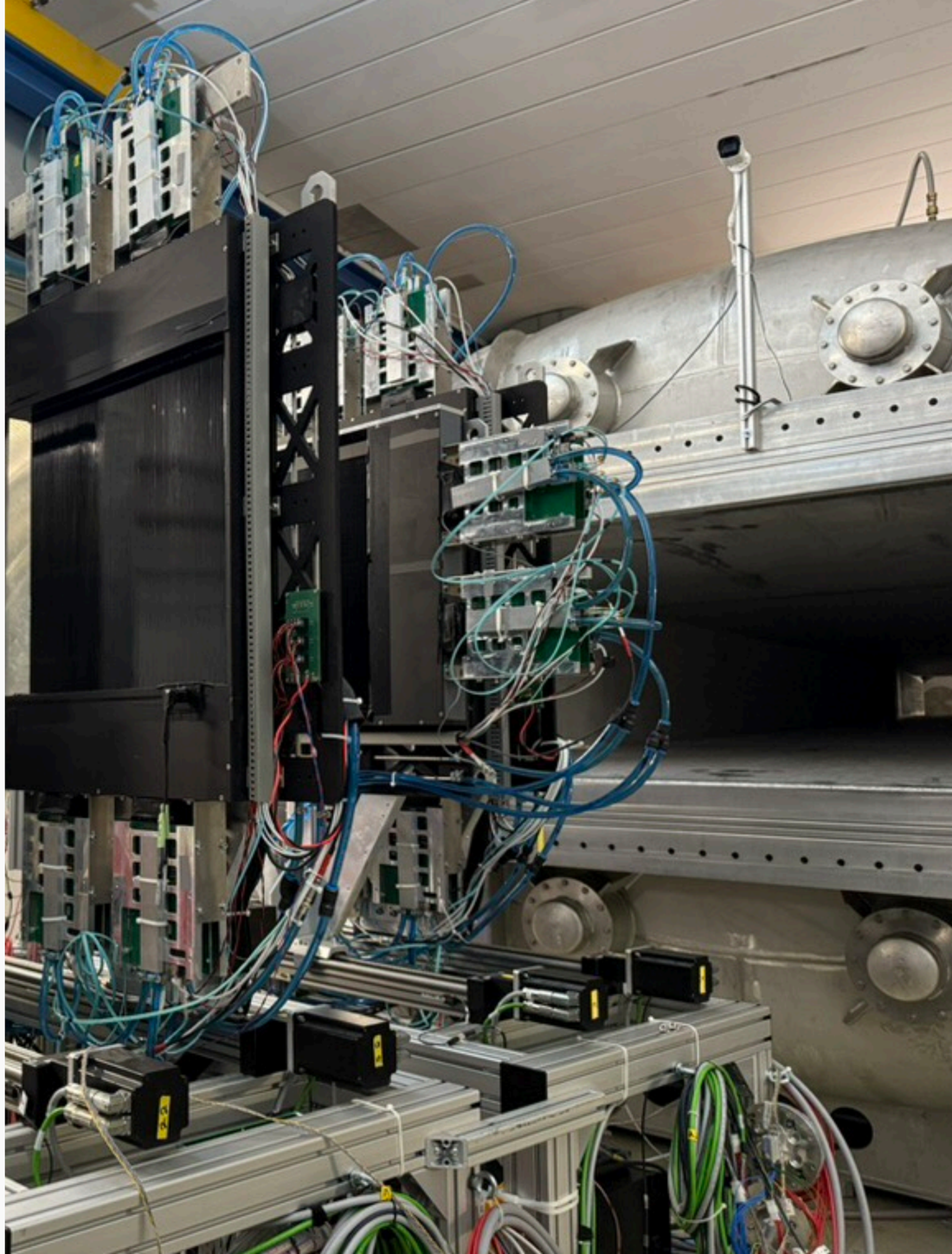
Study of neutron-rich isotopes $^{23,\,24,\,25}$F in inverse kinematics with the R3B experimental setup at GSI/FAIR

