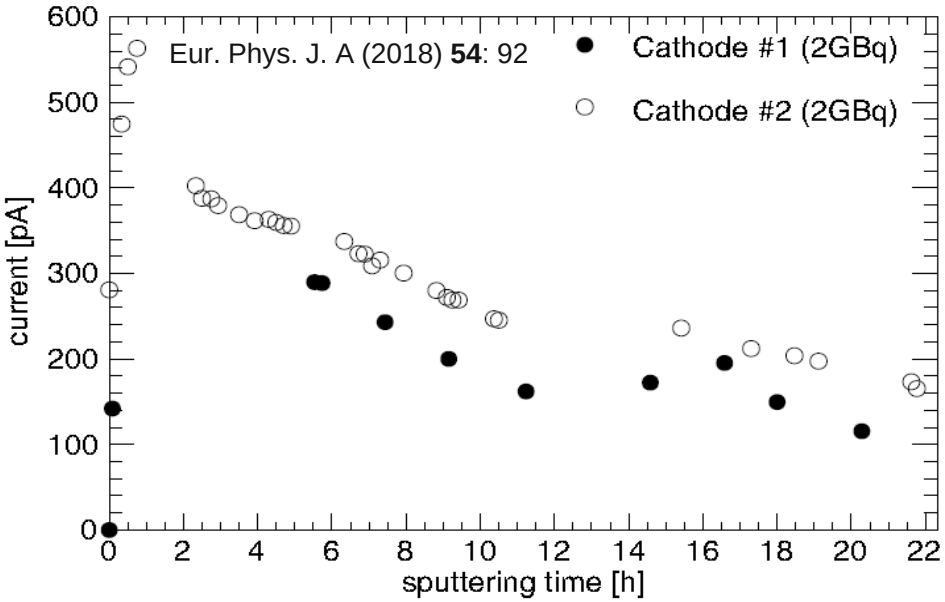
Test and mounting

SNICS-40
ions source.

Intensity up to 10^{9} pps.

