Experimental measurement of the $^{12}C+^{12}C$ reactions via charged-particle detection

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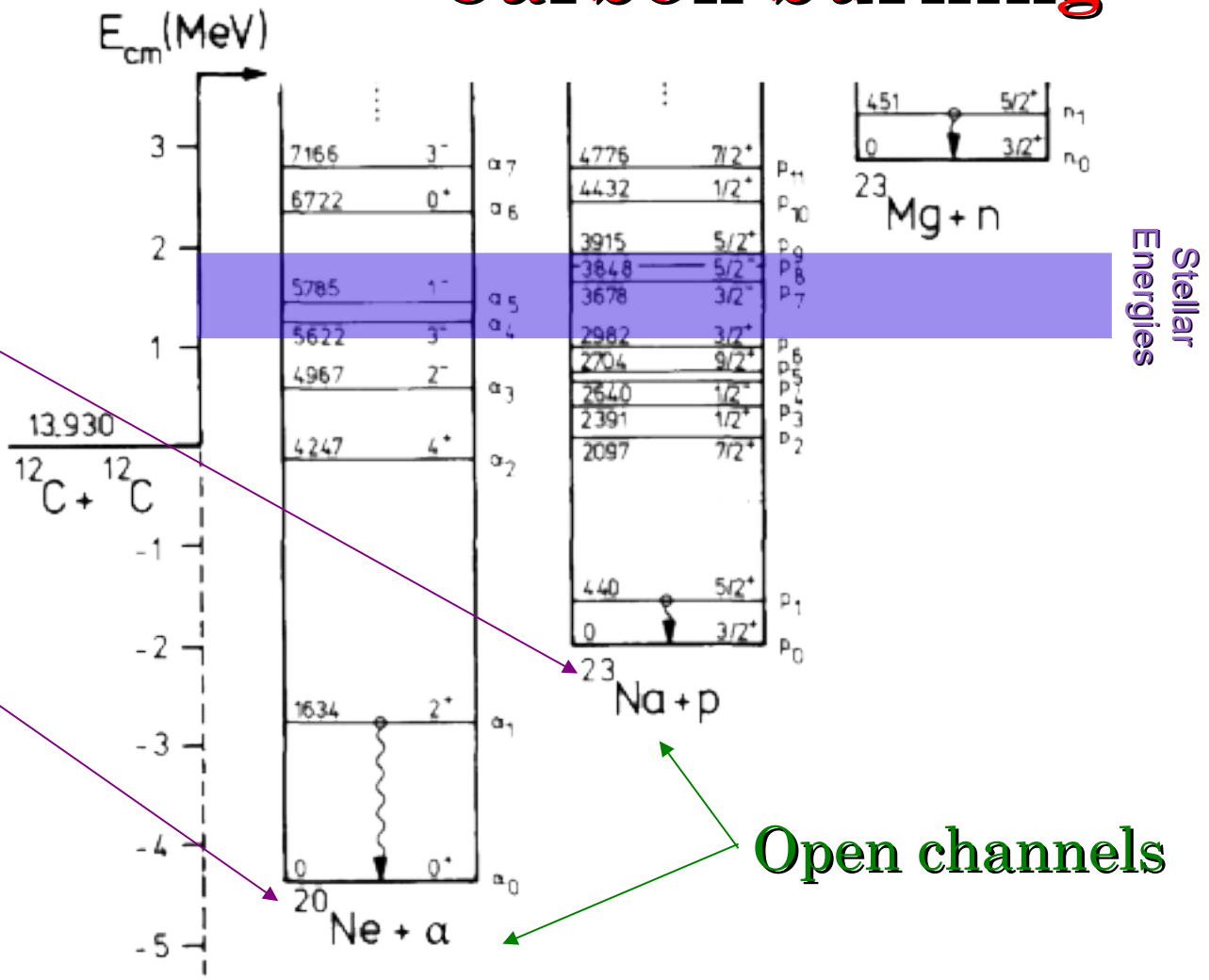
IX Incontro dei Gruppi Italiani di Astrofisica Nucleare Teorica e Sperimentale GIANTS 2017

$^{12}C+^{12}C$ reactions in stars:

- Energy range E= 1.5 ± 0.3 MeV

Carbon burning



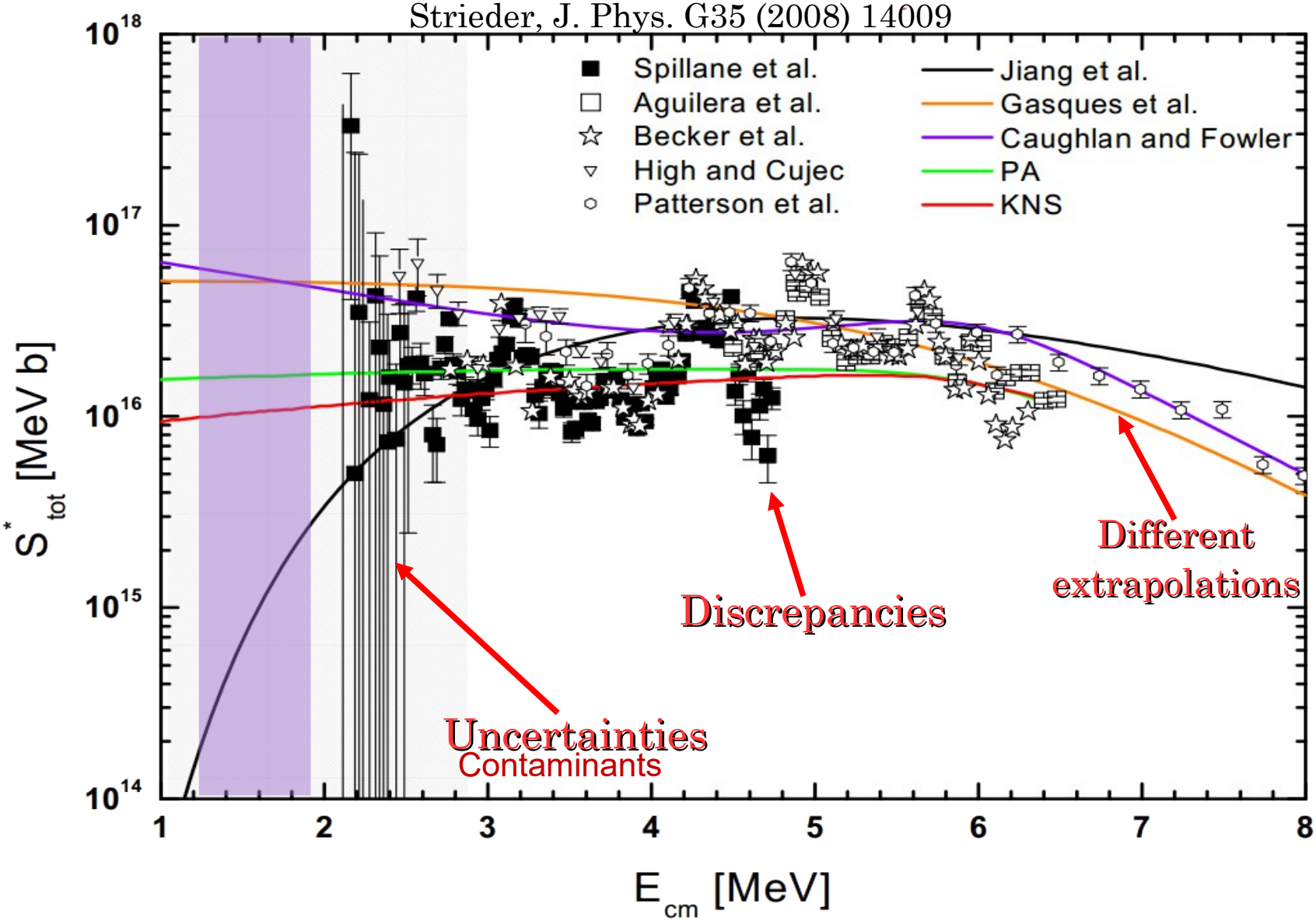
Q = 2.24 MeV

Q = 4.62 MeV

Open channels

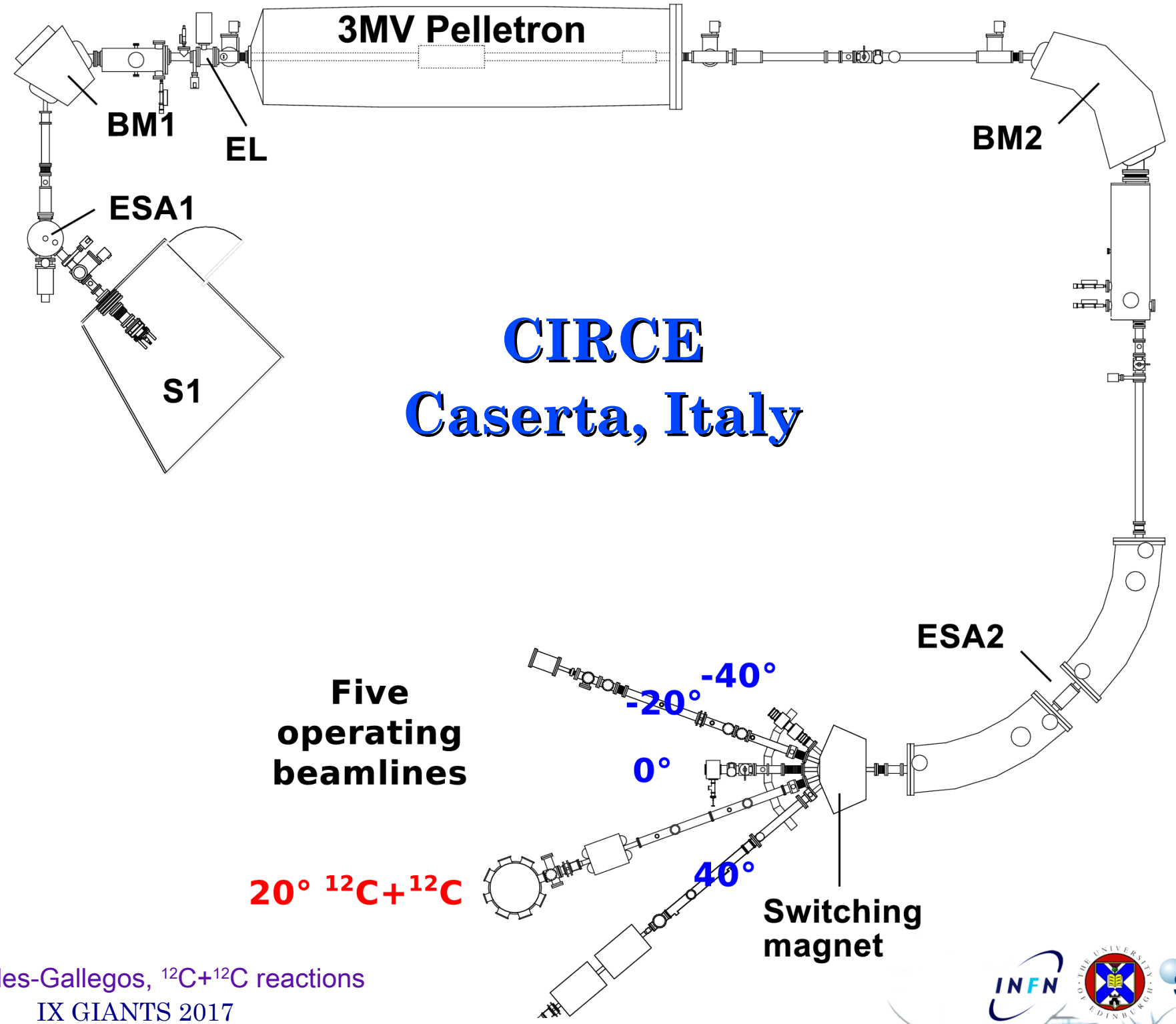
Previous works

Strieder, J. Phys. G35 (2008) 14009

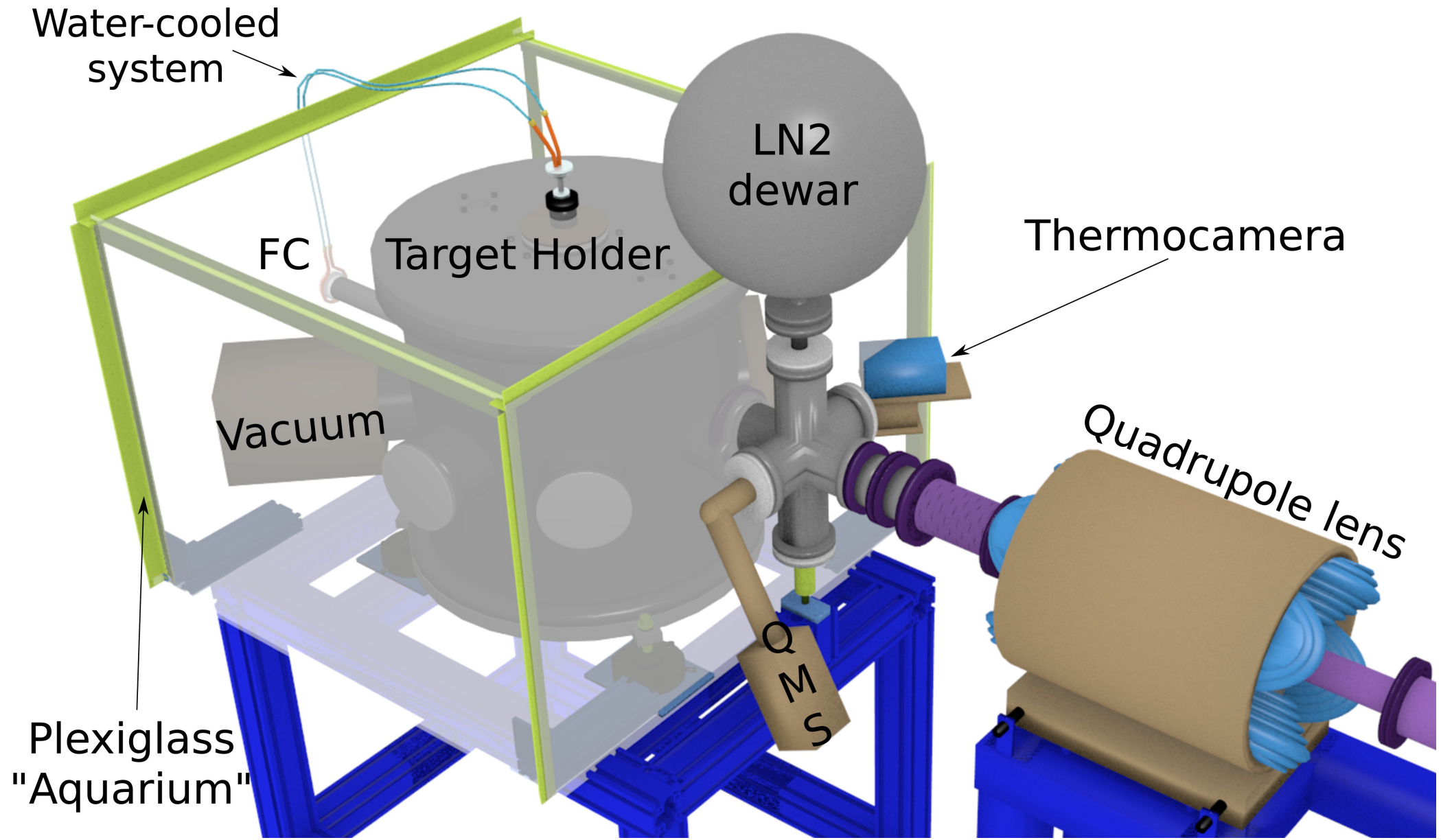


