Università degli Studi della Campania *Luigi Vanvitelli*

Dipartimento di Matematica e Fisica

7Be electron and proton capture in astrophysical conditions

L. Gialanella – ERNA and AsBeST collaborations

INFN Istituto Nazionale di Fisica Nucleare

CIRCE is part of the laboratory hub of the Department of Mathematics and Physics

- AMS
- IBA
- ICPMS and IRMS
- eSEM
- Laser spectroscopy
- α, β, γ counting
- chemistry and electromechanical support laboratories

- Basic research (nuclear, molecular and atomic physics)
- Applied research (environment, cultural heritage, biophysics, metrology, material science, ion implantation)
- University training (bachelor, master, PhD)
- Service

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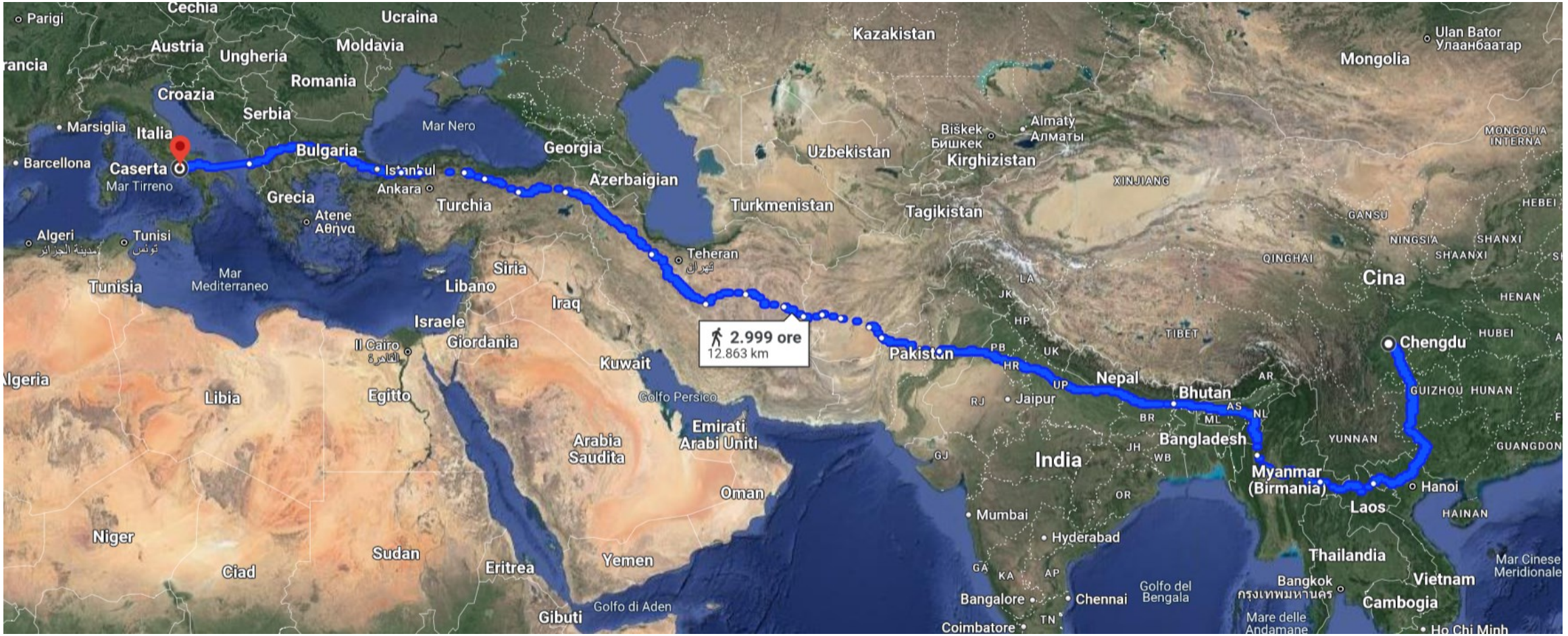
Istituto Nazionale di Fisica Nucleare

