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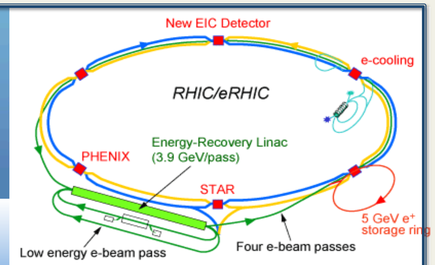
Budker Institute of Nuclear Physics
BROOKHAVEN NATIONAL LABORATORY
Collider-Accelerator Department
RHIC Relativistic Heavy Ion Collider
Accelerator Research & Development Division



PS14 Toby Miller

Instrumentation designs for beam distribution measurements in the ERL Beam Dump at BNL

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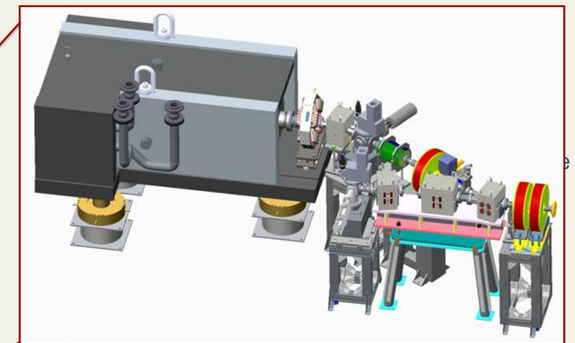
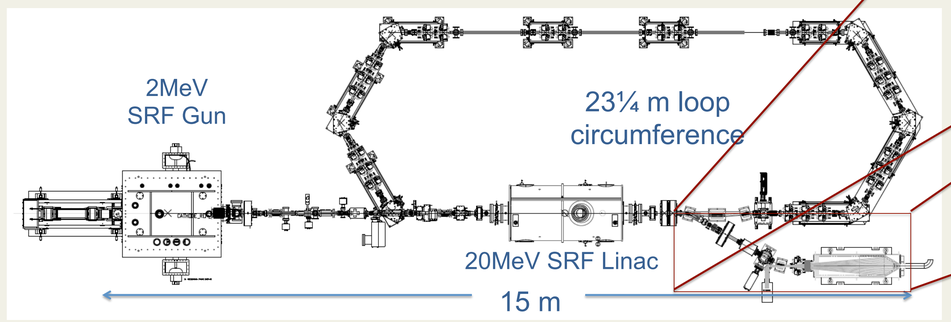
Abstract

The R & D ERL is being fitted with instrumentation to measure the beam distribution in and around the high power e-beam dump. For low power, this includes a new rad-hard version of 7/8" heliax ion chambers that encage the dump both in circular and axial directions. For high power, this includes 1) "pinhole" like multipoint imaging of the dump with ion chambers positioned over an array of holes drilled in the shielding around the beam dump and 2) an Infrared imaging system to peer through an upstream dipole chamber in the extraction line to monitor the temperature distribution on the target surface inside the dump. This paper presents the design details of these three systems.

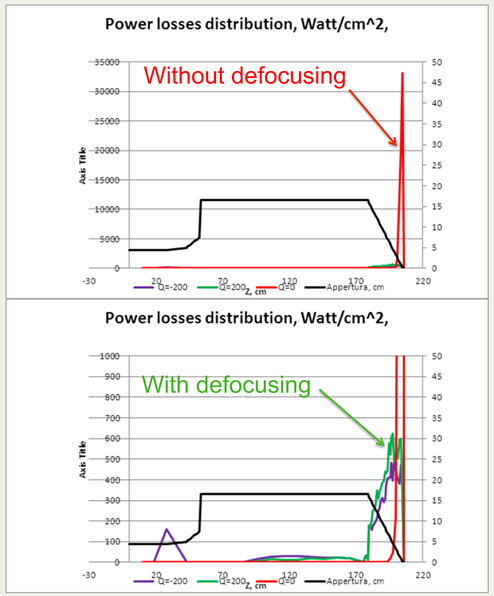
BEAM PARAMETERS	(low charge / high current)
Inj. Energy:	2.0 MeV
Max Energy:	20.0 MeV
Bunch f:	9.383MHz / 351MHz, 703MHz
Bunch Q:	0.050 – 1.4 nC / 1.4, 0.7 nC
Current:	14 / 500mA
Bunch length (rms):	60 – 120pS / 2 – 40 pS
Loop circ. ; time:	23 ¼ m ; ~75nS

