BREAKUP OF $^{8}B+^{90}Zr$ AT THE SUB-BARRIER ENERGY OF 26.5MEV

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7th Workshop of the Hellenic Institute of Nuclear Physics, 31st May – 1st June, UoI, Ioannina

OVERVIEW

- Motivation
- Experimental Details:
  - Facility
  - Beam Production
  - Detector Set-up
- Break-up Analysis – Preliminary Results
- Summary - Conclusions

MOTIVATION

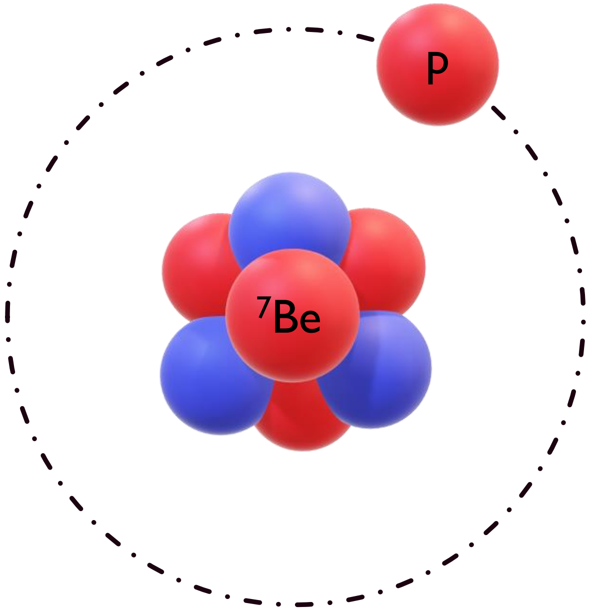
Interesting coupling effects below barrier

^{8}B: - Weakly bound radioactive nucleus

- Proton halo structure

- Important for astrophysics

- Break–up threshold: 0.137 MeV



$^{8}B \rightarrow {}^{7}Be + p$

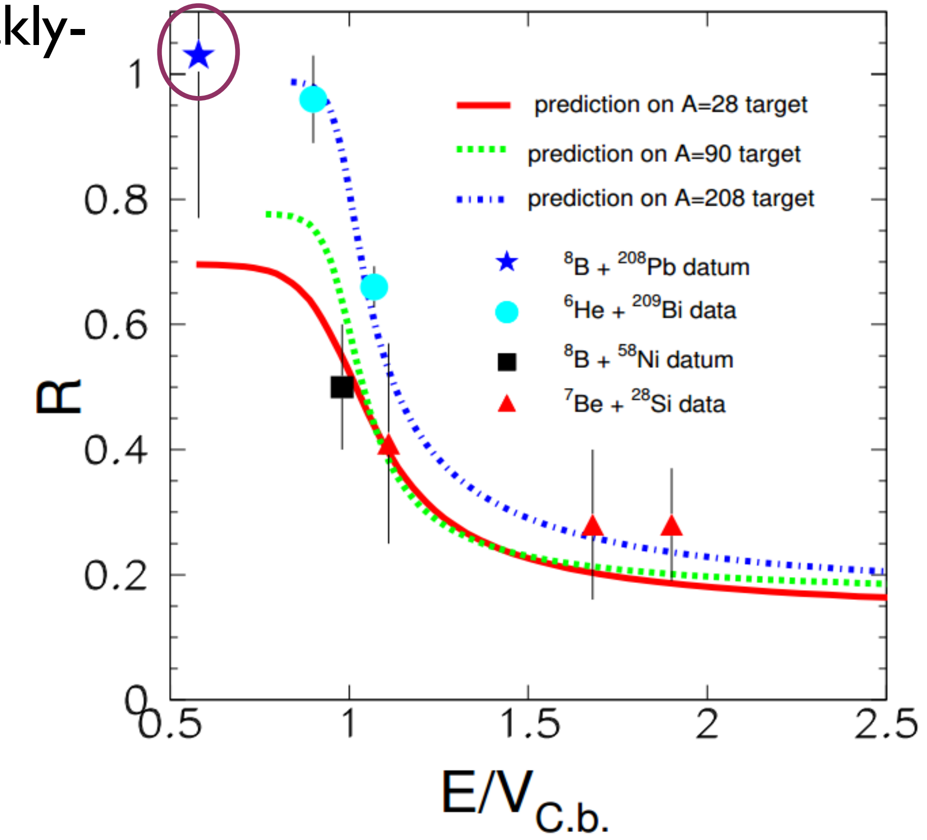
MOTIVATION

Prediction of direct-to-total cross section ratios for weakly-bound nuclei (A. Pakou et al., Eur. Phys. J. A (2015) 51: 55) :

- Heavy Targets: 100%
- Medium Mass Targets: 80%
- Light Targets: 70%

Medium Mass Target: ^{90}Zr

For ^{8}B + ^{90}Zr at sub barrier energies break up is expected to be the dominant reaction channel.



From: A. Pakou et al., Phys. Rev. C **102**, 031601(R) (2020)

