e768s Experiment analysis report

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2019

The collaboration

- Spokepersons: A. Gottardo, M. Assié
- The Mugast, AGATA and VAMOS collaboration

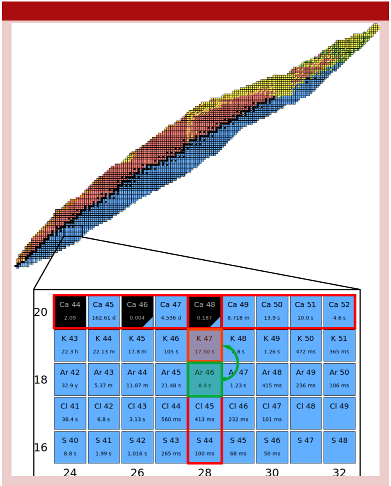
What we aim for

The aim of the experiment is to probe the proton wavefunction by a transfer direct reaction in ^{46}Ar

Note that:

- We are looking into a well studied isotope $\Longrightarrow$ We are not interested in studying the spectroscopy in search of new states
- The crucial aspect is to investigate the L transfer
- Thanks to the capabilities of the experimental apparatus, self consistency checks will be employed to control and quantify possible systematic errors (more on this later)

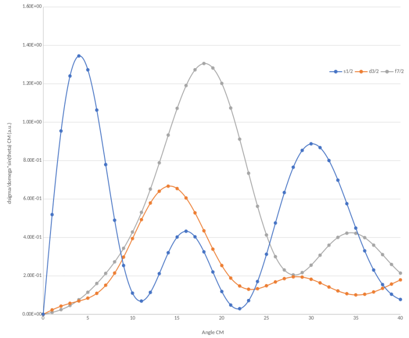
The N=28 shell closure



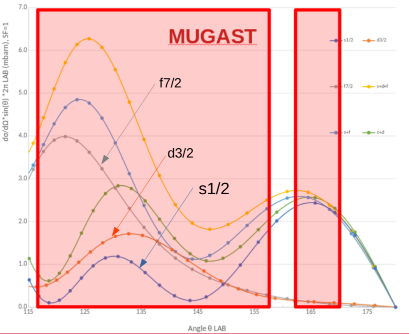
- Nuclear models seem to fail in reproducing proton-wave dependent observables
- Inferring spectroscopic factors, which are very sensitive to proton shell-occupancies, might help the understanding of the issue
- Transition probabilities are in fact not in agreement with calculations in the framework of SPDF-U interaction

Angular Distributions

- $^{46}Ar(^{3}He, d)^{47}K$ @ 10MeV/u. (TWOFNR)



CM distributions show a high sensitivity to the transferred wave

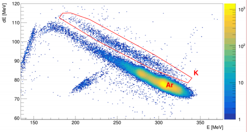


Lab distributions show a high sensitivity to the transferred wave

VAMOS

- VAMOS at zero degrees proved itself crucial to:
  1. Monitor the beam, mainly the energy loss in the target over time
  2. Select reaction fragment

Z selection

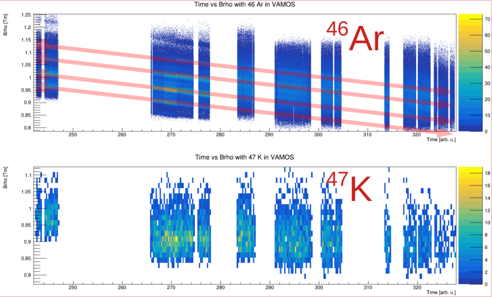


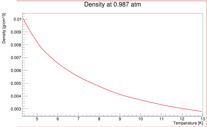
- Z selection improves requiring no pileup
- Likely improvement will be returned by considering the IC mylar deformation

- Many tweaks are still needed in the analysis

Target behaviour over time

Total thickness over time can be extrapolated from BRho





^{3}He density (and thickness) over time is known from experimental data $\Longrightarrow$ ice thickness over time can be extrapolated

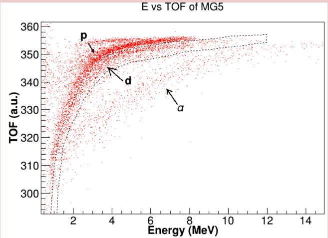
The total statistics

- 4×10^6 ^{46}Ar ions identified in VAMOS $\Longrightarrow \approx 4 \times 10^9$ ^{46}Ar integrated current
- 6.4×10^3 ^{47}K reaction fragments
- 12×10^9 ^{46}Ar beam time request
- 1/3 of the requested statistics

