Synchrotron Radiation in eRHIC IR and Detector Background

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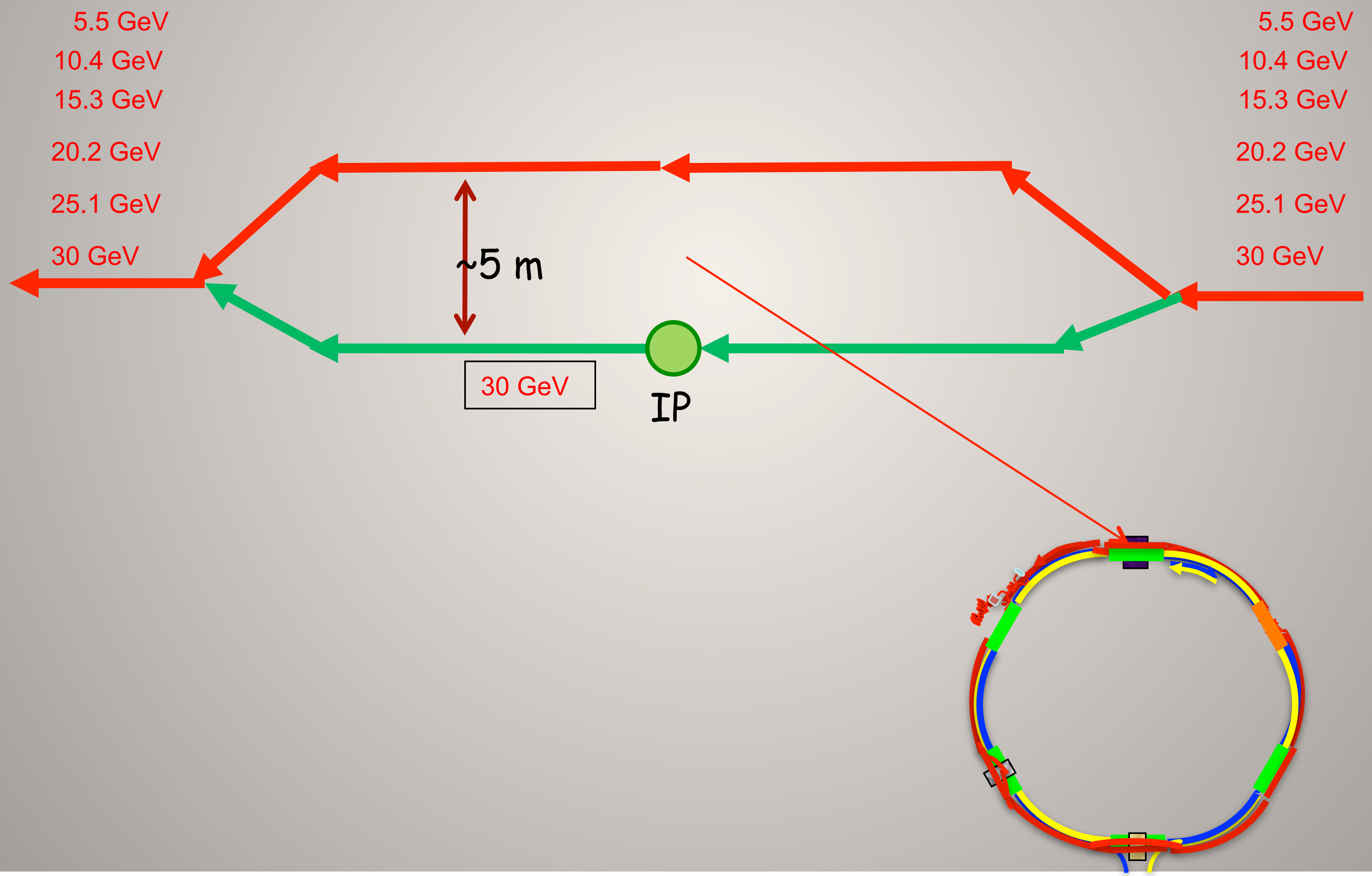
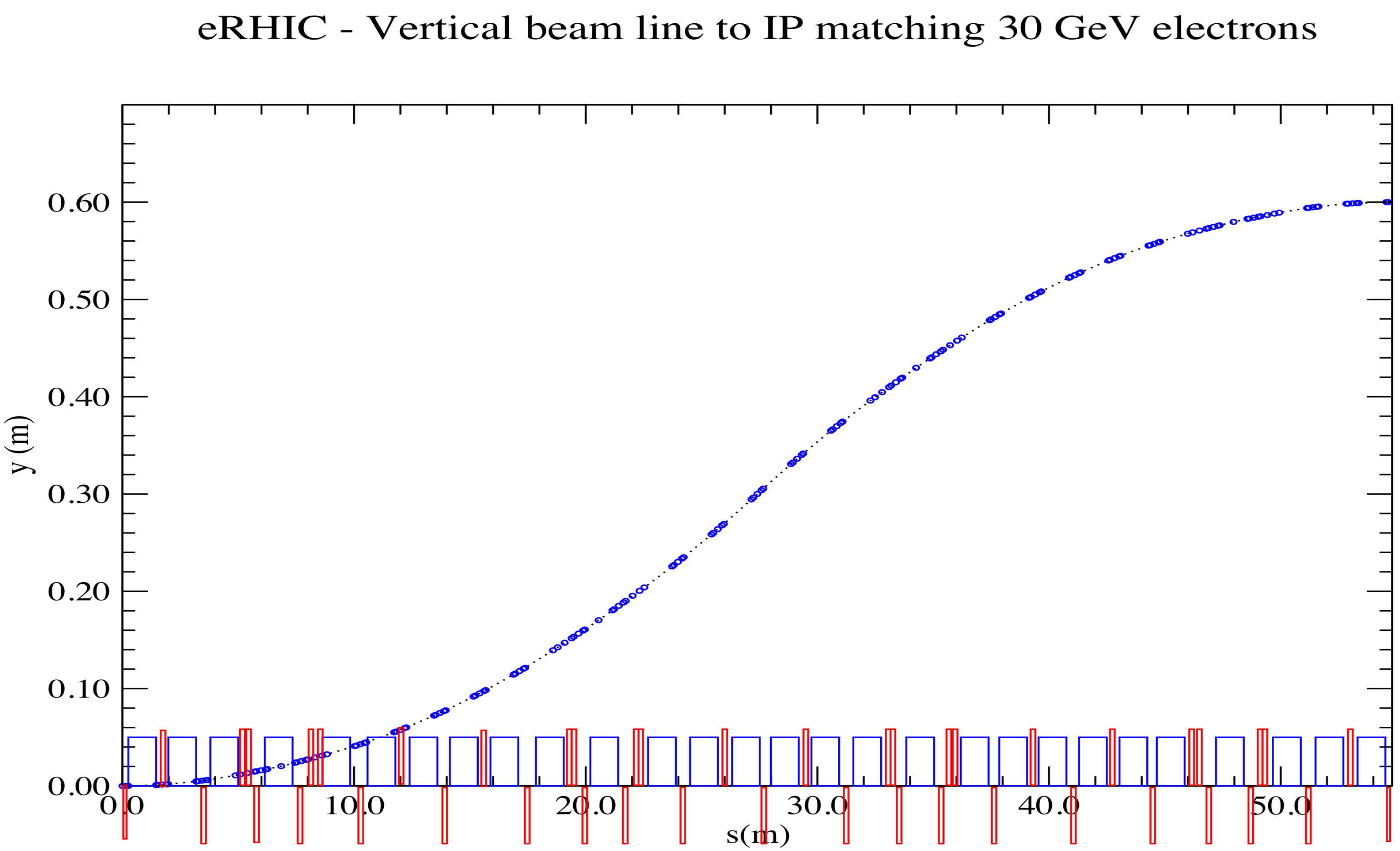
Bring Final Energy e Beam into IR



