Cryogenic Scintillators for Dark Matter, Status of the SciCryo Project

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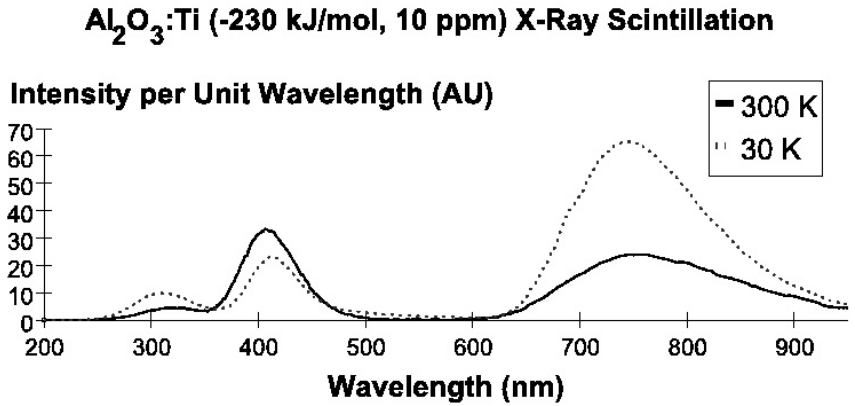
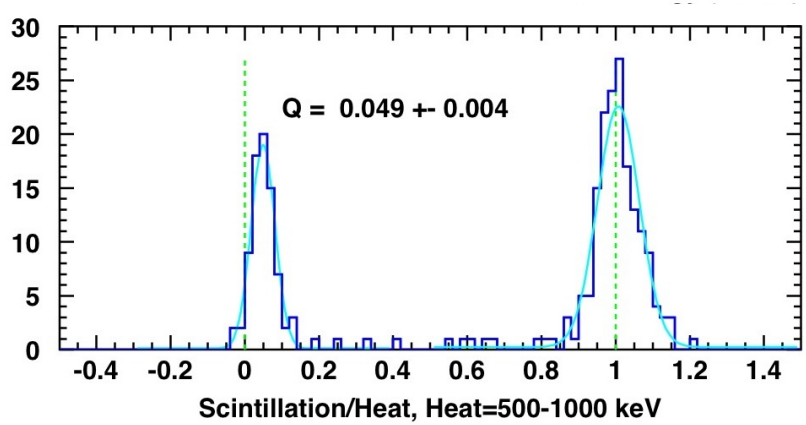
The SciCryo Project

- Spectroscopy of sapphire (M. Luca thesis)
- Quenching in IAS sapphire detector in EDWII (M. Luca thesis)
- Cryogenic Scintillators Studying
- French ANR funding
- Collabaration with :
  - IAS Orsay
  - MPP München
  - LPCML Lyon
  - + Oxford Physics

