G4LifeTime(G)

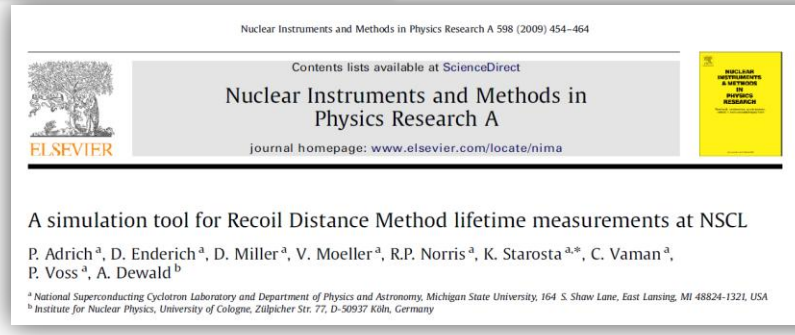
09/22/2012

Antoine LEMASSON

NSCL

History for G4LifeTime

- **Starting point :**
  original Code from P. Adrich *et al.* (NIM A) (2009)
  Geant4 /C++
- **Since 2010 - Upgrade of the code :**
  - Cleaning up, removal of GUIROOT dependencies
  - Rewriting of the output/storage and analysis
  - More realistic Geometry :
    (Improvement on Caps, Dead layers, …)
  - Additional feature (Cascade decays, …)
  - Long term maintenance :
    Compatibility with upgraded version of G4 (4.9.4p4),
    Git Version control
  - Documentation :
    Wiki + Doxygen + Simulation Database
- **Lifetime measurement oriented**
  (RDDS, Line-Shape, DSAM)
- **S800 + SeGA (Plunger / Barrel)**
  experiments at NSCL
- To date : Version 0.4-RC2 (Sept. 2012)


Nuclear Instruments and Methods in Physics Research A 598 (2009) 454–464

Contents lists available at ScienceDirect

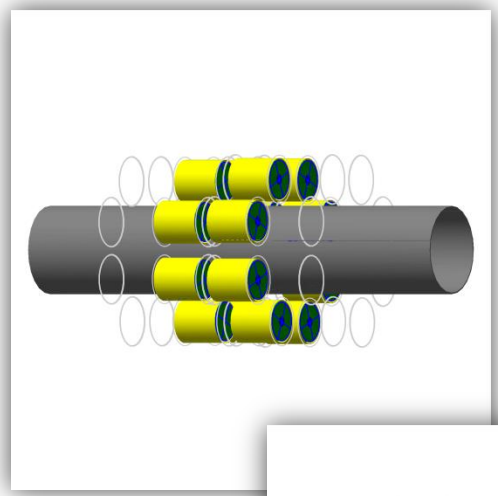
Nuclear Instruments and Methods in Physics Research A

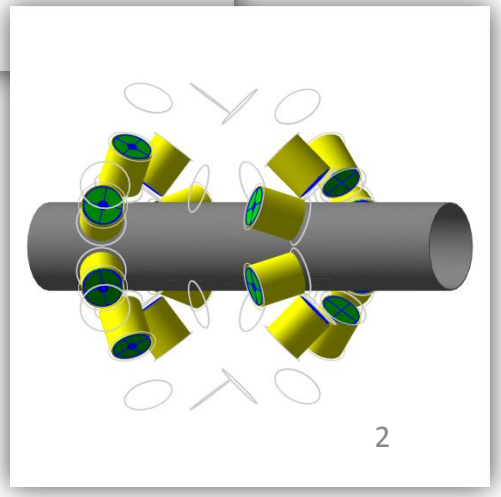
journal homepage: www.elsevier.com/locate/nima

A simulation tool for Recoil Distance Method lifetime measurements at NSCL

P. Adrich [a], D. Enderich [a], D. Miller [a], V. Moeller [a], R.P. Norris [a], K. Starosta [a,*], C. Vaman [a], P. Voss [a], A. Dewald [b]