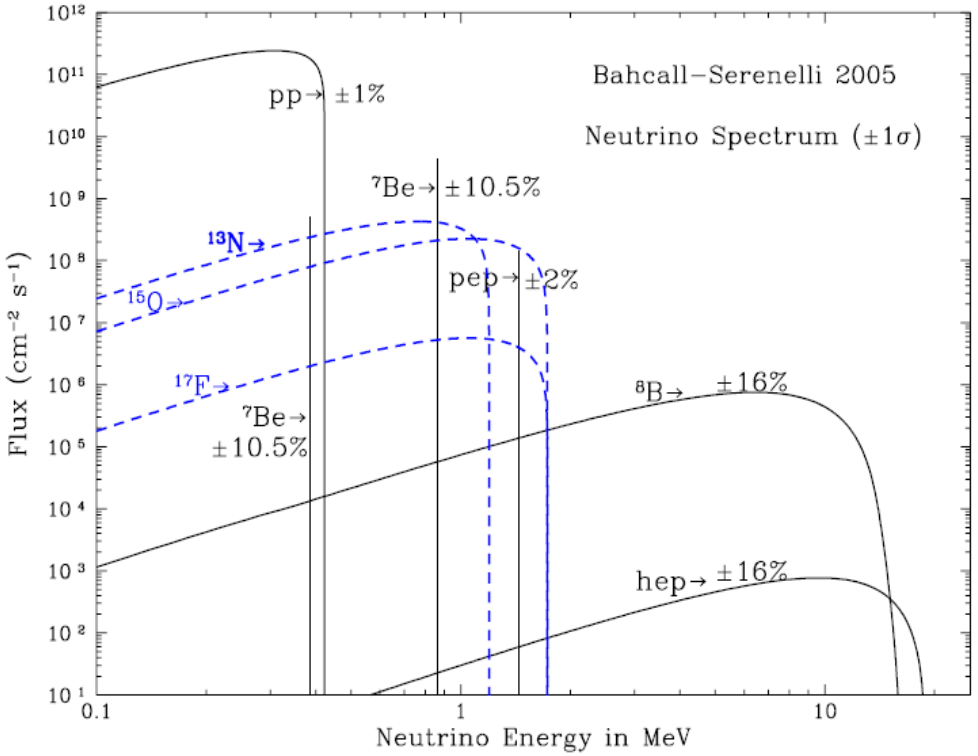


Radiochemistry Laboratory

Preparation in batch mode of medium lived radioactive ion beams: ^{7}Be

Radioactive ion beam injector

Hydrogen burning and solar neutrinos



^{7}Be production

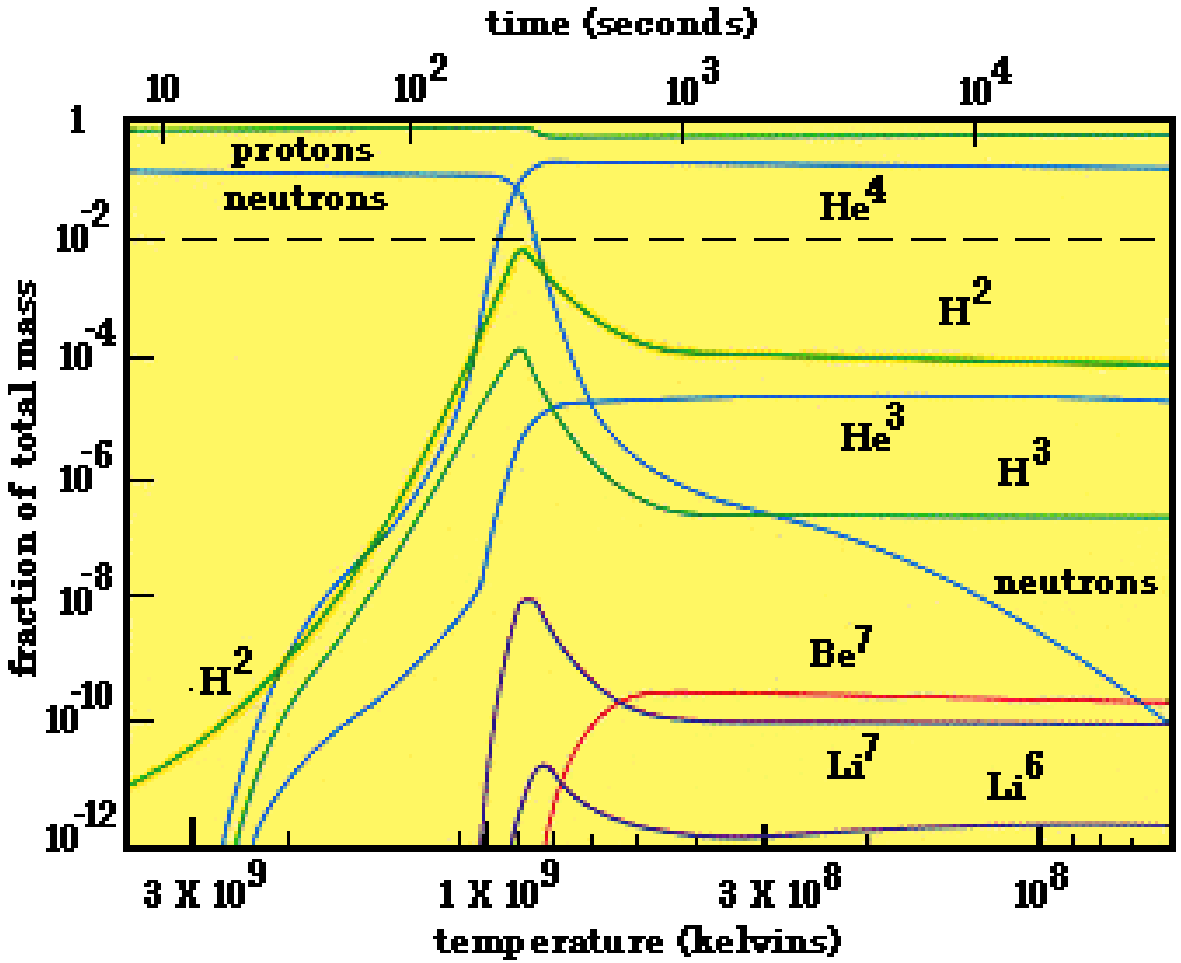
^{3}He(^{4}He,γ)^{7}Be

^{7}Be destruction

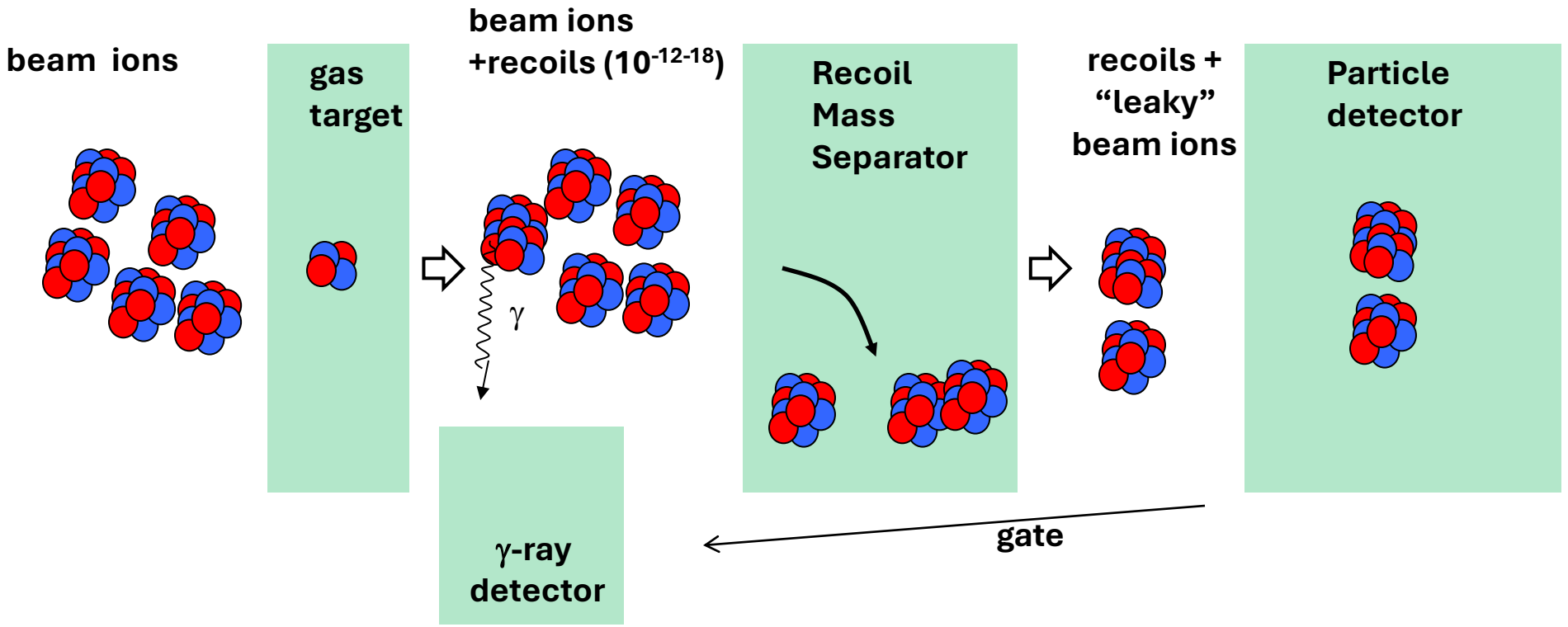