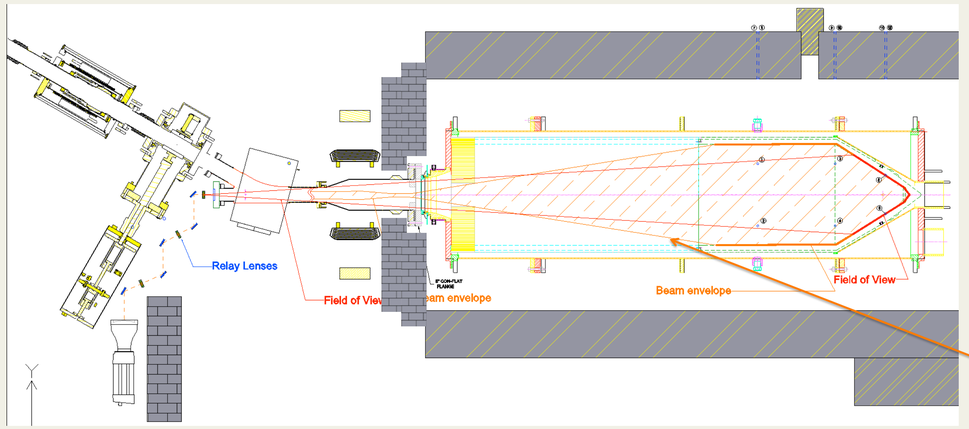




Simulations of deposited power & radiation:

- Max Distributed Power: 600W/cm^2
- Max focused Power: 33kW/cm^2
- Radiation inside shield: 38Mrad/hr
- Radiation back stream: 2.5Mrad/hr

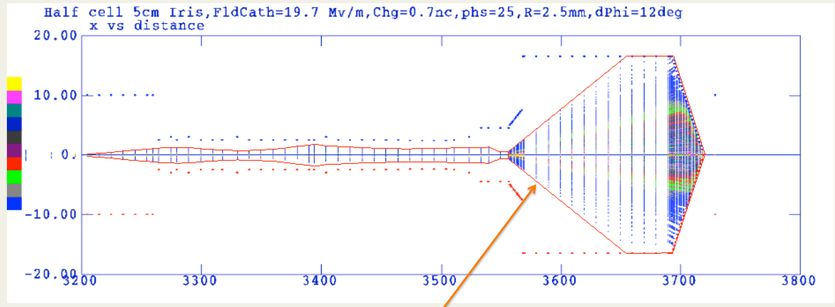




Layout of the beam dump, showing the beam envelope (orange) and the IR camera and its field of view (red), as well as the "butter-dish steel shield & lead bricks (grey).

Simulation of electron beam distribution:

- Beam envelope outlined in red
- Beam defocusing by upstream quadrupole

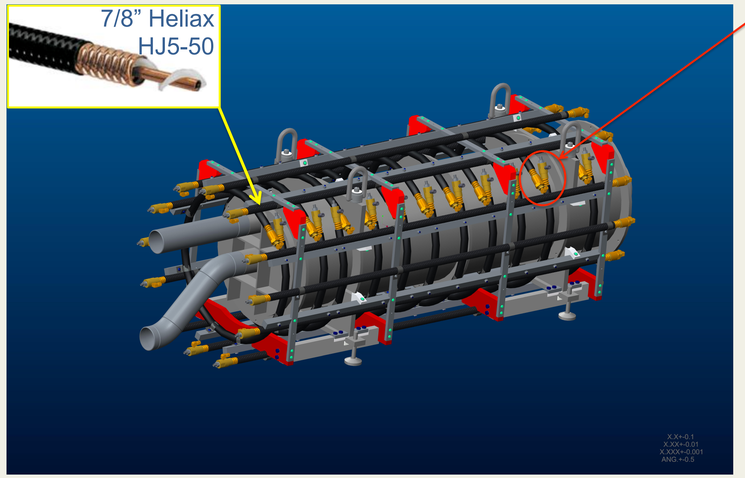


Beam envelop scaled and overlaid on dump layout drawing showing the actual beam envelope (orange).

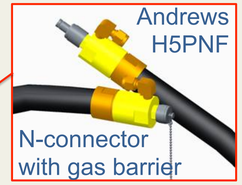
LOW POWER RADIATION MEASUREMENT

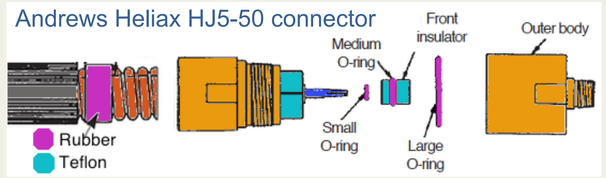
Beam Dump with 24 Channels of BLMs

Long Ion Chambers made of air dielectric coaxial cable, filled with flowing argon, biased to -200V



