University of Saskatchewan Dept. of Physics and Engineering Physics

Blowfish update

Photoneutron Reactions

Rob Pywell

U of S Photonuclear Group

Current:

Rob Pywell
- Professor

Ward Wurtz
- Ph.D. Graduate Student (2009, expected graduation)
- ^{6,7}Li(γ,n), Blowfish Efficiency

Octavian Mavrichi
- M.Sc. Graduate Student (2008 expected graduation)
- Photon Flux Monitor

Daron Chabot
- M.Sc. Graduate Student (2008 expected graduation)
- Data acquisition system hardware & software upgrades

Robin Wilson
- Summer student 2007 & Prospective Graduate Student
- ^{4}He(γ,n) possible project

Past Members:

Ru Igarashi
- Adjunct Professor
- Chabot co-supervisor

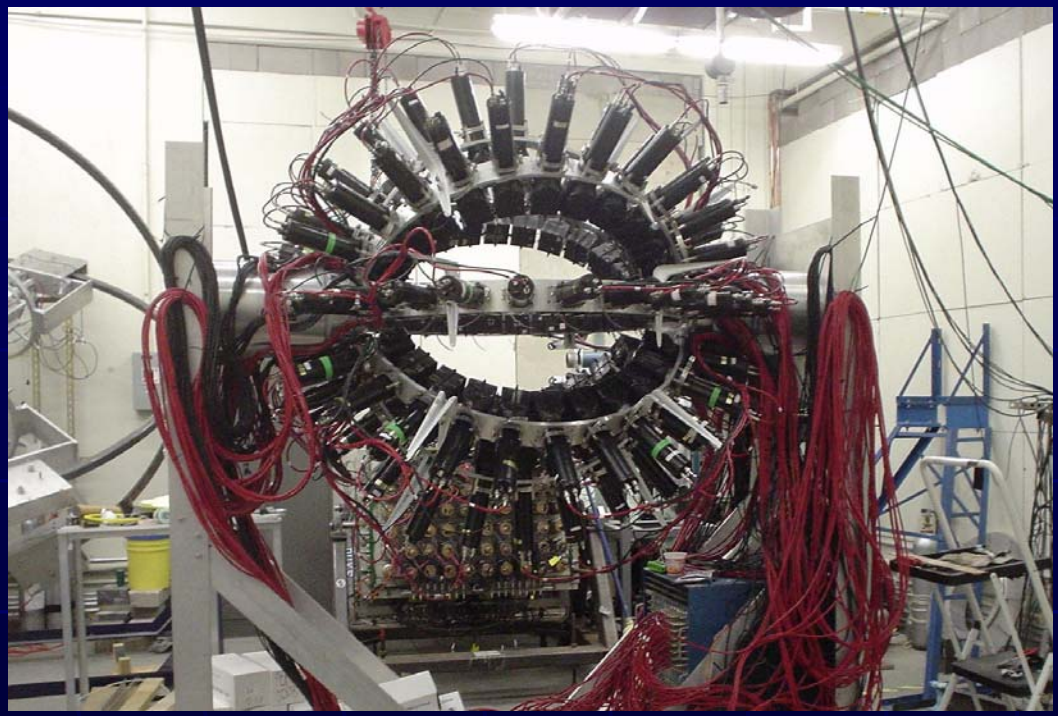
Brian Bewer
- M.Sc. Student (2006 graduated)
- Fibre optic gain stabilization for Blowfish