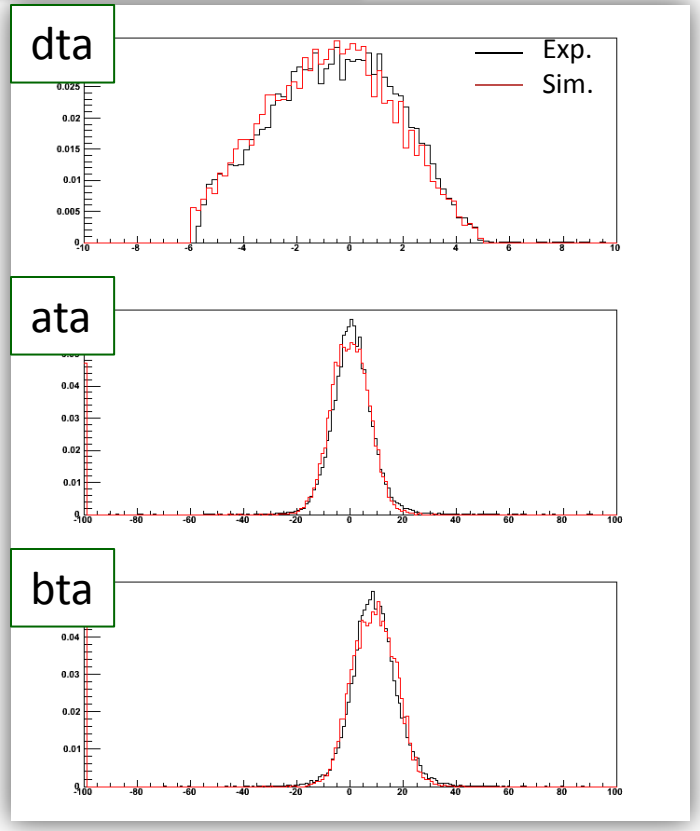
[a] National Superconducting Cyclotron Laboratory and Department of Physics and Astronomy, Michigan State University, 164 S. Shaw Lane, East Lansing, MI 48824-1321, USA
[b] Institute for Nuclear Physics, University of Cologne, Zülpicher Str. 77, D-50937 Köln, Germany

