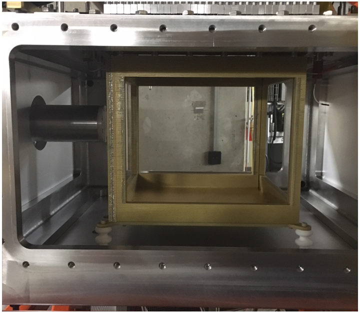
Commissioning of the ACTAR TPC

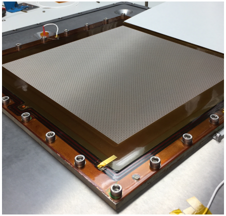
Benoît Mauss, on behalf of the ACTAR TPC collaboration

European Research Council
Established by the European Commission

laboratoire commun CEA/DSM CNRS/IN2P3

The ACtive TARget and Time Projection Chamber

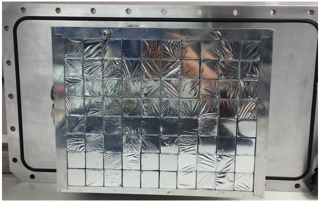


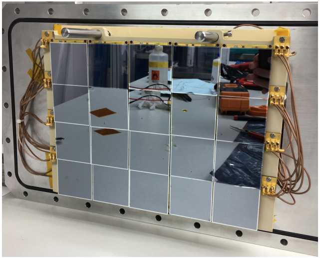


TPC: $295 \times 295 \times 255$ mm^3

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

MICROMEGAS: gap size 220 μm

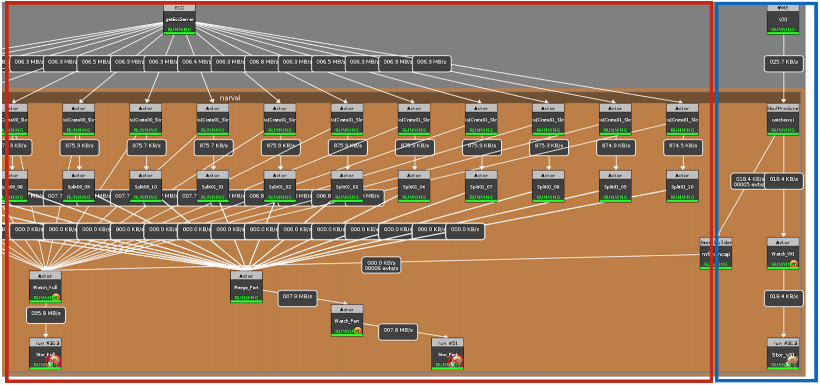




Optional, on the rear panel:

- CsI wall
- Si (size: 5 cm$\times$5 cm and 700 μm 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

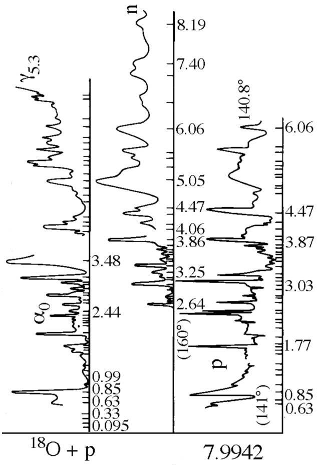
$\longrightarrow$ Si as L0 trigger and L1 ok from the pads

Experiment:

Beam: 3.2 MeV/nucleon ^{18}O
Target: iC_4H_{10} at 100 mbar
Observable channels:

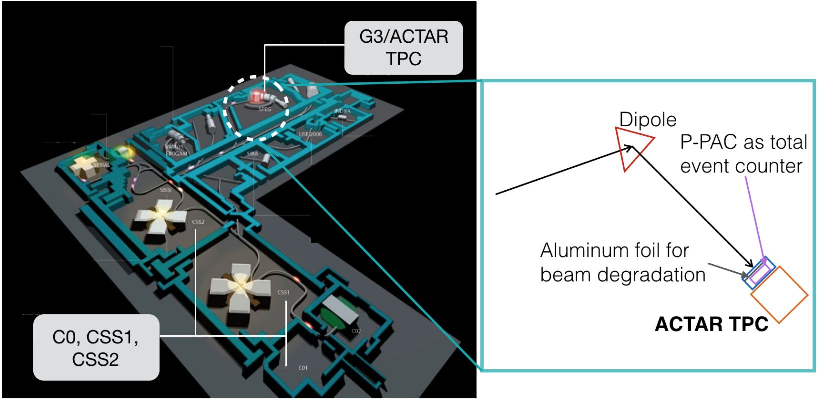
- p-p
- p-α

1. Experimental set-up
2. Detector capabilities
3. Extraction of the excitation function and results



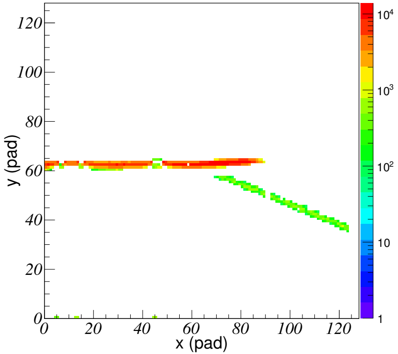
Installation of the ACTAR TPC at GANIL

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



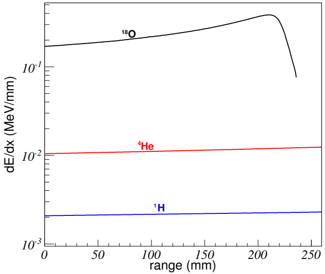
- 63μm thick aluminium foil for energy degradation down to 3.2 MeV/nucleon
- Energy straggling at the entry of ACTAR TPC: $\sigma \simeq 600$ keV
- Beam intensity: $\simeq 10$ kHz during 20 hours

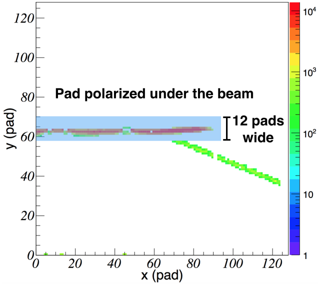
Experimental tracks and pad polarization



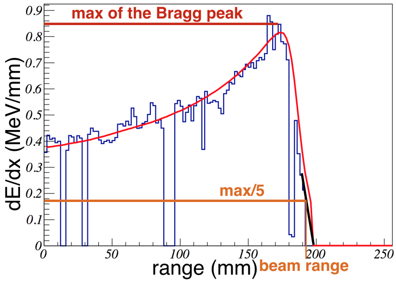
- Target: iC_4H_{10} at 100 mbar, stops the beam
- Large energy deposit discrepancies during the experiment
- Use of pad polarization, electronic gain capacitance at 120 fC for all pads

SRIM tables for typical particle energies during the commissioning

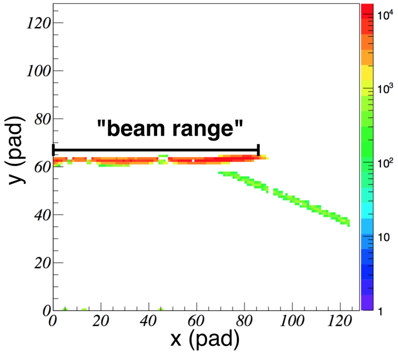




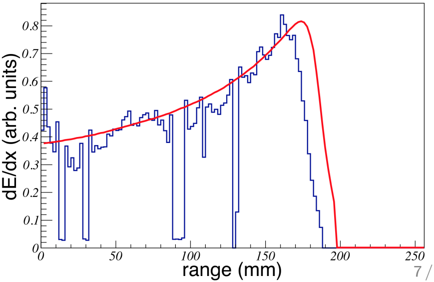
Determining the beam range



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

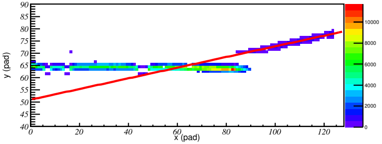


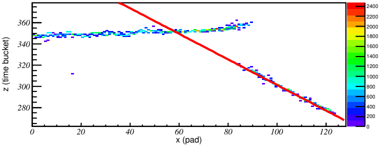
Shorter range depending on the energy transferred to the target after reaction



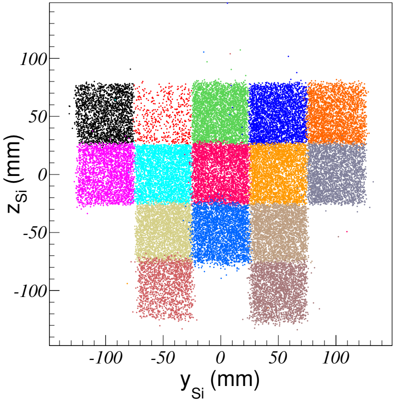
Track fit and angular resolution

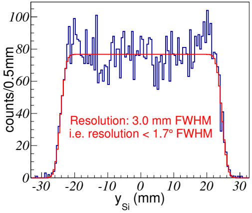
3D fit projected on two 2D projections:

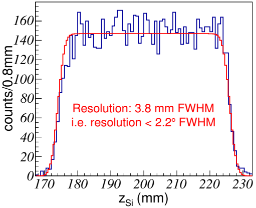




Extrapolation of the fit on the Si Wall:







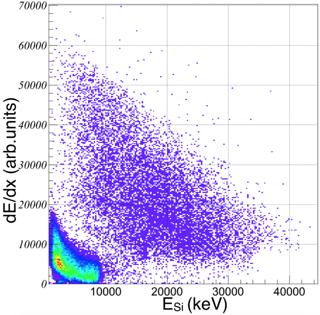
Summary of extracted observables

- Beam range
- Laboratory angle of the recoiling particles
- Energy deposit of the recoiling particles

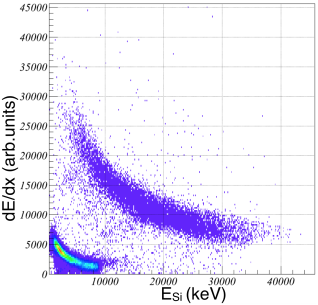
- Energy of the backward angle recoiling particles in the Si wall

Particle identification

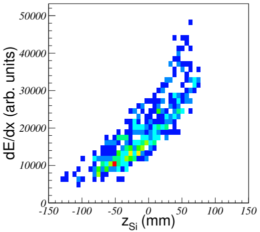
Raw spectrum of $\frac{dE}{dx} = f(E_{Si})$ for all Si detectors



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



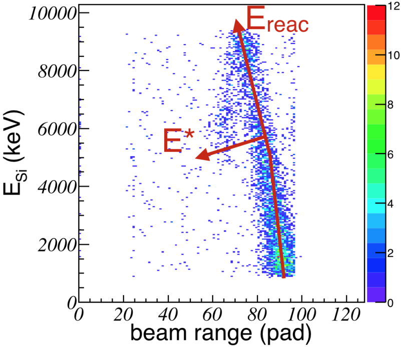
Height and energy deposit correlation due to electron attachment from O_2 pollution



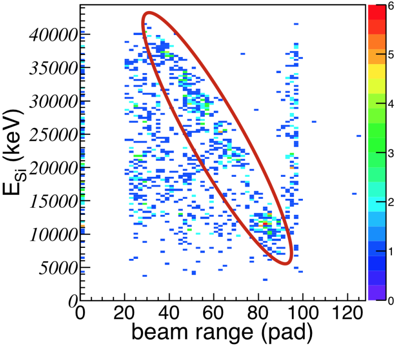
$\longrightarrow$ p-p and p-α channel selection

Extraction of the excitation function from the scattered particle's fundamental

p-p channel



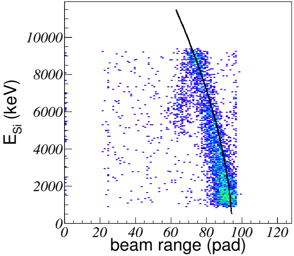
p-α channel

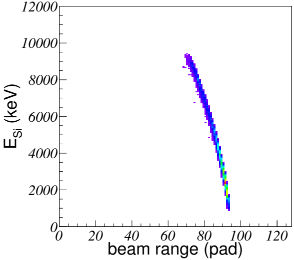


$\longrightarrow$ Selection of the ground state channels from the range and the energy in the Si detectors

2 methods to extract the excitation function

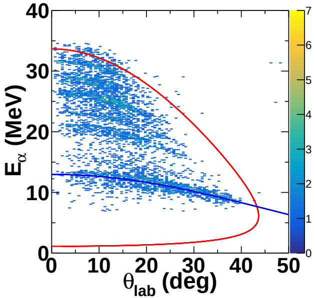
Projection on the simulated kinematic line.