^{7}Be BEAM

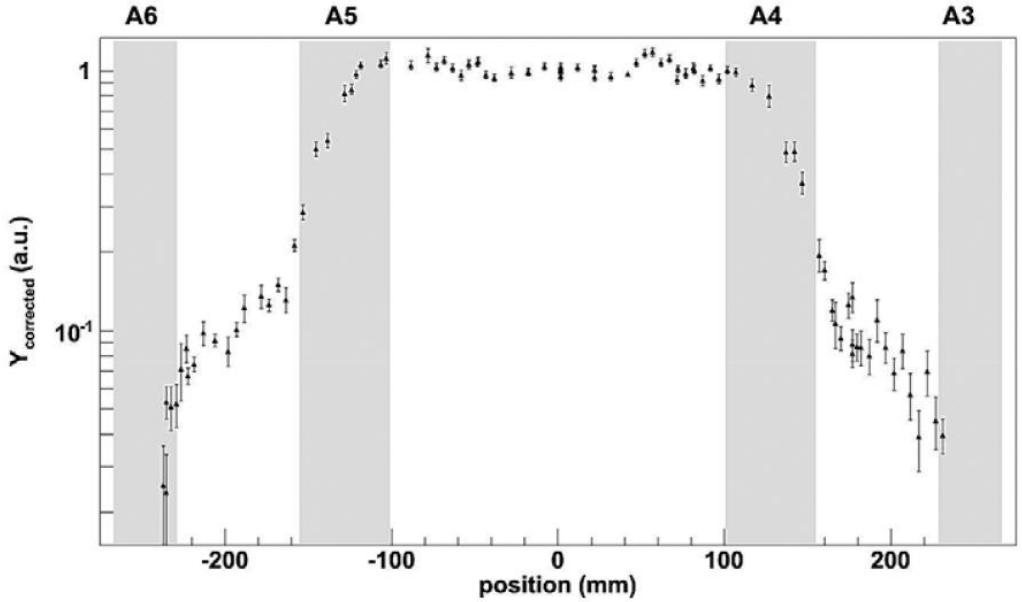


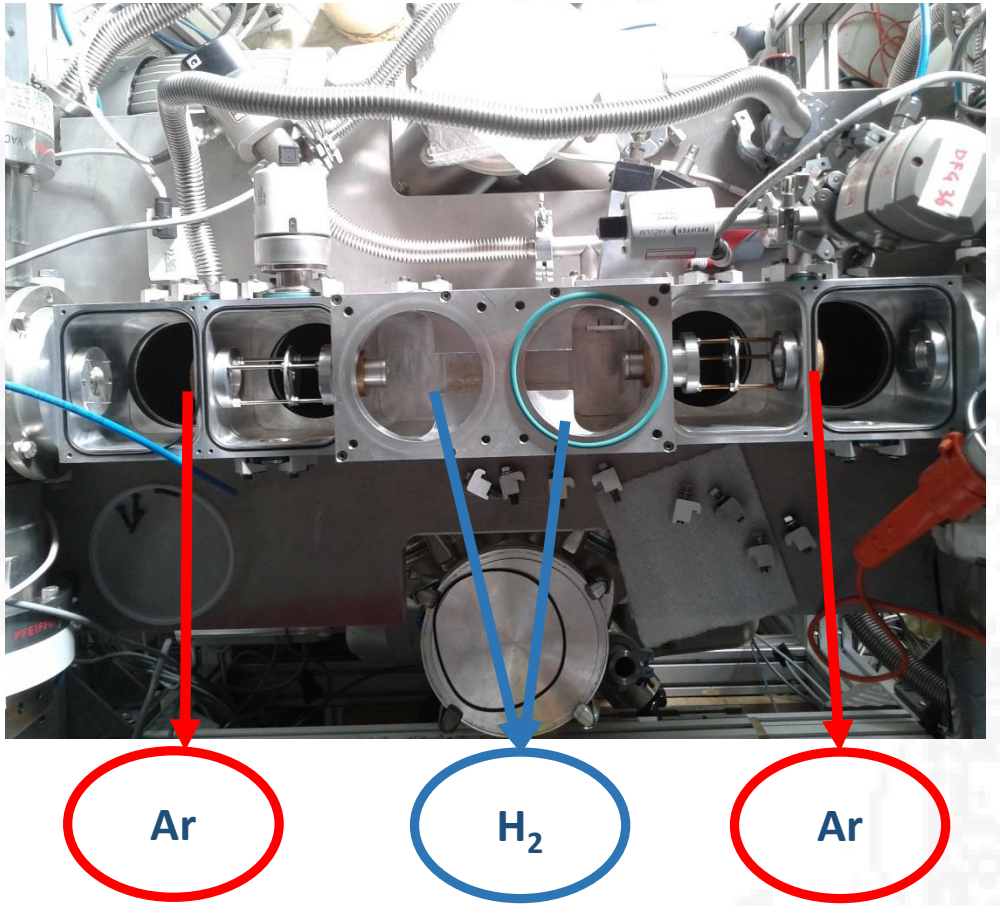


The number of incident projectiles, including lithium contamination, is monitored on line through elastic scattering.

