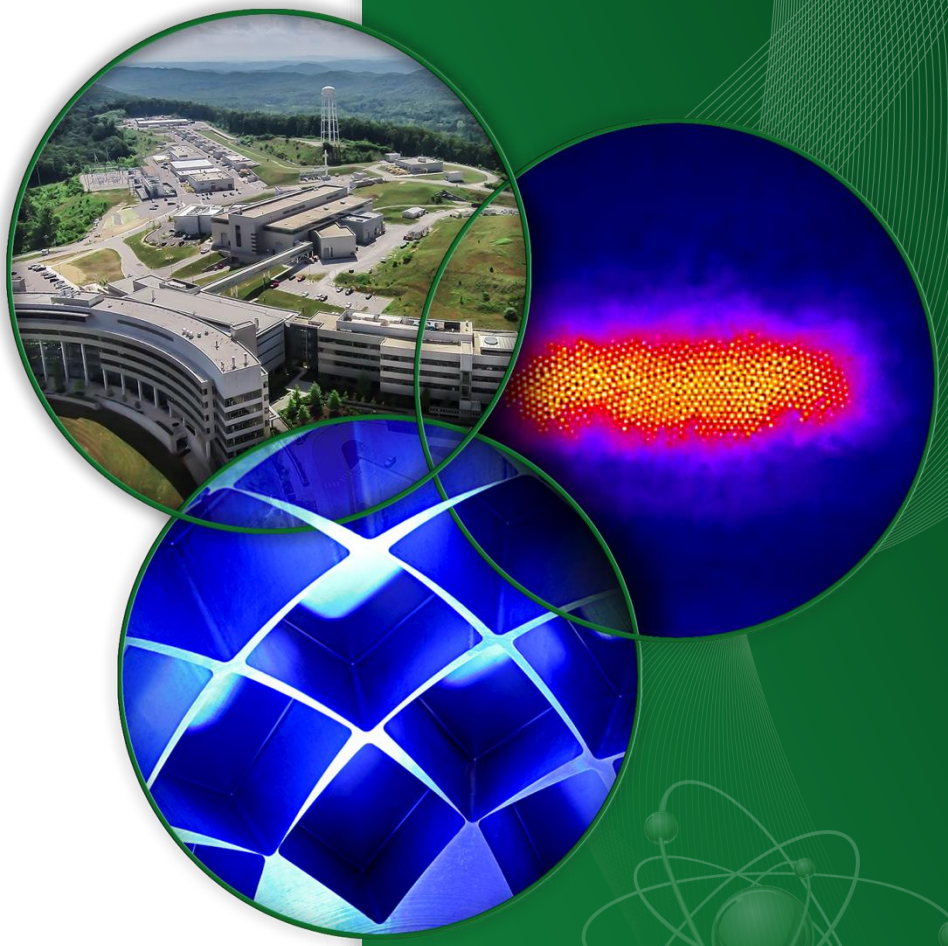
Superconducting Linac (SCL) Systems Overview



Presented at the
Accelerator Advisory Committee Review

Sang-ho Kim
SCL Systems Group
Research Accelerator Division

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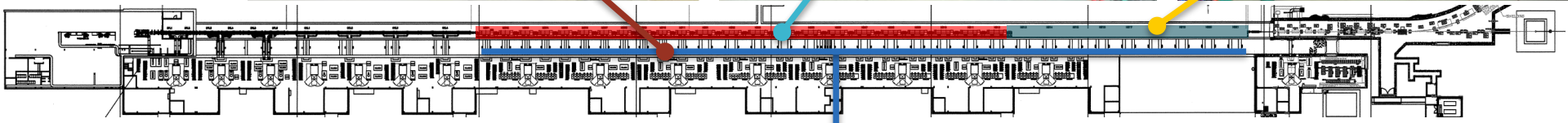
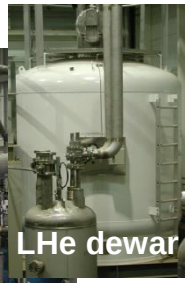
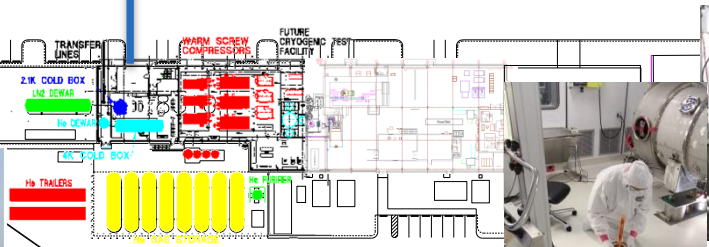
Outline

