$\nu 0p_{1/2} - \nu 0p_{3/2}$ spin-orbit splitting in ^{20}O

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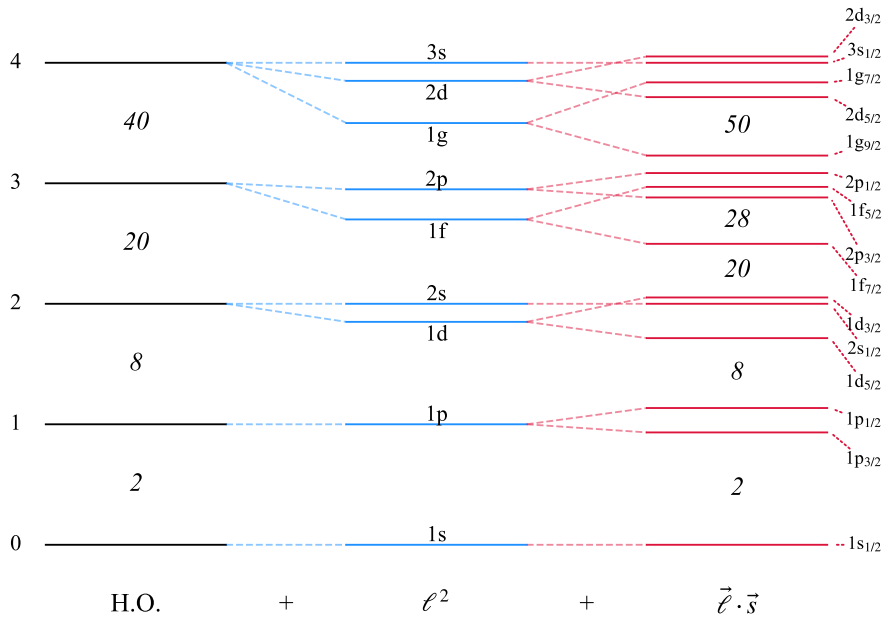
EuNPC 2025 - Caen

A recap on the SO splitting

Introduced by M. Goeppert-Mayer, the SO potential successfully reproduces magic numbers in stable nuclei.



It is mainly a surface effect:

$$V_{SO} = -\frac{1}{\hbar^2} V_{so} (\vec{l} \cdot \vec{s}) \left(\frac{1}{r} \frac{dV}{dr} \right)$$

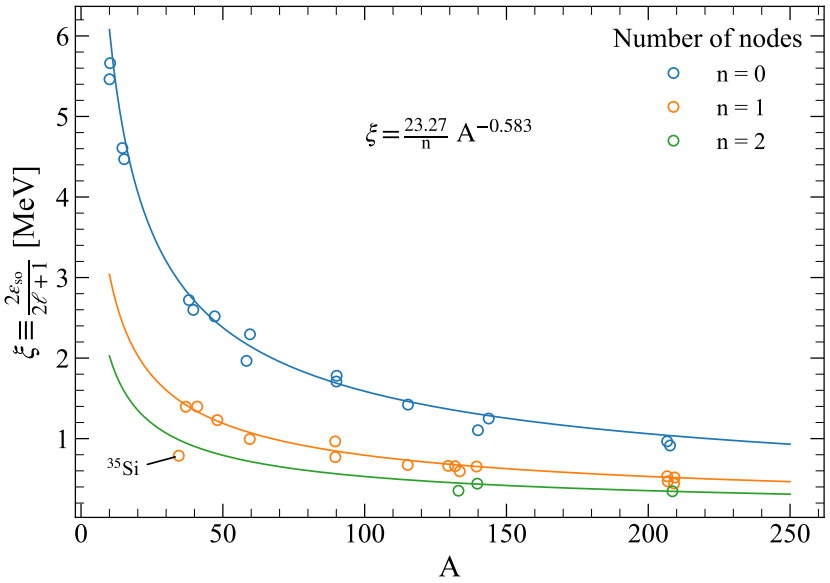
yielding a ℓ-dependent gap:

$$\Delta_{so} = \frac{\hbar^2}{2} (2\ell + 1) \xi$$

$\Rightarrow$ Expected to evolve towards more exotic nuclei, as surface blurs and hence $\xi \sim dV/dr$ changes.

