

# BigBite Timing Hodoscope Update

John R.M. Annand  
School of Physics and Astronomy



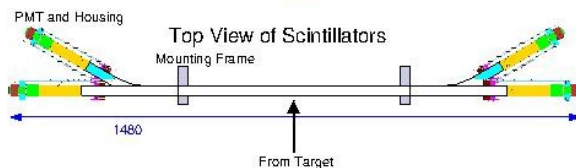
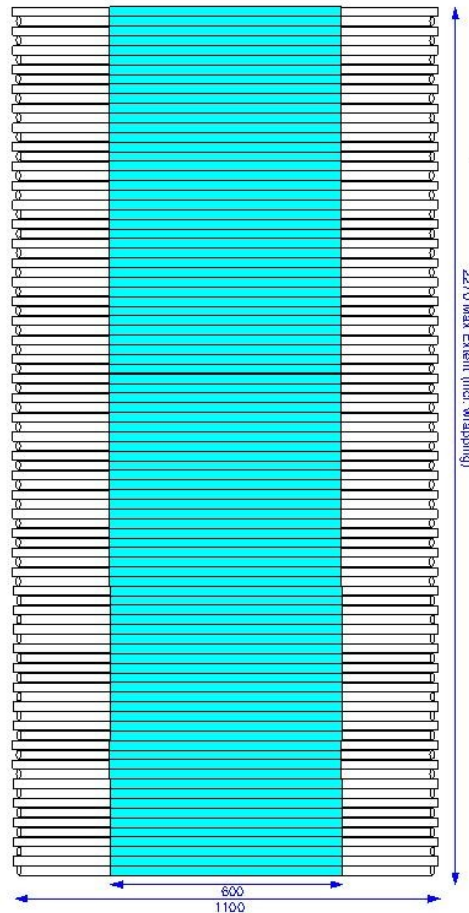
University  
of Glasgow

# BB Timing Hodoscope

## BigBite Timing Hodoscope

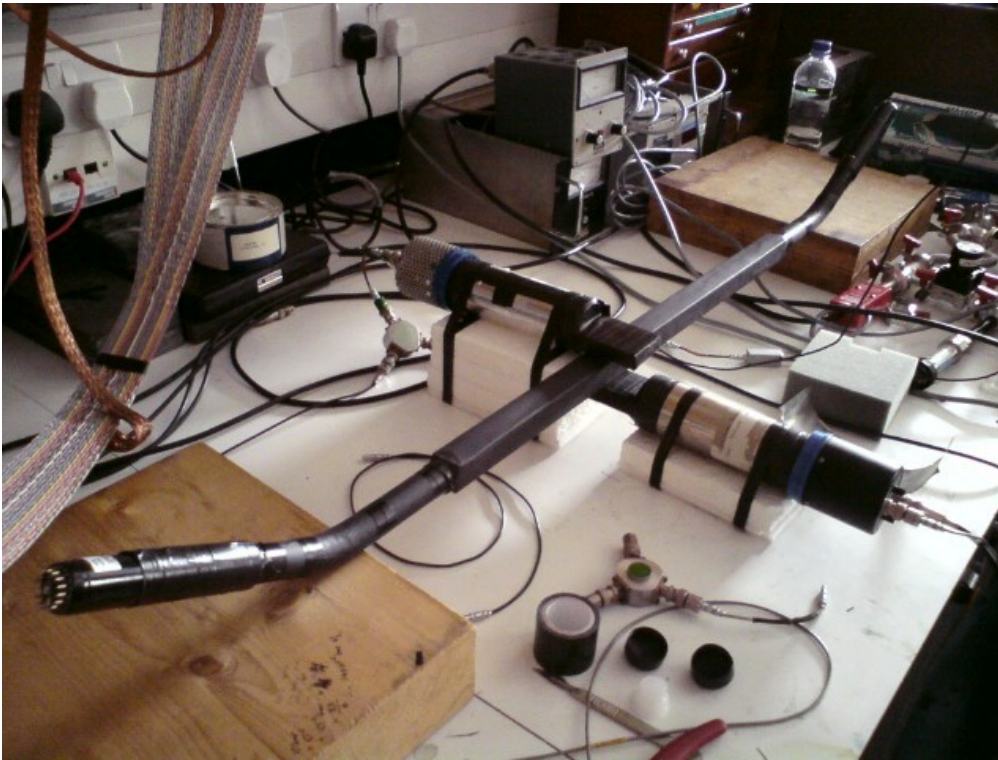
90 off 600 x 25 x 25 Plastic Scintillator  
 J.R.M. Annand 16th August 2012  
 Dimensions in mm

