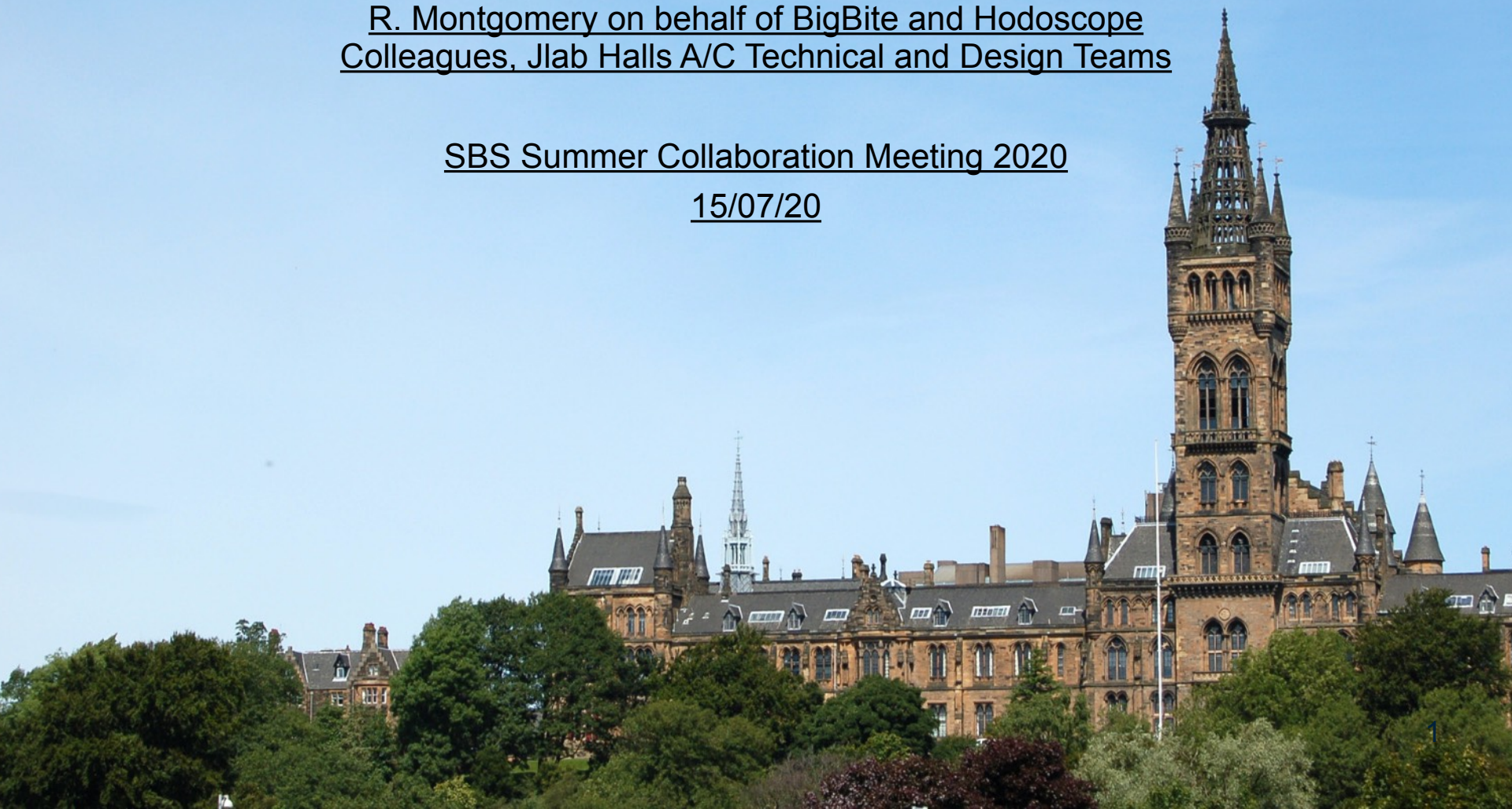
BigBite Timing Hodoscope Update

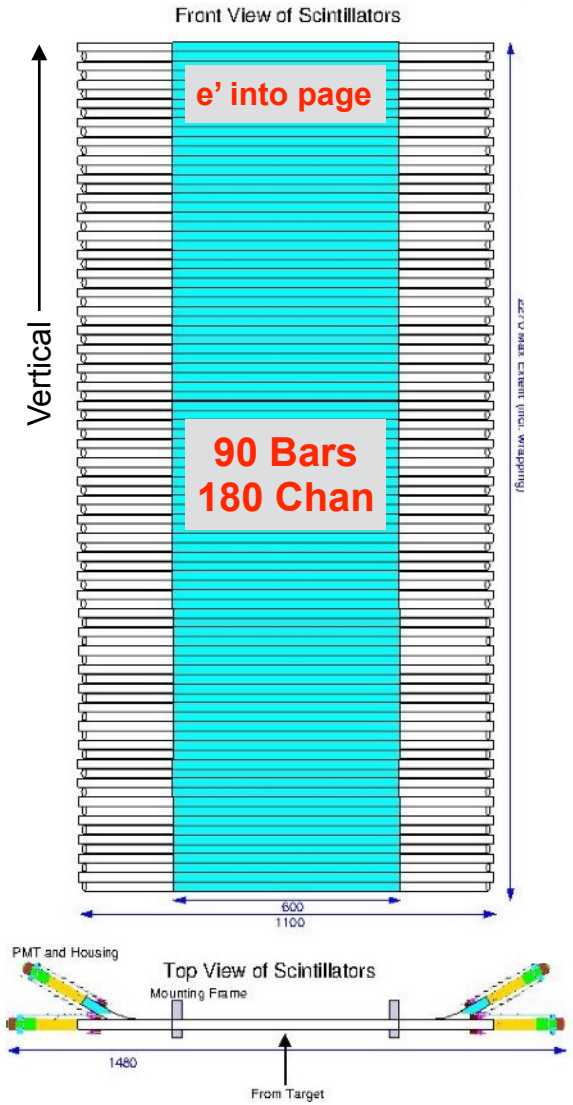
R. Montgomery on behalf of BigBite and Hodoscope Colleagues, Jlab Halls A/C Technical and Design Teams