MEASUREMENTS

I. Break-up of $^{8}B+^{90}Zr$ at 26.5 MeV

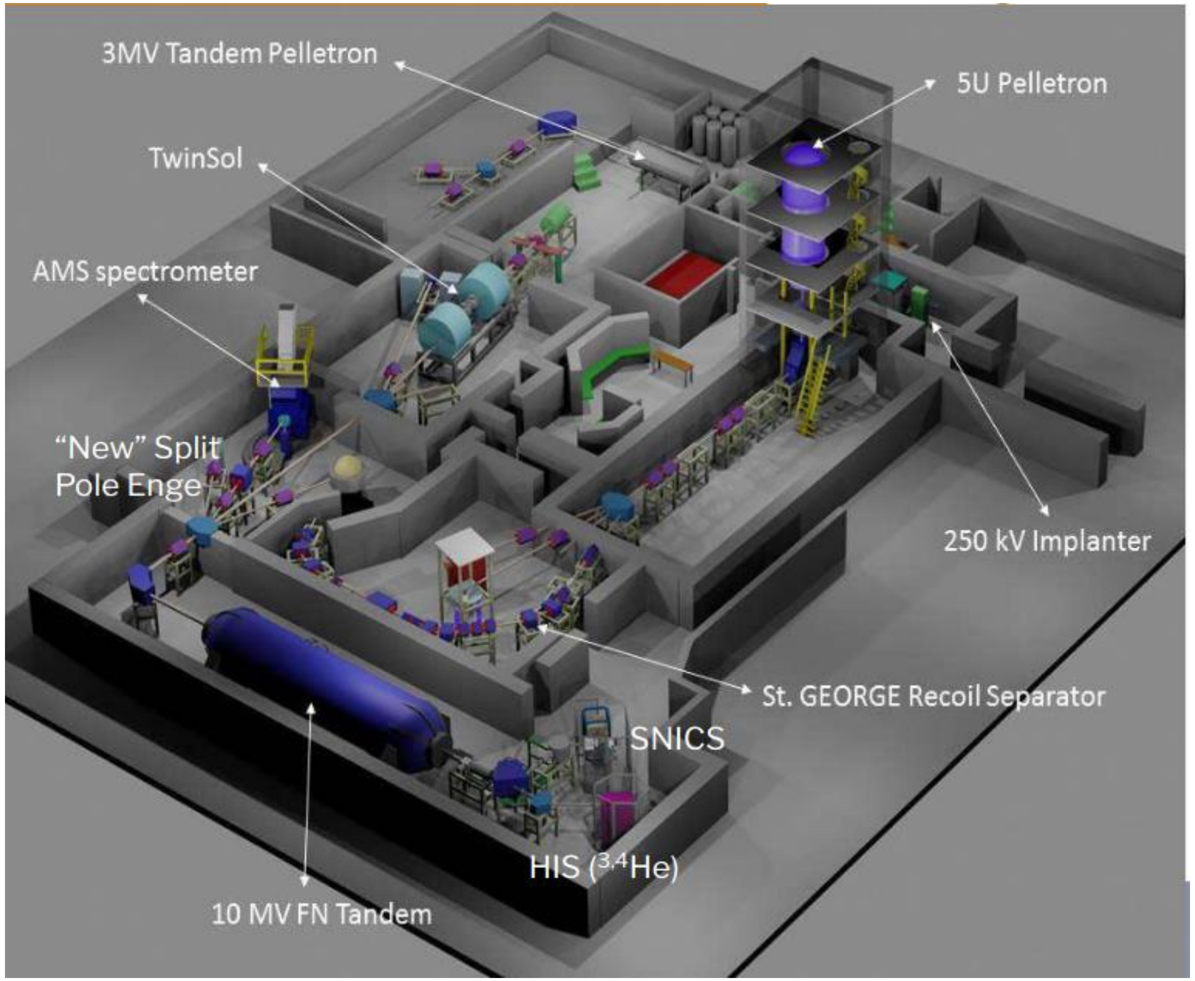
II. Elastic scattering of $^{8}B+^{90}Zr$ at 26.5 MeV