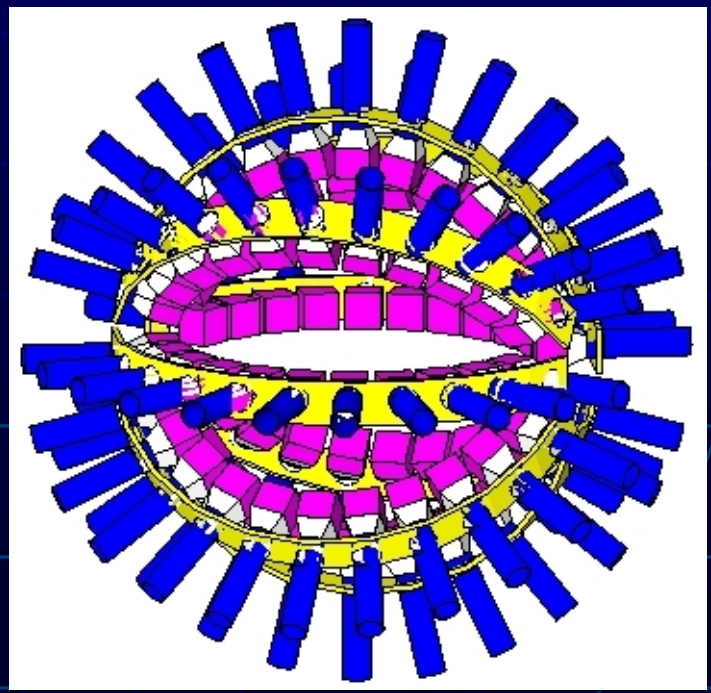
Past students
- Graduate Students: Joss Ives, Tom Regier
- Summer Students: Mike Barnett, Jennifer Robb, Joss Ives, Tom Regier
- All have made important contributions to HIGS related research.

Funding

- Natural Sciences and Engineering Research Council of Canada
- Rob Pywell – Discovery Grant (individual program grant)
  - Currently in the first year of a 3-year grant awarded on the basis of proposed research at HIGS.
  - Primarily supports graduate students and travel to HIGS
- Kolb, Pywell – Equipment Grant
  - $103,000 for upgrades to Blowfish phototubes and data acquisition electronics