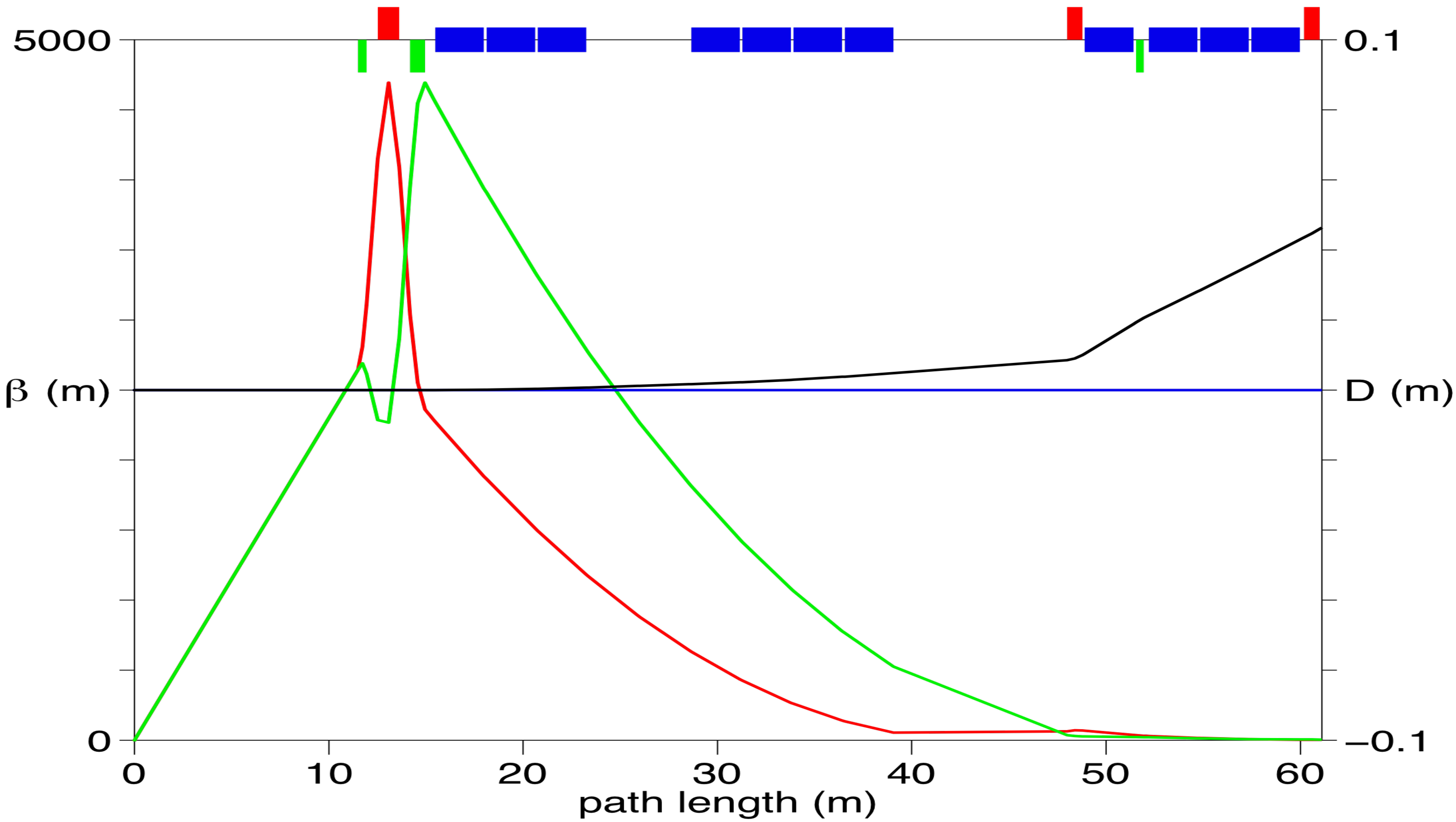
Final Energy e Vertical Beamline Matched to IP