Windowless gas target

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



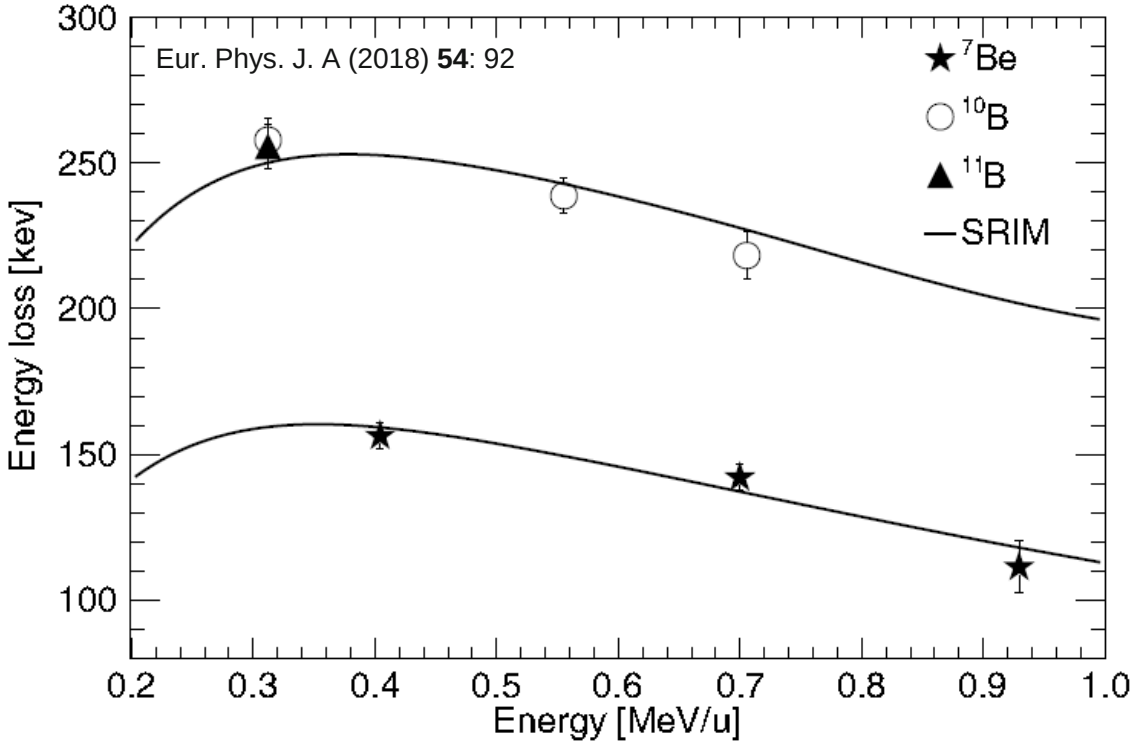


Density profile of the gas target as seen in the yield of the 478 keV γ-ray line from the ^{7}Li(p, p)^{7}Li

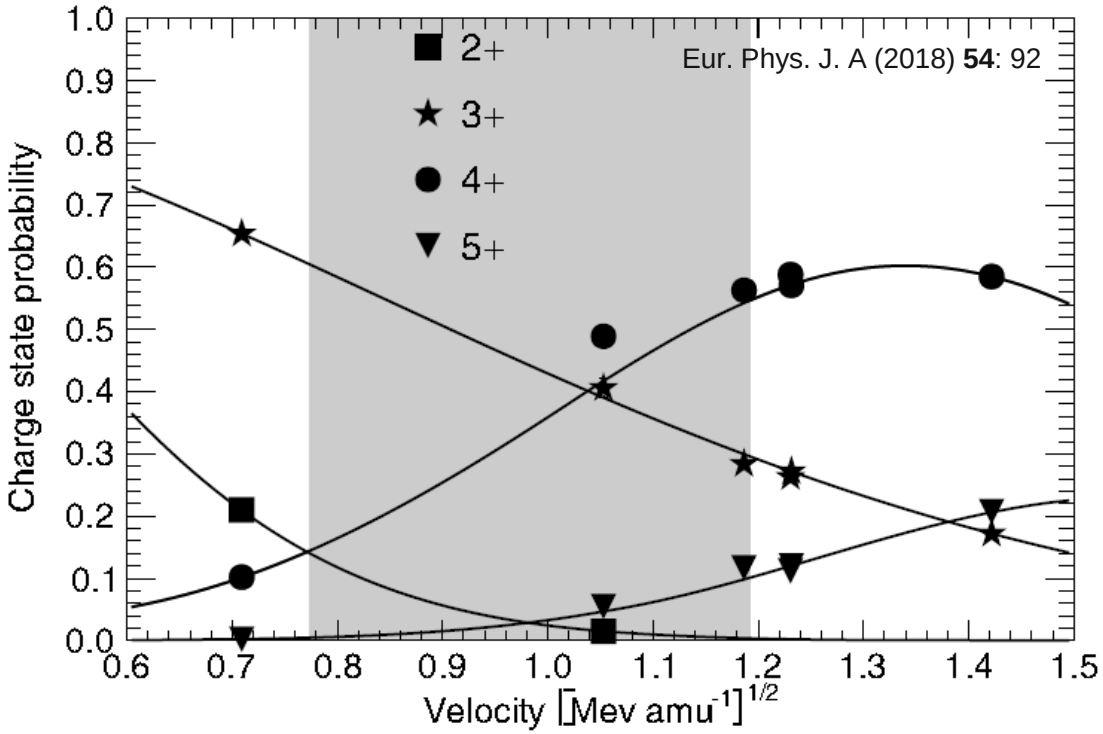
Target density n = 7.22 ± 0.15 · 10^{18} at/cm^2 at 4.9 mbar