SBS Summer Collaboration Meeting 2020

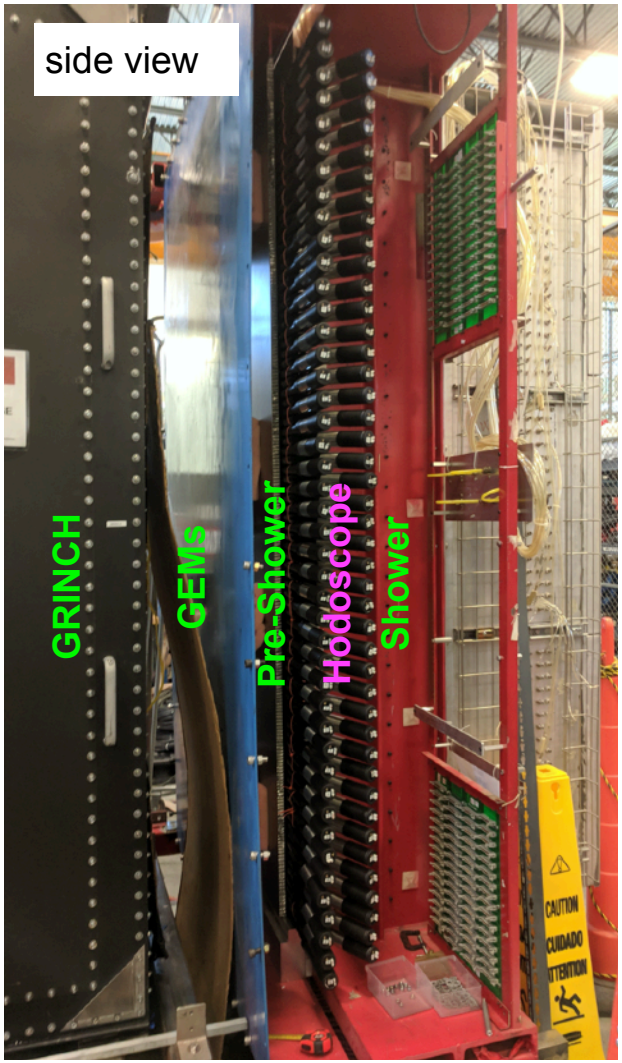
15/07/20



Detector Overview



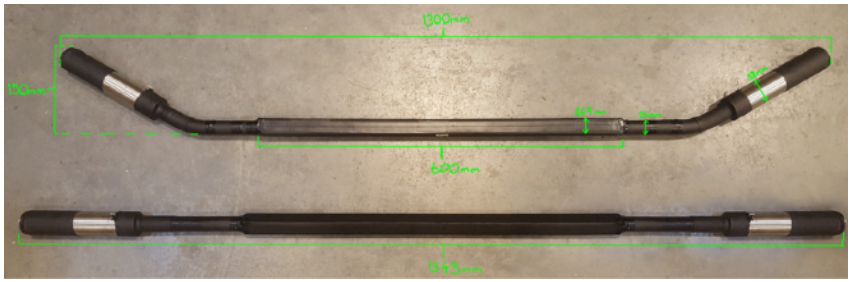
Dual ended readout/bar



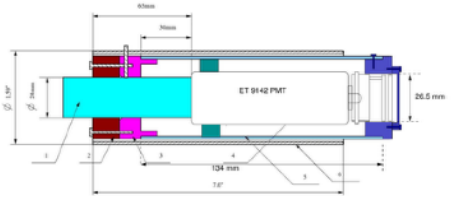
- Subsystem of BigBite
- Positioned between pre-shower/shower
- 90 vertically stacked scintillator bars
- Alternating straight/curved light guides
- Each bar readout at both ends by single channel PMTs
- Time difference → hit position

- High precision timing info for 2-arm (e,e'N) measurements
- (coarse pulse height info from TDC time over threshold (TOT), high efficiency for MIP over BB mom range, hit position info may assist high occupancy tracking)

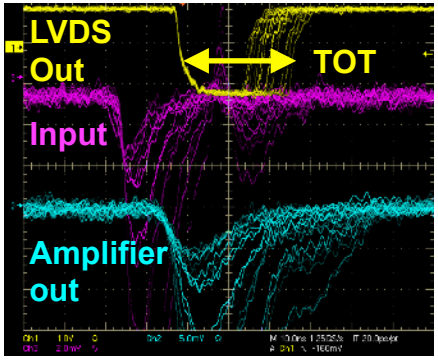
Components

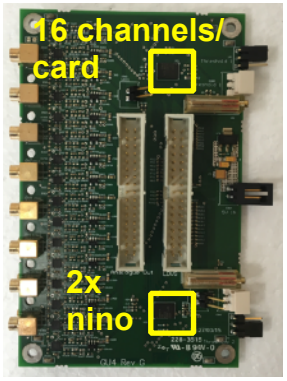


- 90 Scintillator bars: Eljen Technologies EJ200 plastic
- 180 Light guides: Eljen Technologies UVT acrylic rods
- Cement: Dymax 3094 UV curable adhesive



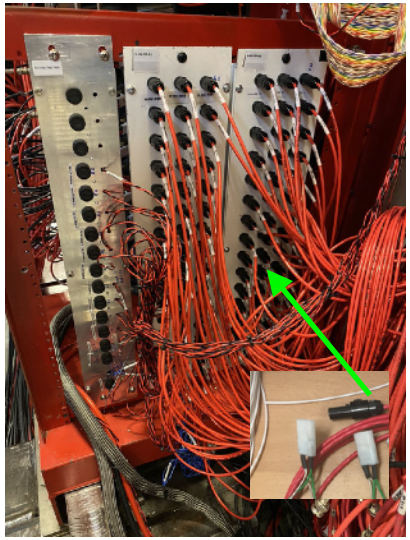
- 180 PMTs: Electron Tubes ET9124SB
- 180 custom bases: low gain, high linearity/ wide dynamic range, faster/cheaper
- 180 PMT assemblies: many components (mu metal, Al housing, washer, base collar, light guide clamp, air inlet). 180 (+ few spare) assemblies completed at JLab 2019

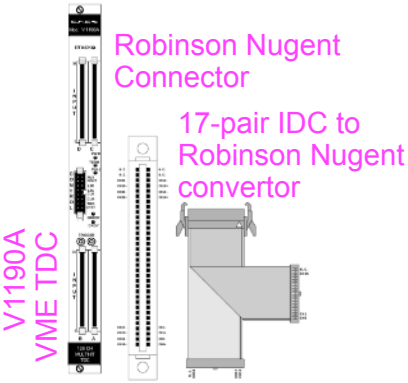


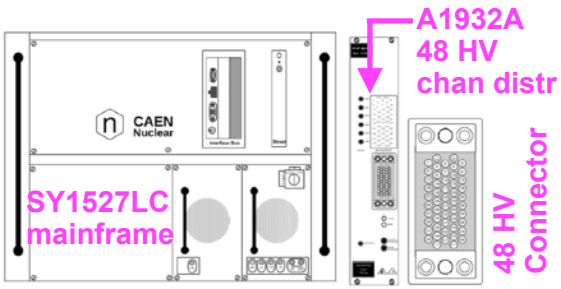


- 180 1.5m MCX-MCX co-ax: PMT → FE
- 12 FE cards: amplifier/discriminator cards based on NINO ASIC
- TOT → amplitude info
- 180 LVDS to 2 CAEN V1190A TDCs
- 64 analogue to 2 CAEN V792 QDCs

