

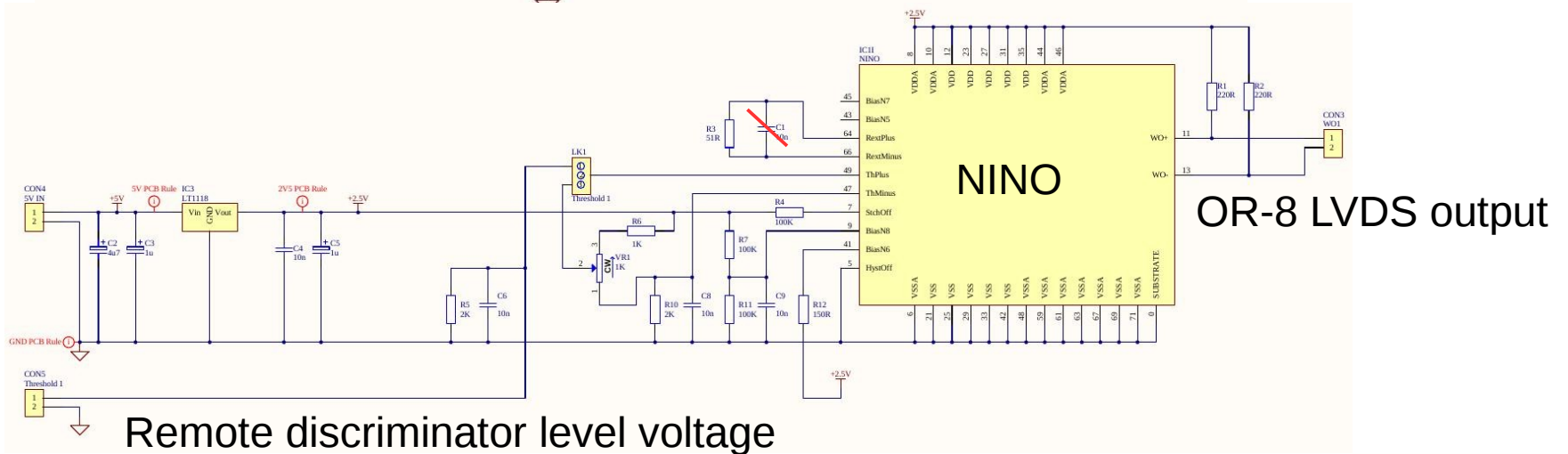
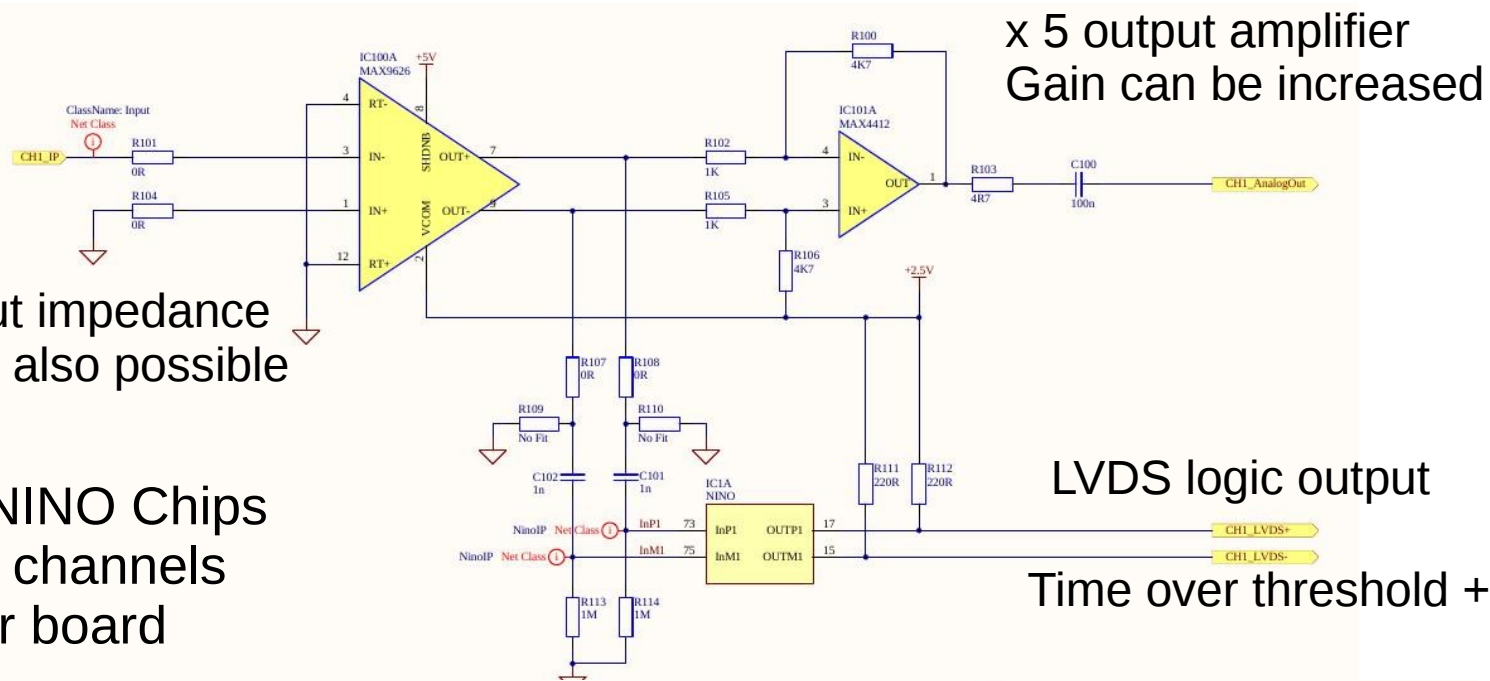
# Status of the NINO Cards and the BB Timing Hodoscope