“Blowfish” Neutron Detector Array



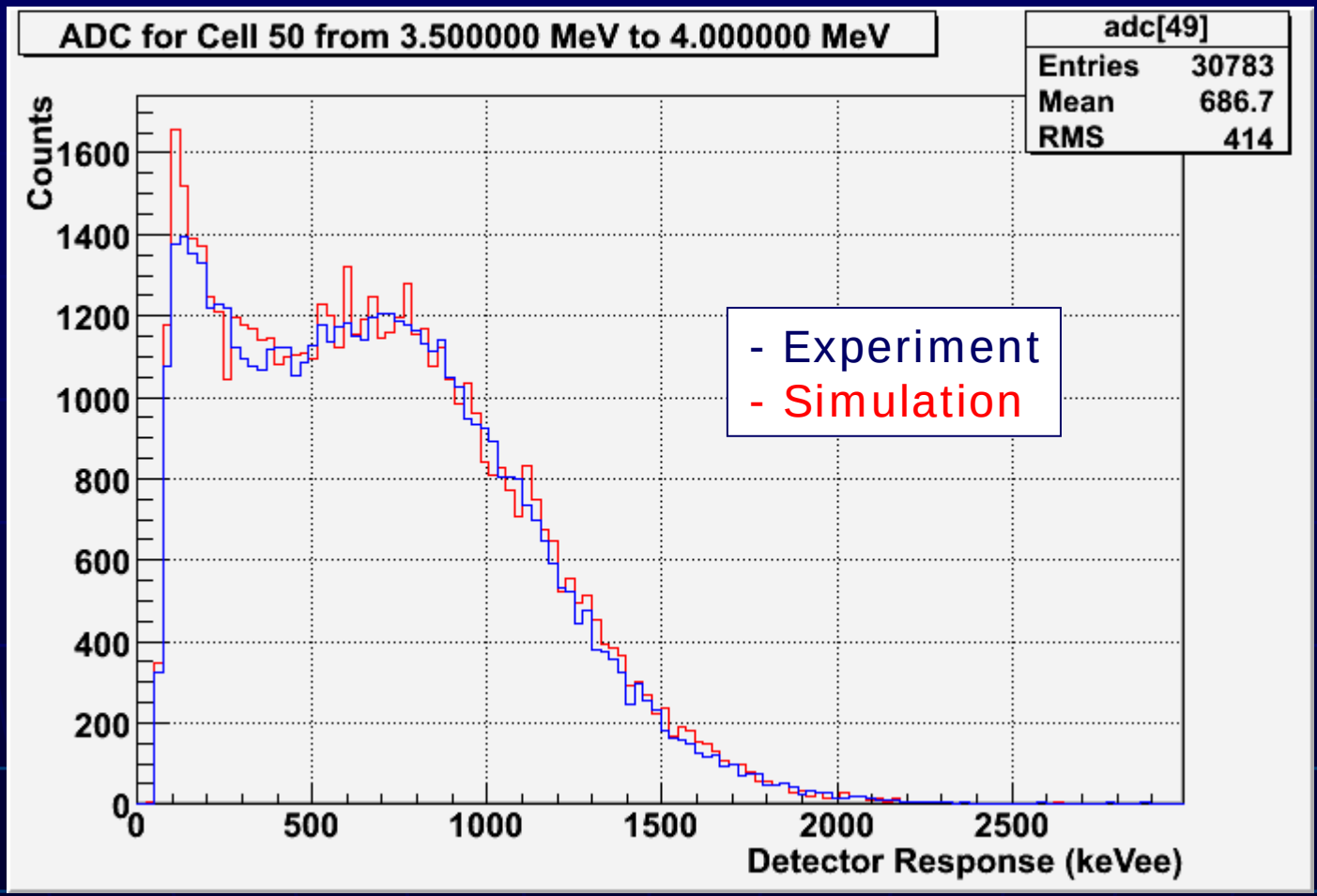


GEANT4

Array Status

- Phototubes/bases
  - upgraded 2003
  - All re-seated and light checked July 2007
- Trigger electronics
  - Received a thorough checkout in July 2007
- BC-505 Light output parameters settled
  - NIMA 565 (2006) 725
- Efficiency Measurements using Cf recoil fission source (December 2005) Ward Wurtz
  - Neutron energy determined by time-of-flight
  - Good agreement of light output spectrum with GEANT4 simulation

Cell Efficiencies



Normalized by number of fission events

Simulation using GEANT4

Gain Monitoring System

- Fibre optic based flasher system (Brian Bewer M.Sc.)
  - Stabilized against radioactive ^{137}Cs source with a GSO monitor detector
  - Installed, tested and used (Feb 2005)
  - Gain known to <1%
    - $\Rightarrow$ efficiency known to < 0.5%

Data Acquisition System

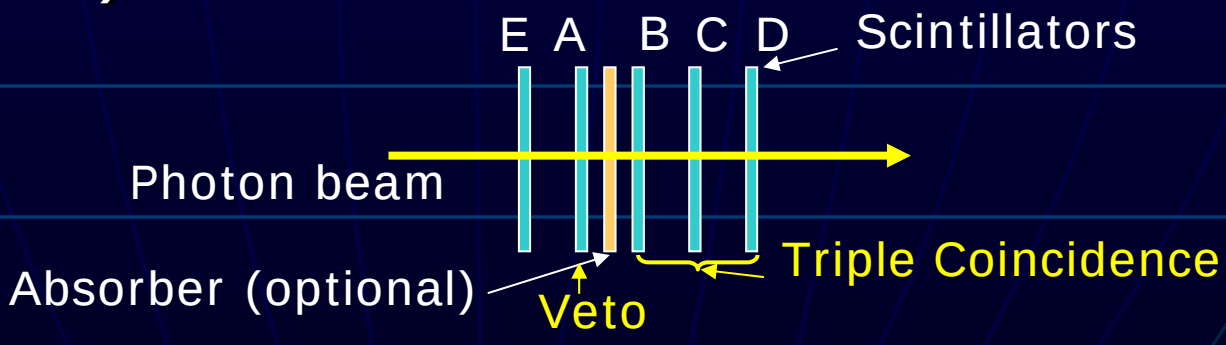
- FASTBUS ADCs and TDCs have been replaced by VME
- Front-End processor ported to PC running RTEMS
  - Fibre optic link to VME
  - 20X increase in maximum data rate
- LUCID
  - Ported to Linux
  - User interface ported to GTK (1.2 now 2.x)
  - Mature interface to Root (Ward Wurtz)
- DVD writer for data storage