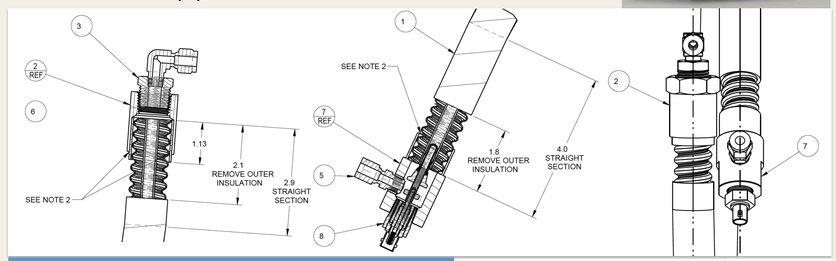
Typical Heliax Terminations



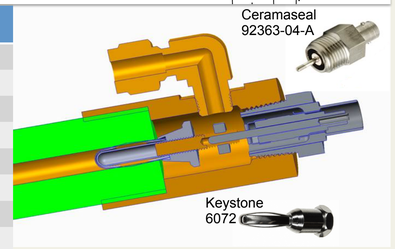


Rad-Hard Heliax Terminations

Brass ends are soldered to the cable’s copper shield and NPT fittings are sealed with Loctite 580 PST Nuclear Grade pipe sealant



Ref	Description
1	7/8” Heliax cable HJ5-50
2	Copper female adapter, 1” tube socket x ½” NPT
3	Brass Reducer Bushing, ½” NPTx1/8” NPT-M
5	Brass Tube fitting, ¼” tube x 1/8” NPT-M
5	Brass Tube fitting, ¼” tube x 1/8” NPT-M
7	Custom BLM end fitting
8	BNC signal feedthrough, ½” NPT
Note 2	Solder Joint for low pressure gas seal



Rad-Hard Signal Transport

Signal transport out of the shielded is accomplished by Kapton coaxial cable and PEEK insulated BNC connectors

Accuglass 100720

Accuglass 111023

HIGH POWER RADIATION MEASUREMENT

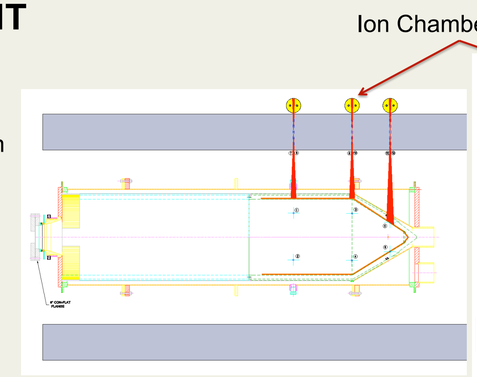
“Pin-hole” Radiation Monitors

For full power operation, Ion Chamber BLMs measure radiation through ¼” holes in the shield for a coarse map of the beam distribution. 9 top x 9 side sensors cover active region.

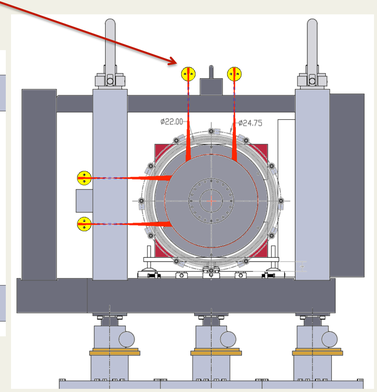
RHIC style beam loss monitors are ion chambers made of 113cc glass tubes with 0.95 atm of argon and nickel electrodes. Hey are biased with +1400V.

~400 installed in the RHIC ring

Ion Chamber BLMs



Side view of detection areas



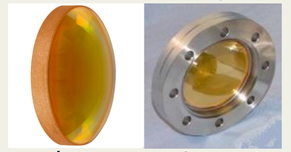
End view of detection areas

IR IMAGING OF THE DUMP TARGET

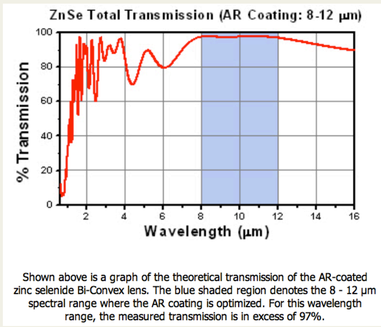
IR Optics

ZnSe viewport and optics allow an IR camera to monitor the temperature distribution of the dump’s internal surface. Turning mirrors and relay lenses extend the camera’s range to hide behind lead shielding *(not shown)*.

AR coated ZnSe optics

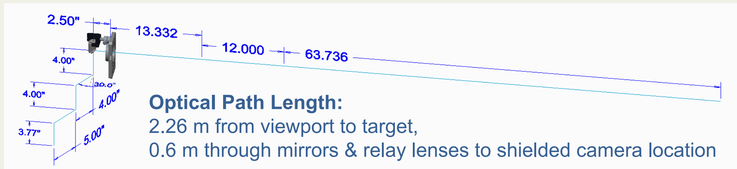


Lens viewport



Shown above is a graph of the theoretical transmission of the AR-coated zinc selenide Bi-Convex lens. The blue shaded region denotes the 8 - 12 µm spectral range where the AR coating is optimized. For this wavelength range, the measured transmission is in excess of 97%.

FLIR model A310 IR Camera, 320 x 240 px, Uncooled Micro-bolometer (7.5–13 µm spectrum)



Optical Path Length:
2.26 m from viewport to target,
0.6 m through mirrors & relay lenses to shielded camera location

Optics Layout

IR Optics placed just upstream of last dipole in extraction line