*John R.M. Annand*  
*School of Physics and Astronomy*



University  
of Glasgow

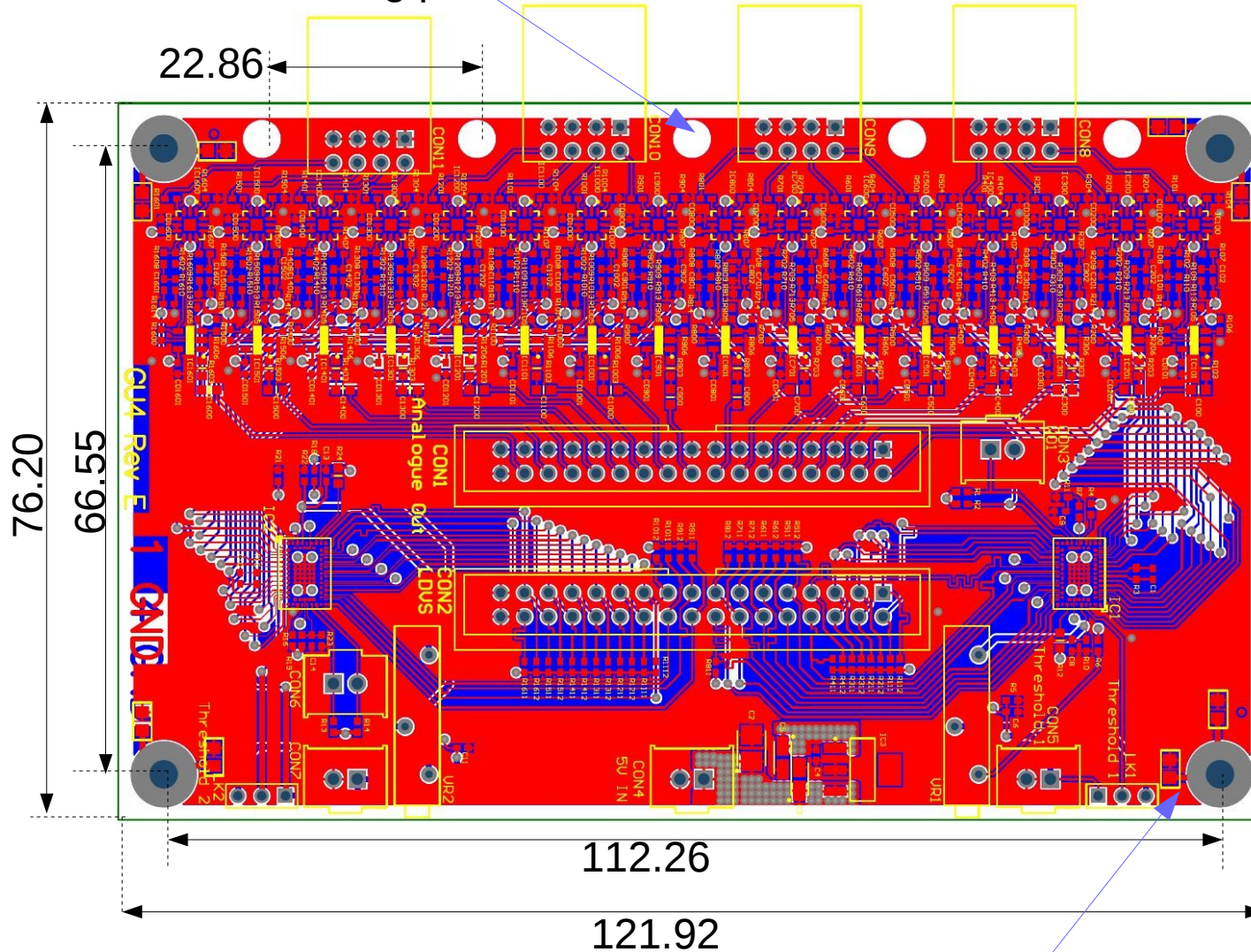
# NINO Discriminator



# NINO Discriminator (for GRINCH)

4 of 4-pair Input Connector

Strain-relief mounting points



50 cards ordered  
ZOT electronics

Input Cables  
Make new...  
based on RG174  