Targets

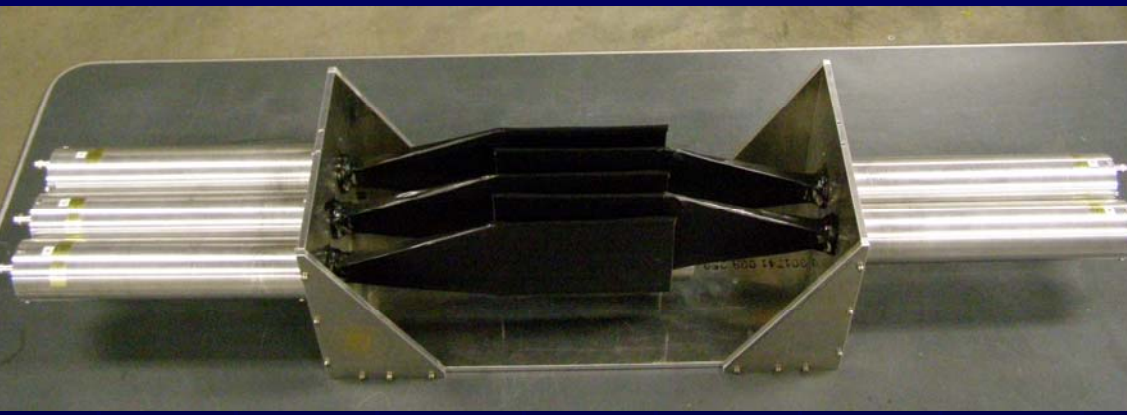
- ^{6}Li and ^{7}Li targets constructed and ready to use.
- Possible gas proportional counter active target design for ^{3}He & ^{4}He.

Photon Flux Monitor

- Designed, Constructed and tested
  - Stable continuous flux monitor
  - Insensitive to gain/threshold shifts
  - Can be used with a simple scalar
    - gated/ungated – no dead-time issues
  - Absolute flux monitor (GEANT4 Simulation – to be experimentally verified)

