14N+p @ Bellotti IBF:
Status of data taking and analysis

Alessandro Compagnucci

UPDATE

Summary

- **Progress of data taking**
- Analysis status
  - Targets characterization
  - Efficiency
- Initial results
- Outlook

Summary of July data taking

- **Goal**: Excitation function
- Detector configuration:
  - **GeGenova @ 55°, 0 cm** (from reference 0 cm position)
- Use of implanted and sputtered targets
- **Energy range**: 400 – 1300 keV (50 keV steps) + 250 keV
- Main issue with beam collimation

Summary of October data taking

- **Goal**: Angular distribution
- Detector configuration:
  - **GeGenova @ 55°, 10 cm**
  (from reference 0 cm position)
  - **GeBochum @ 135°, 10 cm**
  - **Can60 @ 90°, 5 cm**
- Three targets used:
  - 2 Sputtered LNL targets
  - 1 Implanted target from October 2023
- **Energy range**: 500 -1100 keV (~ 100 keV steps)
- Aperture installed

Summary of February data taking

- Setup configuration A:
  - **GeGenova @ 55°, 10 cm** (from reference 0 cm position)
  - **GeBochum @ 135°, 10 cm**
  - **Can60 @ 90°, 5 cm**

- Setup configuration B:
  - **GeGenova @ 0°, 10 cm** (from reference 0 cm position)
  - **GeBochum @ 120°, 10 cm**
  - **Can60 @ 90°, 5 cm**

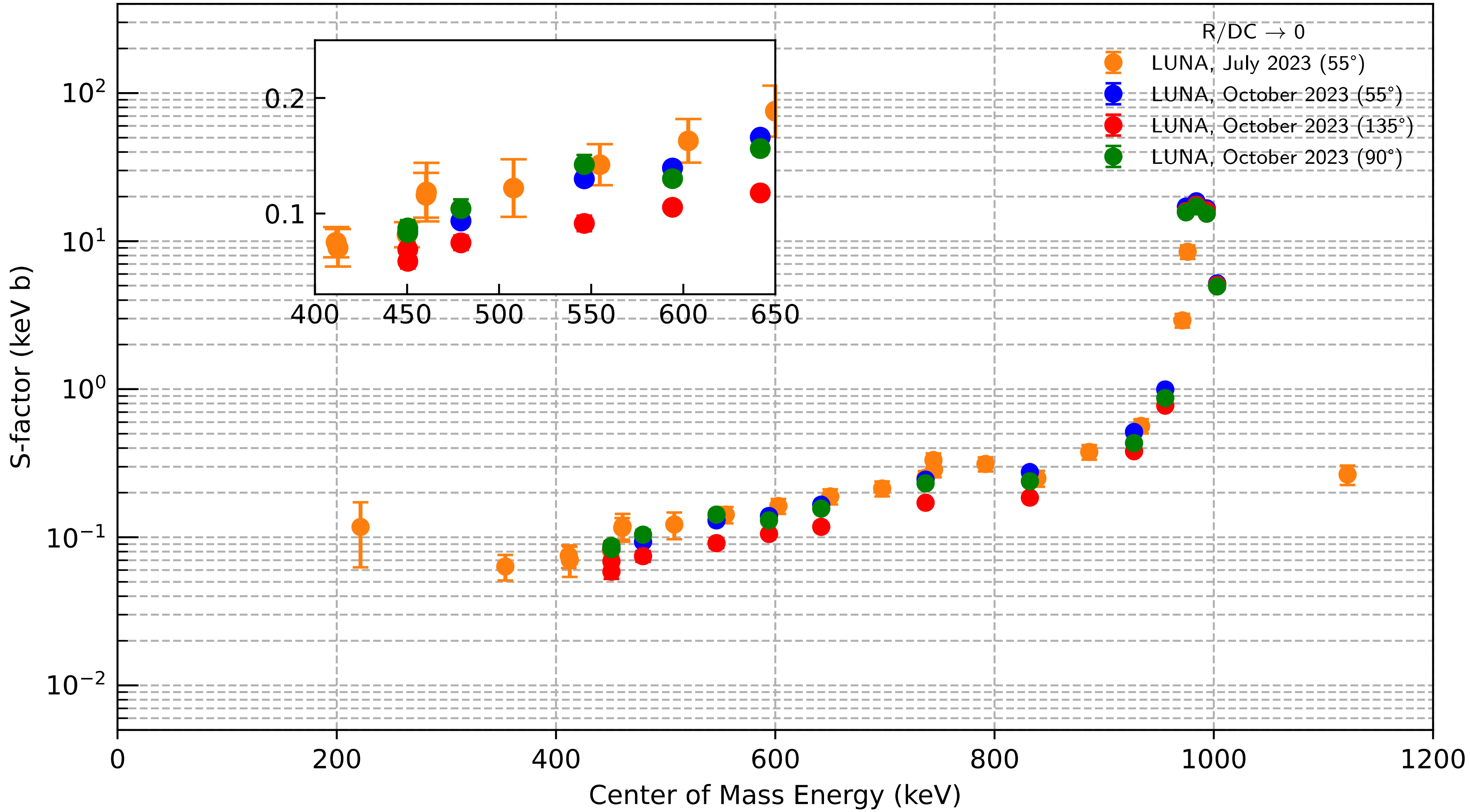
Summary

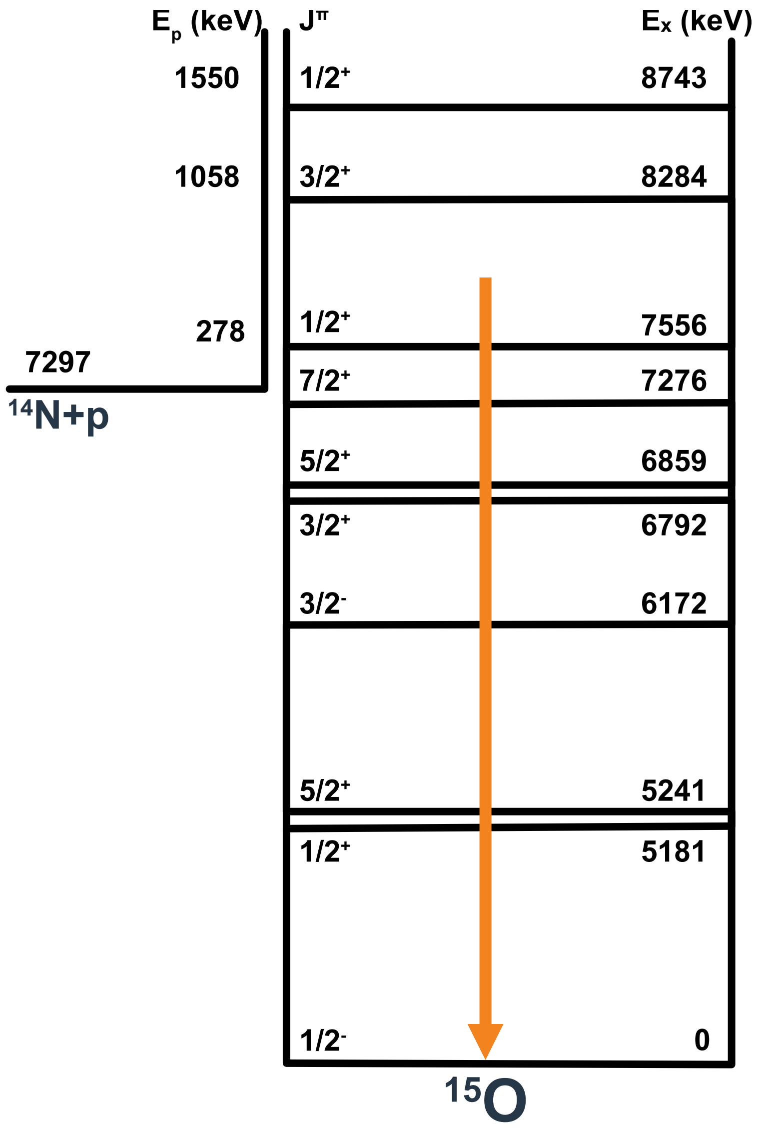
- Progress of data taking
- **Analysis status**
  - Targets characterization
  - Efficiency
- Initial results
- Outlook

Summary

- Progress of data taking
- Analysis status
  - Targets characterization
  - Efficiency
- **Initial results**
- Outlook

