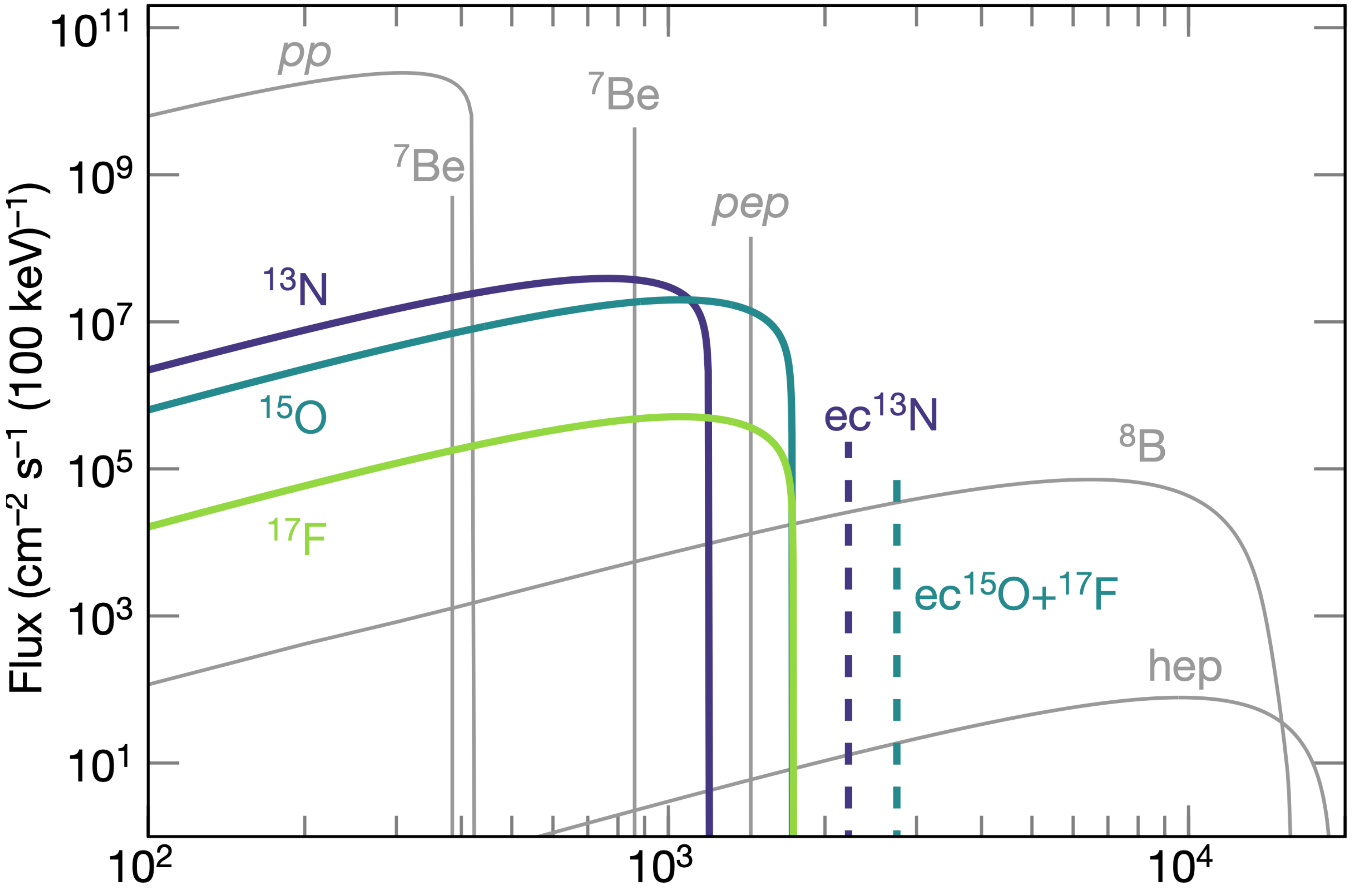
^{7}Be production at the ATOMKI Cyclotron for ^{7}Be(p,γ)^{8}B measurement with the recoil separator ERNA

Antonino Di Leva
Università di Napoli Federico II and INFN Sezione di Napoli

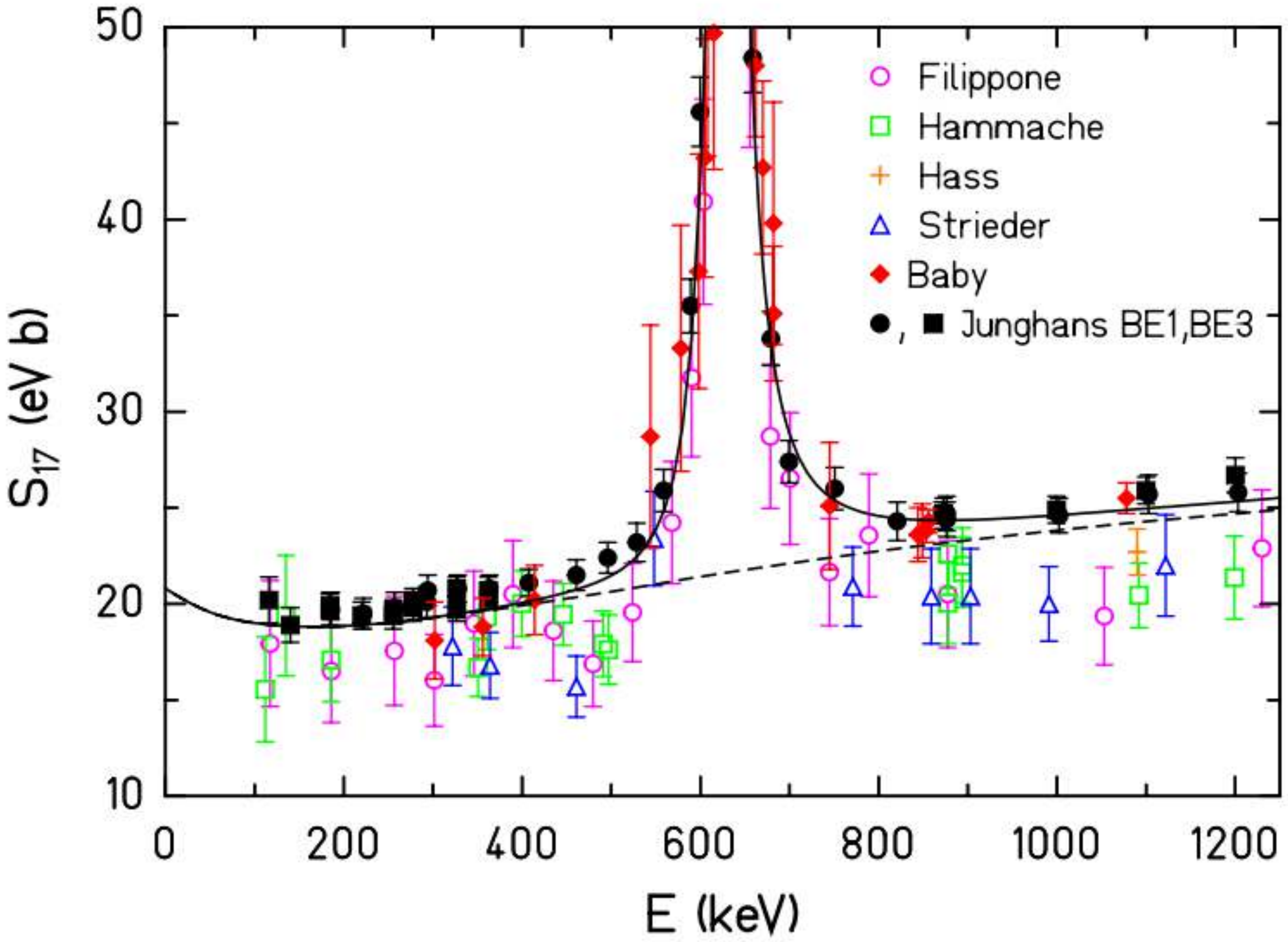
ChETEC-INFRA General Assembly, Padova 1 June 2022