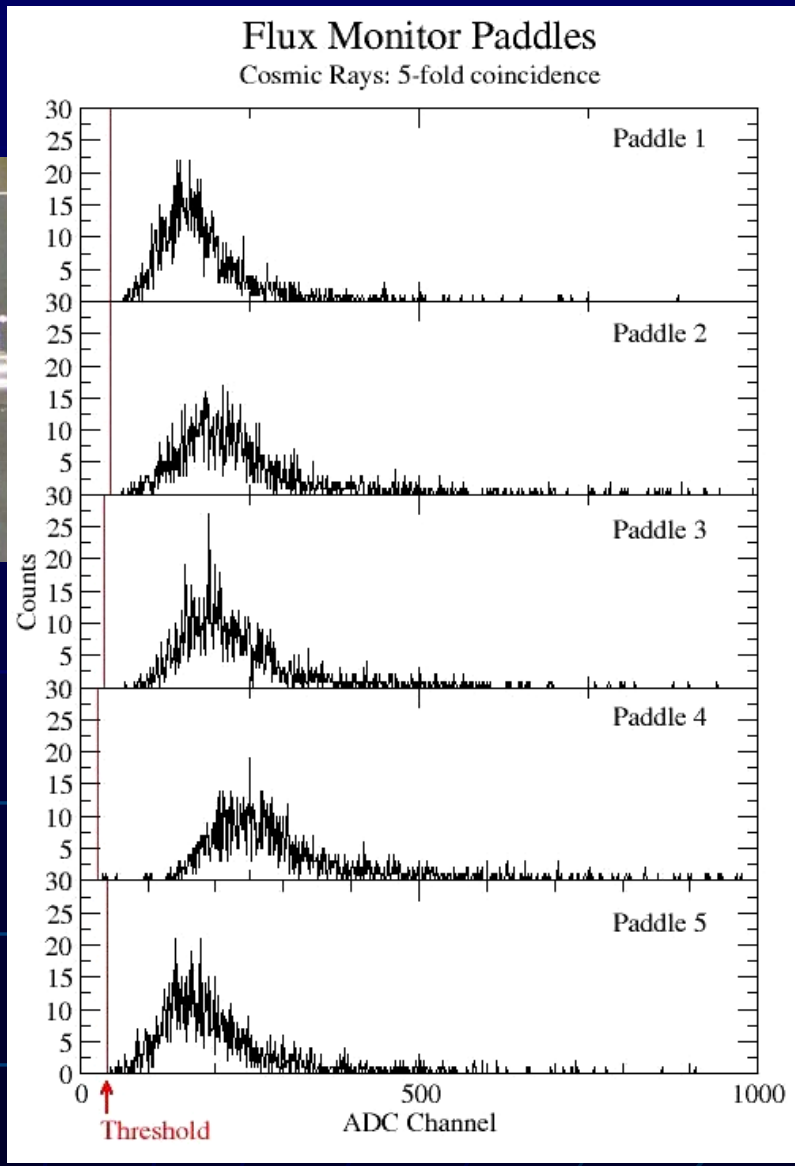


Photon Flux Monitor



Tested using cosmic rays.

Yet to be tested with beam.

