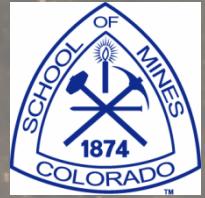


EXPERIMENTS TO FURTHER THE UNDERSTANDING OF TRIPLE-ALPHA PROCESS IN HOT ASTROPHYSICAL SCENARIOS

Nidhi R. Patel
August 20, 2007



UChicago ▶
Argonne LLC



ASTROPHYSICAL MOTIVATION

Carbon nucleosynthesis

** Crucial element of life: ^{12}C

** Two step triple-alpha process

◇ $\alpha(\alpha, \gamma)^8\text{Be}$ and $^8\text{Be}(\alpha, \gamma)^{12}\text{C}$

- ▲ Short-lived ^8Be ground state
- ▲ Conveniently located inside the Gamow window
- ▲ Helium burning Red Giant stars
- ▲ An s-wave resonance

ASTROPHYSICAL MOTIVATION

Carbon energy states

** 1990 – Ajzenberg-Selove

** 1999 – NACRE

◊ No experimental evidence of
9.117 MeV 2^+ state

** Others only use the 7.65 MeV
states

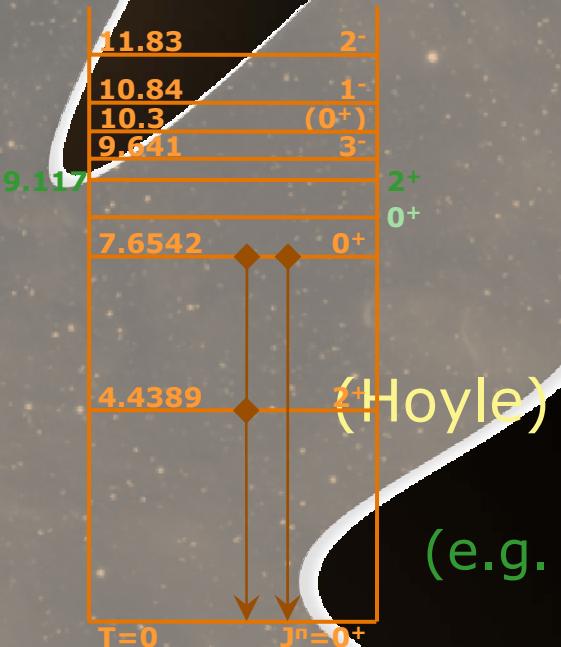
◊ Insufficient in explosive scenarios
(Supernovae)