European Recoil separator for Nuclear Astrophysics

$^7Be(p,\gamma)^8B$ and the solar neutrino



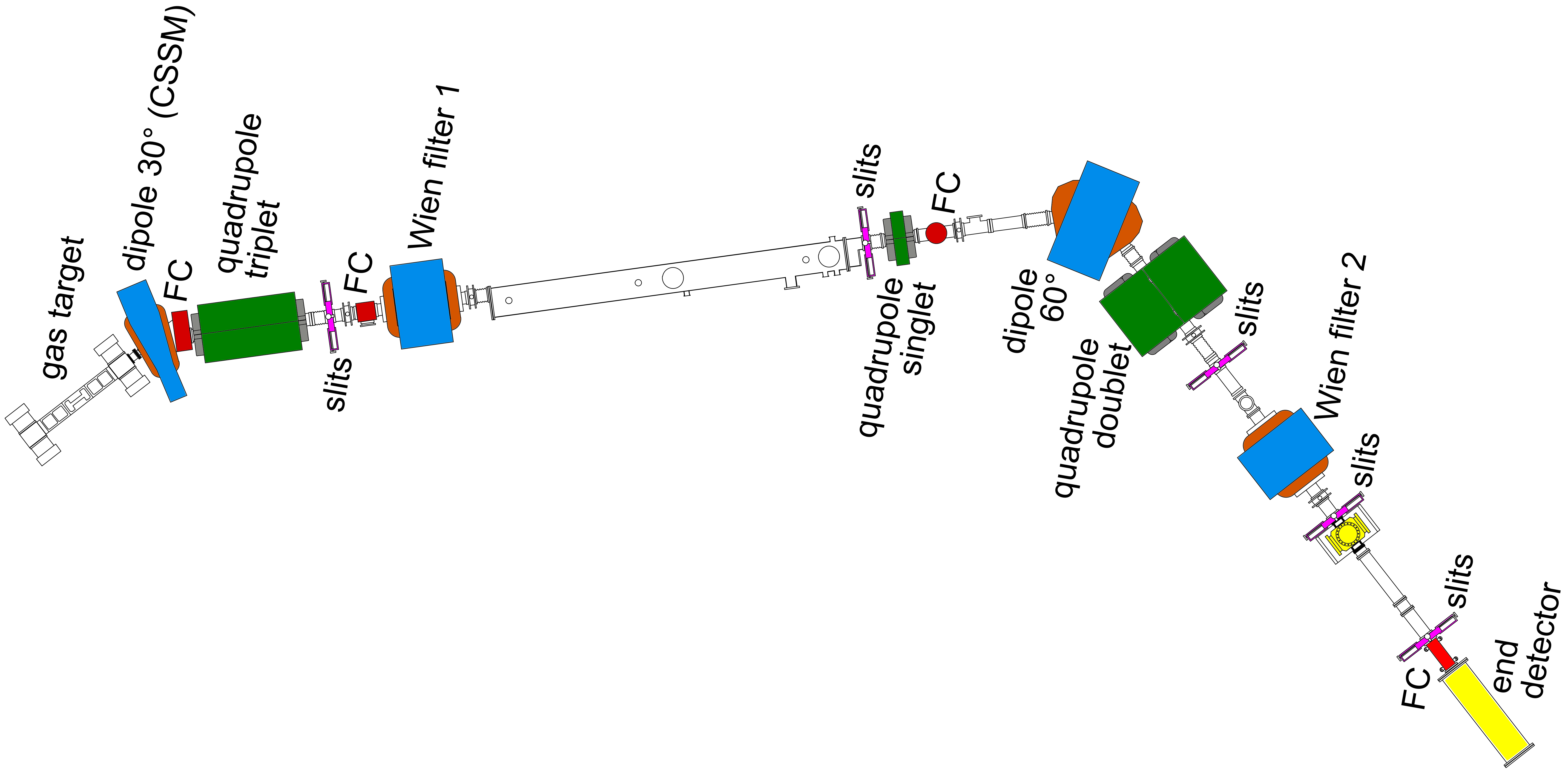
The Borexino Collaboration, Nature 587(2020)577

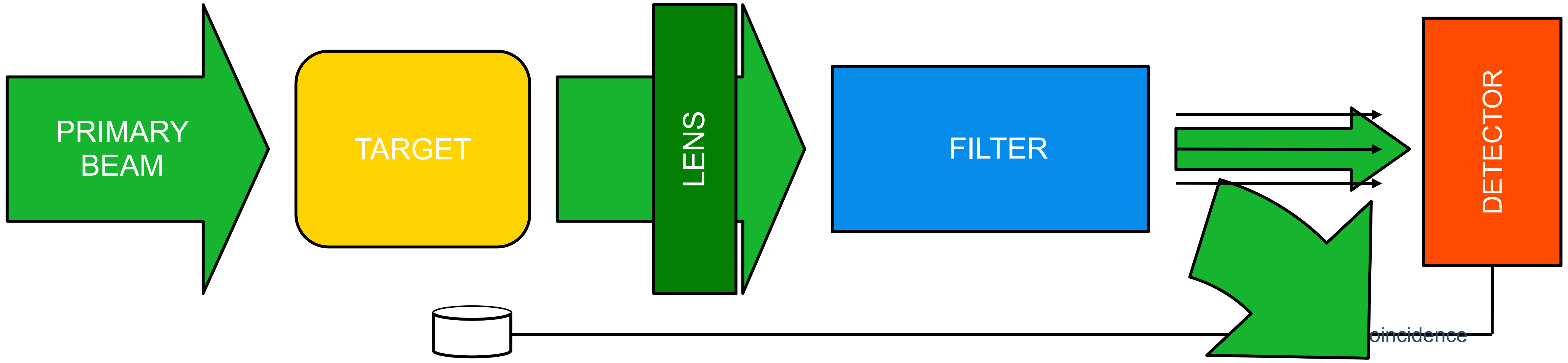


Adelberger et al. Rev. Mod. Phys. (2011)

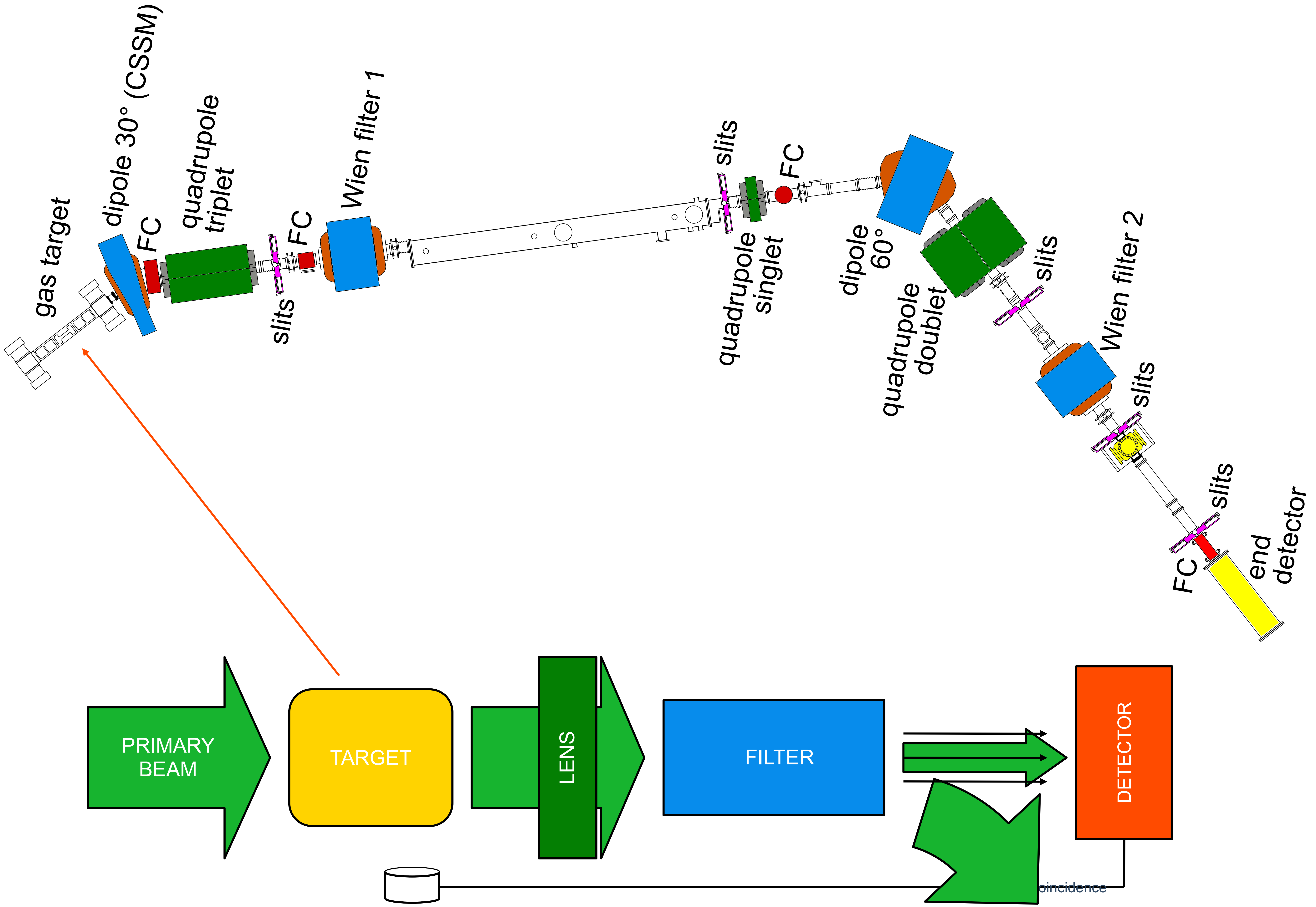
European Recoil separator for Nuclear Astrophysics