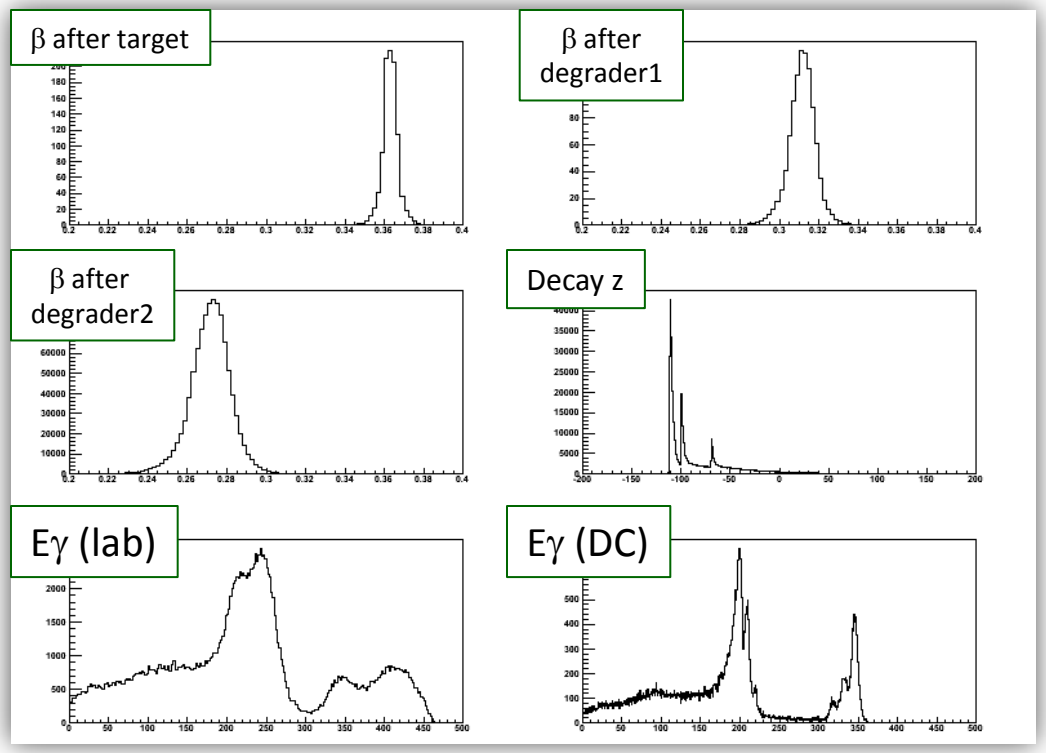




Main Features

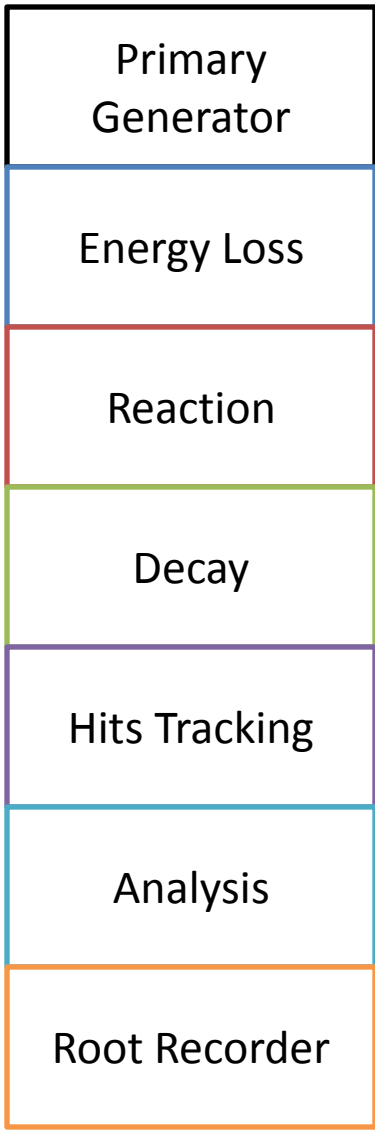
- Incoming Beam / Outgoing Beam properties
- Basic reaction mechanisms modeling of Knock Out and fragmentation
  to reproduce S800 measured outgoing momentum (phenomelogical)
- Basic S800 Acceptance cuts on :
  Momentum (dta) and scattering angle (ata, bta)
- Single target or Plunger (Energy losses)
- γ-ray decay in flight (also cascade decays)





G4Lifetime event timeline

- Shoot Beam
- Track Beam (Energy Loss)
- Reaction
- Track Outgoing reaction product (Energy Loss)
- Decay In flight (Optional)
- Track Gamma rays
- Track Outgoing reaction product (Energy Loss)
- End of Event :
  - Analysis : Sorting events from Hits Collections
    - observables for outgoing ions to S800,
    - Gamma Rays : E_γ , interaction points, Segment energies (SEGA), Doppler Correction
  - ROOTRecorder to store in Tree/Histograms



