A Spin-Light Polarimeter for the EIC: An Update (RD 2012-11)

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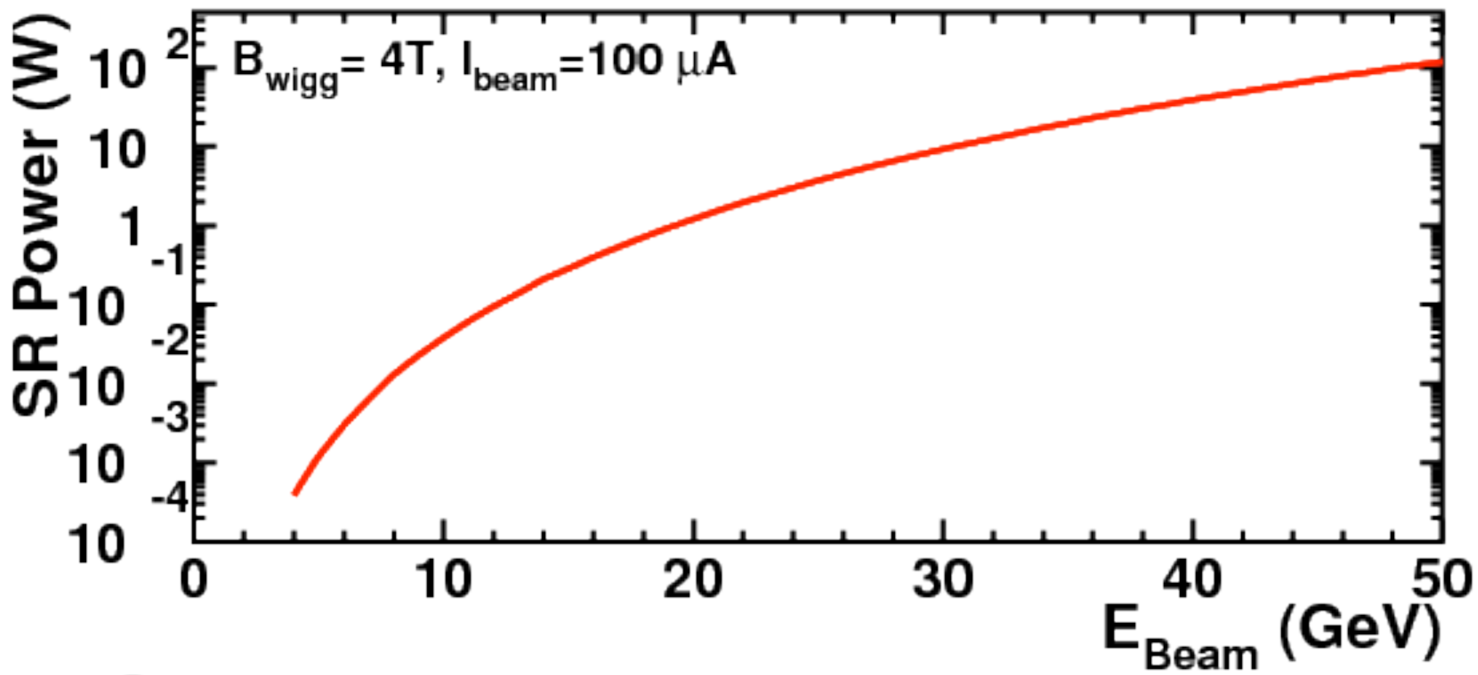
Outline

- **Challenges presented at last meeting**
  - Heat load from SR
  - Collimators interfering with accl. operation

- **New developments & new challenges**
  - Possible location in MEIC lattice
  - New detector options
  - smaller asymmetry