A recap on the SO splitting

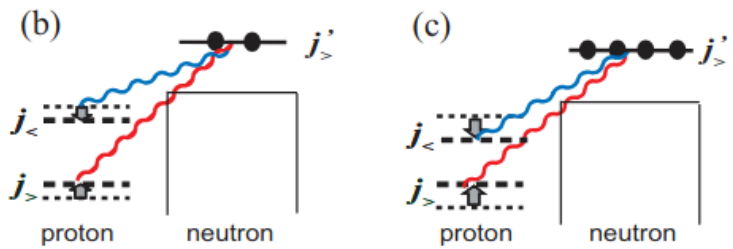
G. Mairle *et al.* (PLB 304 (1993)) found systematic trends easily parametrizable.



Proton-neutron interactions drive **shell evolution**

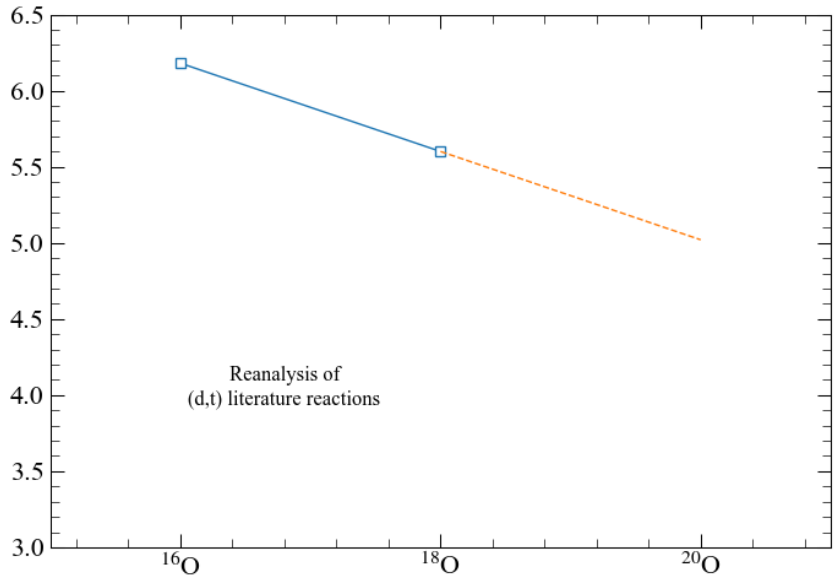
Deviations from the trend are found though:

1. Loosely bound orbitals
2. Nuclear matter deplection (^{35}Si?)
3. Role of **tensor force**



SO gap for $Z = 8$ isotopes

Evolution of the SO gap is plotted below for neutron-rich O isotopes.



Will ^{20}O follow the trend?

Could be determine tensor $\pi\nu$ contribution?

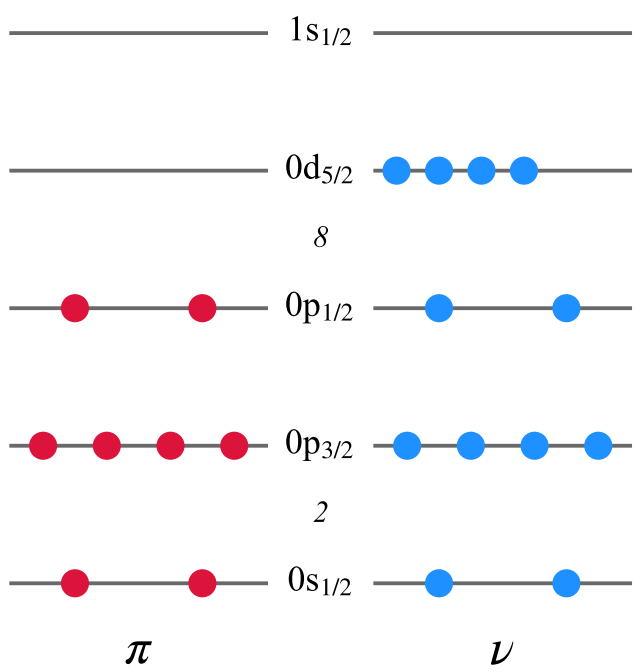
Physics case

Transfer reactions to probe single-particle occupancies in ^{20}O.

1 **Proton** pickup
$^{20}O(d, ^{3}He)^{19}N$

some results from Juan and cite

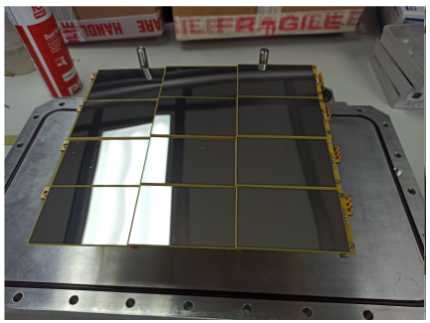
2 **Neutron** pickup
$^{20}O(d, t)^{19}O$ this analysis and .....