coaxial cable

Original BaBar  
cable very fine  
gauge: fragile and  
difficult to solder

Main mounting points optionally connect to ground



# NINO Board Layout

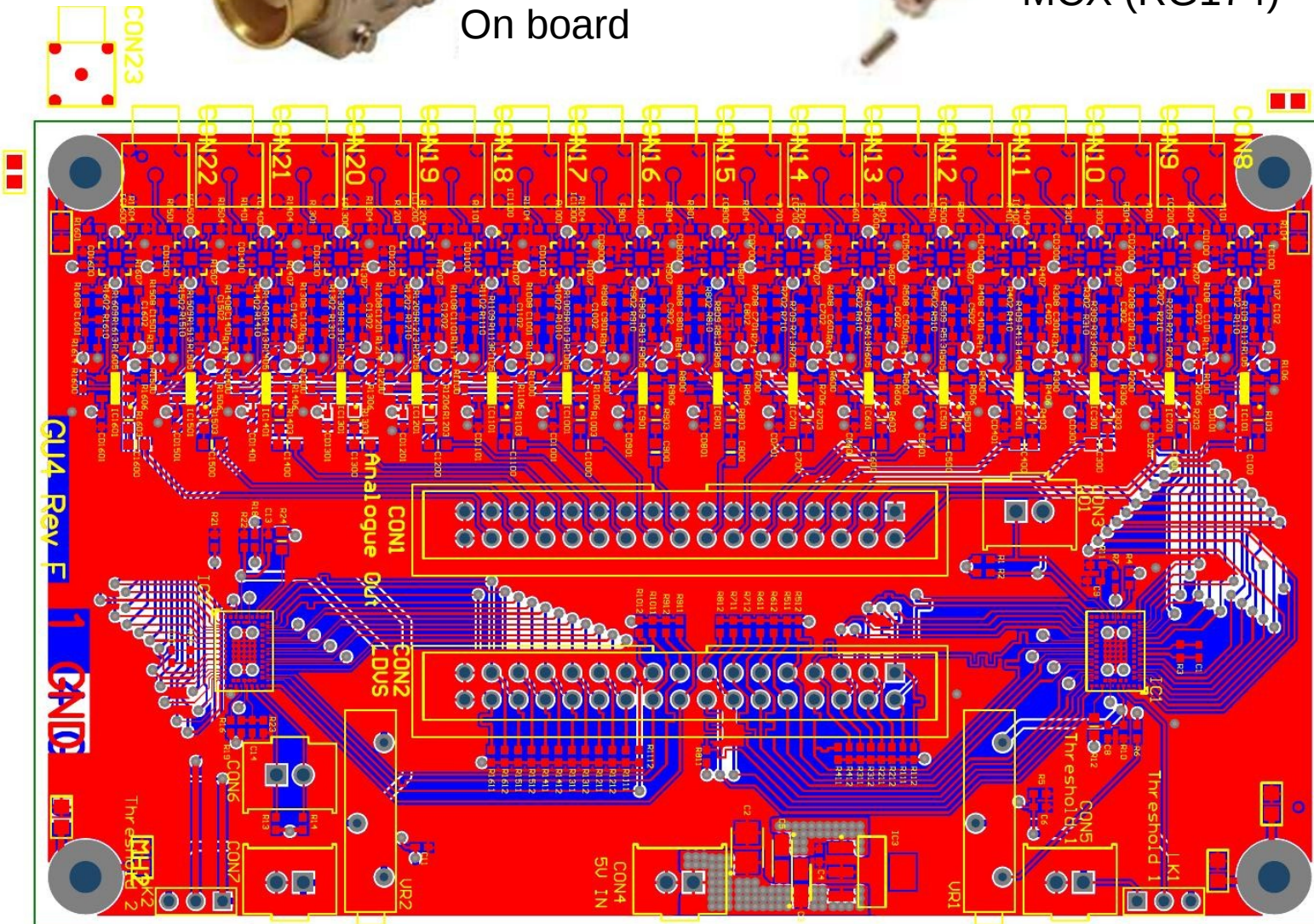
## Alternative Input Connector (not ordered)



MCX Jack  
Surface mount  
On board



Cable connector  
MCX (RG174)