Front View of Scintillators



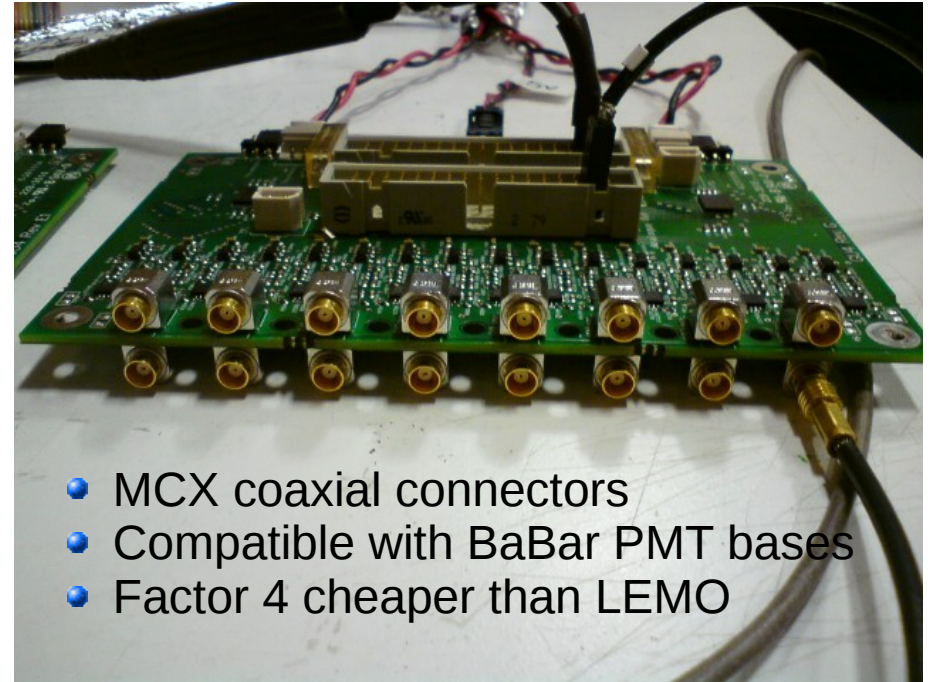
- 90 Bars EJ200 Scintillator  
600 x 25 x 25 mm
- Readout at each end  
via light guide
- Alternate straight and bent lightguide  
to fit PMT and housing
- ET9142 PMT + custom base
- NINO front-end amplifier/discriminator
- Frame ?

## Testing with ET 9142 PMT



- Cosmic-ray tests of a sample scintillator bar
- Various PMT types tested: ET9142 eventually chosen
- Procured 200 ET 9142 SB variant with integrated mu-metal shield
- Testing voltage dividers...from ET and also custom built

# Version G NINO Card

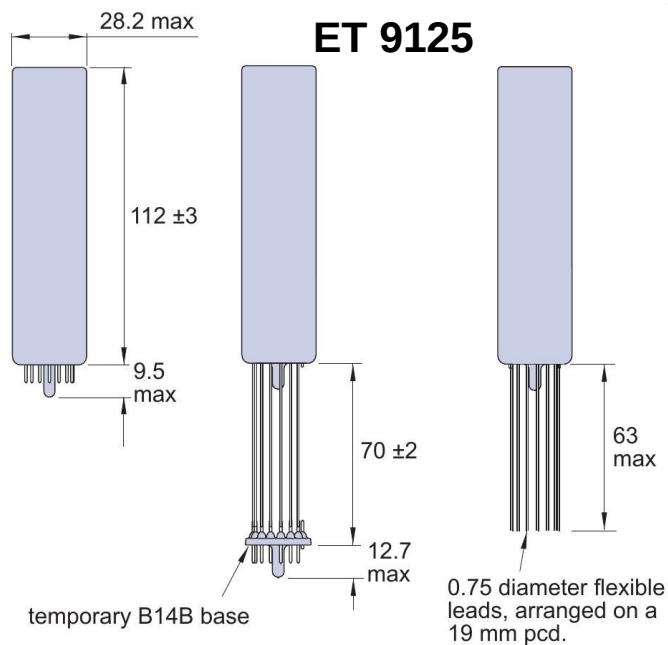


- MCX coaxial connectors
- Compatible with BaBar PMT bases
- Factor 4 cheaper than LEMO