◊ Higher temperature – need to include
other states

** 2005 – Jyväskylä and CERN/Isolde

◊ Suggests another 0^+ state above Hoyle

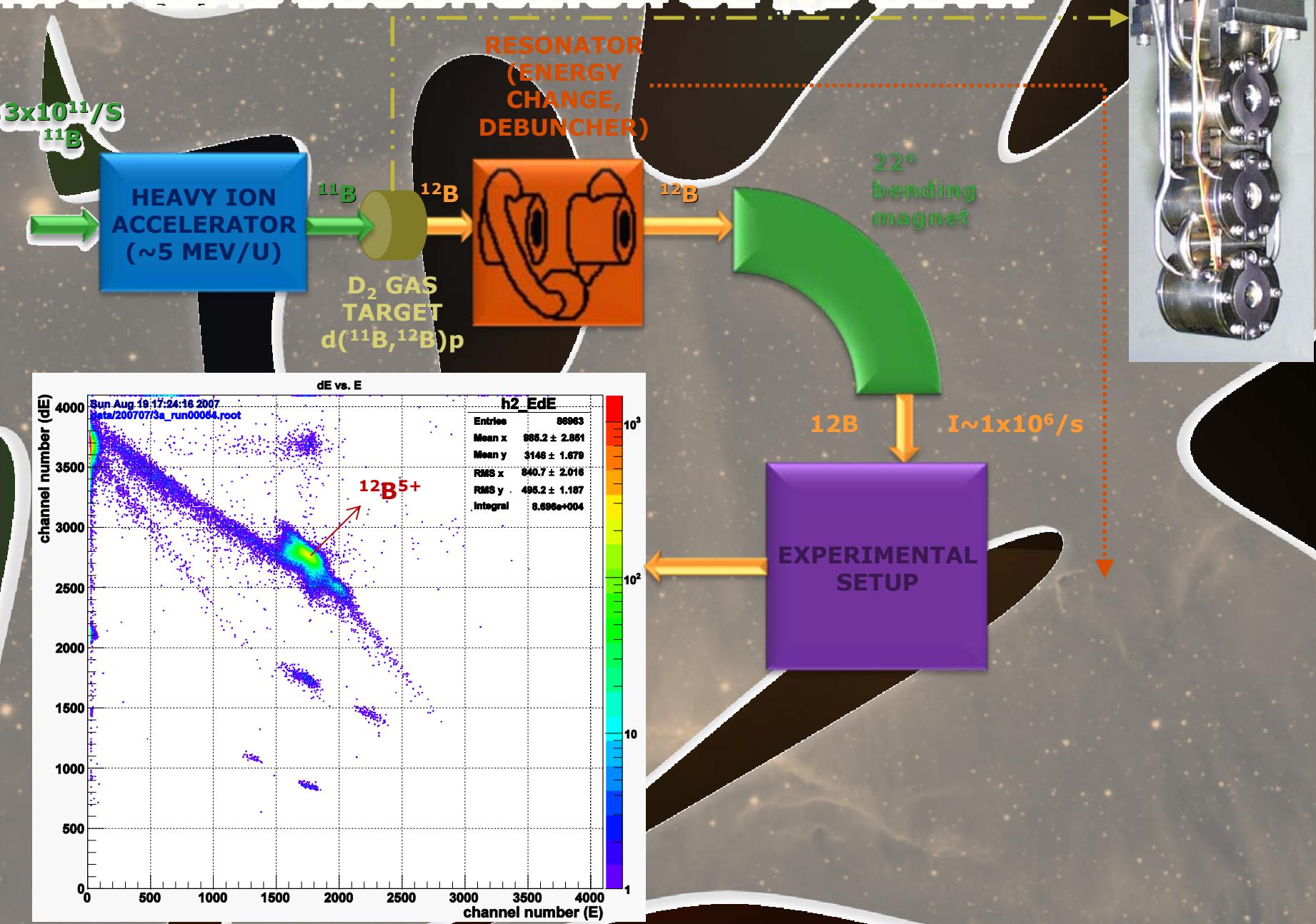
◊ 1 MeV cut-off in detector sensitivity



EXPERIMENT OVERVIEW

- Explore interference between 1st and possible 2nd 0⁺ ^{12}C states populated by beta decay of ^{12}B and ^{12}N
- ** Twin Frisch Gridded Ionization Chamber (GIC) used recently in ^{16}N decay experiment
 - ◆ 130 keV cut-off in detector sensitivity
 - ◆ Obtain angle information of alphas
- ** Phase I (Nov. 2006)
 - ◆ Investigated the technique of stopping ^{11}B beam in GIC
- ** Phase II (Jul. 2007)
 - ◆ Successfully identified and stopped ^{12}B beam at GIC's center
 - ◆ Observed the 7.6542 MeV (Hoyle) and 10.3 MeV states
 - ◆ Ongoing analysis to determine whether alphas from ^8Be are resolvable
- ** Phase III (Sept. 2007)
 - ◆ Gather statistics
- ** Phase IV (2008)
 - ◆ Repeat experiment with ^{12}N beam

