Measurement of β-delayed α spectrum of ^{16}N with a new technique (1)

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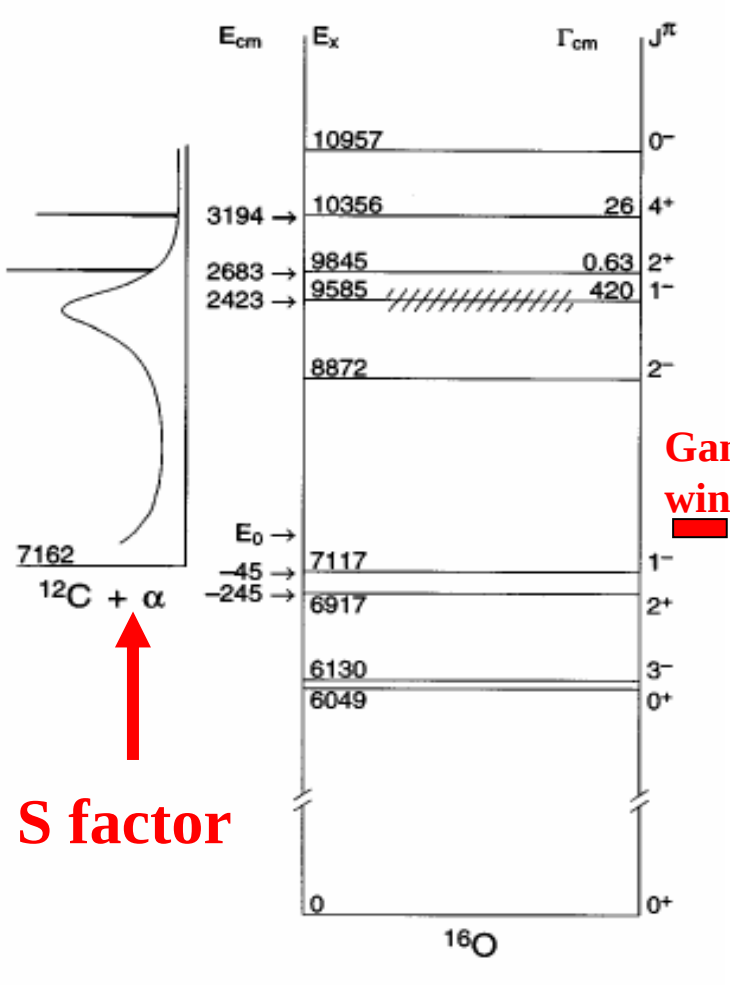
1. Motivation --- ^{12}C(α,γ)^{16}O reaction
2. β-delayed α decay of ^{16}N
3. Production of ^{16}N beam
4. Slowing down the ^{16}N beam

Motivation

- $^{12}C(\alpha,\gamma)^{16}O$ reaction
- Significant effects on $^{12}C/^{16}O$ ratio produced by helium burning, subsequent nucleosynthesis and supernova explosion
- Required cross section for energies of about 0.3 MeV

Direct measurement only for ≥ 1 MeV

Extrapolation to the lower energies using R- or K-matrix theories, but complicated by two sub-threshold states, $J^{\pi}=1^{-}$ and 2^{+}.