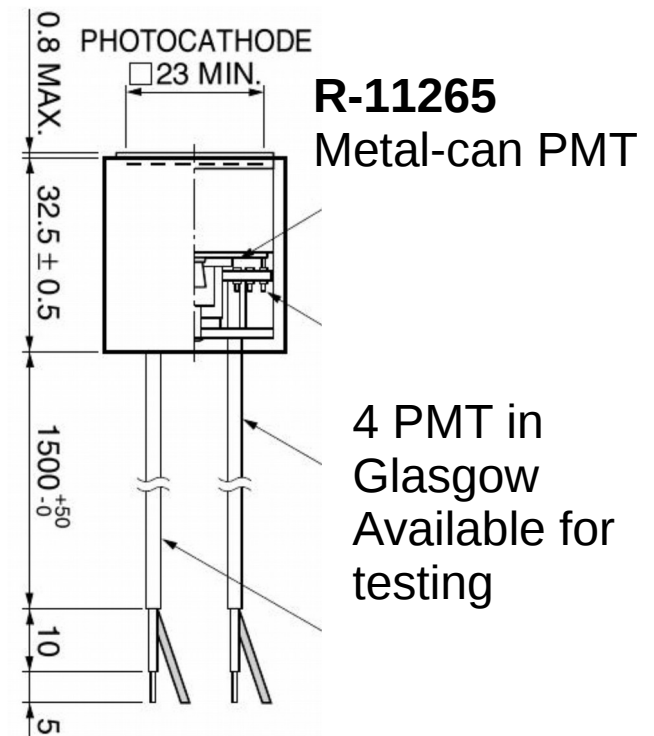
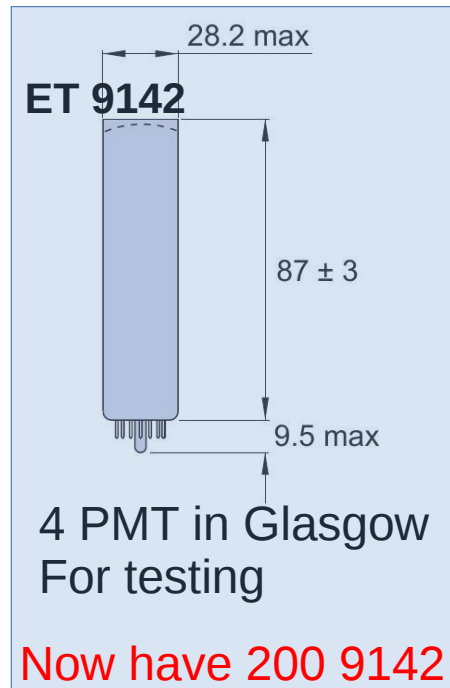
- Version G intended for GRINCH and BB Timing Hodoscope
- 50 cards (800 channels) produced at Zott electronics
- Cards for GRINCH shipped to W&M
- BB hodoscope cards in Glasgow...one or two require small problems to be fixed
- 800 1.5 m MCX coaxial cables produced for GRINCH and Hodoscope  
Much cheaper than Lemo connectors (but less robust)

# PMTs Tested on a Hodoscope bar

PMT Type	Rise Time (ns)	Transit Time (ns)	TT Jitter (ns)	QE @ 400 nm	Maximum Gain	PH Res (Cs137)	B-Field (Gauss)
ET 9125	4.5	33	4.0	28%	$2.0 \times 10^7$	7.5	2.0
ET 9142	1.5	19	1.5	28%	$1.0 \times 10^7$		2.4
H-11265	1.3	5.8	0.27	35/43%	$1.3 \times 10^6$	3.1	75