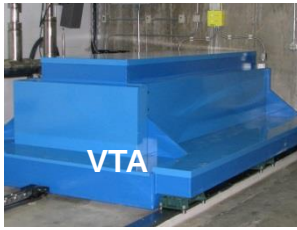
- Recommendations from the last AAC
- SCL system status
- Issues and plans
- Summary

SNS SCL Systems









Response to recommendations from the last AAC

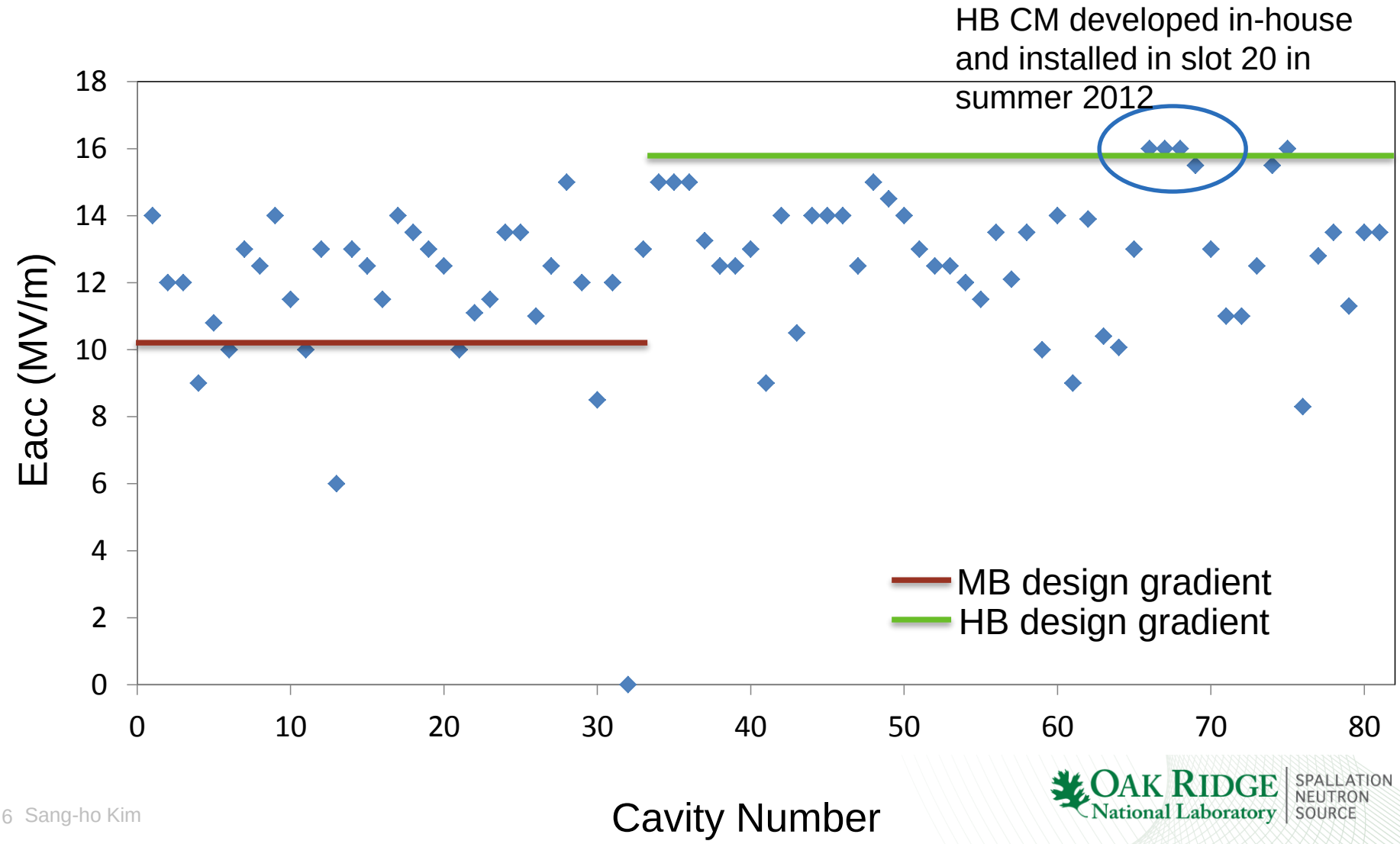
- Proceed with the MPS upgrade to 5 μsec response time
  - Lab test is completed (BI group) using BCMs
  - Implementation/Test with machine will be in near future (BI/Control/RF/Operation groups)
- Take reasonable steps to shorten the long lead time on the spare medium beta cryomodule
  - Design package is 95 % complete
  - Cavity prototyping efforts with local vendor is ongoing
- Complete construction of a spare medium beta cryomodule as soon as possible
  - Ready for long lead item procurement
  - Waiting for funding