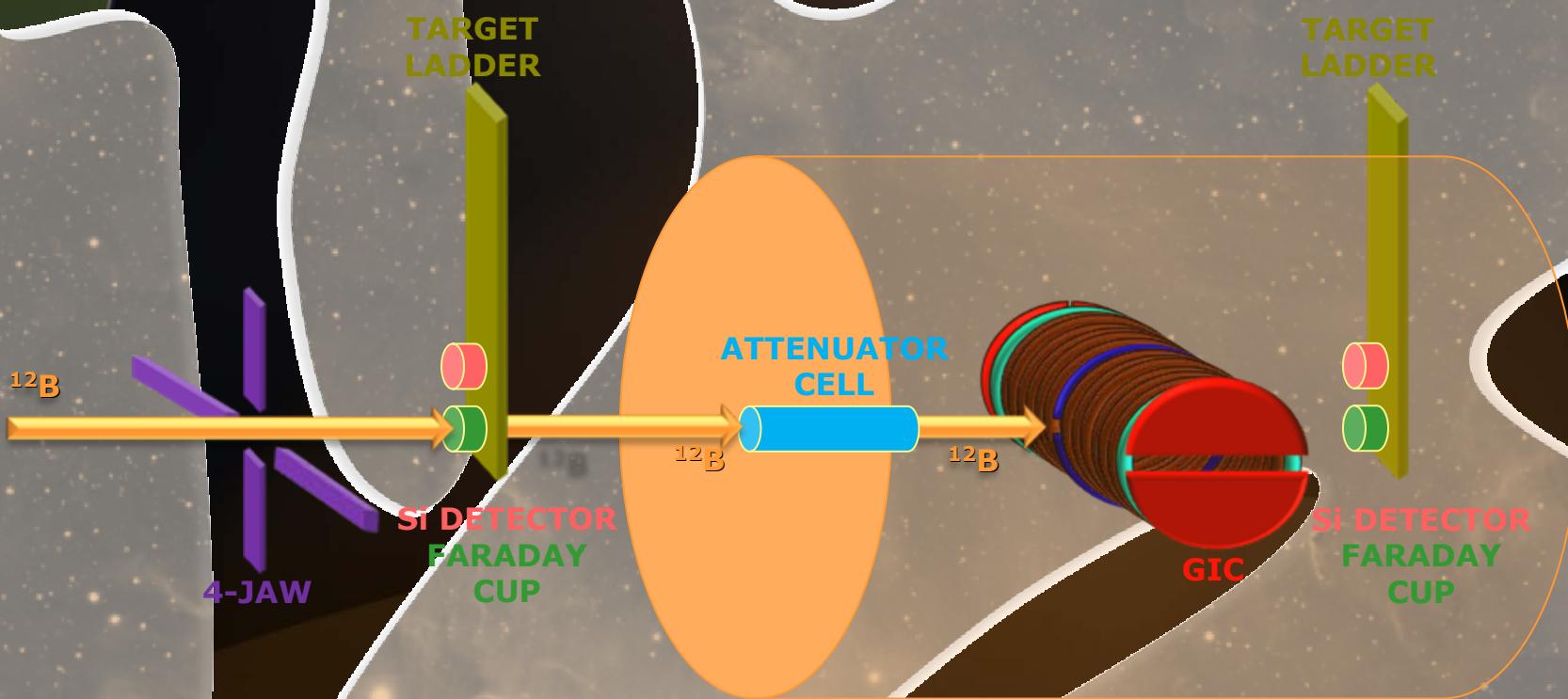
IN-FLIGHT PRODUCTION OF ^{12}B BEAM



EXPERIMENTAL SETUP

• Bragg detector

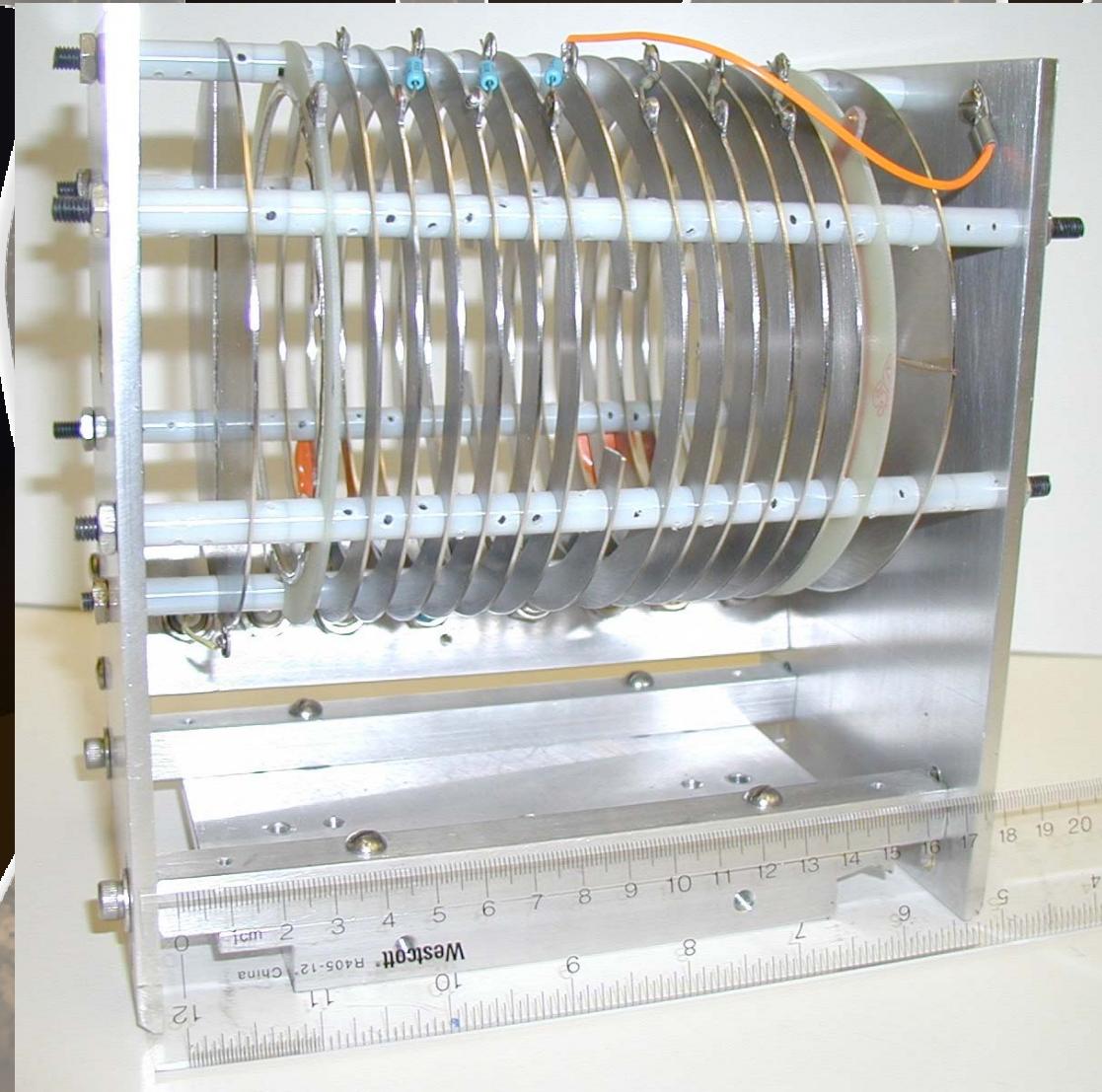
* Twin Frisch GIC perpendicular to the beam