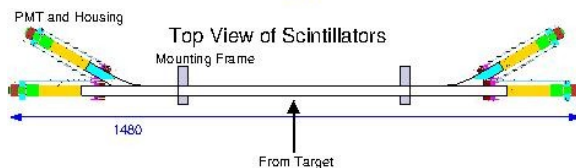
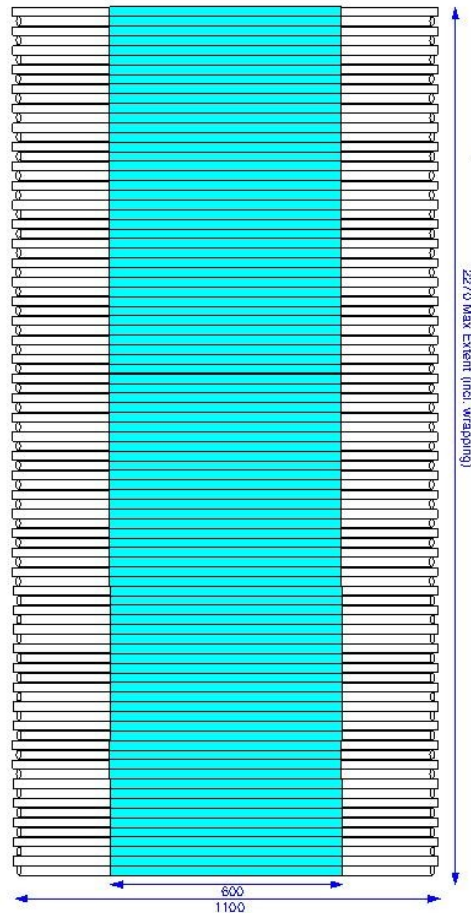


# BB Timing Hodoscope

## BigBite Timing Hodoscope

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

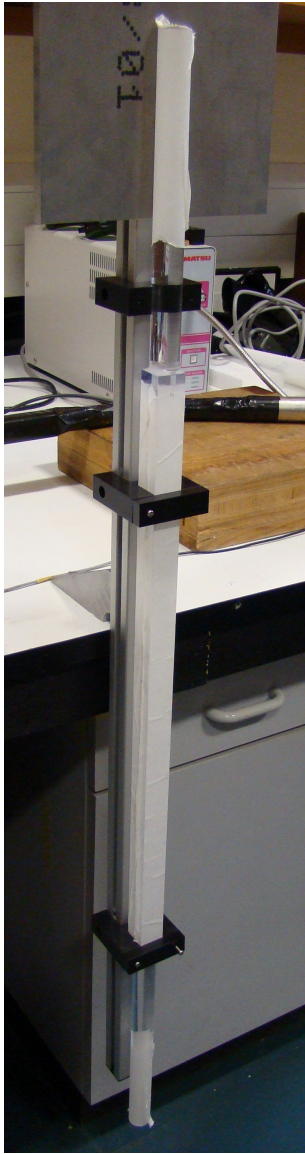
Front View of Scintillators



- 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
- ET9125 PMT from BaBar  
custom voltage divider
- NINO front-end card
- Frame...design at Jlab.