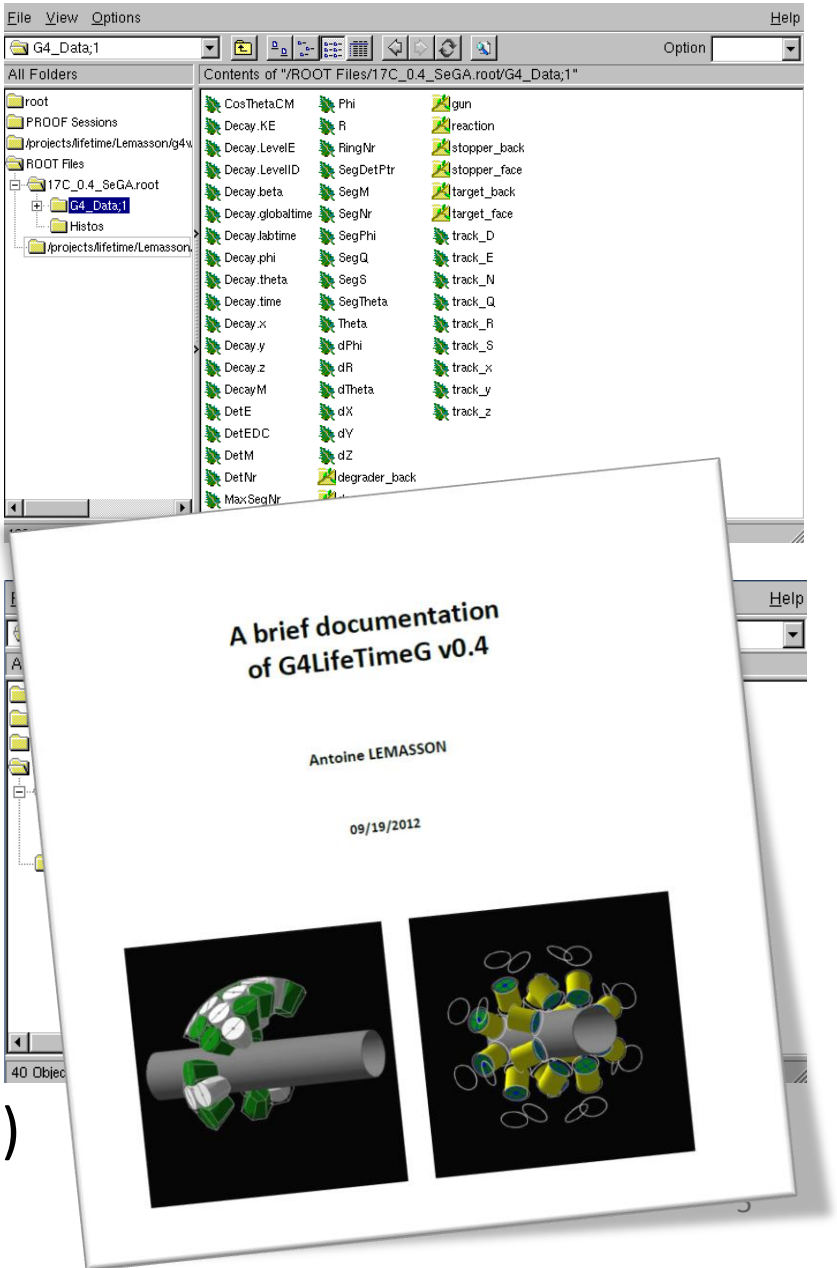
Root Output

- **G4 Data Tree (List Mode)**
  - Positions (reaction, decay, γ-ray interaction points, …)
  - Ion Energy (Gun, E Loss in target and degraders)

- **Relevant Histograms**
  - S800 :
    - ata, bta, dta, yta
  - SeGA : γ-rays spectra
    - E gamma (lab)
    - E gamma Doppler Corrected (various options …)

- Modular :

  any body should be able to write its own output format (GEB centric ?)