4 basic cells (2 bending up, 2 bending down) bring beam down 60cm over 55m



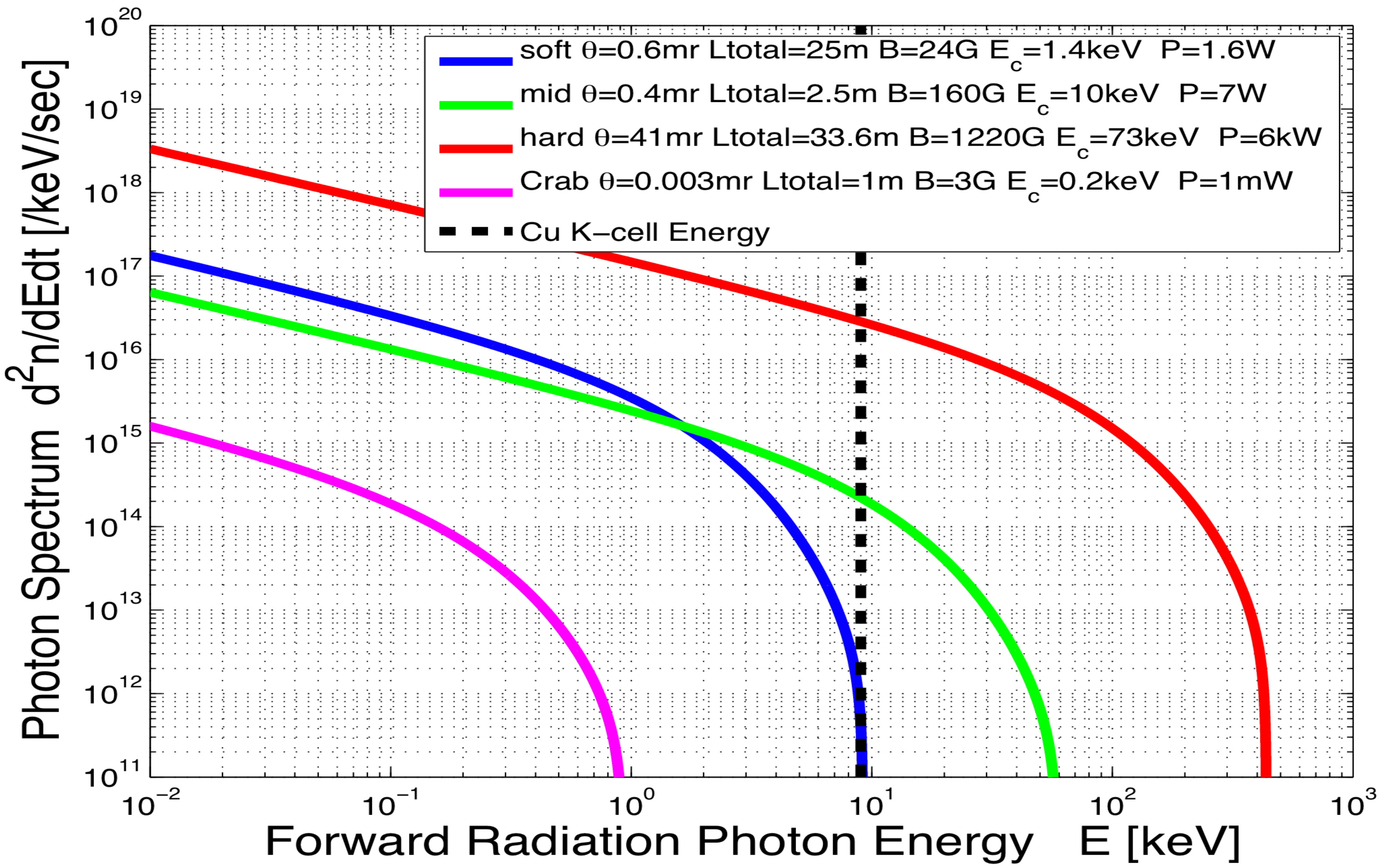
eRHIC IP to Arc Beamline (vertical)