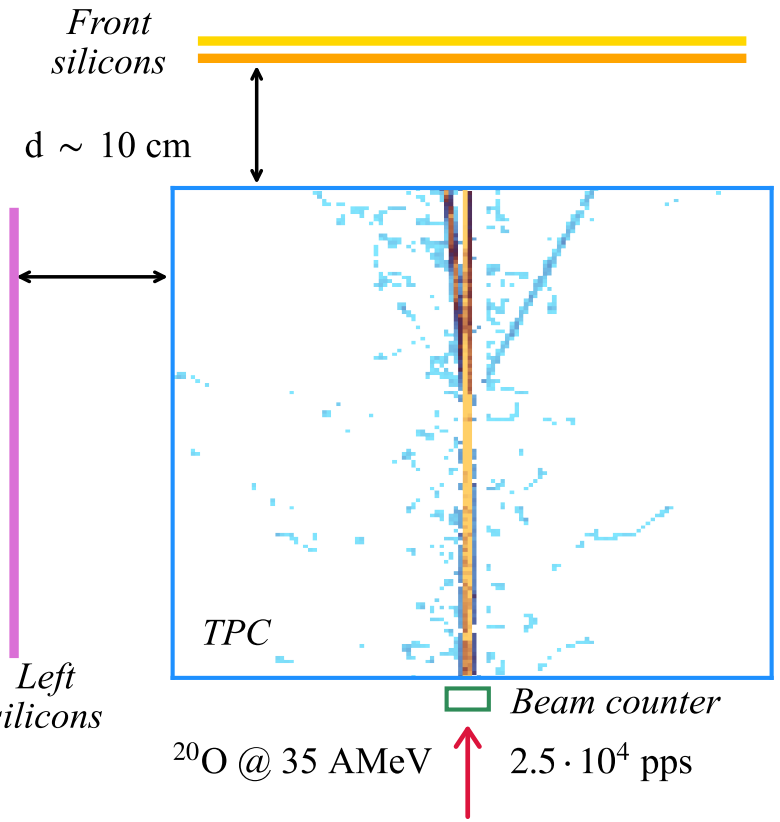
IPSM of ^{20}O

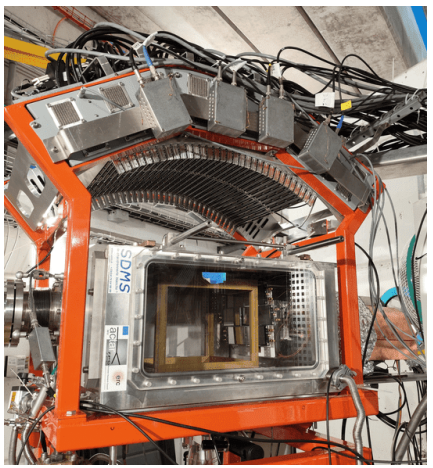
Experimental setup

E796 @ LISE in 2022. First transfer experiment with ACTAR TPC!