# Construction

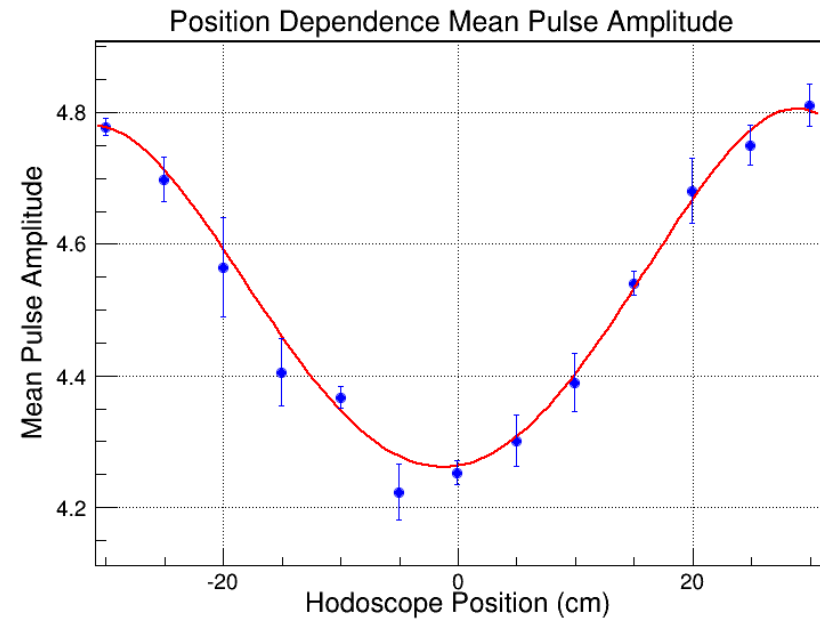
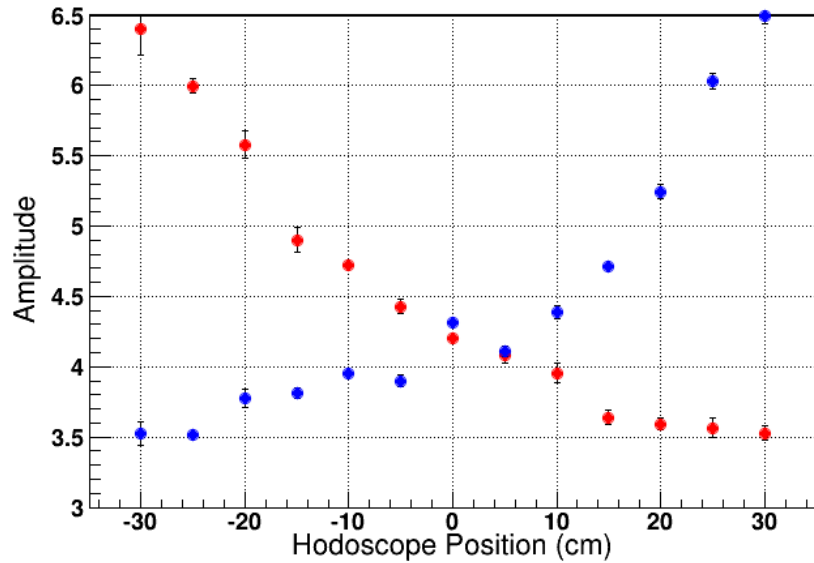


- Custom jig made to position light guide on scintillator for gluing
- Use UV curable cement...speeds up process.  
Test pieces show good mechanical strength.  
Optical properties of joint good.
- Scintillator wrapped in black paper  
Light propagation by total internal reflection  
Black paper avoids sharp rise in light collection near PMT  
Probably not a big issue with long light guides  
Black paper does not cling to scintillator surface
- Outer wrapping Tedlar sheet  
This is tough and opaque...can probably dispense with black paper



Light Guides

# Position Dependence Amplitude



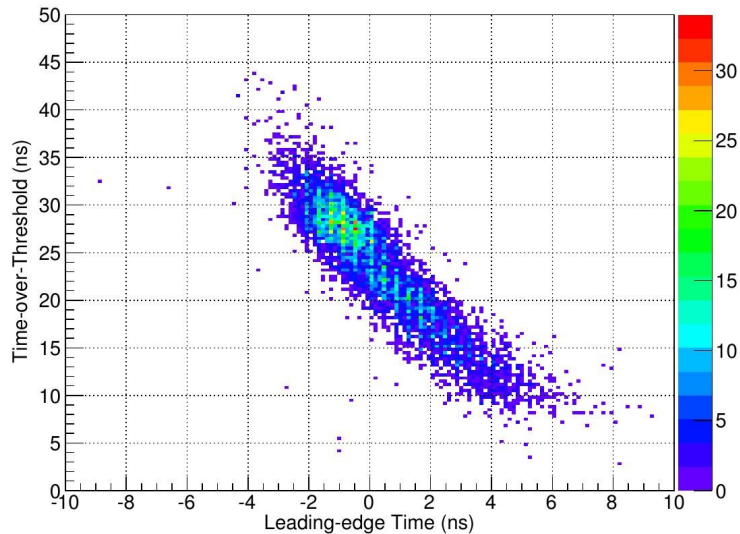
Data from Connor Cumming, M.Sci. final-year project, University of Glasgow

Factor  $\sim 1.9$  variation in single PMT amplitude along bar

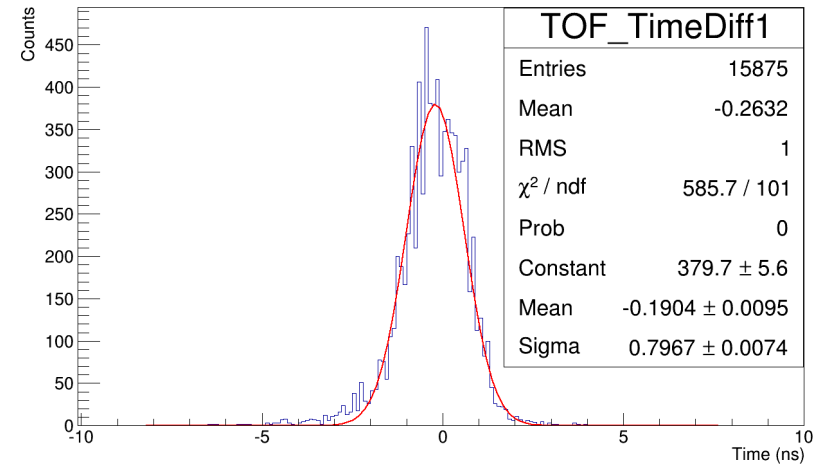
Factor  $\sim 0.11$  variation in mean amplitude along bar

