

MP Questions for LE eCooling

Why talk about this now?

- Is there additional equipment needed, not yet considered? (nor costed)
 - Interfaces to systems that participate in beam Permits
 - Interfaces to Laser/shutter for Reliably turning off e-beam (fail safe?)
 - Do we need a backup system to turn off e-beam? Yes, RF.
 - Any new instrumentation (not already considered) E.g., thermocouples, pin diodes, etc.
- We do have to estimate the labor – which will be impacted by the complexity of the MP
- Okay, we could make cost estimates now and we don't see anything we consider a challenge, but it is worth at least discussing to make sure we are not missing anything.

Systems that need to be protected

- Superconducting RF Cavities
- Superconducting Solenoid in SRF
- 500 MHz RF Cavities
- Beam pipe in bending magnets (i.e., e-beam has enough energy density to burn a hole in the pipe)
- Vacuum interlocks
- Beam Dump (can it overheat?)
- Ion Beam heating from mistuned cooling?
- RHIC
- YAG screens

Operation Modes

- 4 modes of operation
 - e-Beam disabled
 - Low current beam for diagnostics
 - When beam is in RHIC
 - When beam in RHIC is disabled
 - e-Beam enabled
- Systems that participate in a local permit (disable e-beam)
 - All bending magnets
 - Insertion devices
 - Thermocouples
 - Vacuum gauges/pumps
 - Loss monitors (pin diodes? Phototubes?)
 - Superconducting systems
 - BPM systems
- Systems that participate in RHIC permit (disable ion beams)
 - Insertion devices
 - Vacuum systems

Some what-ifs

- What if
 - Gating of laser fails and continuous stream of 84 MHz e-beam bunches enter RF?
 - Enters Dump? (what are dump limits? – how is this monitored?)
 - A common dipole (for RHIC and e-beam) fails and e-beam goes down RHIC beam pipe into the RHIC cryostat?
 - A device gets inserted while RHIC beam is enabled? (i.e., when do we interlock RHIC beam and when do we interlock e-beam systems – and how do we avoid race conditions?)
 - How do we distinguish between a beam loss from the e-beam and a beam loss from the ion-beam?
 - e-beam energy “suddenly” changes - how fast must we respond?
 - YAG inserted for low current diagnostics and suddenly high current burst occurs – how fast to respond?
 - No losses are seen, but difference in dcct’s is very large? (blind loss)
 - E-beam is brought on before ions are at full energy or at “store” conditions? (at injection, during any ramp [tune or orbit shifts], etc.)

SRF Off-normal events, consequences and actions ??

Event	Impact on cavity	Consequences	Sensors & signals
SRF Cavity quench	Excessive heat dissipation	Helium bath pressure burst	Fast rise of the He bath pressure; Excessive RF power demand
HOM damper quench (is there an HOM damper?)	Excessive heat dissipation	Elevated HOM damper temperature	IR & Temperature sensors
RF system trip	No RF power for field regulation	High amplitude/phase noise	LLRF or High power RF is not ready
Tuner malfunctioning	Cavity voltage out of spec	Cavity quench	“Tuner is out of spec” from LLRF
Cryogenic problem	Loss of He pressure/level control	High He pressure / low liquid He level	He pressure or LHe level are out of spec
Cavity/beam pipe vacuum leak	Poor vacuum	Numerous, depending on scenario	Signals from vacuum gauge and pump controllers
Insulation vacuum leak	High heat leak to LHe	High He pressure/low liquid level	He pressure or LHe level are out of spec
Multipacting	Excessive local heating	Vacuum spike, cavity quench, elevated temperature	Signals from vacuum gauge and pump controllers
FD malfunctioning (is there a FD??)	Excessive RF power	FD overheating	FD temperature sensors; High RF load power from LLRF
Beam dump	-	No beam induced voltage	“Beam dump” from Control System
Solenoid Trip	-	No focusing	PS or Permit drop from Control System

Reaction to all off-normal events should be:

- Turn off the electron beam
- Turn laser pulses off (same thing?)
- detune the cavity to “home” position

Stolen/copied from Sergei B. table for 56 MHz system.

Mode State Definitions

e-Mode	RHIC-Mode	e-Systems states
e-Beam OFF	OFF	any state
	ON	Vacuum ready (below some threshold) Common YAG screens retracted/disabled Common Bend Magnets all on or all off
e-Beam low current	OFF	Vacuum ready (below some threshold) Bend Magnets at setpoint RF enabled (can be On) All YAG screens enabled
	ON	Vacuum ready (below some threshold) Bend Magnets at setpoint RF enabled (can be On) Common YAG screens retracted/disabled
e-Beam ON	OFF ON	Vacuum Ready (below some threshold) Bend Magnets at setpoint RF enabled (can be On) All YAG screens retracted/disabled

More Questions

- What are timing requirements? (how fast do interlock system have to respond?)
- How do we ensure Laser/shutter is turned off reliably
 - Uh, is that how we turn off the e-beam?
- What is the fastest the e-beam can “heat” the ion beam, possibly causing beam losses elsewhere in RHIC?
- What have I missed?