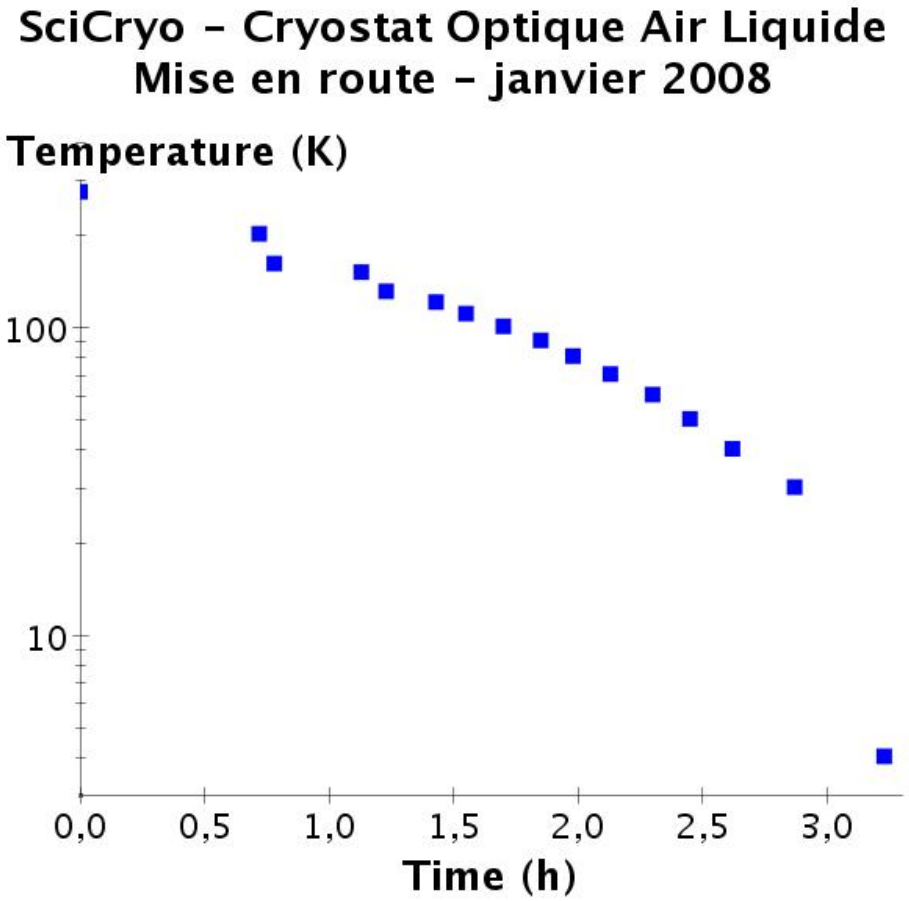




The SciCryo Optical Cryostat

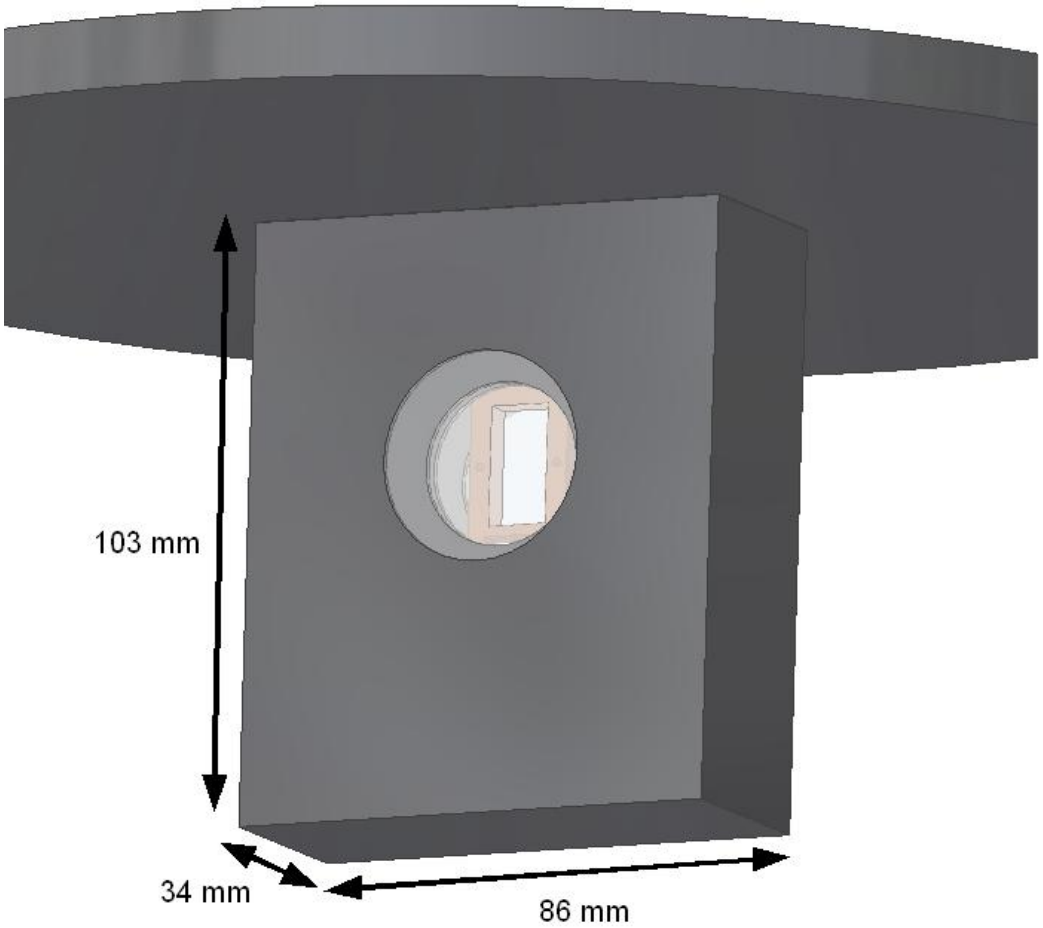
- Built by Air Liquide
- In Lyon since january 2008
- Helium closed circuit with pulse pube (CryoMech)
- 250 mW at 4 K
- Temperature monitoring between 3 K and 30 K
- Easy to use