Recoil Mass Separator ERNA

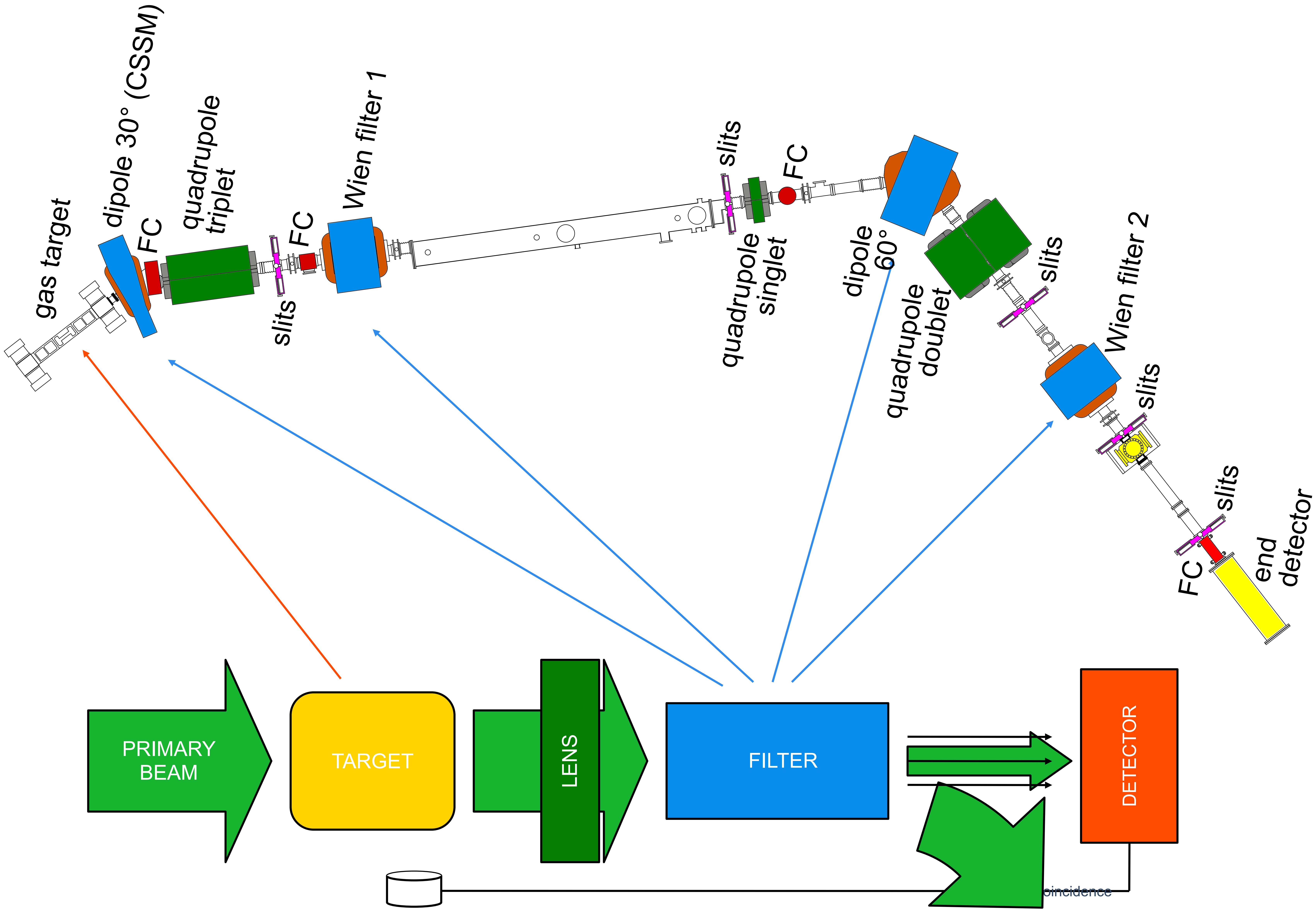




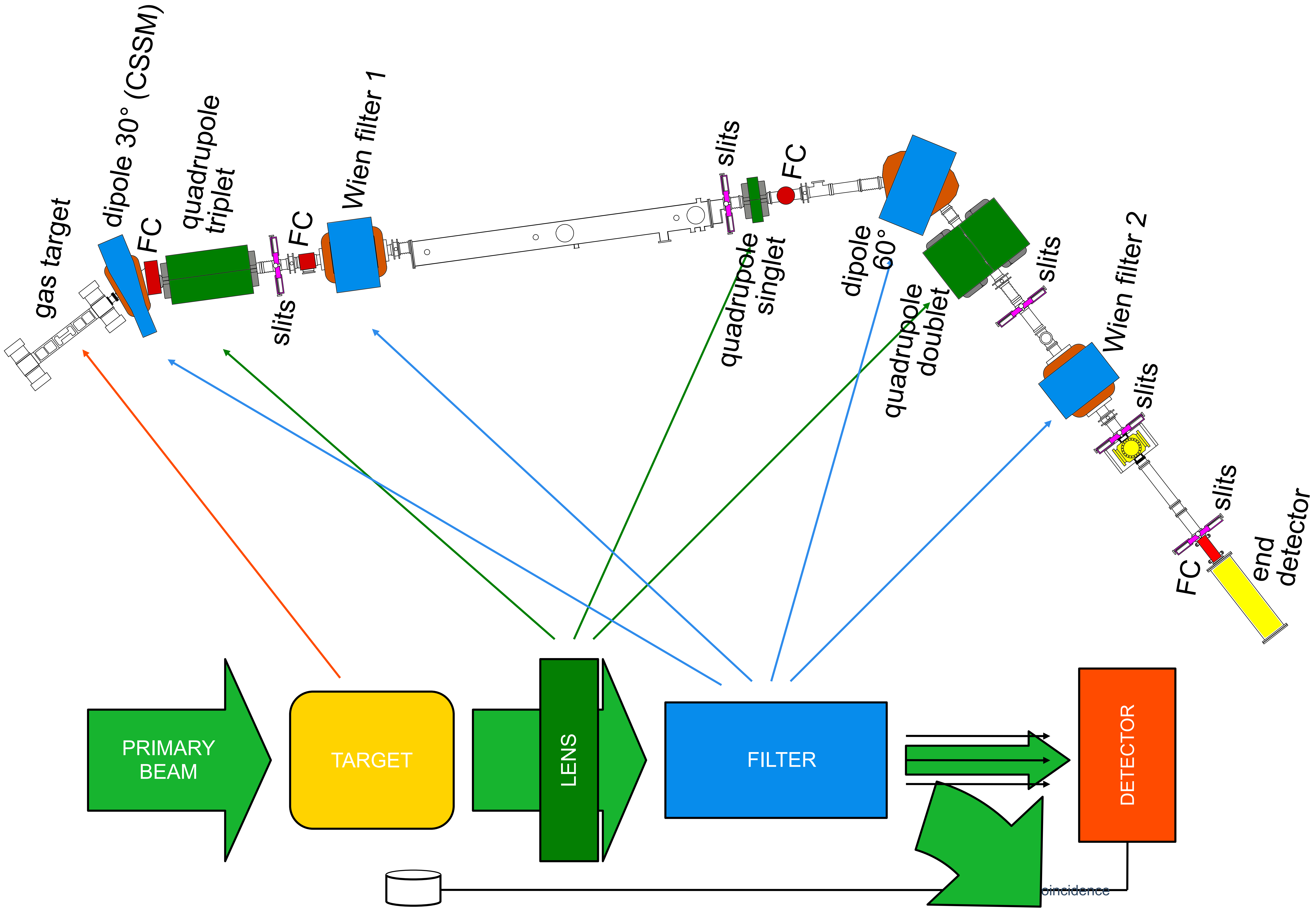
Recoil Mass Separator ERNA



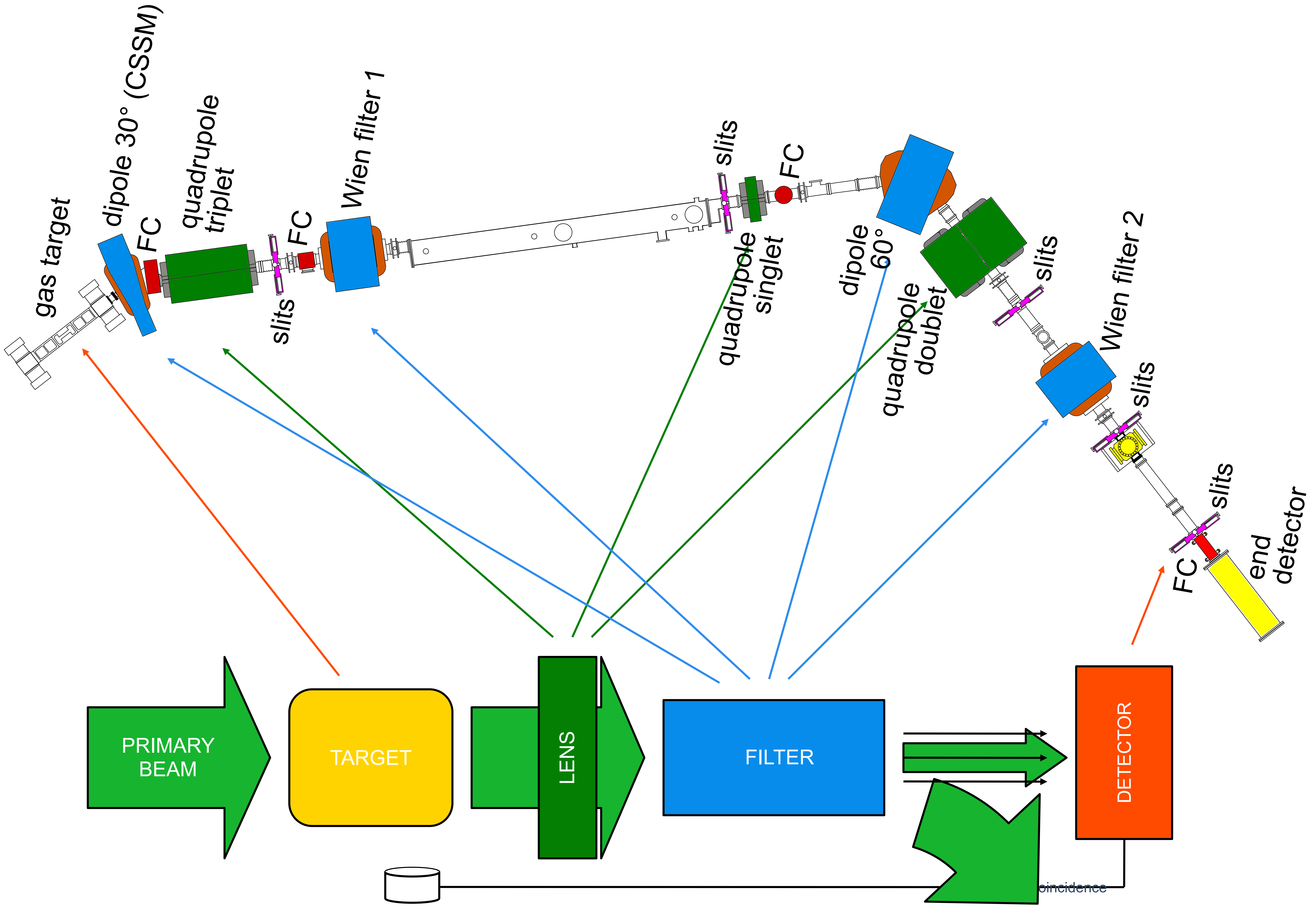