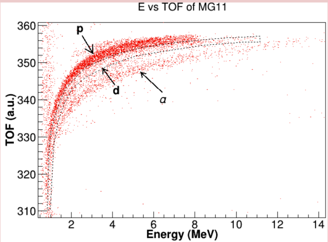
MUGAST: Particle discrimination

- The DSSD detector was essential to:
  1. Measure Angular distributions
  2. Discriminate the light fragment (d)

Trapezoid



Anular

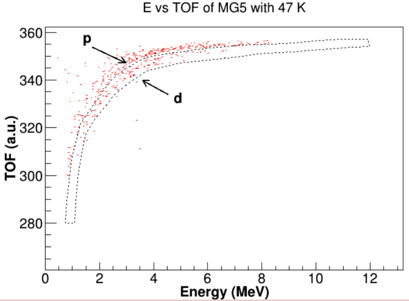


- Particles can be distinguished by Energy vs Time of Flight (between CATS2 and the detector)
- Energy not yet corrected from energy loss in the target

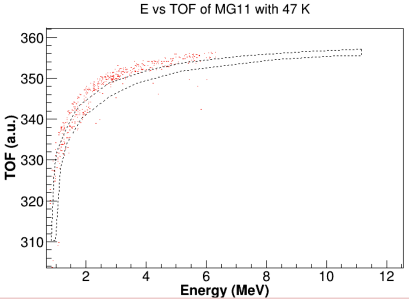
Particle discrimination

- Selecting ^{47}K as the heavy partner in VAMOS

Trapezoid

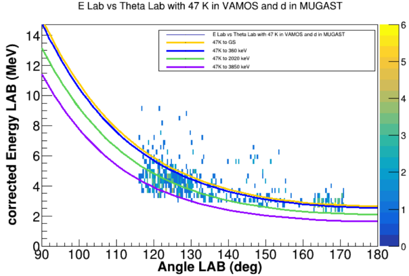


Anular



- Deuteron energy is clearly centered at different values in anular vs trapezoid detectors
- Separation will possibly be improved in the final analysis

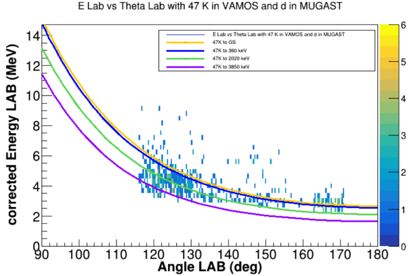
Kinematics



The kinematic line shows encouraging results, but also that considerable attention must be taken to caracthterize the energy loss in the target

The shape of the target has been measured and compared with the theoretical deformation.

Kinematics



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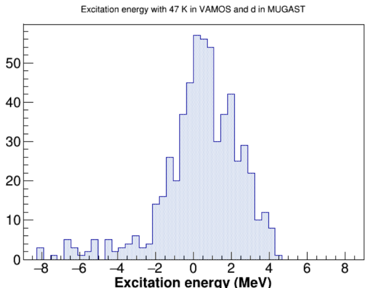
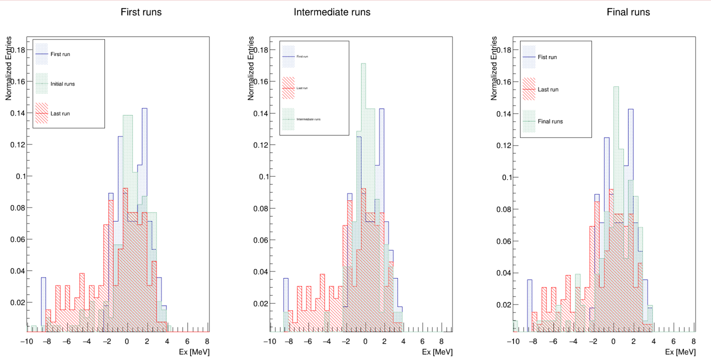
(Preliminary) Ex plot



Much work needs to be done

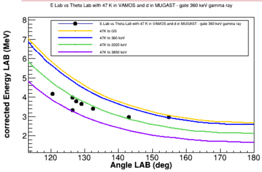
Ex evolution over time



- breaking up Ex over various runs show that a time-dependent energy correction must be included