- **Path forward**
  - More simulations
  - explore location in eRHIC lattice

Some Challenges



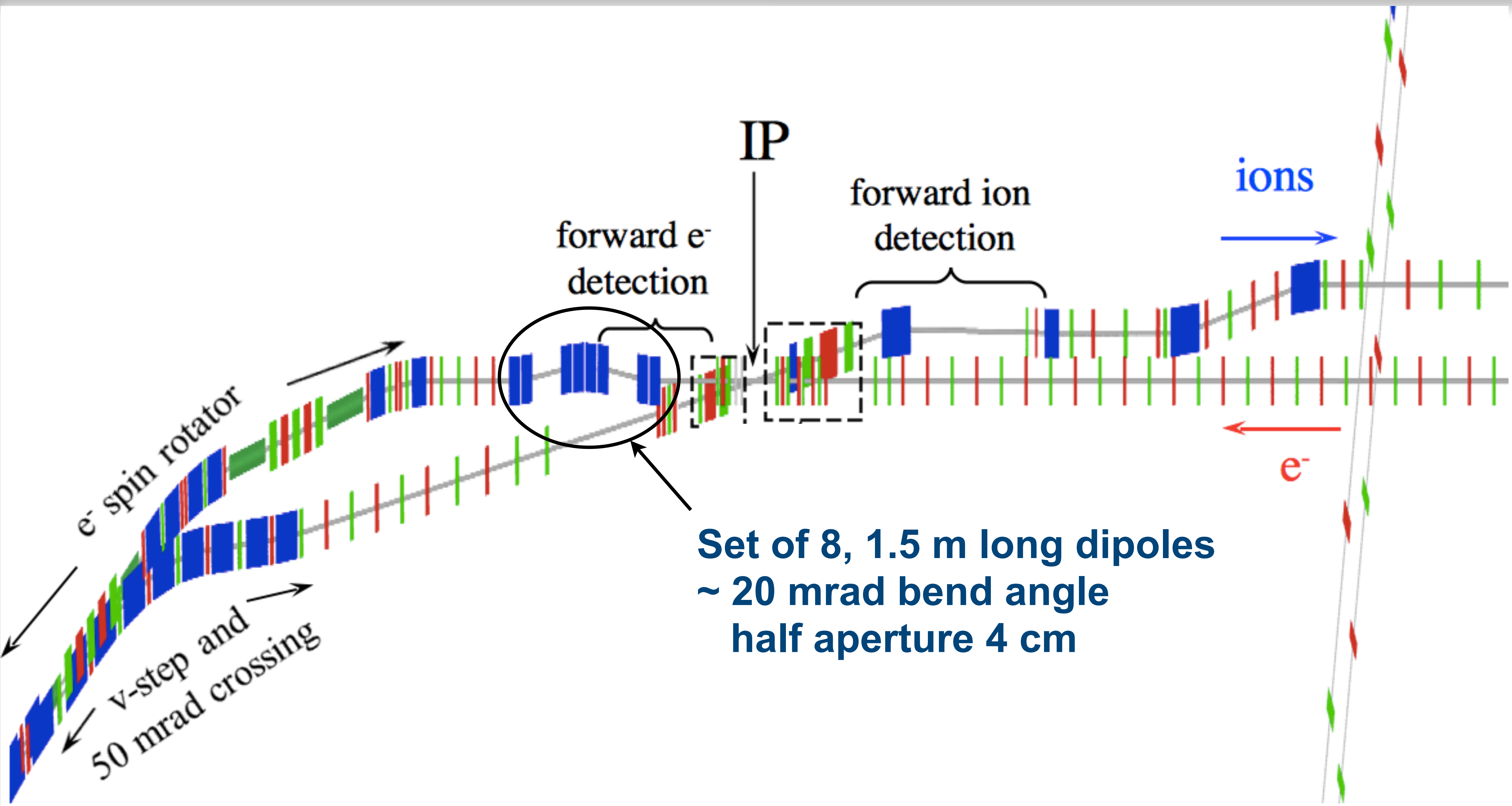
SR power will be distributed over an area of 100 mm x 1 mm.

