# IRIS Experiments S1396 and S1203

Alisher Sanetullaev

St. Mary's University/TRIUMF
ISAC Science Forum
Auditorium, TRIUMF

November 2013, 2013

# Outline

- Motivation
- Overview of IRIS Facility
- Experiment S1396
- Experiment S1203
- Summary

# Motivation for S1396 and S1203 Experiments

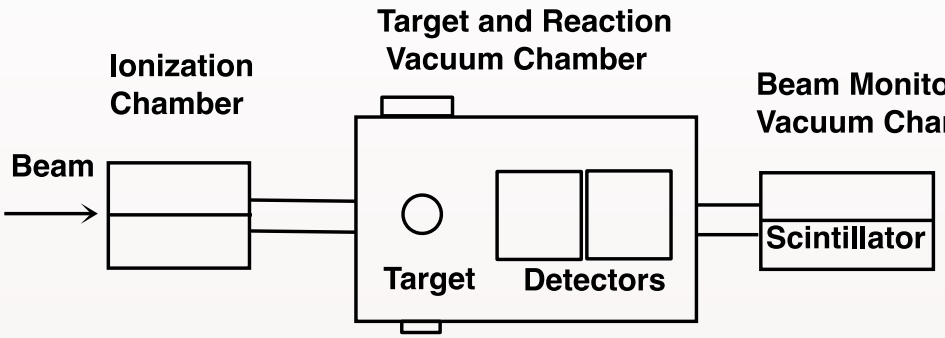
S1396:

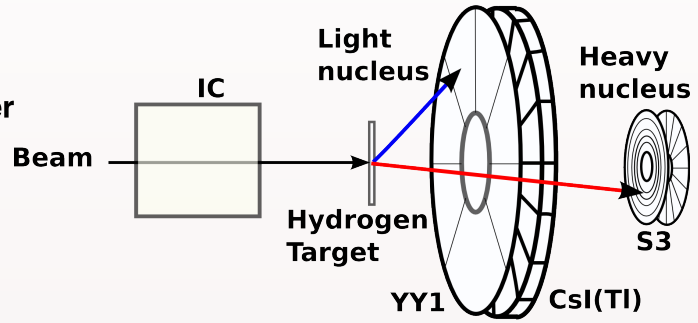
- Study of effects of three-nucleon force in elastic scattering through a first direct comparison to ab-initio reaction cross sections of the $^{10}$C(p,p)$^{10}$C reaction with no core shell model wave-functions

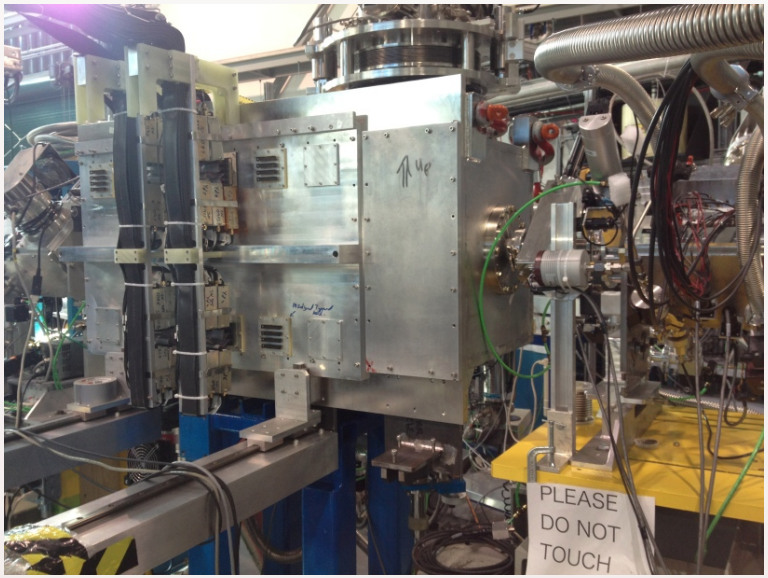
S1203:

- Search for resonance in $^{12}$Li using the $^{11}$Li(d,p)$^{12}$Li reaction
- Search for resonance in $^{11}$Li using the $^{11}$Li(d,d')$^{11}$Li reaction
- Search for resonance in $^{10}$Li using the $^{11}$Li(d,t)$^{10}$Li reaction
- The selection condition of this reaction is expected to provide clear evidence on p-wave resonance in $^{12}$Li
- There is a possibility of observing d-wave resonance as well