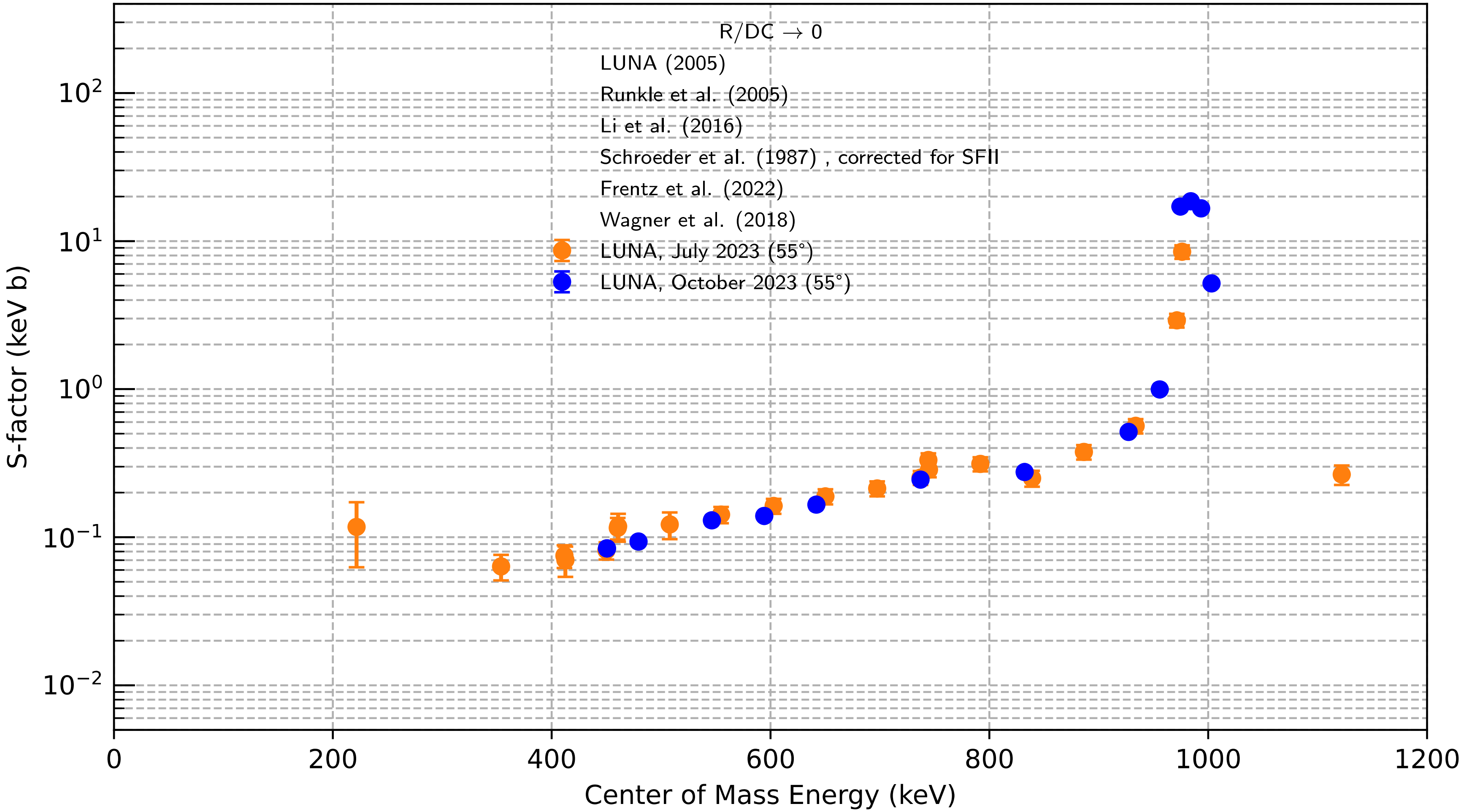
S-factor: Ground state transition

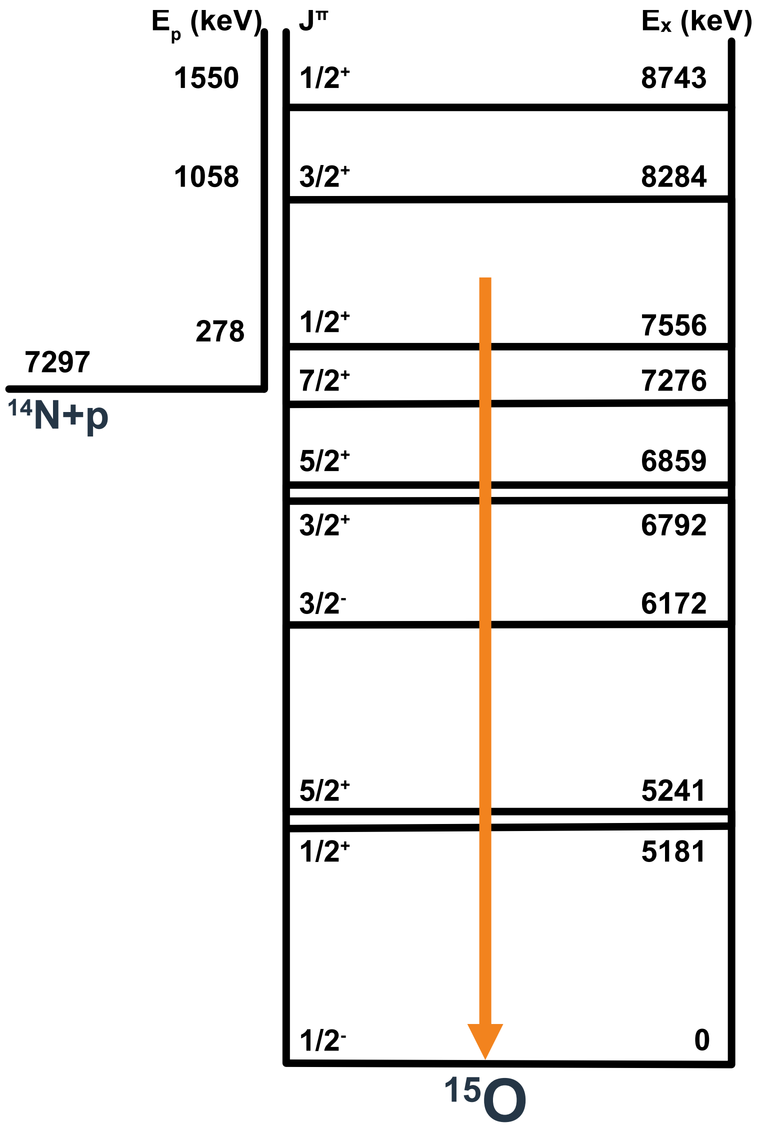




Level scheme for ^{15}O

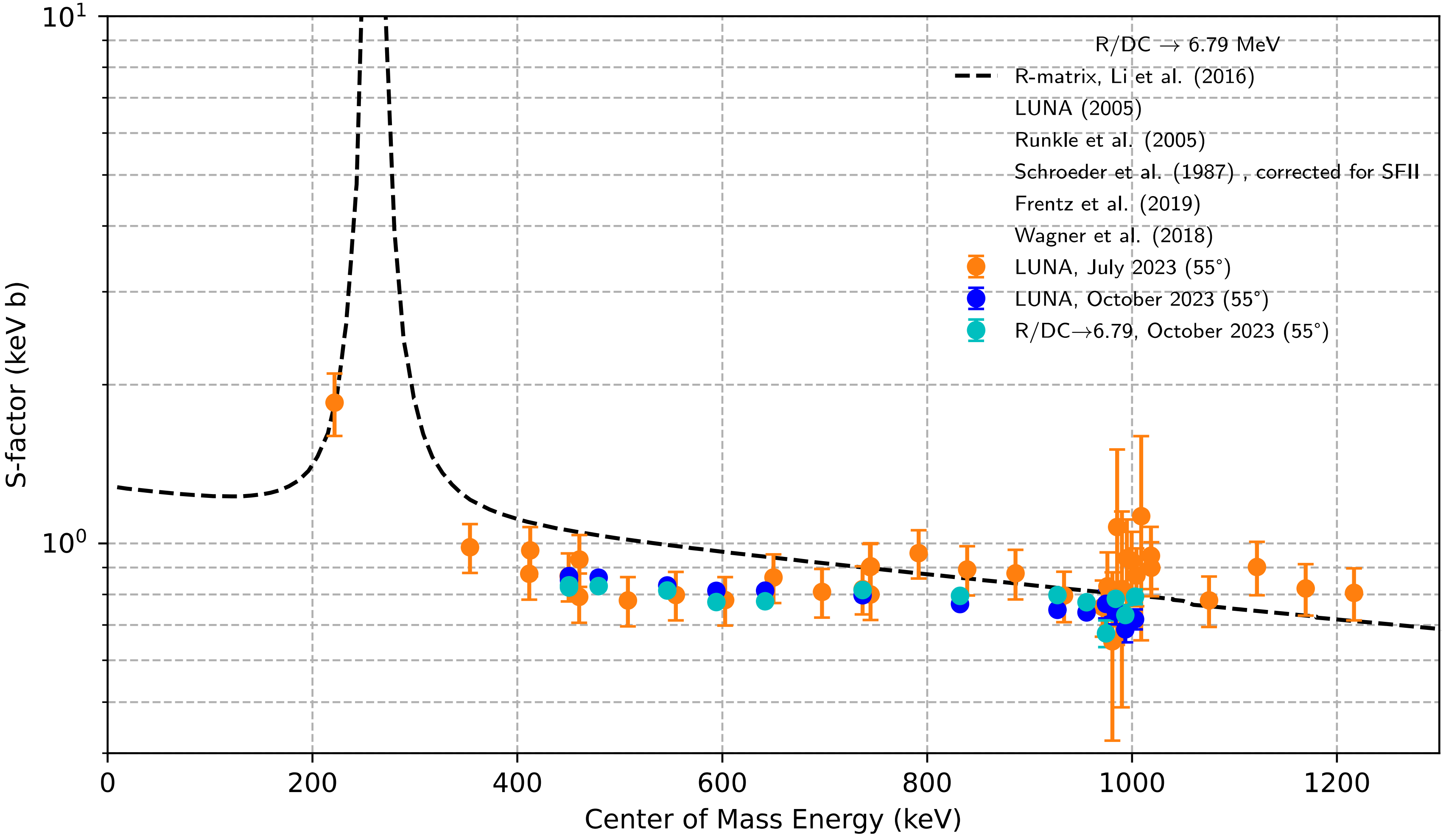
S-factor: Ground state transition

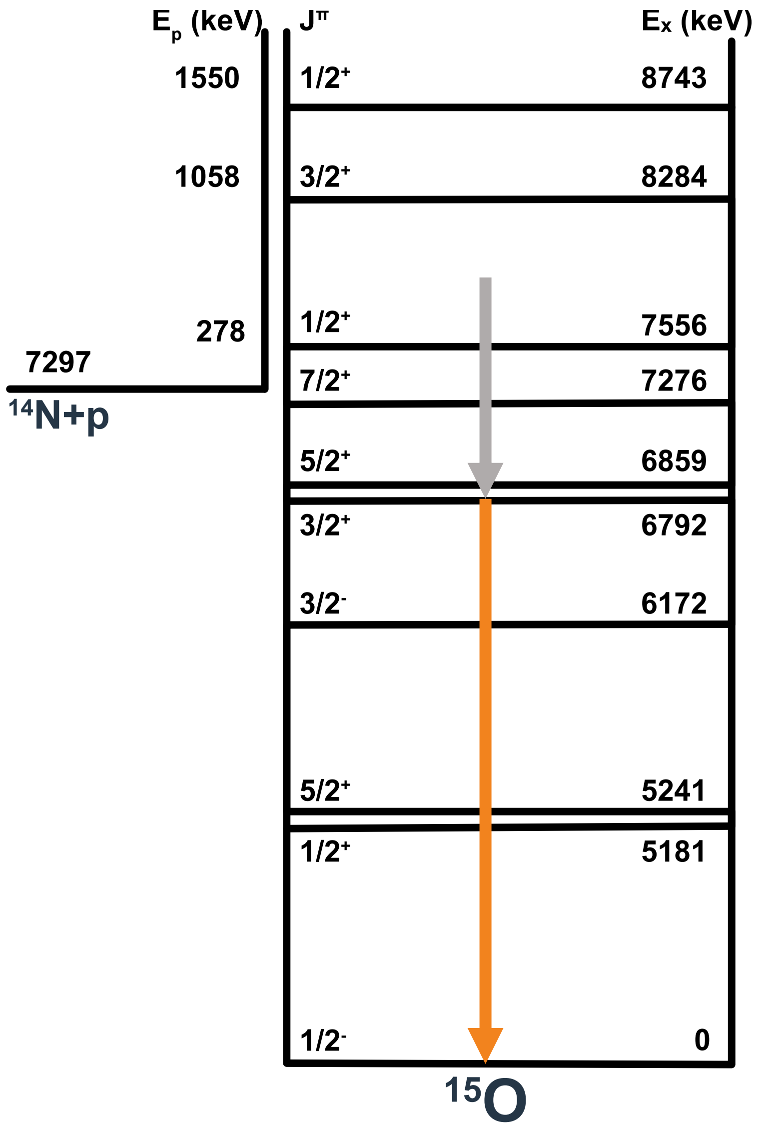




Level scheme for ^{15}O

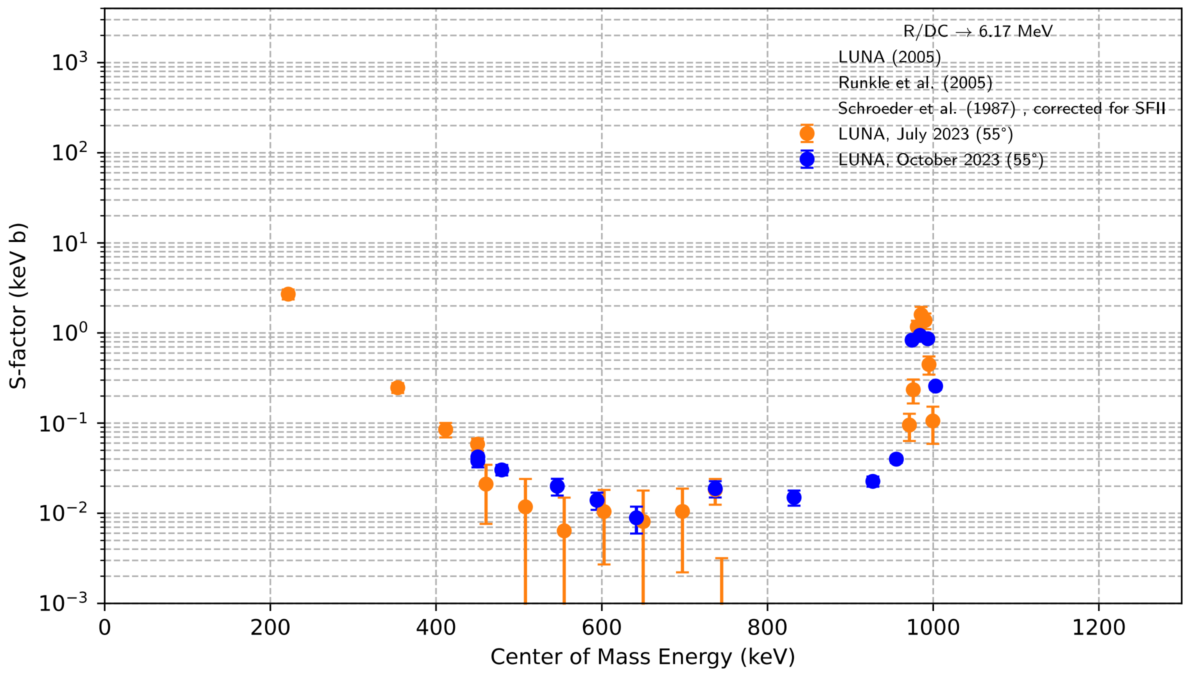
S-factor: 6.79 MeV transition