EXPERIMENTAL SETUP

• Bragg detector

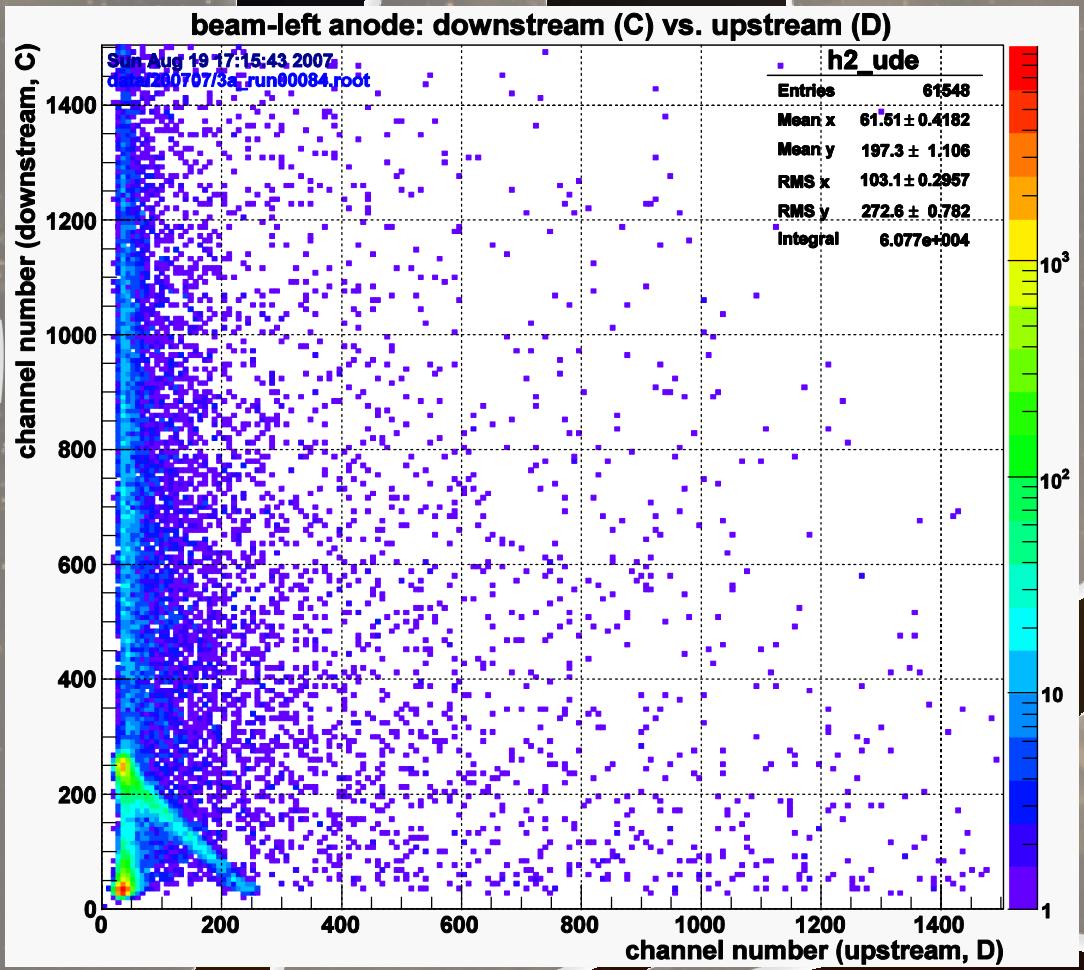
* Front view of twin Frisch GIC



PHASE II RESULTS

- Beam-left anode upstream vs. downstream for three different pressure in attenuator cell