Components







HV:

- 1x CAEN SY1527LC mainframe w/ 4x A1932A 48-chan HV distributers
- Individual channel HV control
- 4x 60m 52-chan multiway cables w/ copper braiding and 52-pin connectors
- 4x 48-chan HV distribution boxes
- 180x 2m custom HV cables - distribution boxes to PMT bases

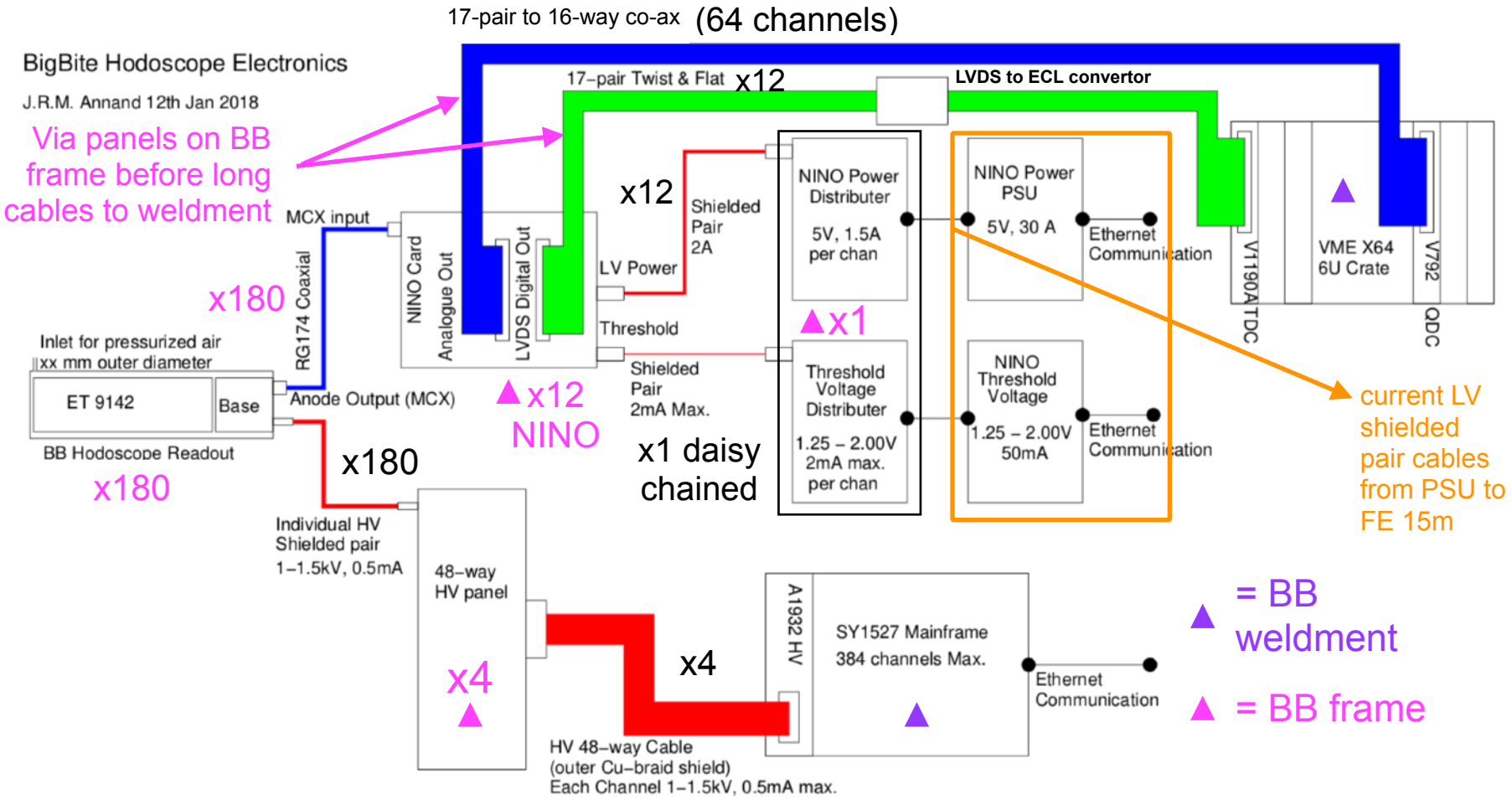
LV:

- 1x Agilent N5761A 19” 1U high-current PSU for NINO power
- 1 pair shielded cables PSU to LV distribution panel (15m)
- 1x distribution panel
- Shielded pair cables distribution panel to NINOs (<10m)

Readout:

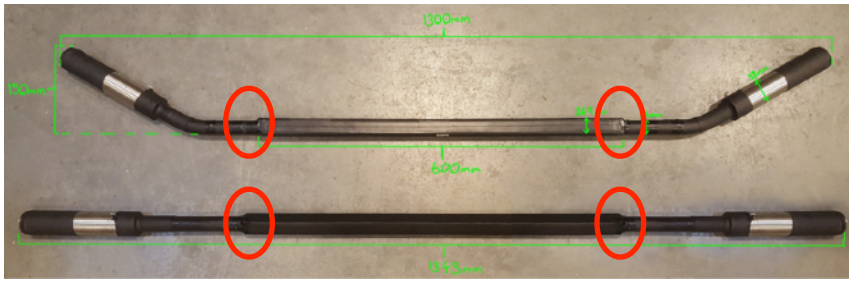
- 1x Wiener VME64x6023 crate
- 2x CAEN V1190A multi-hit TDC, 128 chan,100ps
- 8x Robinson-Nugent converters
- 2x V792 32 chan QDC
- Communicated w/ TDC - need to set up trigger for cosmic runs and v792

Detector Chain



- All components (except flat ribbons) delivered/installed at Jlab including spares (see previous GMn ERR talks for details, eg #spares etc)
- Nothing in UoG except 1 bar, spare NINO cards, [15 bars/30 LG/1 PMT assembly to be returned]
- HV, LV systems, PMTs, FE cards installed/signals checked 2019
- Outstanding: finish installation 64 analogue cables and 12 LVDS flat ribbon cable chain, DAQ trigger (if possible LV PSU for NINO threshold, (~50mV, 2V) - not mandatory)

