C-AD

Radiation Safety Committee

Issued: March 26, 2014

Minutes of RSC Subgroup Meeting of March 24, 2014

Subject: CeCPoP at IR2

Present: D. Beavis, R. Karol, E. Lessard, A. Etkin, K. Kusche, M. Pedurin, C. Folz, M. Minty, P. Sullivan, J. Reich, C. Theisen, S. Belomestnykh, I. Pinayev

The committee met to review three aspects of the Coherent Electron Cooling Proof of Principle (CeCPoP) experiment that will be conducted at RHIC IR2. The first aspect was the interlocks for the warm cavities and the superconducting gun. The second was the potential radiation exterior to the shielding if electron beam was allowed to operate to a temporary beam dump. The third was the request that the electron beam test be allowed to be conducted using an exemption of the Accelerator Safety Order (ASO) requirement for an ARR.

Exemption of ASO ARR Requirement

The superconducting gun can only be operated when the RHIC cryogenics system is in operation. The cryogenics system is expensive to operate and therefore no extra time is scheduled before or after a RHIC beam run except that required to test RHIC systems before and after RHIC operations. The present RHIC run is scheduled to stop at the first week of July and the following RHIC run will start in the late fall or winter. For CeCPoP to be a timely success it is important to test the gun as soon as possible. Therefore, the project is making an effort to have the gun operational by June 1, 2014. This would allow the project to gather information on the gun and take corrective actions during the summer shutdown and retest the gun in the fall.

A description[1] of the setup for RHIC run 14 was provided by I. Pinayev. There is substantial work to complete before a test of the gun with beam can occur. The work periods are limited to scheduled maintenance days for RHIC. This makes it difficult to complete the work during the run. The project foresees the need to do testing in the first 2 months or RHIC operations next year without an ARR being completed. This is mainly a matter of resources, i.e. if personnel are focused on the ARR their time will be diverted away from the completion of tasks necessary for early testing of the gun. It is expected that the safety analysis for the entire effort will be complete before RHIC run15.

[1] I. Pinayev, March 10, 2014, "Low-Power testing of Coherent Electron Cooling Injector"

The committee recommends that the Department proceed with requesting an exemption from the ARR requirement of the ASO for the early gun testing.

Changes to the configuration between the anticipated operations in RHIC run14 and RHIC run15 must be reviewed by the RSC to ensure any operations in Run15 do not have increased hazards which would not warrant operations under an exemption. For example the Linac is expected to be installed for run15. It will be required to be RS LOTOed off. Another example is the magnet bends that will be added to the beam transport. They will be required to be RS LOTOed off. The beam dump location will move and any potential change in external radiation levels must be examined.

ATS-RHIC-Nov. 1,2104- (Beavis& Pinayev)Review changes to the CECPoP configuration in regards to the exemption if granted.
Interlocks for Run14 testing

J. Reich provided a description[2] of the 1002 CeC/PASS interface, logic, and operation. For run14 the potential radiation hazards are the warm cavities and the superconducting gun. If electrons are not driven off the cathode by the laser then these systems can be tested as RGDs. However, the warm cavities are expected to produce[3] x-rays dose rates above 50 rads/hr at a foot. The gun is expected have the potential to produce 10's of rads/hr at a foot but for the hazard analysis it will be assumed to be at least 50 rads/hr at a foot. Therefore, dual interlock chains must be used to prevent access to these radiation fields.

The two PLC access control systems at IR2 will be modified to monitor the critical devices for the gun and the buncher cavities. The modifications will not allow the devices to be turned on if the area is not secured for either beam or CeCPoP RF operations. If there area is entered or a crash cord pulled then the devices will be turned off.

The gun has two safety-rated contactors that are connected in series to allow or prevent the 112 MHz gun RF system from operating. Unfortunately both contactors were purchased from the same vendor and are the same model. This means there is an increased risk of manufacturer flaws that could cause common mode failure. With this concern the committee will require a reachback device to provide additional protection if the contactors fail to function properly. The drive signals will be used as reachback. The delay time for the reachback will be 3 seconds. If a failure occurs the reachback status will be latched, which will require operator intervention to reset.

The 500 MHz buncher cavities will use two contactors in series as critical devices. The contactors are in the process of being purchased. It was requested that if possible that the purchase order be changed so that safety contactors from different manufacturers could be used. In either case the drive signal will be used for the reachback with a 3 second delay and a latch.

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[2] J. Reich, March 1, 2014," 1002 CeC/PASS interface, logic, and operation"
[3] Based on private communications and the RHIC warm cavities.

The electron beam from the gun will use the two contactors as critical devices. The maximum energy from the gun is 2 MV with a power of 0.8 kW.