# TDC Spectra

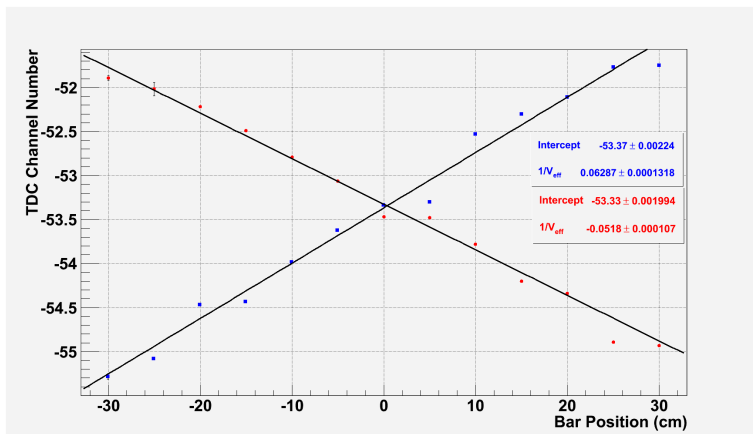
Times corrected for Walk  
NINO + Plastic-scintillator



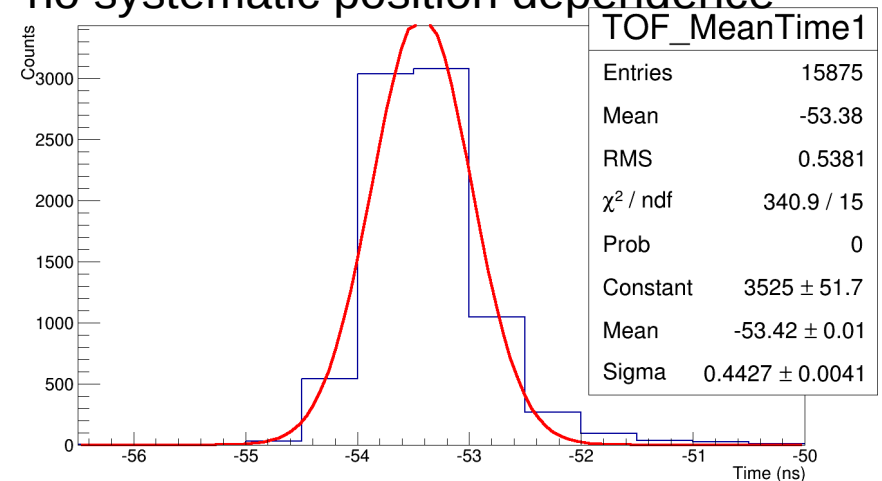
Position resolution along bar ~ 14 cm



Dependence single-PMT time on position is linear.  $5.7 \text{ ns/m} = 0.53 \text{ c}$



Time resolution ( $\sigma$ )  $\sim 0.44/\sqrt{2} = 0.31 \text{ ns}$   
no systematic position dependence

