



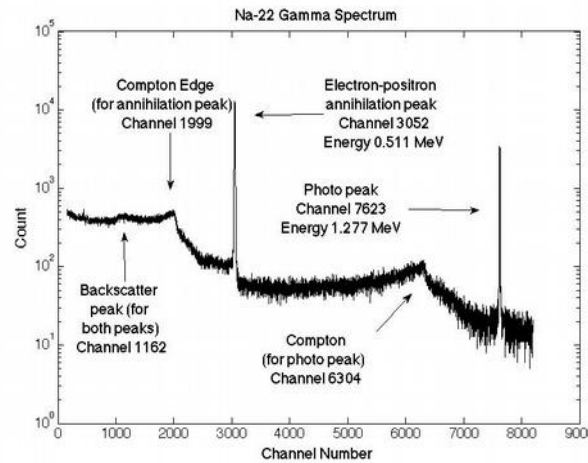
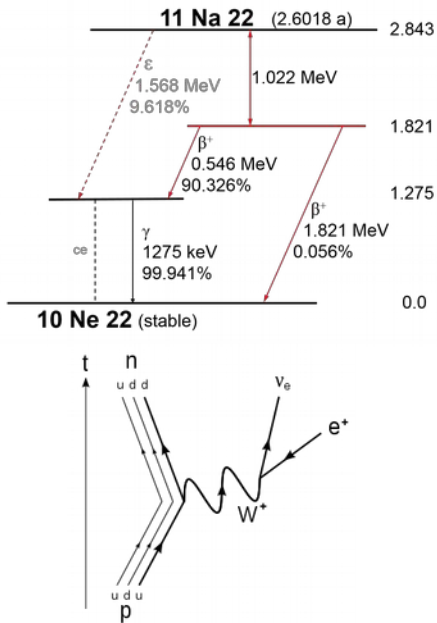
*Vladimir Berdnikov, Tanja Horn*

**The light yield measurement test stand  
for characterization of the calorimetry scintillator materials**

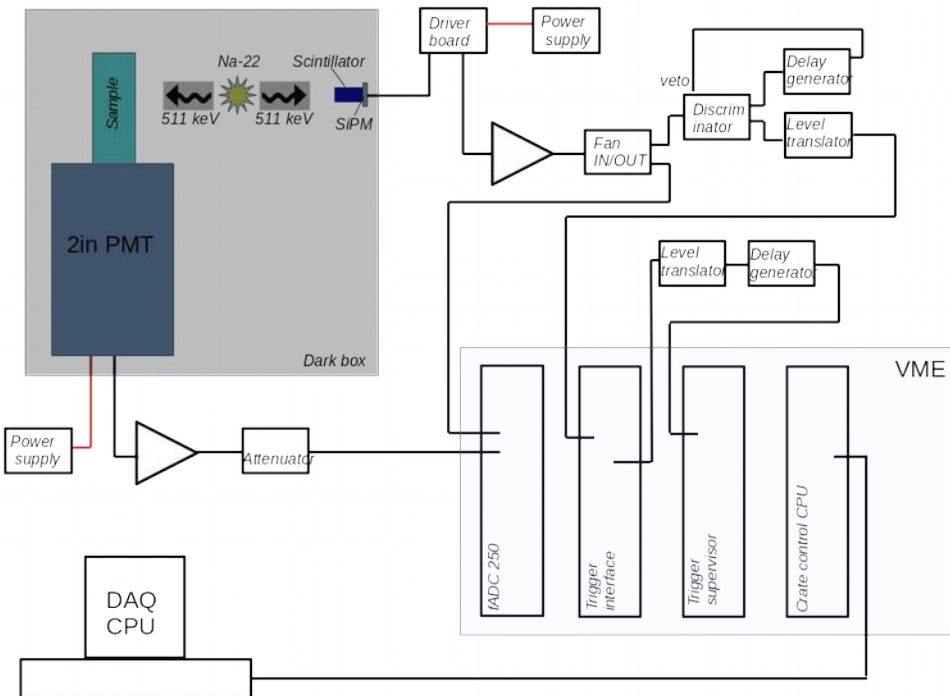
# Motivation

- The light yield (LY) scintillator characterization is the important part of general quality assurance and necessary for feedback during scintillator manufacturing
- A test beam is the best way to characterize scintillators but beam time, space for test setup, number of accesses and etc. in the experimental hall is limited
- The test stand with Na-22 X-ray source in the HallC NPS laboratory/cleanroom is straightforward method to measure LY for QA purposes
- The stand currently using for fast feedback to VSL/CUA/Scintilex during glass scintillator formulation optimization
- The similar test stand at CUA currently using for crystal characterization and QA of SICCAS and Crytur PWO crystals for HallC NPS project
  - \* *50 SICCAS crystals from 460 was questionable because of LY results, later on most of them was rejected*