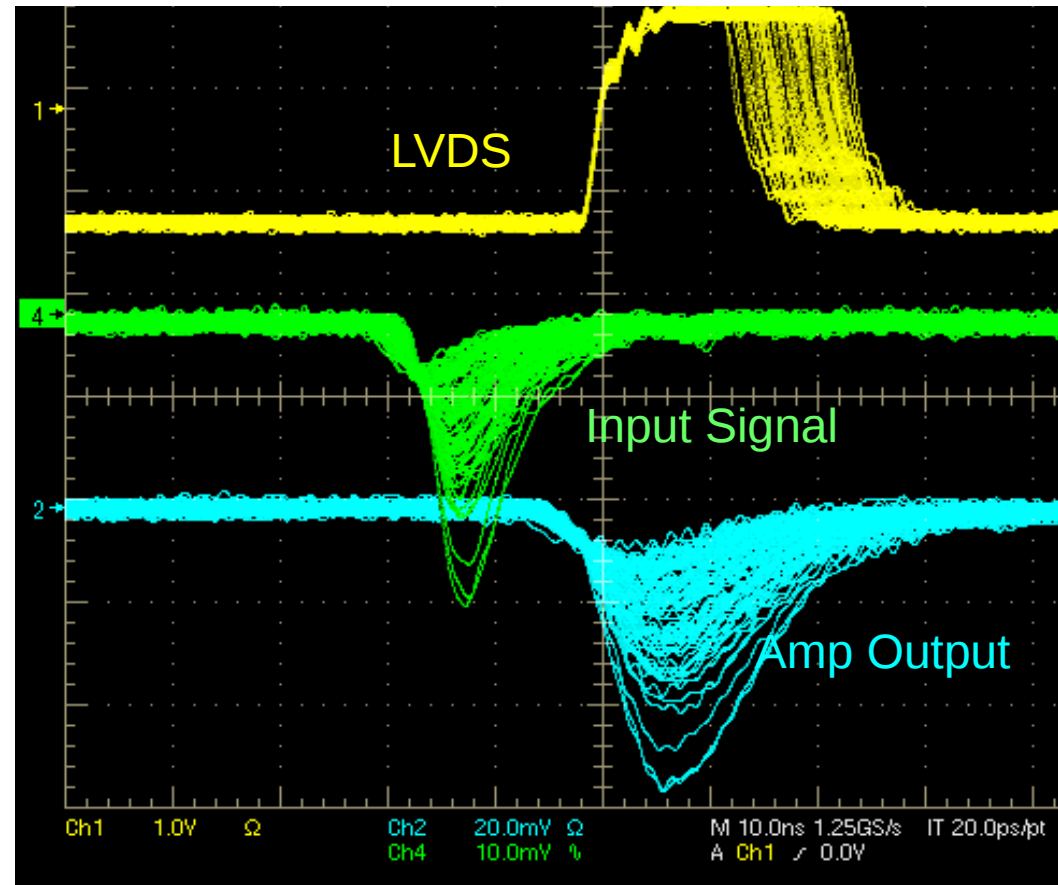
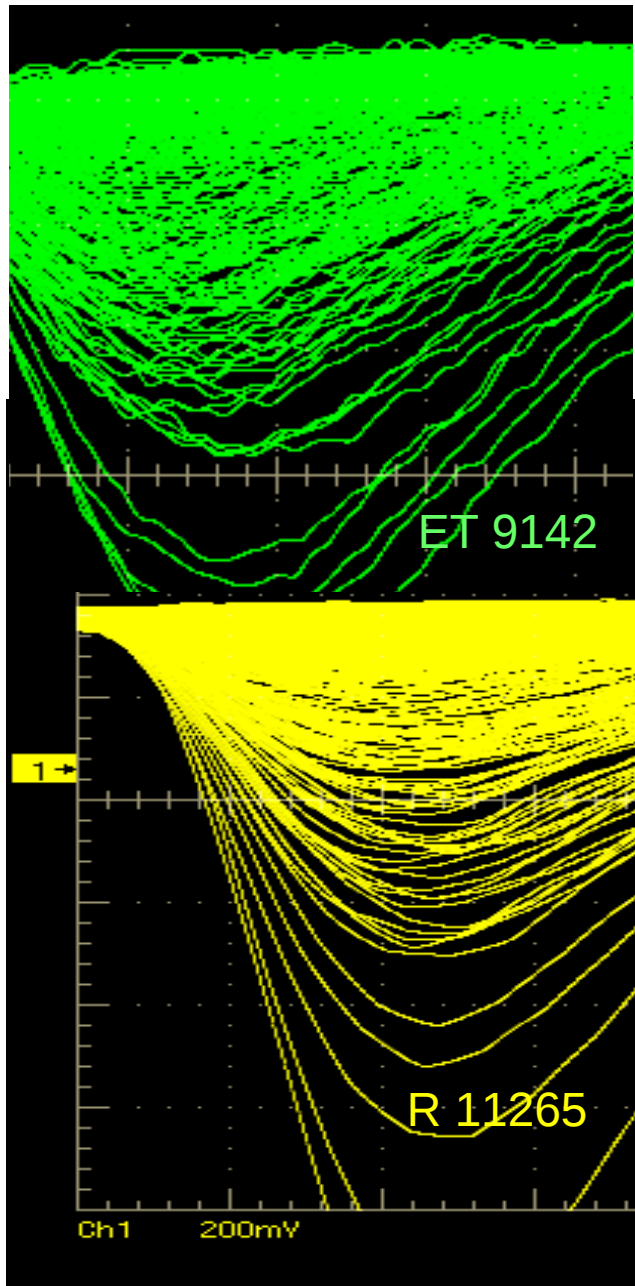


