Introduction to the Review of the RHIC 56 MHz Superconducting Storage Cavity

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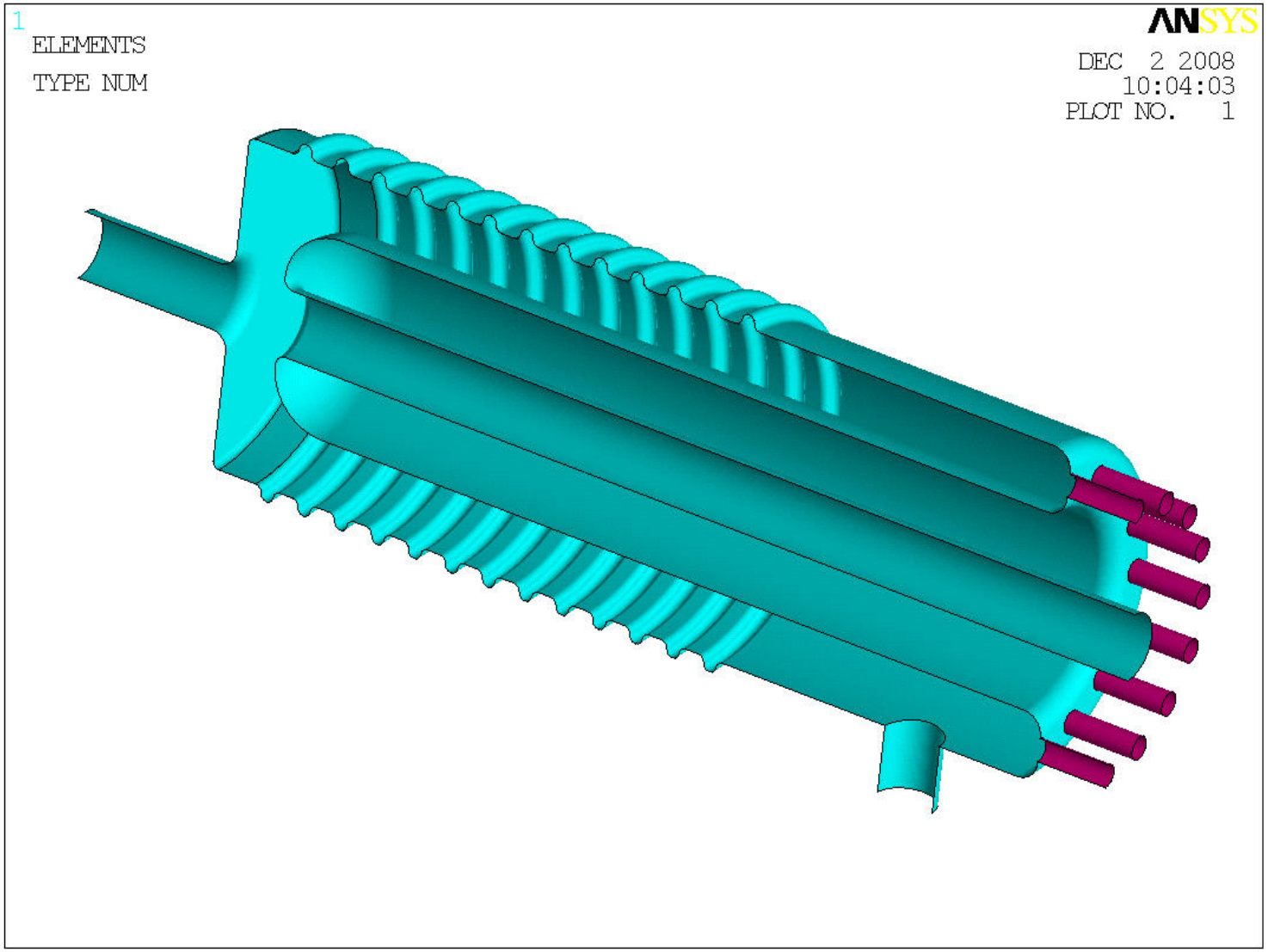
The Superconducting 56 MHz Cavity