S factor

Gamow window

$$S_{total}=S(E1)*f(S(E2)/S(E1),\Phi)$$

C. Brune, Phys. Rev. C64,055803(2001)

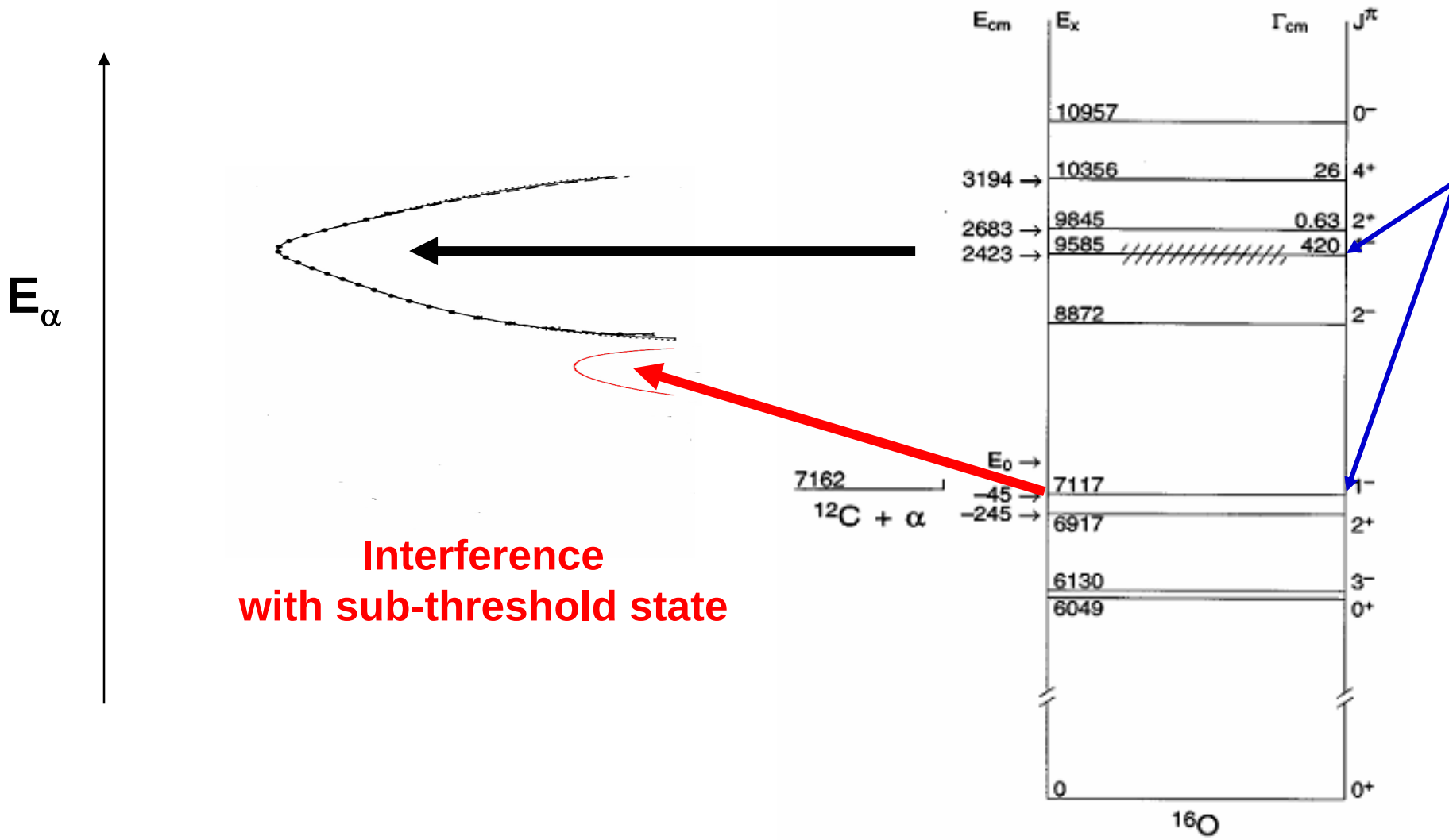
Input:

S(E1): ^{16}N β decay

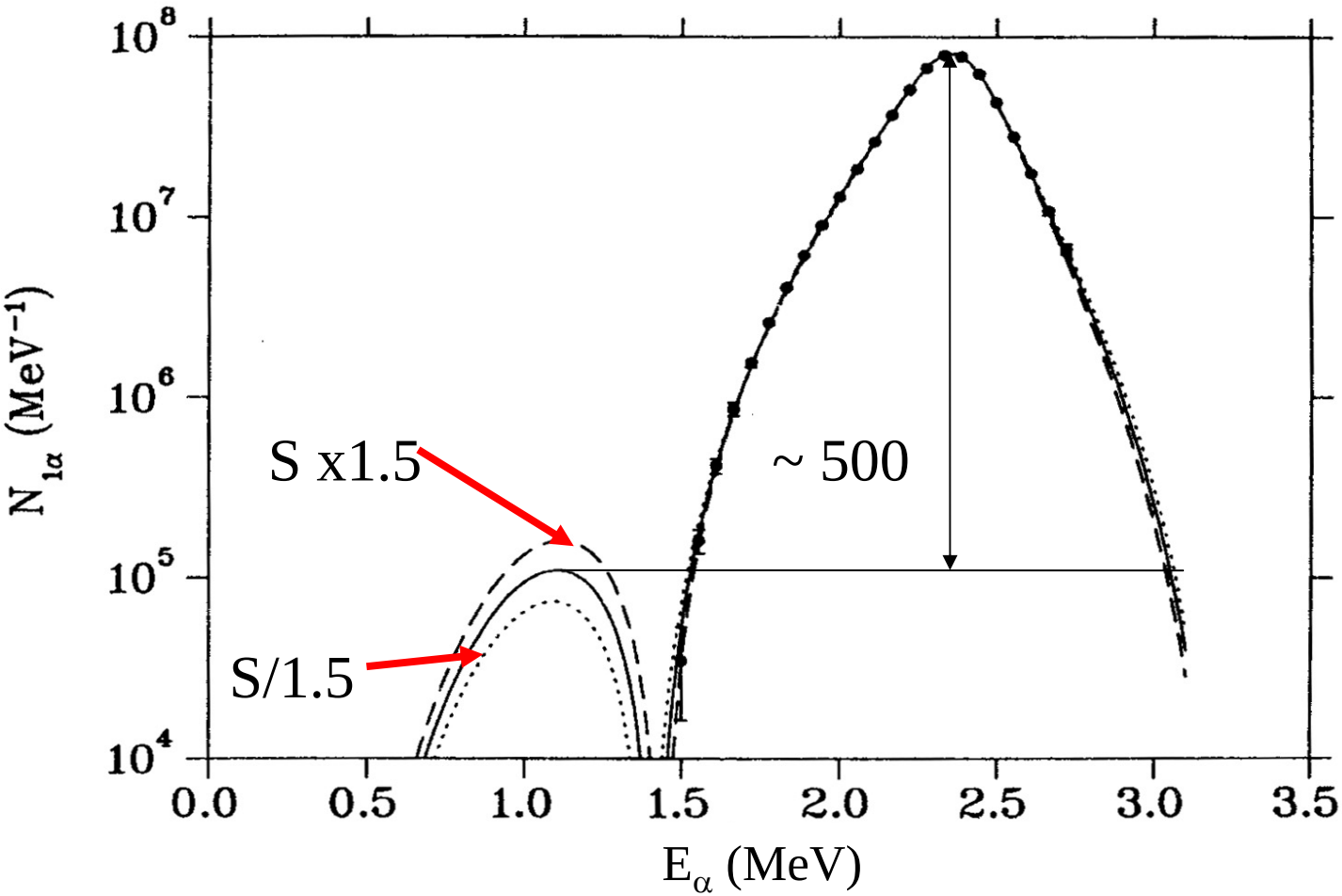
S(E2)/S(E1): direct meas. at higher energies