Recoil Mass Separator ERNA



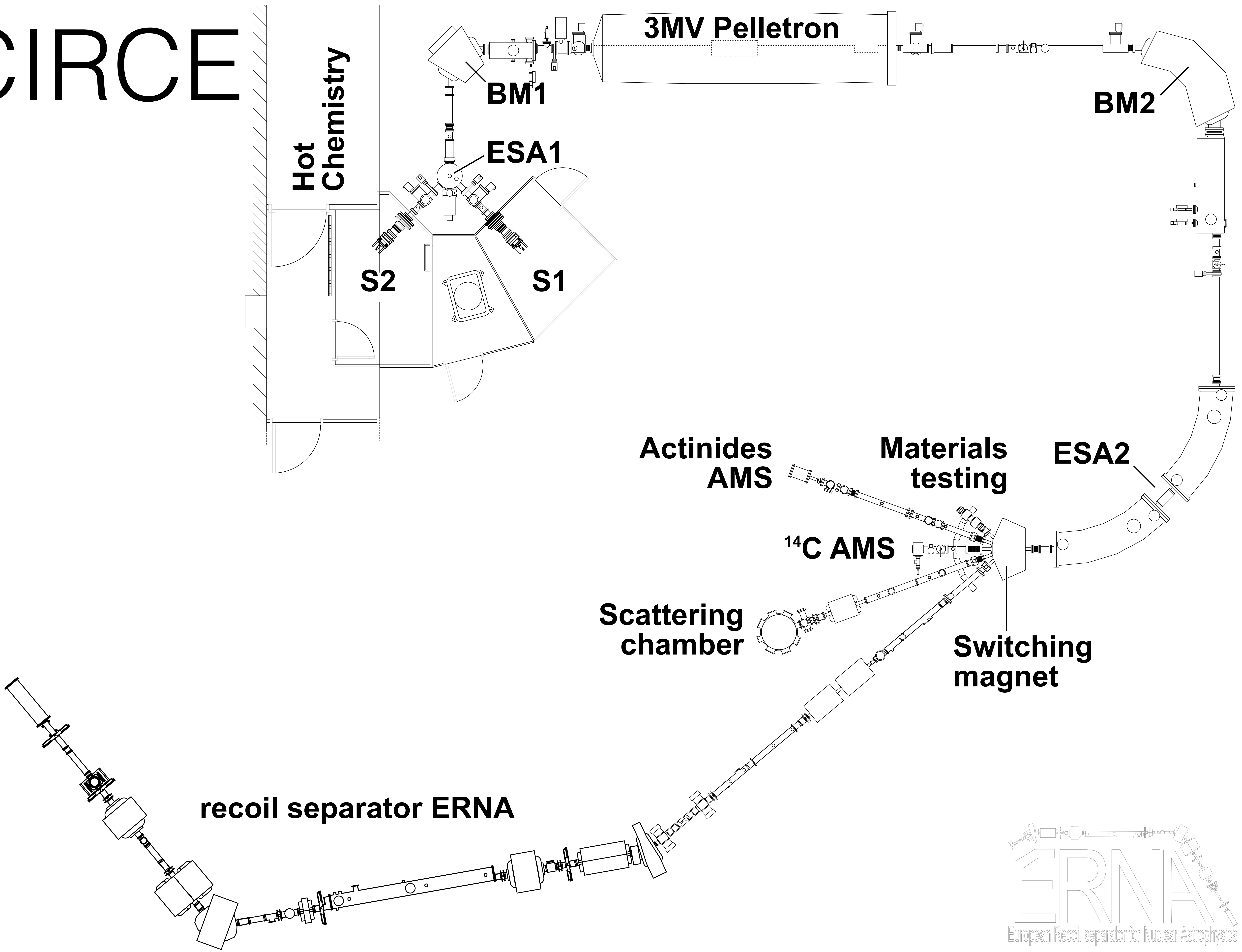
Recoil Mass Separator ERNA



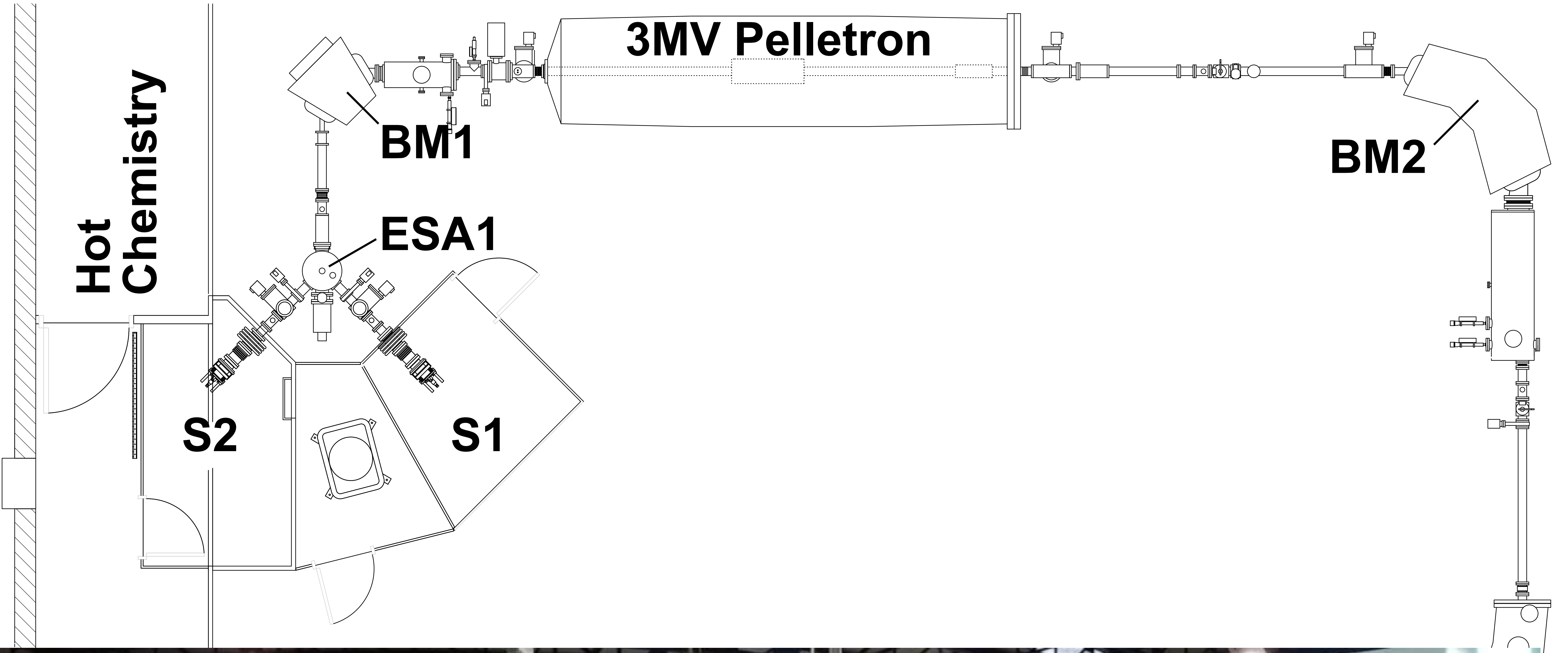
Recoil Mass Separator ERNA



ERNA @ CIRCE