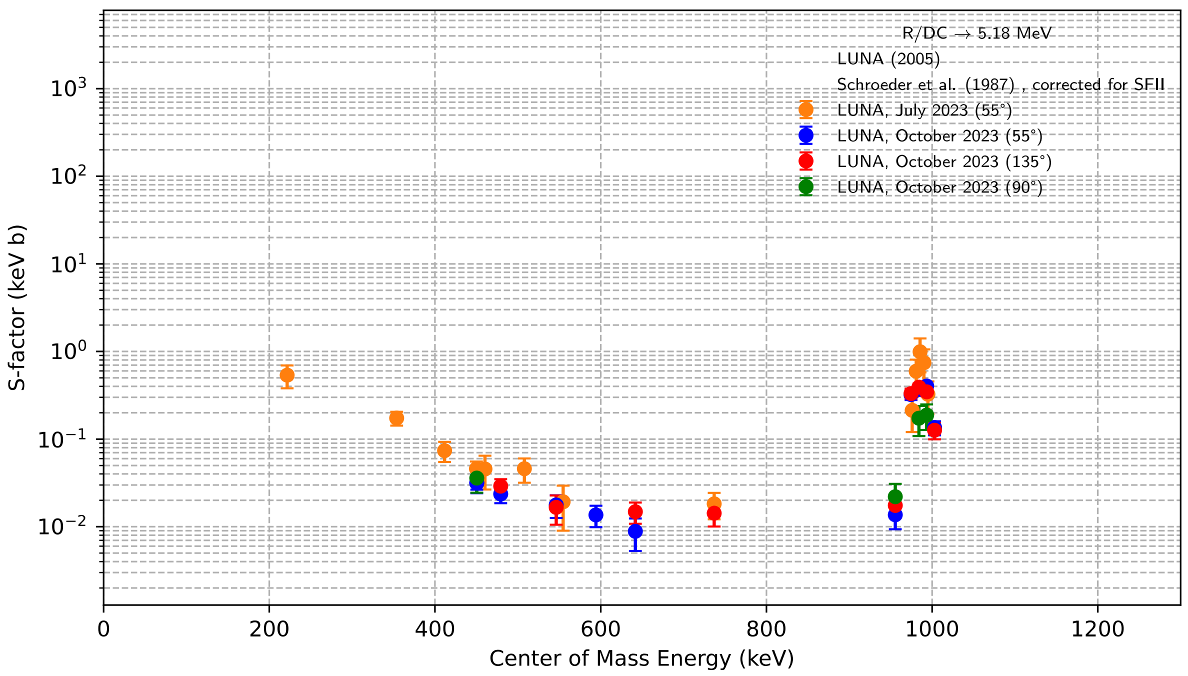




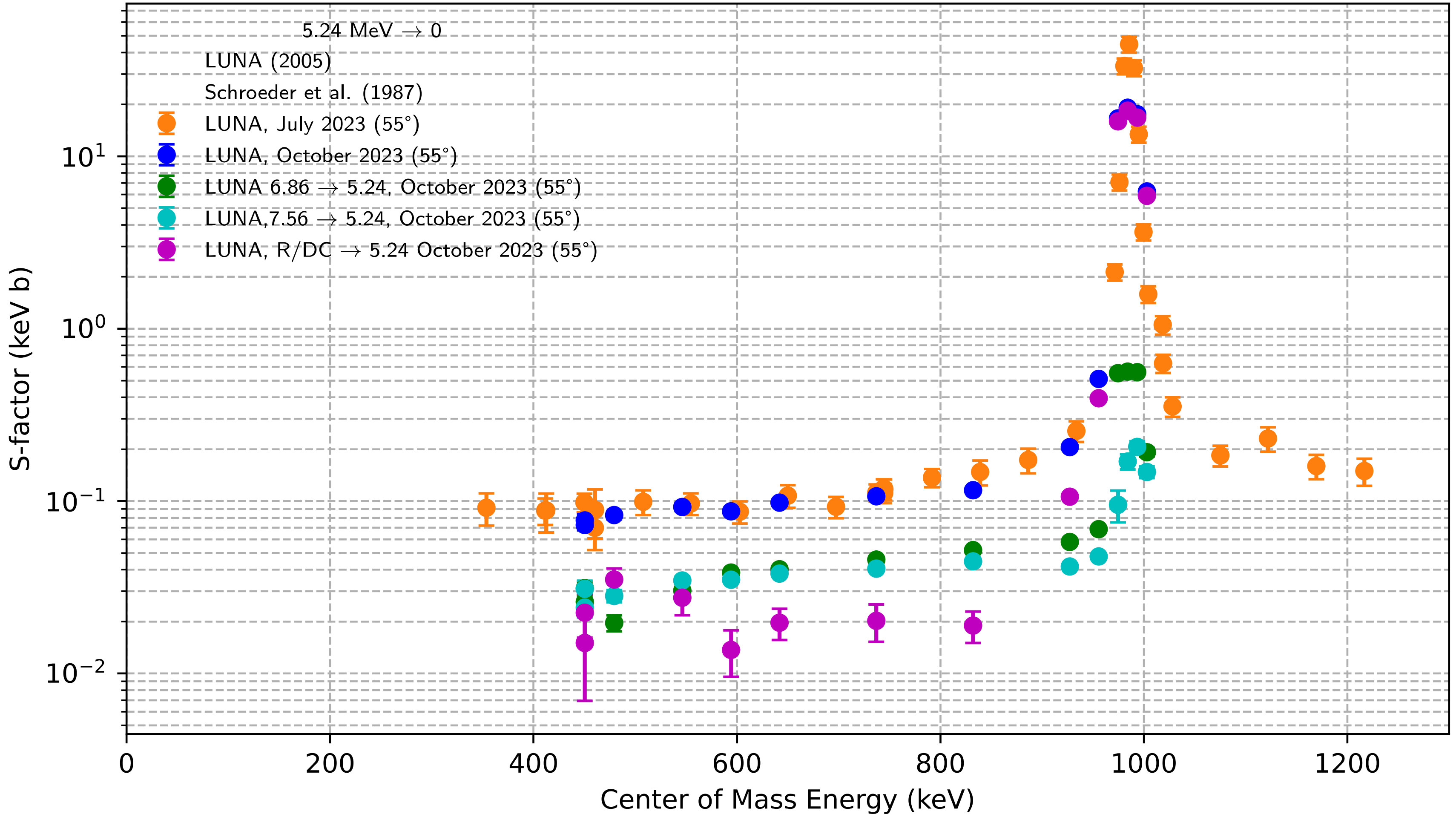
Level scheme for ^{15}O

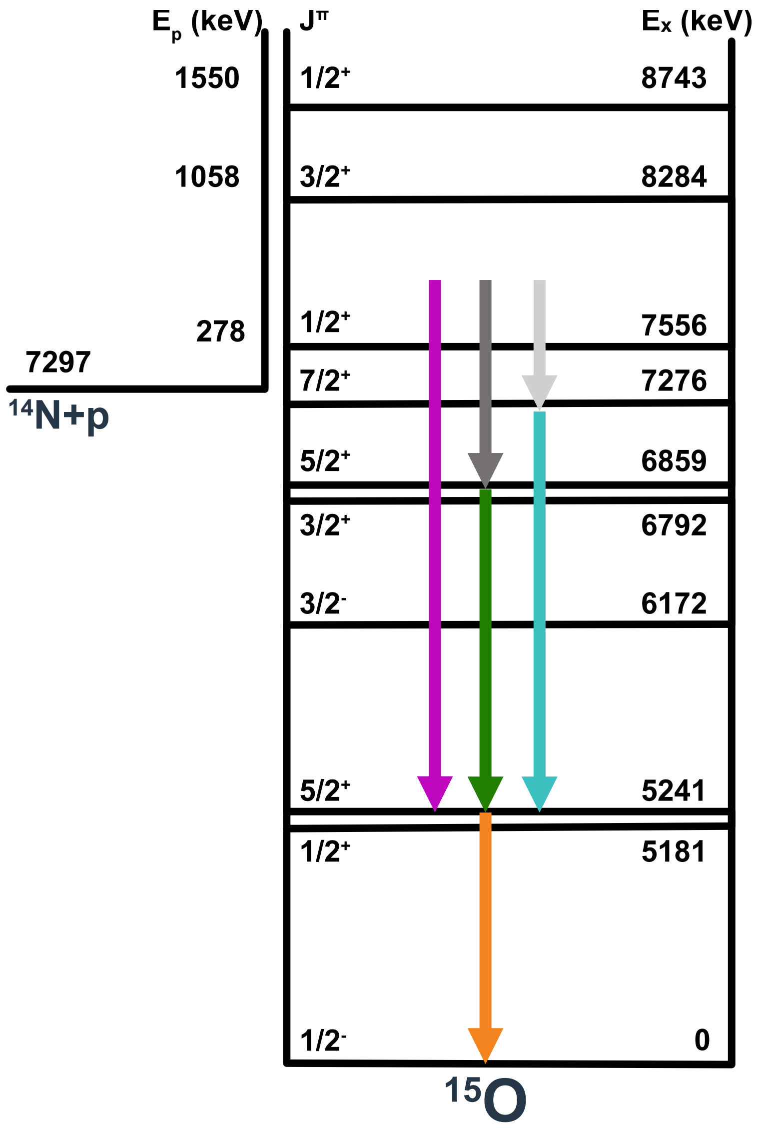
S-factor: 6.17 and 5.18 MeV transition





S-factor: 5.24 MeV transition



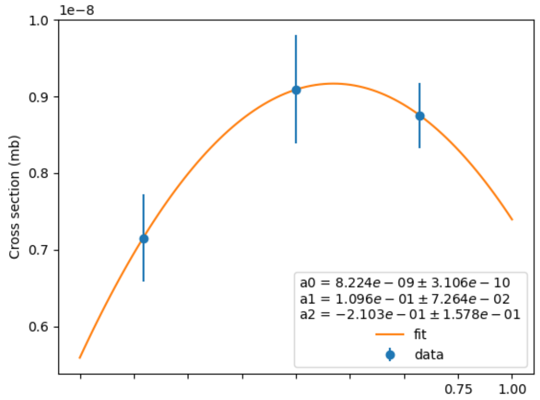


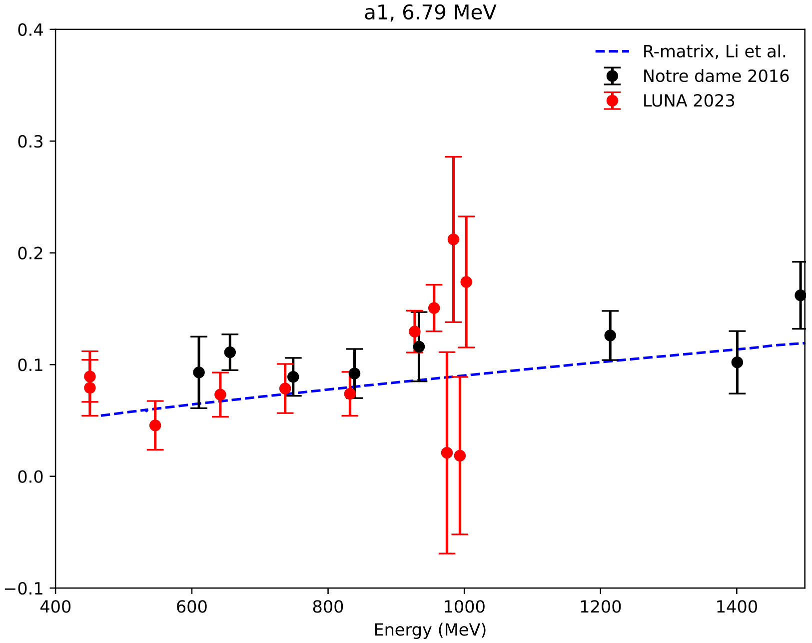
$\sigma_{R/DC\to5.24} = \sigma_{5.24\to0} - \sigma_{6.86\to5.24} - \sigma_{7.28\to5.24}$