Silicon sizes:
$80 \times 50 \times 0.5\text{mm}^3$

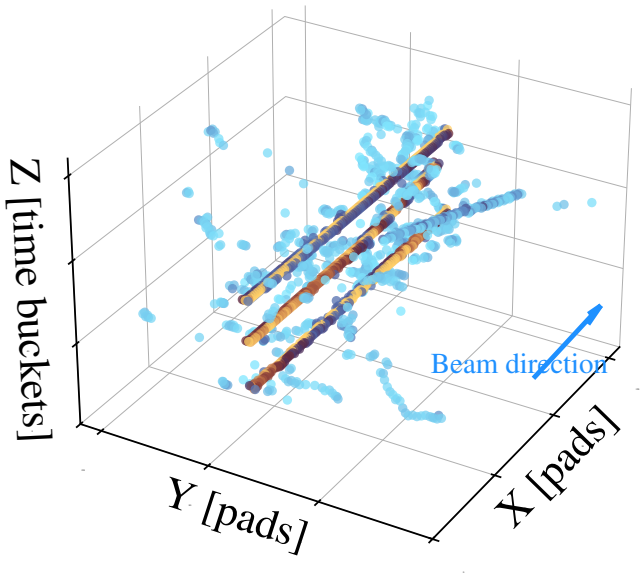


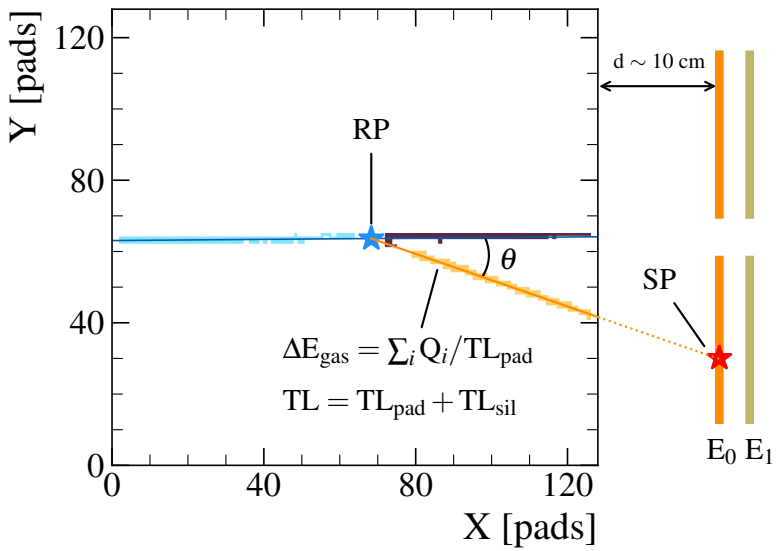


Gas setup:
90 % D_2 + 10 %
iC_4H_{10}
@ 950 mbar

A window to the analysis

Intricate analysis to extract reactions of interest out of noisy data.





Conversely, the TPC offers unique advantadges:

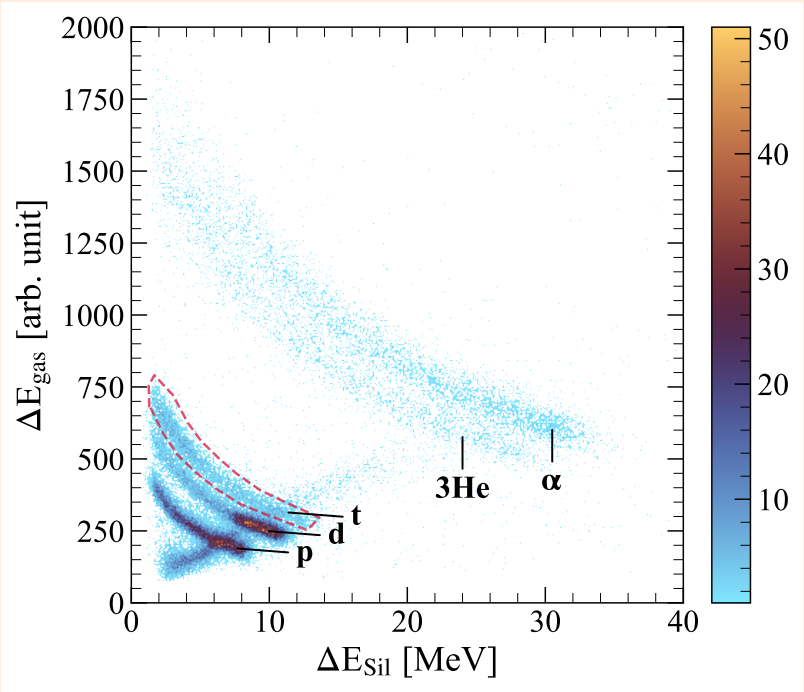
1 Precise **vertex** determination
2 Improved ΔE corrections