Current state-of-the-art can withstand power densities of 100 W/mm^2
A Spin-light device of the conceptual design is best suited for the 4 - 20 GeV energy range for currents less than 10 mA

For the proposed compact design the collimators and slits needed would be difficult to accommodate in a collider.

Possible solution: use bending magnets that are part of the current lattice

Possible Location at MEIC

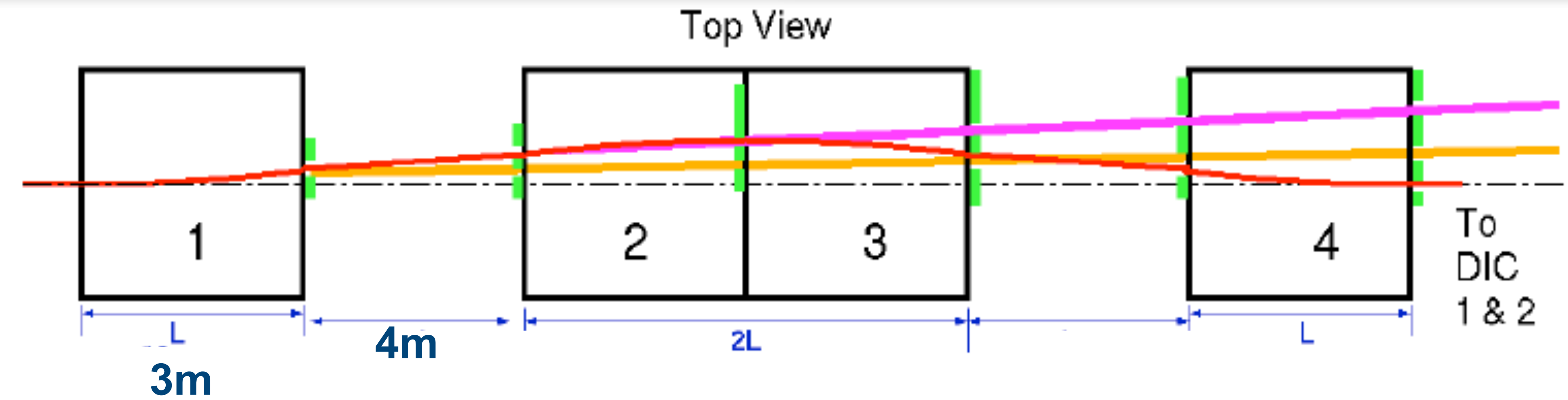


Set of 8, 1.5 m long dipoles
~ 20 mrad bend angle
half aperture 4 cm

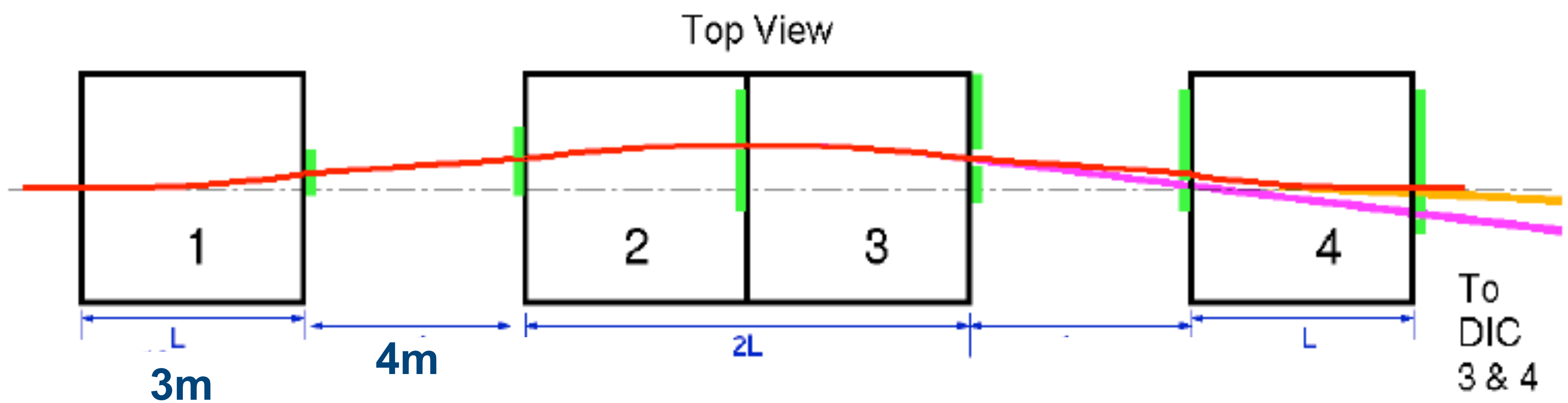
Large separation between the magnets and 20 mrad bend angle may allow for a set of collimators that can separate the SR fan from each dipole.