JLab have several thousand ET 9125 from BaBar DIRC



# ET 9142 Pulse Forms

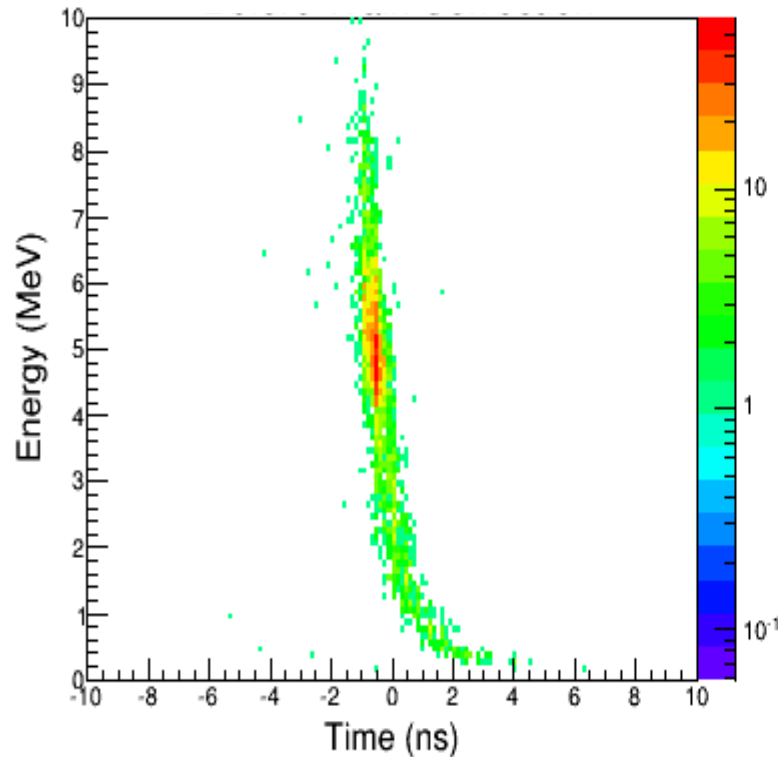
ET 9142 & NINO



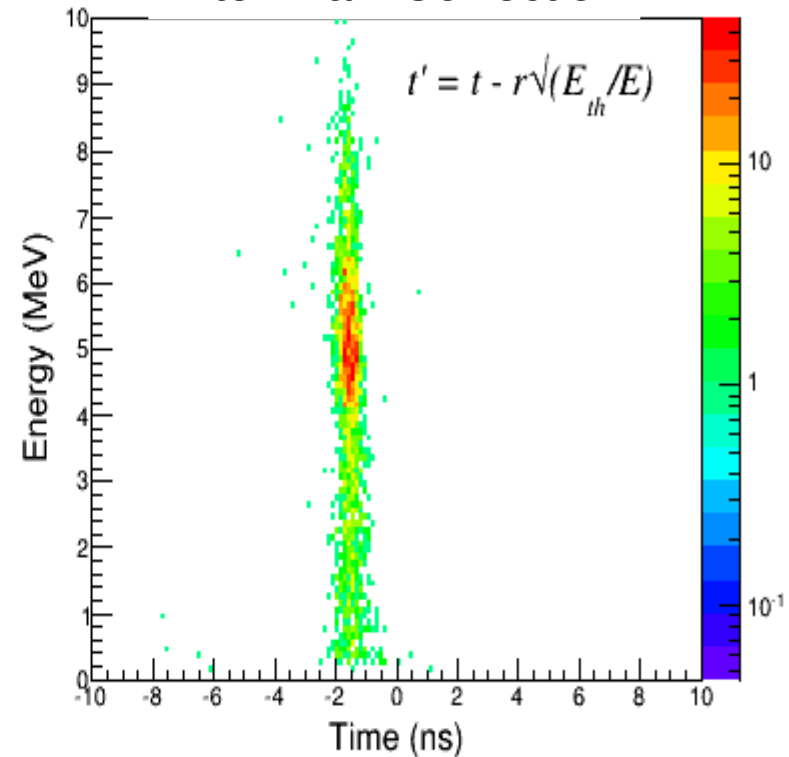
- Pulse rise time  $\sim 2$  ns both ET-9142 & R-11265
- R-11265 has higher quantum efficiency and better immunity to magnetic fields
- ET-9125 (BaBar) rise time 4 – 5 ns
- ET-9142 factor 4.5 cheaper than R1165