SCL system is performing reliably for neutron production

- **Matured operational experience of pulsed proton SCL as a user facility**
- **Learned a lot in the last 10 years about operation of pulsed SCL**
- **Stable and reliable SCL operation**
  - Average trip (downtime): < 1 trip/day (<5 min./day)
  - Availability last 4 years:
    - **98 %** (Whole SCL system including RF, HVCM, Control, Vacuum, etc.)
    - **99.5%** (SCL cavities/cryomodules/CHL)
  - Operational flexibility is critical for high availability of SCL
    - Keep the last cavity (23d) as an energy reserve at the start of every run period
    - Almost every run several cavities have problems sustaining the nominal operating gradients
      - lower Eacc or turn-off to minimize downtime and use energy reserve
    - Overall no systematic performance degradation so far, but requires many actions to keep performance/integrity

Current SCL operating gradients

- Average Eacc of medium and high beta cavities:12 MV/m, 13 MV/m respectively



Cryomodule performance

- SCL output energy has been at 940 MeV last 1.5 years
  - Operating gradients based on the 60 Hz collective limits
  - Main limiting factor is electron loading in HB cavities
    - Partial quench at the end group is the limiting condition
- Several cavities are showing performance degradation
  - Vacuum activity created by errant beam, ion pump burst, etc
    - Have better understating of errant beam condition and related cavity trips
    - Successfully tested cryomodule operation with ion pump off since last summer
  - Some are showing elevated x-ray levels
  - Some are showing significant increase in cryogenic load
    - hot spot in very low field region in the end group
  - When a cavity shows a symptom of performance degradation, lowering gradient slightly (mostly < 1 MV/m) to avoid further degradation and to minimize downtime