^{7}Be(p,γ)^{8}B

^{7}Be EC decay to ^{7}Li

Big Bang Nucleosynthesis



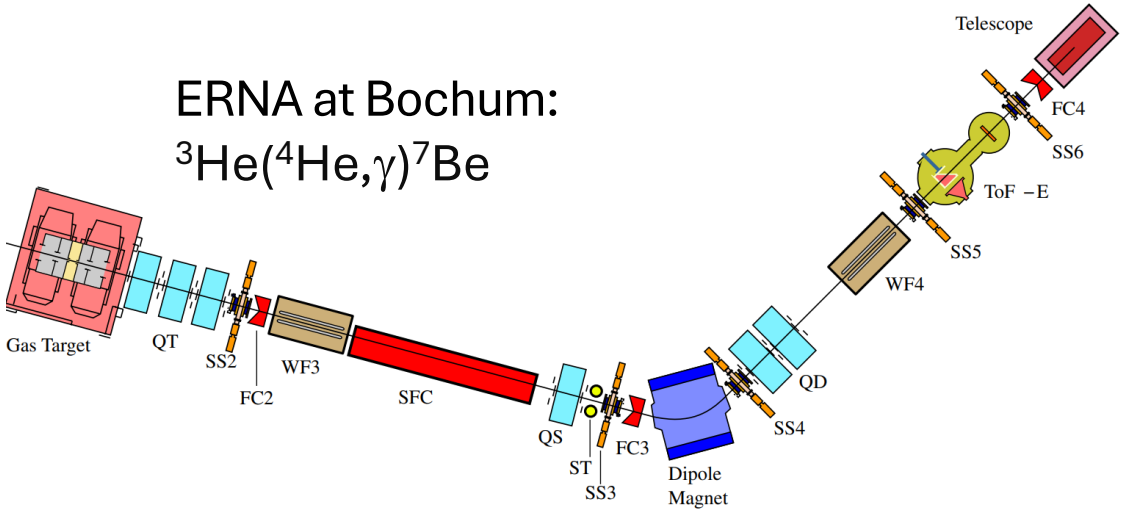
RMS : working principle

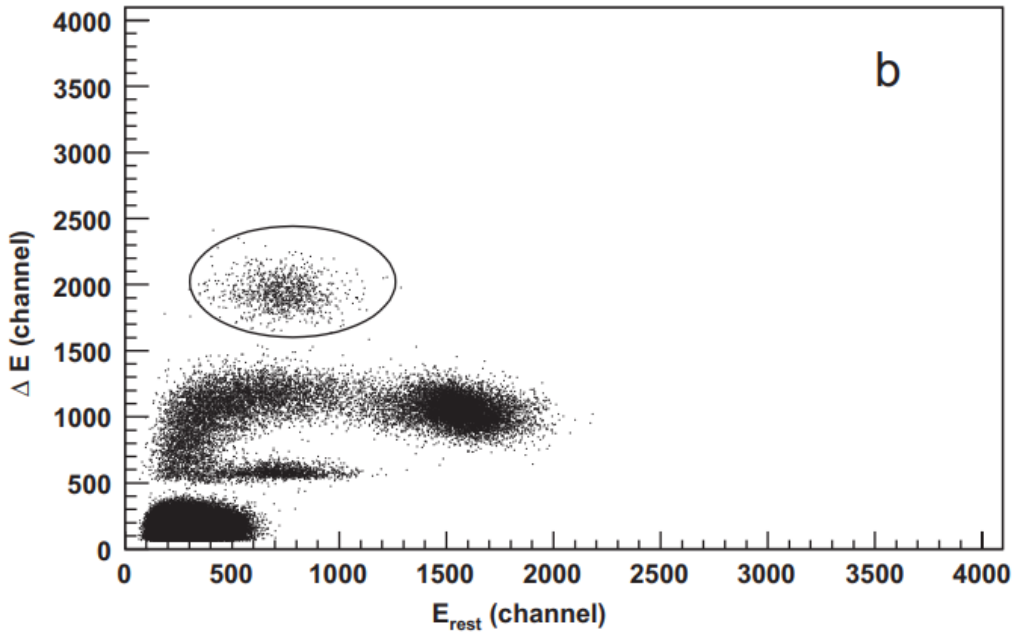


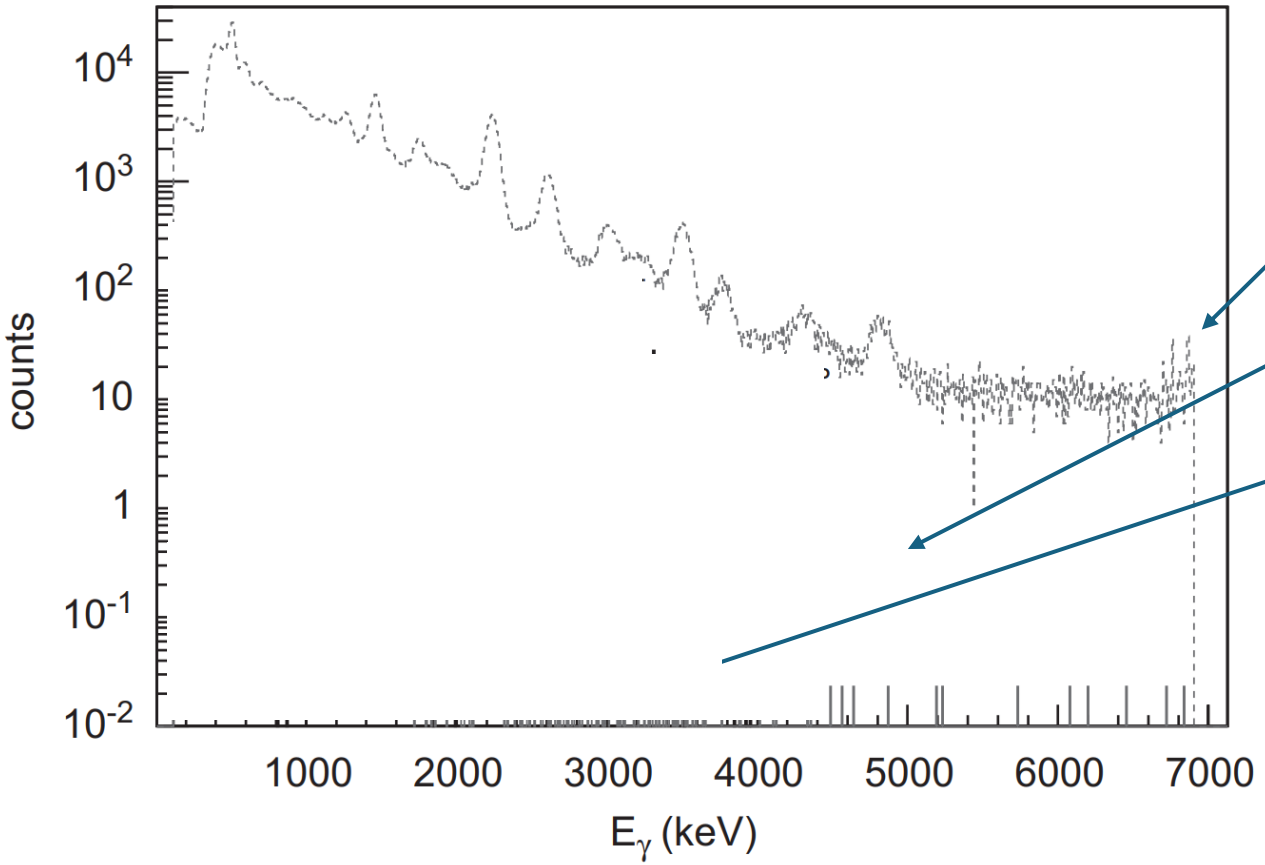
$$N_{recoils} = N_{projectiles} \times n_{target} \times \sigma \times T_{ERNA} \times \underline{\Phi}_q \times \varepsilon_{part}$$