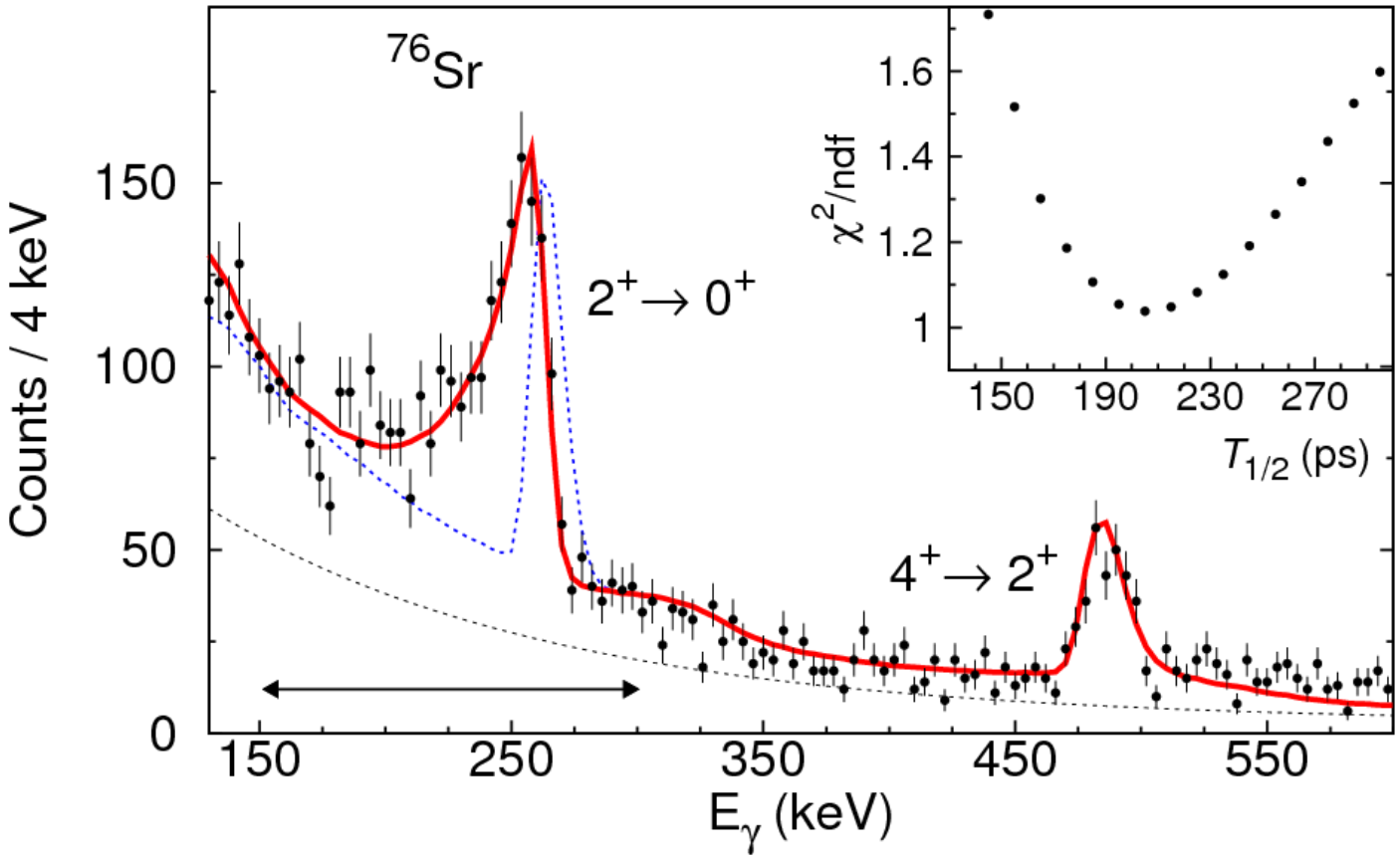


Practical examples (I)

2+ state lifetime ^{76}Sr :

A.L. Phys Rev C, Rapid Com (2012).

- γ-ray peak line-shape method
- 2^+ state lifetime : $T_{1/2}$ = 205 (25) ps

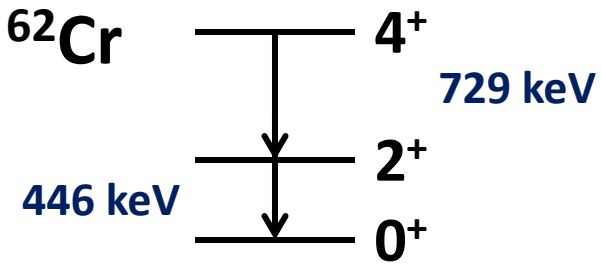


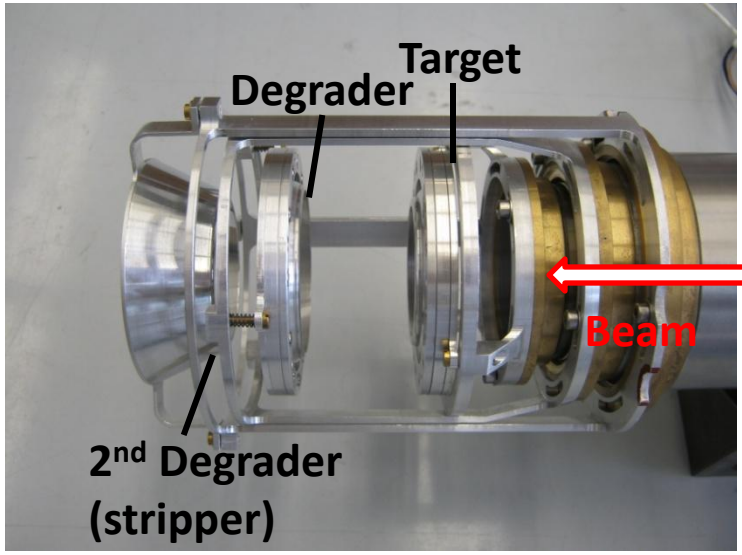
Practical examples (II)