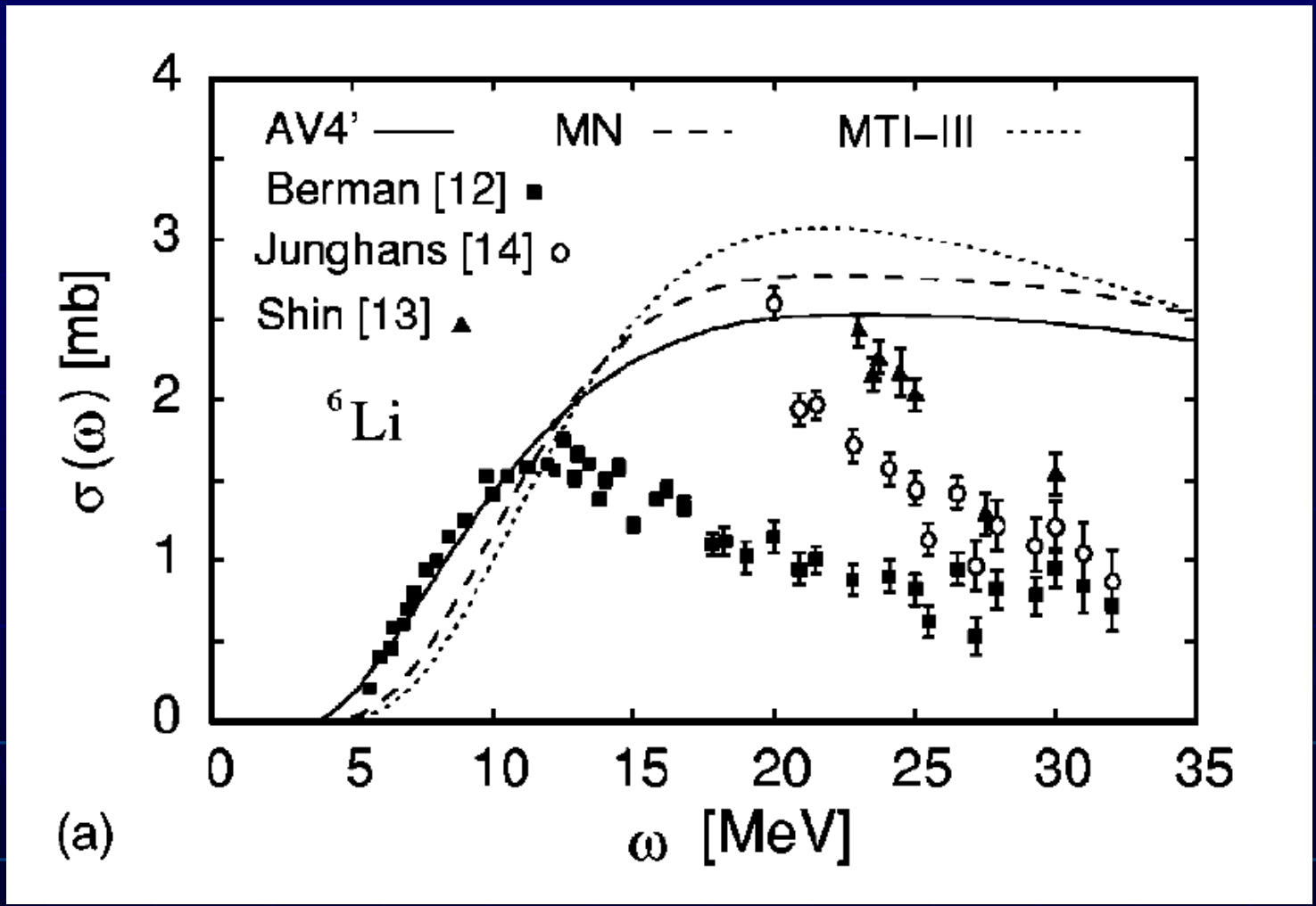


Few-Body Photodisintegration

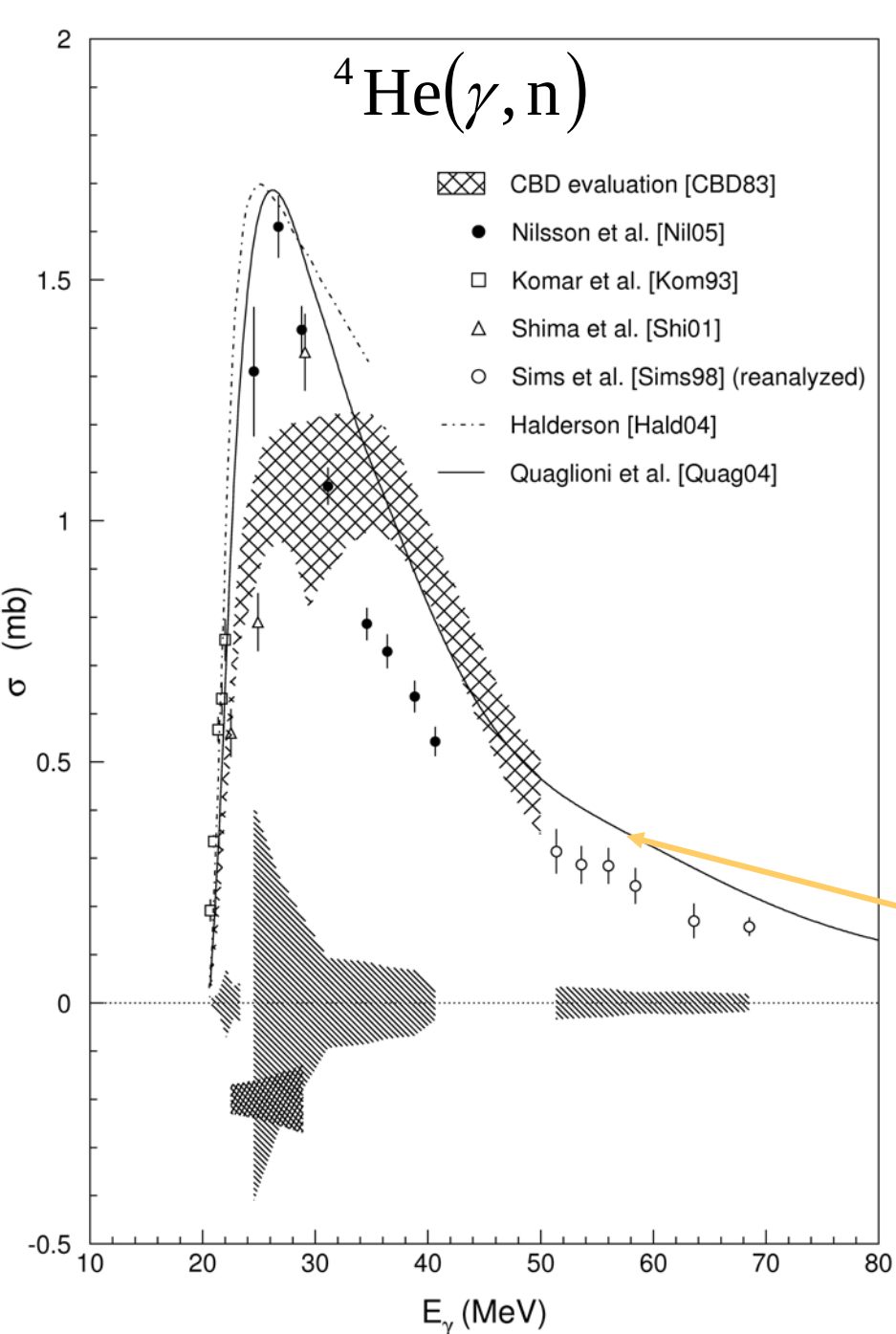
Accurate theoretical calculations are now possible