But the field strength ranges from 0.22 - 0.55 T
(compared to the 4T wiggler in the original design)

Collimating the SR

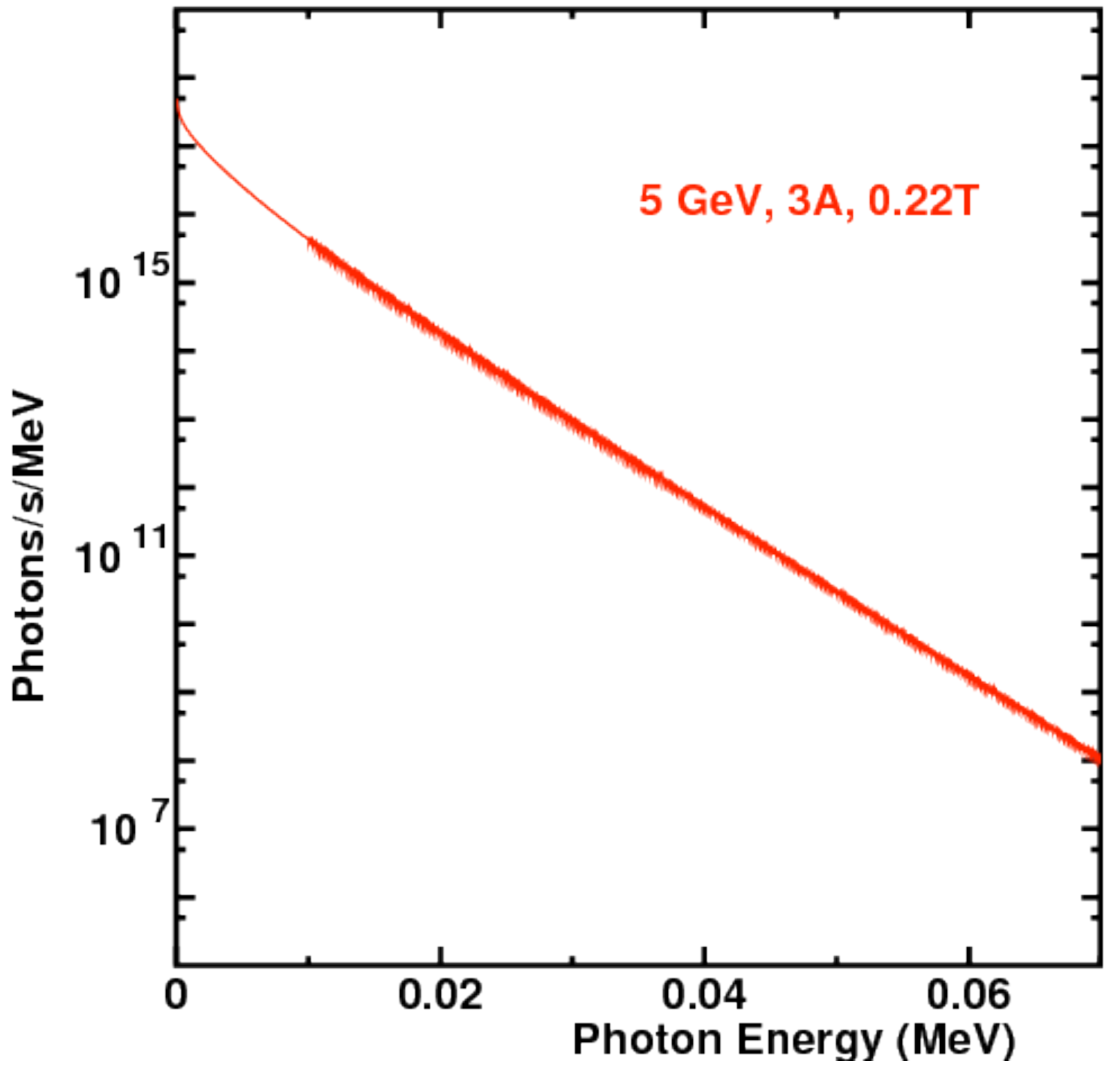