A new mode will be added to the logic for the area similar to the 200 MeV linac and RHIC IR4. Mode 26 will be RF No Access (RFNA) which will allow for operation of the RF but not beam. The area will be allowed to move from Mode 24 (beam allowed) to mode 26 but not the other way. When the area is swept for mode 26 the alerts in the area will go off for 90 seconds before the radiation hazard is allowed to be turned on.

The doors at the internal gates in the middle of the arcs are being modified to take into account that the 2 O'clock area can have a radiation source on.

The sweep procedure will be examined for adequacy with the layout of new equipment and the changes necessary to accommodate sweeping for mode 26.
ATS-RHIC-May 15, 2014-RHIC-(C. Naylor& D. Beavis) Modify IR2 sweep procedure.

The project is hoping to be ready to test the warm cavities by May 15. This is a tight schedule for both the project and the access controls. The access controls group belives they can have the interlocks fully documented and tested by the end of May and maybe by May 15.

Radiation Analysis

Radiation analysis of the potential hazards was provided by D. Beavis.[4] The analysis assumed that the beam was operating at 2kW. The gun has a maximum output expected to be 0.8 kW. The present laser system to be used this year will limit the maximum possible beam power to 400-500 Watts if the cathode efficiency was 100%. The efficiency of the photocathode is expected to be less than 10% so the maximum expected beam power is 40-50 Watts this year. The committee recommended rescaling the table of routine and fault doses to 0.8 kW of beam. The table of expected dose rates is given at the end of these minutes. The updated table includes the set of pipes to the berm that were analyzed in footnote 4 but not placed in the table of that report

It is noted that the dose from the two cryo-pipes would be additive at building 1002B which would increase to the dose rate to a maximum of 4.2 mads/hr. No additional controls were recommended.

The cableway has an acceptable dose rate for routine operations but a potential fault dose to 44 mrads/hr. This is too high for a exemption request. This must be lowered and signed off on the check-off sheet. Two possible options are to do a more careful analysis which

[4] D. beavis, March 20, 2014, "CeCPoP Beam Test"; http://www.c-ad.bnl.gov/esfd/RSC/Memos/rsc%20memos/main%20pages/rsc_memos.htm

would be expected to decrease the anticipated dose rate in a beam fault or to add shielding to reduce the dose rate at the port to be less than 5 mrads/hr.
ATS-RHIC-CEC-May 15, 2104-(Beavis&Folz): Cableway port must be below 5 mrads/hr due to beam faults.

The CeCPoP has no desire to operate to full power during the exemption. The committee saw no reasons to limit the beam power based on the analysis of the dose rates outside the shielding in areas that are not locked for RHIC operations. The beam can only be operated while the RHIC cryogenics system is on. The entire berm is posted as a Controlled Area. The area near the shield wall is posted at no ladders or climbing. No access to high elevations at the shield wall is allowed.

The committee requires that the operation of CeCPoP with beam will only be conducted with the MCR manned so that alarms can be proper response to alarms.
ATS-RHIC-CEC-May 15, 2104-(Beavis&Pinayev)

A series of radiation surveys must be conducted and if beam operations occur then a set of surveys and fault studies must be conducted with beam.
ATS-RHIC-CEC-May 15, 2104-(Beavis&Pinayev)

An RSC check-off list must be prepared and completed before RF operations of the systems and operations with beam. The check-off list can be written to allow initial RF testing without beam and then testing with beam if the schedule allows.
ATS-RHIC-CEC-May 15, 2104-(Beavis&Pinayev) Prepare RSC Check-off list

Table III: Dose rates at various locations for 0.8 kW of electron beam

Location	Routine Dose Rate mrads/hr	Beam Fault Dose Rate mrads/hr	Comments
Roof	$1*10^{-2}$	2.7	Locked area
Side wall	$1*10^{-8}$	$1.8*10^{-6}$	
Sector 1 gate	$1.4*10^{-2}$	2.5	Potential shielding from beam dump ignored
Sector 3 gate	Less than $31.4*10^{-2}$	Less than 2.5	Expected to be much lower
Cableway	0.2	42	Could be blocked for test or better calc.
4-inch holes in buss blocks	0.026	4.4	15 feet above ground access not permitted
Labyrinth (1 Oclock side of IR)	0.004	0.7	
Labyrinth (to bldg. 1002A)	$7.*10^{-6}$	0.01	Routine uses wam cavities—fault uses beam Chipmunk at gate
IR emergency ventilation shaft	$8*10^{-4}$	0.1	Locked area
IR gas vent	$2*10^{-4}$	0.04	Locked area
Tunnel ventilation shaft	0.06	3.	Routine source is warm cavity —locked area
HVAC shaft	$8*10^{-6}$	.0004	Routine source is warm cavity
Cryo-pipe bldg. 1002B	0.01	2.1	Cryo-pipe material ignored
Cryo-pipe-fence	0.004	0.6	Cryo-pipe material ignored
Set of pipes to berm	negligible	negligible	Exits in locked area on berm

CC:

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RSC
RSC Minutes File
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