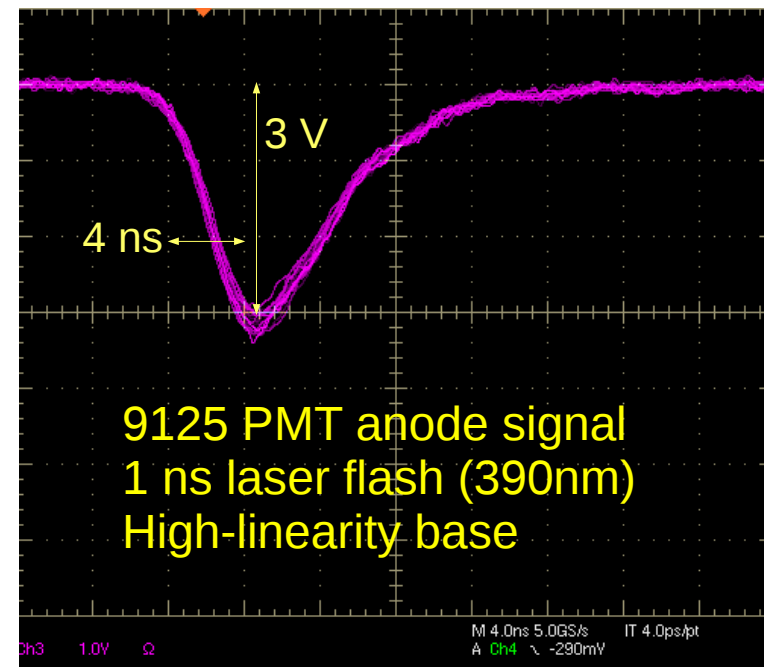
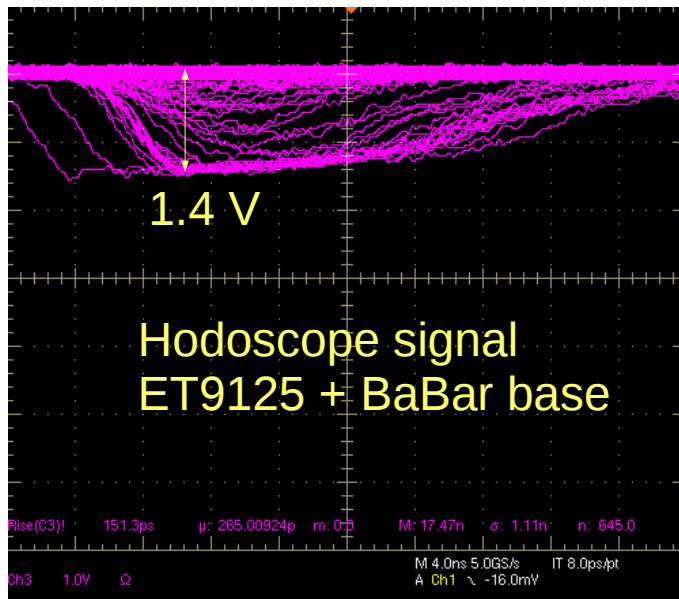




# ELT9125 PMT (from BaBar)

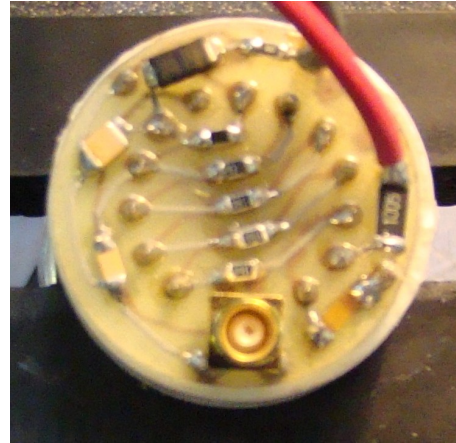


- BaBar base design for Cherenkov counter
- Should be good for BB-GRINCH
- Signal from scintillation light saturates
- Redesign for BB Hodoscope



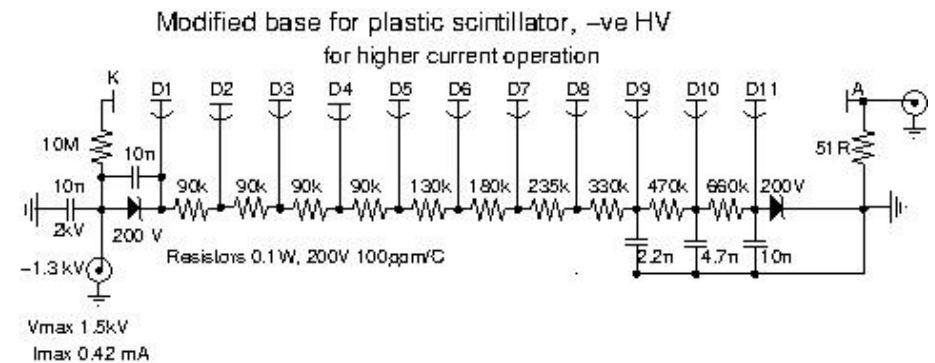
# ET9125 Base for Scintillation Counters