mid & soft bending cleans SR at the detector



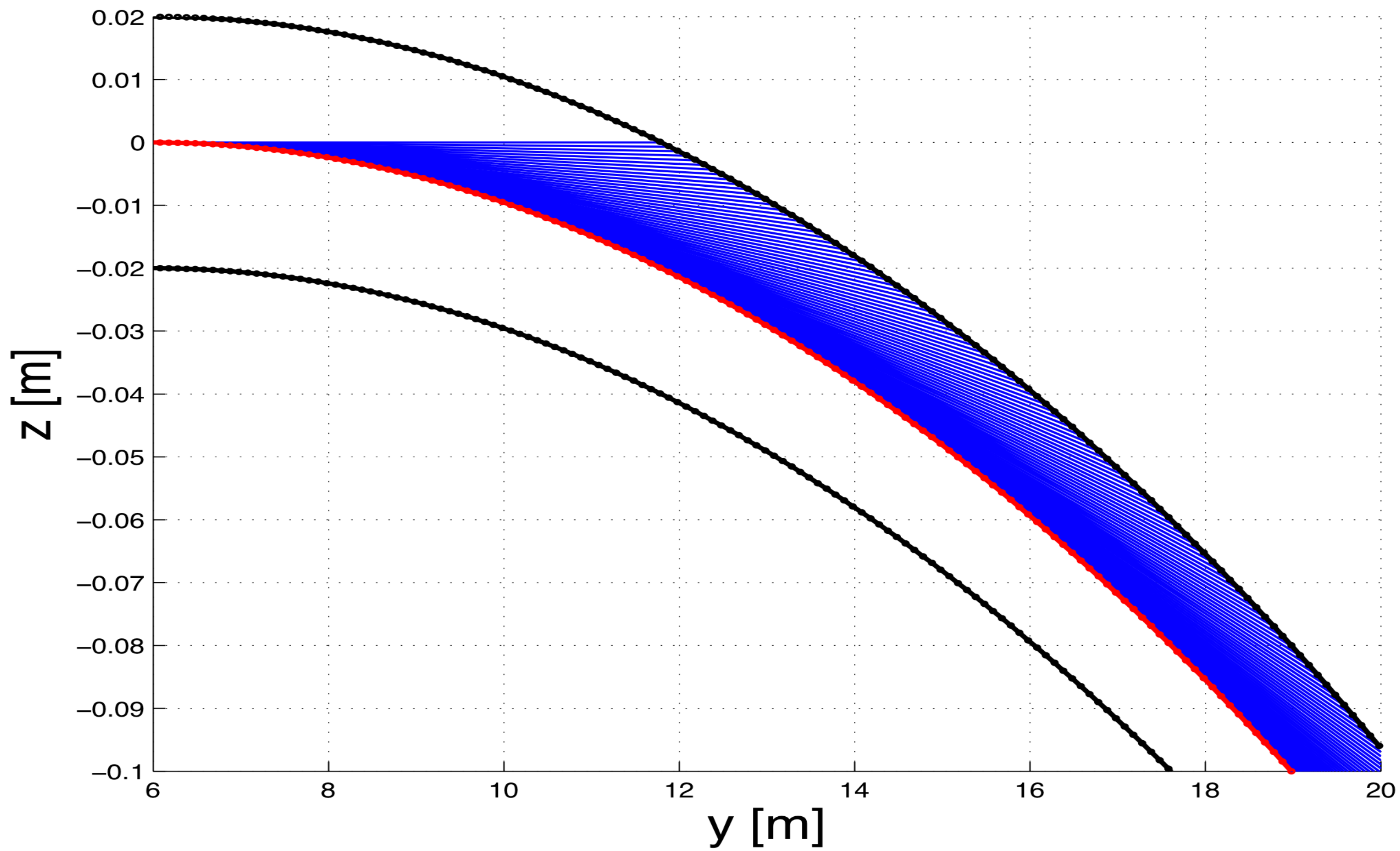
Primary Synchrotron Radiation

hard bending brings beam in, mid & soft cleans SR at the detector



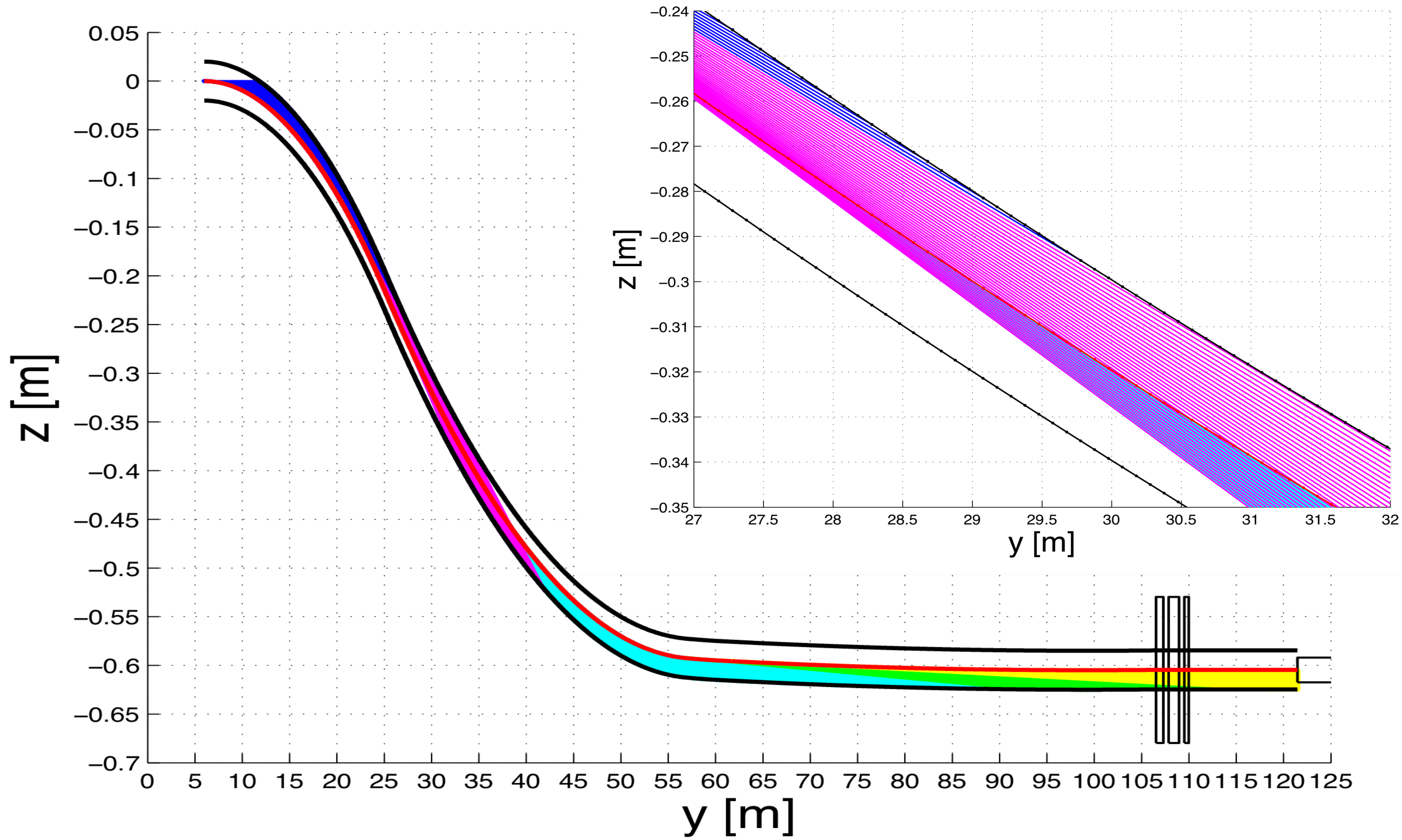
Direct Synchrotron Radiation onto Absorbers

The electron beam line right after the arc



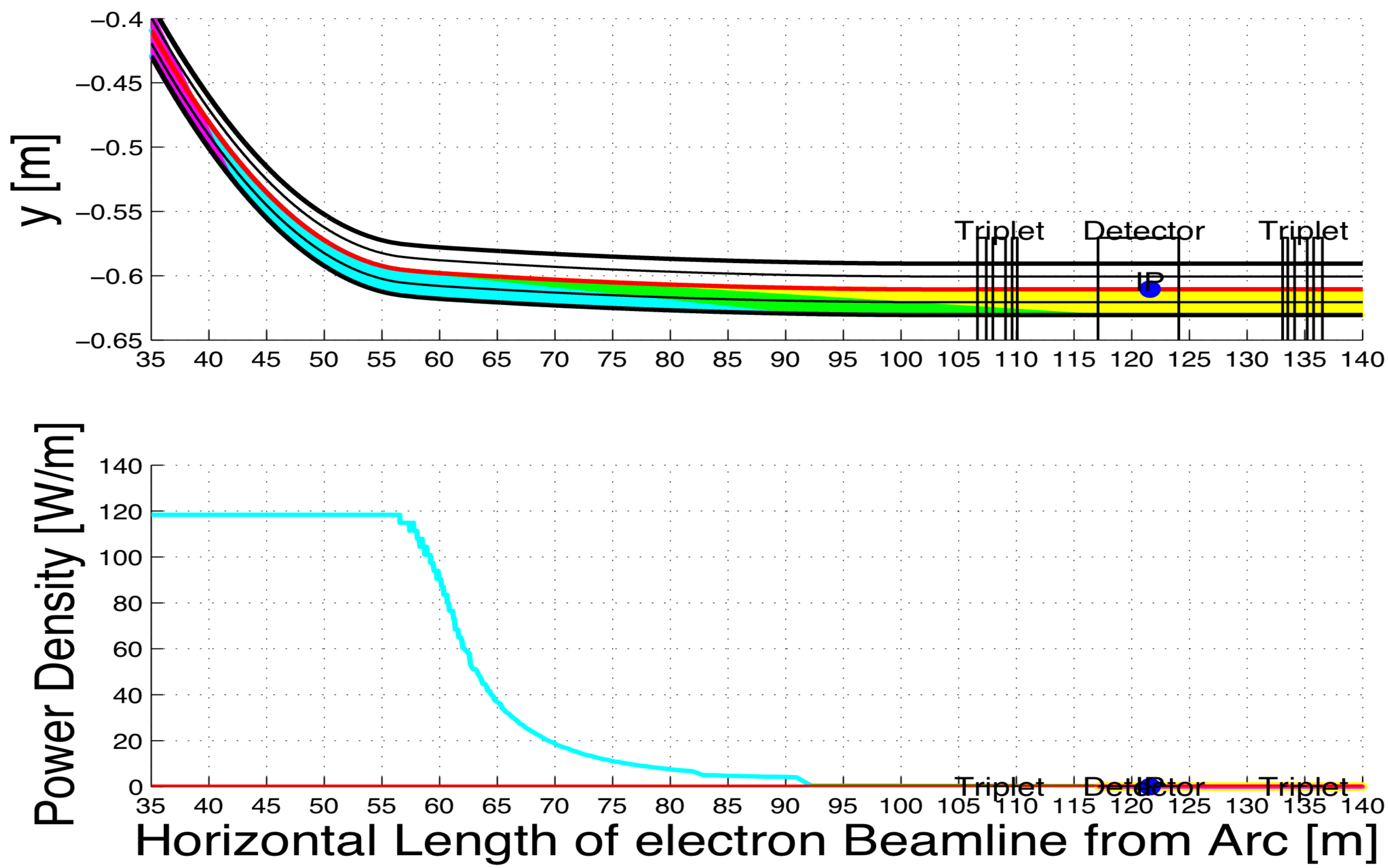
Direct Synchrotron Radiation onto Absorbers