$$N_{\gamma} = N_{recoils} \times \varepsilon_{\gamma}$$

ERNA at Bochum:
$^3He(^4He,\gamma)^7Be$







Coincidence condition with any ion

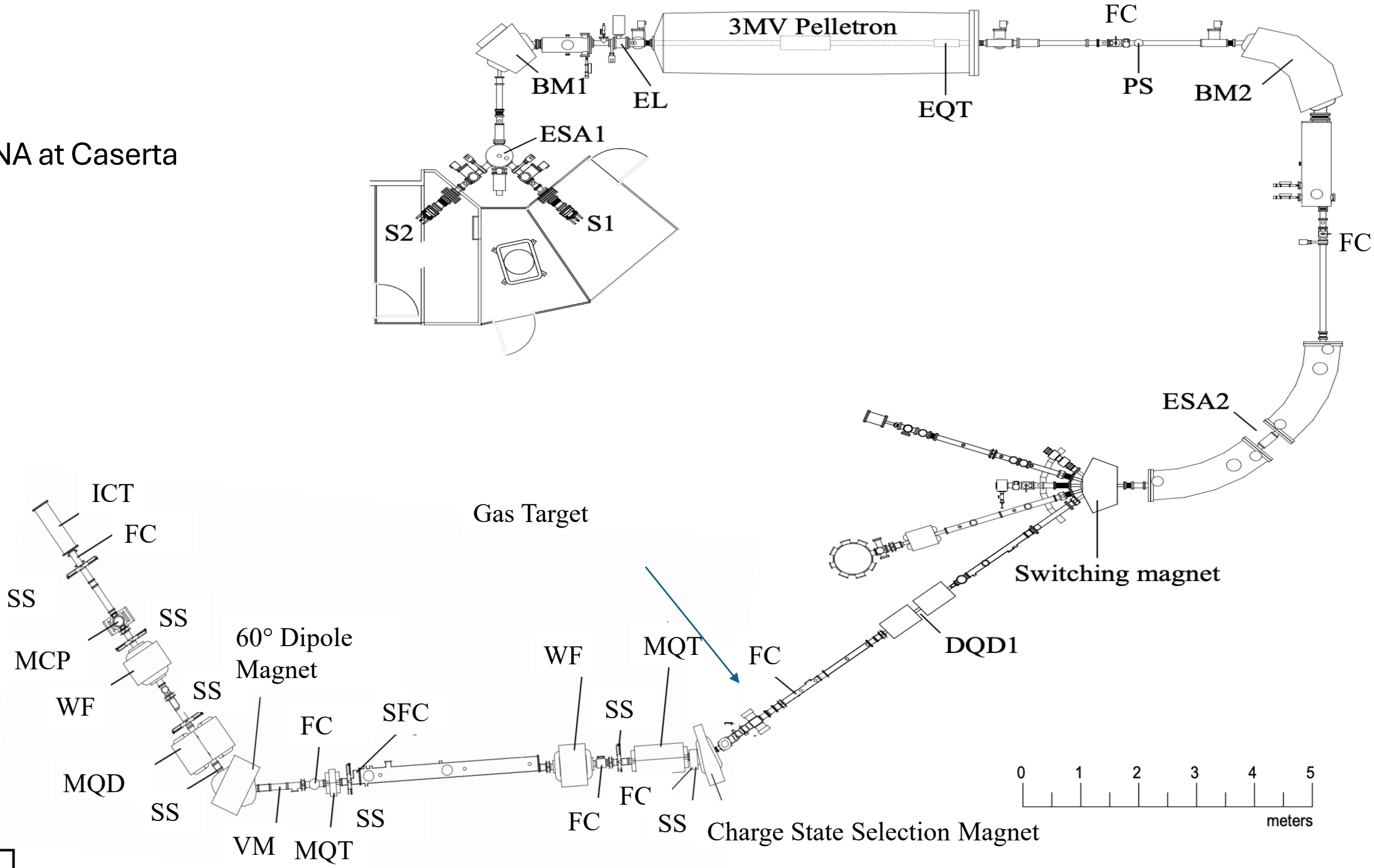
Coincidence condition with 7Be ions

Normalized coincidence with leaky ions,
i.e. residual background

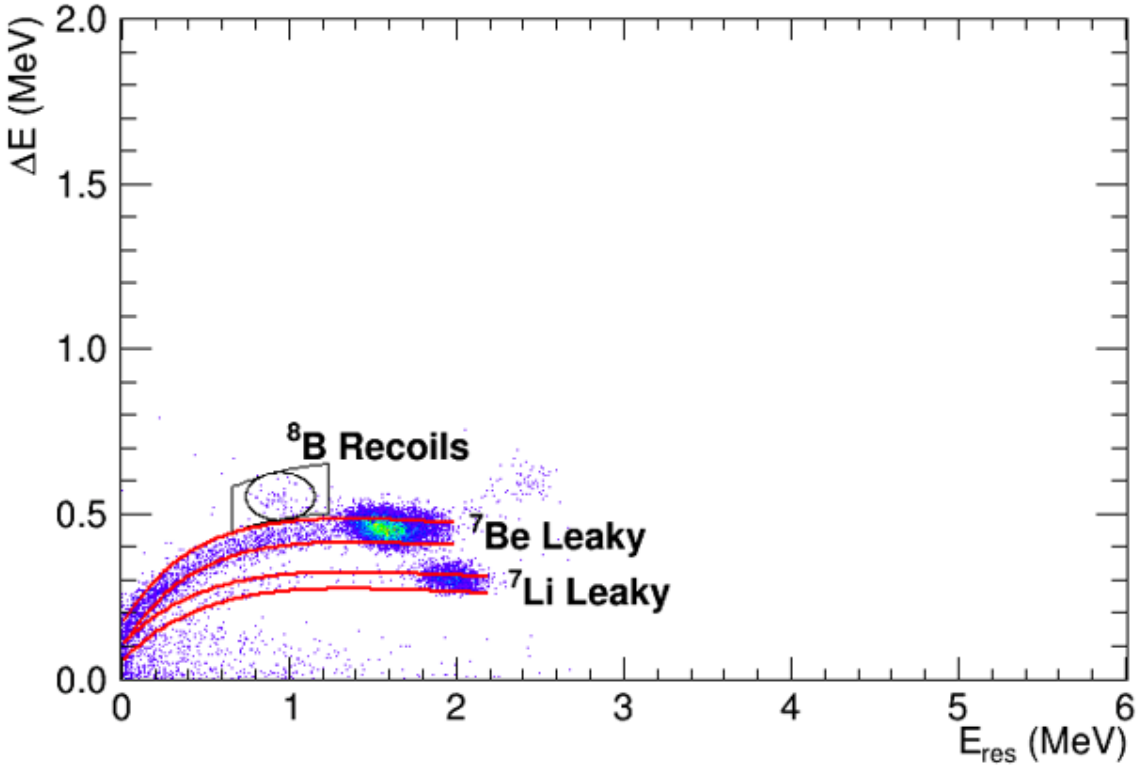
Overall γ–ray background suppression ~ 10^{-5}
NOTE: with no passive shielding