Φ : ^{12}C + α phase shifts

β-delayed α decay of $^{16}N \rightarrow {}^{16}O$



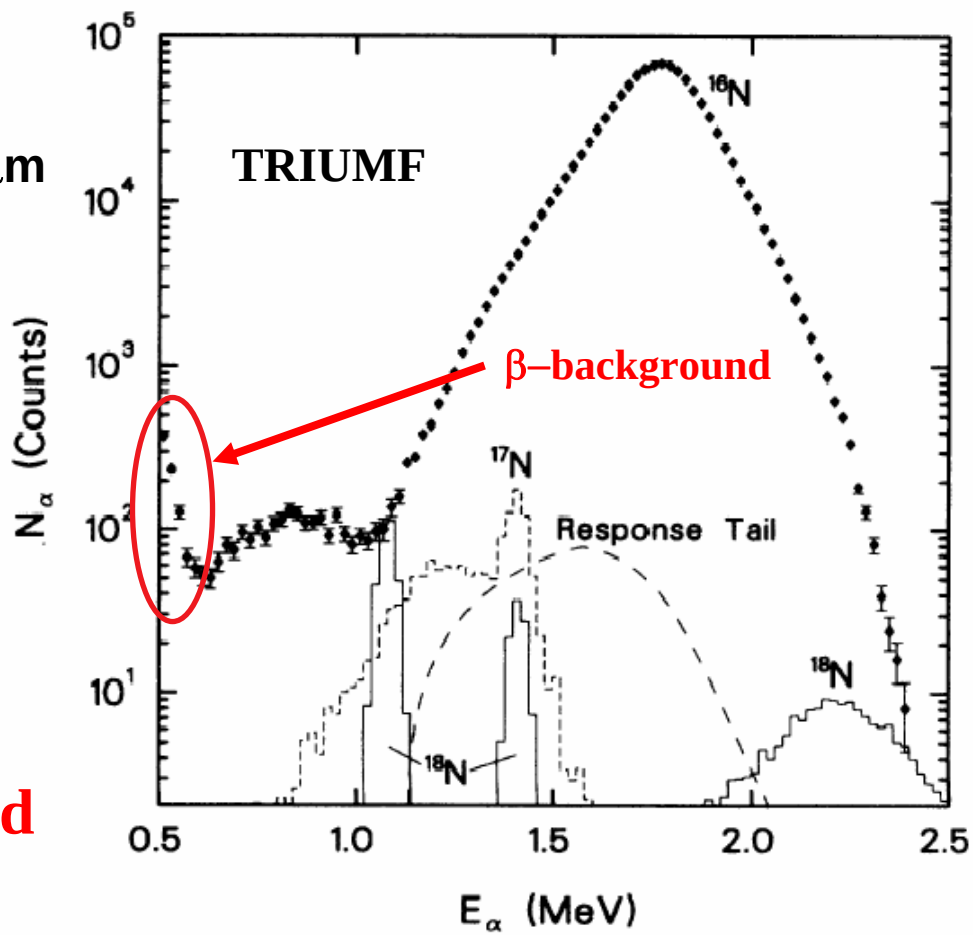
Interference peak



J. Humblet et al., Phys. Rev. C44, 2530(1991)

Previous Measurements of the β-delayed α decay of ^{16}N

- Mainz (1969-1974) Si 35 μm
- Yale (1993-1997) Si 50 μm
- Seattle (1994-1995) Si ? μm
- TRIUMF (1993-1997) Si 11-16 μm



•Goal of future experiments: reduce low-energy background

Goal:

- **No contamination from ^{17,18}N**
- **Thin targets**
- **Setup with different detectors which are insensitive to β's**