The electron beam line from arc to IP



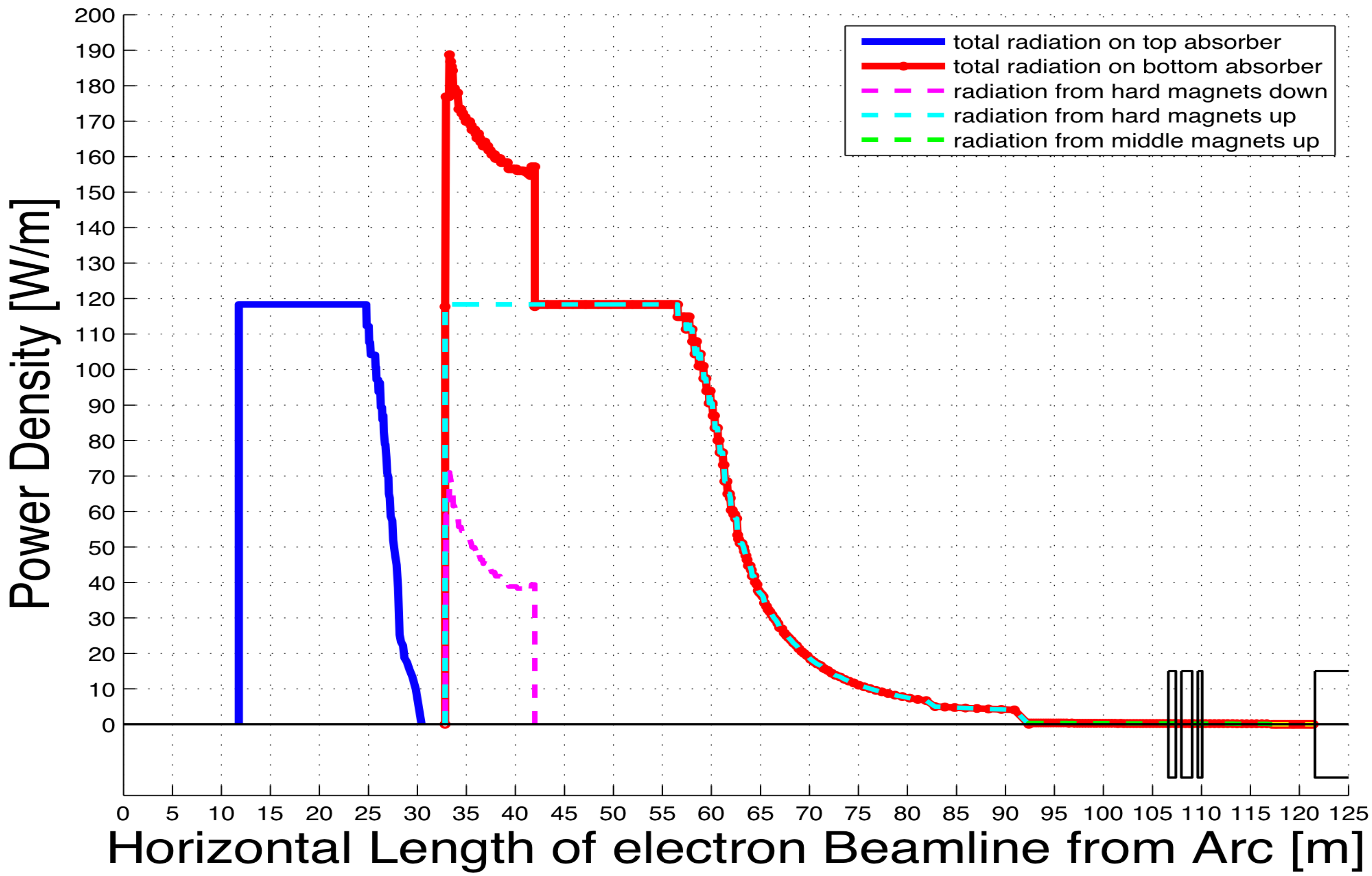
Direct Synchrotron Radiation onto Absorbers