Need for Repairs/Status



Initial stacking

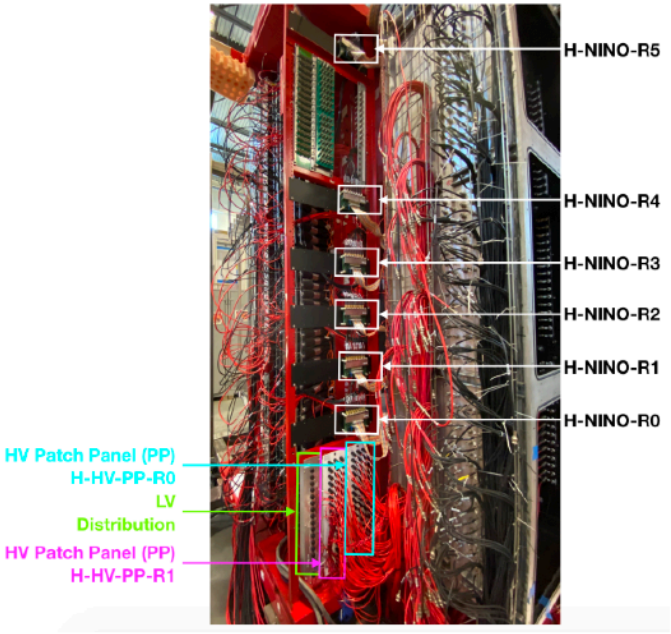
Early 2020

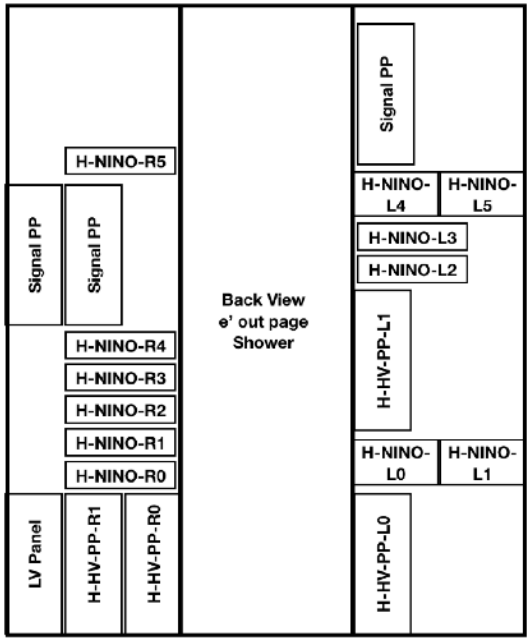
- 2019: bars stacked, HV, LV, FE cards installed
- HV, LV, FE cards, signals from all channels checked and good
- Early 2020 - significant fraction bars broken at glue joint between LG/bar on at least 1 side
- Major repairs of all bars, stacking system , PMT assemblies needed
- Major efforts recently towards this by teams at JLab (B. Wojtsekhowski, A. Shahinyan, BB team, Halls A/C tech teams, design group)
- Several tasks remain

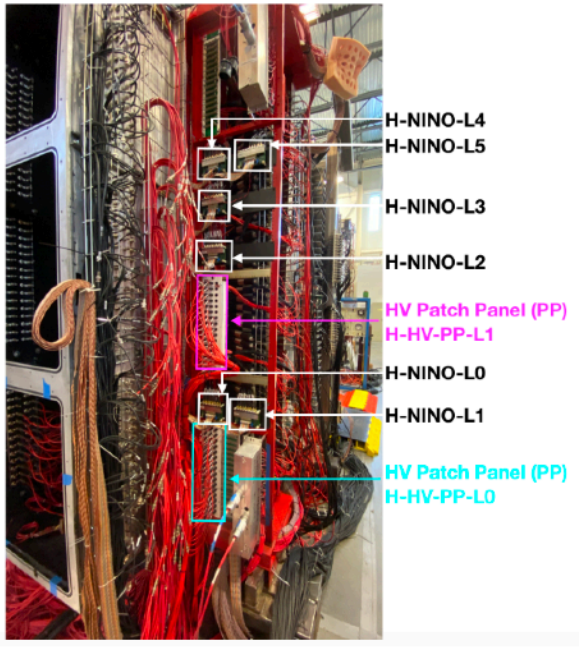
- UoG/CNU PhD student R. Marinaro now at JLab full time (pending lab entry)

- Remaining UoG (UK) work force can come for several rotations of shorter trips (2/3 weeks/ trip) once international travel restrictions lifted (when?) (R. Montgomery, A. Clarkson, D. Hamilton, J. Annand, plus 1 new PhD student by Summer 2021 (SBS PhD topic))

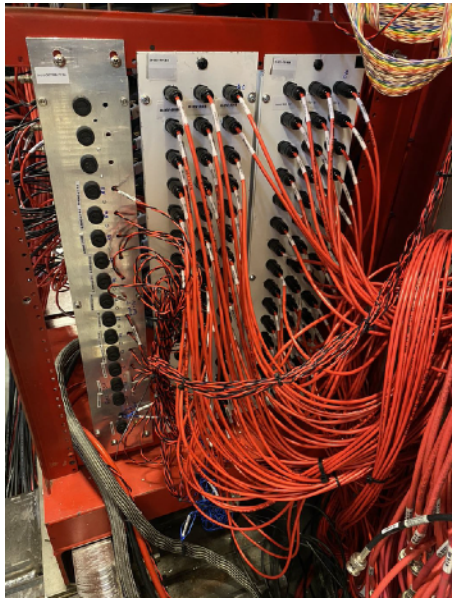
Before De-Stacking for Repairs

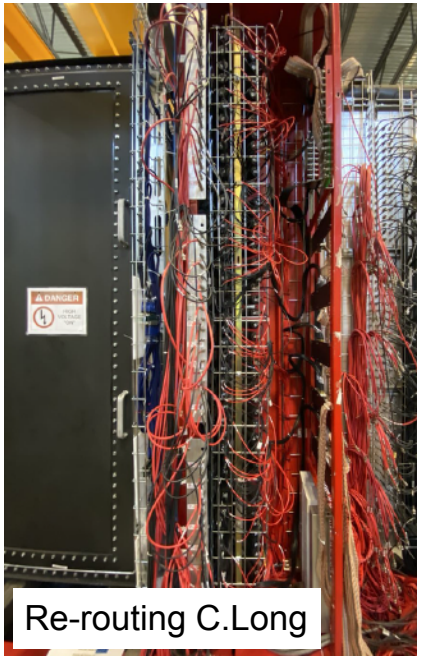




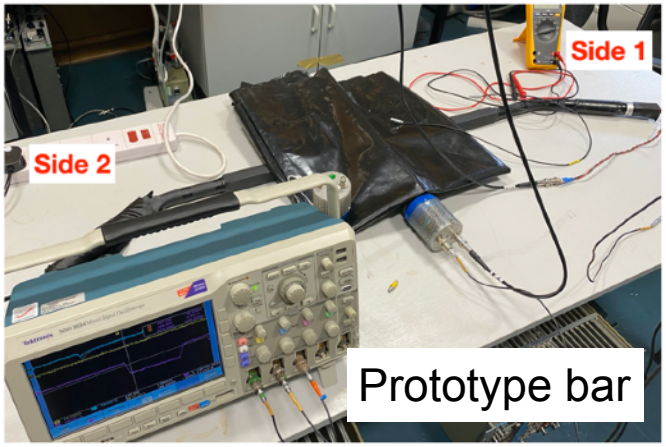


Mapping completed and documented (except flat-ribbons) - should make re-stacking faster