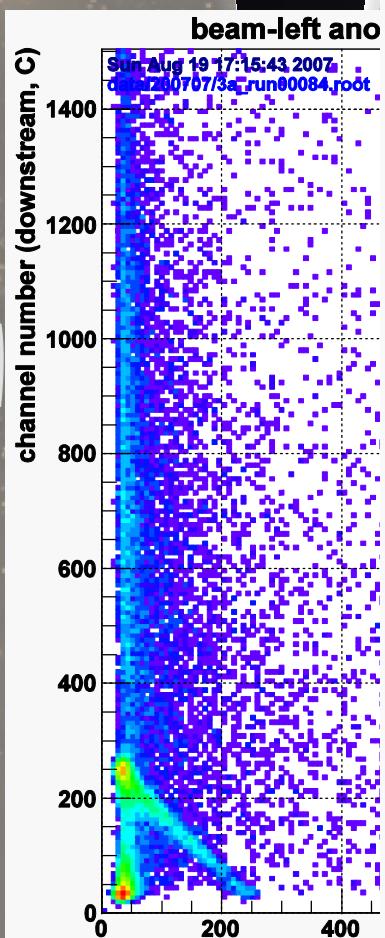
80 torr



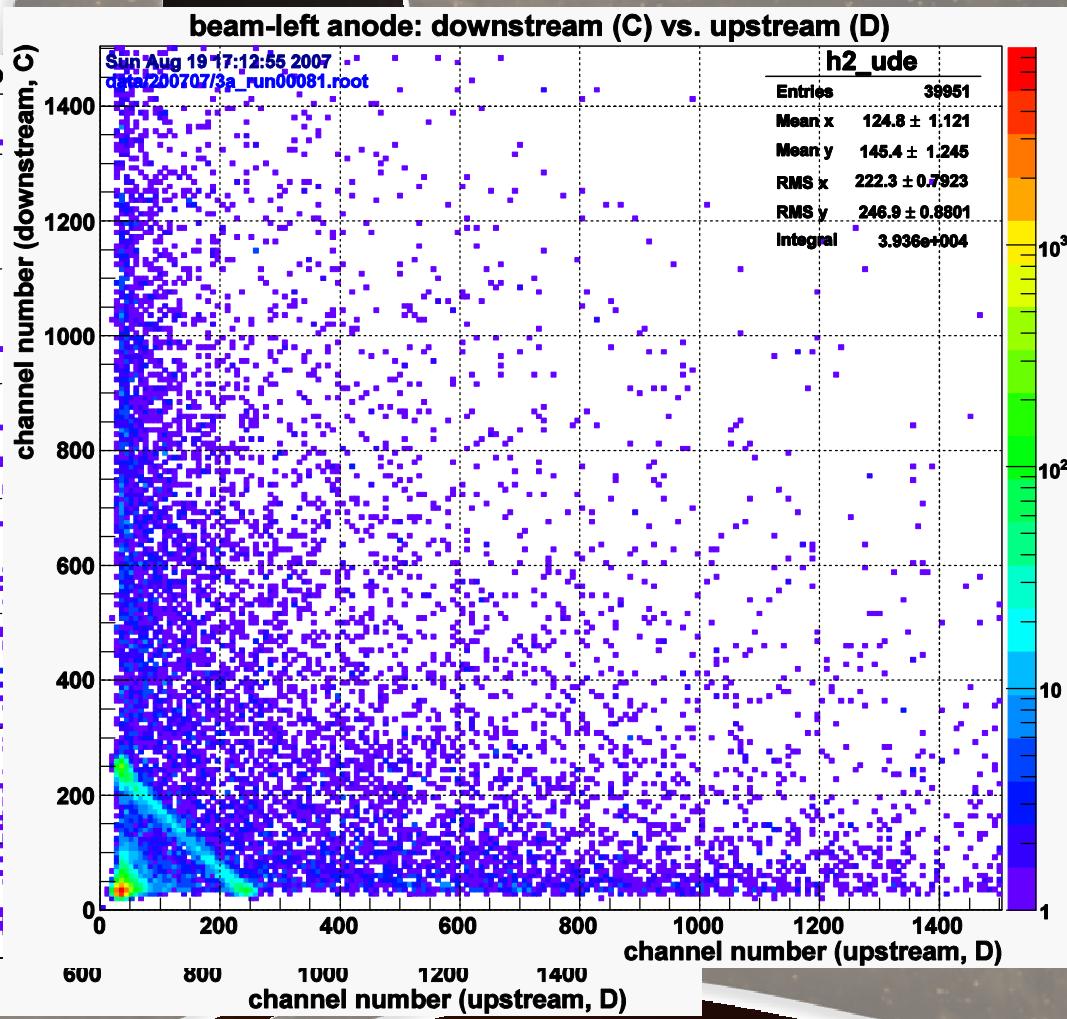
PHASE II RESULTS

- Beam-left anode upstream vs. downstream for three different pressure in attenuator cell