XVII CPAN DAYS

Pablo González Rusell

19/11/2025



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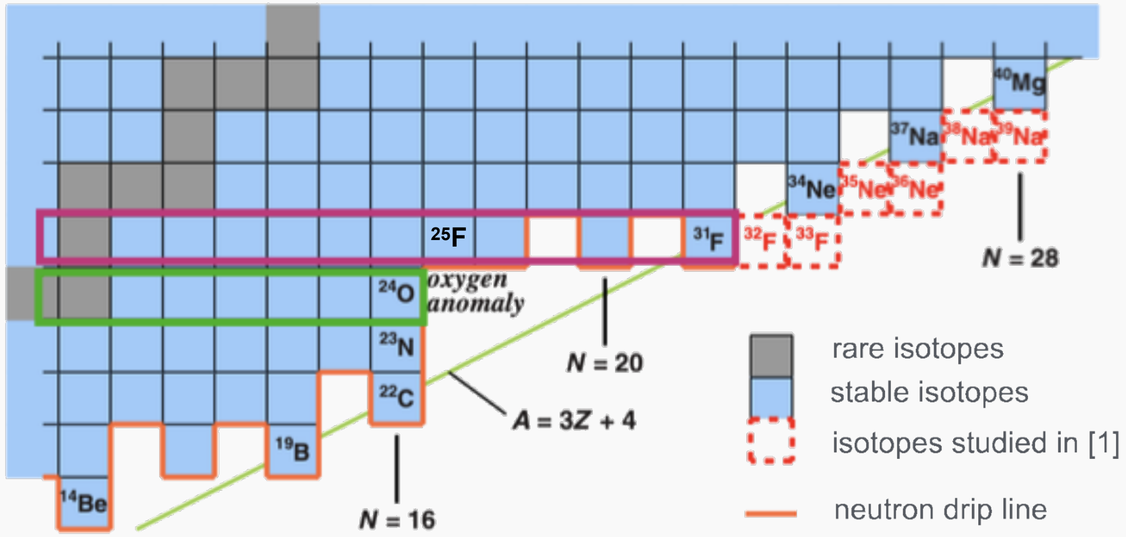
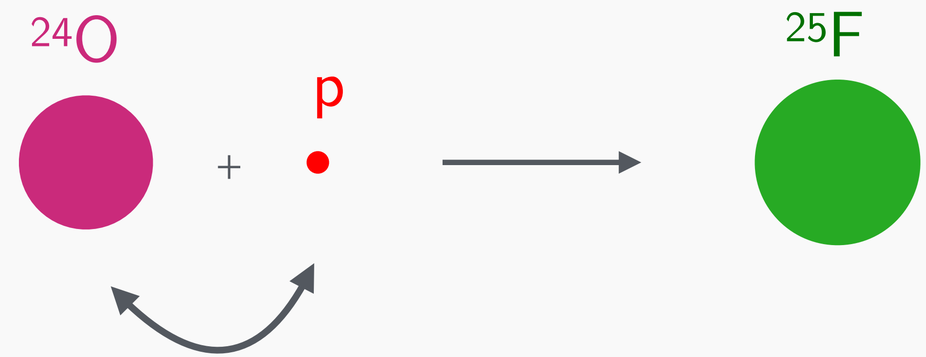
Motivation: The neutron dripline



[D. S. Ahn et al.]

$Z = 8 \longrightarrow {}^{24}O$

$Z = 9 \longrightarrow {}^{31}F$

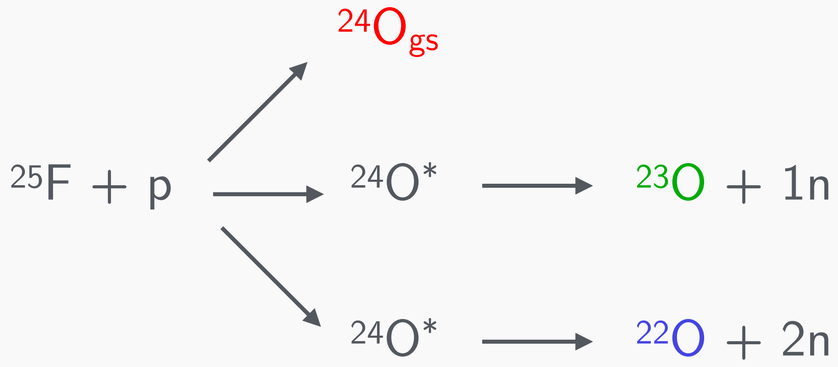


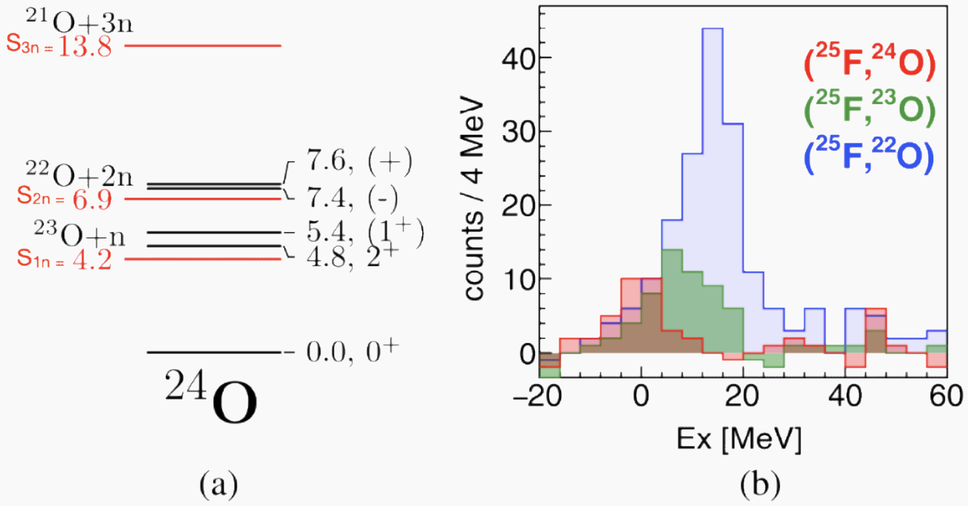
np tensor interaction

Motivation: The ^{25}F

Key result in RIKEN ⟶ the ^{25}F(p,2p)^{24}O reaction, was studied:

- 65% of ^{24}O produced were in excited states. ⟶ Additional p breaks the "magicity" of the core.
- Poor energy resolution of ^{24}O states.