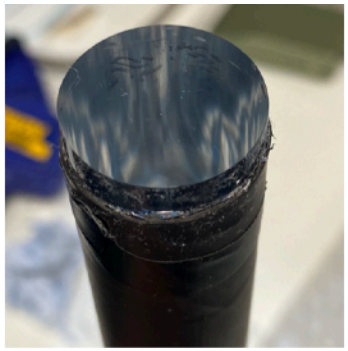




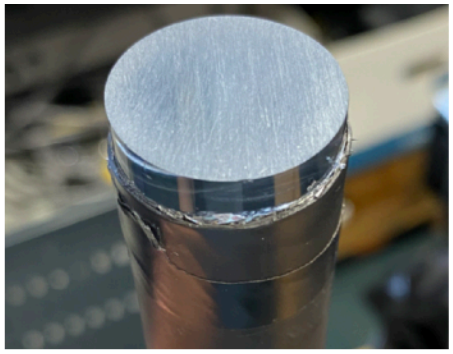
Roughening/Glueing Tests

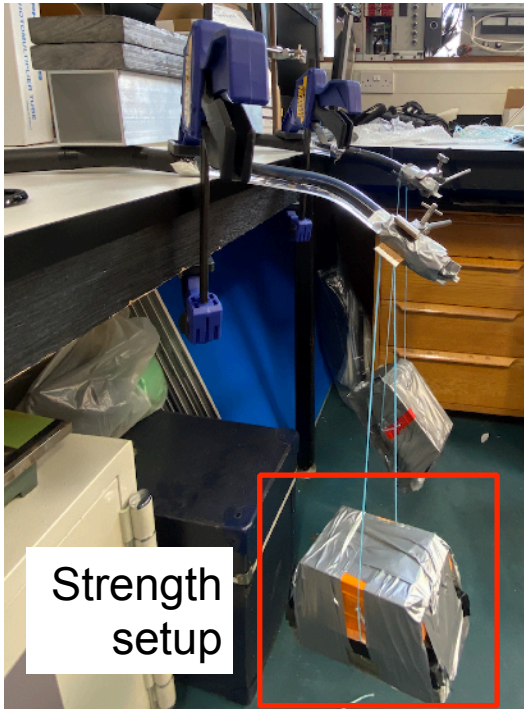


Original surface



Grit 400 roughened

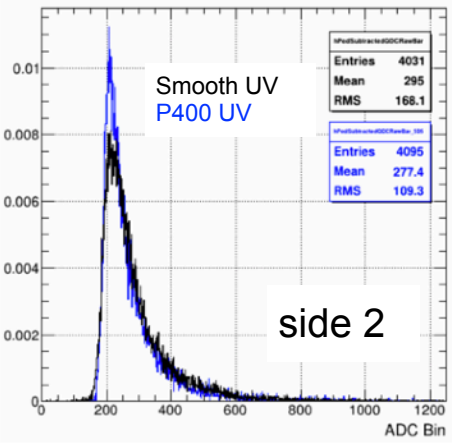


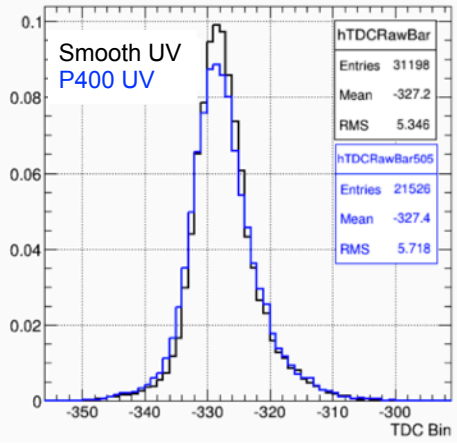


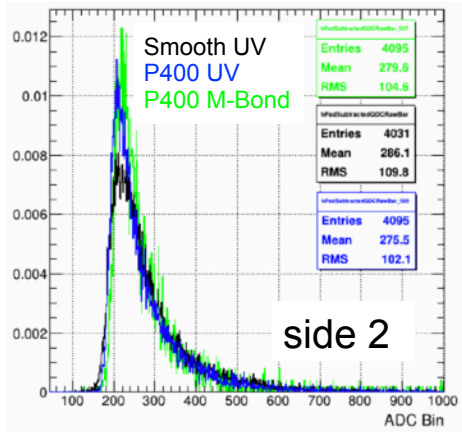
- Feb de-stack: original surfaces smooth → roughen
- Planned repairs @UoG → preliminary roughening/glueing/ bond tests → completeness affected by lockdown/components
- Set-up: 1 bar w/ curved LG, 1 PMT, 1 base, cosmic coincidence trigger; v792 ADC/v1190a TDC readout
- Preliminary work for clamp designs

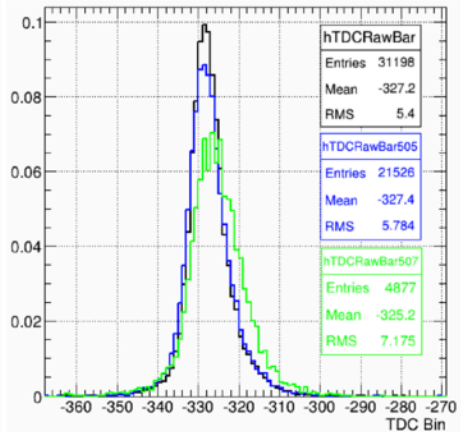
- Direct contact w/ Eljen (and lit review, e.g. CLAS CTOF) - grit P400 (35μm) for roughening
- Procured M-Bond 200 cyanoacrylate (CLAS12 CND https://doi.org/10.1016/j.nima.2018.07.029) to compare w/ original Dymax UV curable adhesive
- First 15 bars+LG arrived UoG day before lockdown
  - Will return to JLab for repair asap