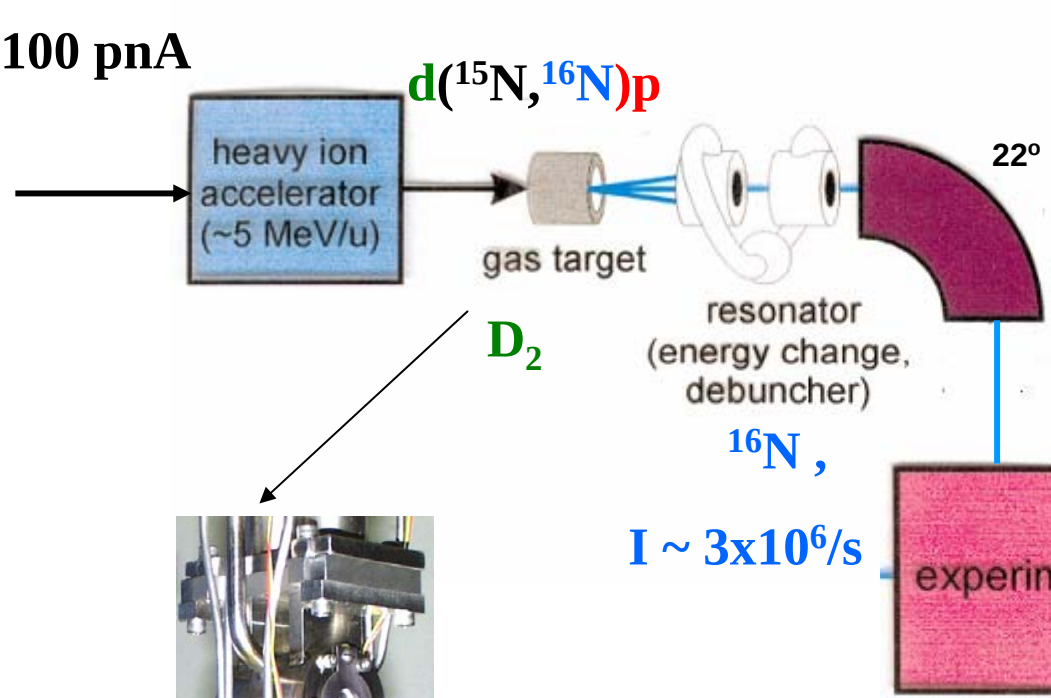
Experiment

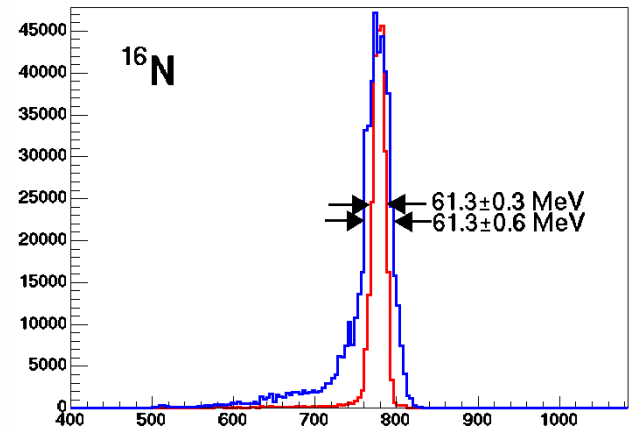
- **Beam production**
- **Stopping of the ^{16}N beam**
- **Detector**
- **Energy calibration**
- **Backgrounds**
- **Preliminary results**