Our experiment

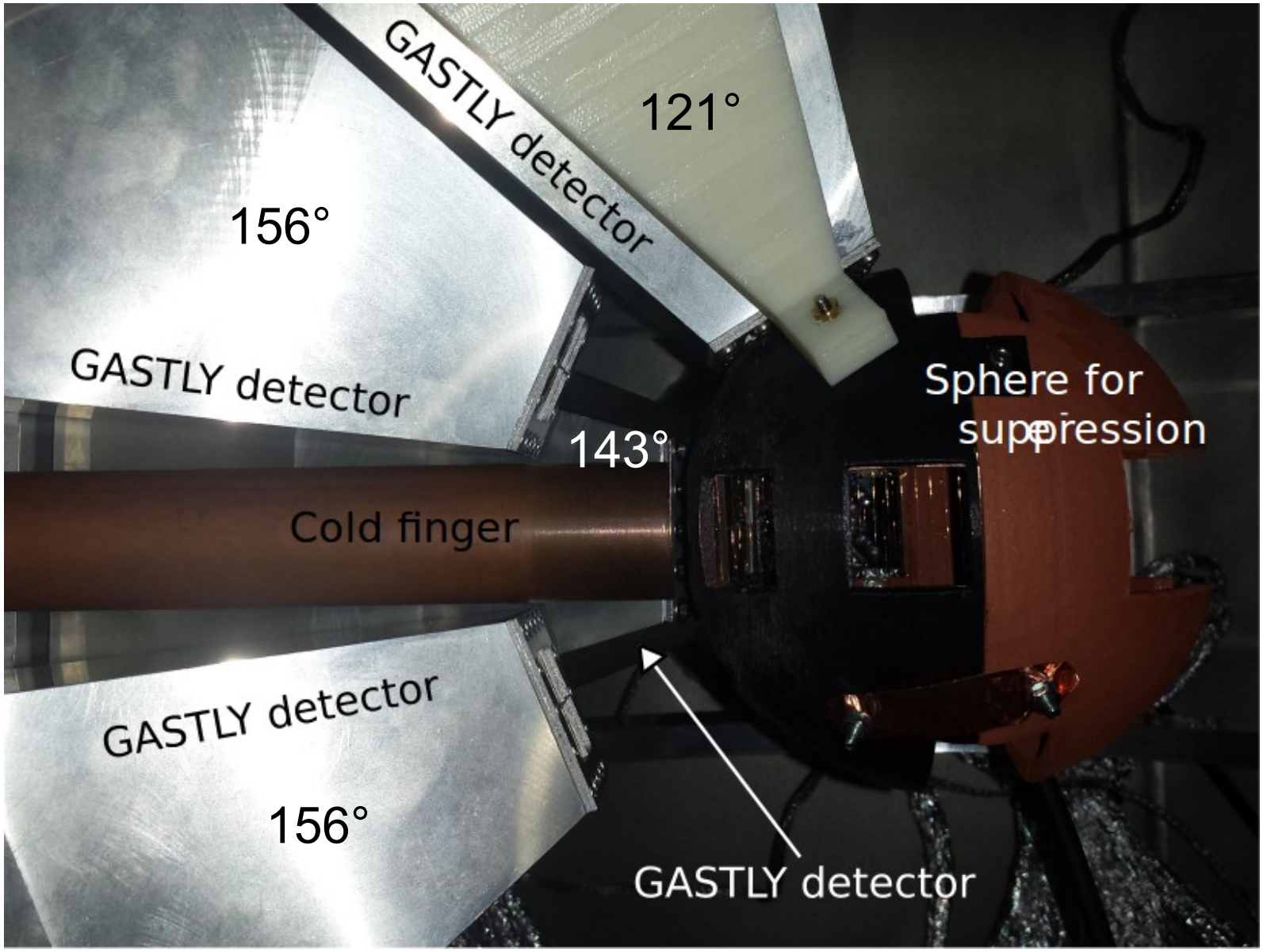
- CIRCE accelerator, Caserta (CE)
- Four ΔE-Erest detectors, HOPG target
- Study of carbon targets contamination VS temperature
- $^{12}C+^{12}C$ reactions measurement E_{lab} = 5.05 – 8.6 MeV (50 keV steps)
- Skewed Gaussian fitting functions to the spectra
- Extraction of yields, cross sections and modified S-factors


3MV Pelletron
BM1
EL
BM2
ESA1
S1
CIRCE
Caserta, Italy
ESA2
Five
operating
beamlines
-40°
-20°
0°
40°
20° $^{12}C+^{12}C$
Switching
magnet