Cooling



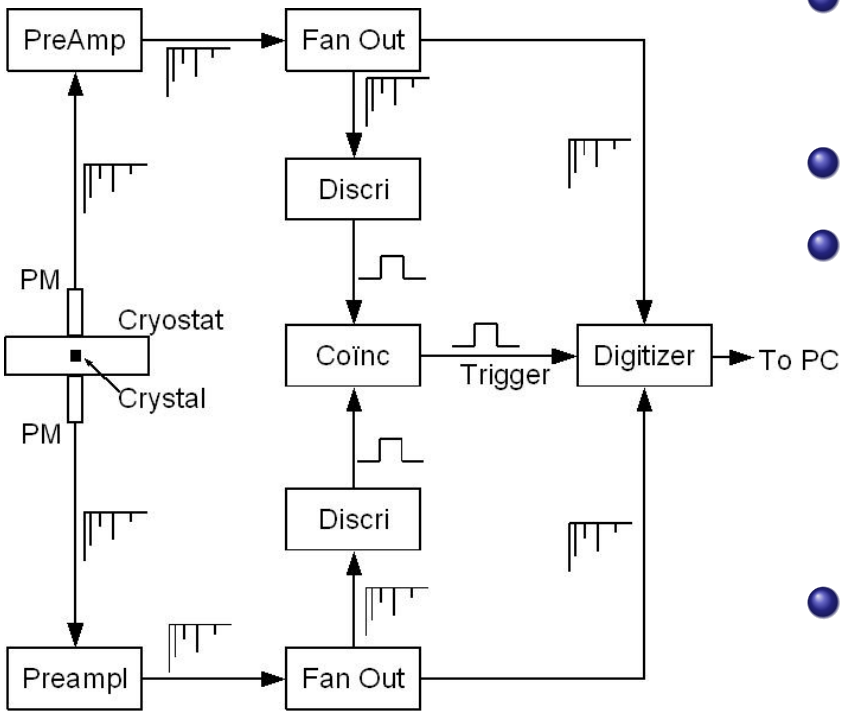
- From 300 K to 3 K in 3 hours
- $T_{min} = 2.8K$

