Commissioning of the ACTAR TPC

Benoît Mauss, on behalf of the ACTAR TPC collaboration
The ACtive TARget and Time Projection Chamber

**TPC**: $295 \times 295 \times 255 \text{ mm}^3$

Pad plane:
128 $\times$ 128 pads of size 2 mm $\times$ 2 mm

**MICROMEGAS**:
gap size 220 $\mu$m

Optional, on the rear panel:
- CsI wall
- Si (size: 5 cm $\times$ 5 cm and 700 $\mu$m thick, $\sigma \approx 30$ keV) wall
Electronic set-up, NARVAL topology

GET electronics used for the 16384 pads

Analog electronics used for the Si and CsI detectors

→ Si as L0 trigger and L1 ok from the pads
Experiment:

Beam: 3.2 MeV/nucleon $^{18}$O
Target: iC$_4$H$_{10}$ at 100 mbar
Observable channels:

- p-p
- p-$\alpha$

1. Experimental set-up
2. Detector capabilities
3. Extraction of the excitation function and results
Installation of the ACTAR TPC at GANIL

$^{18}$O entering G3 with 6.6 MeV/nucleon

- 63µm thick aluminium foil for energy degradation down to 3.2 MeV/nucleon
- Energy straggling at the entry of ACTAR TPC: $\sigma \sim 600$ keV
- Beam intensity: $\sim 10$ kHz during 20 hours
Experimental tracks and pad polarization

- Target: $iC_4H_{10}$ at 100 mbar, stops the beam
- Large energy deposit discrepancies during the experiment
- Use of pad polarization, electronic gain capacitance at 120 fC for all pads
Determining the beam range

Example of a typical beam event aligned on a SRIM energy loss curve

Shorter range depending on the energy transferred to the target after reaction
Track fit and angular resolution

3D fit projected on two 2D projections:

Extrapolation of the fit on the Si Wall:

Resolution: 3.0 mm FWHM
i.e. resolution < 1.7° FWHM

Resolution: 3.8 mm FWHM
i.e. resolution < 2.2° FWHM
Summary of extracted observables

- Beam range
- Laboratory angle of the recoiling particles
- Energy deposit of the recoiling particles
- Energy of the backward angle recoiling particles in the Si wall
Particle identification

Raw spectrum of $\frac{dE}{dx} = f(E_{Si})$ for all Si detectors

Correlation between the impact height and charge deposit measured permits a correction:

Height and energy deposit correlation due to electron attachment from O$_2$ pollution

→ p-p and p-α channel selection
Extraction of the excitation function from the scattered particle’s fundamental

\[ p-p \text{ channel} \quad \rightarrow \quad p-\alpha \text{ channel} \]

\[ E_{\text{reac}} \quad \rightarrow \quad E^* \]

\[ E_{\text{Si}} \text{ (keV)} \]

beam range (pad)

Selection of the ground state channels from the range and the energy in the Si detectors
2 methods to extract the excitation function

Projection on the simulated kinematic line.

Iterative procedure using the energy and the angle of the recoiling particle:

1. $E_{Si}, \theta_{lab} \Rightarrow E_{reaction 1} \Rightarrow$ vertex 1
2. vertex 1, $\theta_{lab} \Rightarrow E_{p, \alpha, vertex 1} = E_{Si} + E_{SRIM1}$
3. $E_{p, \alpha, vertex 1}, \theta_{lab} \Rightarrow E_{reaction 2} \Rightarrow$ vertex 2
4. vertex 2, $\theta_{lab} \Rightarrow E_{p, \alpha, vertex 2} = E_{Si} + E_{SRIM2}$
5. ...
Theoretical results to be reproduced:

p-p channel: R-matrix calculation

R-matrix calculation performed with the AZURE2 code.

p-α channel: previous experimental data

Results and comparison with former data: p-p channel

Use of R-matrix calculation for the p-p channel, convoluted with a Gaussian function filter of resolution 23.5 keV FWHM. $\theta_{cm} = (160 \pm 5)^\circ$

Projected on kinematic line

After iteration on the reaction energy
Results and comparison with former data: \( p-\alpha \) channel

Use of a previous experimental graph for the \( p-\alpha \) channel, convoluted with a Gaussian function filter of resolution 47 keV FWHM. \( \theta_{cm} = (170 \pm 5)\degree \)

Projected on kinematic line

After iteration on the reaction energy
Conclusion

- Use of many channel with GET was a success
- Pad polarization worked well
- Reconstruction of the excitation function consistent with previous data
- Finish the normalization of the excitation function
- Correct the few remaining problems for future experiments
## Collaboration

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Thank you for your attention

The research leading to these results have received funding from the European Research Council under the European Union’s Seventh Framework Program (FP7/2007-2013)/ERC grant agreement n° 335593.