Radioactive Beam Production

^{15}N 82 MeV

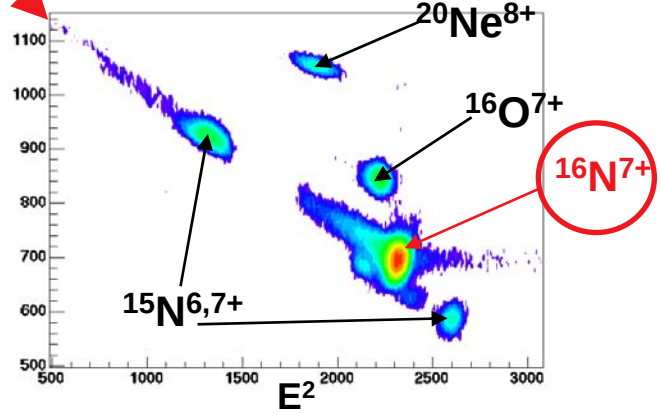
~ 100 pnA



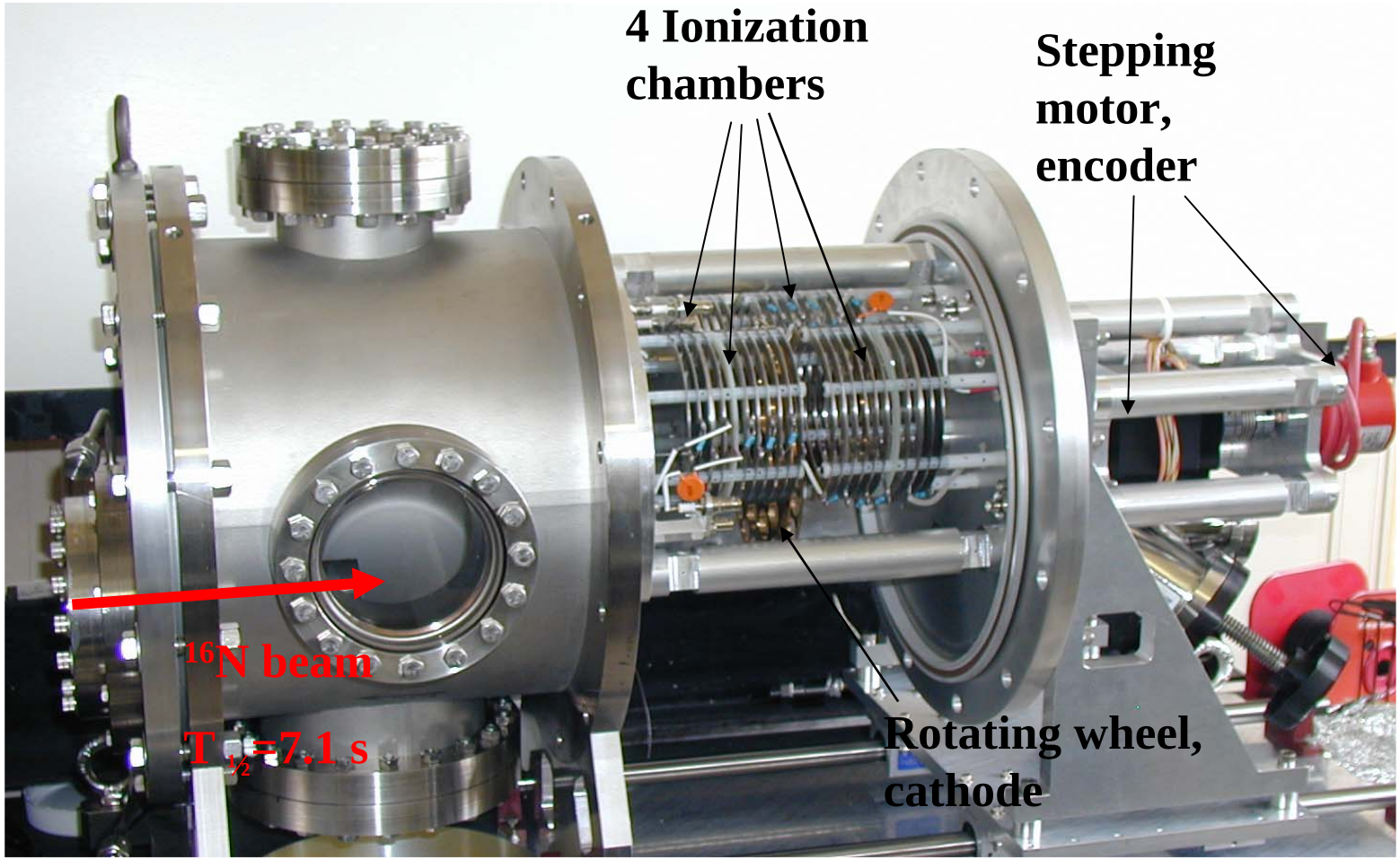


Particle identification

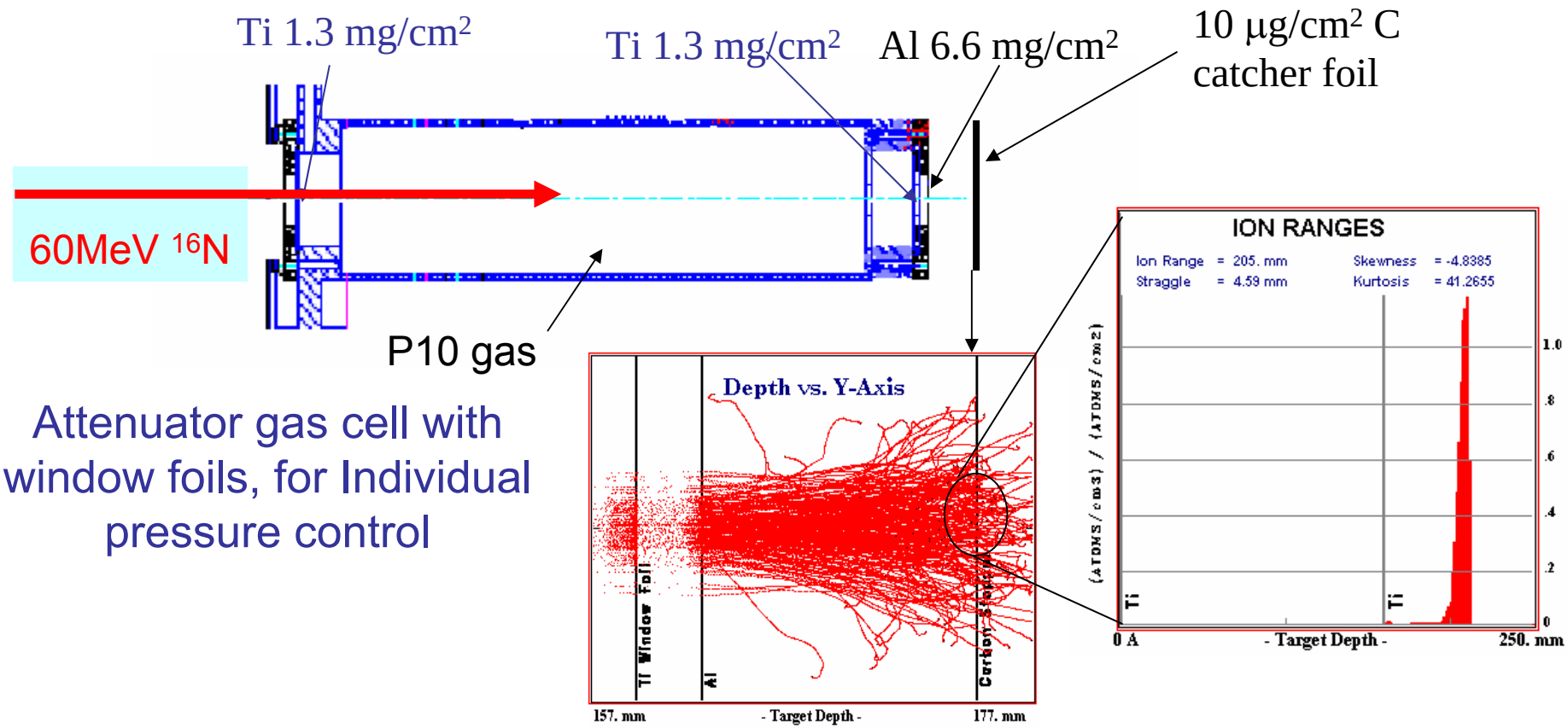
range