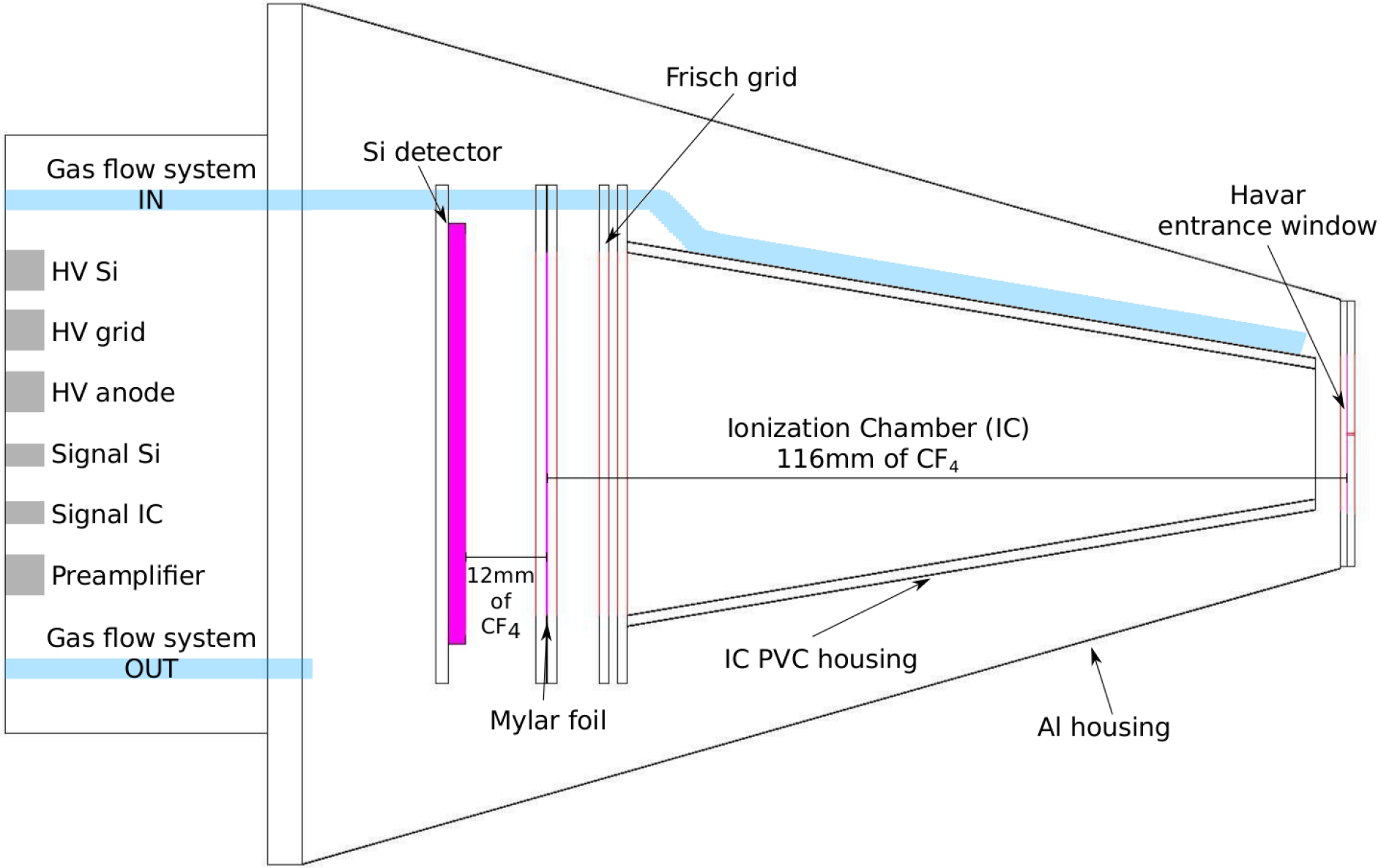
Beamline


Water-cooled system
LN2 dewar
FC
Target Holder
Thermocamera
Vacuum
Quadrupole lens
QMS
Plexiglass "Aquarium"