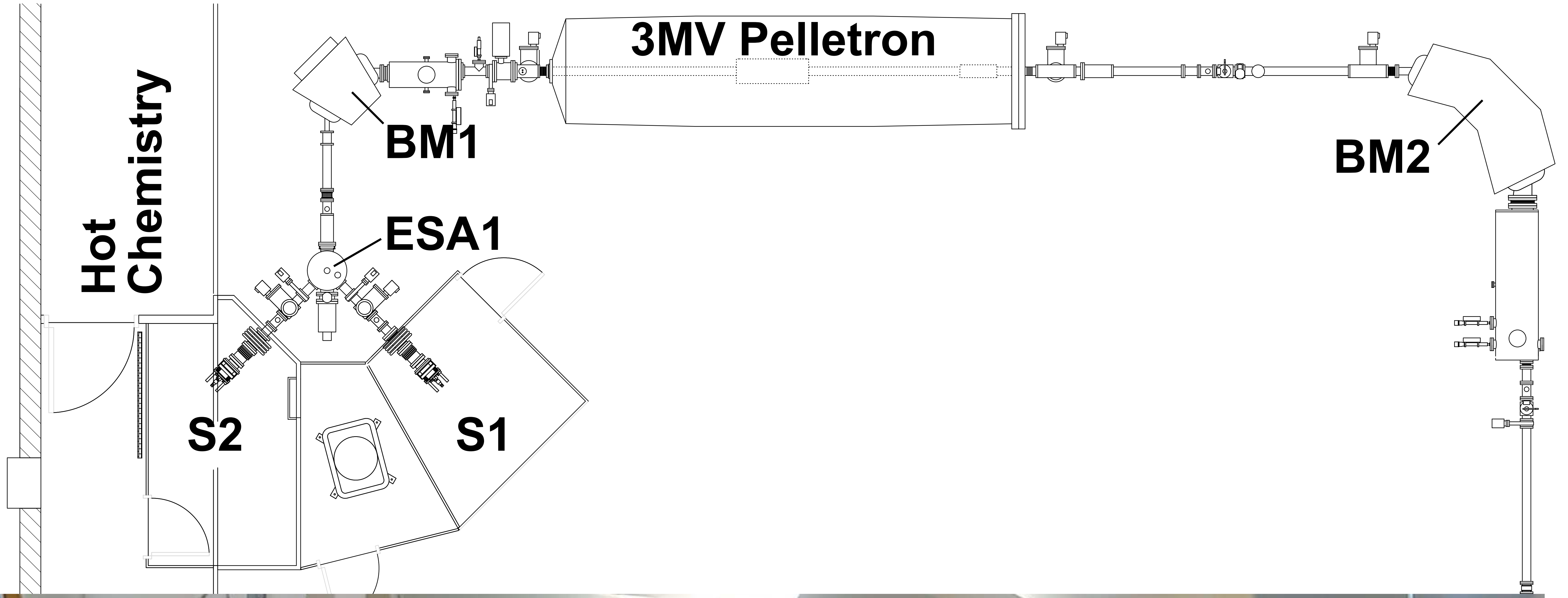

3MV Pelletron
BM1
BM2
Hot Chemistry
ESA1
S2
S1
Actinides AMS
Materials testing
ESA2
^{14}C AMS
Scattering chamber
Switching magnet
recoil separator ERNA

