Optimization of the RICH Cooling System

Presented by Tyler Lemon
Detector Support Group
Jefferson Lab, USA

Sandro Tomassini, Dario Orecchini
INFN, Italy

October 30, 2019
Contents

- Overview
- Status
- Optimization
- Tasks
  - Near future
  - Long term
- Conclusion
Cooling Settings in Previous Run

- **FPGA Temperatures**
  - Average 57 ± 11 °C
  - Max 68 °C (Tile 128)
  - Min 46 °C

- **Compressor**
  - Low threshold 104 psi
  - High threshold 113 psi
  - Duty cycle ~95%

- **Airflow**
  - Total 900 slm
    - Airflow 1 500 slm
    - Airflow 2 400 slm

CSS screen for RICH FPGA temperature monitoring as taken with settings from previous run.
An Atlas Copco SF 11+ FF compressor pumps air to buffer tank.

Regulators and rotameters control airflow to RICH electronic panel (EP).

Two compressors on-hand but power limitations allow only one to be operational at a time.
Optimization

• Goals
  – Lower duty-cycle for compressor
    ✓ Manufacturer specification: 50% duty cycle
  – Reduce power-cycling of compressor units
  – Keep FPGA temperatures under 75 °C

• Optimization tests performed in two stages
  – Adjust compressor low-high threshold with 900 slm airflow to RICH.
    ✓ Compressor units turn off when pressure ≥ pressure high threshold.
    ✓ Compressor units turn on when pressure ≤ pressure low threshold.
  – With new thresholds, lower flow to RICH
Optimization Results

- Compressor low – high threshold adjusted
  - (104 psi – 113 psi) → (80 psi – 100 psi)

- Airflow (AF 1+AF 2) reduced
  - 900 slm (500 + 400) → 720 slm (450 + 270)

- Results
  - Compressor duty cycle ~50%
  - Max FPGA temperature ~73 °C

Top: buffer tank pressure (directly related to compressor output pressure) with optimized on-off range and airflow.

Bottom Left: RICH FPGA temperature map with 720 slm (450 + 270) airflow.
Other Possible Improvements

• Relocate buffer tank to cooler area of Hall B
  – Installed sensors to measure temperature gradient
    ✓ Sensors on each level of forward carriage

• Insulate tank to lessen effects of ambient temperature

• Use chilled water to keep tank temperature ~18 °C
  – Cooler air in buffer tank improves heat removal capability of system
  – At ~18 °C (~65 °F) reduced risk of problems due to condensation
Near Future Tasks

• Run Compressor 2 for tests and upcoming physics run

• If needed, attach external blowers to exhaust lines to provide additional cooling airflow

External blower rated for 863 cfm flow
Long Term Tasks

• Investigate new compressor able to run two RICH sectors
  – Must be rated for 100% duty-cycle (constant operation)
  – Provide at least 2000 slm of airflow

• If new compressor procured, existing Compressor 1 and Compressor 2 would be used as spares and could be used in EEL for assembly and testing of new RICH sectors
Post-Optimization Temperatures Agree with Calculation

- Resulting FPGA temperatures agree with calculation performed for RICH EP heat load with 700 slm airflow.
Conclusion

• Compressor 2 operational for next physics run

• Cooling system optimization complete
  – Compressor low-high threshold evaluated
  – Airflow adjusted to 720 slm (450 + 270)

• Other ways to improve cooling under investigation
  – Relocate, insulate, and/or chill buffer tank
  – Use external blowers to provide additional flow to electronic panel

• Researching better suited new compressors for operations
Thank You