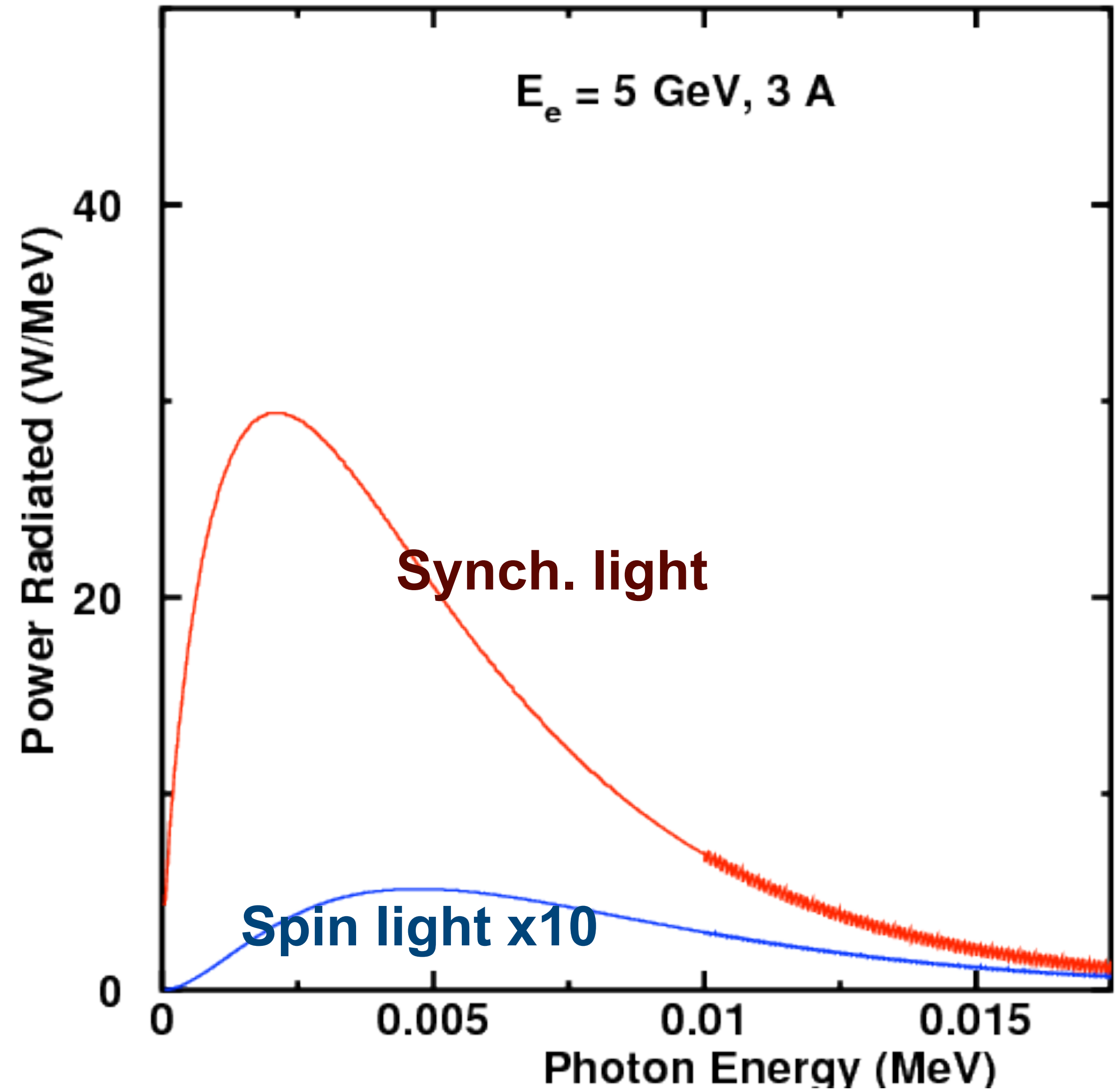
20 mrad bend



The placement of collimators and slits is much simpler and will not interfere with accelerator operations.