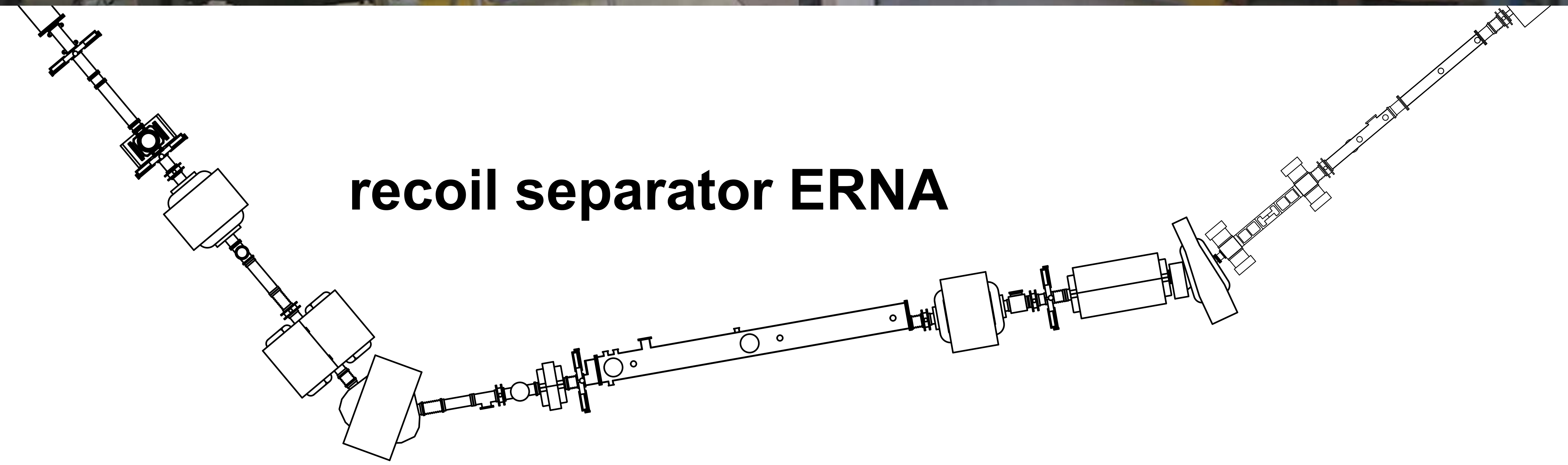
ERNA @ CIRCE


3MV Pelletron
BM1
BM2
ESA1
Hot Chemistry
S2
S1


recoil separator ERNA

ERNA @ CIRCE


3MV Pelletron
BM1
BM2
Hot Chemistry
ESA1
S2
S1


recoil separator ERNA

^{7}Be beam production

^{7}Be production at ATOMKI cyclotron with 7Li(p,n)7Be

Transport to CIRCE of activated Li targets

Extraction of ^{7}Be from Li bulk with hot chemistry procedure

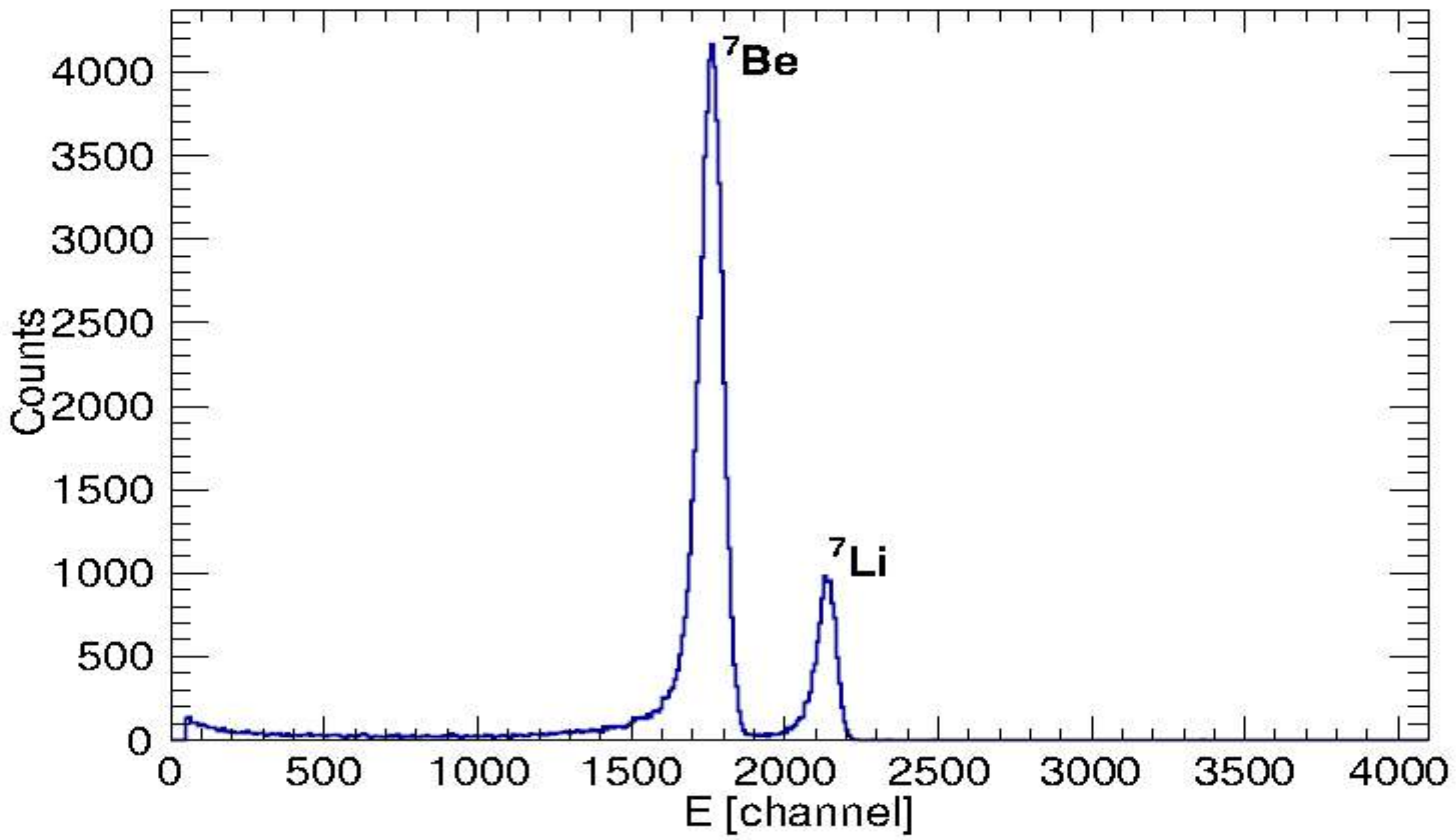
^{7}Be (and Li) deposited into source cathodes, typically 1.5 GBq each

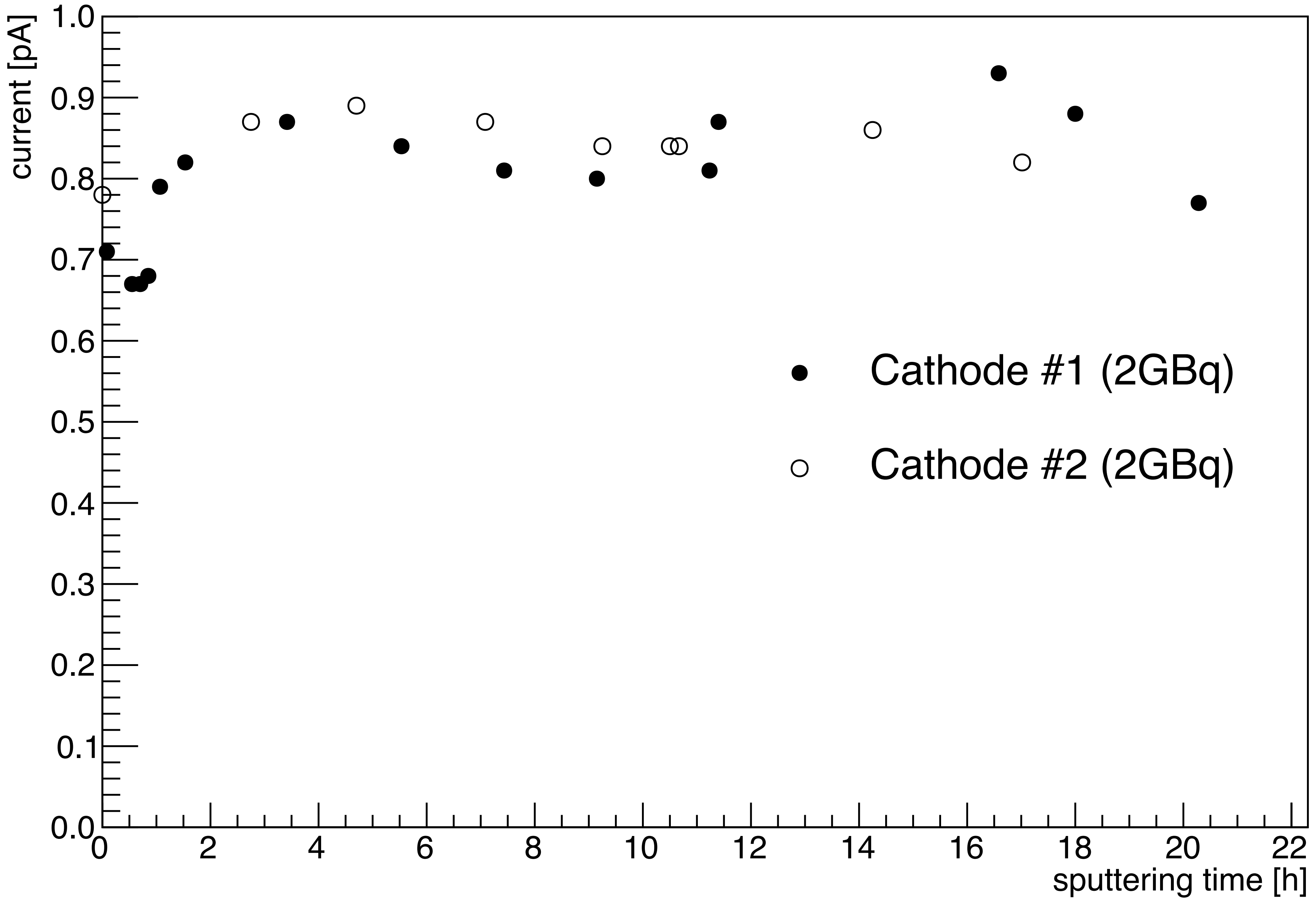
Cathodes are loaded in RIB dedicated SNICS S2