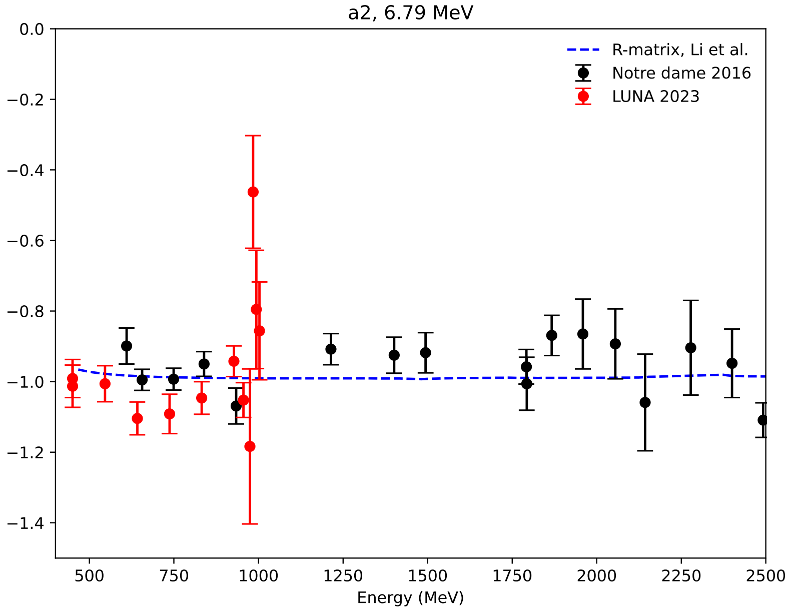
Level scheme for ^{15}O

Angular distribution R/DC → 6.79 MeV

- Tentative fit for the observed angular distribution
  $W(\theta) = a_0(1 + \sum_{i=1}^{n} a_i Q_i P_i(\cos\theta))$, with i up to 2.
- Q1 and Q2 ≈ 1, to be adjusted.
- results are consistent with what observed by Li et al.: $a_1>0$ and $a_2 \approx -1$