3 Factor 10 in target number
4 Implicit PID with ΔE_{gas}

A window to the analysis

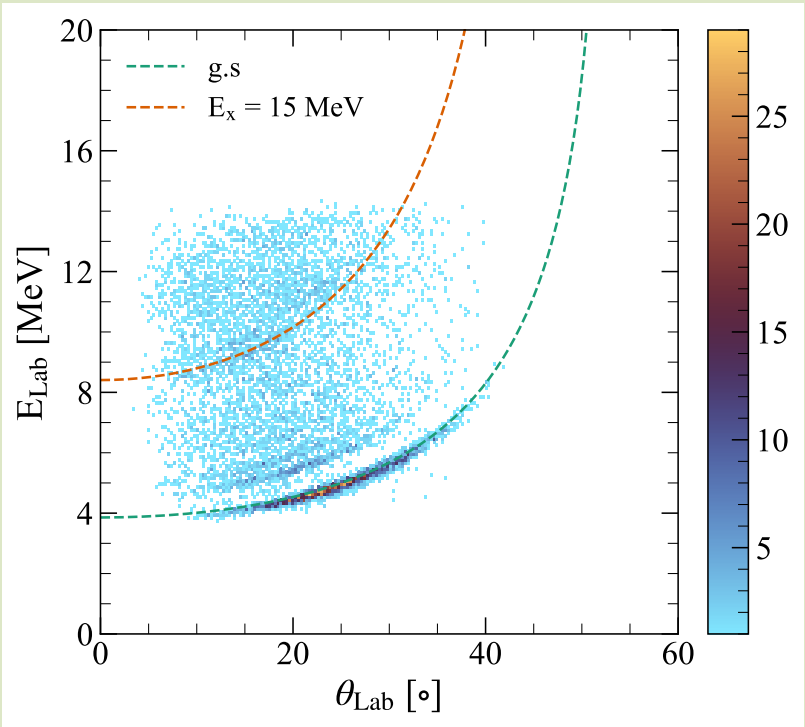
Two steps needed after data has been processed.

1 Triton identification in PID

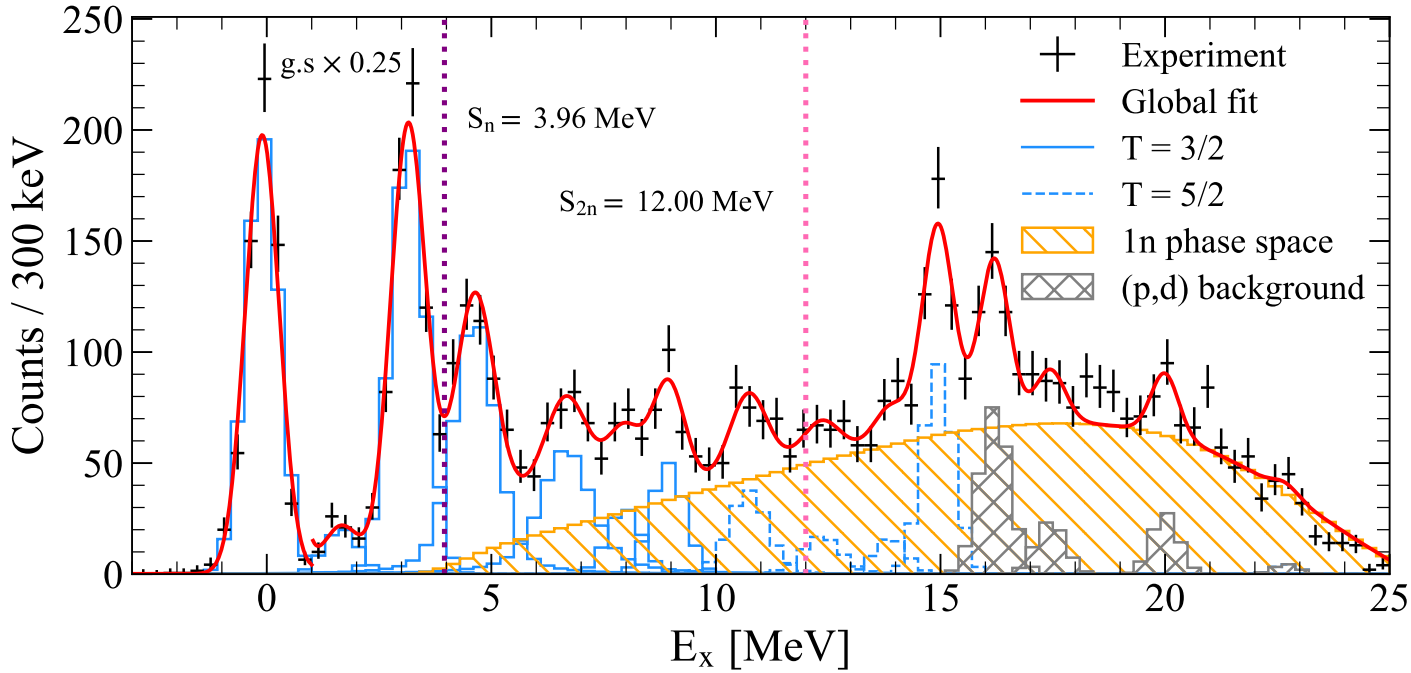


Vetoing punch-through to 2nd front layer

2 Reconstruct E_x by **missing-mass** technique



Results: E_x spectrum



11 observed states!
(p,d) background at high E_x

T assigments based on comparison with $^{20}O(d, ^3He)^{19}N$

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