# Time-Walk Correction with NINO

Before Walk Correction

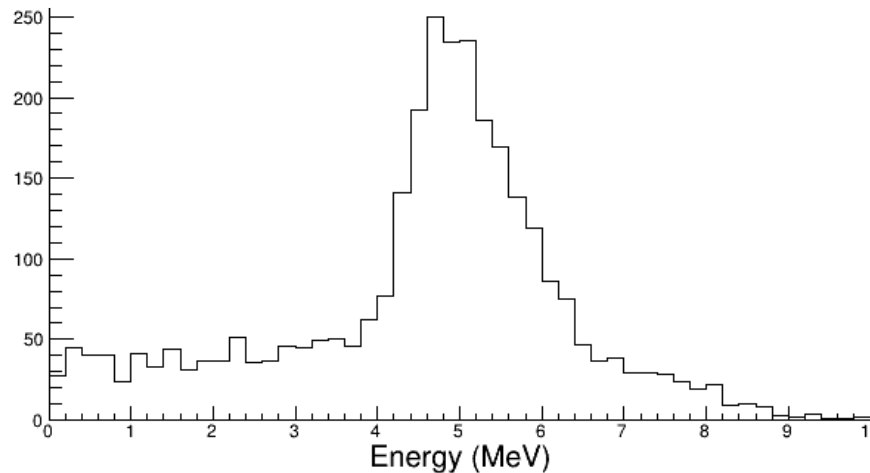


After Walk Correction



Muon Pulse Height Spectrum Single Hodoscope PMT

Test made with  
R-11625 PMT



Time over threshold  
can also be used for  
walk correction

# Hodoscope/NINO Time Resolution

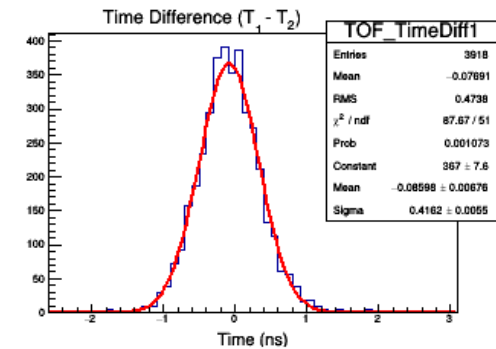
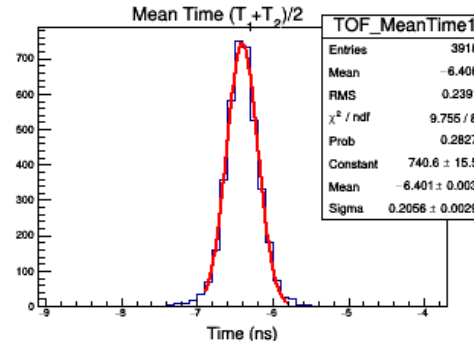
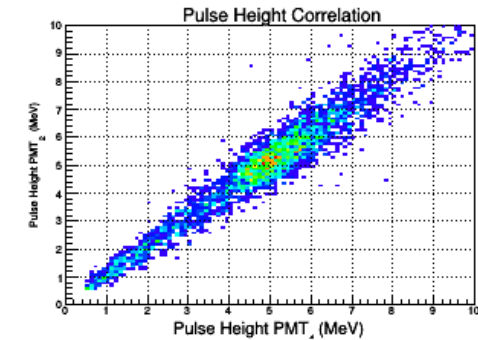
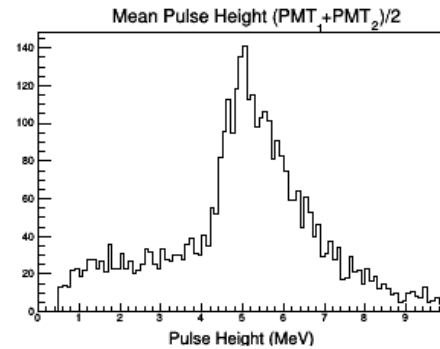
## Timing Resolution

R-11265 has the best timing resolution

ET9142 is slightly poorer (but much cheaper)

ET9125 (BaBar) has significantly poorer timing resolution

ET9142 offers acceptable performance and affordability



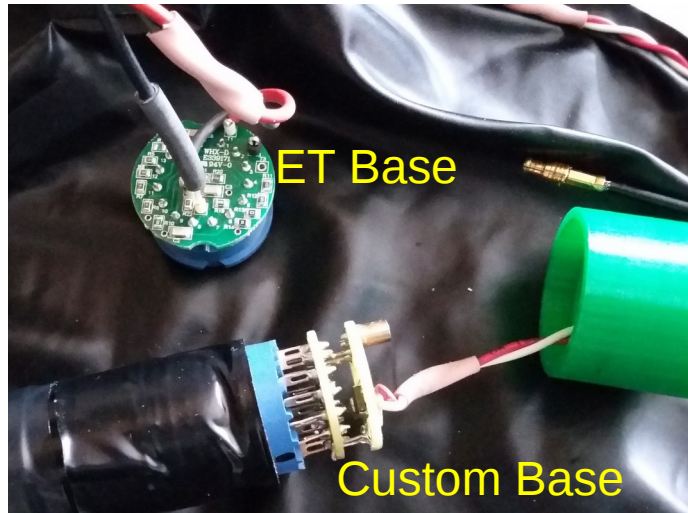
## Cosmic Ray Tests with ET 9142

Time Histogram	ET-9125	R11265	ET-9142
PMT-1	0.5	0.20	0.30
PMT-2	0.6	0.21	0.30
Mean	0.44	0.14	0.21
Difference	0.80	0.28	0.42