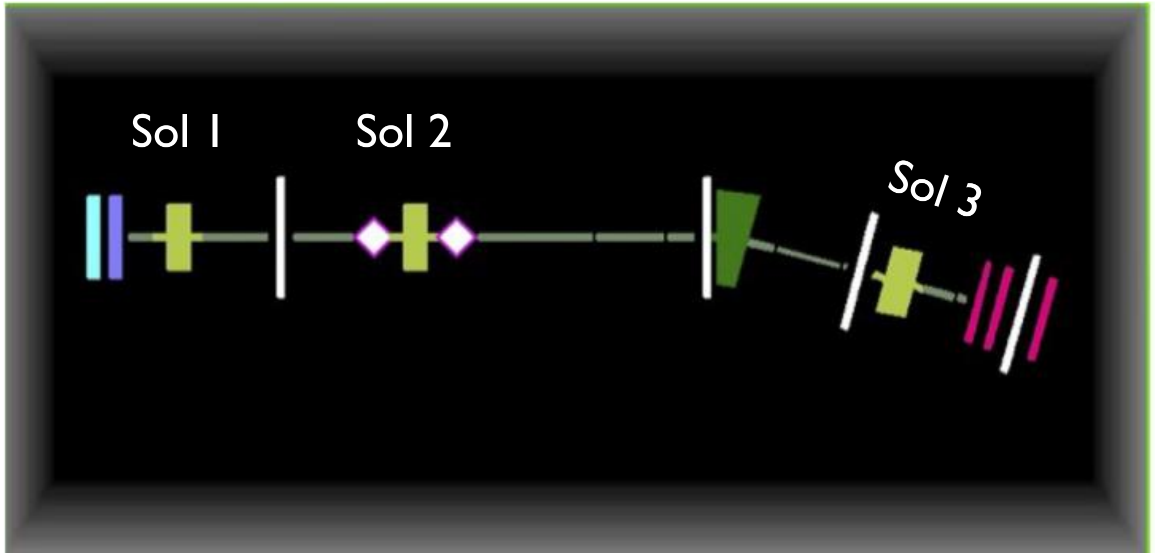
Phys. Rev. C, accepted for publication

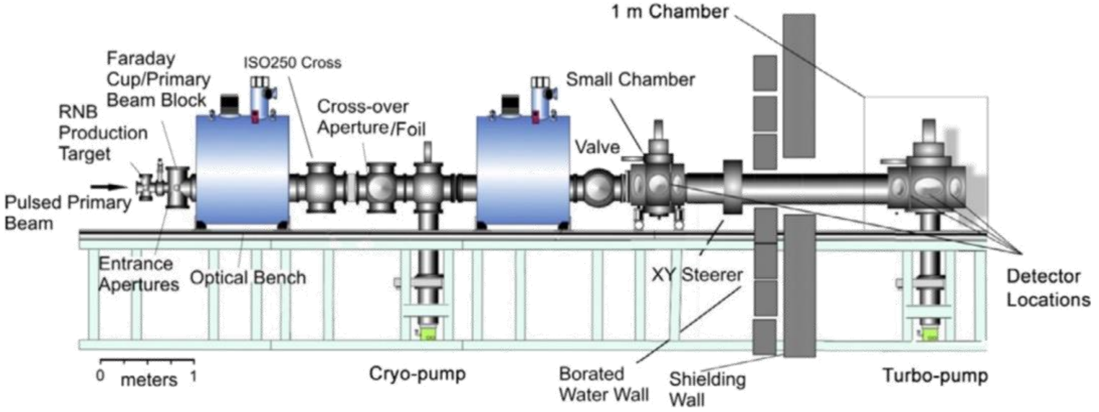
III. Elastic scattering of $^{7}Be+^{90}Zr$ at 19.7, 21.3, 22.9, 26.6, and 27.5 MeV

Phys. Rev. C**107**,064613(2023)

TRISOL FACILITY (P. D. O'MALLEY NIM P. S., S. A 1047, 167784 (2023))







BEAM PRODUCTION

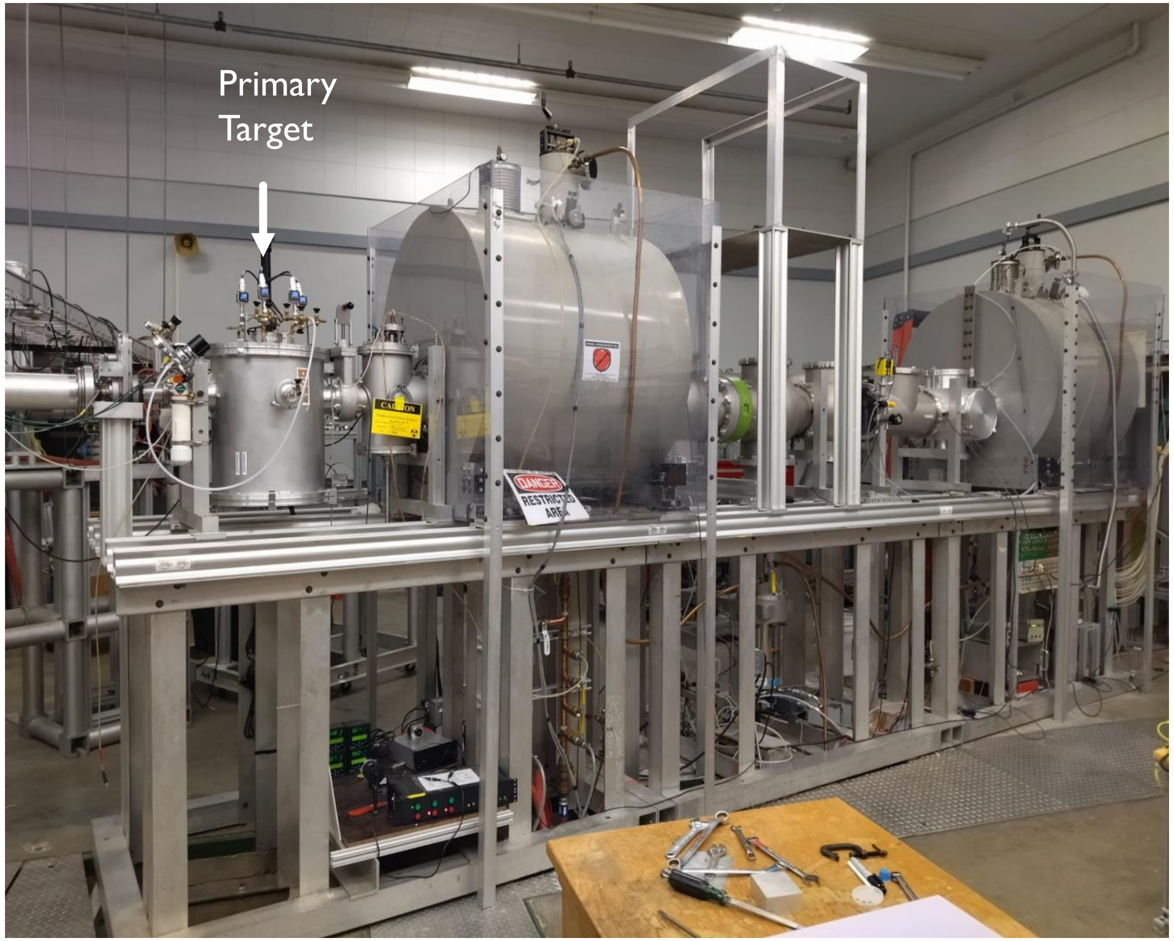
- In flight production of the beams.
- For ^{8}B Beam: 2p transfer reaction:

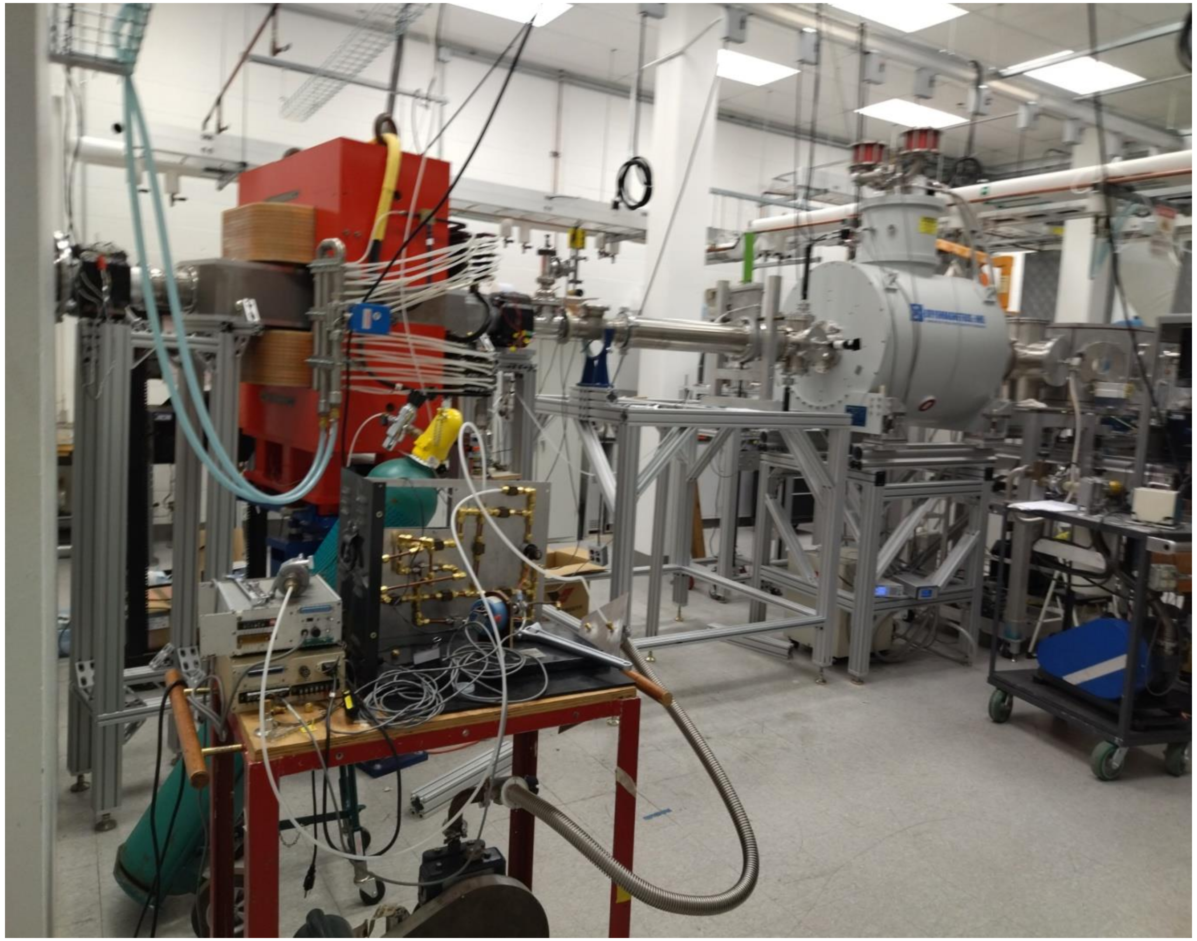
  $^{6}Li(^{3}He,n)^{8}B$; $^{6}Li(^{3}He,d)^{7}Be$; $^{6}Li(^{3}He,^{2}p)^{7}Li$ → ^{6}Li@37 MeV
- Beam Energies: ^{8}B@27.7 MeV

  ^{7}Be@20.1 MeV

  ^{7}Li@14.9 MeV
- Products separated by Time Of Flight (TOF) and ΔE-E techniques.
- For ^{7}Be beam: $^{6}Li(d,n)^{7}Be$; $^{6}Li(d,p)^{7}Li$