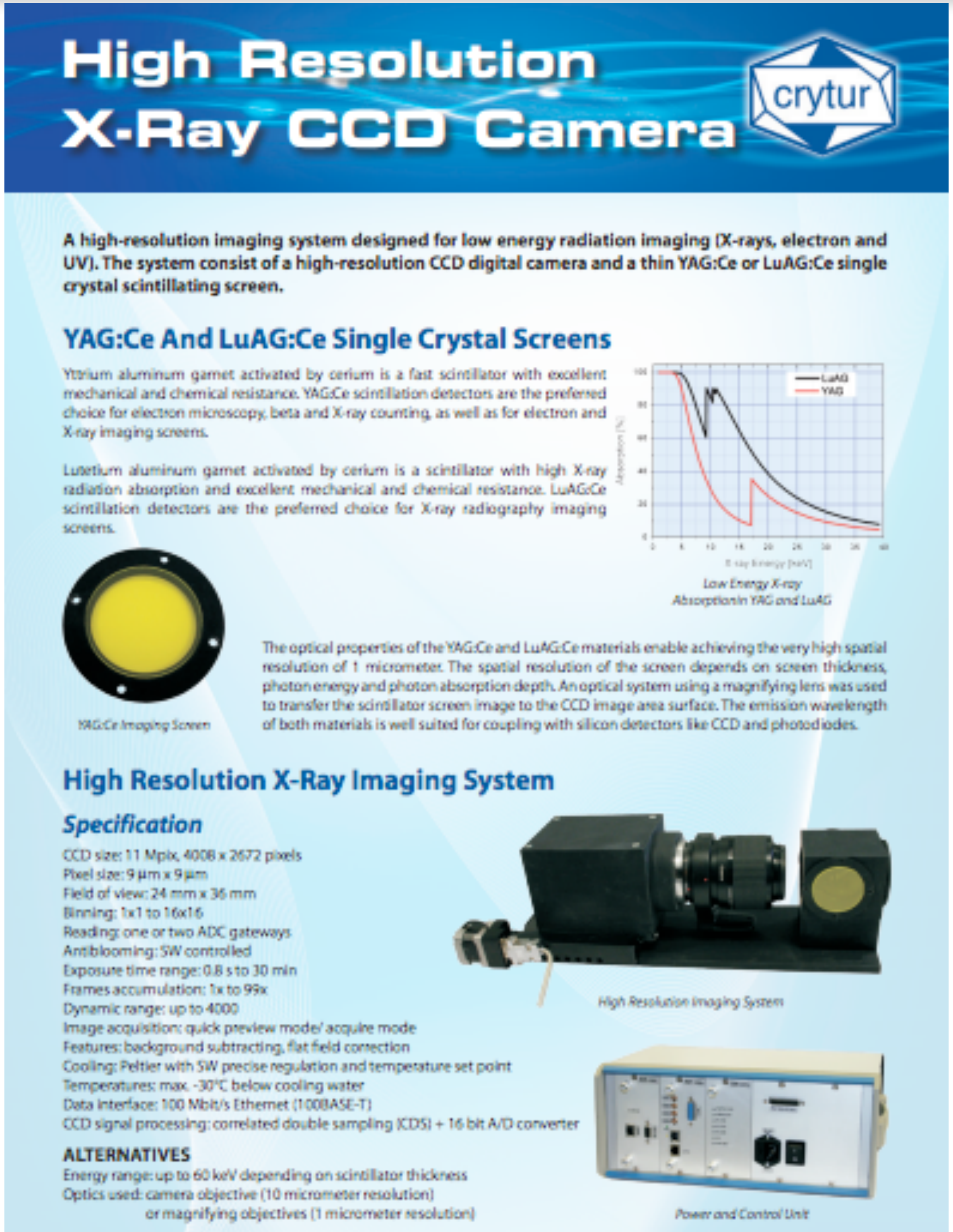
Some Spin Light Spectra





Photon energy now peaks in the 10s of keV range. Opens up several more detectors options such as x-ray CCD with 1 μm resolution.

CCD X-Ray detectors



High Resolution X-Ray CCD Camera

crytur

A high-resolution imaging system designed for low energy radiation imaging (X-rays, electron and UV). The system consist of a high-resolution CCD digital camera and a thin YAG:Ce or LuAG:Ce single crystal scintillating screen.

YAG:Ce And LuAG:Ce Single Crystal Screens

Yttrium aluminum garnet activated by cerium is a fast scintillator with excellent mechanical and chemical resistance. YAG:Ce scintillation detectors are the preferred choice for electron microscopy, beta and X-ray counting, as well as for electron and X-ray imaging screens.

Lutetium aluminum garnet activated by cerium is a scintillator with high X-ray radiation absorption and excellent mechanical and chemical resistance. LuAG:Ce scintillation detectors are the preferred choice for X-ray radiography imaging screens.

Low Energy X-ray Absorption in YAG and LuAG

YAG:Ce Imaging Screen