80 torr



100 torr

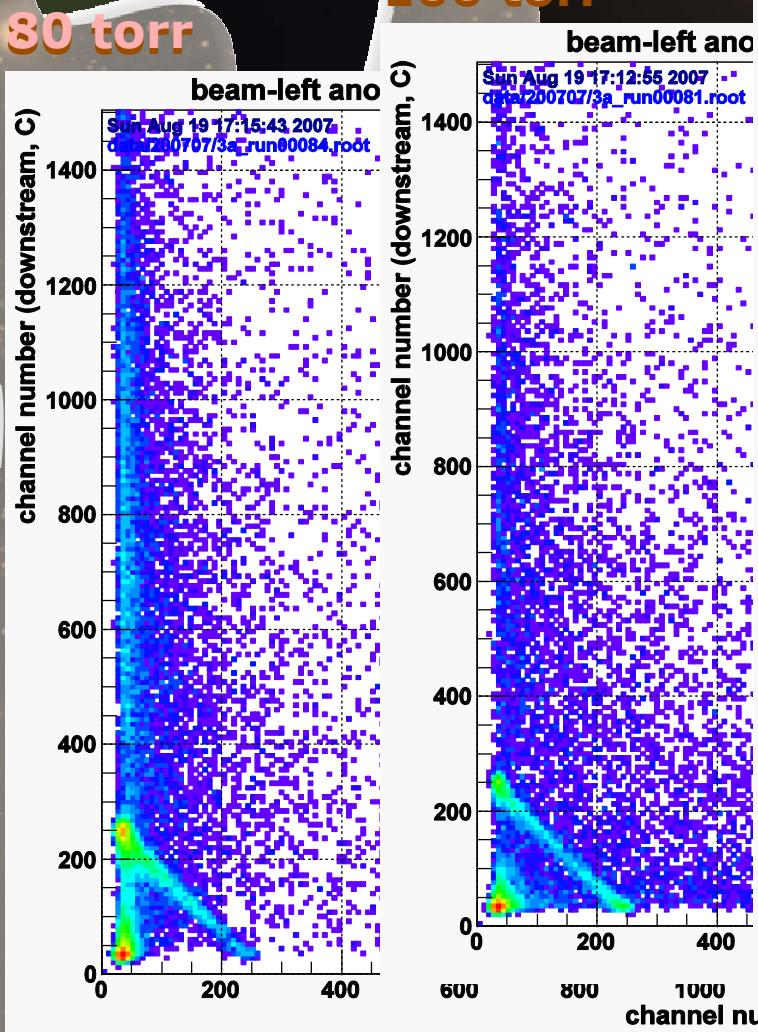


PHASE II RESULTS

Beam-left anode upstream vs. downstream for three different pressure in attenuator cell