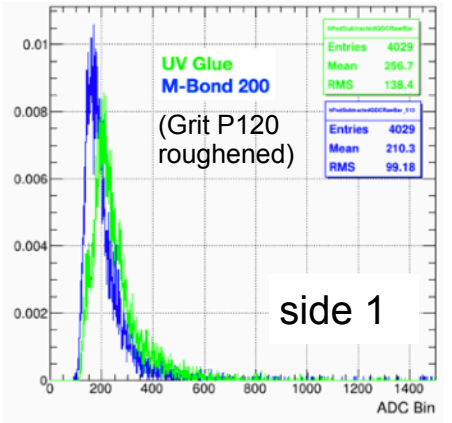
Roughening/Glueing Tests

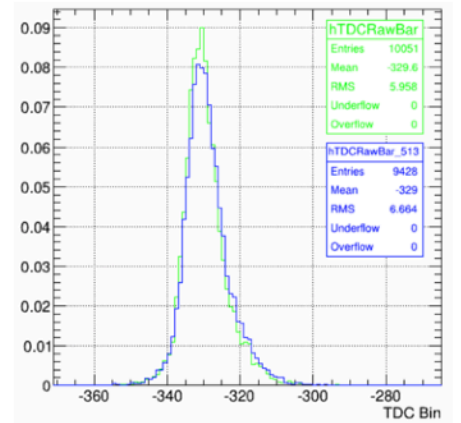








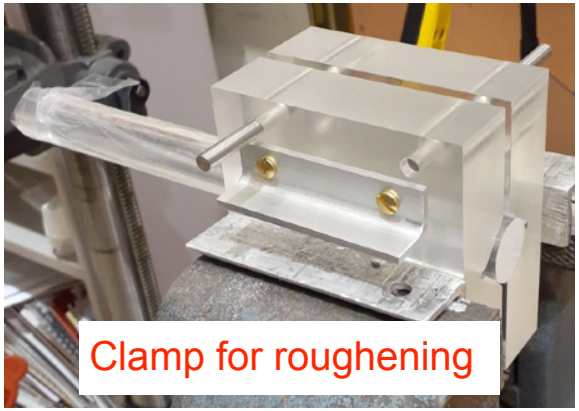


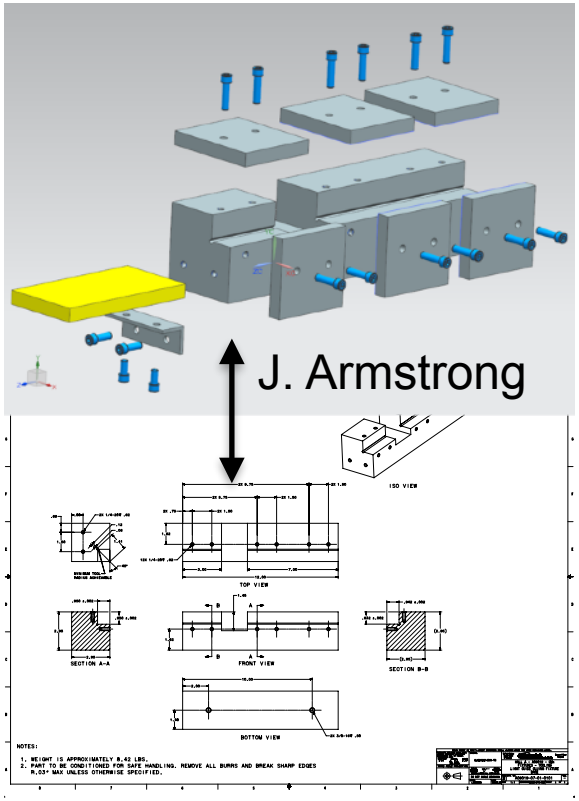


Configuration	Surfaces	Bond	Previous Breaks	Breaking Torque (N)
TH bar, side 1	Original smooth	Dymax 3094	None	20.5
TH bar, side 2	Original smooth	Dymax 3094	None	10.2
TH bar, side 2	Grit 400	Dymax 3094	One	20.5
TH bar, side 2	Grit 400	M-Bond 200	Two	By Hand
Light Guides	Original smooth	Dymax 3094	None	15.3
Light Guides	Grit 400	Dymax 3094	None	25.6
Perspex Pieces	Grit 400	Dymax 3094	None	20.5
Perspex Pieces	Grit 400	M-Bond 200	None	30.7

- Variation in breaking torque for original joints
- Roughening improves strength
- Perspex tests → M-Bond 200 stronger
- Bar tests → inconclusive (due to surface damage on bars/LG from repeated breaking by stress)
- Catalyst did not arrive in time for tests (w/ catalyst M-Bond 200 should cure in s)
- Without catalyst M-Bond 200 taking at *least* 24h to cure
- Results and recommended procedure, part #s etc → written up and passed on to JLab

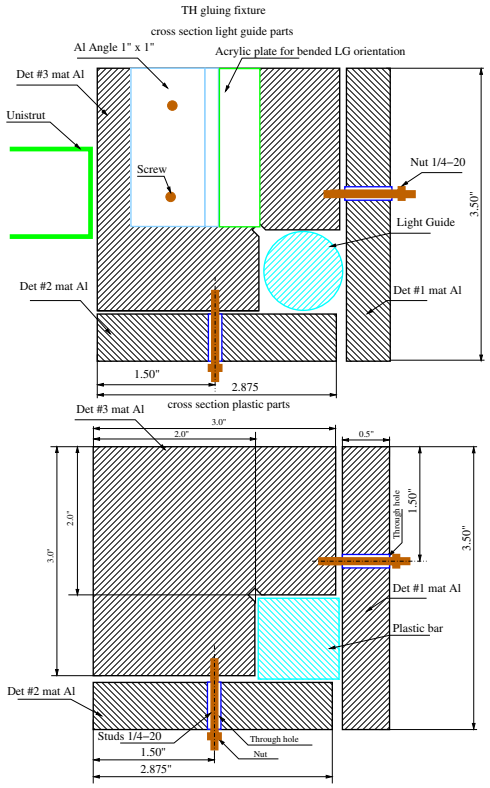
Roughening/Gluing At JLab Status

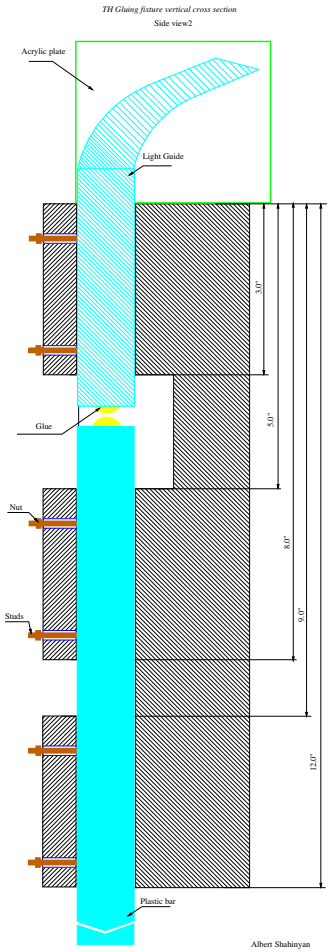


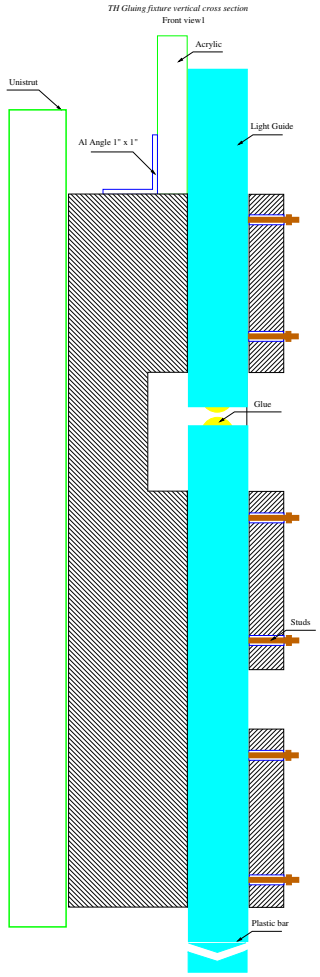


- A. Shahinyan, B. Wojtsekhowski worked on clamp designs
- CADs for outsourcing parts: Jlab engineering - J. Armstrong
- Parts ordered
- C. Long started cleaning bars and LG to remove glue