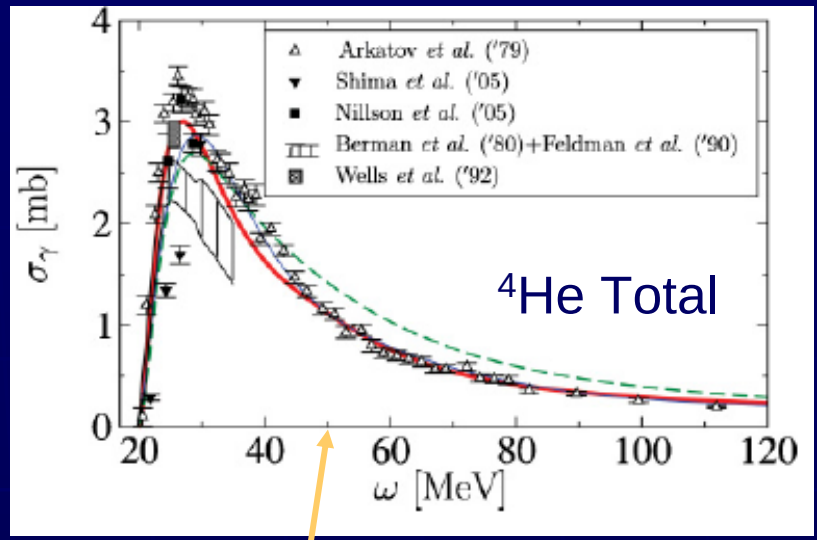
- e.g. Lorentz Integral Transform technique (e.g. Bacca, PRC 75, 044001 (2007))
- Now possible to see significant differences between the predictions of different nucleon-nucleon potential models in the giant dipole resonance region.
- Current measurements do not have the quality to differentiate between potential models.
- HIGS has the potential to address this. Aiming for measurements with uncertainties less than a few percent.

^{6}Li



Bacca et al., Phys.Rev. C 69, 057001 (2004)





– V_{UCOM} – AV18+UIX - - JISP
Bacca, Phys. Rev. C 75 (2007) 044001

Quaglioni, Lederman, Orlandini, Barnea, Efros, Phys. Rev. C 69 (2004) 044002

Nilsson et al., Phys. Lett. B 626 (2005) 65-71

Few-Body Photodisintegration

Time is right for “precision” cross-section measurements.