- The current RHIC RF system: Each ring has two copper accelerating cavities at 28 MHz and five copper storage cavities at197 MHz.
- The 56 MHz cavity, a C-AD AIP project is a niobium superconducting quarter-wave resonator.
- The 56 MHz cavity will increase the RHIC luminosity by providing a larger “bucket”.
- We aim for operations at Run 11 (starting late 2010).
- A single cavity will serve both RHIC rings.
- Reliability and availability are prime considerations.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Design Features 1

- The 56 MHz cavity is at harmonic 720 of the RHIC revolution frequency.
- It is beam driven. A 1 kW amplifier will provide:
  - Conditioning capability
  - Fast tuning range of ±0.75 Hz
  - Amplitude and phase stability
  - Feedback for ponderomotive stabilization.
  - Make-up power for intrinsic losses (~40 watts)
- The cavity is not designed to follow the large frequency change from injection to store energy.

Design Features 2

- The cavity's fundamental mode will be detuned and strongly damped during injection and acceleration.
- At store energy, first the fundamental damper will be withdrawn and then the frequency will be tuned (approaching from below the beam frequency) to achieve the desired voltage (~2.5 MV)
- HOM dampers are always present.
- Combination slow-fast external mechanical tuner.
- Frequency errors beyond the RF feedback range can be reduced by the piezoelectric tuner.

Design Features 3

- Cavity compliant with ASME Pressure Vessel Code.
- Cavity is quite rigid.
  - First mechanical mode frequency 98.5 Hz
  - Frequency-pressure detuning 0.282 Hz/mbar
  - Lorentz detuning 231 Hz for full voltage.
- Multipacting-free cavity design.
- High degree of HOM damping and fundamental damping (during beam injection and acceleration)
- Low noise cryogenic system.

Design Features 4

- The cavity shape is optimized. At 2.5 MV we get:
  - E_p =44 MV/m, H_p =105 mT
  - Power dissipation 42 Watt (assuming 10 nΩ residual surface resistivity).
- Compare to the SPIRAL's 88 MHz high β QWR:
  - Accelerating field over 11 MV/m for $Q_0 = 10^9$
  - This is equivalent to E_p 62 MV/m, H_p 112 mT.
  - Pressure detuning 4.5 Hz/mB (0.282 Hz/mB)
  - Lorentz −1.58 Hz/(MV/m)^2 Equiv. 191 Hz (231 Hz)

The Review

- The timing of the review is such that:
  - The physics design has been mostly finished.
  - Engineering detailed design is in progress.
  - This allows implementation of recommendations.
- **Charge:** The committee is requested to look for errors or weak points in the design. The committee is requested to provide advice on how to proceed with the project and recommend changes as necessary.

International Review Committee

- Jean Delayen, JLab, Chair
- Rick Baartman, TRIUMF
- Sergey Belomestnykh, Cornell Univ.
- Steve Plate, BNL
- Jacek Sekutowicz, DESY

Today's presentations agenda

- 9:15-9:45 Beam stability, Mike Blaskiewicz
- 10:45-11:15 Cavity EM design, Xiangyun Chang
- 11:15-11:45 Fundamental Damper, Eunmi Choi
- 1:00-1:30 HOM Damper, Eunmi Choi
- 1:30-2:00 Multipacting, Damayanti Naik
- 2:00-2:30 Mechanical Design, Chien Pai
- 2:30-3:00 Cryogenic system, Roberto Than
- 3:30-4:00 Chemistry and testing, Andrew Burrill
- 6:00 No-Host Dinner. Committee hosted by C-AD

Thanks to the C-AD staff who spent time to design the cavity and prepare for the review.

Thanks to the committee for providing their valuable time to review the design.