Time Resolution  $\sim 0.21/\sqrt{2} = 0.15$  ns



# ET 9142 PMT Bases

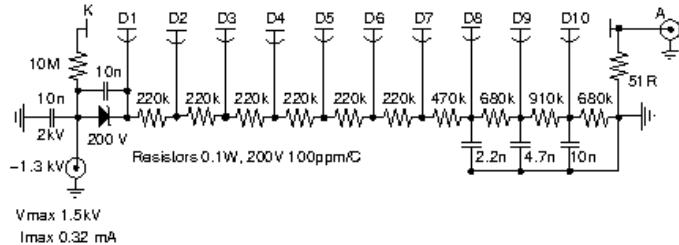


Custom base will have MCX anode connector and BaBar-pattern HV connector

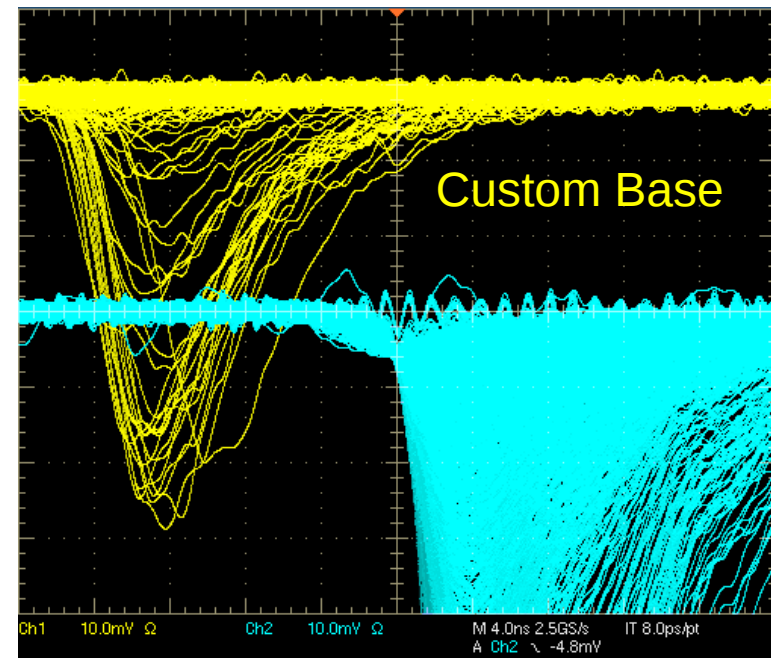
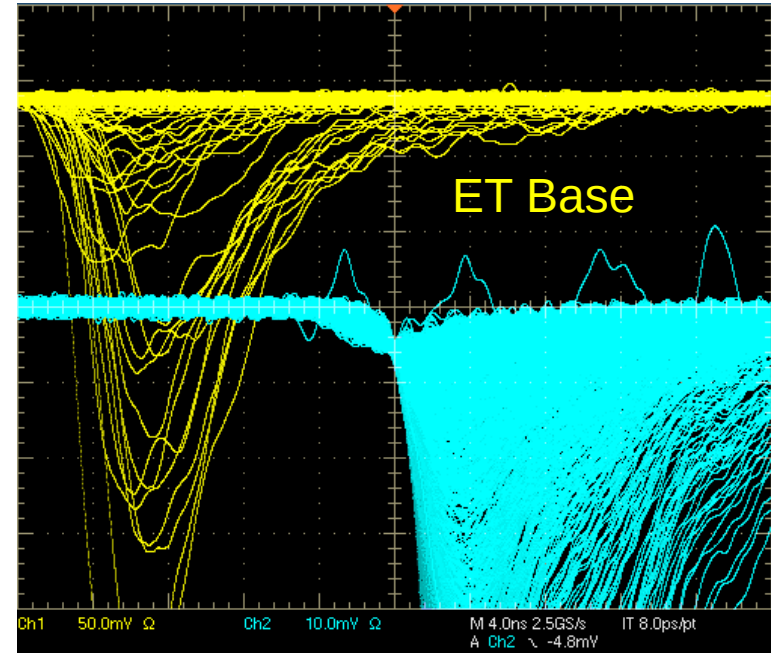
Voltage divider for ET9142SB 28mm PMT, Hall-A JLab.