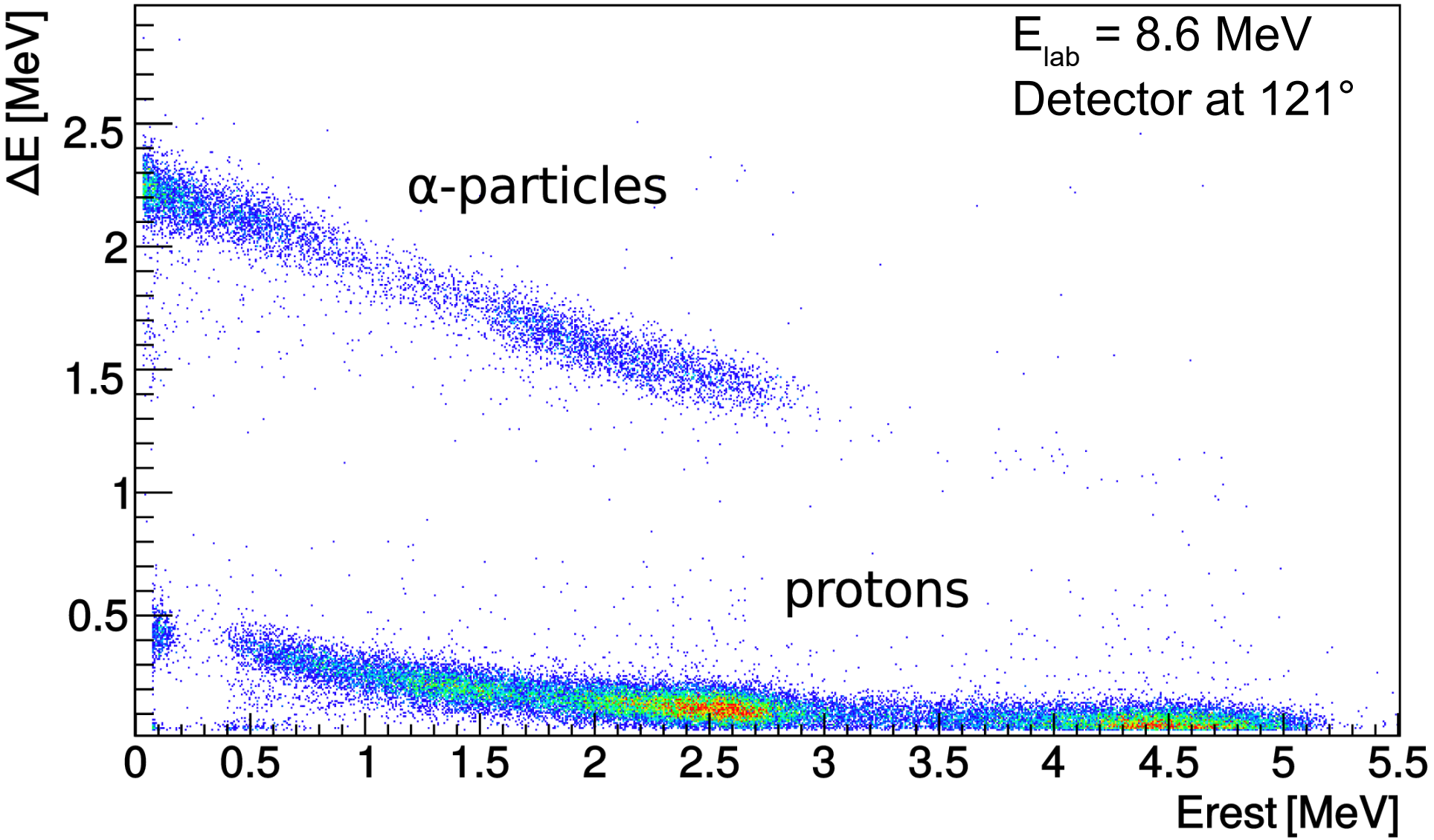
GASTLY detectors



GASTLY detectors



GASTLY ΔE-Erest Matrix



Beam induced background

Contaminant direct reactions:

$p(^{12}C,p)^{12}C$

$d(^{12}C,d)^{12}C$

No p at backward angles

$p(^{12}C,d)^{11}C$

$d(^{12}C,p)^{13}C$

Contaminant secondary reactions:

Stopped in IC

$^{12}C(p,p)^{12}C$

$^{12}C(d,d)^{12}C$

Closed (Q=-16.5 MeV)