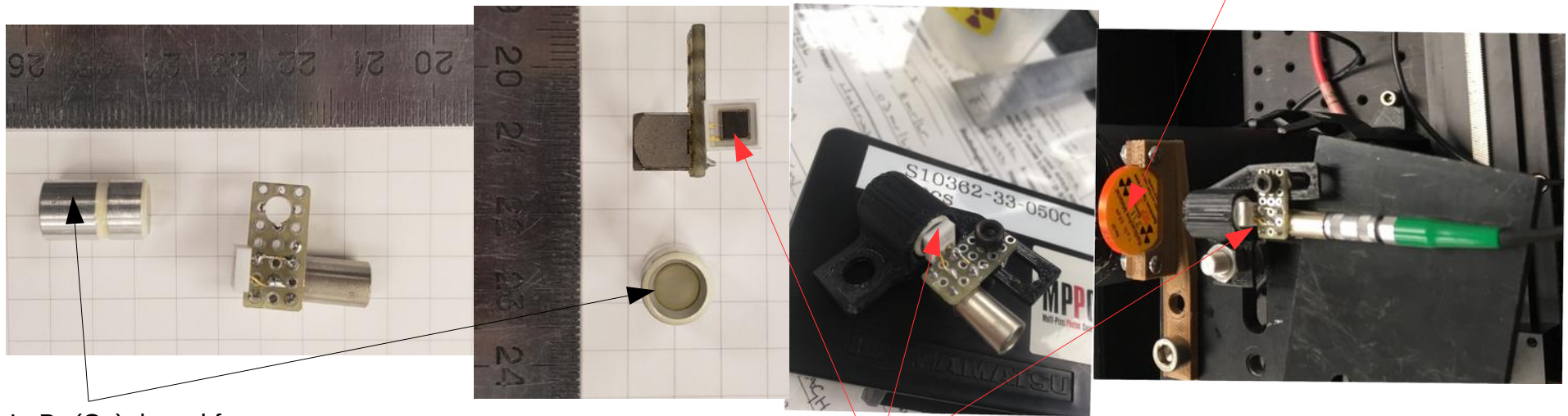
# The light yield measurement method and test stand



- Na-22  $\beta^+$  and gamma source
- Electron-positron annihilation produce back to back 511keV photons
- Triggering from one 511keV photon with better well known detector to study interaction of second photon with scintillator sample
- Method allowed to clean the signal of interest by reducing noise presented in self trigger read-out mode