Di Leva et al, Phys.Rev. Lett. 102(2009)
Di Leva et al Nucl. Instr. Meth. A (2008)

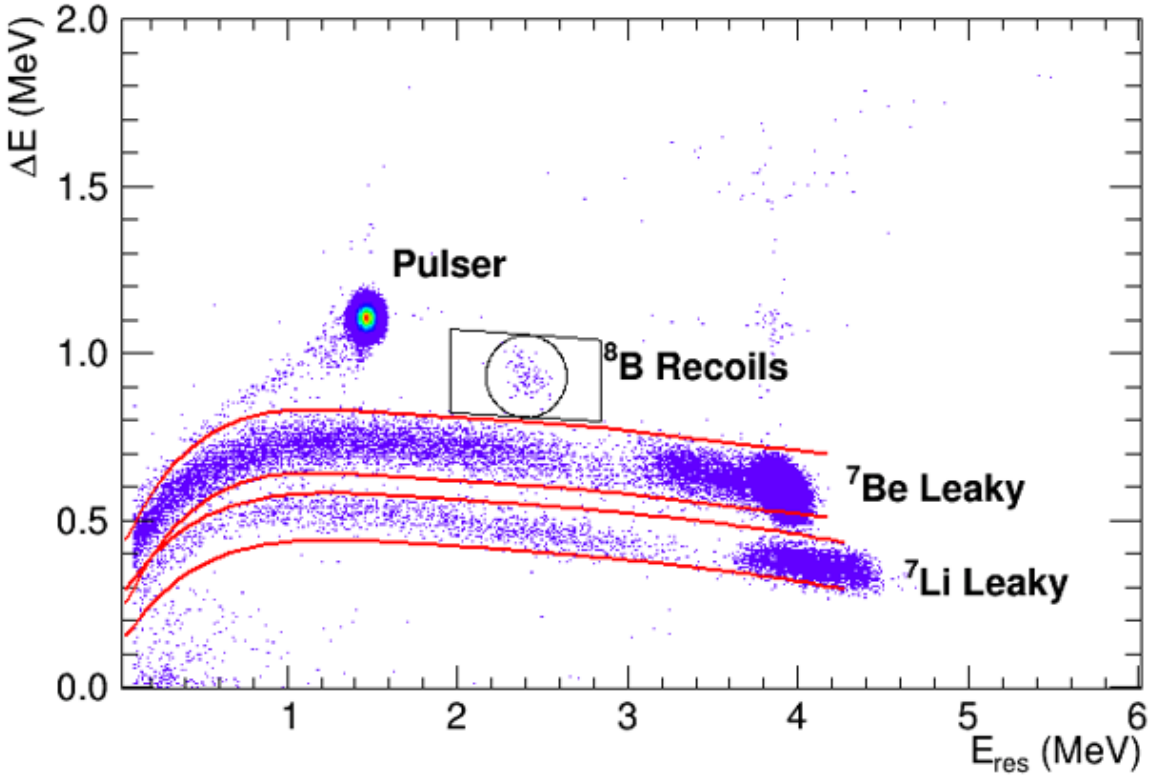
ERNA at Caserta



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

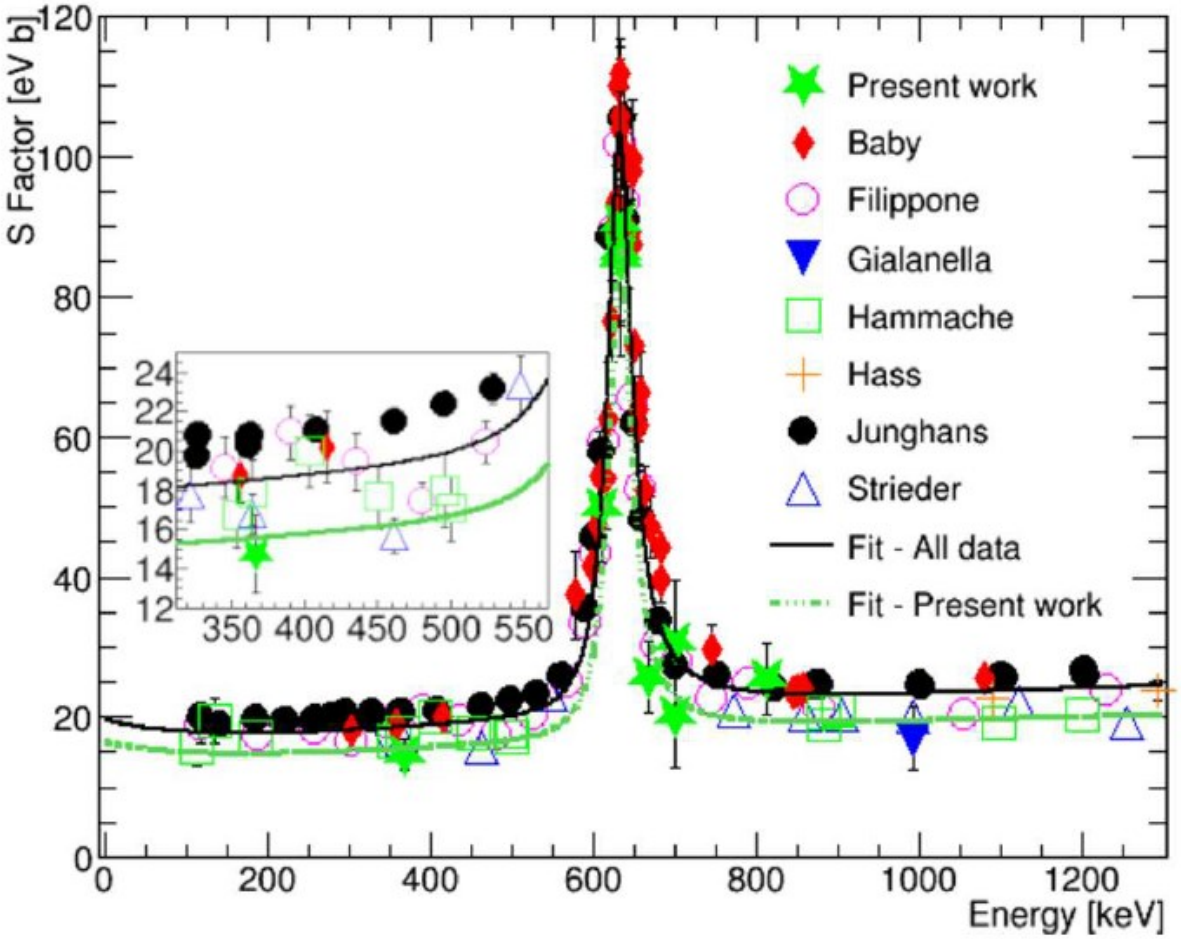