Experimental setup for the study of the β-delayed α decay of ^{16}N



Slowing down the ^{16}N particles



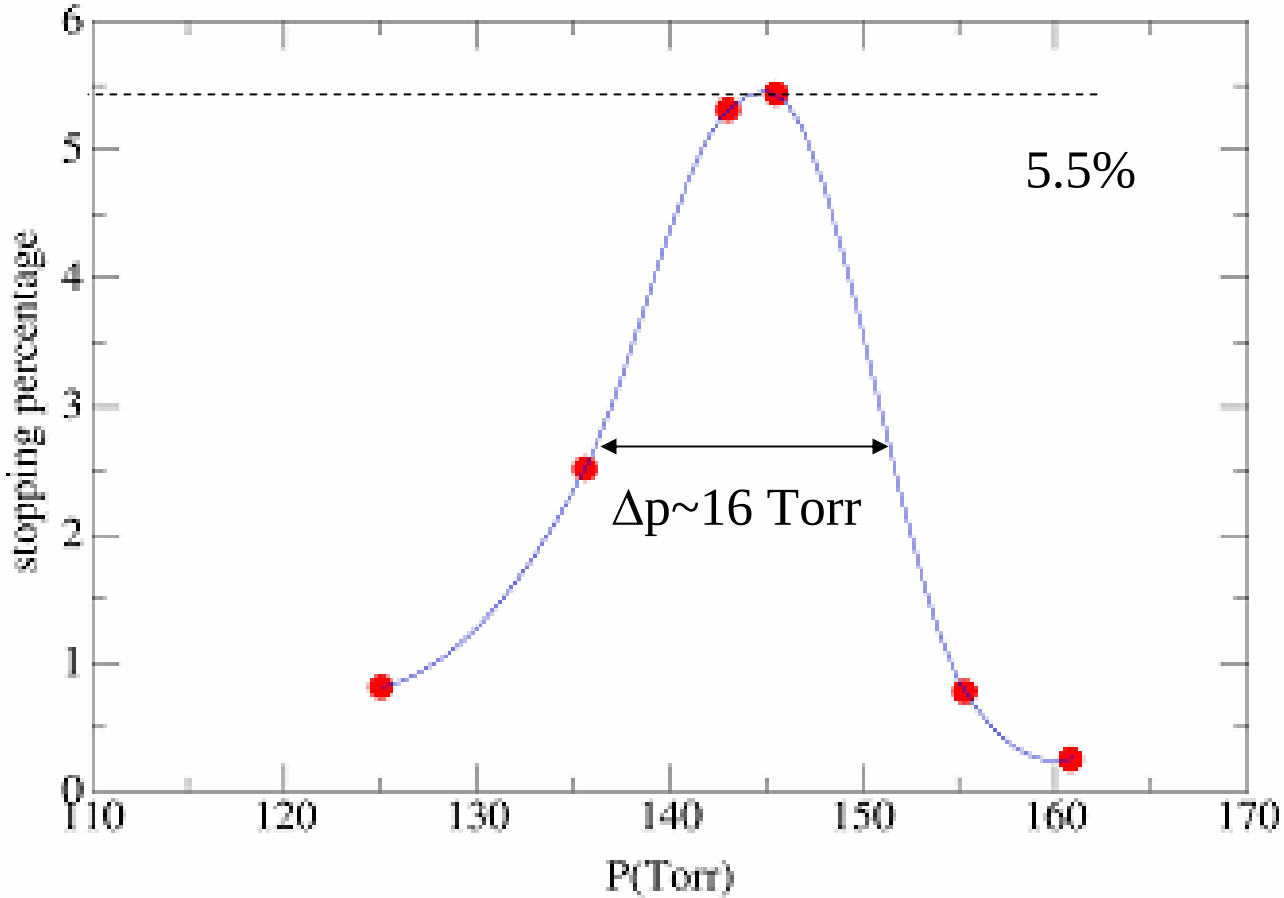
Attenuator gas cell with window foils, for Individual pressure control

Simulation of Monte Carlo Code

P(P10 gas) =149 torr

C: Eff_calc = 3.7%

Choosing the optimum pressure



P(P10 gas) =146 torr (149 torr) **C: Eff_exp = 5.5% (3.7%)**

Event rate ~ 3×10^6/s x 10^{-5} x 0.055 x 0.38 = 38 counts/min