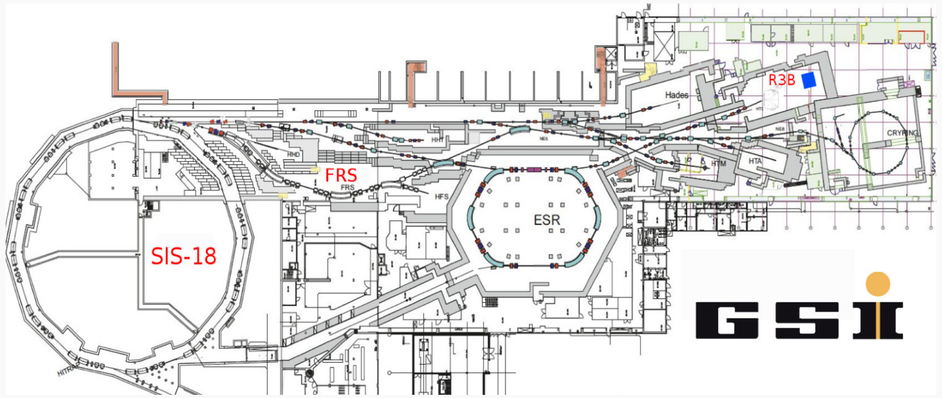




[T. L. Tang et al.]

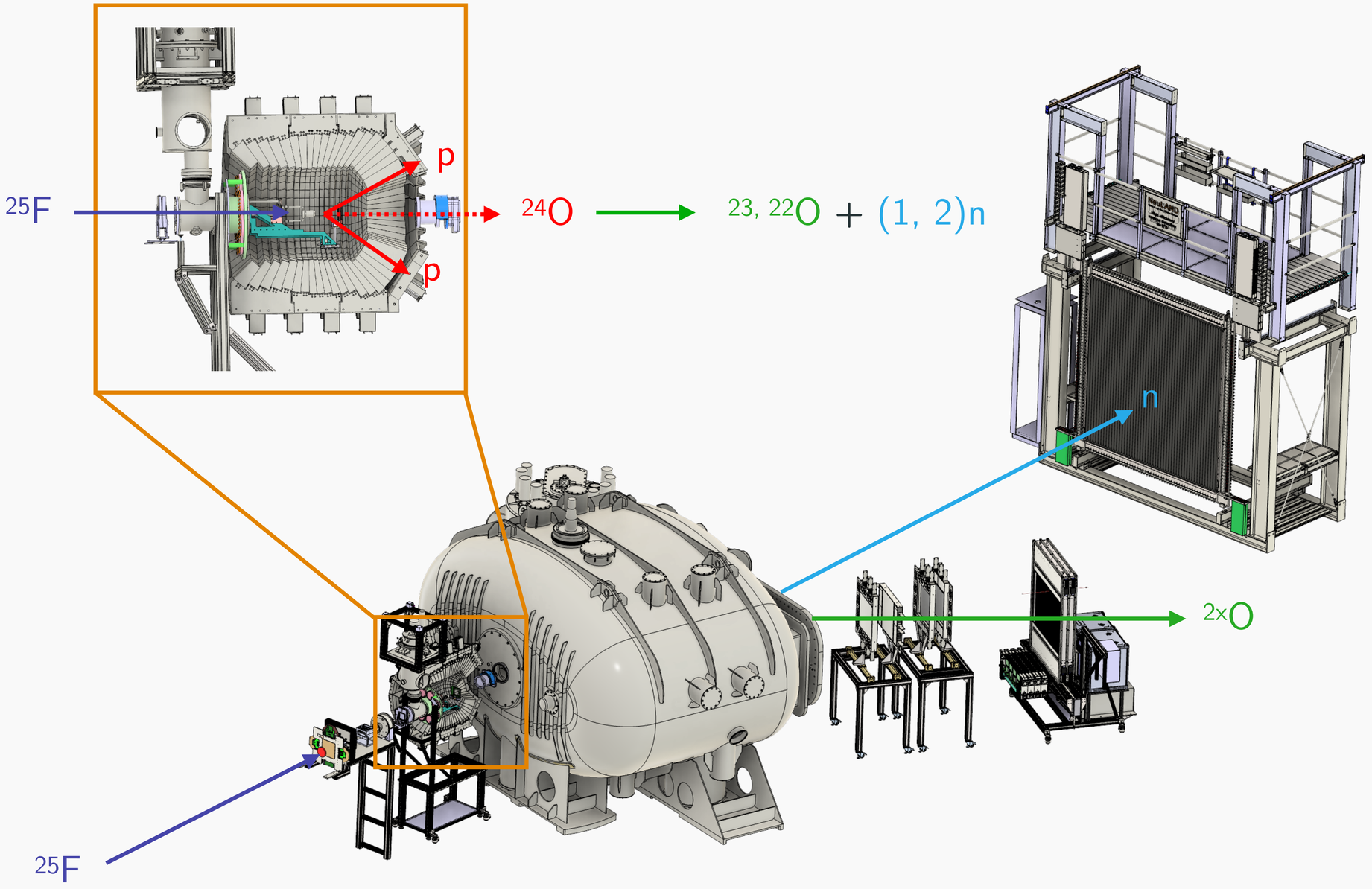
Experimental setup: Our experiment

In June of this year, at GSI:

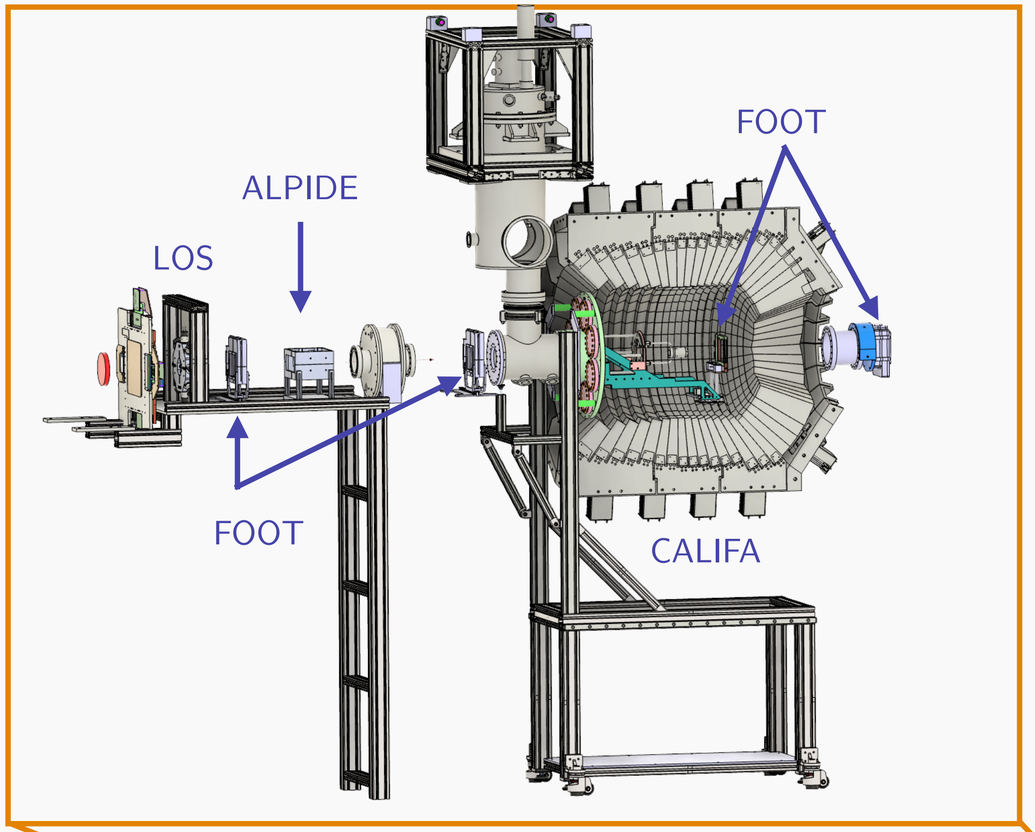


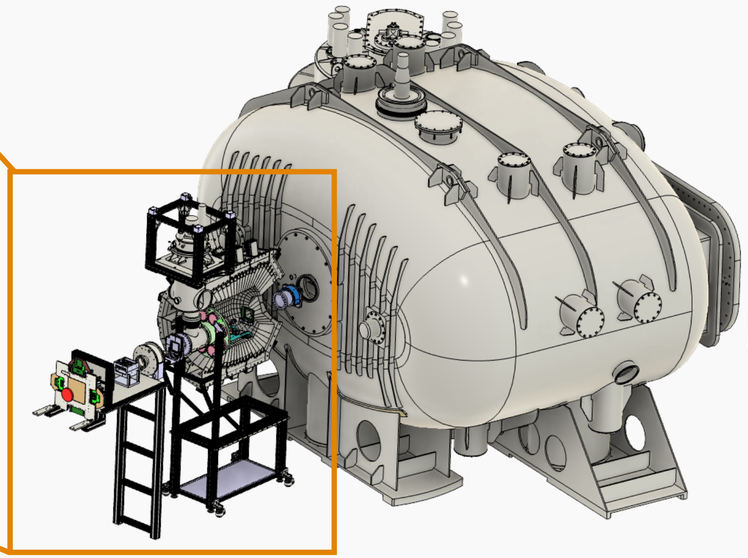
- ^{25}F(p,2p)^{24}O @ 650 MeV/u ⟶ Cocktail beam tuned from ^{40}Ar at FRS + LH_2 target.
- We aim at measuring: E_{rel} spectra, cross sections, momentum distributions...
- **Objective** ⟶ Study both bound and unbound states of ^{25}F (with more statistic than in RIKEN).
  ⟶ Extend this study to $^{23,\ 24}$F.