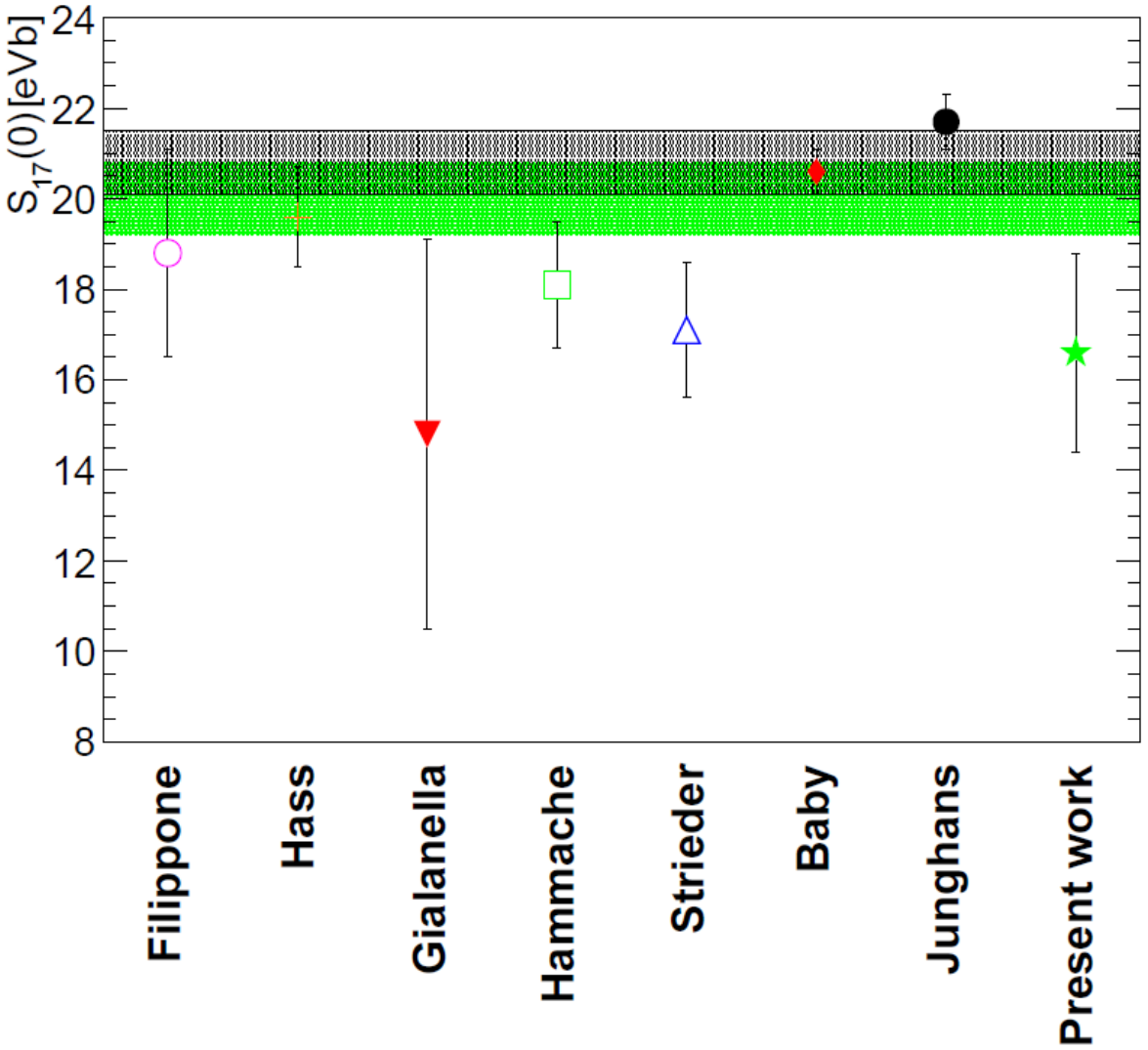
E=367 keV



E=632 keV

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

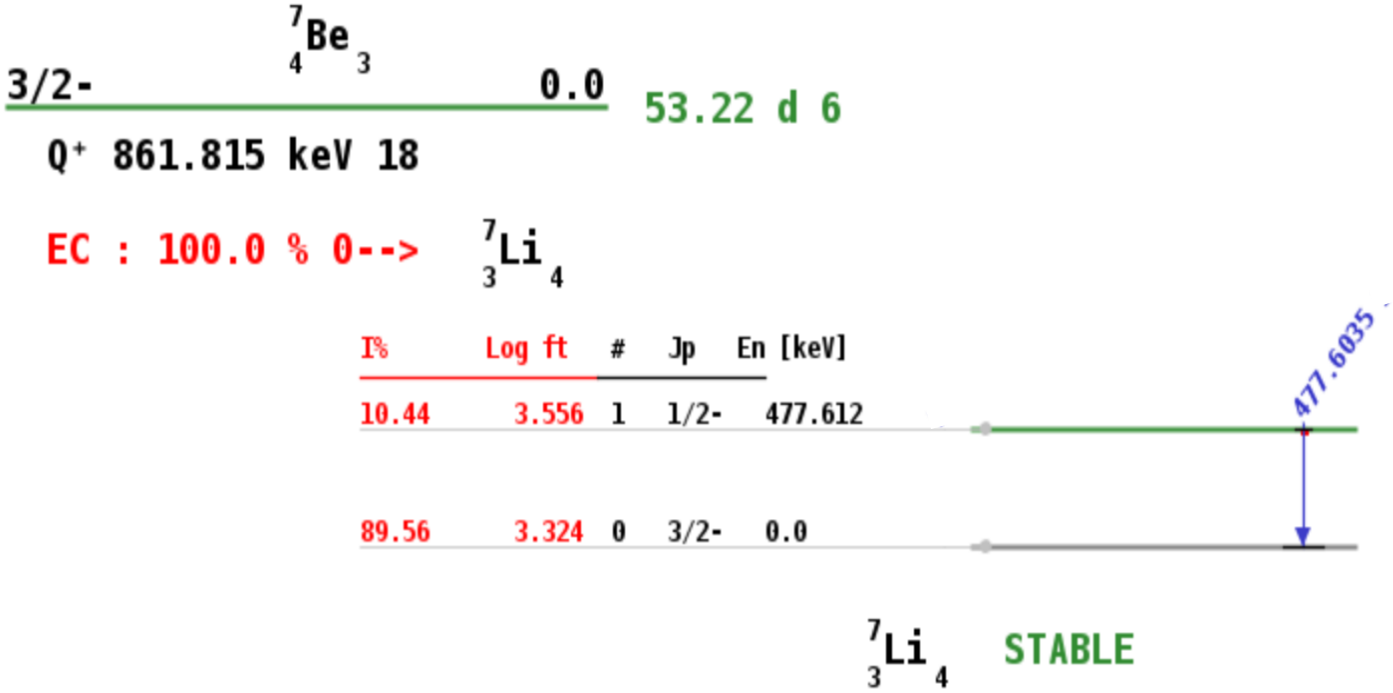




Buompane et al, Phys.Lett. B 824(2022)
Buompane et al Eur. Phys. J. A 54(2018)