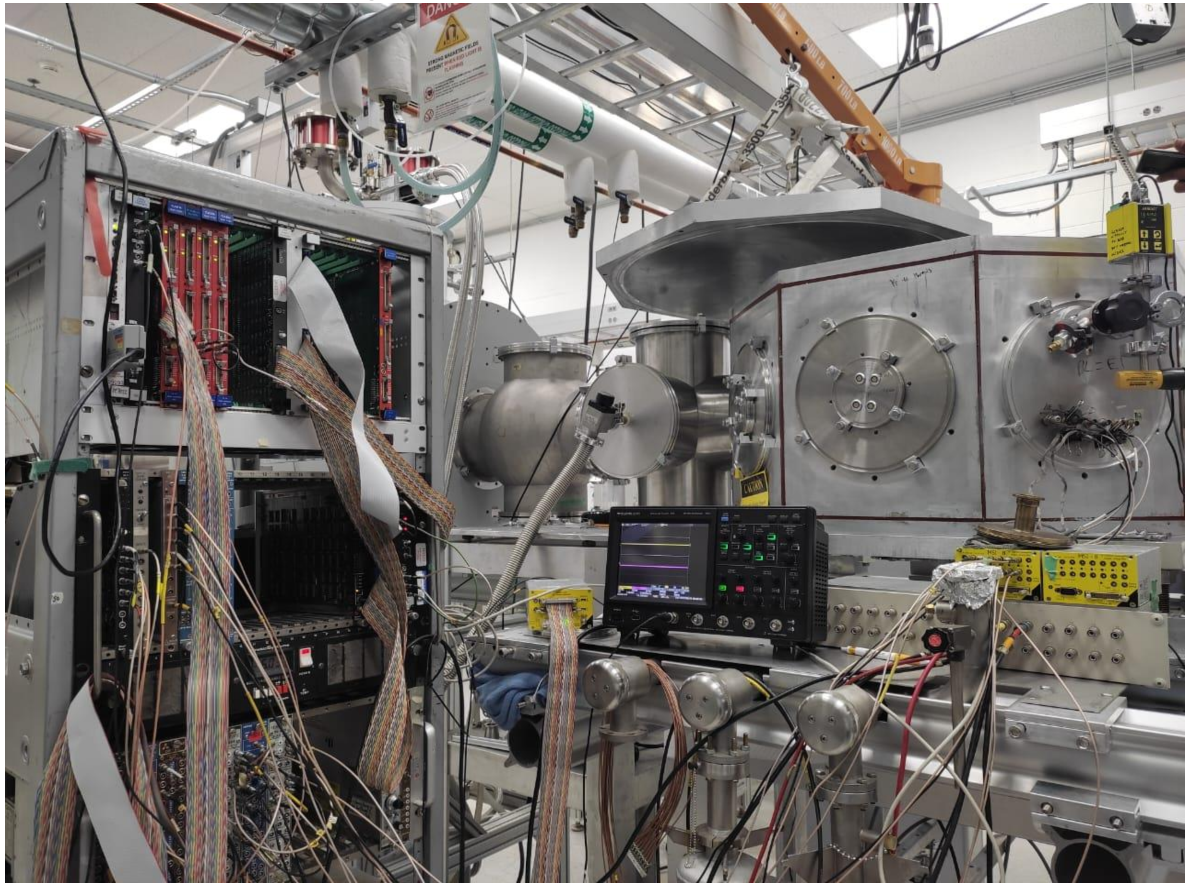
BEAMLINE OF TRISOL



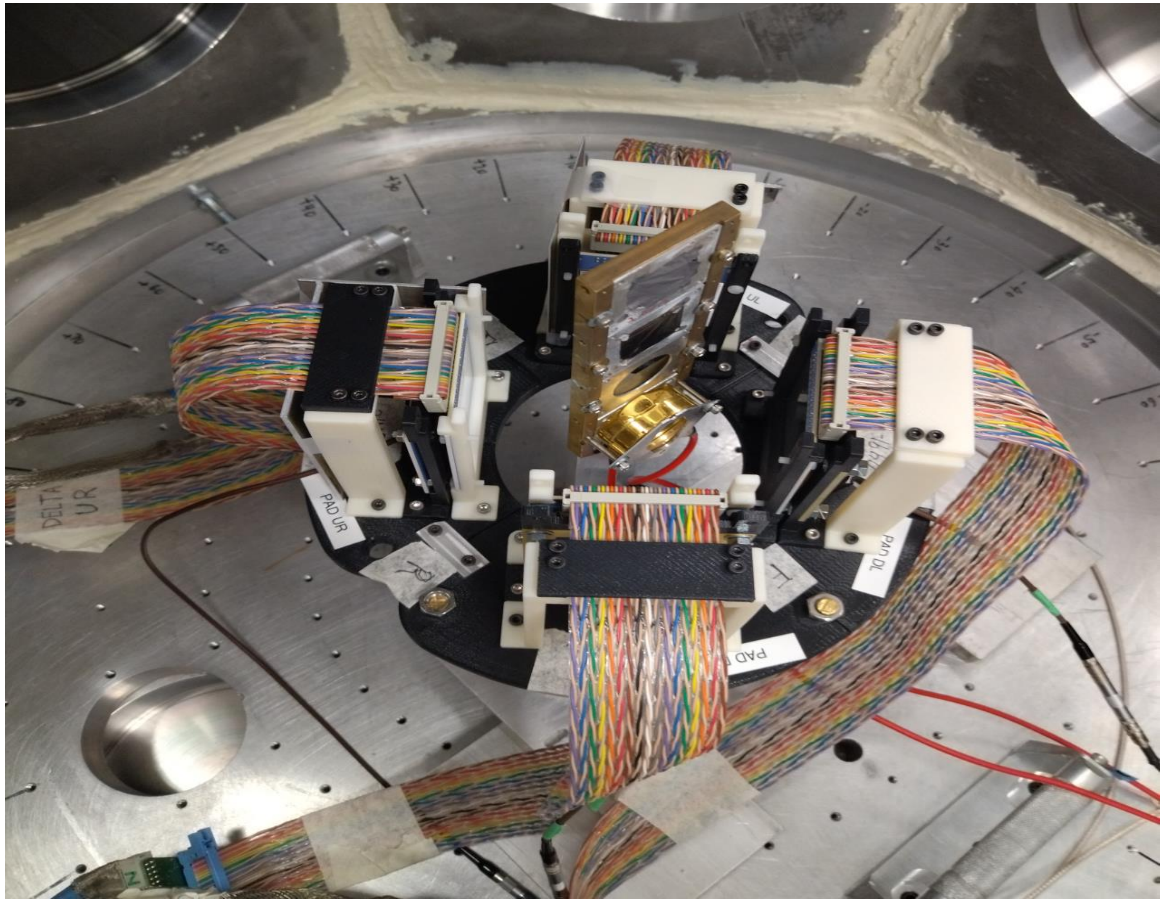


EXPERIMENTAL SET-UP

Scattering Chamber

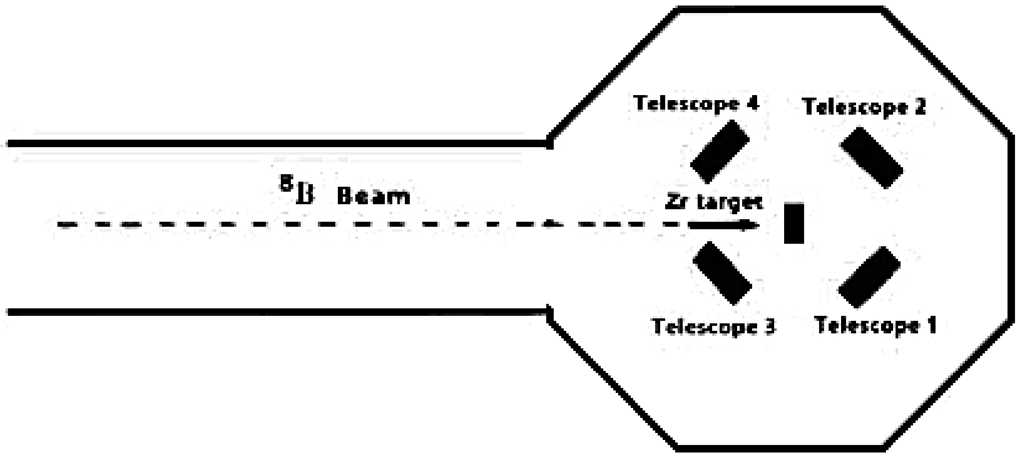


Detectors + Target Ladder in the scattering chamber



DETECTOR SET-UP

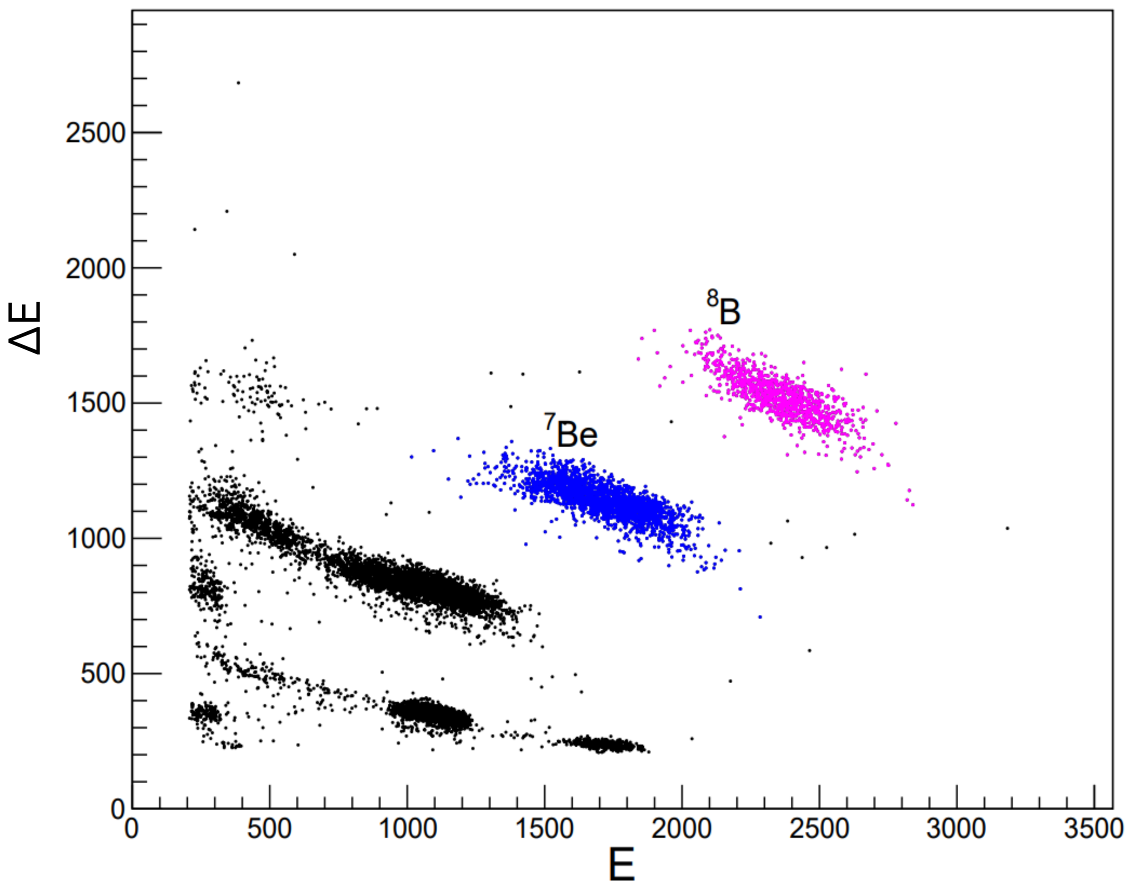
- Target thickness: 1.95 mg/cm^2
- Telescope dimensions: 5.4 x 5.4 cm
- 4 DSSSD (Double Sided Silicon Strip Detectors)
  - 3 with thickness 20 μm
  - 1 with thickness 15 μm
- 4 PAD Si detectors
  - Thickness 130 and 500 μm
- Angular range: Forward Telescopes: 20° - 60°
  Backward Telescopes: 110° -150°
- Detectors placed at ~6 cm from the target in symmetrical positions.
- Beam Flux: ~1500 - 6000 pps