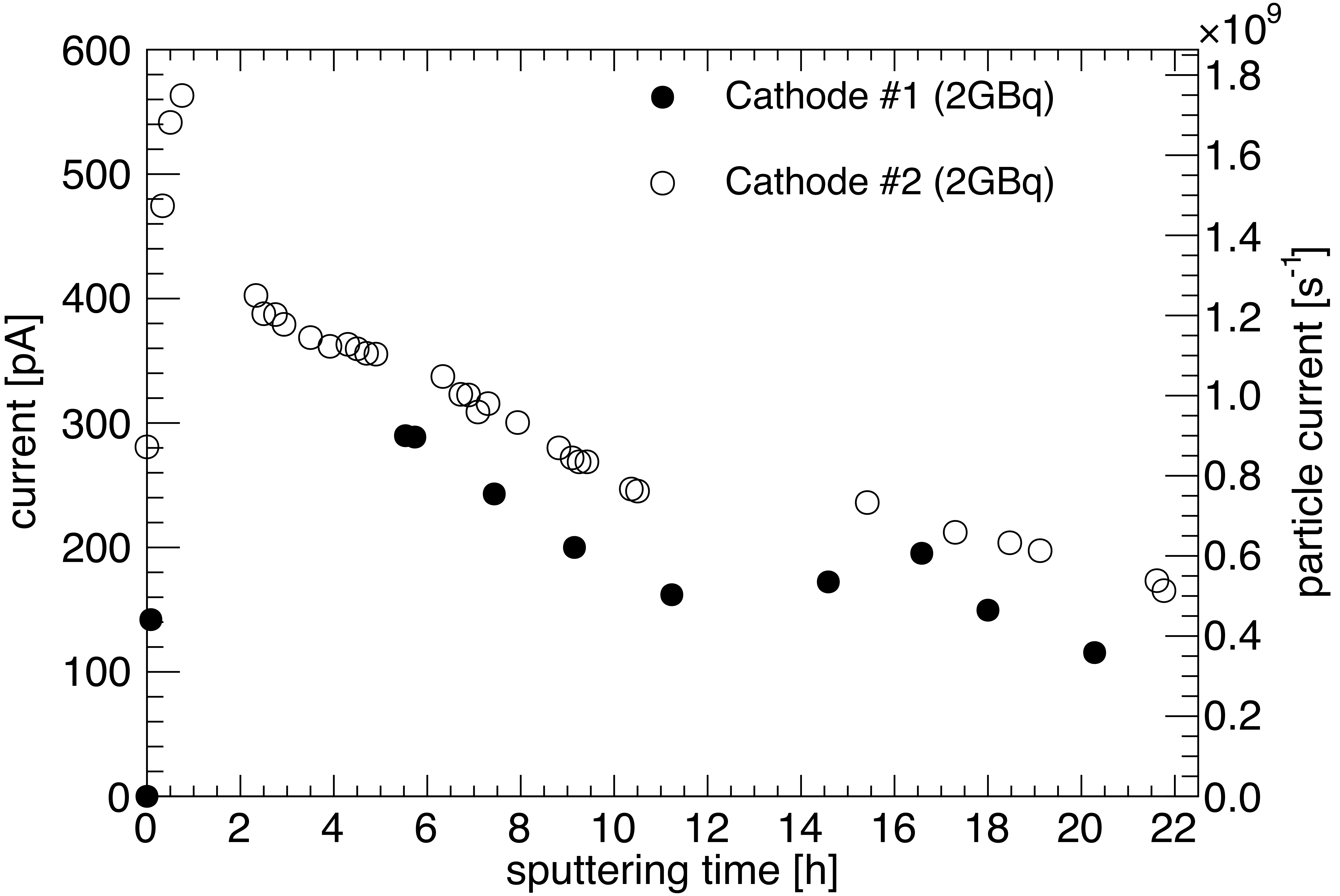
ion beam production

European Recoil separator for Nuclear Astrophysics

^{7}Be beam

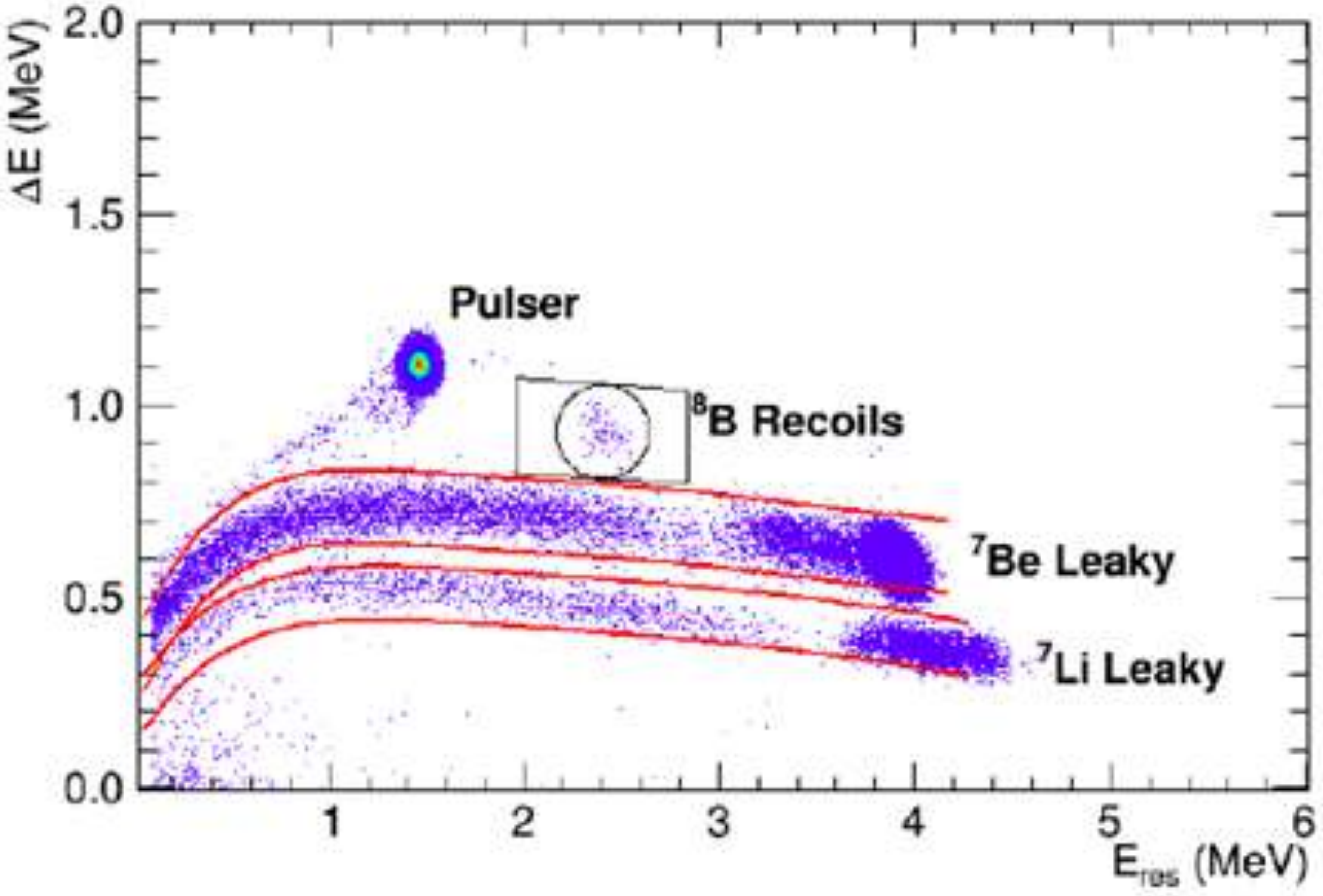


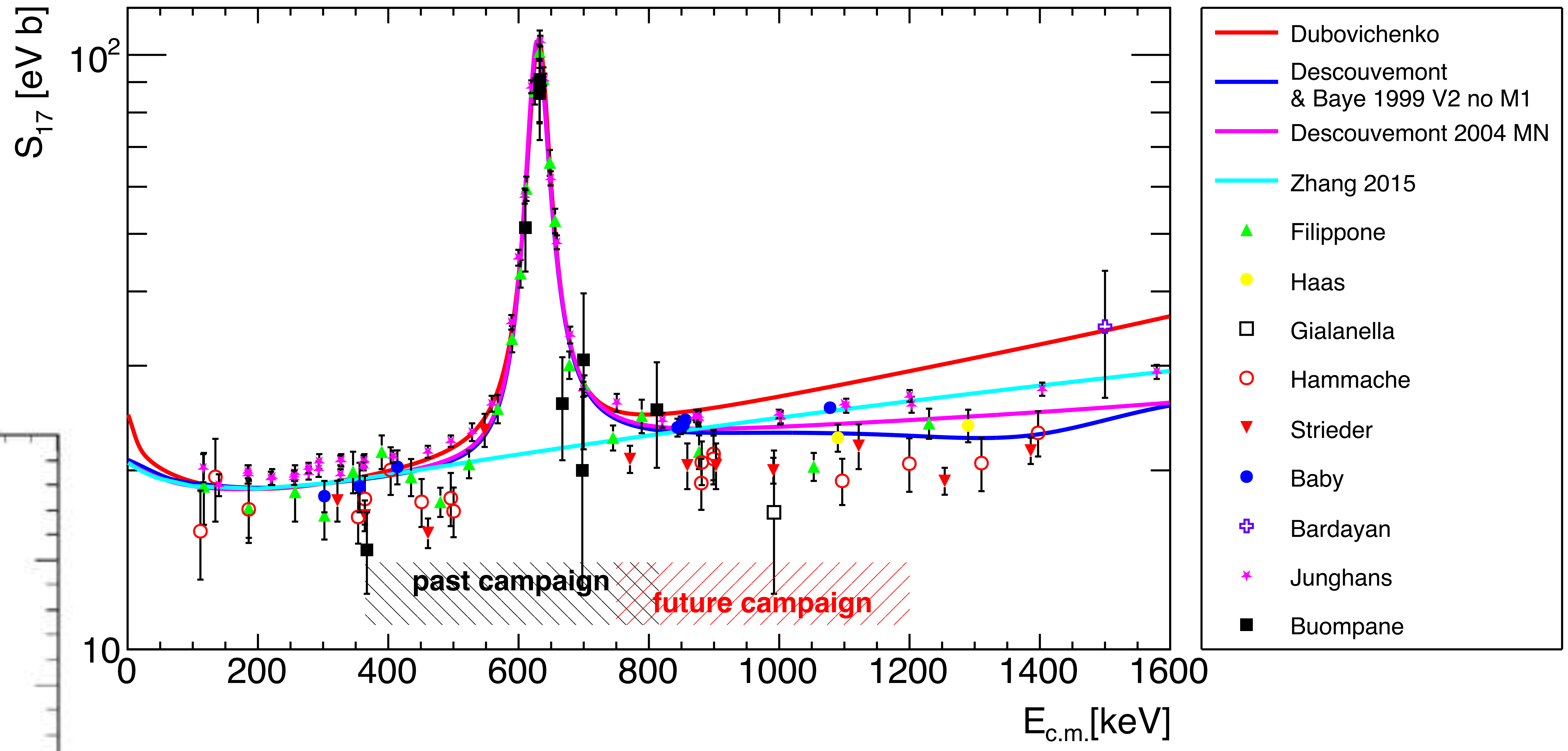




ERNA
European Recoil separator for Nuclear Astrophysics

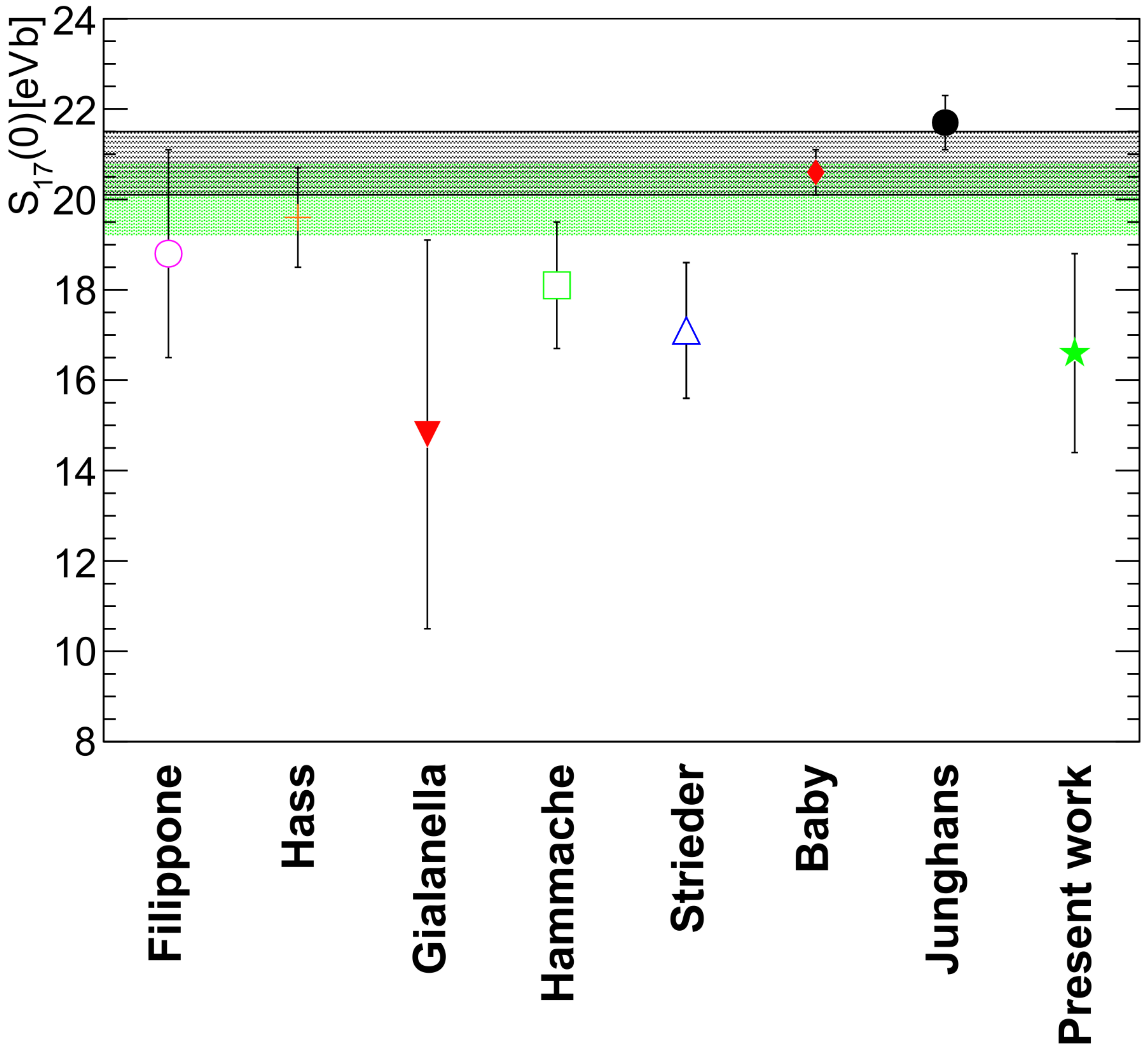
$^7Be(p,\gamma)^8B$ measurements





ERNA
European Recoil separator for Nuclear Astrophysics

The $^7Be(p,\gamma)^8B$ in the sun: S_{17}



Buompane et al., Physics Letters B 824/2022)136819

Next steps

- Further insight into this reaction needs precise and accurate absolute scale cross section measurements
- New measurements above the resonance, even at a limited number of energies, can help understanding whether differences are due to statistics or unaccounted systematic effects
- Thanks to a newly installed tandem solid stripper an extension of the previous campaign with ERNA has been planned up to about $E_{c.m.}$~1.2MeV (maximum achievable for $^{7}Be^{3+}$ and 3MV at terminal)
- The H_2 gas target has been replaced with a ^{4}He jet gas target. As a solution for $^{7}Be(p,\gamma)^{8}B$ measurements, owing to larger energies involved, solid polymer foils ($C_{10}H_8O_4$ or C_3H_6) can be used
- Actual measurement performed a few weeks ago, more to be done in the near future