The electron beam line from arc to IP



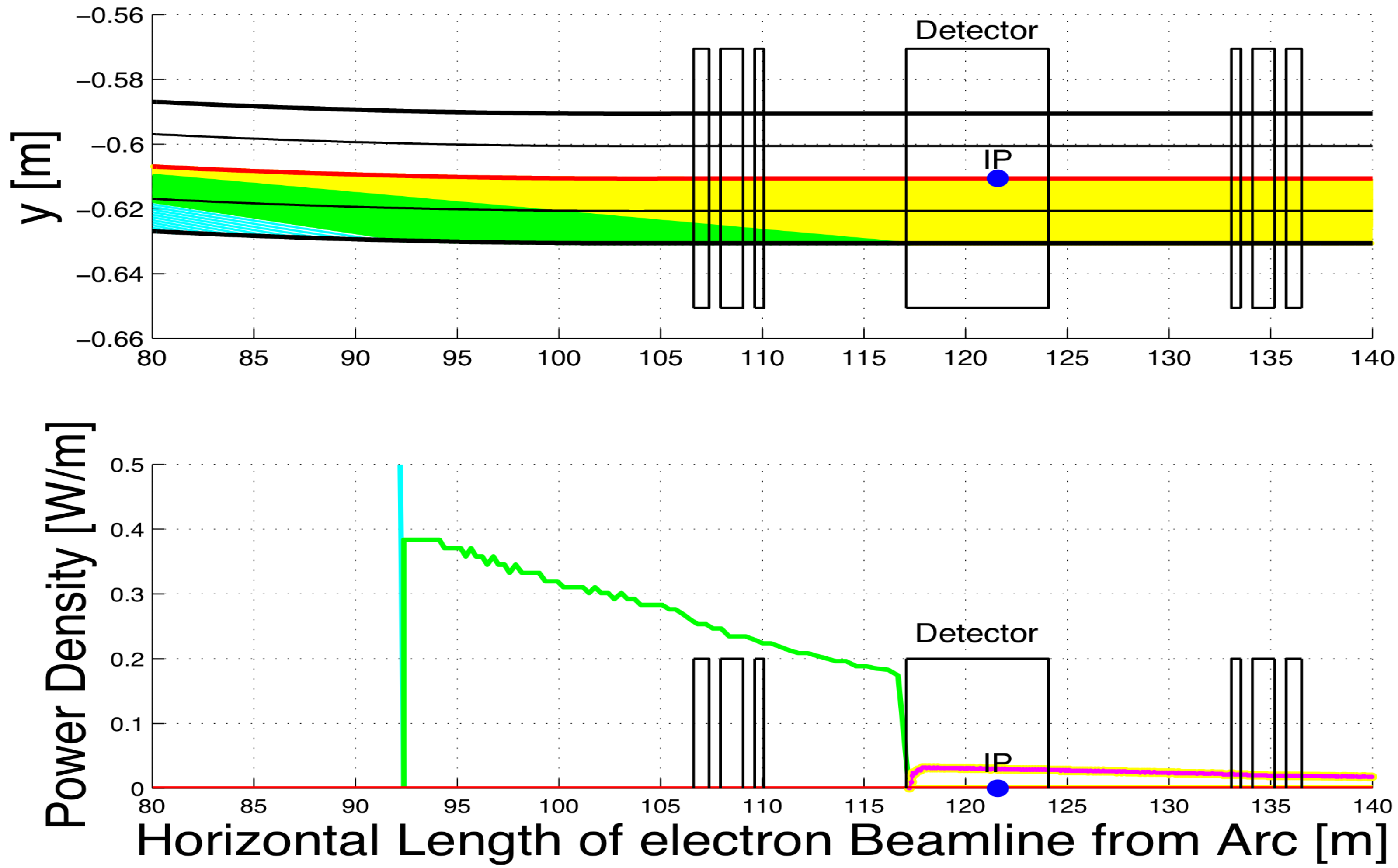
Linear SR Power Density onto Absorbers

The electron beam line from arc to IP



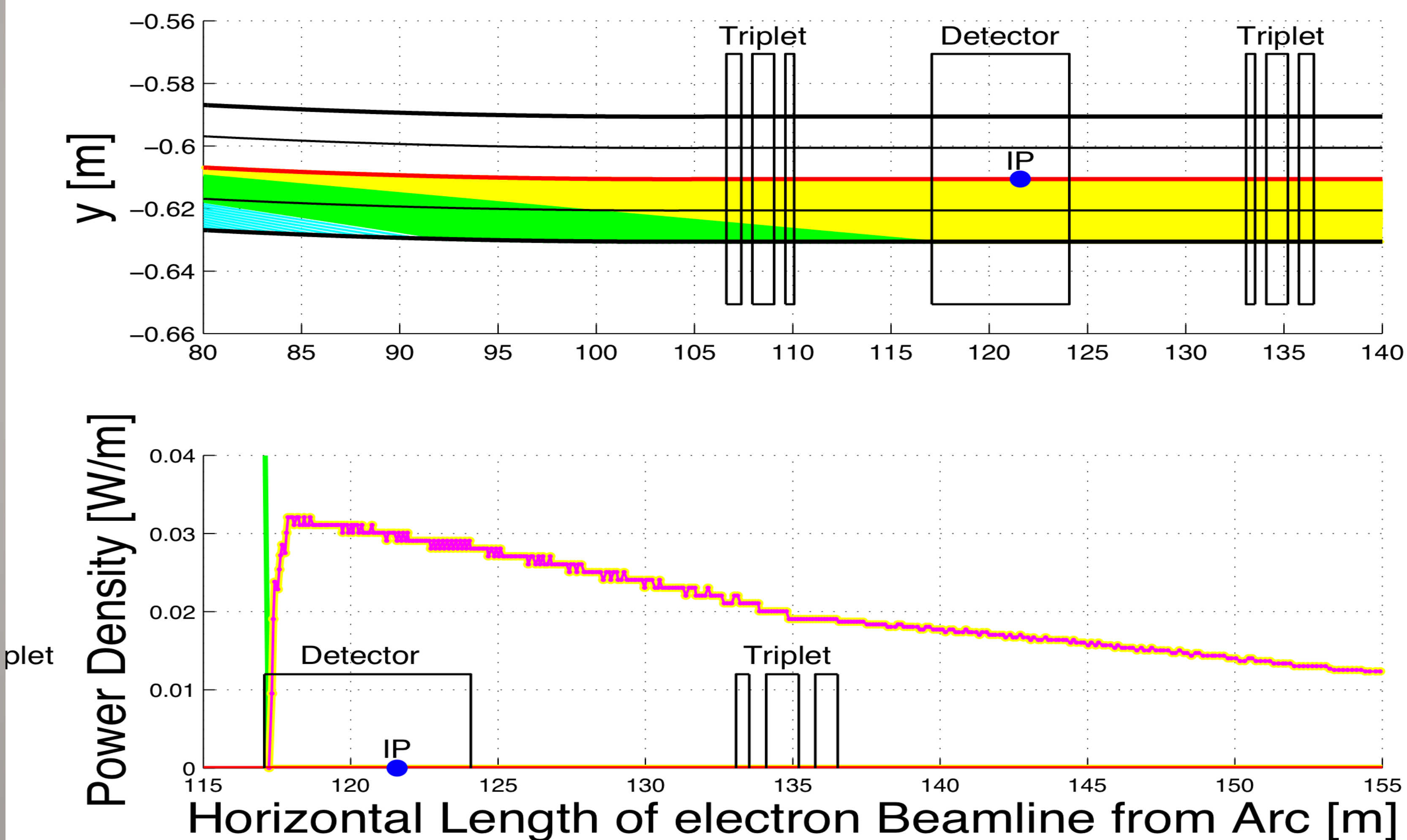
Synchrotron Radiation & Linear SR Power Density