Optical Specificities



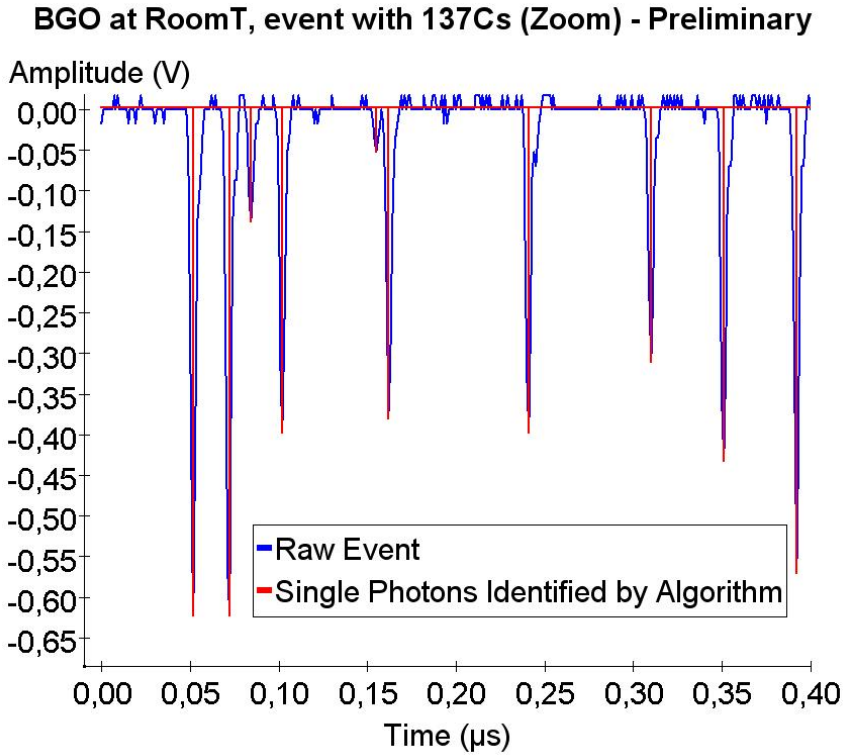
- Geometry compact and original
- Quartz window on each side
- Only 17 mm from the center to the photodetectors
  $\Rightarrow$Maximal light collection

Experimental Setup



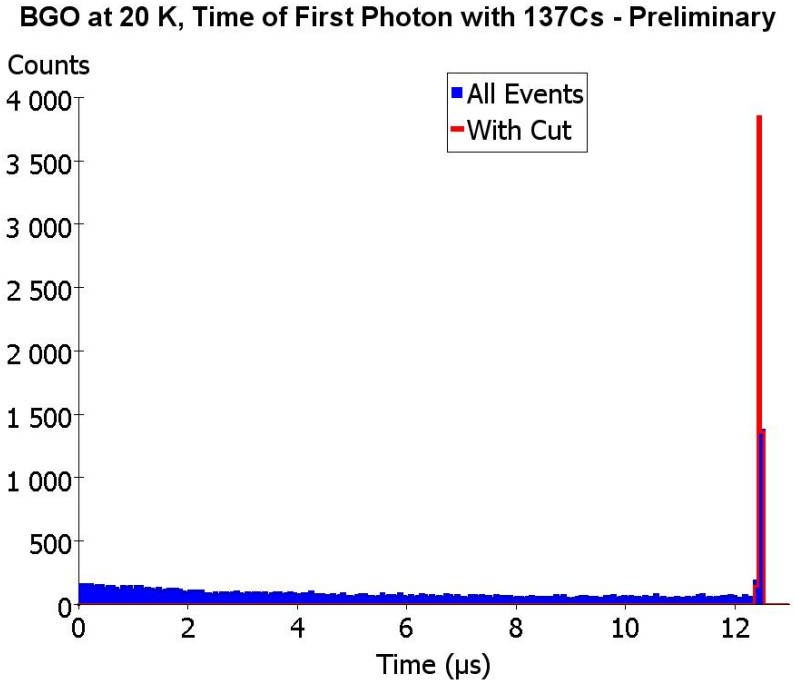
- BGO crystal of 20x10x5 mm^3 to test setup
- ^{137}Cs γ source (40 kBq)
- Old setup :
  - 100MHz sampling rate
  - Noisy old PMT Photonis XP2982
  - No coincidences
- New setup since june 2008
  - 1 GHz sampling rate
  - PMT Hamamatsu R-7207
    - Few dark counts $\Rightarrow$ fewer spurious events
    - small photocathode ($\phi = 1$ cm) $\Rightarrow$ light collection not optimal