$^{12}C(p,d)^{11}C$

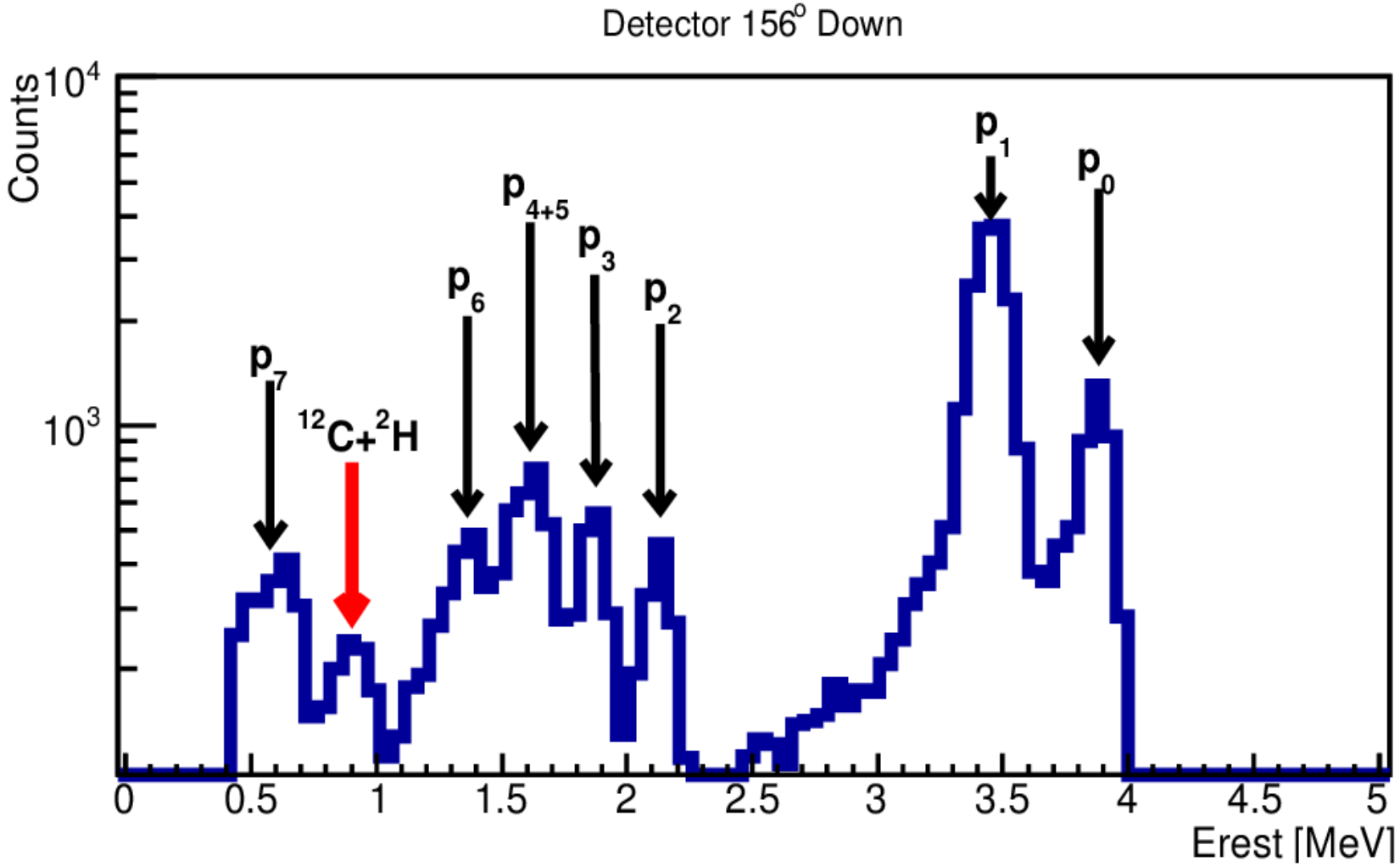
~~$^{12}C(d,p)^{13}C$~~

Beam induced background

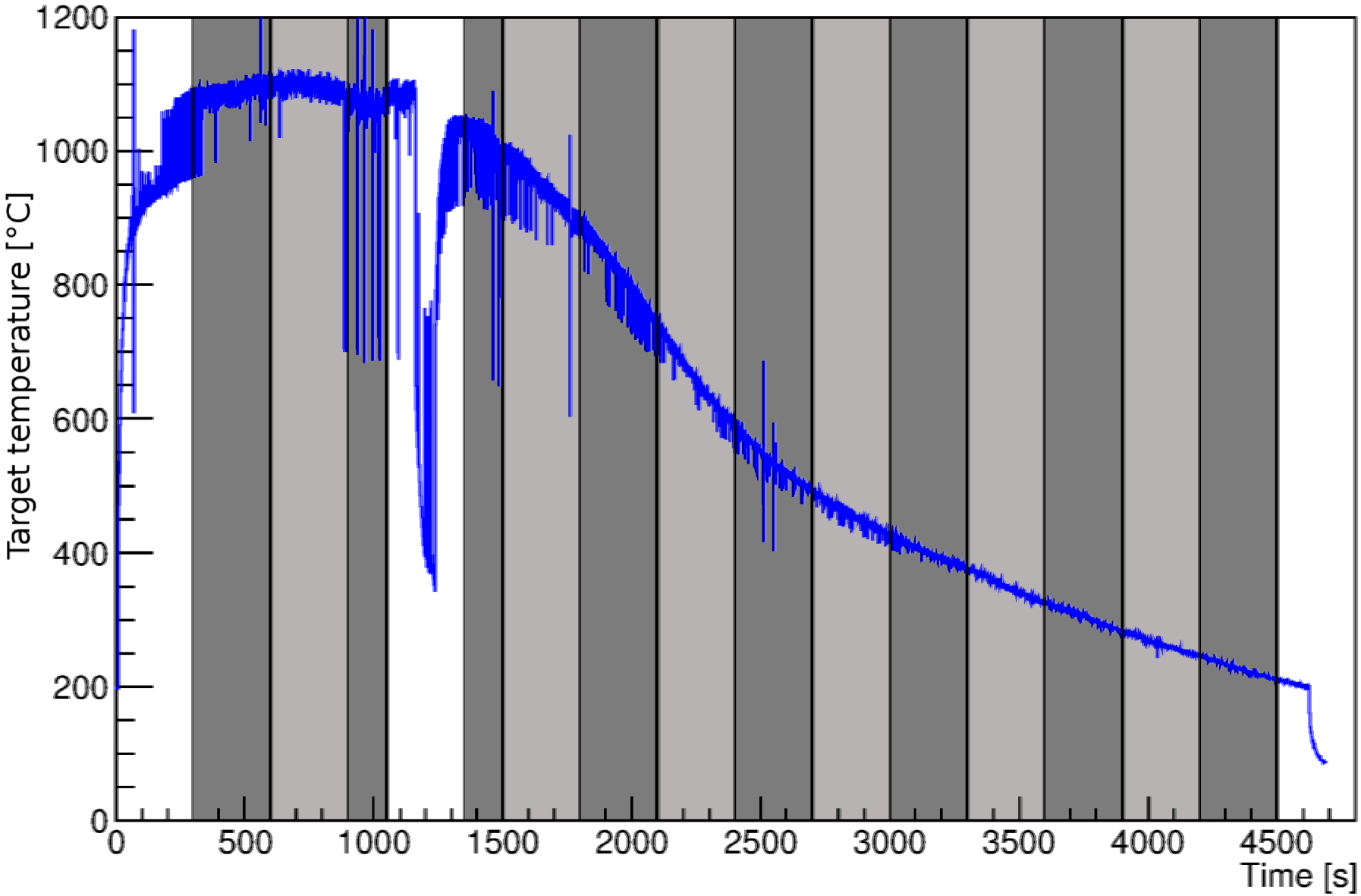
Targets:

NG
HOPG

(1mm)



Targets deuterium reduction



Targets deuterium reduction Results

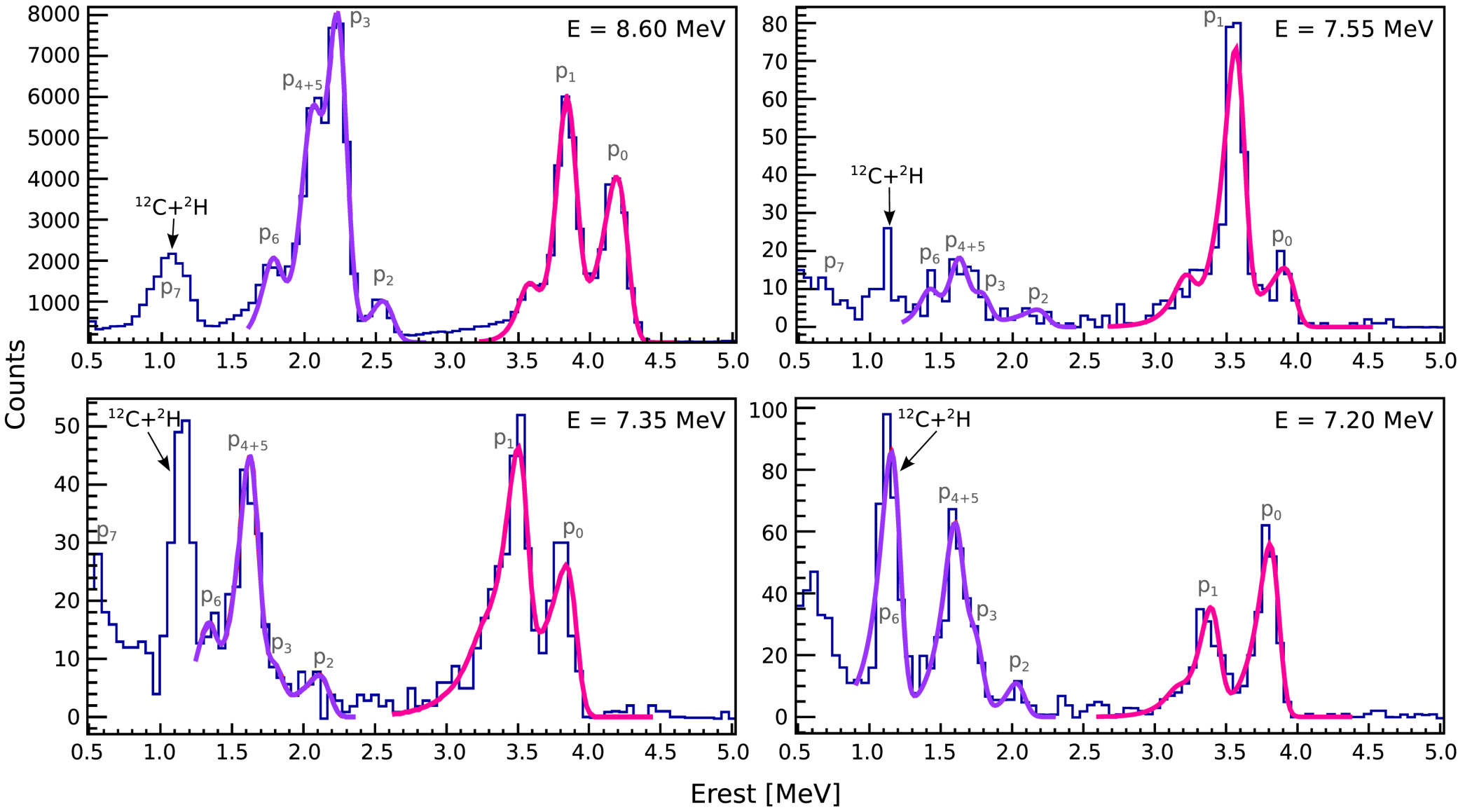
Reduction of ^{2}H contaminants in targets of 50-80% depending on detection angle

Reduction of ^{2}H contaminants in targets with the use of the N_2 "aquarium" (800°C – 1000°C)

For beam-induced background minimization in the $^{12}C(^{12}C,p)$ reaction measurement:

- Target temperature > 400°C
- N_2 "aquarium" at E_{lab} < 5.50 MeV

GASTLY Erest spectra Det. 156°



Future work

- Theoretical work on the possible new resonances
- Analysis of the alpha channel
- Measurement of angular distributions using SSDs and eight GASTLY modules at different angles

Grazie!