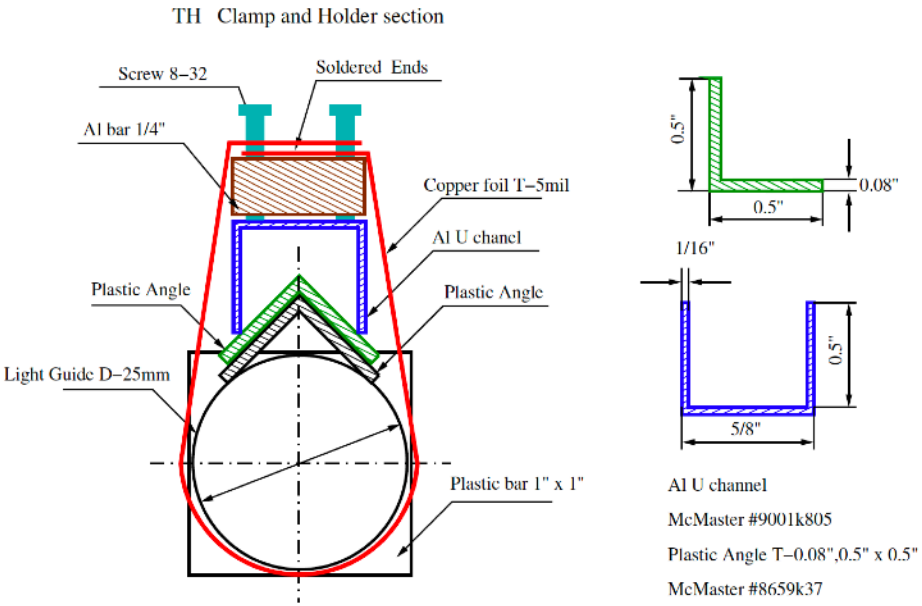
A. Shahinyan







Support Structures Underway At JLab

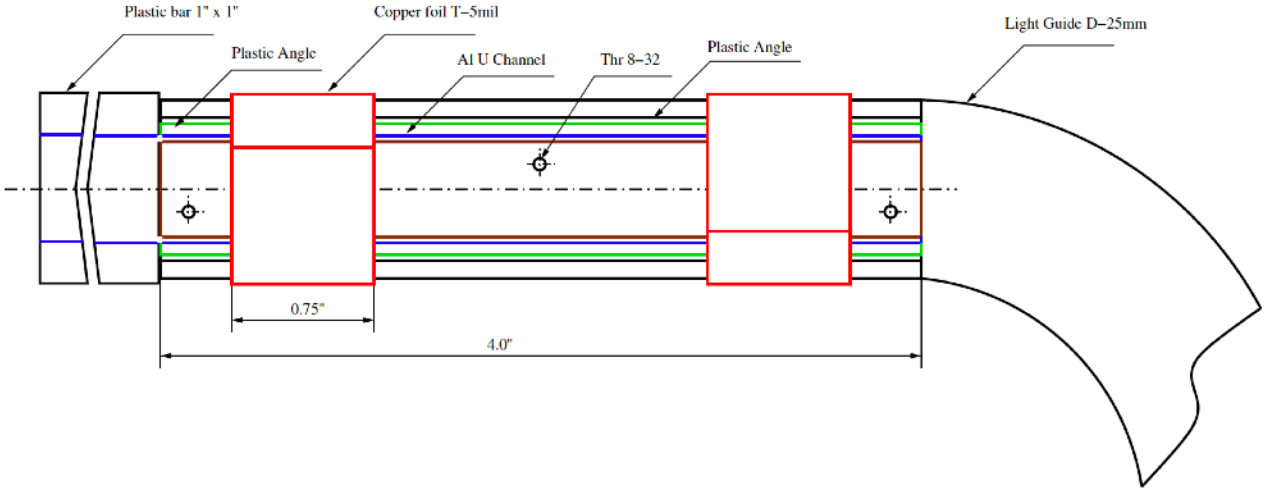


- To prevent further breakages
- Design: A. Shahinyan, B. Wojtsekhowski
- Support design for curved LG bars shown
- Al bar runs entire length of scintillator and fraction of LG, plus Al U-channel and 2 plastic angles for correct thickness
- For straight LG bars, U channel + tape
- Gentle force applied with Cu belt soldered on to Al bar, fixed by screw holes
- Parts ordered
- Tension of Cu belt has to be prototyped
- To be fixed to all bars