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

Energy loss and charge state measurements

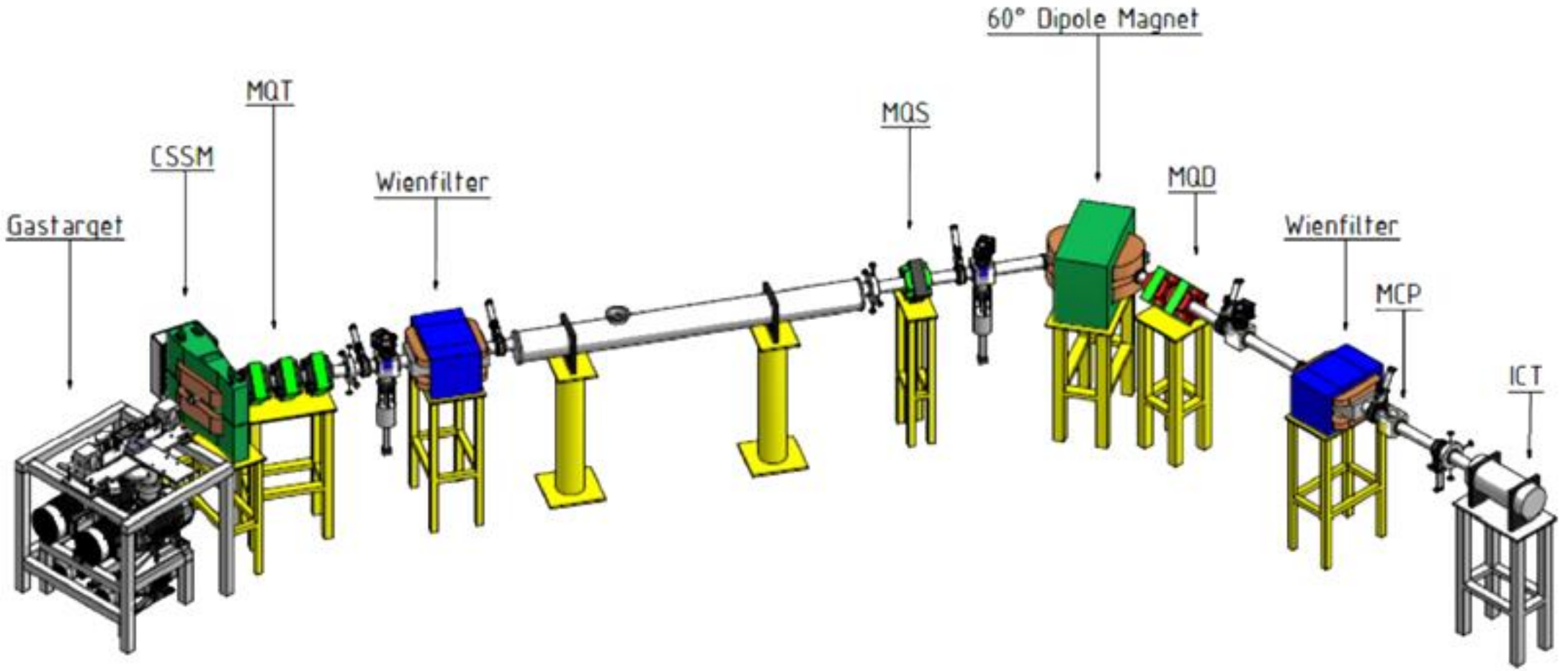


Energy loss of ^{7}Be, ^{10}B, and ^{11}B ions in the hydrogen gas target as a function of the beam energy. The lines show the results of the code SRIM-2013, scaled by a factor 0.68 for beryllium and a factor 0.82 for boron.

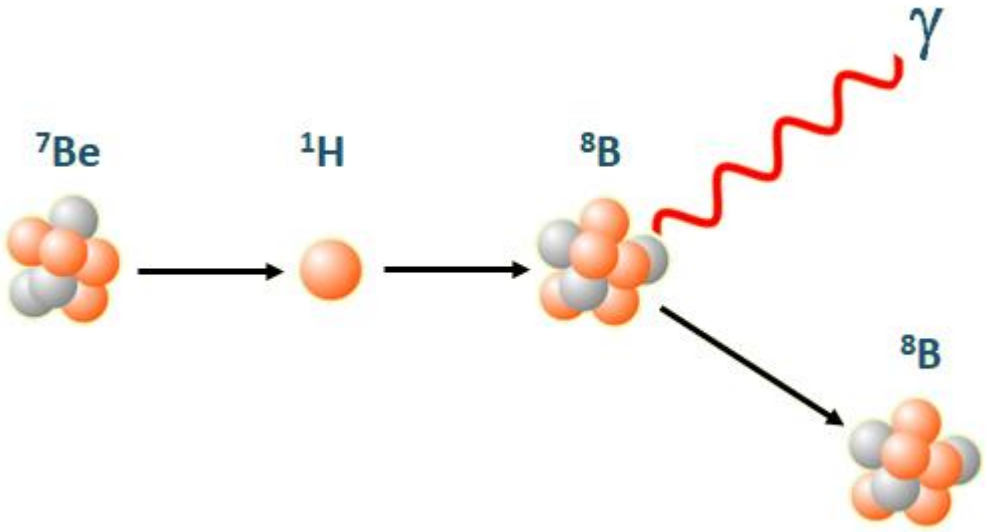


^{8}B ion charge state probability distribution as a function of the ion velocity. The shadowed area indicates the region where cross section measurements are planned.