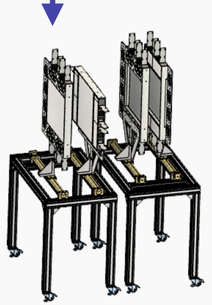
Experimental setup

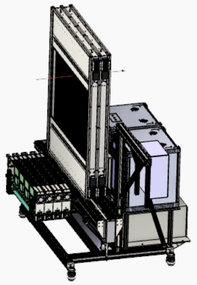


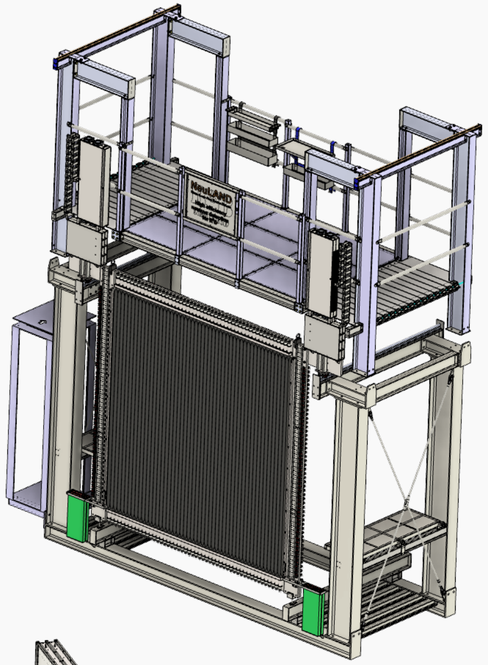
Experimental setup





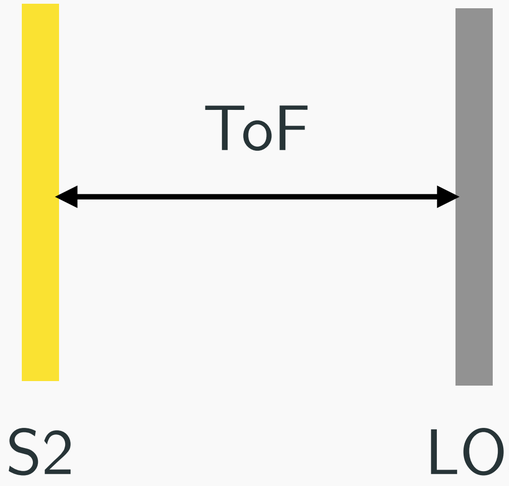






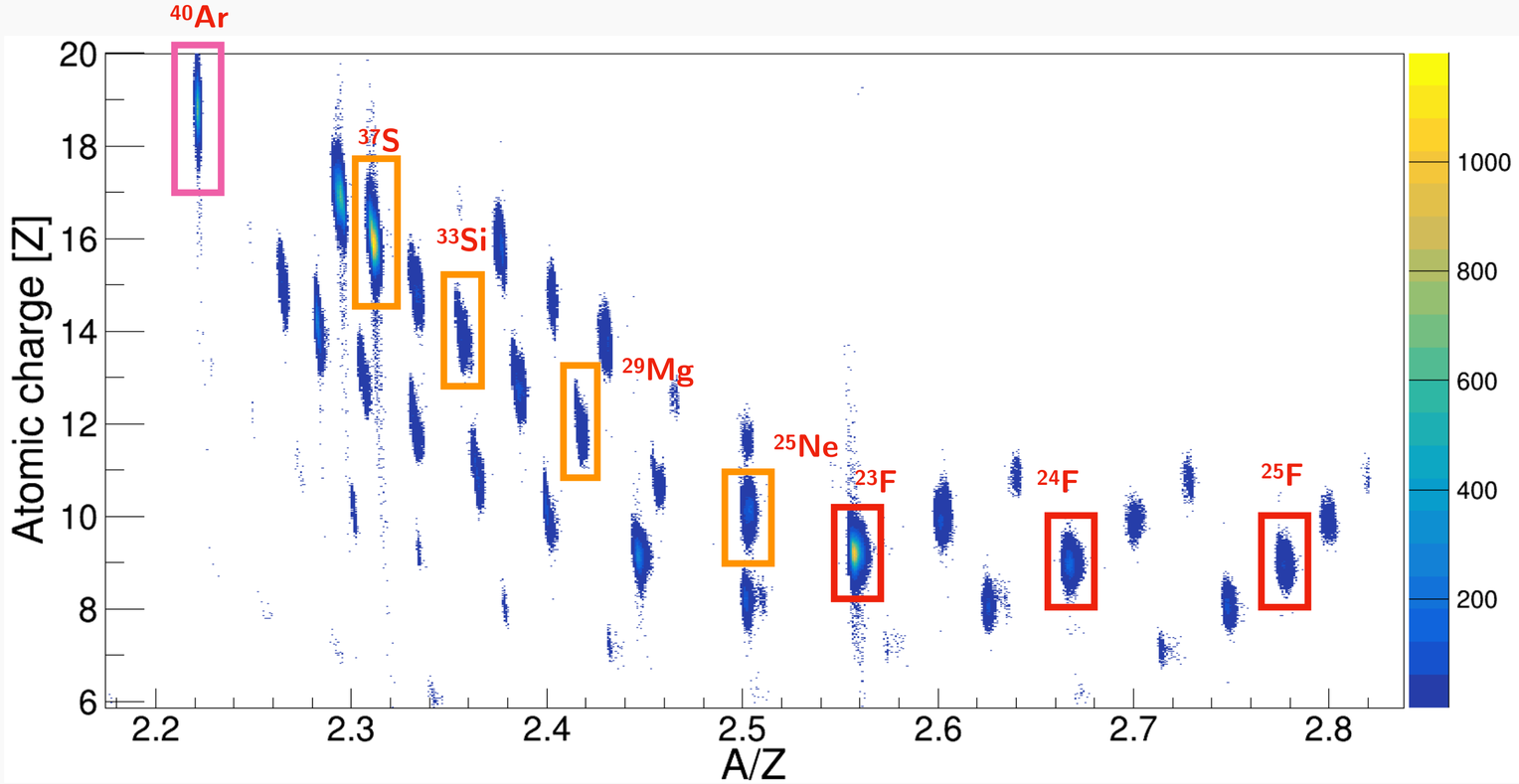
Analysis: Incoming PID

- A/Q and Z



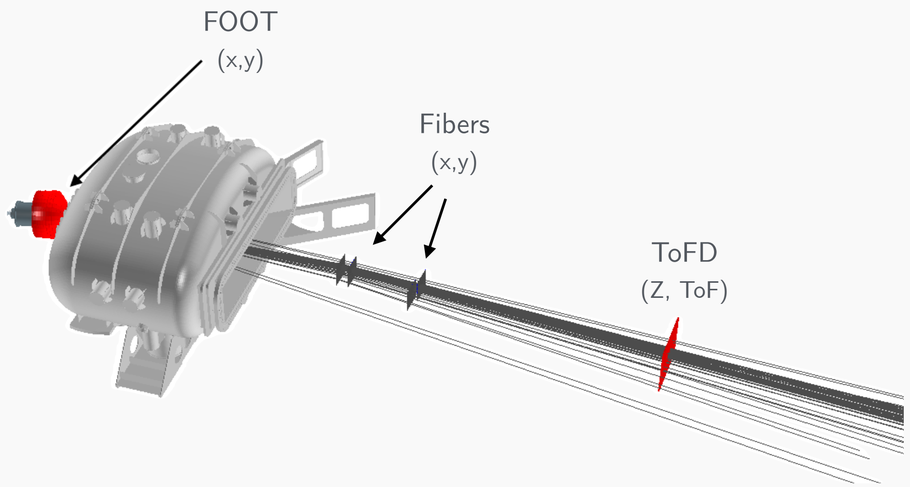
$$B\rho = B\rho_0 \left(1 - \frac{x_{S2}}{D}\right) \qquad \frac{A}{Q} = \frac{B\rho e}{\beta\gamma m_u c}$$