Performance recovery and improvement

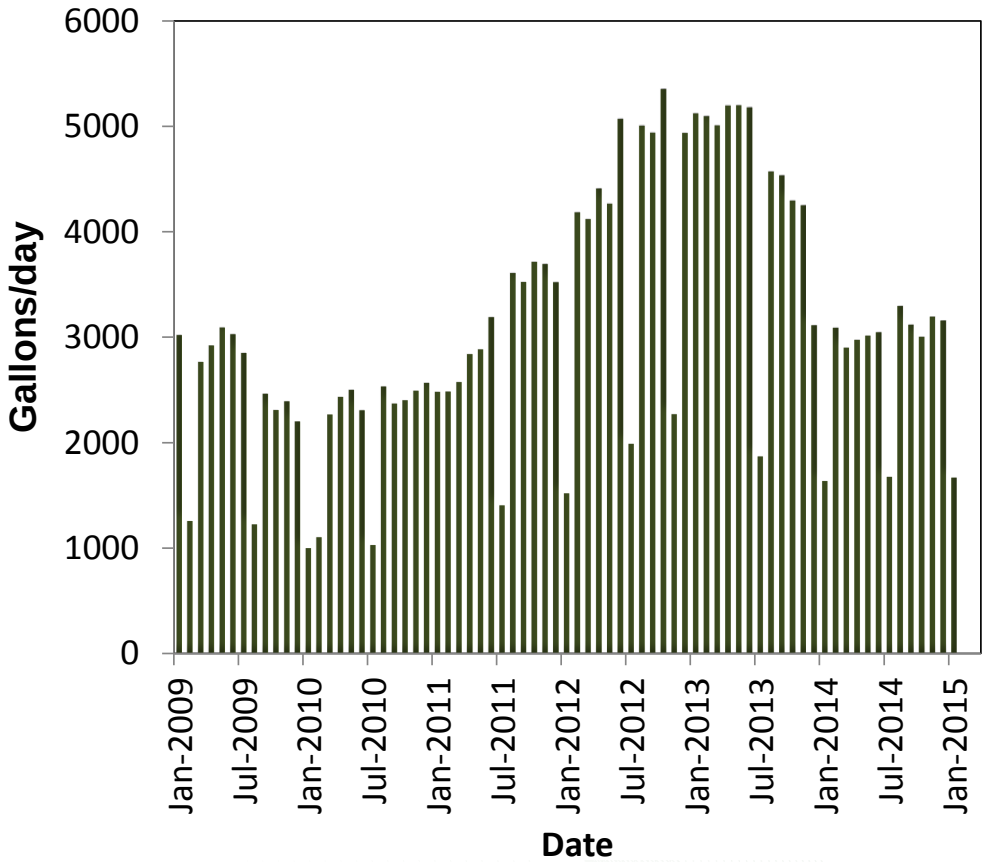
- Thermal cycling: recovery from performance degradation
  - Performances of several cavities were recovered after thermal cycle (gaseous contamination)
  - But two cavities were not (seems to have particulate contamination or defects were created)
  - Several CMs are waiting for thermal cycling
    - Risk that thermal cycling could create leaks or make an existing leak bigger
- Rework of cryomodules (in-situ or off-line): only option for unrecoverable damage (tuner, HOM couplers, FPC, Leaks, etc.)
  - High beta spare cryomodule is actively used for off-line repair of HB cryomodules
  - Medium beta spare is waiting for funding
- In-situ processing
  - Cost effective method to reach 1GeV operation
  - Investigated possible method for the SNS CMs
    - Helium processing: did not work due to severe MP in the end group/HOM
    - Plasma processing: R&D is actively ongoing with promising results.

Central Helium Liquefier (CHL) System

- Reliable operation
  - Typically one 2K cold box trip per year
  - CHL control room: 1 shift/day to cover CHL operation and to conduct daily maintenance
  - Full time monitoring of impurities of helium (O2, N2, water, Oil)
  - In-line spares for critical components (e.g. one spare warm compressor for each stage)
  - Auto-dial system for alarm conditions
  - CCR operators got trained for control of some CHL parameters
- CHL plant shut down
  - Total plant shut-down to conduct electric maintenance work (summer 2014)
  - First time at the SNS
  - Total shut down duration: 8 hrs.
    - 75 % of liquid helium in the tunnel was evaporated (all cryomodules remained cold)
    - All helium was recycled (thanks to having additional fixed Dewars for CTF and Fill Station)
  - Flawless recovery
- Next summer shut down
  - Another CHL plant shut down is planned to upgrade the CHL control system

Operational studies to improve CHL performance are ongoing

- Had an abnormal liquid nitrogen consumption
  - Gradually increased starting 2011
  - Recovered back to normal consumption in 2014
  - Suspect contamination but more studies are needed
- 2K pump down gives problems intermittently
  - Root cause is not clear but VFD circuit is suspicious
  - Under discussion with the partner lab for troubleshooting and improvement



Summary

- SCL System is performing reliably at 940 MeV up to 1.4 MW operation
- Active efforts are in place to ensure long-term sustainability and performance improvement

Following talks will cover details on

- SRF Activities: John Mammosser (20 min)
- Plasma Processing R&D: Marc Doleans (30 min)
- SRF strategy for STS: Matt Howell (25 min)