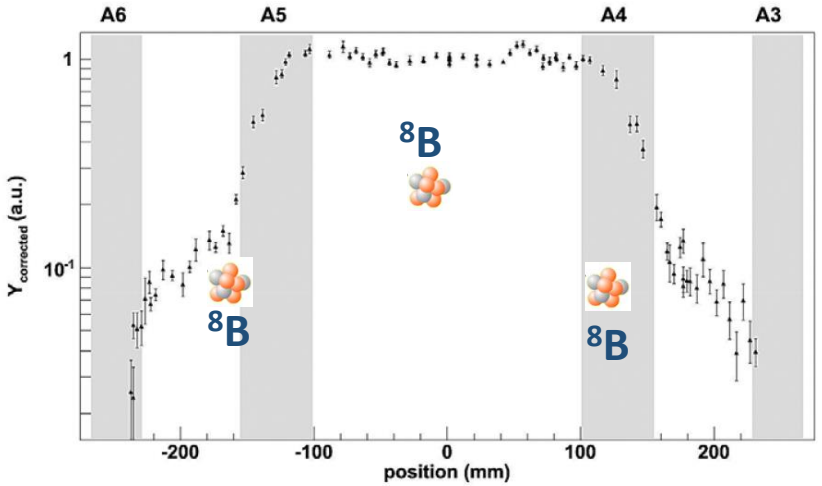
European Recoil mass separator for Nuclear Astrophysics (ERNA)



Recoils emittance



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



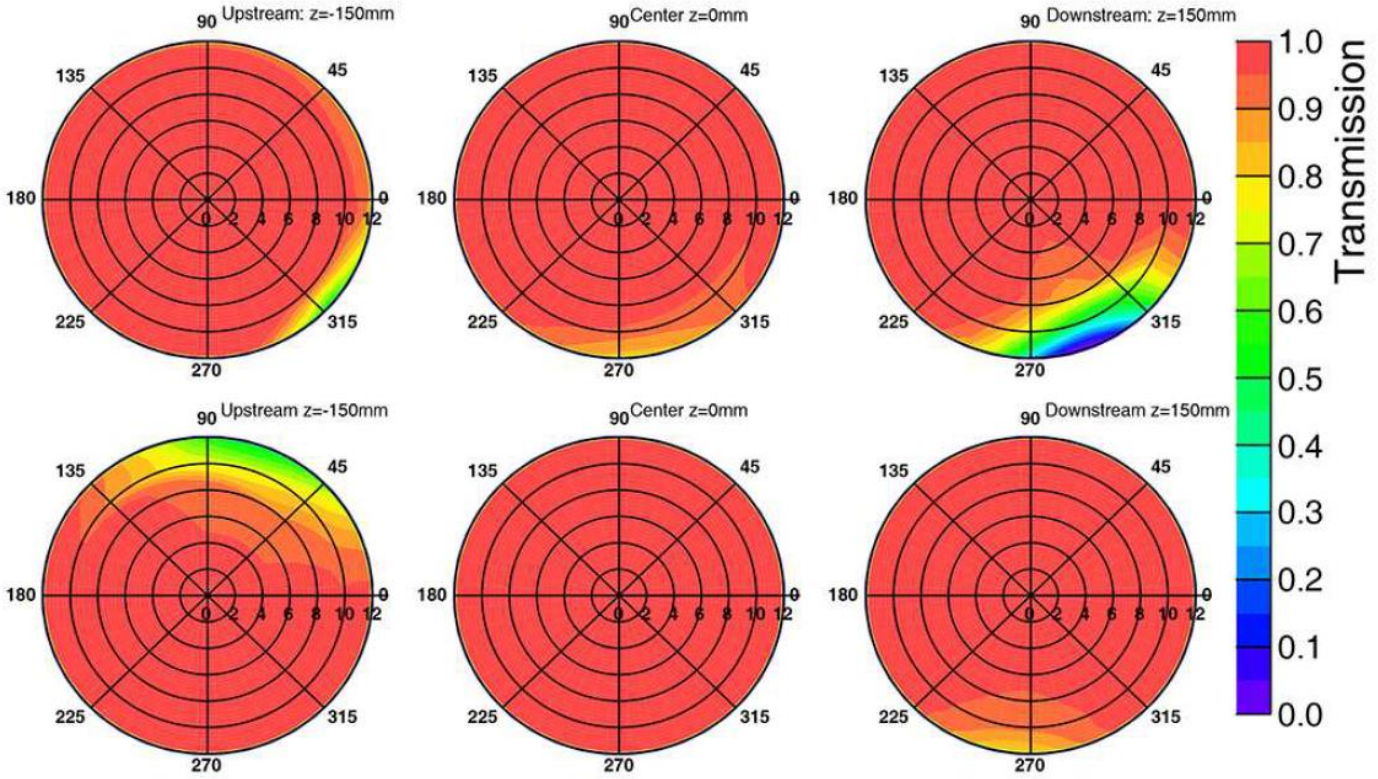
Recoils emittance is determined by reaction kinematics and straggling due to interaction with target gas.