# Overview of the Facility

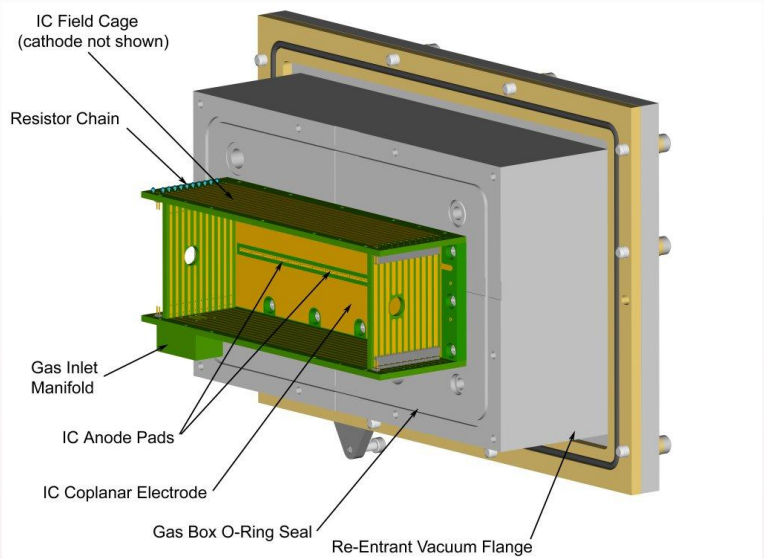


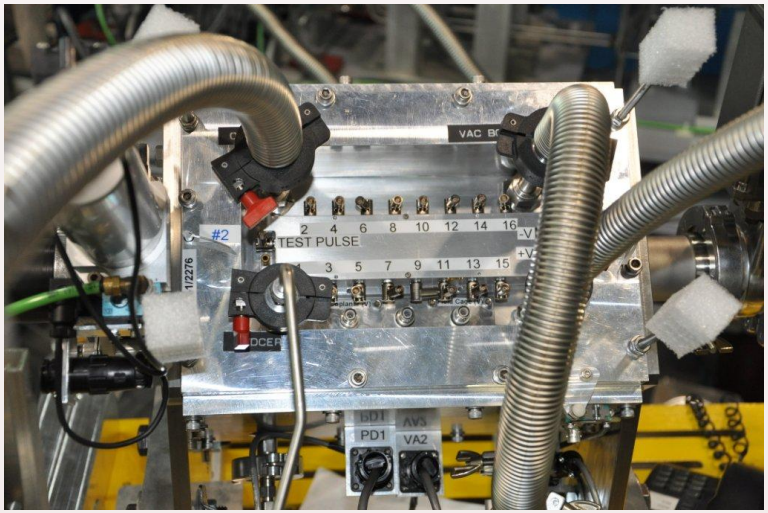




- IRIS is fully operational
- The setup can work with solid $H_2$ as well as solid $D_2$ target

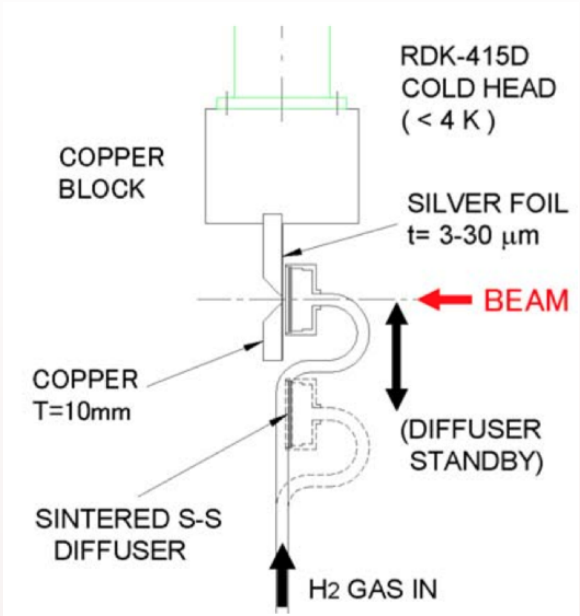
# Ionization Chamber




- The low pressure Ionization Chamber (IC) is used for identifying beam contamination (beam isobars)
- Beam particle energy loss is measured event-by-event
- The IC is placed upstream of the reaction vacuum chamber
- The IC is filled with isobutane at 19.5 Torr
- Beam particle energy loss is read out by 16 anodes, grouped in 4, 8 and 16