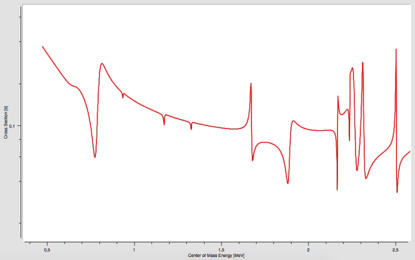
Iterative procedure using the energy and the angle of the recoiling particle:

1. E_{Si}, θ_{lab} $\Rightarrow$ $E_{reaction1}$ $\Rightarrow$ vertex 1
2. vertex 1, θ_{lab} $\Rightarrow$ $E_{p,\alpha\,vertex1} = E_{Si} + E_{SRIM1}$
3. $E_{p,\alpha\,vertex1}$, θ_{lab} $\Rightarrow$ $E_{reaction2}$ $\Rightarrow$ vertex 2
4. vertex 2, θ_{lab} $\Rightarrow$ $E_{p,\alpha\,vertex2} = E_{Si} + E_{SRIM2}$
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

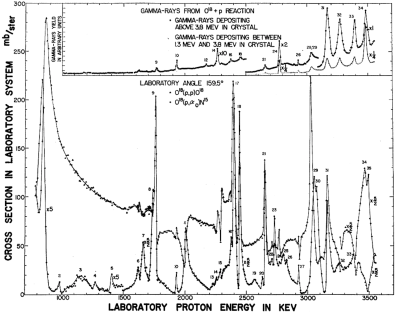
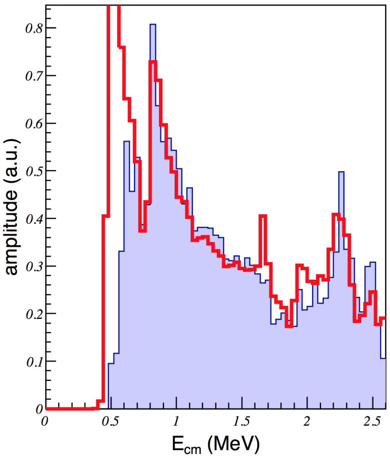


FIG. 4. Absolute laboratory differential cross sections for $O^{18}(p,p)O^{18}$ and $O^{18}(p,\alpha_0)N^{15}$ as a function of laboratory proton energy observed at laboratory angle 159.5°. The gamma-ray yield curve (upper part of figure) was observed at 90°.

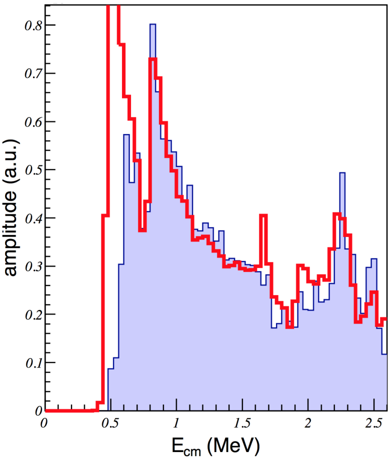
R. R. Carlson, C. C. Kim, J. A. Jacobs and A. C. L. Barnard in Physical Review 122, 607-616 (1961)

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. $\theta_{cm} = (160 \pm 5)^{\circ}$



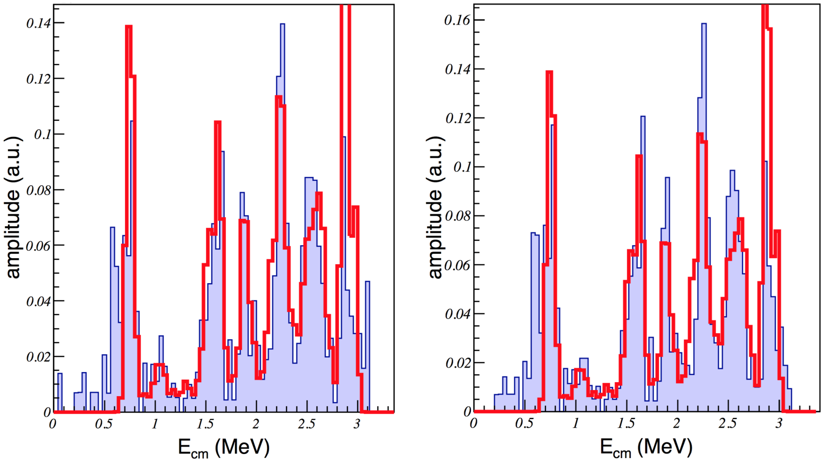
Projected on kinematic line



After iteration on the reaction energy

Results and comparison with former data: p-a channel

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



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

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