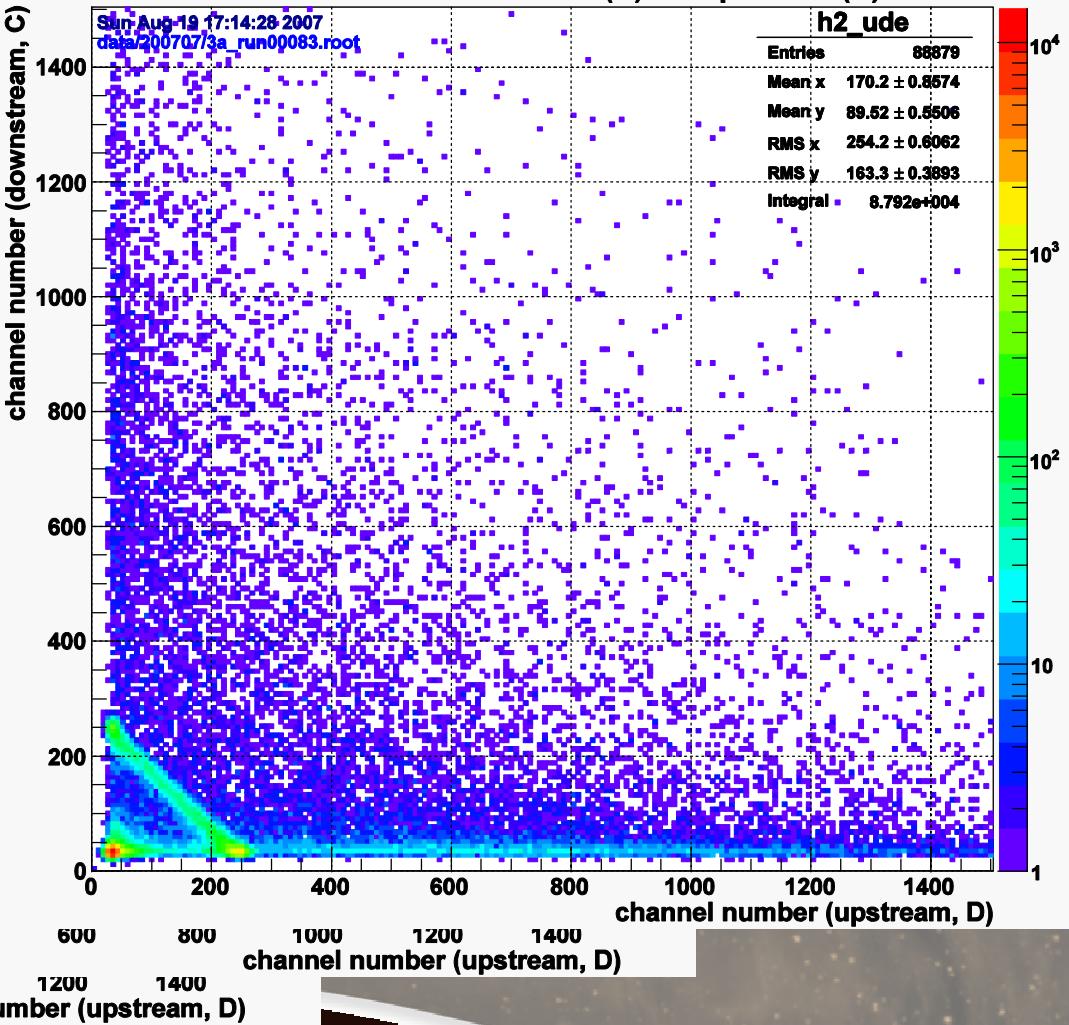
120 torr

80 torr



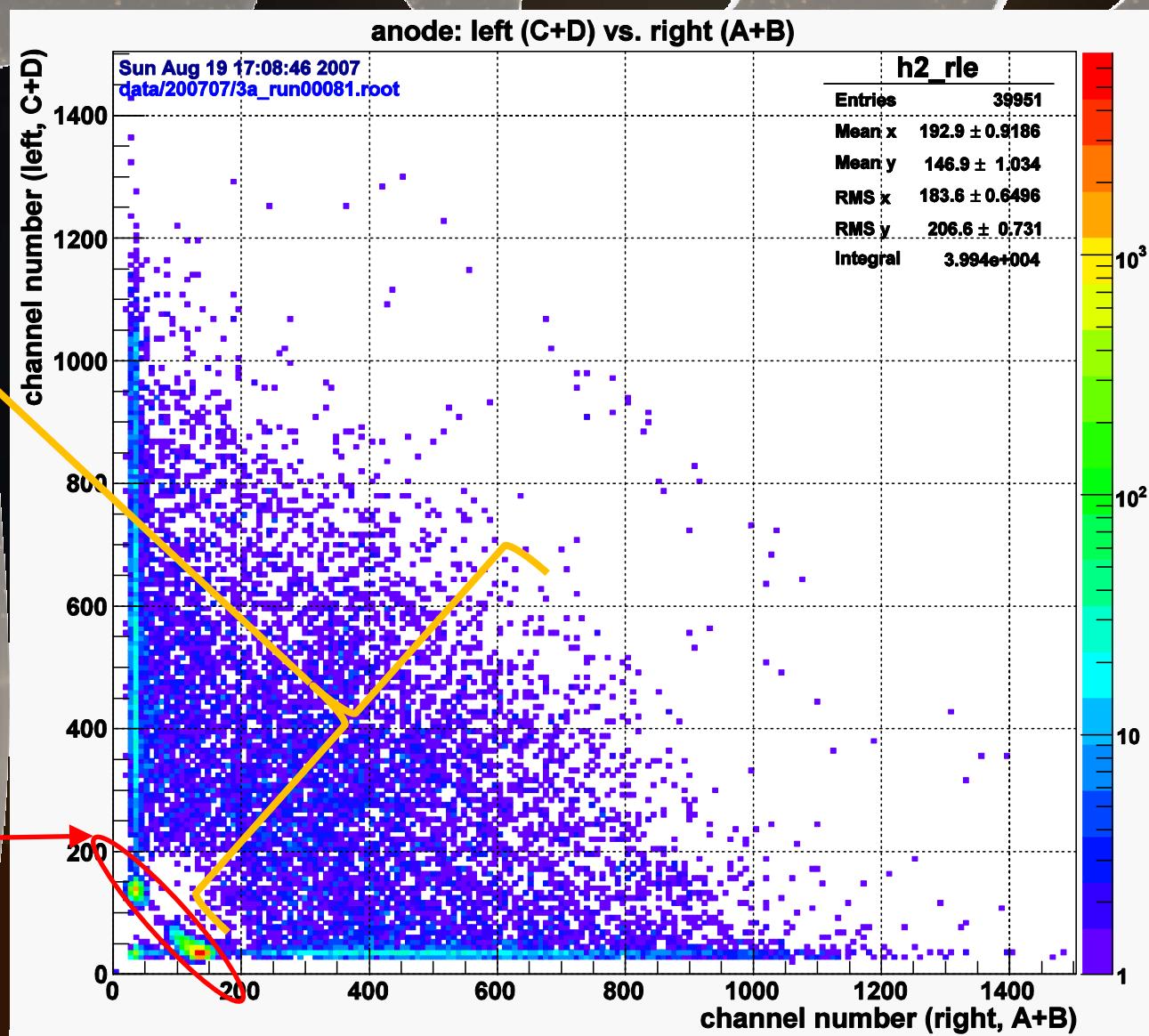
100 torr

beam-left anode: downstream (C) vs. upstream (D)



