DSG NPS Status Update

Aaron Brown and the Detector Support Group
May 12, 2022
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Gantt Chart for Controls & Monitoring System

- Completed items highlighted in yellow
- DSG plans to complete Controls & Monitoring System by end of July

<table>
<thead>
<tr>
<th>Controls &amp; Monitoring System</th>
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</table>
• Clicking “Front Temperatures” button opens the “Front Crystal Zone Temperatures” screen in a new window
  – Displays temperature, average temperature, standard deviation, and status

• Developed by Mary Ann Antonioli
Detector Frame Sensor Locations

- Proposed temperature and humidity sensor locations (red circles)
  - Ten locations in all; four sensors per location
  - Electronics zone volume $= 0.37 \, \text{m}^3 \, (13 \, \text{cf})$
- 3D rendering by Marc McMullen
• Testing the Phoebus-based alarm system using test PVs
  – Uses randomly generated test PV values
• Being developed by Peter Bonneau
NPS Module Dimensions

- Dimensions of PbWO$_4$ crystal, PMT, and divider base
  - Model developed to be used in Ansys
## Ansys Thermal Simulation Parameters

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<thead>
<tr>
<th>Component</th>
<th>Property</th>
<th>Value</th>
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<tr>
<td>PbWO$_4$ crystal</td>
<td>Size</td>
<td>20x2x2 cm</td>
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<td>PbWO$_4$ crystal</td>
<td>Thermal conductivity x- and y-axis</td>
<td>2.4 W/m·K (x- and y-axis)</td>
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<td>PbWO$_4$ crystal</td>
<td>Thermal conductivity z-axis</td>
<td>2.0 W/m·K (z-axis)</td>
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<td>Carbon fiber dividers</td>
<td>Thermal conductivity</td>
<td>0.5523 W/m·°C</td>
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<td>Mu-metal dividers</td>
<td>Thermal conductivity</td>
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<td>Copper cooling shell</td>
<td>Temperature</td>
<td>10°C</td>
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<tr>
<td>Ambient air</td>
<td>Temperature</td>
<td>20°C</td>
</tr>
</tbody>
</table>
Ansys Steady-State Thermal Analysis

- Slices of crystal array
- Cu cooling shell, carbon fiber and mu-metal dividers
- Ambient temperature = 20°C
- $Q = 0.5\ W$ per crystal
Ansys Steady-State Thermal Analysis

- Model with Cu shell, carbon fiber and mu-metal dividers
- Ambient temperature = 20°C
- $Q = 0.5$ W per crystal
- Heat flux full scale model
  - $\geq 240$ W dissipated in mu-metal
Ansys Steady-State Thermal Analysis

- ~210 crystals in the central zone are at ~22°C
Ansys Steady-State Thermal Analysis

- Streamline plot generated using temperature probe data extracted from Ansys steady-state thermal simulation

- Plot shows heat flow on the front crystal faces
  - Central zone is warmest (~22°C)
  - Peripheral zone is at coolant temperature (~10°C)
Based on Lytron 6320 heat exchanger data
- Assume generated heat $Q = 1000$ W
- Assume maximum allowed temperature in electronics zone 20°C
- Coolant temperature 10°C
- Initial Temperature Difference (ITD) = 10°C
- Required performance = $Q/ITD = 100$ W/°C
- Four Ostro fans at ~525 CFM
- ~160 volume (13 cf) exchanges per minute

Because of the volume exchanges, estimated temperature in the electronics zone is close to ambient temperature
Thermal Calculations

- Air entering the electronics zone will be ~20°C (if zone is in a cabinet)
- Assuming RH is ~40% and temperature in electronics zone is ~20°C, dew point is ~6°C
- No condensation issues
Ansys Fluent Fluid Thermal Analysis

- Fluent thermal simulation includes heat removal effects from heat exchangers
- Maximum temperature of ~26°C
- Developed by Pablo Campero
Ansys Fluent Fluid Thermal Analysis

- Electronics volume includes the air surrounding the electronics zone
  - ~26°C
• Mindy Leffel has potted the Radiall connectors of 20 high voltage supply cables
High Voltage Supply Cable Testing

- Testing results for cable #37 before back-potting (left) and after (right)
  - No difference between before and after
- Cables back-potted by Mindy Leffel and tested by George Jacobs
Conclusion

• Controls & Monitoring System progressing well
  – Developing EPICS Phoebus monitoring and alarm system
  – Developing engineered interlocks system

• Ansys Thermal Analysis
  – Steady-state analysis indicates central zone crystal temperature of ~22°C
  – Fluent analysis in progress for electronics, PMTs, and crystals; indicates temperature in electronics zone and rear face of crystals to be ~26°C

• High Voltage Supply Cables
  – Back-potting of Radiall connectors has no effect on cable performance
THANK YOU!
Backups
Ansys Steady-State Thermal Analysis

- 20°C ambient temperature
- No dividers or perimeter cooling
- Q = 0.5 W per crystal