The optical properties of the YAG:Ce and LuAG:Ce materials enable achieving the very high spatial resolution of 1 micrometer. The spatial resolution of the screen depends on screen thickness, photon energy and photon absorption depth. An optical system using a magnifying lens was used to transfer the scintillator screen image to the CCD image area surface. The emission wavelength of both materials is well suited for coupling with silicon detectors like CCD and photodiodes.

High Resolution X-Ray Imaging System

Specification

CCD size: 11 Mpix, 4008 x 2672 pixels
Pixel size: 9 µm x 9 µm
Field of view: 24 mm x 36 mm
Binning: 1x1 to 16x16
Reading: one or two ADC gateways
Antiblooming: SW controlled
Exposure time range: 0.8 s to 30 min
Frames accumulation: 1x to 99x
Dynamic range: up to 4000
Image acquisition: quick preview mode/ acquire mode
Features: background subtracting, flat field correction
Cooling: Peltier with SW precise regulation and temperature set point
Temperatures: max. -30°C below cooling water
Data interface: 100 Mbit/s Ethernet (100BASE-T)
CCD signal processing: correlated double sampling (CDS) + 16 bit A/D converter

ALTERNATIVES
Energy range: up to 60 keV depending on scintillator thickness
Optics used: camera objective (10 micrometer resolution)
or magnifying objectives (1 micrometer resolution)