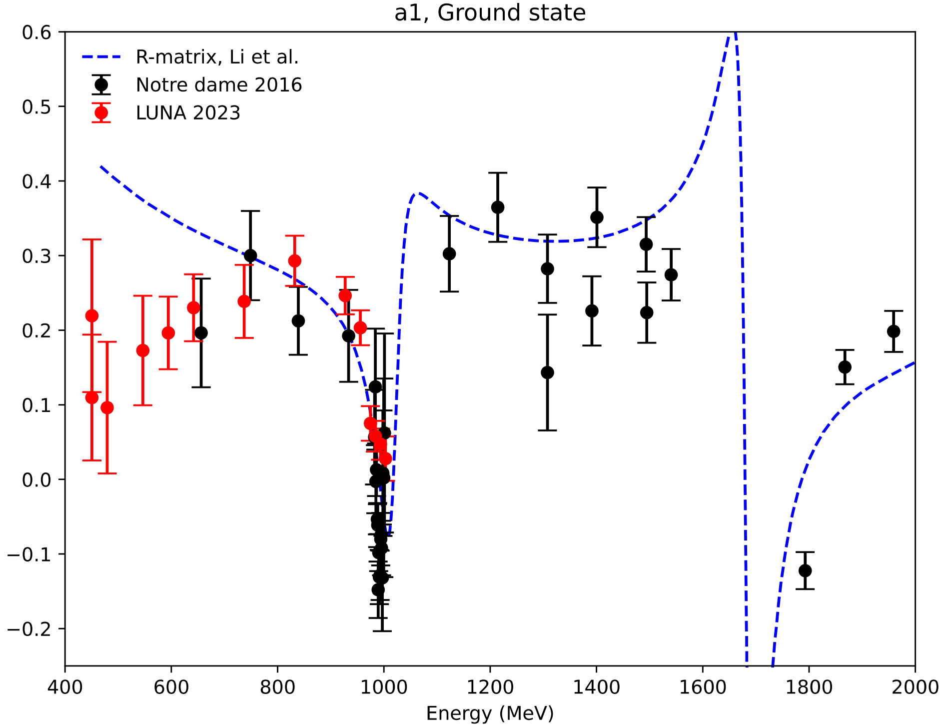


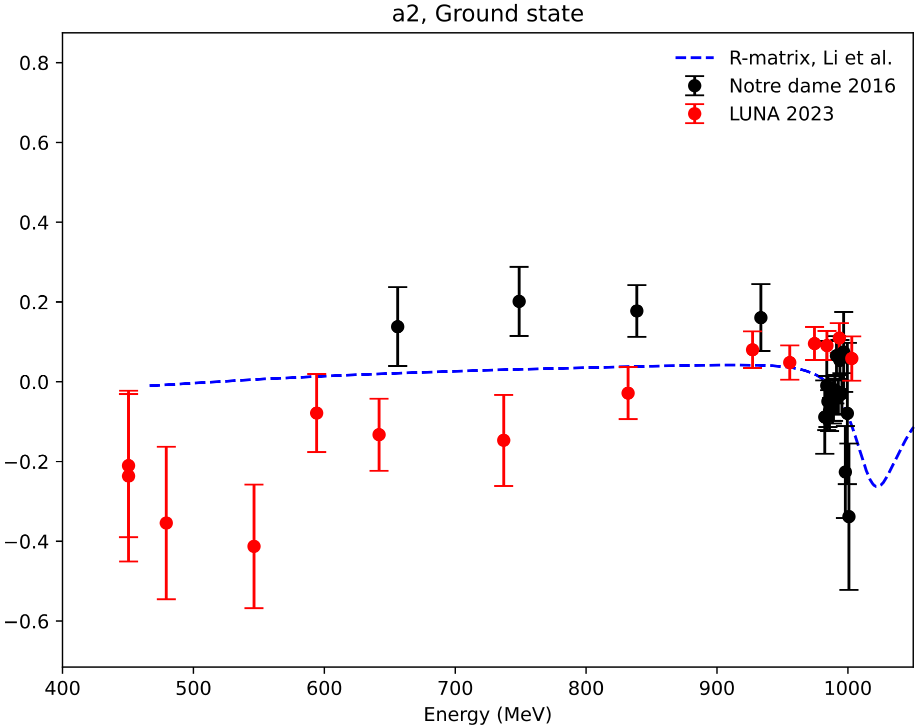




Angular distribution R/DC → g.s.

- Tentative fit for the observed angular distribution $W(\theta) = a_0(1 + \sum_{i=1}^{n} a_i Q_i P_i(\cos\theta))$, with *i* up to 2
- Q1 and Q2 ≈ 1, to be adjusted.
- results are consistent with what observed by Li et al. in their energy range, interesting behavior observed below 600 keV.



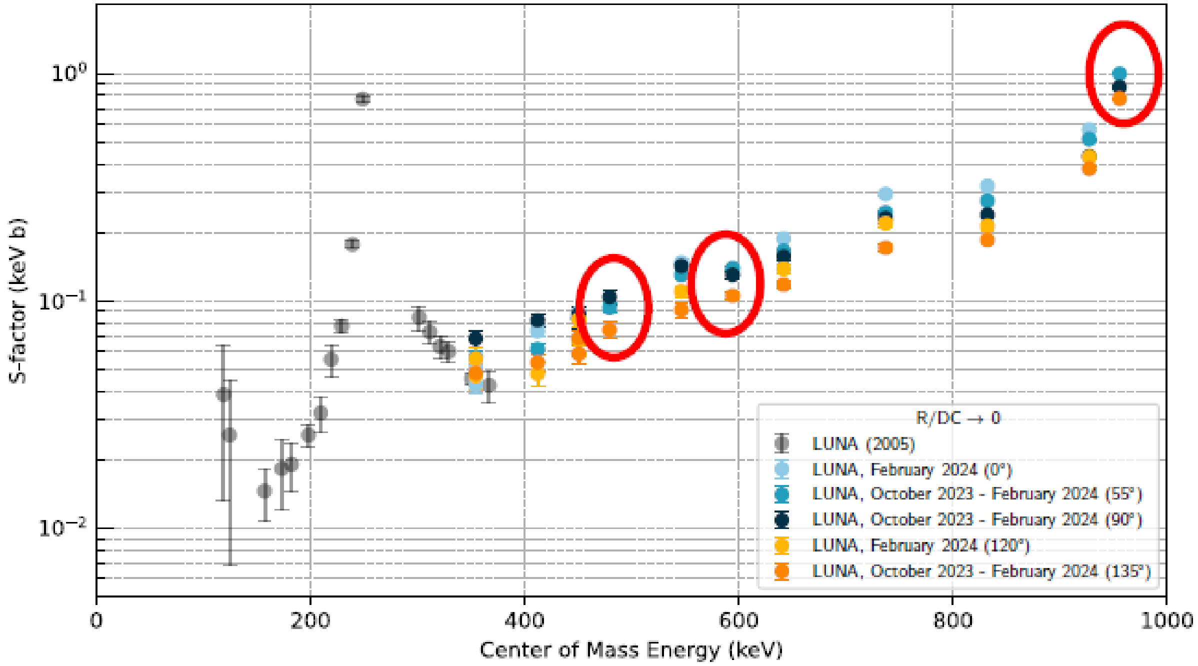


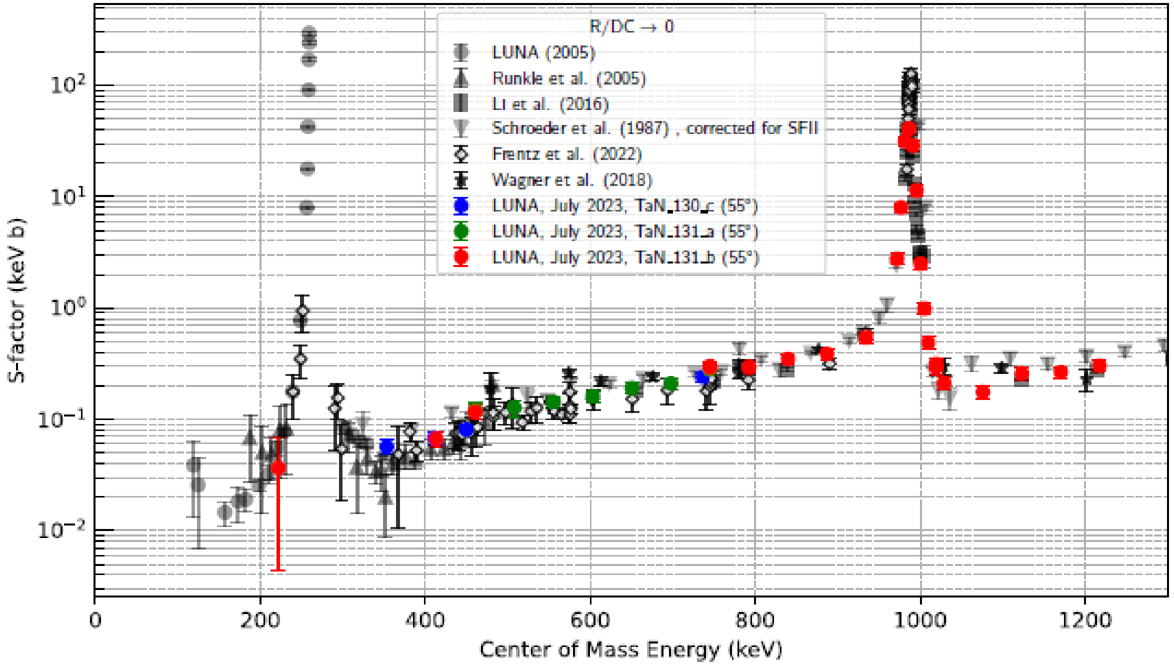
Goals for the next campaign

- Low energy gammas attenuation (needed for high energies):
  - We need to have an estimate of how many lead sheets (1 mm thick) are needed
  - Design and build a simple holder