- PID of incoming beam (8 FRS settings)



Analysis: Outgoing PID

- For the outgoing PID we use:

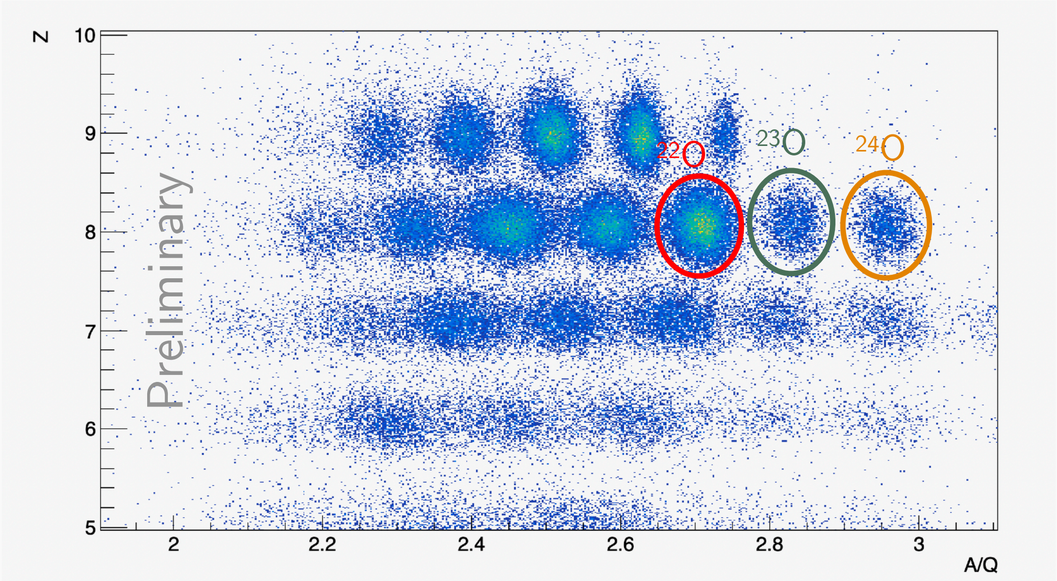


Multidimensional Fit

Observables ⟷ P/Q and A/Q

Simulations

- (p,2p) in CALIFA



Results: Relative energy spectra

- The first observable of interest is the relative energy.
- To test our calibrations and algorithms $\longrightarrow$ ^{24}O $\longrightarrow$ ^{22}O + n + n.