*J.R.M. Annand 28th May 2014.*

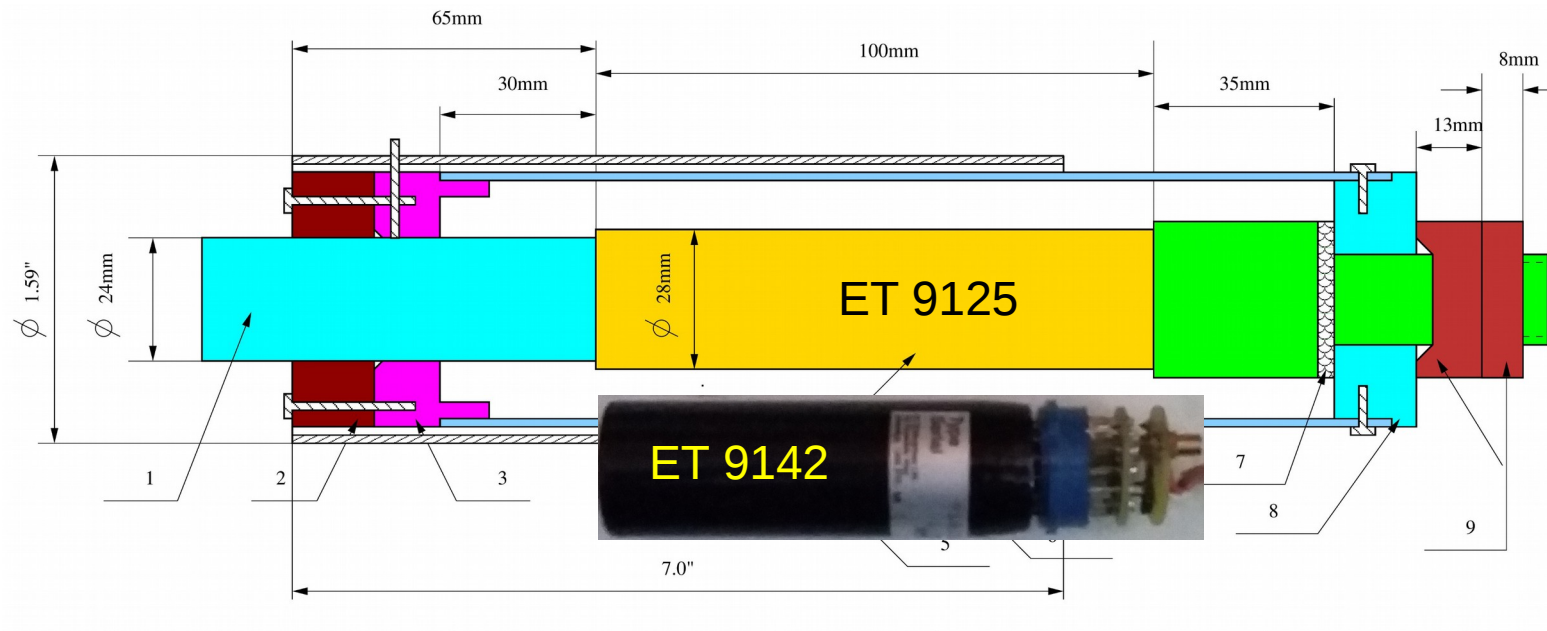
*J.R.M. Annand 8th March 2016*



Custom base has lower gain  
 (NINO discriminator has high sensitivity)  
 Should have better linearity over extended dynamic range  
 Faster signal return to base line  
 Cost about the same as ET version  
 Out sourced production 200 custom bases



# PMT Housing



Original drawing: A. Shahinyan  
for ET 9125 BaBar PMT

ET 9142 has same diameter but shorter

Status/location of previously manufactured housing not known  
If the parts are at JLab (and can be found) then modification  
will be necessary

Need to know soon if effort at Glasgow mechanical shop required

# BB Timing Hodoscope Outlook

- Scintillator and light guides glued.  
Await go from JLab to ship...need space & need to arrange technician time  
50  $\mu\text{m}$  tedlar (PVF) sheet sourced...will wrap detectors in Glasgow
- Cosmic ray tests have been performed with ET-9125 (BaBar), Hamamatsu R-11265 and ET-9142 PMTs
- 100 ps time resolution is obtained using the R-11265,  
150 ps for the ET 9142.  
320 ps for the ET9125.
- The R-11265 is too expensive to afford 200 off.
- Taken delivery of 200 ET9142 PMT.
- Production of 200 custom bases under way.  
PMT housing will require modification (or new pieces machined)

# What is happening with BigBite??

- BigBite was originally scheduled to run in the  $^3\text{H}/^3\text{He}$  experiments Autumn 2016 (now Spring 2017). Configuration similar to that for  $e'$  detection in 6-GeV experiments
- For safety and logistical reasons BigBite will not be used (close proximity to  $^3\text{H}$  target might inhibit maintenance)
- March 2016 The “original” BigBite detector was still under test in the Test Lab.
- Will any other pre-SBS experiment use BigBite?
- When can work on the new detector stack commence? New frame is required for the following:
  - GEM trackers
  - GRINCH particle ID
  - Timing Hodoscope
  - Pre-shower Pb-Glass particle ID
  - Shower Pb-Glass Trigger
- Shower and preshower counters reused from original detector