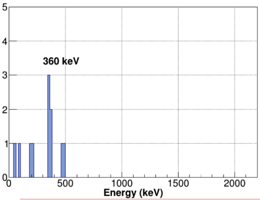
Kinematics+AGATA+VAMOS

Kinematic line in coincidence with 360 KeV γ-ray



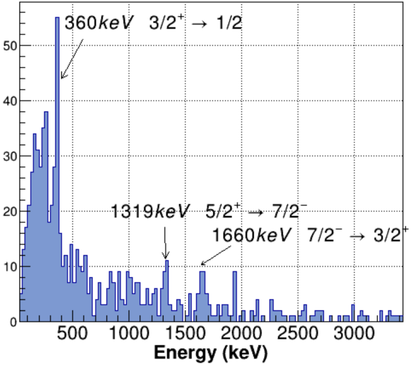
- 360 keV γ detected by AGATA+^{47}K identified in VAMOS+ deuteron measured in MUGAST $\Longrightarrow$ clear kinematic line
- Very low statistics

γ-rays in coincidence with d and ^{47}K



- Only few counts are present with 1.4MeV $<$Ex$<$ 2.1MeV , but enough to check for consistency
- No peak visible for Ex$<$ 1MeV

What about the protons?



- Many protons are identified in MUGAST (one order of magnitude more respect to the deuterons)
- The protons are likely due to the inelastic breakup of d, an already observed reaction channel. Further investigation is necessary, is it a direct reaction?

Simulating AGATA

The efficiency of AGATA can be precisely estimated with the Geant4 Monte Carlo simulation. $\Longrightarrow$ comparison with Ex

- The lifetimes of the $3/2^+$ and $7/2^-$ states are known (respectively 1.1 ns and 6.3 ns)
- This implies a great difference in detection efficiency
- The cryogenic target WILL be included to account for absorption

An ^{152}Eu run was acquired with the cryogenic-target in place, which will be used to check and rescale correctly the simulation

Future improvements

- Possible improvements on E-TOF selection?
- Efficiency considerations on AGATA
- VAMOS selection needs to be improved, accounting for IC mylar deformation and many other aspects
- MUGAST simulation needs to be changed to compute angular distributions, as the anular detector has a different size
- Include a parametrization of the energy loss over time, based on what VAMOS is measuring
- Inclusion of precise deformation as a function of the angle for energy loss estimate

Conclusions

In conclusion:

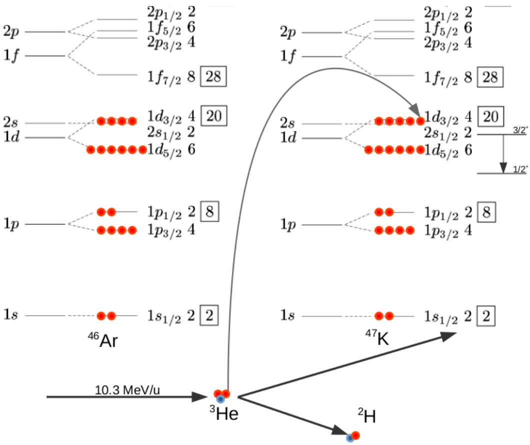
- The reaction is clearly populated and the fragments identified
- All problematic aspects can, in principle, be accounted for
- A solid (in my opinion) analysis strategy has been proposed
- Only 1/3 of the statistics acquired in very fragmented conditions: scientific outcome at risk

Thank you for your attention

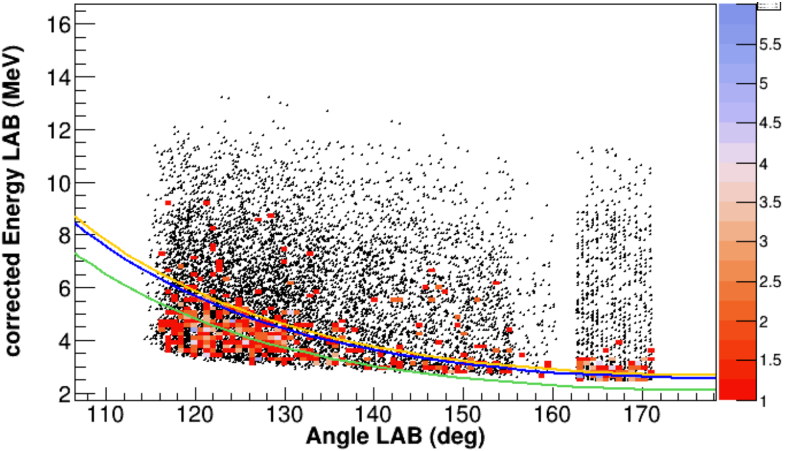
Overview

Backup Slides

Simplistic Shell model picture



Protons vs Deuterons



- d gate traced without VAMOS $\Longrightarrow$ more noise
- No kinematic line for protons (three body process)

^{47}K level scheme