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

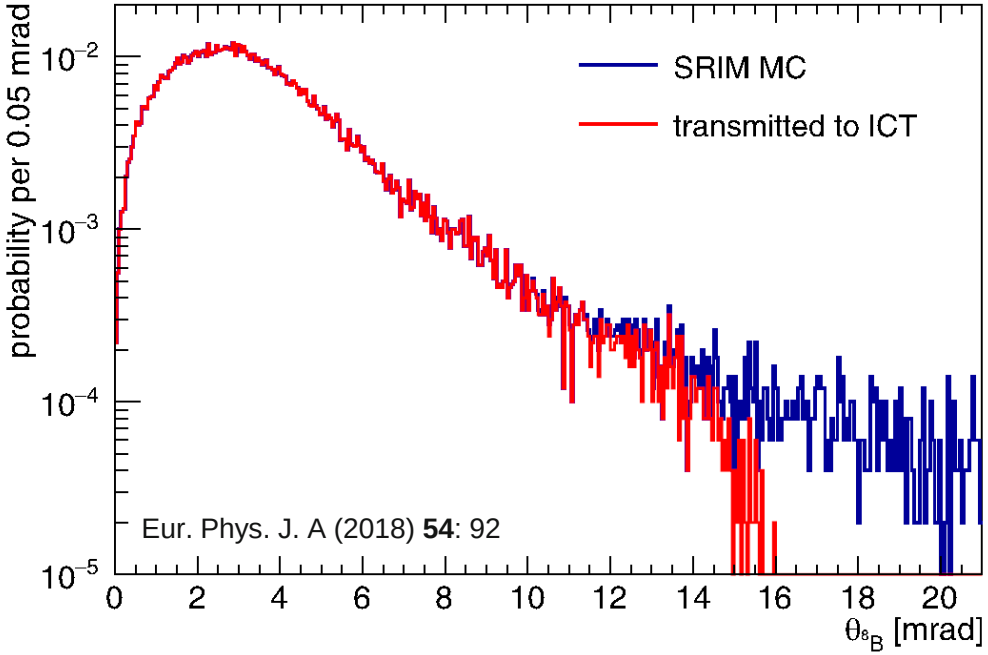
In all conditions full transmission to the end detector of the recoils in the selected charge state is mandatory.

Recoils Acceptance

Eur. Phys. J. A (2018) **54**: 92



Angular acceptance plots for $^{7}Be(p,)^{8}B$ at Ecm = 348 and 799 keV (top and bottom panel, respectively).