Prototype base Glasgow



Redesigned base fits inside BaBar  
Plastic housing

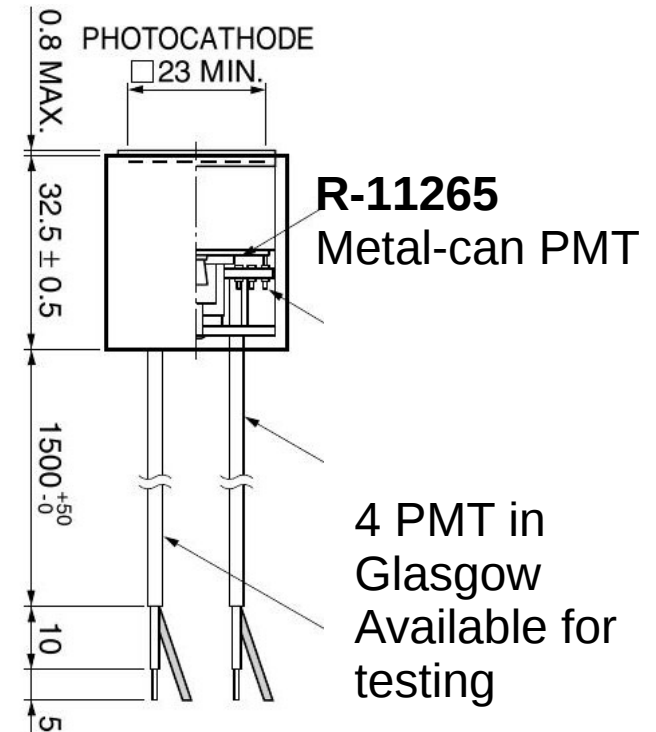
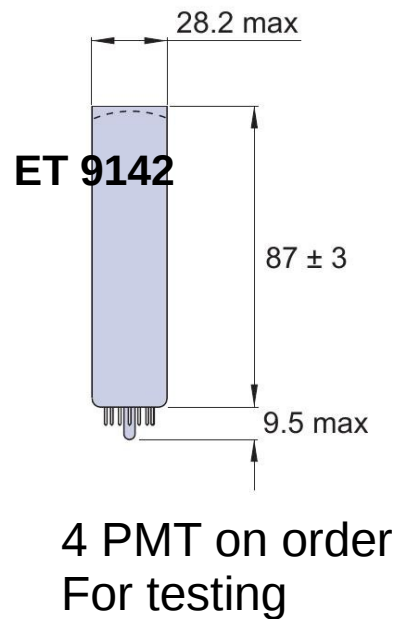
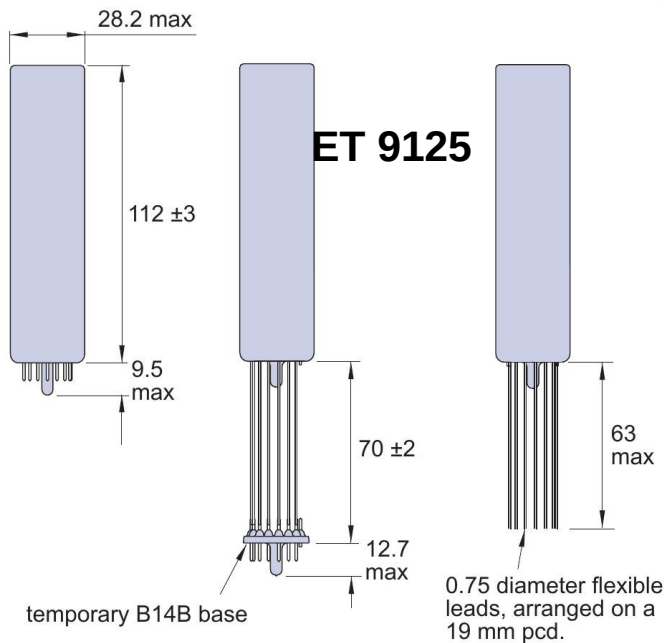
- ELT9125 has high gain
- Can afford to improve linearity at the expense of gain. NINO operates with small-amplitude input
- Zener maintains k-d1 200V
- “Progressive” voltage gradient distribution
- HV card production for hodoscope outsourced: better quality, through-plated holes
- Production cards will have HV connector.



# Time Resolution Limitation ET9125 PMT

## Testing alternative PMTs 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



How good does the hodoscope time resolution have to be ?  
CEBAF RF 500 MHz....lower frequency possible ?

# Outlook

- 50 NINO cards ordered from ZOT electronics...this more than covers GRINCH and the Timing Hodoscope
- Components to make new coaxial input cabling ordered
- Funding from W&M (\$15k) and Glasgow (~\$15k)
  
- Hodoscope bar: light guides glued to scintillator
- Cosmic Ray testing in progress, finalise best wrapping  
Check performance with small-amplitude signals
- PMT base circuit board production/assembly outsourced  
will re-use pins and chassis of BaBar base
- Requested UK funding for faster PMT + new bases  
+ additional NINO. Final outcome known ~August 2014



# Costs (incl. 20% UK Purchase Tax)

Converted to US\$, £1.00 = \$1.60

Item	Cost (\$)	Procured by	Comment
Hodoscope bars	16730	Glasgow	Already procured
Light Guides	9312	Glasgow	Already procured
New 9142 PMT	91392	Glasgow	Requested STFC
New 9142 Bases	16439 (est)	Glasgow	Requested STFC
PMT Housing	?	CSU	
Mu Metal Shields	5760	Glasgow	Requested STFC
Wrapping etc.	1000	Glasgow	Already procured
Frame	6720 (est)	??	??
NINO Development	1850	Glasgow	Already covered
NINO card production (15)	9900	Glasgow	Requested STFC

Proposal "Jlab Upgrade" submitted to UK STFC PPRP 25 Feb 2014.