PHASE II RESULTS

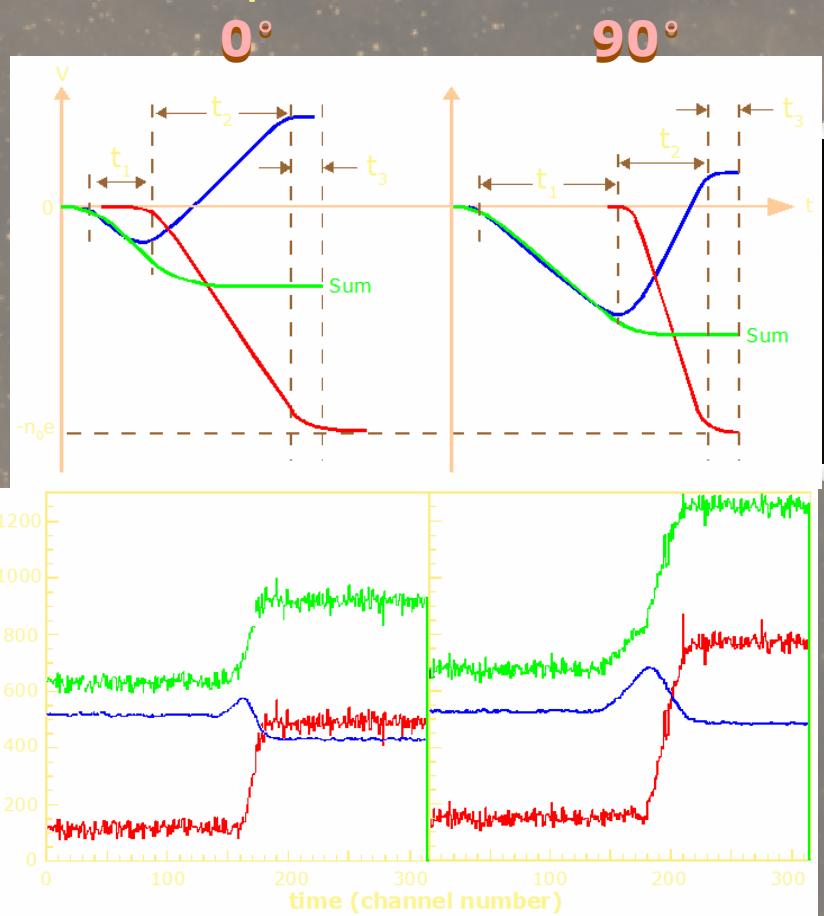
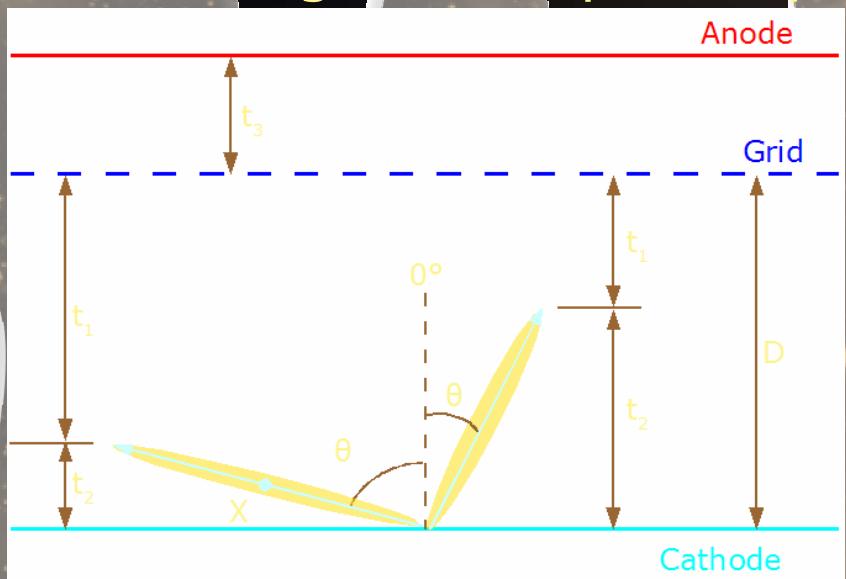
Beam-left anode vs. beam-right anode



FUTURE EXPERIMENTS

Phase III

- ** Lower the threshold for grid electronics
- ** Gather statistics with ^{12}B beam
- ** Use digitizer to possibly resolve two alphas from ^8Be



Phase IV

- ** Repeat experiment with ^{12}N beam

ACKNOWLEDGEMENTS

- U. Greife (CSM)
- D. Henderson (ANL)
- H. Y. Lee (ANL)
- M. Notani (JINA/ANL)
- K. E. Rehm (ANL)
- X. D. Tang (ND)