# Trigger

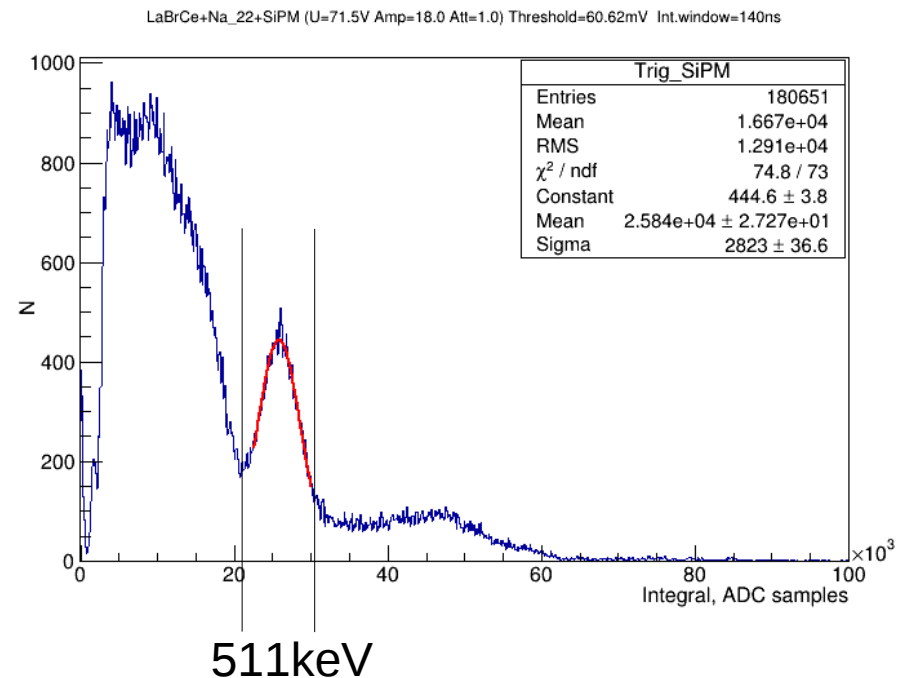


LaBr<sub>3</sub>(Ce)+barrel frame  
 Diameter 8mm  
 Length 12mm

SiPM 3x3 Hamamatsu  
 MPPC S10362-33-050C

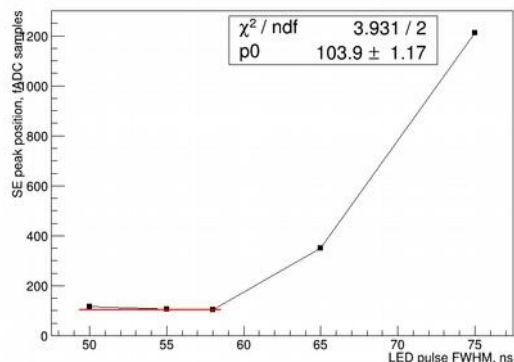
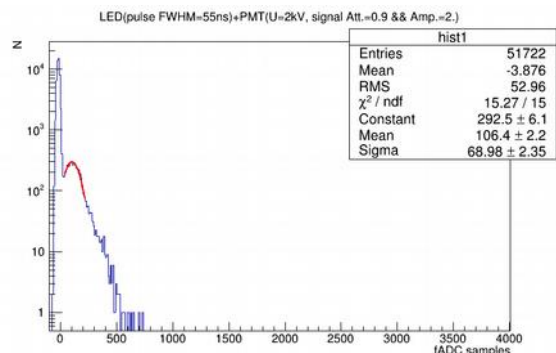
Na-22 source

- Trigger detector is combination LaBr<sub>3</sub>(Ce) scintillator + Hamamatsu SiPM 3x3mm<sup>2</sup> photodetector
- SiPM driver board is modified DIRC version with SiPM mounted outside of the box. Made by F. Barbosa and C. Stanislav
- Detector mounting frame by B. Bunton
- Good energy resolution ~11% for 511keV photons
- Compact photodetector have high sensitivity in energy range of interest (5-700) keV

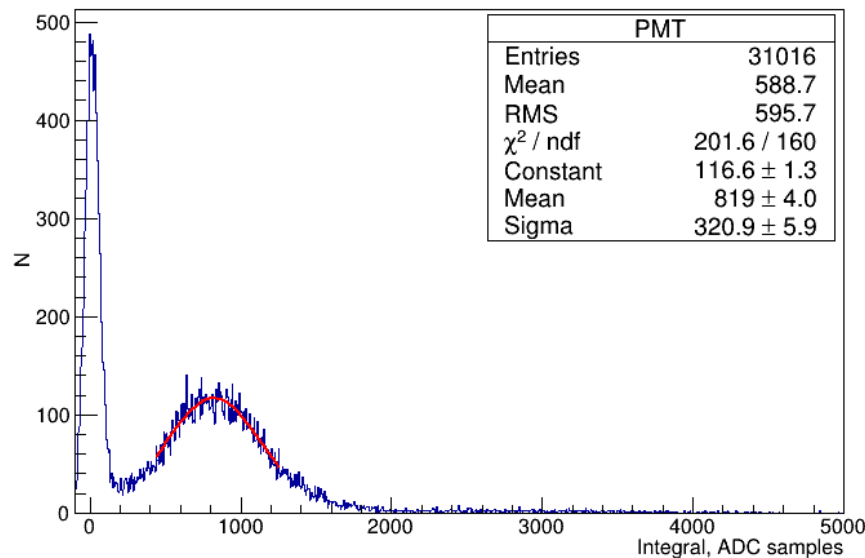
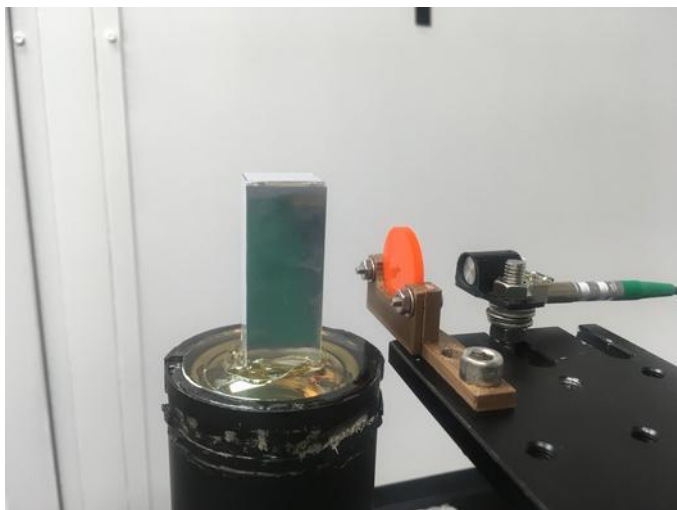