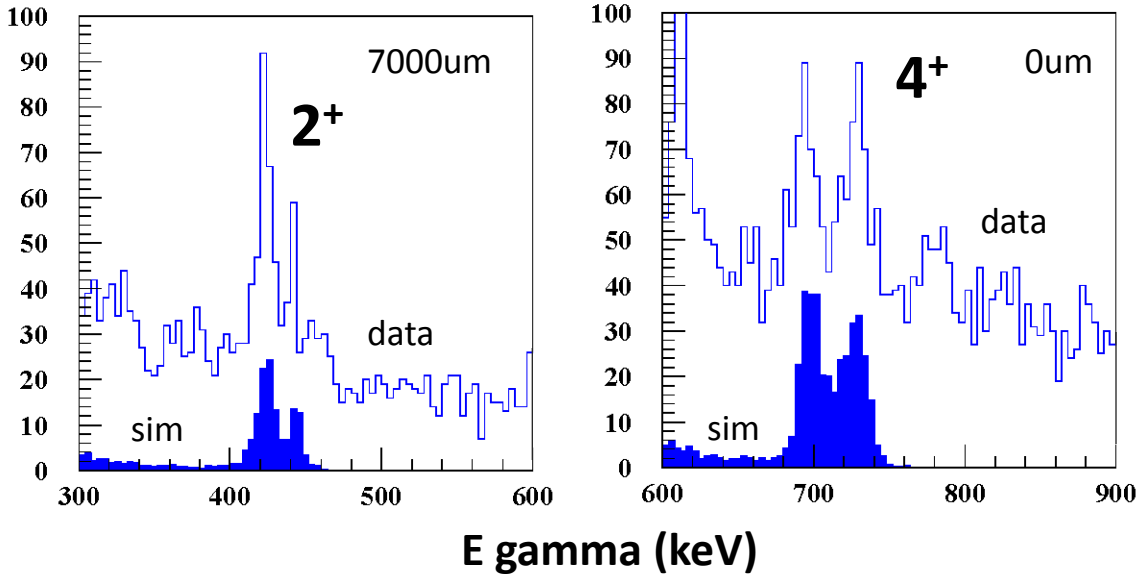
TRIPLEX campaign in Dec 2011

(**TRI**PLE **PL**UNGER for **EX**OTIC BEAMS)

1. Br exp : shape coexistence at N=Z
2. Cr exp : collectivity at N=40





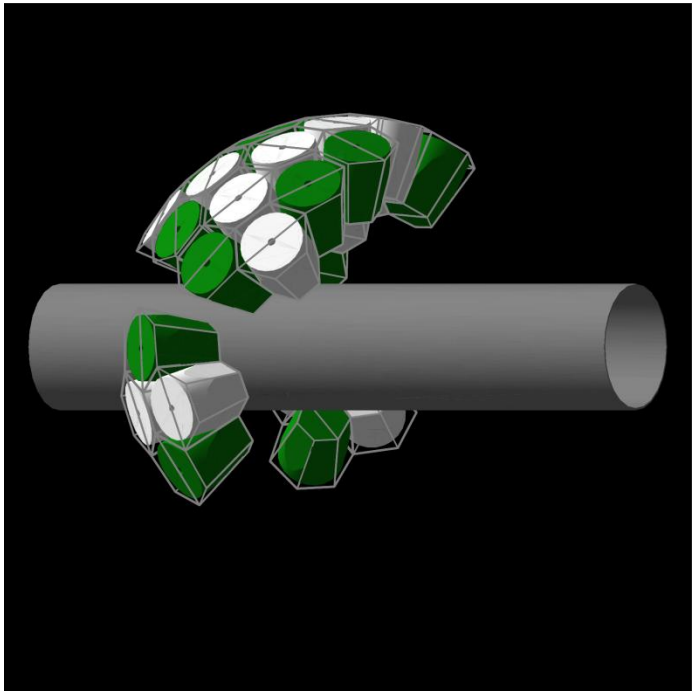


Online spectra compared with preliminary simulations

Simulations were made “” before the experiment “”

G4LifeTime(G) v 0.4 (beta version)

- Including Gretina geometry description from Chris Campbell into G4LifeTime(G)
- Euler Angles input files for NSCL setup
- /!\ No comparison with “real” data so far !



/!\ Simplest Geometry into the existing Code,
No surrounding materials

/!\ Position Resolution 3D Gaussian ! FWHM is input

/!\ no advanced feature for Add-Back, γ-ray tracking …

NNSA-NSSC program (2011-2016)
improve modeling of advanced γ-ray tracking array
(Chris Morse, Kenneth Whitmore, H. Iwasaki, PD(?))

Outlook

Some goals to improve/complete G4LifeTime(G) simulation :

- **Improve the description of geometry for Gretina**
  (position, and size of crystal, dead layer)

- **Incorporating surrounding materials in the geometry**
  (Sphere, Dewar, Pipe, Plunger, …)

- **Comparison with data:**
  - The highest priority of the group is to have spectral shapes which are good enough to be used for lifetime measurement and not much on absolute efficiency for now.
  - Plunger data/lifetime from coming experiments (Oct 2012) .
  - Efficiency, Peak to Total for single crystal.

- **Challenges :** Understand the effect of Pulse Shape Analysis and Tracking
  - Peak-to-Total, Position resolution, efficiency.
  - and incorporate them in GEANT4 simulation …