For a recent evaluation wait for Solar Fusion 3

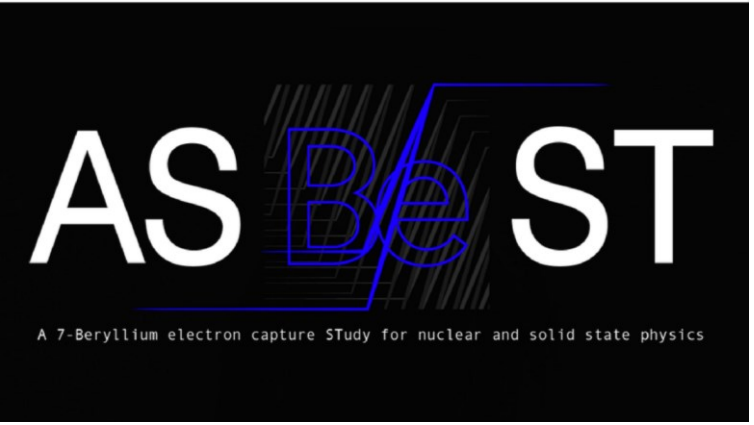
^{7}Be EC decay to ^{7}Li



$t_{1/2}=\kappa/f_0\xi$

$\xi=B_F+B_{GT}$

f_0 is not the same in astrophysical and terrestrial condition



A 7-Beryllium electron capture STudy for nuclear and solid state physics (ASBeST)

MUR
Ministero dell'Università e della Ricerca

How can we change f_0 in a laboratory?

In solid state environments

Università degli Studi della Campania *Luigi Vanvitelli*

Dipartimento di Matematica e Fisica

Università di Salerno
Dipartimento di Ingegneria Industriale

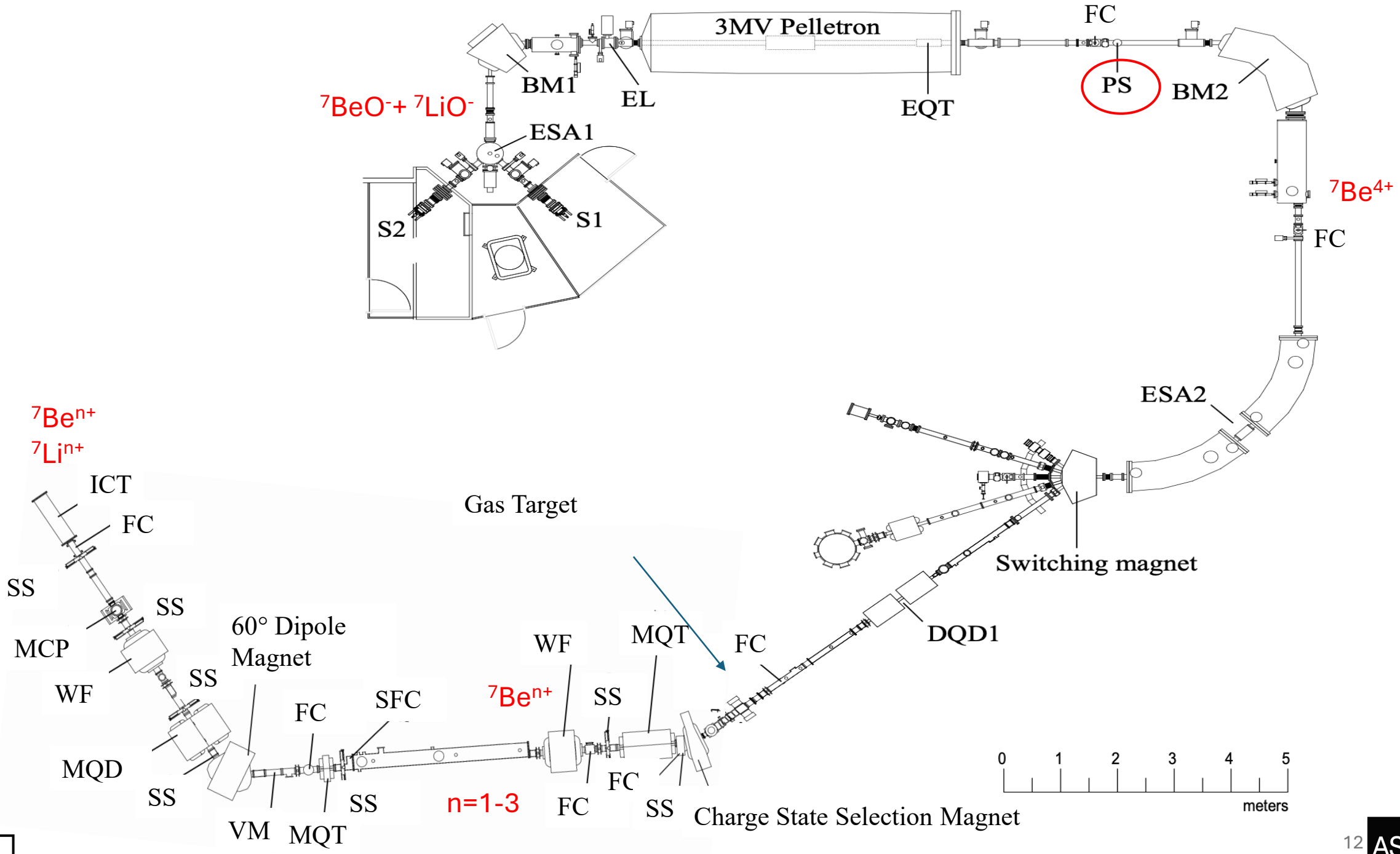
INFN LNGS

In ions

INFN ROMA

IMM Institute for Microelectronics and Microsystems

atomki DEBRECEN


3MV Pelletron
FC
PS
BM2
BM1
EL
EQT
$^{7}BeO^{-}$+ $^{7}LiO^{-}$
ESA1
S2
S1
$^{7}Be^{4+}$
FC
ESA2
$^{7}Be^{n+}$
$^{7}Li^{n+}$
ICT
FC
Gas Target
SS
SS
MCP
60° Dipole
Magnet
WF
SS
MQT
FC
DQD1
SS
FC
SFC
$^{7}Be^{n+}$
WF
SS
MQT
FC
MQD
SS
n=1-3
FC
SS
Charge State Selection Magnet
VM
MQT
0
1
2
3
4
5
meters