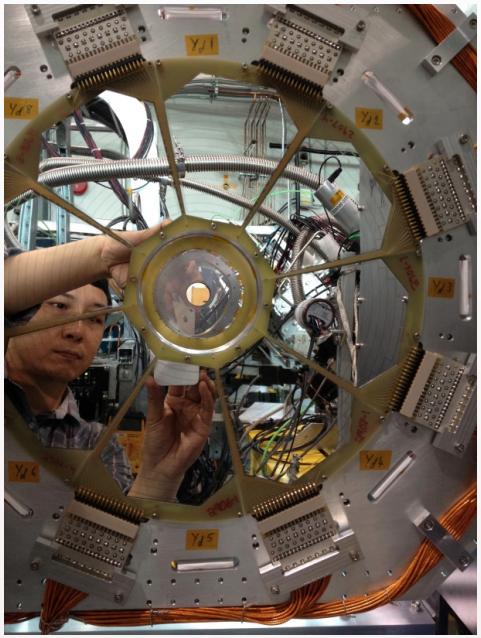
# Overview of the Facility: Solid Hydrogen Target




- 30-300 $\mu$m solid hydrogen target at 4 K, with 6 mm diameter
- Placed inside the Target and Reaction Vacuum chamber in $\sim$1x10$^{-7}$ Torr vacuum
- Hydrogen gas is sprayed and condensated onto 5 $\mu$m Ag foil at 4 K through a diffuser
- Heat shield used for keeping the temperature low

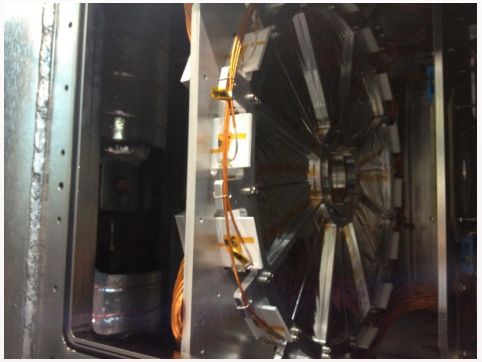
# Overview of the Facility: Detectors

YY1 Detectors



- Measure the energy and scattering angle of the target-like light particle (e.g. p,d,t)

CsI(Tl) detectors

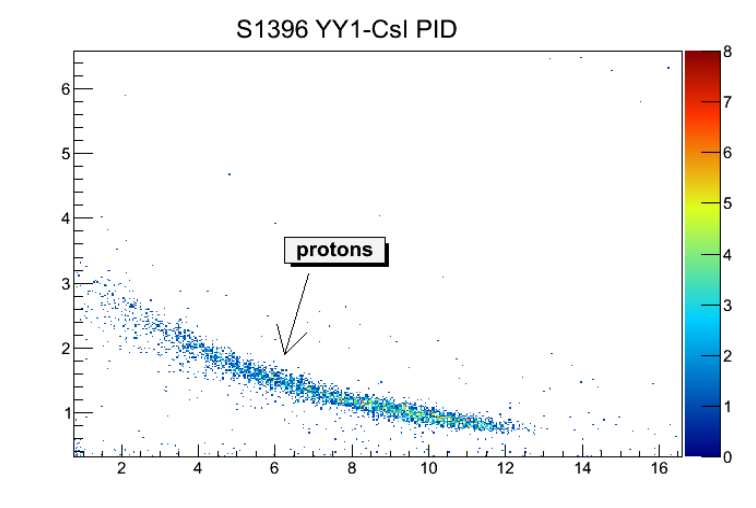


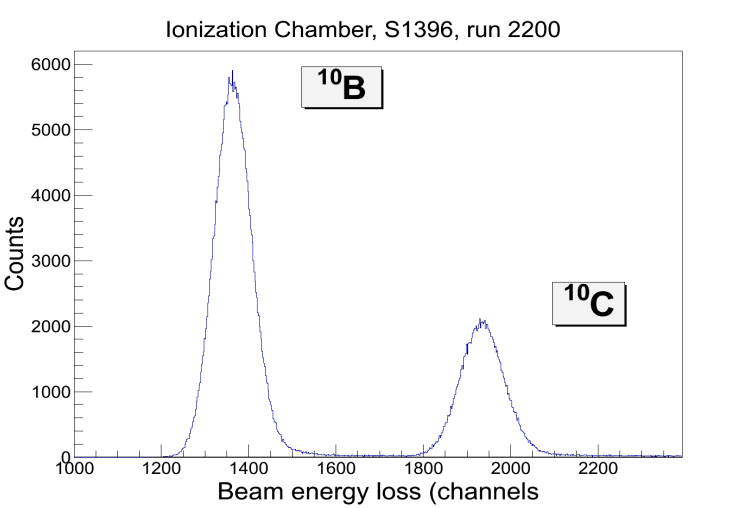
- Stop and measure the remaining energy of the target-like light particle (e.g. p,d,t) that punches through YY1

S3 Detectors

- Measure the energy loss and scattering angle of the beam-like heavy particle (E.g. $^{10}$C, $^{11}$Li)