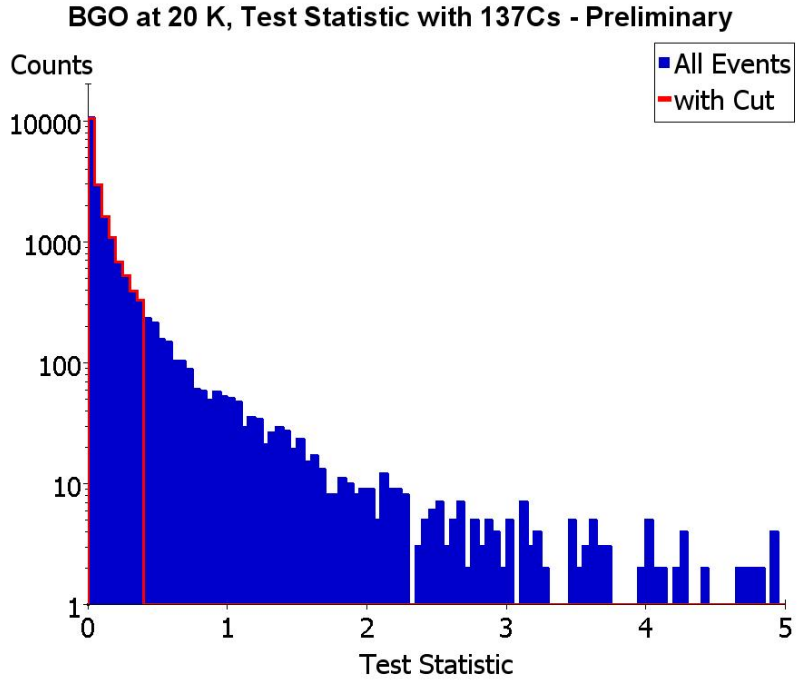
Analysis Method



- Multiple Photon Counting Coincidence (MPCC) technique (H. Kraus, V.B. Mikhailik, D. Wahl, Nucl. Instr. and Meth. A 553 (2005) 522)
  - Detection of individual photons
  - Applying cuts to obtain decay time and LY for each temperature