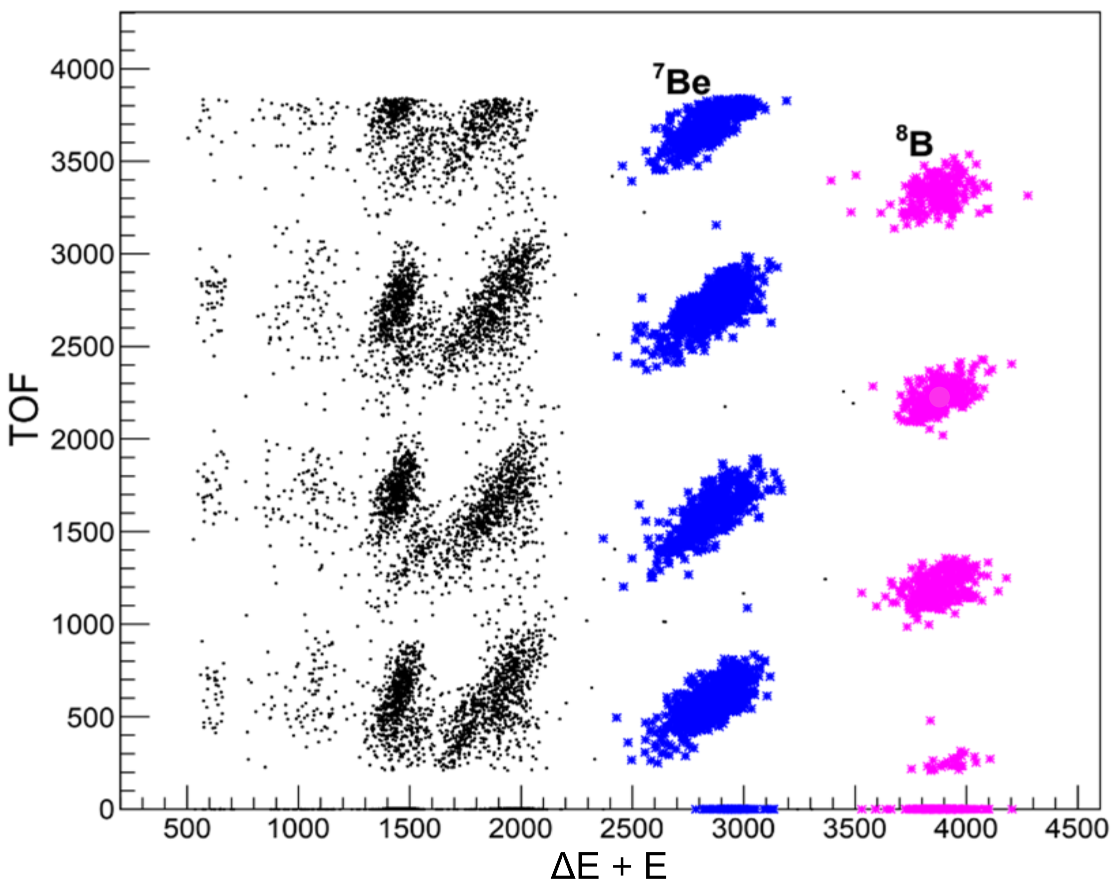
Detector Set-up

DATA

ΔE – E Plot

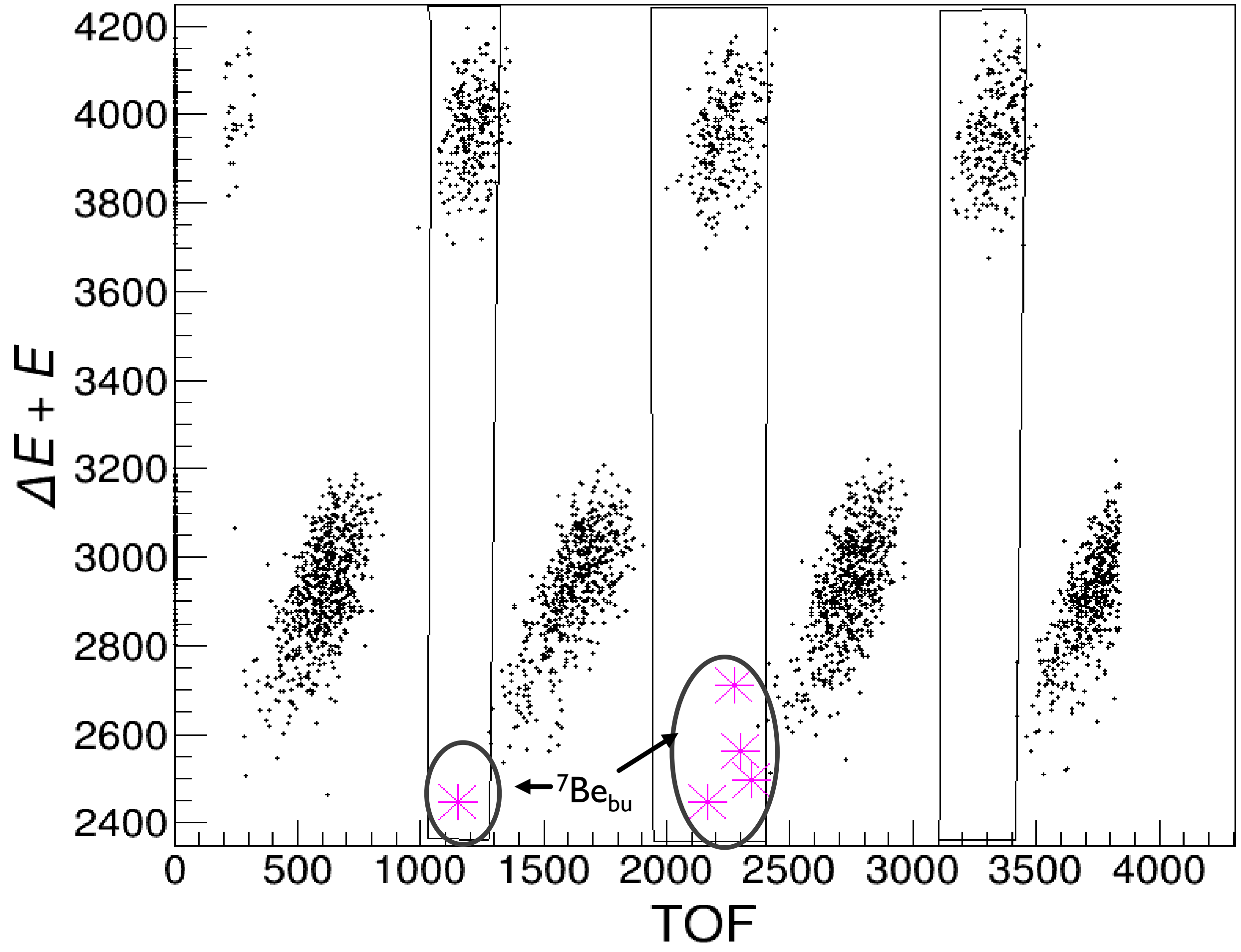


TOF Plot



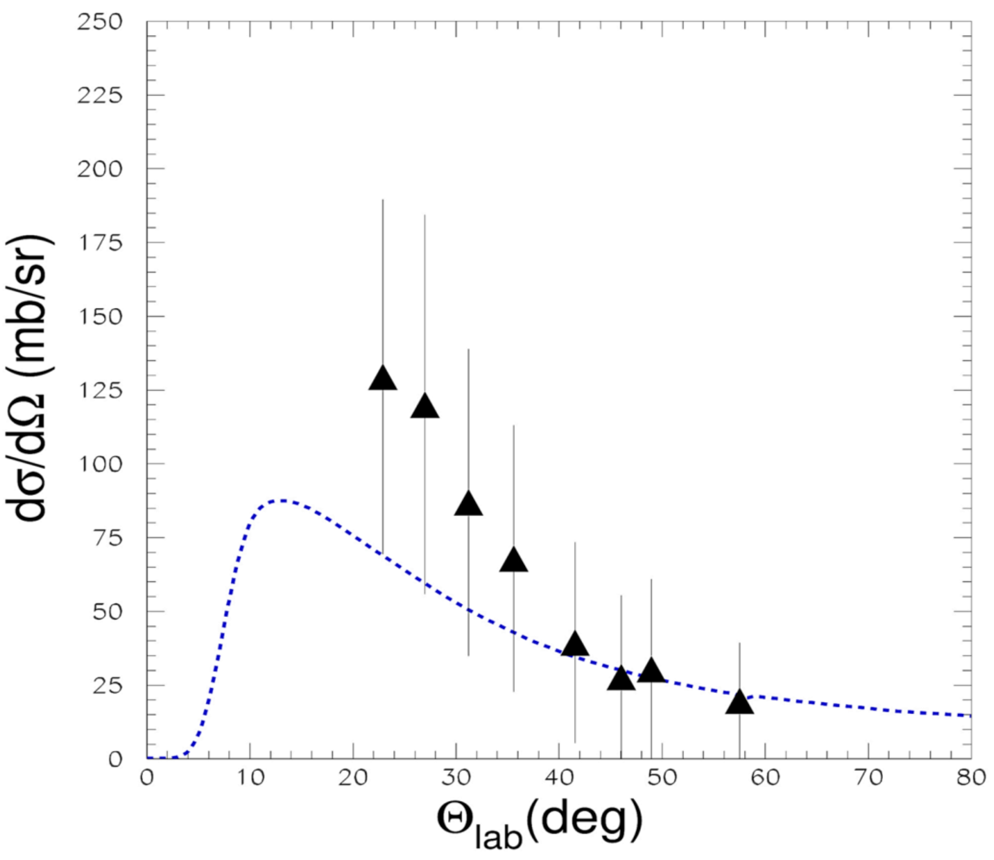
BREAKUP ANALYSIS : TOF Spectrum

- Separation of elastic ^{7}Be from break-up events is necessary
- Time Of Flight (TOF) technique
- Good separation between ^{8}B and ^{7}Be for part of the data.

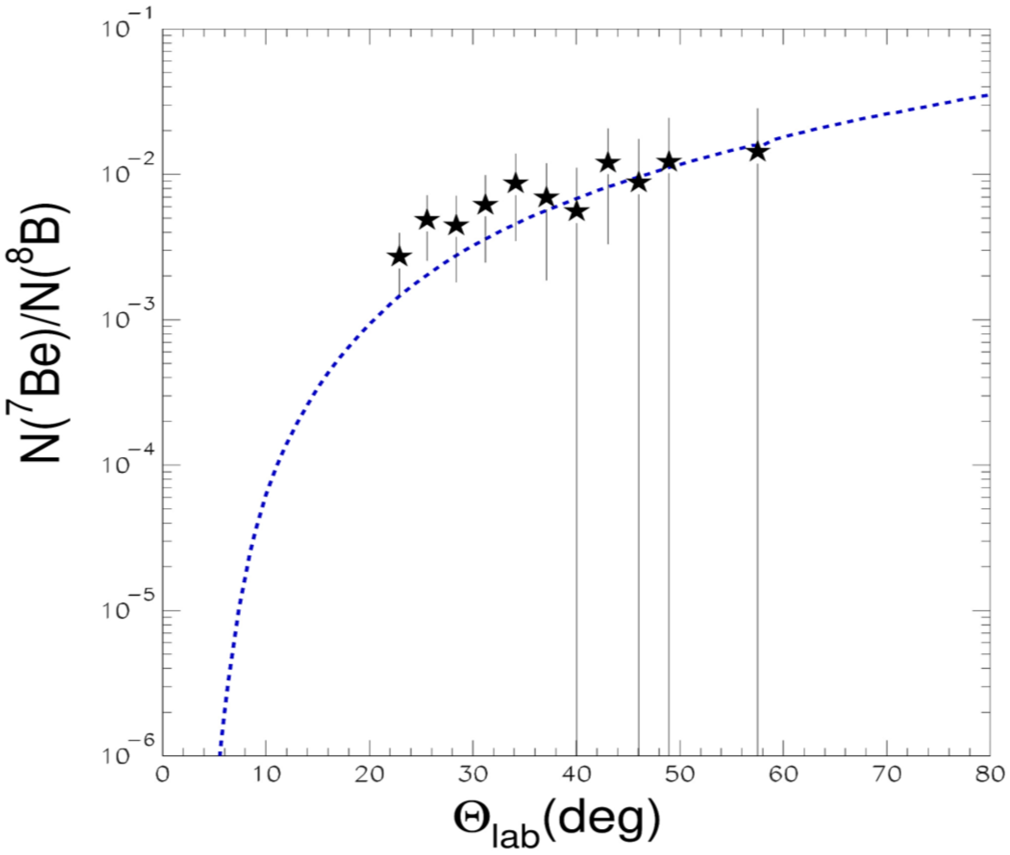


BREAKUP ANALYSIS: Preliminary results

Angular Distribution



Probability



Blue Lines: CDCC

$\sigma_{tot} = 180 \pm 50\, mb$

$\sigma_{bu}^{\text{CDCC}} = 211$ mb

→ Indication

$\sigma_{bu} = 200 - 250\, mb$

SUMMARY - CONCLUSIONS

Summary

- We measured breakup for $^{8}B+^{90}Zr$ at the sub-barrier energy 26.5 MeV, at the *TriSol* facility of the University of Notre Dame.
- We have performed breakup analysis for part of our data using the Time of Flight (TOF) technique for the separation between the breakup products and the elastic ^{7}Be.
- We presented preliminary results for the break-up differential cross sections and probabilities compared with CDCC calculations by A. Moro. Experiment and theory are in fair agreement.
- The break up cross section seems to exhaust the total reaction cross section. One cannot obtain absolute conclusions due to the large statistical errors.

Next Steps

- Continuing of the break up analysis of the rest of the experimental data to improve statistics.
- Extraction the break-up cross section and the direct –to –total reaction cross section ratio.

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THANK YOU!!!