Goals for the next campaign

- Measure some missing energies in the 0°,90°,120° configuration:
  - 540, 650, 1030 keV ..
  - Angular distribution measurements above 1.1 MeV

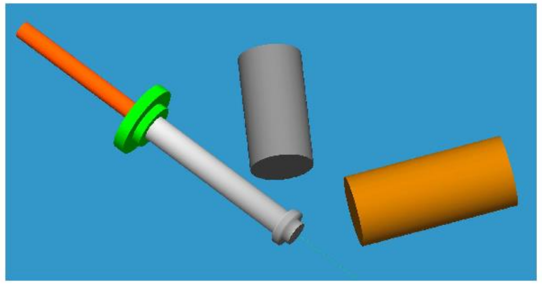


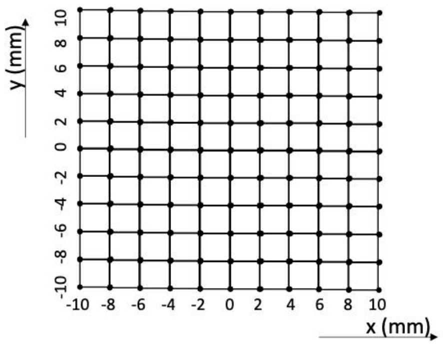


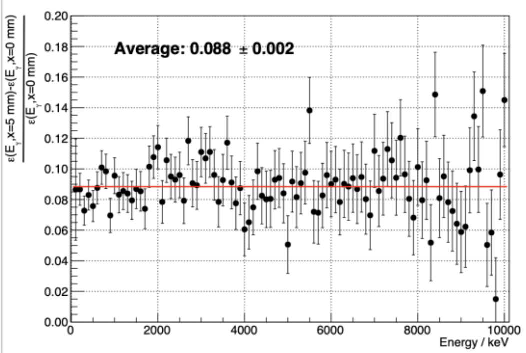
Spare slides

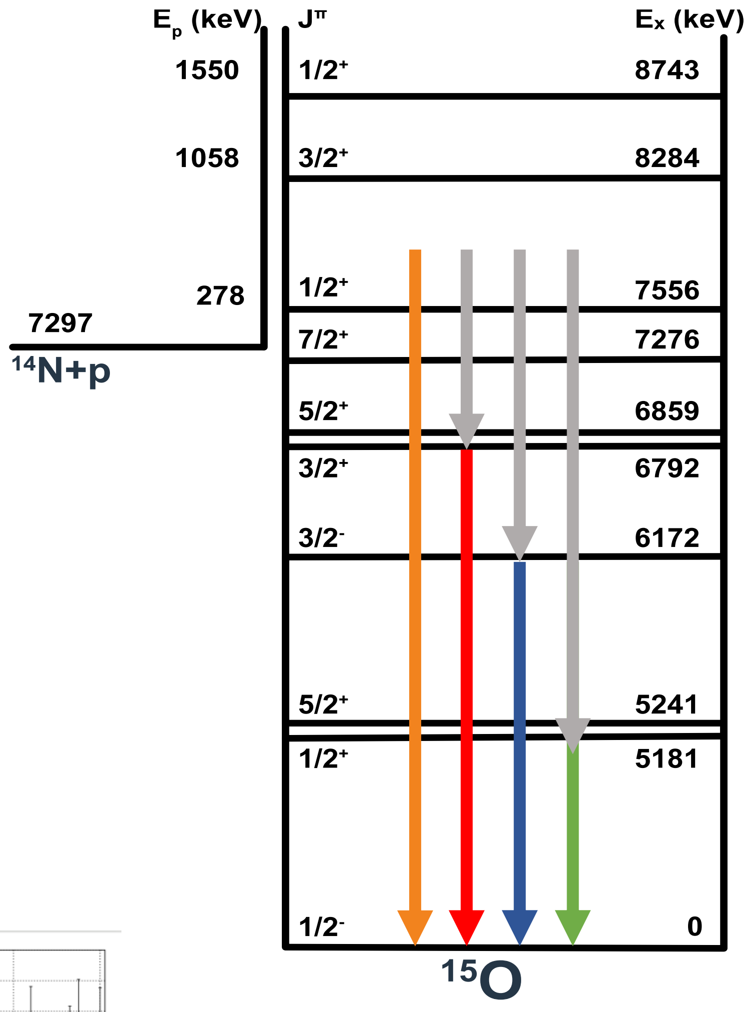
Analysis status

- Summer dataset:
  - ✓Efficiency and target characterization
  - ✓Study of secondary transitions (**6.79**/**6.17**/**5.24**/**5.18** → **0**) and **ground state**
  - ✓Simulations for beam position uncertanty (Work of A. Di Leva and G. Saturno)







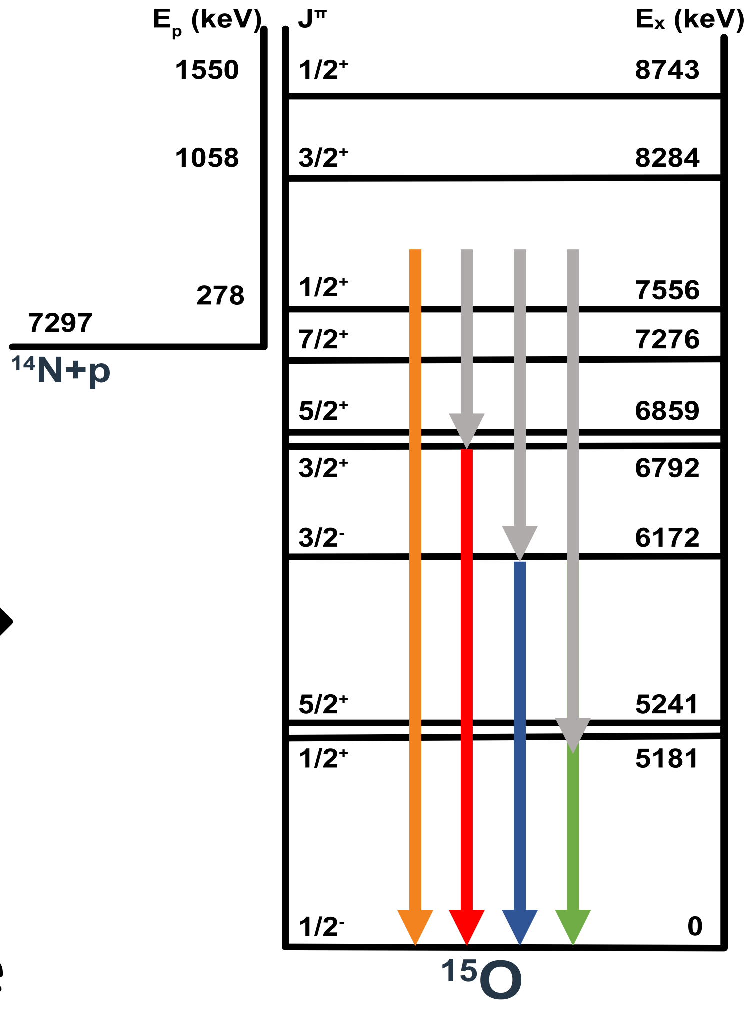


Level scheme for ^{15}O

Complementary analysis with a focus on implanted targets from G. Ciani and F. Conserva

Analysis status

- October dataset:
  - ✓Efficiency and target characterization
  - ✓Study of secondary transitions (6.79/6.17/5.24/5.18 → 0)and **7.28/6.86 → 5.24**
  - ✓Study of primary transition for 6.79 → **0** and ground state
  - ✓Preliminary angular distribution (only three angles 55°, 135° and 90°) for **R/DC → 6.79/g.s.**



Level scheme for ^{15}O

Complementary analysis with a focus on implanted targets from G. Ciani and F. Conserva