at eRHIC detector and upstream triplet



Synchrotron Radiation & Linear SR Power Density

at eRHIC detector and downstream triplet



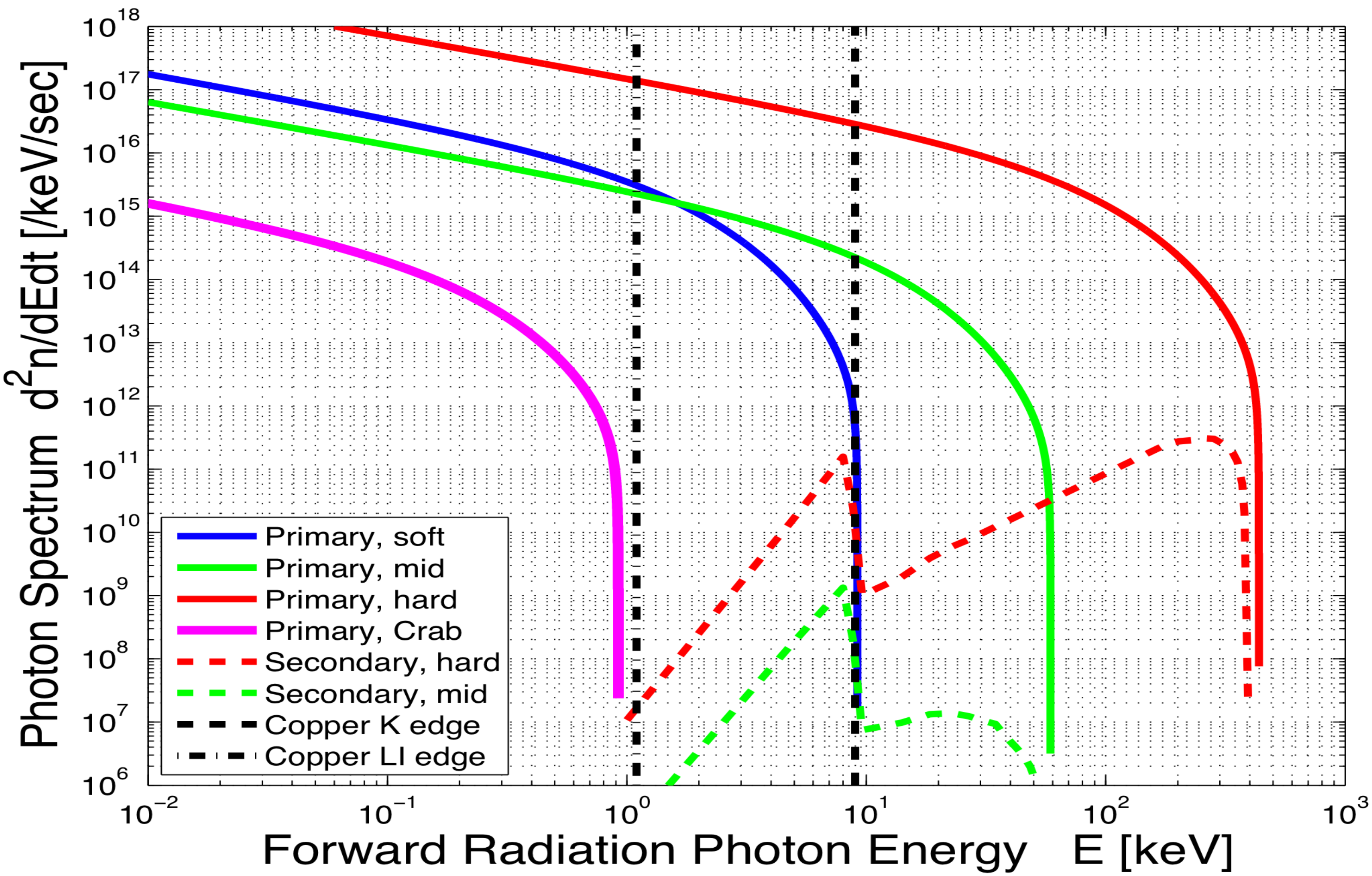
eRHIC Detector Specifications (preliminary)

Communication with Elke Aschenauer

- Total detector length 7m.
- 4.5m on the outgoing ion side.

1. 2.4m on the outgoing electron side.
2. Beryllium pipe inside detector and on outgoing electron side (from the exit of the detector to the hard bending magnet.
3. Alumlum pipe and copper absorber/collimator/mask on the outgoing ion side is fine.
4. Needs to bend the electron up closer to the detector. (the vertical bending on the two sides of IP un-symmetric).
5. No special requirement for the shape and size of Beryllium pipe inside and outside of detector.

Primary and Secondary Synchrotron Radiation in IR



Interaction of Photon-Beryllium

Be (Z = 4)