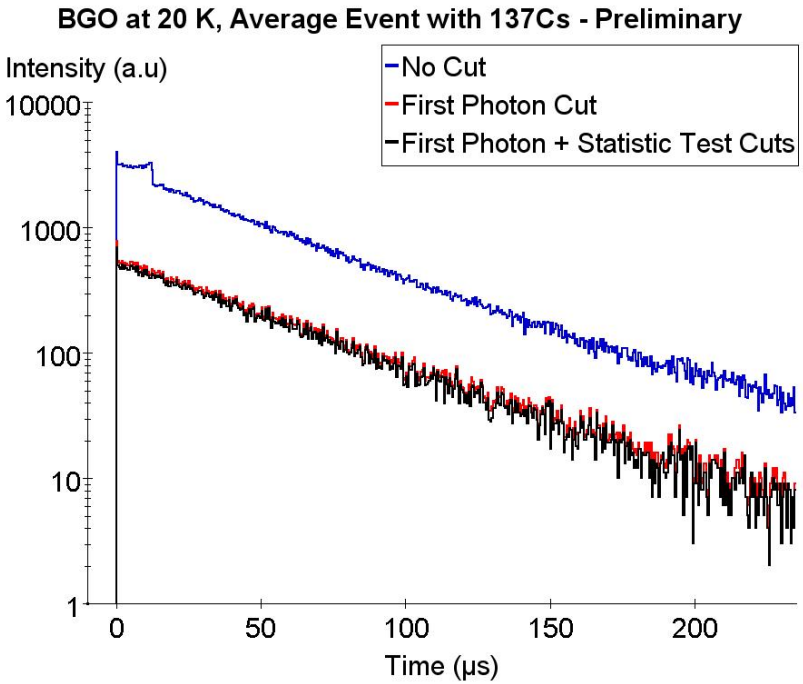
Analysis Method

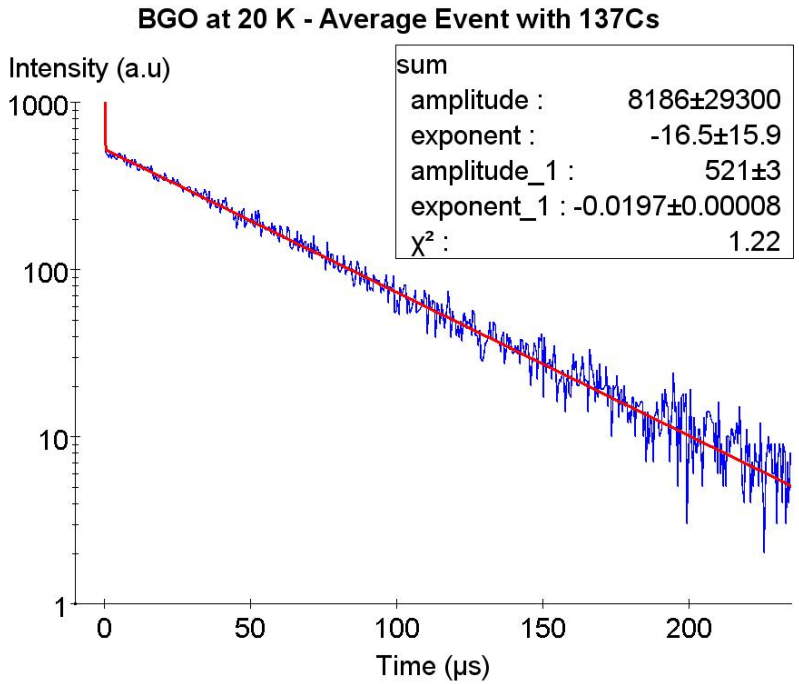




- First photon arrival time cut
  $\Rightarrow$ rejects pretrigger pileups
- Test statistic cut : compares time constant of event to the most likely time constant
  $\Rightarrow$ rejects other pileups