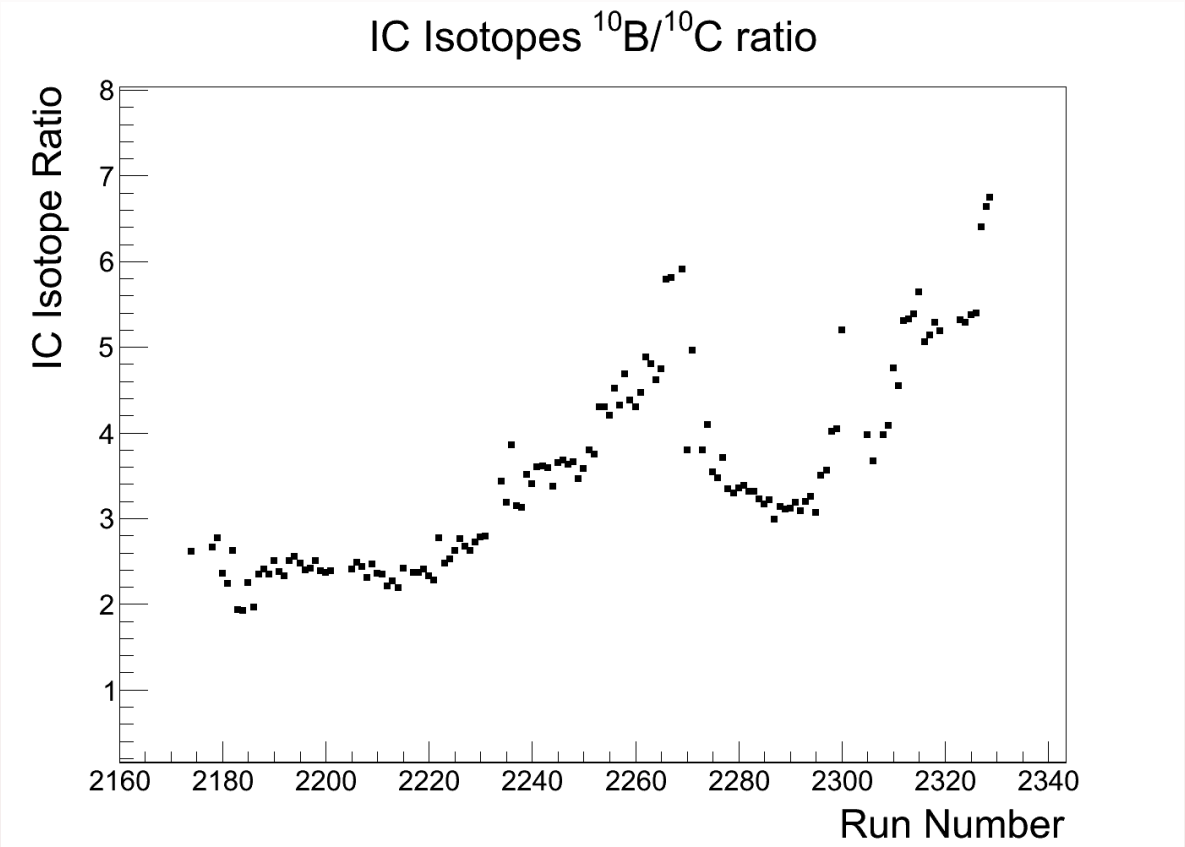
# Experiment S1396



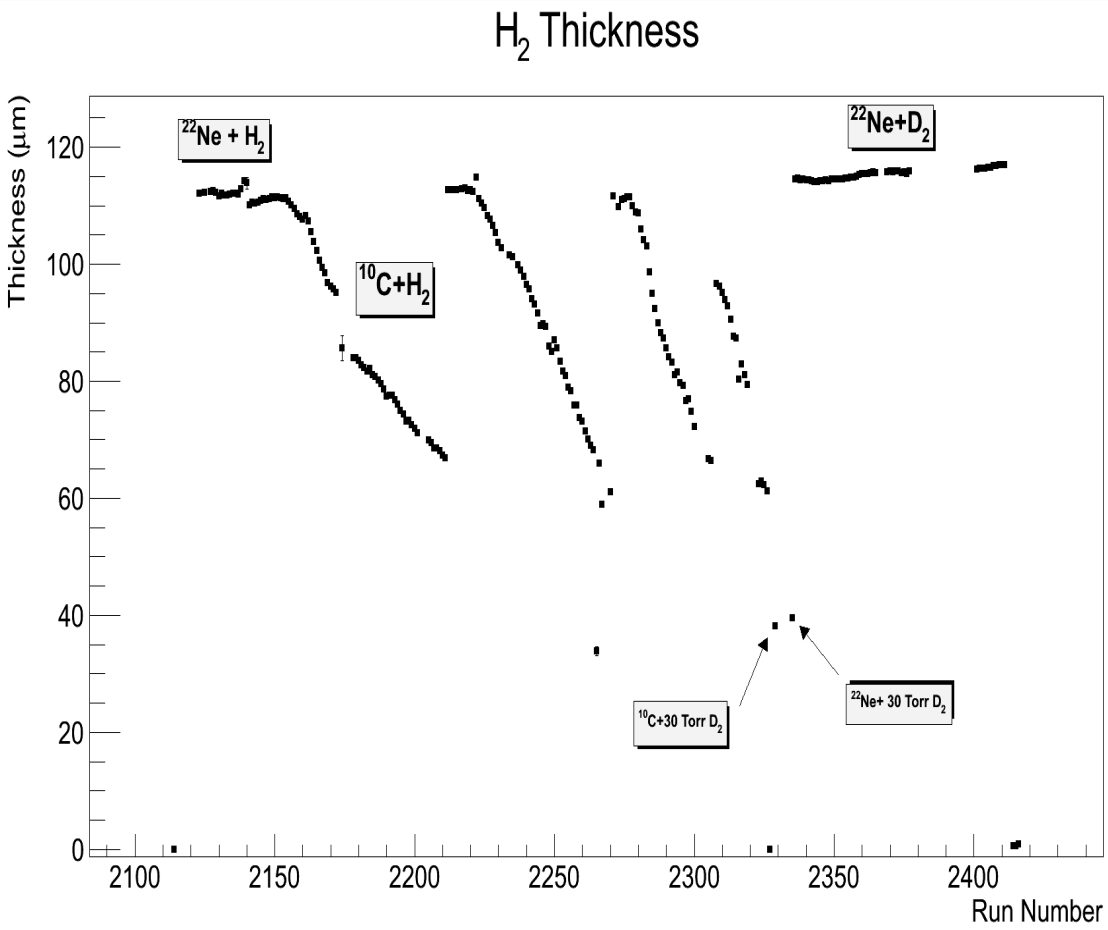

- 6 MeV/u $^{20}$Ne pilot beam
- 6 MeV/u $^{10}$C beam
- 50-100 $\mu$m Solid $H_2$ target
- p($^{10}$C,p)$^{10}$C elastic scattering
- $^{10}$C stops in the $\Delta$E S3
- $^{10}$B contaminant identified on an event-by-event basis
- H-target thickness determination (elastic scattering)