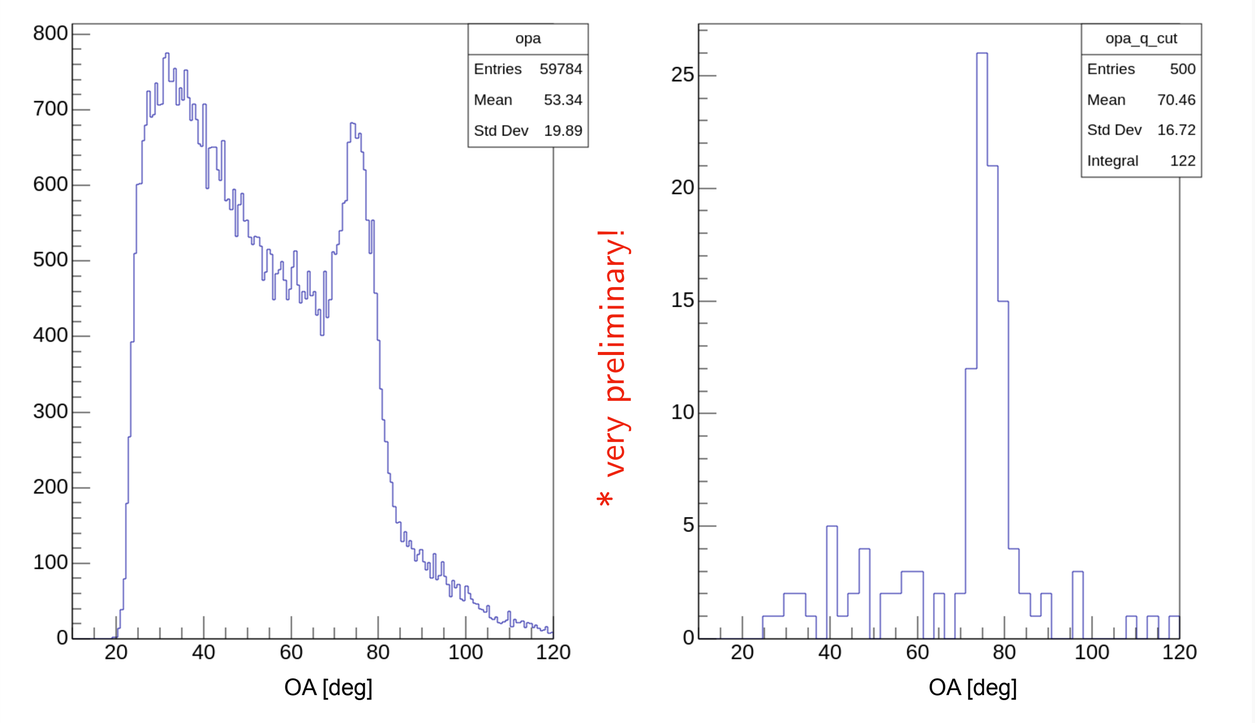
$$E_{\text{rel}} = \sqrt{(E_1 + E_2)^2 - |\vec{p}_1 + \vec{p}_2|^2} - (m_1 + m_2)$$

- Following cuts:

1. ^{25}F for the incoming isotope.
2. Z = 9 for incoming isotope in FOOTs and Z = 8 for the outgoing.
3. ^{22}O for the outgoing isotope.
4. First neutron (in position) that arrives at NeuLAND.