- Time is required to accumulate enough counts to reach good statistical precision (we’re anyhow in the few events/h range)

ChETEC-INFRA TNA

- Application at ChETEC-INFRA TNA for production of ^{7}Be at cyclotron ATOMKI in August 2021
- Two weeks beam time allocated, production of about 6GBq in late April 2022
- Experimental activities are running for setup finalisation and first data taking at $E_{c.m.} \gtrsim 800$ keV

ERNA European Recoil separator for Nuclear Astrophysics

Conclusions

- A very intense ^{7}Be beam, up to 10^{9} pps, is routinely produced and characterized at the CIRCE laboratory;
- A total cross section measurement in inverse kinematic using a recoil separator of the $^{7}Be(p,\gamma)^{8}B$ reaction, between $E_{c.m.}$=366.9 and 812.3 keV, has been performed;
- A fit to ERNA data alone yields $S^{17}(0)$ =16.5 ± 2.0 eV b, this value is compatible only with a subset of previous determinations;
- A global fit including all data sets and considering the inflation of the systematic uncertainties provides an estimate S17(0) =19.6 ± 0.8 eV b that we suggest here.
- Further measurements to assess the absolute scale, also at energies above the resonance, are in our view important to get to amore accurate $S_{17}(0)$ estimate
- Support of the ChETEC-INFRA TNA action provided further access to ATOMKI Debrecen to start the high energy measurement campaign