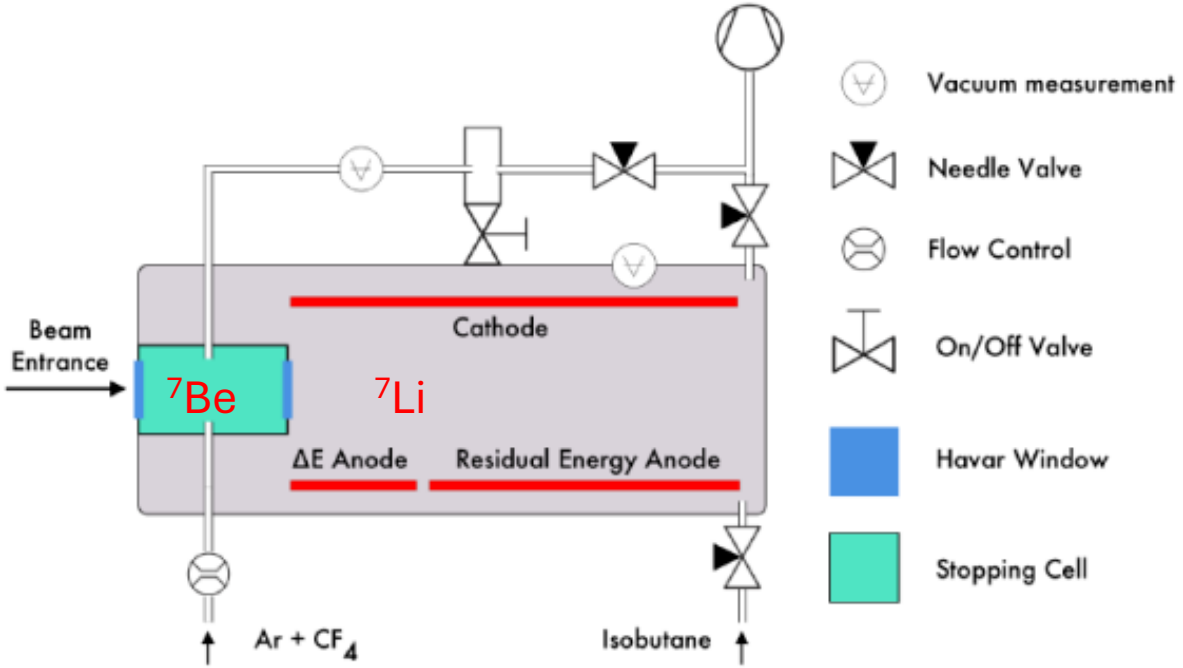


Fig WP1.2.1 Scheme of the setup of the Ionization Chamber with the additional cell.

We plan to use 80 GBq to reach above 500 counts in the 2+ and 3+ charge states

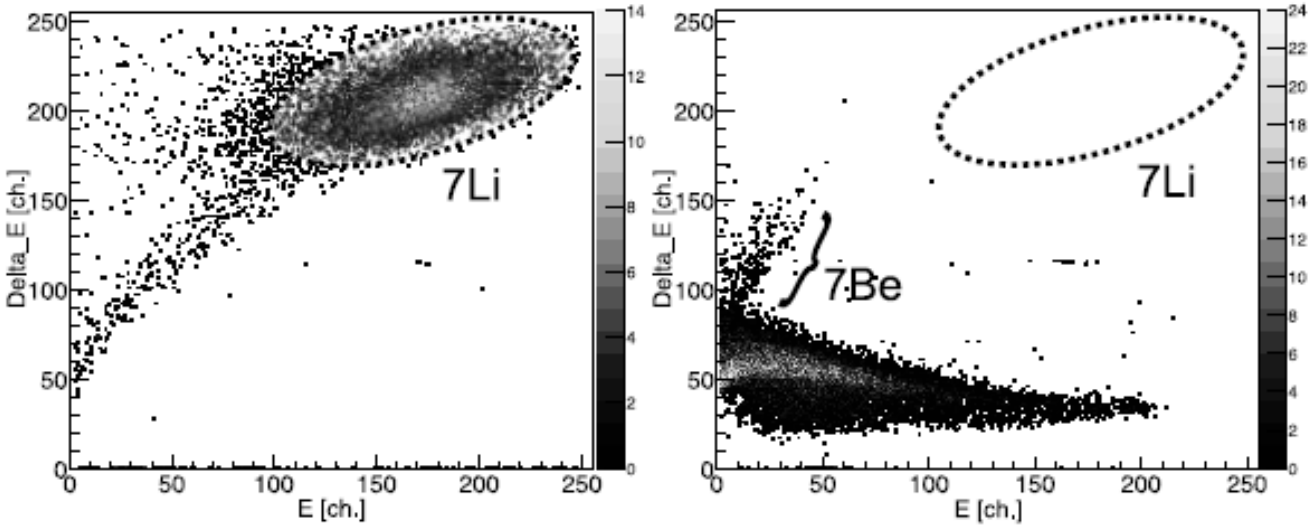
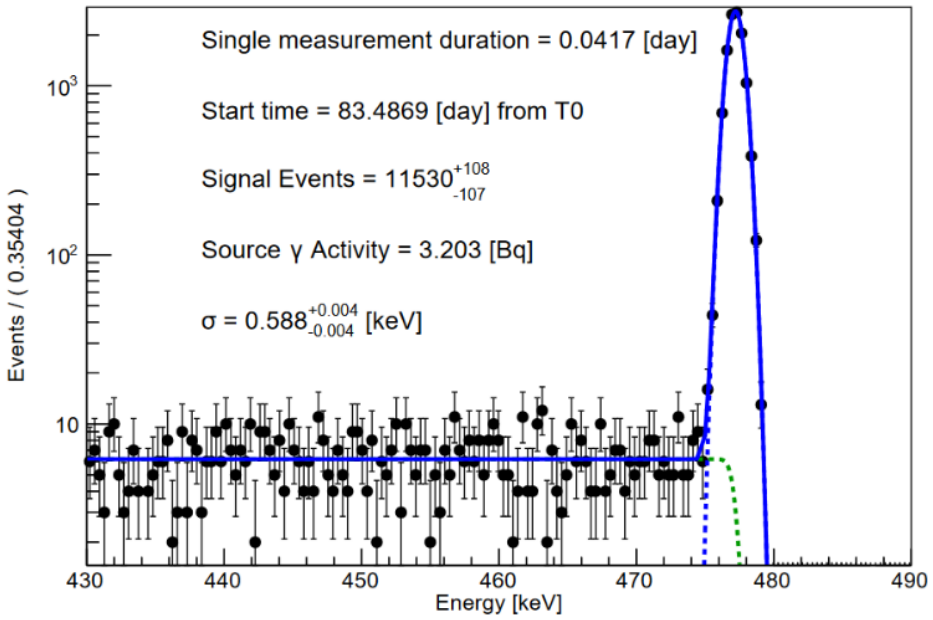


Fig. WP 1.2.2 $\Delta E/E$ matrices with a test ^{7}Li beam (left) and a ^{7}Be beam (right). ^{7}Li spot is ci
in the matrices. ^{7}Be ions may channel through windows causing events on the left of the matri

In the meanwhile, a high precision and accuracy measurement of the ^{7}Be halfllife at LNGS



Santonastaso et al submitted

Outlook:

1. Complete 7Be EC measurements

2. Measurements of $^{12}C(a,\gamma)^{16}O$ with the new jet target and NaI array

3. RMSs, and other active shielding techniques have a lot of potentialities