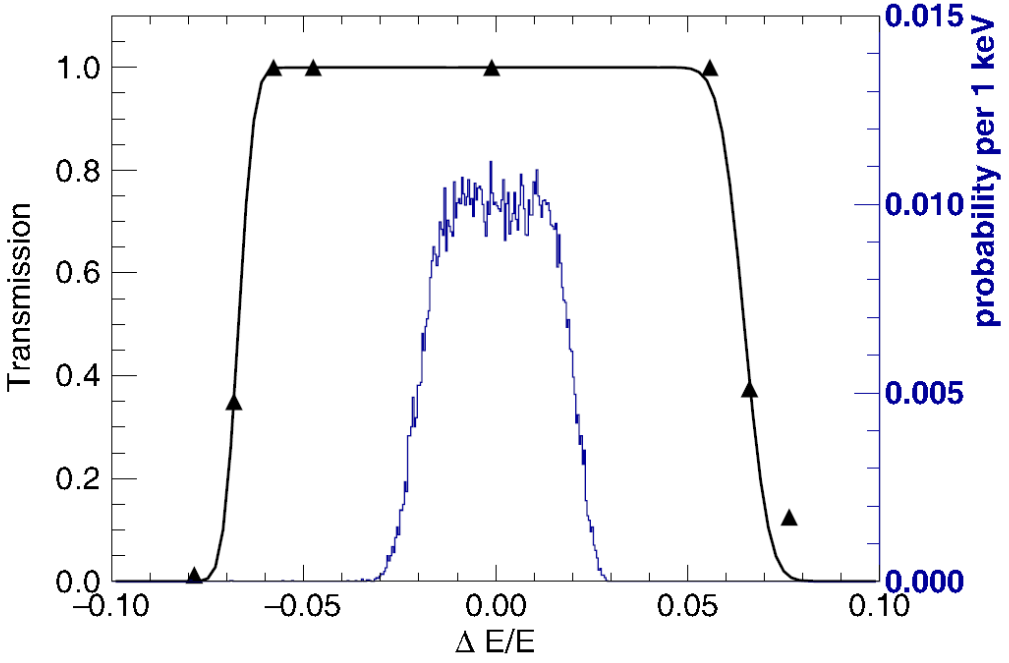


Distribution of the ^{8}B recoils emerging from the target for Ecm = 348 keV (blue line). The red line indicates the recoils reaching the end detector of ERNA using the experimental acceptance curves.