^{6}Li is an excellent test case.

Will measure:

$$^{6}\mathrm{Li} + \gamma \rightarrow n + {}^{5}\mathrm{Li} \rightarrow n + p + {}^{4}\mathrm{He}$$ Thresh 5.7 MeV

$$^{6}\mathrm{Li} + \gamma \rightarrow n + p + {}^{4}\mathrm{He}$$ Thresh 3.7 MeV

$$^{6}\mathrm{Li} + \gamma \rightarrow p + {}^{5}\mathrm{He} \rightarrow n + p + {}^{4}\mathrm{He}$$ Thresh 4.6 MeV

Blowfish can detect these low energy neutrons (as low as 712 keV)

Therefore – below the two body channel threshold (15.8 MeV) – we will measure the total cross section.

Few-Body Photodisintegration using Blowfish

- ^{6}Li & ^{7}Li
  - Beam proposal submitted.
  - All systems in place.
  - Low energy run (6-16 MeV)
    - Shakedown experiment (before GDH)
  - High energy run (16-30 MeV)
  - 150 Hours (2008)
  - Linear polarized photons preferred
  - PhD experiment for Ward Wurtz
- ^{4}He
  - Active gas target development.
  - Possible extension to ^{3}He.
  - 300 Hours (2009)
  - Linear polarized photons

HIGS activities by U of S members

- The SAL data acquisition system, LUCID, was ported from SUN to a PC/Linux system. (Summer Student Project: T. Regier, U od S). Graphic interface ported to GTK+ (partly a Summer Student Project: A. Del Frari, U of S)
- U of S members were collaborators in deuteron photodisintegration measurements near threshold with polarized photons (PhD thesis: B. Sawatzky, U.Va. Completed 2005). Additional measurements made early in 2005. (M.Sc. thesis, M. Blackston Duke U. Completed 2007)
- Phototubes and bases were replaced to reduce noise to allow the measurement of low-energy neutrons. (NSERC equipment grant, 2002). (Summer student project: J. Robb, B. Bewer, W. Wurtz, U of S)
- Fastbus ADCs and TDCs were replaced by VME ADCs and TDCs and associated VME crate. Fastbus electronics would not allow the required data rates needed for future experiments. (NSERC equipment grant, 2002).
- LUCID expanded to include support for VME data acquisition modules. (Summer Student Project: A. Del Frari, U of S)
- LUCID was ported to use a PC running RTEMS with a fast fibre-optic link to VME rather than a VME embedded Motorola front-end processor. (MSc Thesis: D. Chabot, U of S) These upgrades allow a 20-fold increase in data rate.

HIGS activities by U of S members

- A fibre optic light pulser gain monitoring and stabilization system has be designed and installed on all 88 Blowfish cells. (MSc Thesis: B. Bewer, U of S, Completed 2005)
- Significant effort has been put into understanding the response to neutrons of the BC505 cells. A measurement of the efficiency was made over a neutron energy range of 0-6 MeV using a ^{252}Cf source in an ionization chamber, coupled with a GEANT simulation. (MSc Thesis J. Ives, U of S, Completed 2003), (Summer Student Project and MSc project: W. Wurtz, U of S)
- Light output parameters for BC505 determined (Pywell et. al. NIMA 565 (2006) 725).
- A GEANT4 simulation of Blowfish has been developed and is being used for experiment design (Wurtz & Pywell, U of S).
- A novel photon beam position and profile monitor using a scintillator viewed by a CCD camera has been designed and tested (MSc Thesis: T. Regier, U of S, Completed 2003)
- Light pipe designs were tested with the aim of reducing the asymmetric mass associated with active targets (MSc Thesis: O. Mavrichi, U of S).
- Additional BC505 cells being constructed to facilitate testing (W. Wurtz, U of S)
- Photon Flux Monitor designed, constructed and tested (Pywell & MSc thesis: Mavrichi, U of S & summer student project: R. Wilson, U of S)