Cryomodule Recovery- Gradient Loss Avoidance and Recovery Scenarios

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LSD Re-Baseline Review
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Establish and maintain operating limits

- **New Performance Baseline from Recommission**
  - **Make sure we are getting all we can out of the cavities, avoid confusing cavity/cryomodule limitations with other system**

- **Maintain the best possible performance from the cavities/cryomodules**
  - **Closer communication / cooperation between Ops and SRF needed.**
  - **SRF role should not end when the DRVH's are handed over.**
  - **Better management of cavity gradients needed**
    - **Documentation of Performance History, need to help the operators know what is important to us**
    - **Investigation of perceived changes in performance, daily check on all cavities turned down**
  - **Burn–in periods follow commissioning**
    - **Vacuum clean-up**
    - **DRVH verification in the operational environment**

Failure Modes

- *Failure modes and recovery strategies have been reviewed, risk registry updated – procedures, equipment, supplies, and personnel are identified for use if needed*

- **Lower Qo's / High Heat Load due to Field Emission**
  - **Helium Processing 1-2 weeks per zone or pair of zones**

- **Low quench Gradients**
  - **No real options short of a full rework**

- **Hardware failures prevent operation of cavity. (Ex. Tuner)**
  - **Tuner –feedthru replacement (unlikely as all have been inspected during LSD)**

Failure Modes

- ## Vacuum Leaks

  - **Helium into Insulating Vacuum (all)**
  - **Helium into Waveguide Vacuum (C20,C50 only)**
  - **Helium into Beamline Vacuum (C20,C50 only)**
    - **Cooldown related, will not know until the cooldown is complete**

  - **Air Leak into Insulating Vacuum (all)**
  - **Air Leak into Waveguide Vacuum (C20&C50 cold, C100 warm)**
  - **Air Leak into Beamline Vacuum (all)**
    - **Note: Air Leaks are highly unlikely, we have good leak checks on all systems during the LSD**

Recovery strategies

- **Small helium leaks**
  - **Additional pumping, similar to NL11-outgas helium and return to operations or insulating vacuum turbo pump**

- **Larger leaks Warm up the cryomodule**
  - **Repair in place - 2-3 weeks from start of warm up back to 2K**
    - **Fix C100 helium to insulating vacuum leak**
    - **Reconfigure waveguides (C20&C50) to separate waveguides and recover one cavity**

- **Very large helium leaks**
  - **Remove cryomodule and rework, C50 program, 9 months 1 M$**

- **Air leaks are extremely unlikely – we know what to do but not presented here**

Options for Empty Slots

Cryomodule has been removed for repair. How do you make up the lost gradient?

- **FEL cryomodules – Fight with George**

- **Spare NPS quarter cryomodule - ~10 MeV**

- **R100 swap – operate ~ 70 MV in a normal linac zone**

- **Rearrange cryomodules in linacs to optimize gradient?**

- **1-2 Month turnarounds for swaps depending on locations involved**