Decay Time

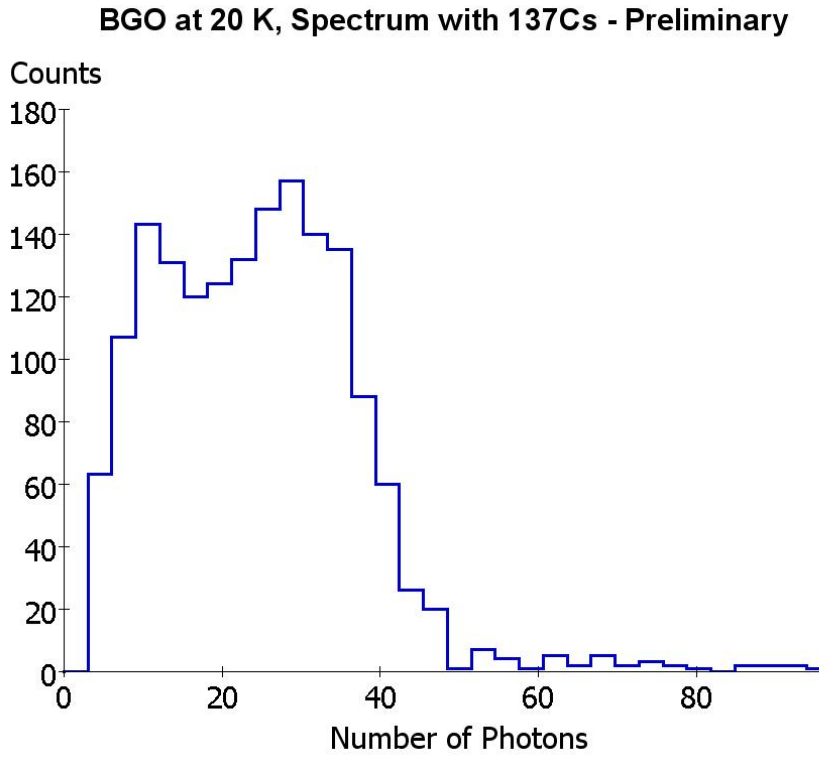




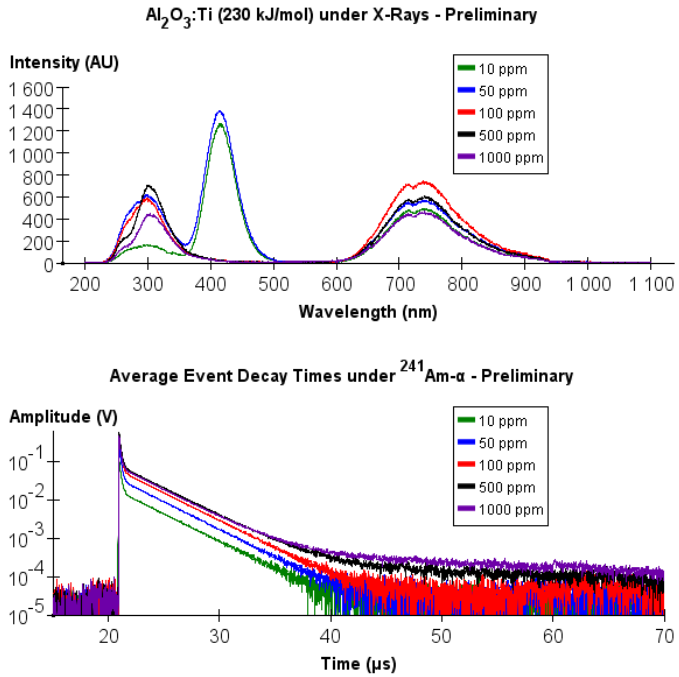
- Large effect of the cuts on average event
- Average event gives decay time value(s)
- Ex : at 20 K $\tau = 50$ μs, consistant with J. Gironnet, et al., Nucl. Instr. and Meth. A(2008)

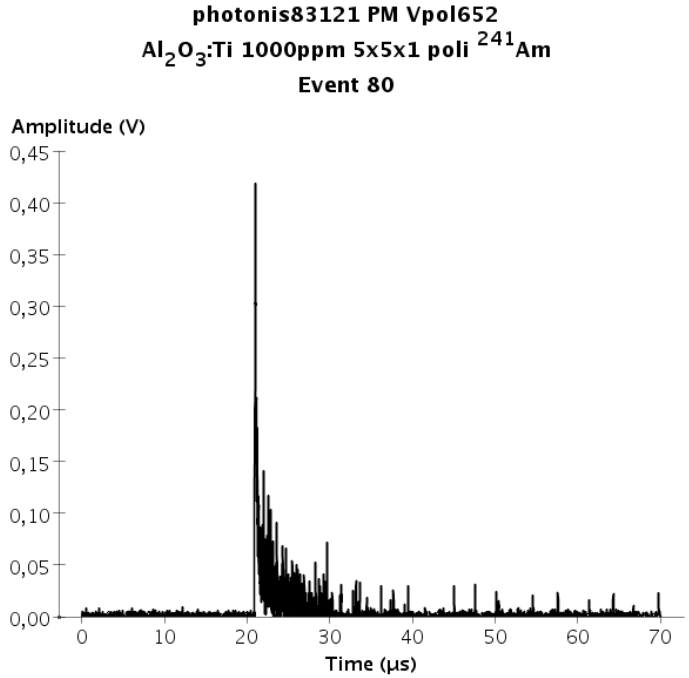
Light Yield

- Few Photons $\Rightarrow$ poor resolution on photopeaks
- LY vs T not yet ready $\Rightarrow$ Need to use PMT with larger photocathode



Sapphire Scintillation - Preliminary





- Ti :Al2O3
- Red sensitive PMT (Noisy)
- Room Temperature Preliminary Tests with old setup
  - X-Rays spectra (LPCML) $\Rightarrow$ several Peaks
  - Room Average events with ^{241}Am α-source $\Rightarrow$ Several decay Times
  - No correlation at the moment
- Will redo measurement with MPCC

Future

- Finish BGO tests with γ
- Implementation of OxRop
- Sapphire
  - Cooling PMTs
  - Optical filters on sapphire to get correlation between spectra and decay times
  - Sapphire in SciCryo with α
- Eager to test other crystals in SciCryo