TH Clamp and Holder Top view

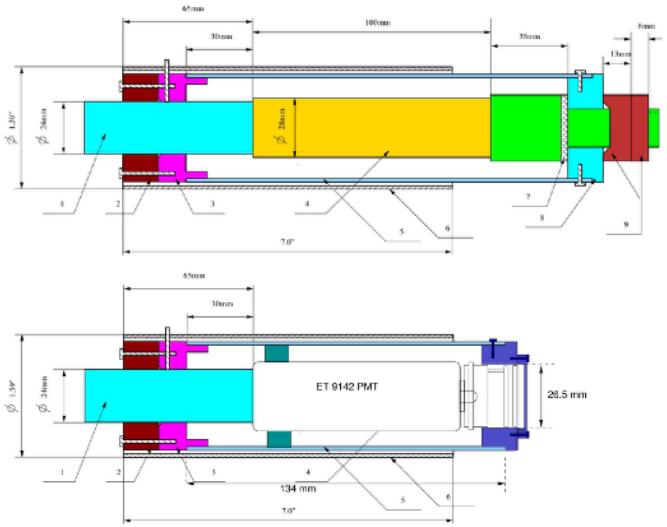
Albert Shahinyan

24 Apr 2020

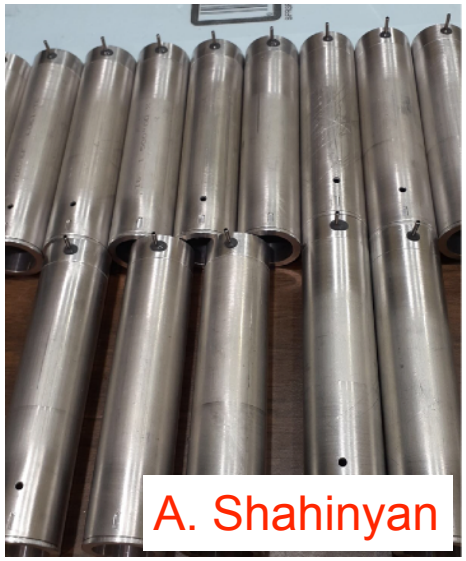


A. Shahinyan

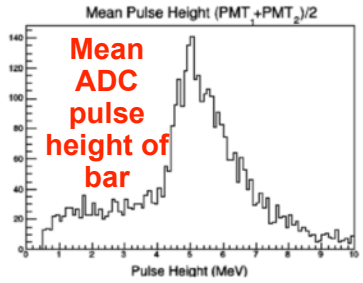
PMT Housing Assemblies Modified at JLab

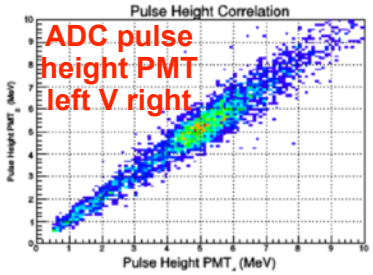


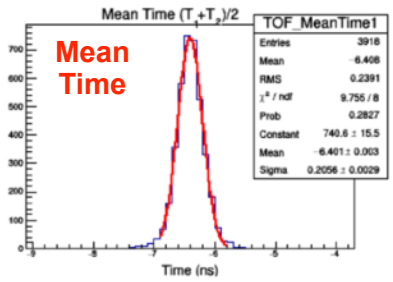
- Several modifications to PMT assemblies suggested (B. Wojtsekhowski, c.f. report W. Tireman)
- A. Shahinyan has completed modifications, including:
  - Removing silicone previous used for light-tight
  - Glueing new air inlets
  - Glueing base collars
  - Ordering new size PMT support washers
  - Mu metal shortened (outsourced to company)
  - Opaque hosing for dry air (part #, to be ordered)

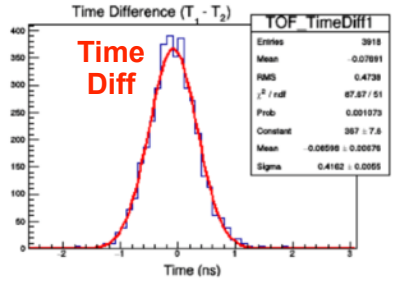


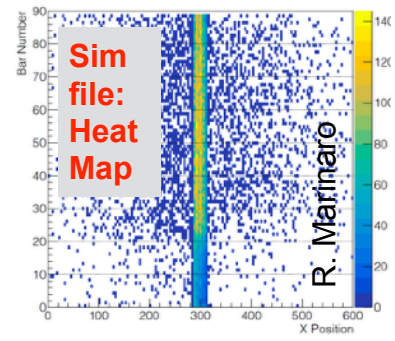
Software

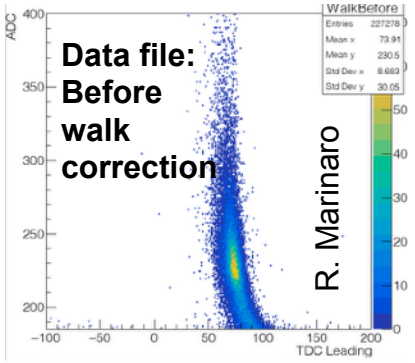


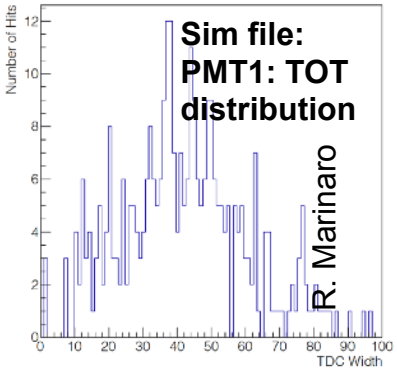


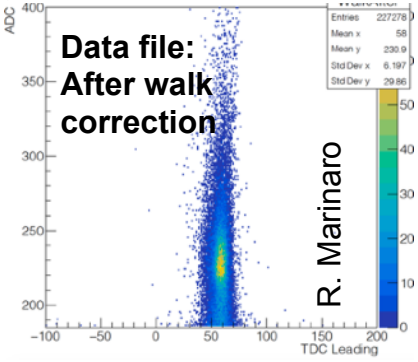












- Online display similar to UoG prototype bar tests

64 QDC Channels for Calibrations:

- QDC spectra, calibrate TOT, time walk correction

All runs, 180 TDC channels:

- All channels: TDC spectra; TOT distributions
- Per Bar: Mean time, time differences

Offline analysis:

- Hit positions, correlation w/ GRINCH/GEM tracks, mean time corrected for flight path length after GEM reco, correlation w/ beam bunch

- Currently integrating features into SBS-offline, generating replay, online display scripts for cosmic running (R. Marinaro)
- e.g. TDC, TOT, bar/channel hit distributions…

- Using GMn sim file (E. Fuchey) w/ digitised time
- Running with SBS-offline
- Database format set up (E. Fuchey, JC Cornejo)
- Need to:
- further check sim decoder/db parameters
- include more features to SBSTimingHodoscope, eg: more robust v1190 edge detection, check walk correction algorithm, ADC implementation

High Level Remaining Task List and Summary

Remaining Task List (FTE in weeks):

- Finishing bar repairs (8-10 weeks)
  - Roughening bar/light-guide surfaces, gluing
  - Wrapping bars/light guides
  - Fitting PMT assemblies, light-proofing
- Assembling hodoscope (4 weeks)
  - Stacking bars, re-cabling
  - System de-bugging/light-tight check
  - Twisted pair flat ribbon cables for LVDS
  - Co-ax cables for QDC calibration
- Support frame (3 weeks)
  - Outsource manufacture (cost needs covered)
  - Install
- DAQ completion (2 weeks)
  - have communicated w/ TDC (A. Camsomme), need: QDC install, cosmic trigger and pedestal set up - likely need DAQ expert help
- Software (4 weeks), currently on-going
  - Complete sbs-offline integration, online display
- Cosmic running (as long as possible until beam)
  - De-bugging, testing, commissioning

Where additional efforts would be highest priority

Timeframe asap

More people working simultaneously would bring forward cosmic running

- With thanks to teams at Jlab/SBS colleagues, repair work has continued during lockdown
- Several tasks remaining