# Beam contaminant Identification in S1396



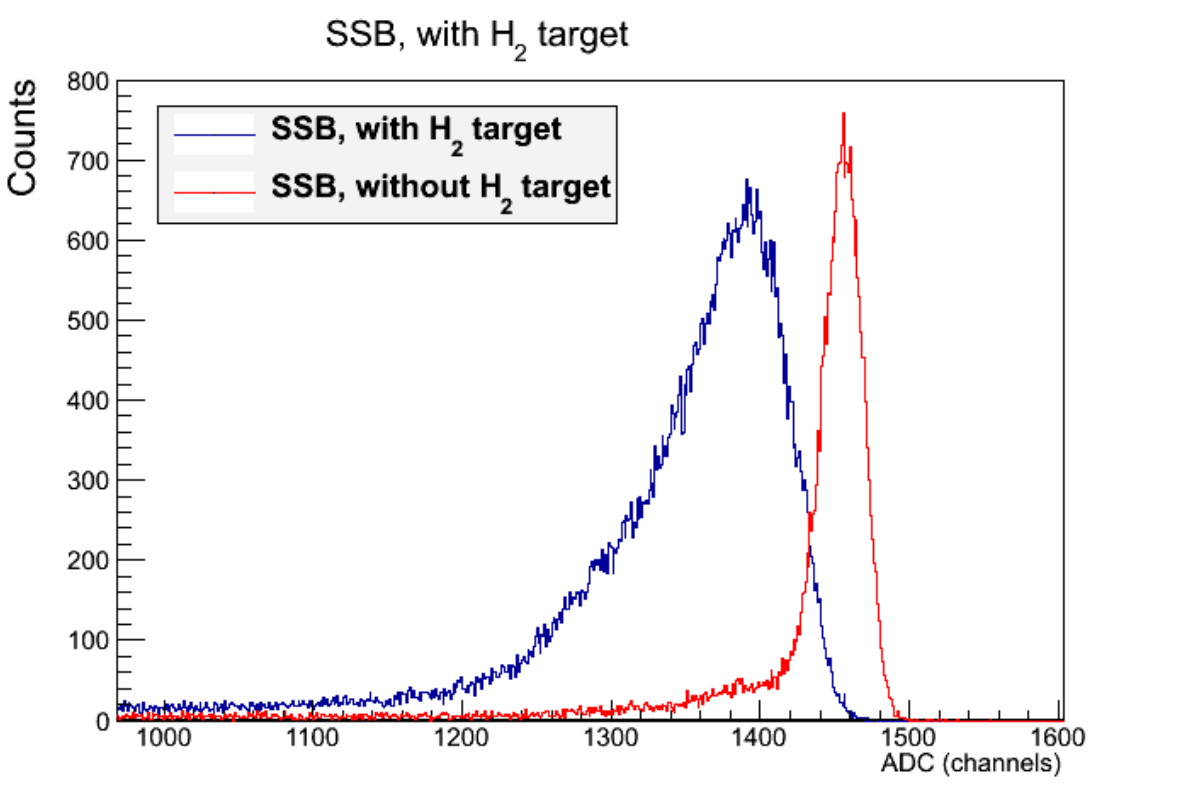

- $^{10}B$ contaminant present in $^{10}C$ beam
- Contaminant to $^{10}C$ ratio was monitored in run-by-run basis
- The $^{10}B/^{10}C$ ratio varied from $\sim$2 to $\sim$6
- IC served it's real purpose in S1396

# Hydrogen target thickness determination in S1396



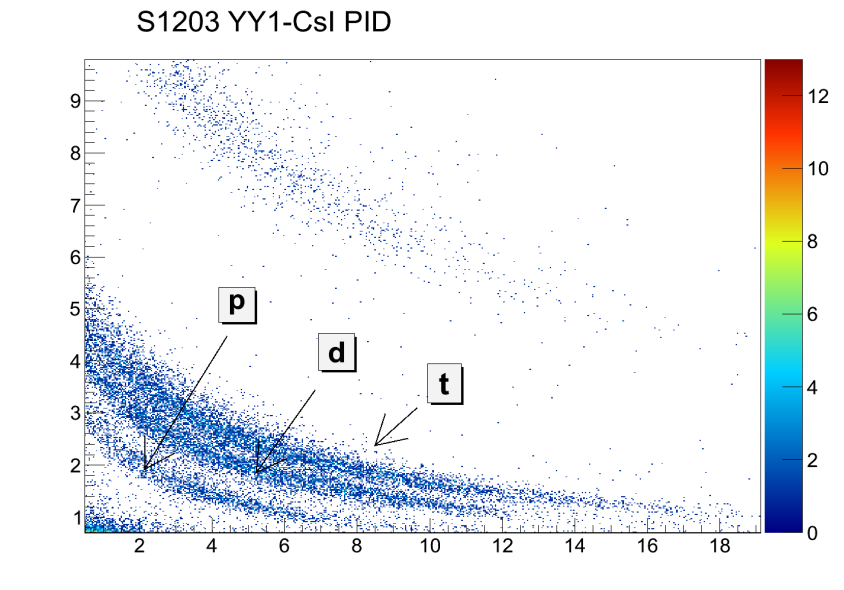

- Changing target thickness can be taken care of during analysis
- Target thickness was constant at the beginning and end of experiment
- For fresh target, the temperature has to go above ∼220 K in the warm up process