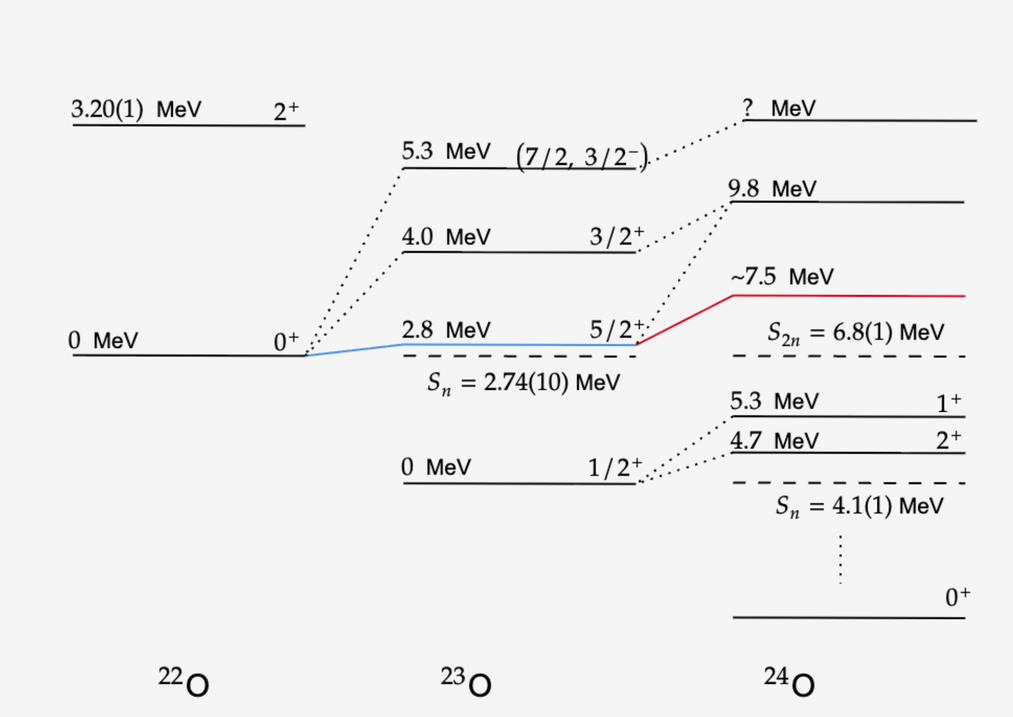
Results: (p,2p) in CALIFA

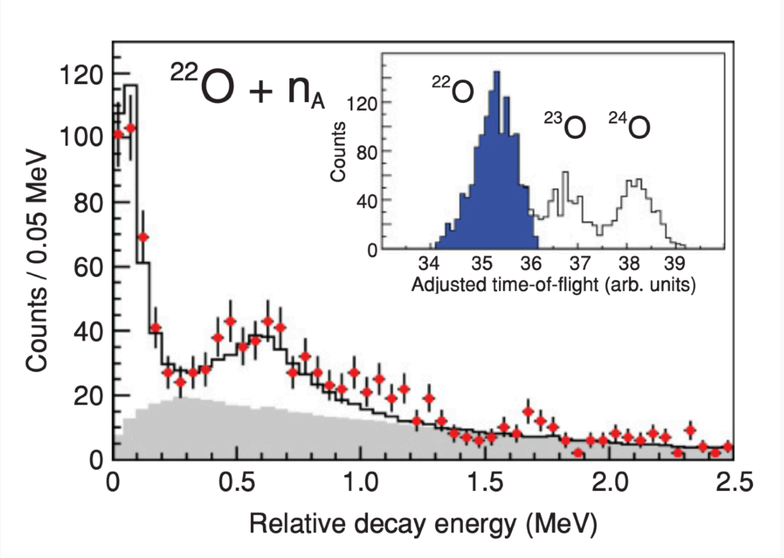
- After applying the cuts:



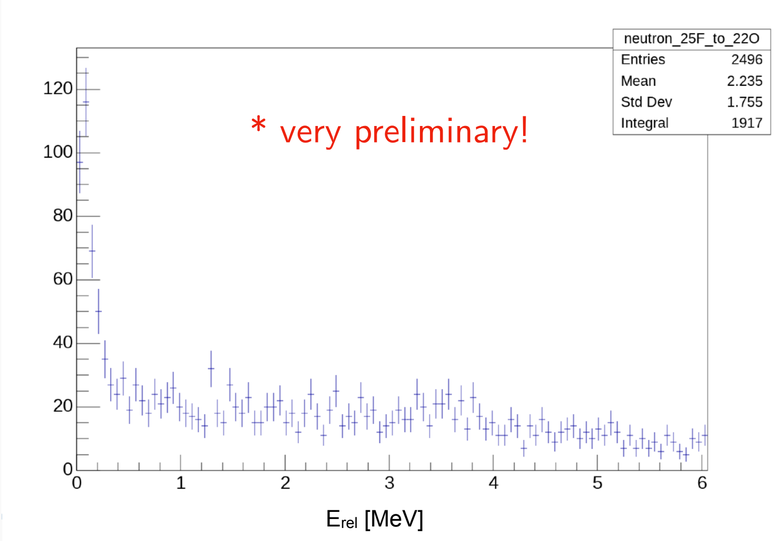
Results: Relative energy spectra

- Two main resonances known





[Hoffman et al.]



Conclusions

To sum up:

- We have completed the calibrations and algorithms for PID.
- Next steps → New MDF and calibrations
  - → 1n E_{rel} for ^{23}O and ^{22}O + 2n E_{rel} for ^{22}O.
  - → Momentum distributions → Spectroscopic factors.
  - → Cross-sections
  - → Extend the study to $^{23,\ 24}F$.

Acknowledgements

José Luís, Héctor, Martina, Valerii, Bea, Manuel, Pedro, Georgina, Martin and R³B people!

Supported by EURO-LABS: European Union's Horizon Europe Research and Innovation programe under Grant Agreement No 101057511

Funded by