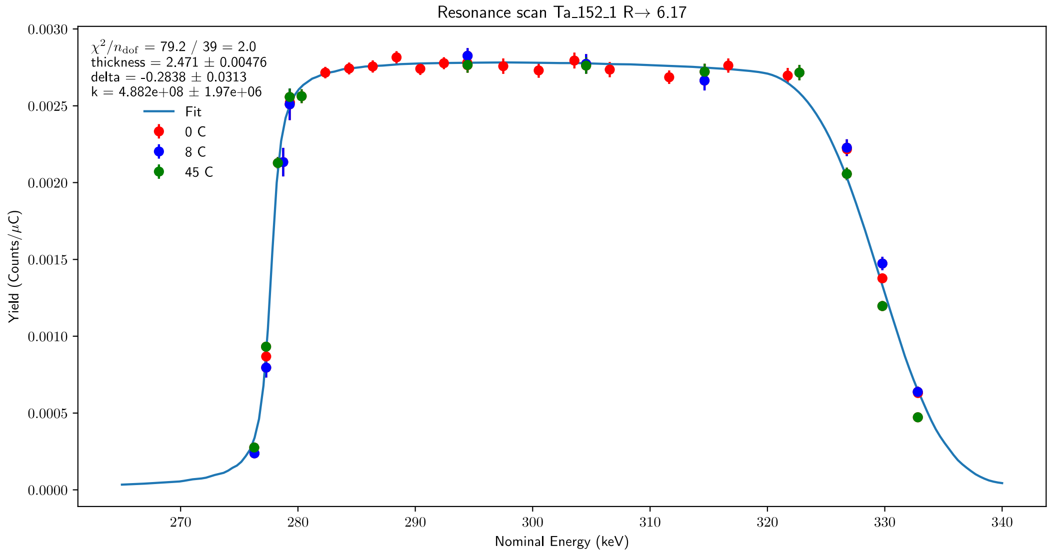
Sputtered targets characterization

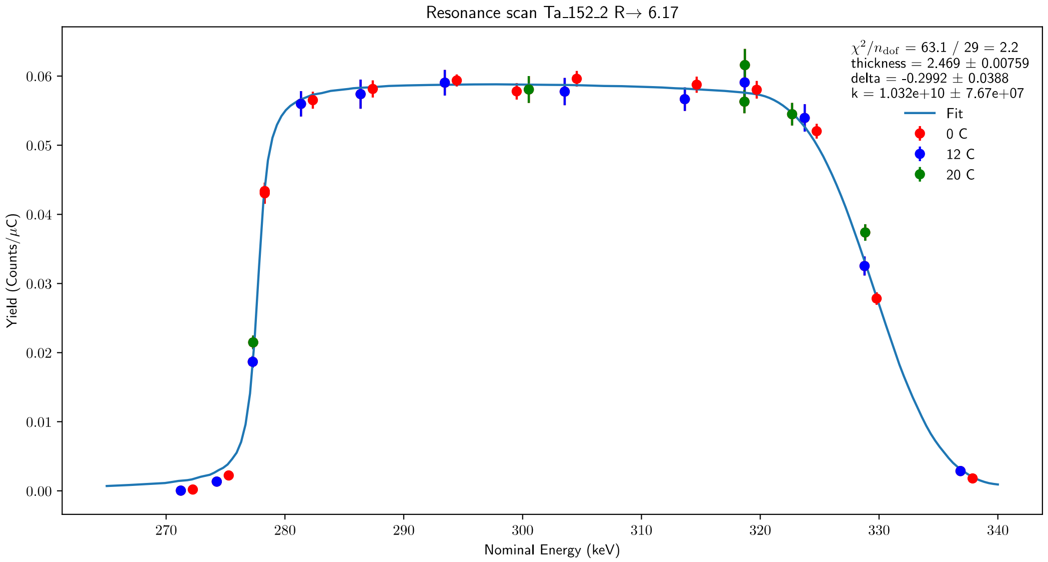
- **Target composition** (RBS): Ta_1N_x x=0.95
- **Thickness** (fit):
  - #152_1 : (2471 +- 5) 10^{15} atm/cm2
  - #152_2 : (2469 +- 7) 10^{15} atm/cm2

$$Y(E_0) = \int_{E_0-\Delta E}^{E_0} dE' \int_{E=0}^{E_0} dE \frac{\sigma_{res}}{\epsilon(E)} f(E_0 - E, E')$$

Gaussian with

$\Delta_{stragg} = 0.6\sqrt{E_0 - E}$





Efficiency parametrization

- Use of the 14N+p reaction at 278 keV resonance.
- Run on top of the resonance at 0, 5, 10 cm from reference
- Standard fit of the observed yields using efficiency parametrization on the right.
- resonance strength and branching ratio from Daigle et al.

$$\ln(\varepsilon_{fe}) = a + b\ln(E_\gamma) + c[\ln(E_\gamma)]^2 \,,$$

$$\varepsilon_{fe}(d) = \frac{1 - e^{\frac{-(d+d_0)}{1+\beta\sqrt{E_\gamma}}}}{(d+d_0)^2} \,.$$

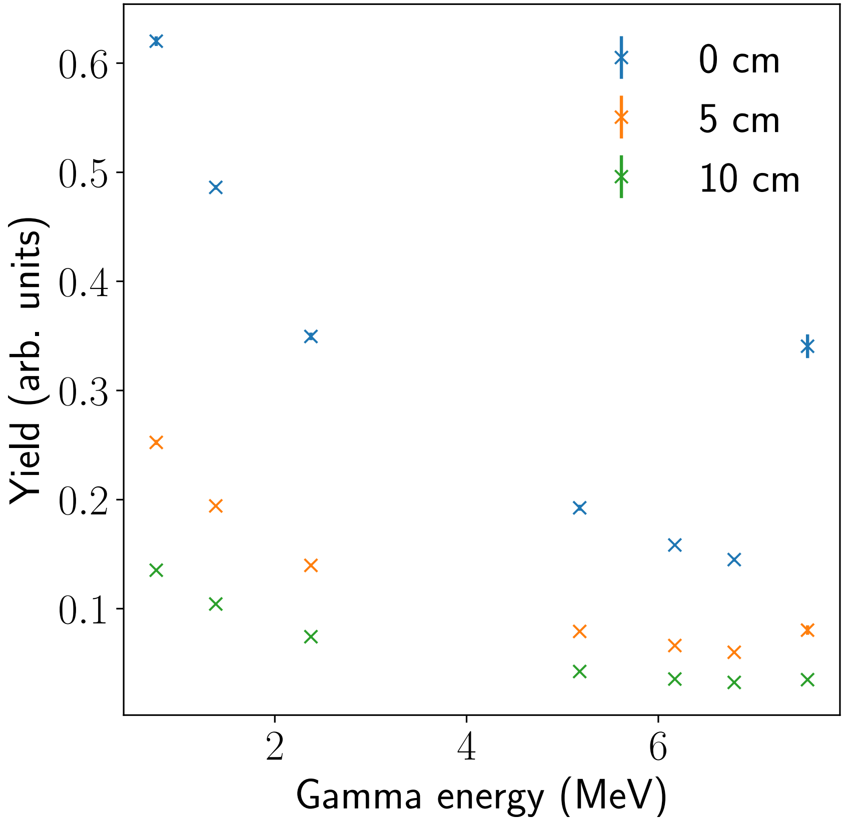
$$Y_{gs} = R\left(b_{gs}\varepsilon_{fe}(E_{gs}) + \sum_i b_i \varepsilon_{fe}(E_i^{sec})\varepsilon_{fe}(E_i^{pri})\right) ,$$

$$Y_{i_{pri}} = R b_i \varepsilon_{fe}(E_{i_{pri}})(1 - \varepsilon_{tot}(E_{i_{sec}})) \,,$$

$$Y_{i_{sec}} = R b_i \varepsilon_{fe}(E_{i_{sec}})(1 - \varepsilon_{tot}(E_{i_{pri}})) \,,$$

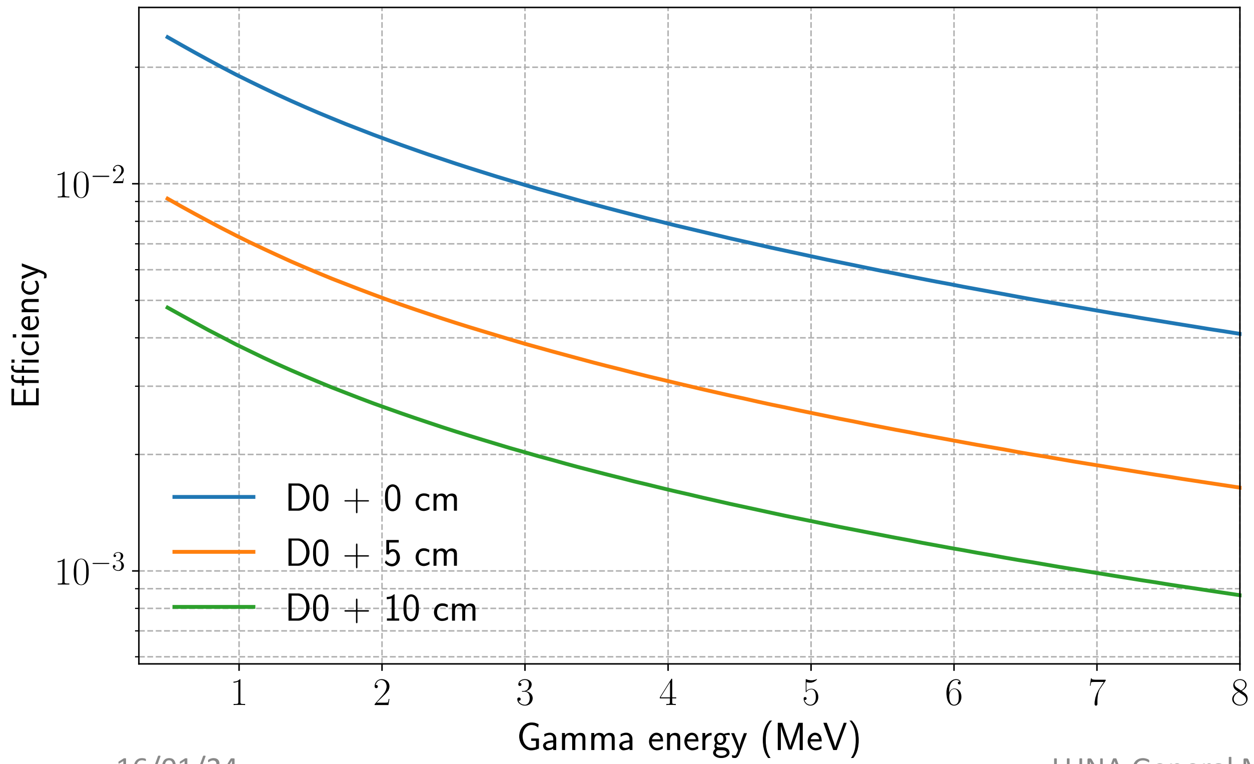
$$\ln\left(\frac{\varepsilon_{fe}}{\varepsilon_{tot}}\right) = K_1 + K_2\ln(E_\gamma) + K_3(\ln(E_\gamma))^2$$