# Additional target thickness measurement using downstream SSB



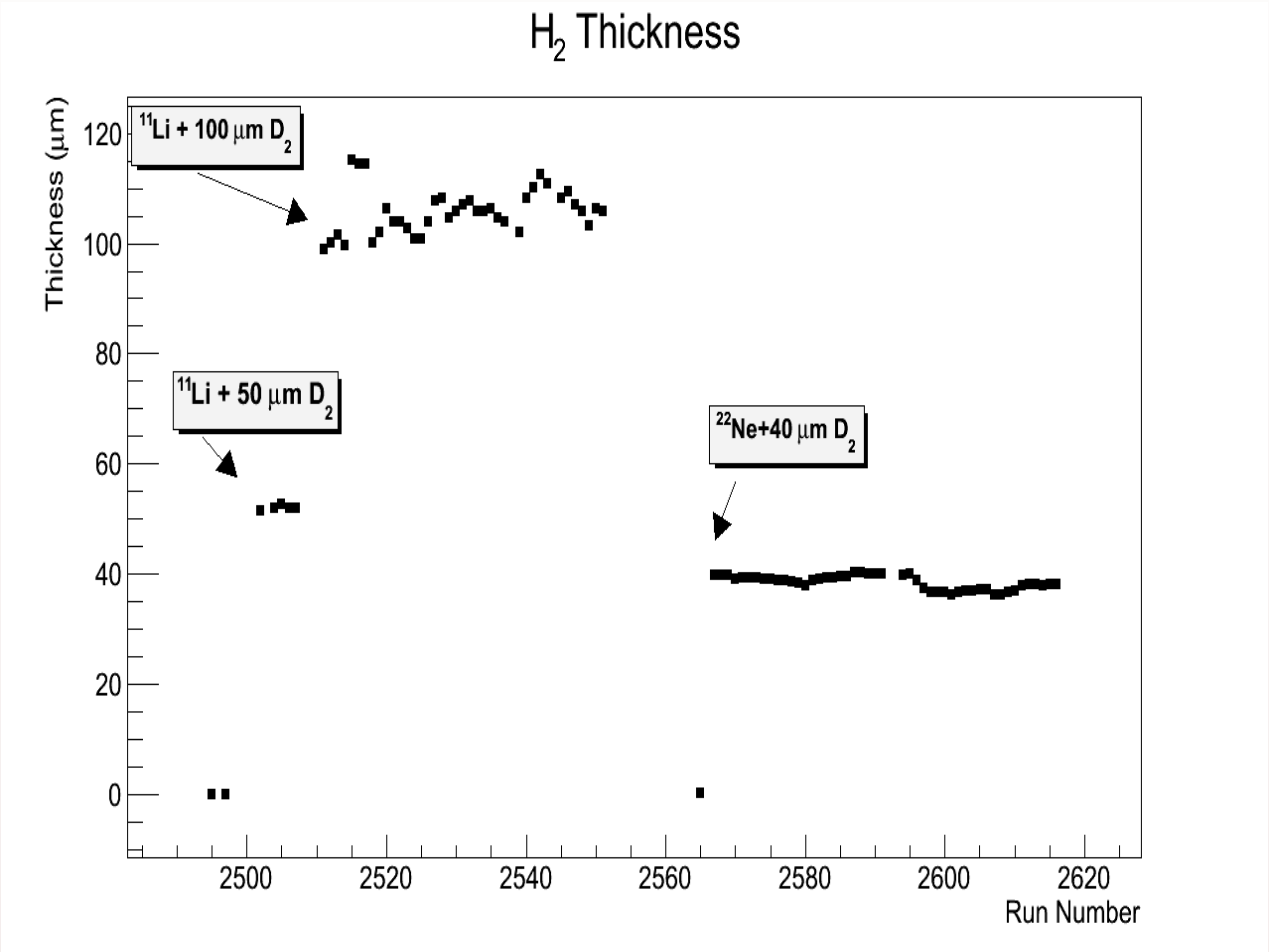

- 500 $\mu$m silicon surface barrier (SSB) detector
- Located in in the monitor box, can be inserted into the beam path
- Beam stops in the SSB
- $H_2$ thickness can be determined comparing energies

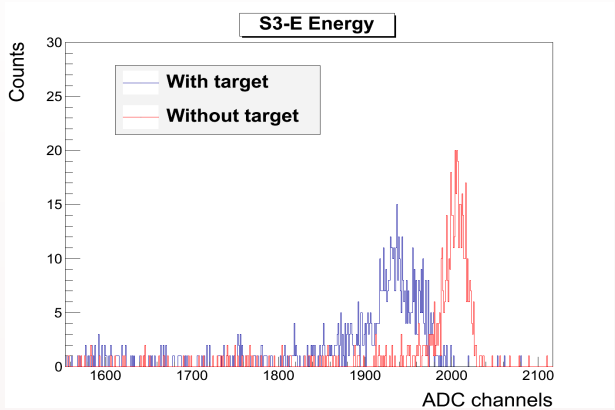
# Experiment S1203




- 5.5 MeV/u $^{22}$Ne pilot beam
- 5.5 MeV/u $^{11}$Li beam
- 100 $\mu$m Solid $D_2$ target
- Reactions
  - d($^{11}$Li,p)$^{12}$Li
  - d($^{11}$Li,d)$^{11}$Li elastic scattering
- H-target thickness determination (elastic scattering)
- Data with Ag backing foil only (no hydrogen)

