Detector Design

- Optical Glue
- Scintillating Bars (90)
- NINOs (180)
- Light Guides (180)
- ADC/TDC/HV Cables
- PMTs (180)
Construction History

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>180 PMT assembly parts</td>
<td>Final parts on site May 2018.</td>
</tr>
<tr>
<td>PMT/mu metal assemblies</td>
<td>Final testing/assemblying completed Jul 2018.</td>
</tr>
<tr>
<td>Assemblies fitted to bars</td>
<td>Completed Jun/Jul 2018.</td>
</tr>
<tr>
<td>Final bar assemblies checked</td>
<td>Jul 2018 initial bar tests/checks using oscilloscope/cosmics.</td>
</tr>
<tr>
<td>PMTs gain matched</td>
<td>Initial, very rough matching performed via oscilloscope w/ cosmics Jul 2018. Await tests with DAQ.</td>
</tr>
<tr>
<td>Stacking of bars</td>
<td>Stacked Fall 2018. Some need repair, will need to be re-stacked spring/summer 2020.</td>
</tr>
<tr>
<td>Initial cabling of HV and LV installed and tested to be working ok</td>
<td>Completed summer 2019.</td>
</tr>
<tr>
<td>De-stacking of bars and start of repairs</td>
<td>Re-routing of cabling, improvements to PMT assemblies etc. tests of repair procedures, Winter - Spring 2020 and on-going</td>
</tr>
</tbody>
</table>
Problems - PMTs

- 20 broken glue joints on right hand side
- 7 broken glue joints on left hand side
- Photos taken as of December 2019
- Caused by bumping against PMTs
- Choice of smooth surfaces not sufficient for long term wear
- No external protection for PMTs

Solutions

- Study conducted by Rachel at Glasgow*
- Tests with roughened surface conducted with same optical glue
- Decided to roughen surface of light guide and scintillating bar
- Additional guarding attached preventing future accidents
- Flexible supports between PMTs for extra reinforcement

*see presentation from summer 2020 SBS meeting, written report available from Rachel
Problems - NINOs

- Not enough solder on connector joints from Zott manufacturer on pins
- Prone to damages from screw attachments which secure card to frame plate

Solutions

- Extra structure added to improve connector joints for more reliable signal
- Support clamps around screws to disperse pressure over larger area to prevent cracking
Cabling and Electronics

- Summer 2019
- December 2019
- Present
Laser Test - Setup

- Ammeter
- Light Guide Holder
- 5V Power Supply
- Photodiode
- Red Laser
## Laser Test - Results

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Transparency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>0.018 μA</td>
<td>-</td>
</tr>
<tr>
<td>Resting w/ Laser</td>
<td>3.311 μA</td>
<td>-</td>
</tr>
<tr>
<td>Single L.G. (smooth)</td>
<td>2.632 μA</td>
<td>86.7%</td>
</tr>
<tr>
<td>Double L.G. (smooth)</td>
<td>2.141 μA</td>
<td>65.9%</td>
</tr>
<tr>
<td>Double L.G. (smooth w/ glue)</td>
<td>2.626 μA</td>
<td>81.9%</td>
</tr>
</tbody>
</table>

- Transparency reduced by **5.54%** between single light guide (smooth) and double light guide (smooth w/ glue)
- Proof that chosen optical glue minimally reduces transparency for polished light guides

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Single L.G. (rough)</td>
<td>0.882 μA</td>
<td>25.3%</td>
</tr>
<tr>
<td>Double L.G. (rough)</td>
<td>0.672 μA</td>
<td>19.2%</td>
</tr>
<tr>
<td>Double L.G. (rough w/ glue)</td>
<td>2.619 μA</td>
<td>81.0%</td>
</tr>
</tbody>
</table>

- Transparency reduced by **1.71%** between double light guide (smooth w/ glue) and double light guide (rough w/ glue)
- Proof that roughness (400 grade) minimally reduces transparency, glue fills abrasions, agrees with Glasgow results Feb. 2020
Stress Test

Setup comprised of two lights guides with roughened surfaces glued together, glue joint positioned directly on edge of clamp.

- 10 and 12 lbs. weights were tested after varying 1-inch interval distances from joint.
- Found that neither 10 lbs. nor 12 lbs. weights could break glue joint with 400 grade roughness.
- Joint had to be weakened with alcohol bath, finally broke using 18 lbs. weight.
- Proof that new method of roughening light guide surface combined with optical glue is sufficiently strong.
- Lower grades of roughness available for testing, but 400 grade is best for strongest glue joint.
Production – Soaking

Before

During

After
Production – Sanding

Before

During

After
Production – Gluing

- Point of Contact
- UV Light Source
- Scintillating Bar
- Light Guide
- Holding Apparatus
- Operating Pedal
Result (for now)
Summary

- Repairs on-going
- Several tests performed to determine best repairs procedure
- Procedure set up as:
  - Clean in bath, roughen in jig, glue in jig
- So far 20 bars completed - estimate about 2-3 weeks remaining
- Wrapping procedure in development, then light tight bars

- DAQ
  - Initial install of v1190 TDCs in VME crate started at beginning 2020 but will require on site expert to help in completion of DAQ set up and cosmic trigger/pulser set up for testing repaired bars

- Software
  - Starting to implement hodoscope in SBSOffline and database requirements etc. but on-going