# BTCP PWO sample measurements

- ADC scale calibration in single photoelectron mode with LED
  - \* 1 PE= 103.9 ADC samples
- LY measurements with high quality PWO sample BTCP 2x2x5cm<sup>3</sup> wrapped with ESR reflector
  - \* 511keV photon produce 7.95 PE in PWO sample energy resolution ( $\sigma/\text{mean}$ ) = 39.2%
  - \* PWO LY of ~16 PE/MeV is in a good agreement with cross calibrated measurements in CUA/IPN-Orsay/Gissen
    - Note: cannot directly compare absolute numbers as setups are different (e.g., PMT QE, reflectors)
- The absolute numbers provided to Crytur and SICCAS are based on those measured with the cross-calibrated setups at CUA/Giessen/CRYTUR
- To make absolute NPE QA measurements of SICCAS crystals at JLab cross-calibration against CUA needed



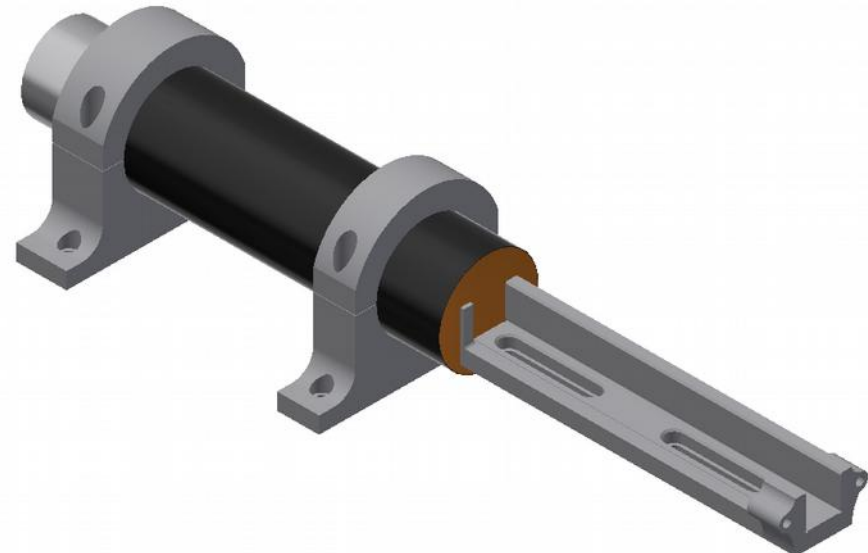
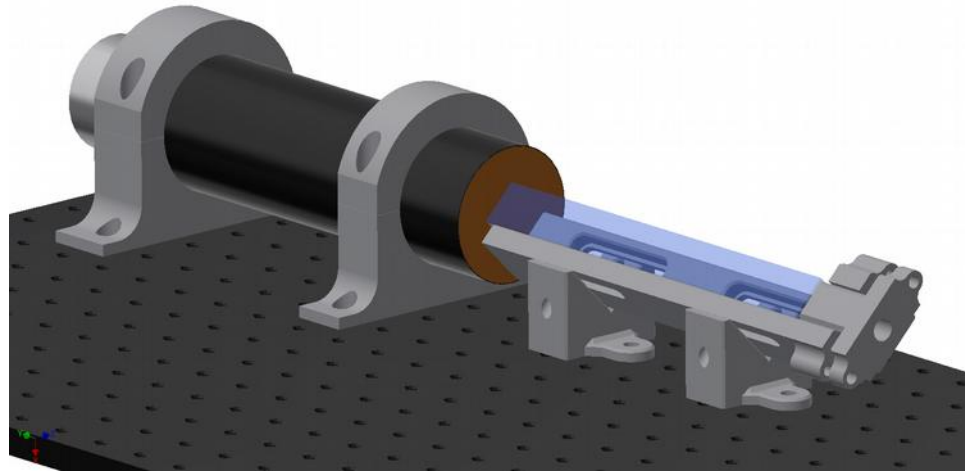
PWO\_BTCP\_2x2x5+Na\_22+PMT (U=2000V Amp=2.0 Att=0.8)Int.window=200ns





# Optimization and improvements

- New 2in PMT with better characteristics purchased by CUA
- SiPM 6x6mm<sup>2</sup> for trigger part and 2x2 matrix for sample readout design work is ongoing in collaboration with F. Barbosa and C. Stanislav
- Optical-mechanical support designing and 3D printing is ongoing in collaboration with J.P. Crafts and B. Bunton
- Linear stage stand designed by N. Sandoval. Relatively cheap/simple setup that would allow for standalone operation ~\$500. It is rated for 0.1mm steps, but safe assumption of +/- .2mm would be best



# Summary

- The light yield measurements stand facility is established at HallC NPS cleanroom
- The method allowed to measure sample light output with good precision
- The results with BTCP PWO in good agreement with other facilities
- The stand allowed to test different type of photodetectors for EIC calorimetry
- Optimization for glass-ceramic characterization and PWO mass measurements is ongoing
- Analysis code exist and works
- The NPS test stand and the one at CUA could help with the FCAL PWO crystal characterization and will increase speed of PWO crystals characterization arriving and already delivered to Jlab