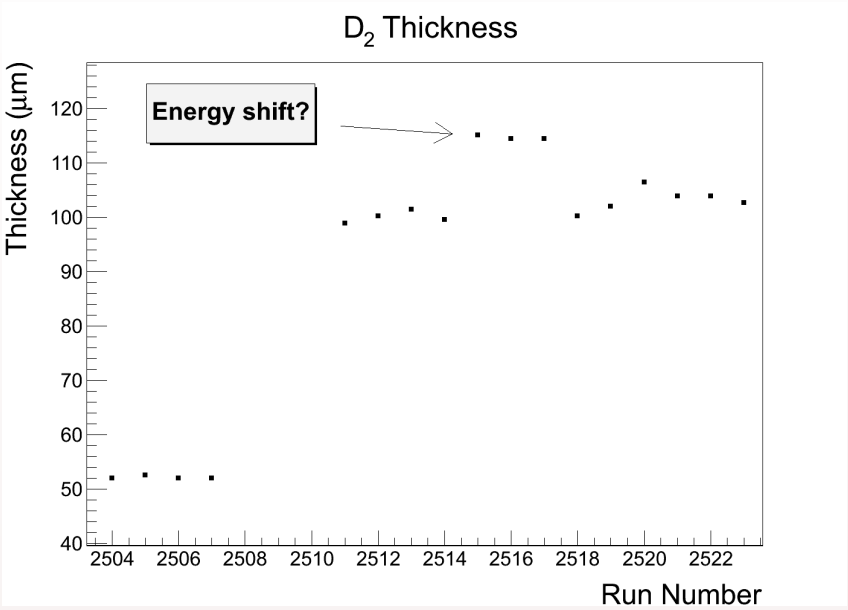
# Hydrogen target thickness determination in S1203

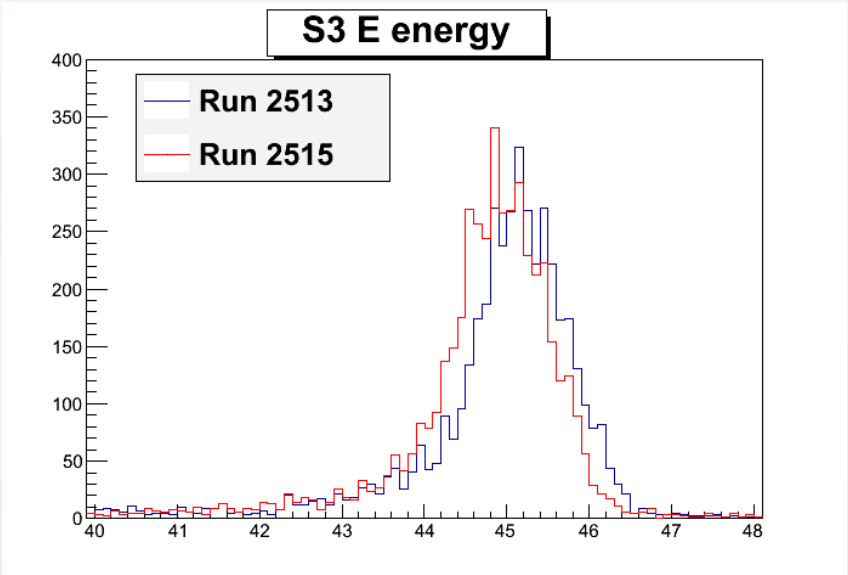



- Target thickness was increased during the experiment
- Deuterium target thickness was constant throughout the experiment
- For fresh target, the temperature has to go above ∼220 K in the warm up process

# Issues




- Energy shift of $\sim$200 keV between runs 2013-2017
- Operators were trying to increase the beam rate
- S3 E energy decreased, while S3 $\Delta$E energy increased by corresponding amount (gain change unlikely)

# Summary

- Experiment S1396: Beam contaminant $^{10}$B was identified with Ionization Chamber
- $H_2$ target performed reasonably well
- Total beam rate 10,000-20,000/sec (including $^{10}$B contaminant)
- Experiment S1203: Good beam of 3000-3500/sec $^{11}$Li throughout the experiment
- $D_2$ target was stable throughout the experiment
- Good PID of Li and other isotopes in S3
- The beam times were successfull

# Acknowledgements

Collaborators:
R.Kanungo (Spokesperson), S. Ishimoto, S. Suzuki, I. Tanihata, J. Tanaka, R. Henderson, G. Hackman, A. Shotter, A. Rojas, G. Christian, B. Davids, R. Kruecken, P. Voss, Z. Wang, D. Cross, H. Savajols, C. Unsworth, A. Gallant, A. Chen, J. Fallis, N. Galinski, J. Lighthall, B. Hadinia, V. Bildstein, E. Rand, A. Laffoley
Many thanks to:
Detector group (A. Miller, G. Sheffer, R. Openshaw)
DAQ group (P.A. Amaudruz, K. Olchanski, T. Lindner)
ISAC Facility support (C. Morton, M. Marchetto, F. Ames and all ISAC operators)
Beamline( D. Preddy, B. Gasbarri, J. McKinnon)
Vacuum group (D. Yosifov, E. DallaValle, D. Wright)
Mechanical Design (C. Holmberg)
Electrical Services (F. Mammarella, R. Creanga)
and Machine shop staff