Atomic weight: A_r = 9.012180 g/mol

Nominal density: $\rho(g/cm^3)$ = 1.848

σ_a(barns/atom) = [μ/ρ] (cm^2/g) x 14.9651

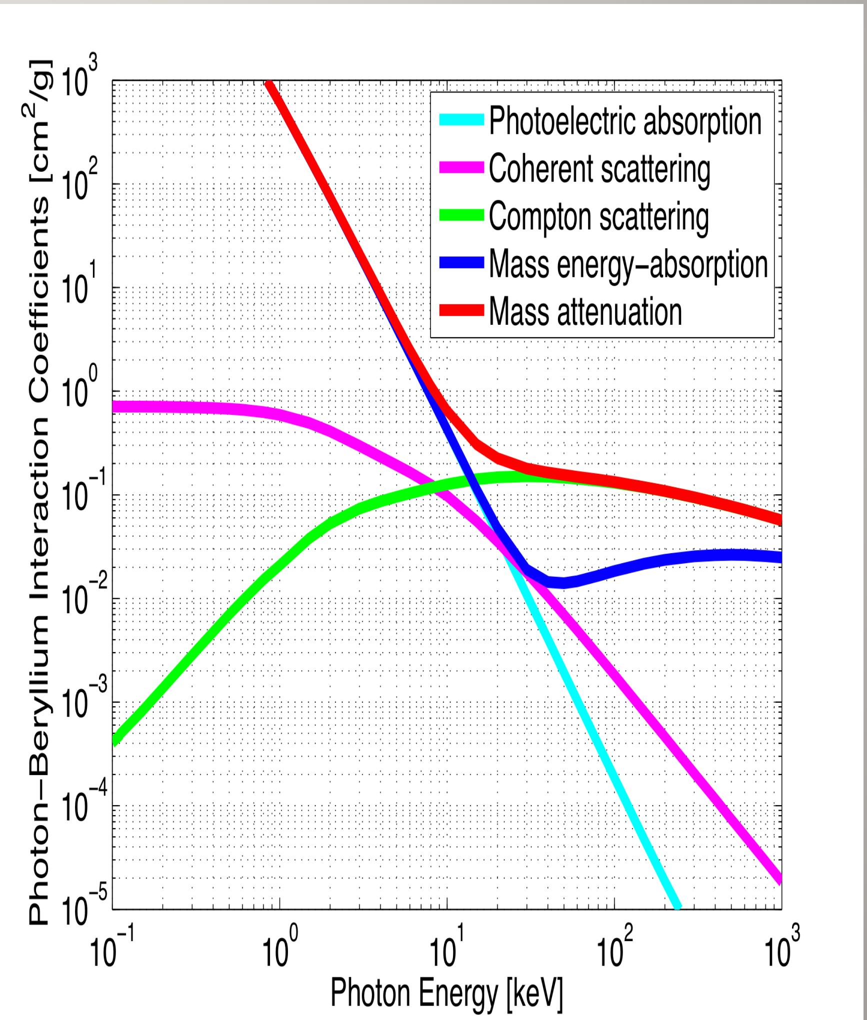
2 edges. Edge energies (keV):

K	1.11E-1
L I	8.42E-3

Data: "Physics Reference Data", Physics Library of NIST

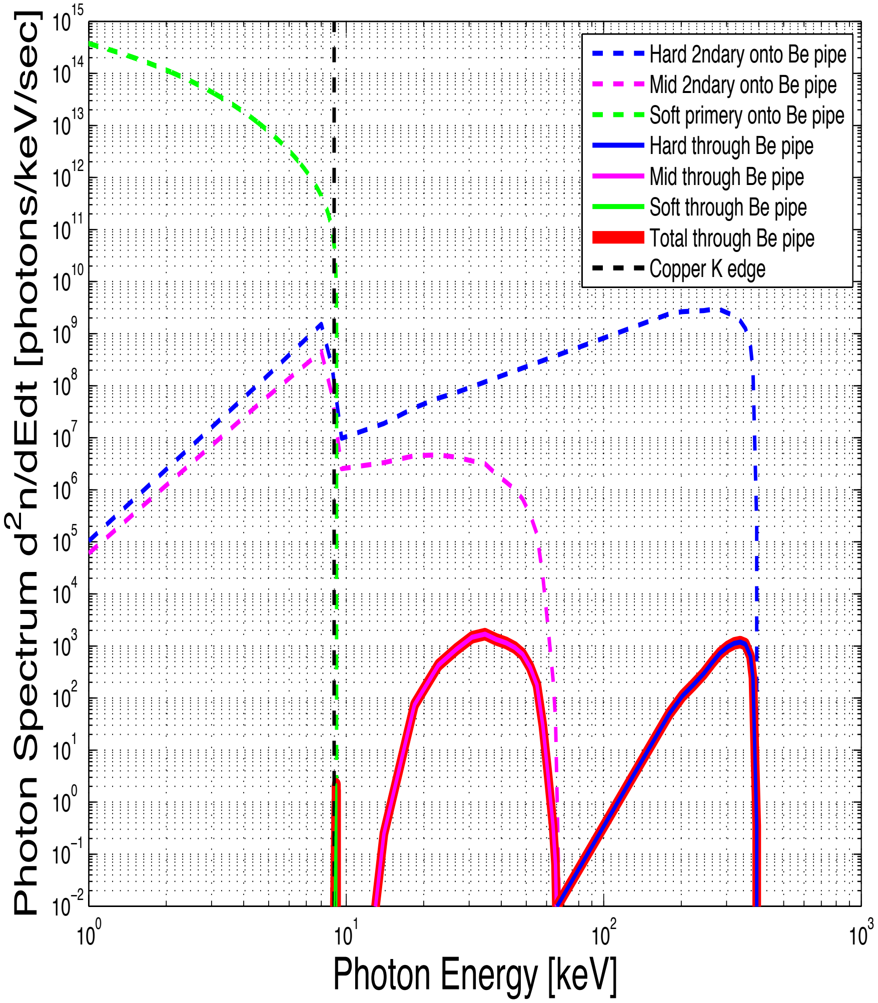
http://physics.nist.gov/PhysRefData/FFast/html/form.html

Database: "Archive of Material Properties" of University of California at San Diego http://aries.ucsd.edu/LIB/PROPS/PHOTON



Estimated SR Background in eRHIC Detector

(Calculated with half average photon pass length in Beryllium pipe)



photons onto Beryllium pipe / photons at detector entrance

2nd Hard	2nd Mid	Prim Soft
0.19	0.34	0.11

	2nd Hard	2nd Mid	Prim Soft
grazing angle, Max [mrad]	1.18	74.97	0.57
grazing angle, Min [mrad]	0	1.18	0.51
grazing angle, Ave [mrad]	0.59	4.63	0.54
pass length in Be, Max [m]		0.847	1.977
pass length in Be, Min [m]	0.847	0.013	1.756
pass length in Be, Ave [m]	1.694	0.474	1.86
effective pass length [m]	50% Ave	50% Ave	20% Ave

Discussions

1. In the photon energy range we are interested in (10^0-10^2 keV)
   1. The secondary radiation (off copper surface, go down stream) rate: ~10^{-6}
   2. The Beryllium pipe (1mm) penetration rate: ~10^{-5}
2. What is not included in this study:
   1. A. Some photons could scatter off the thin pipe (shorter pass length);
   2. B. Backward radiation from the elements down stream of the detector;
   3. C. SR from electron going through triplet;
   4. D. Assumed perfect general background shielding and perfect collimation.
3. In this calculation the effective pass length in the material is half of the physical length in the attempt to account what is not included. It could be an over (or under) estimate.
4. Suggest FLUKA simulation (GEANT may not be suitable for low energy end of this study). FLUKA is now installed on the EIC machines and has local experts.