Measured yields, corrected with Daigle *et al.* branching ratios

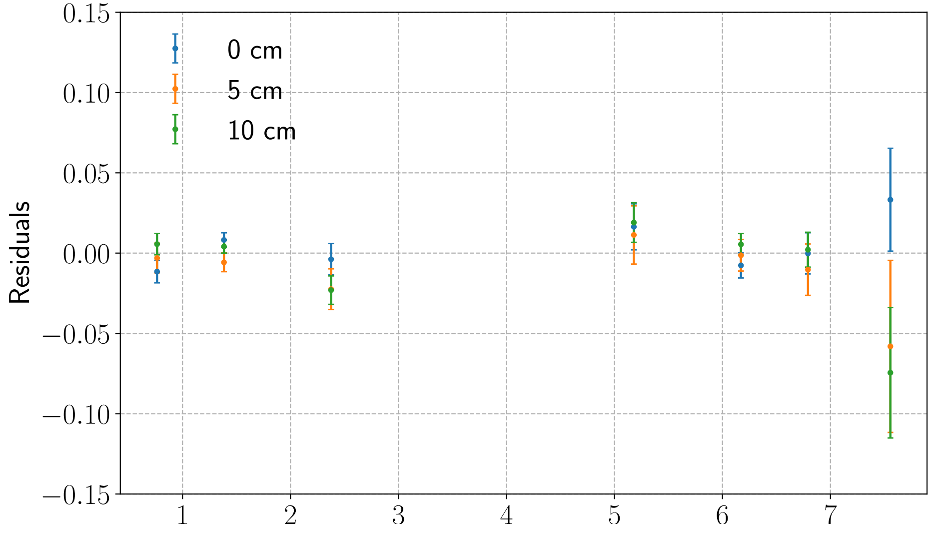


Efficiency parametrization GeGenova 55° October campaign

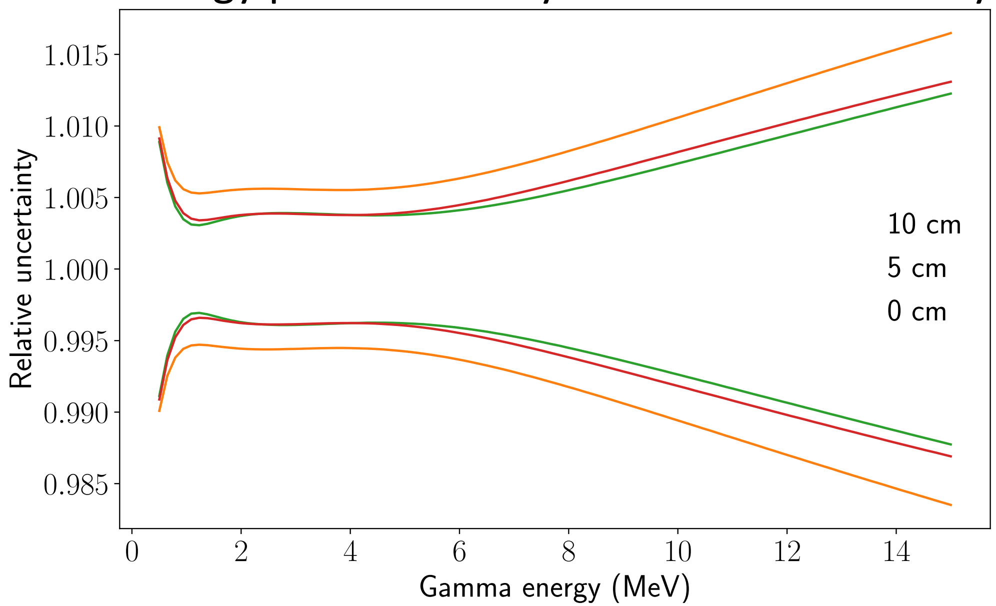
FEP efficiency results



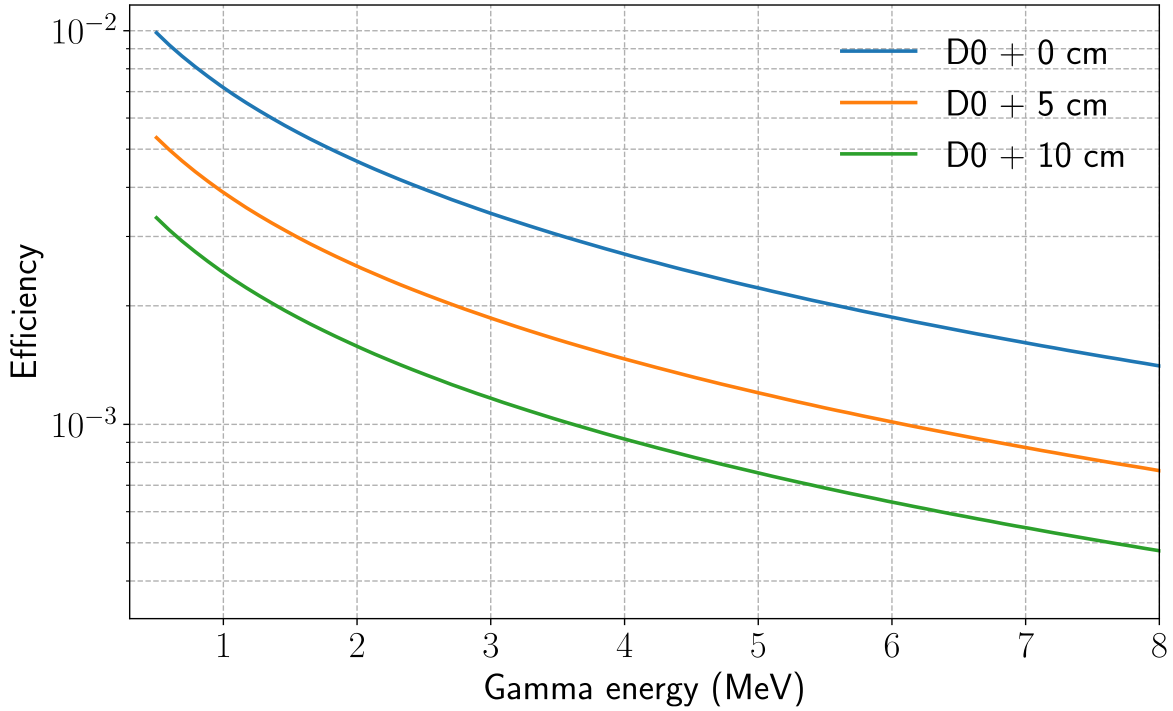
Yield fit residuals

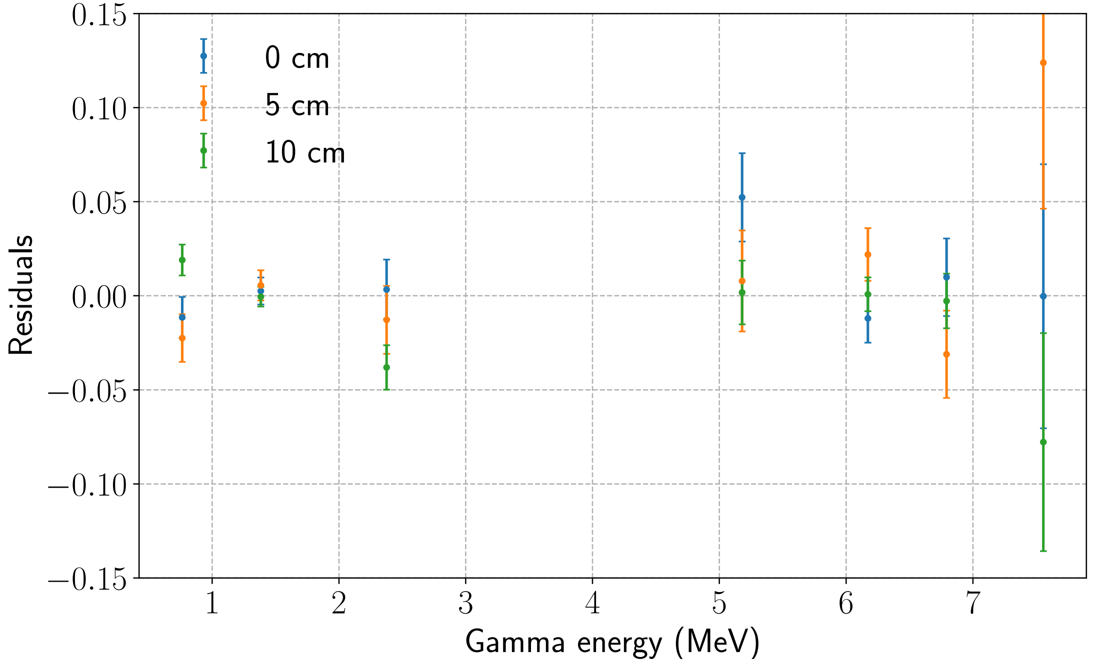


Full-energy peak efficiency fit relative uncertanty



Efficiency parametrization
GeBochum 135°
October campaign





Efficiency parametrization
Can60 90°
October campaign