Recoils Acceptance

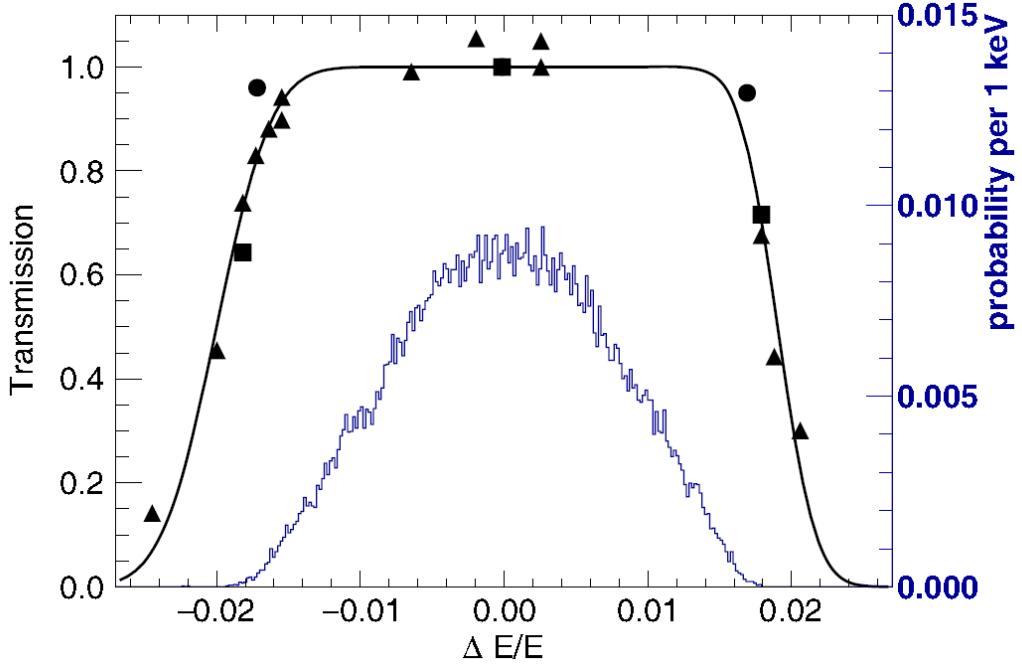
348 keV energy acceptance

Eur. Phys. J. A (2018) **54**: 92



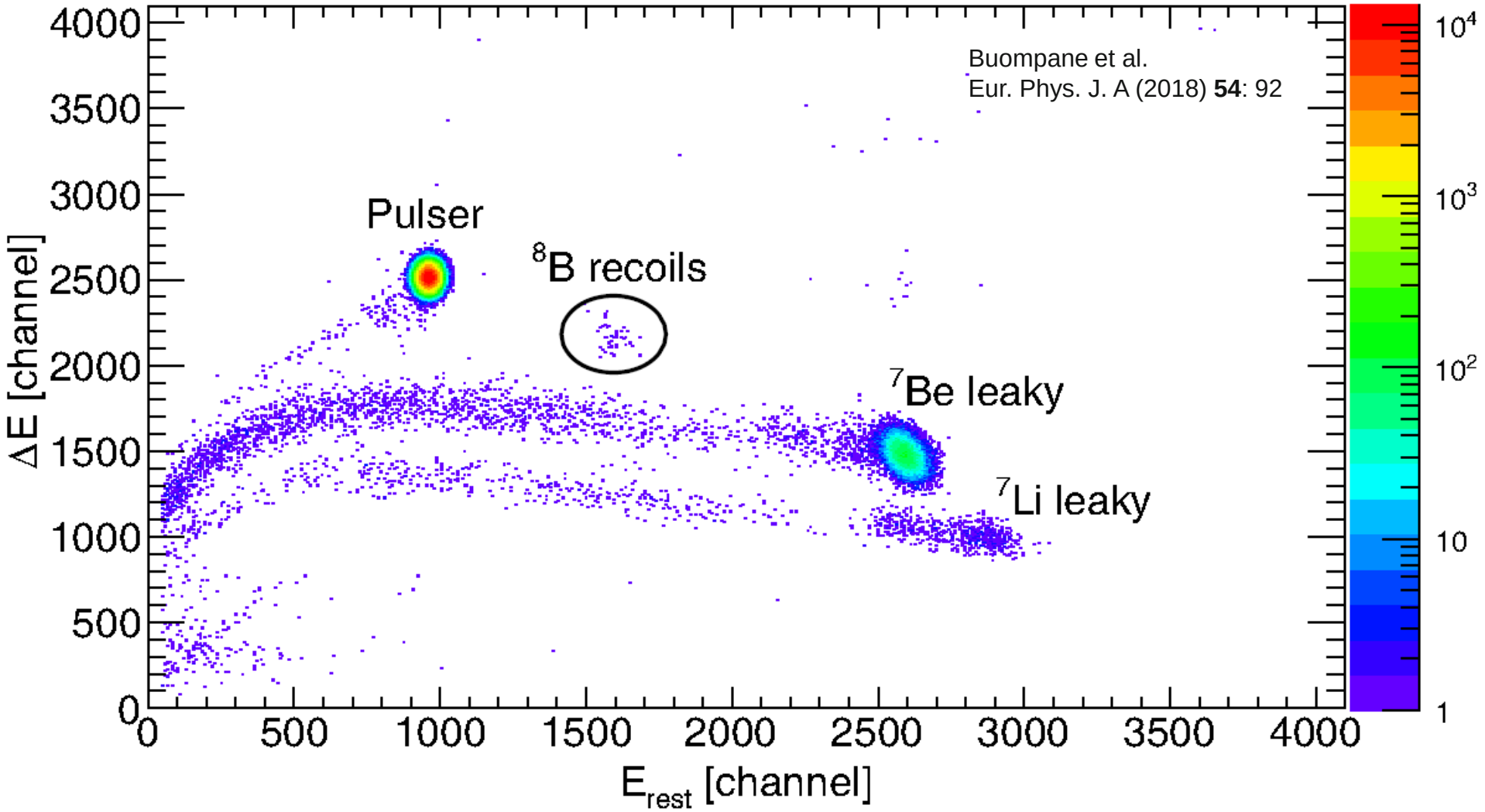
799 keV energy acceptance

Eur. Phys. J. A (2018) **54**: 92



Energy acceptance plots for $^{7}Be(p,\gamma)^{8}B$ at Ecm = 348 and 799 keV (left and right panel, respectively). The blue line indicates the results of a Monte Carlo simulation of the recoils probability density.

Ec.m.= 800 keV measurement



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, 600 and at 350 keV Ecm ;
- The test measurements of the cross section at Ecm = 812 keV with the setup and the analysis details has been recently published [Eur. Phys. J. A (2018) 54: 92)];
- The measurements of absolute cross section, of the $^{7}Be(p,\gamma)^{8}B$ reaction from Ecm = 350 keV up to the Ecm = 800 keV has been performed;
- The analysis of the data was completed, and the impact in the extrapolation of the astrophysical factor will be evaluated;
- New measurements at center of mass energy from 350 to 600 keV Ecm are in program for better understand the discrepancy from different data set existing in this range.

Center for Isotopic Research on Cultural and Environmental heritage (CIRCE)

Thanks