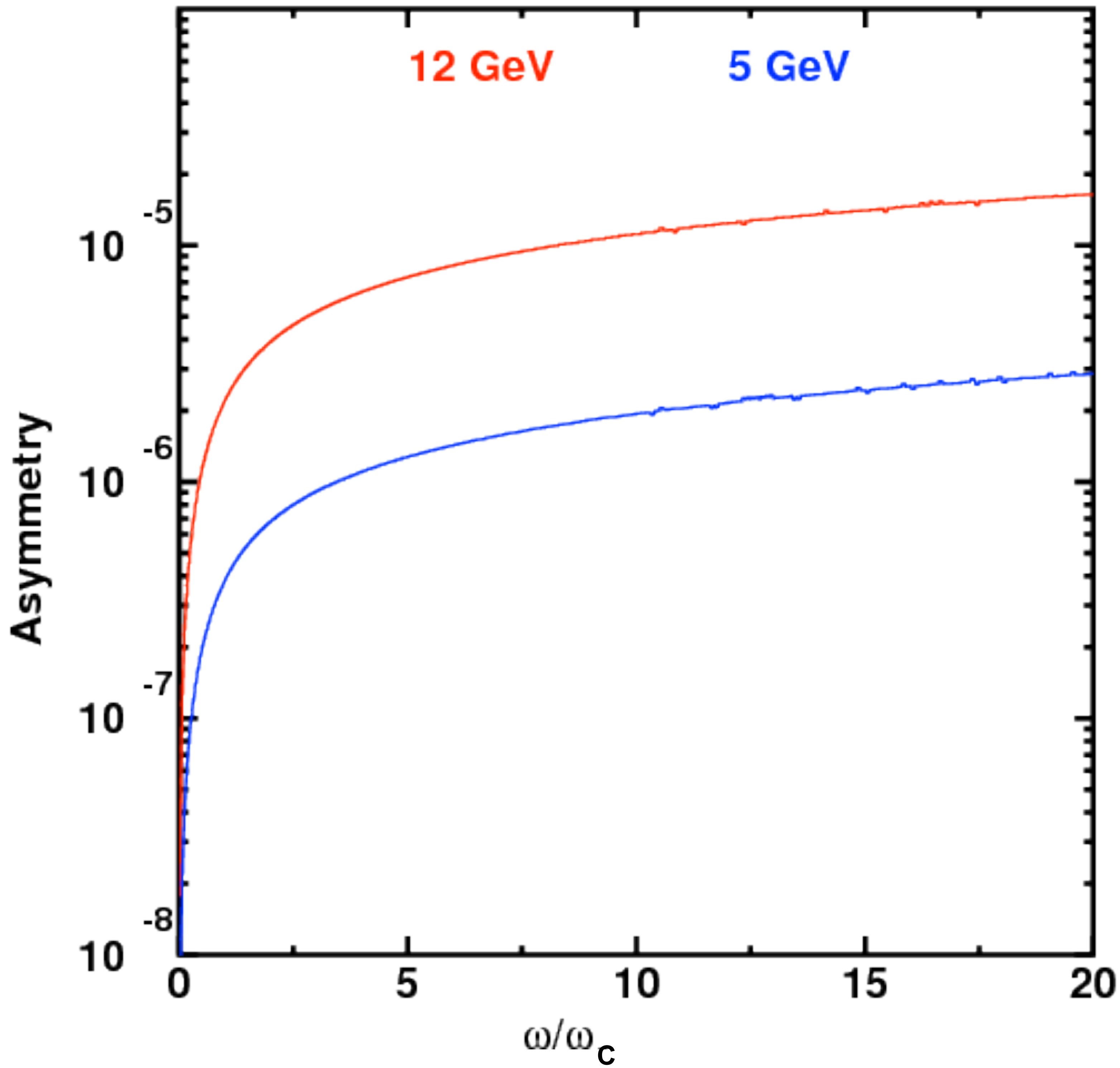
High Resolution Imaging System

Power and Control Unit

High resolution X-Ray CCD cameras available off-the-shelf.

Photon energy now peaks in the 1 - 25 keV range. Opens up several more detectors options such as x-ray CCD with 1 µm resolution.

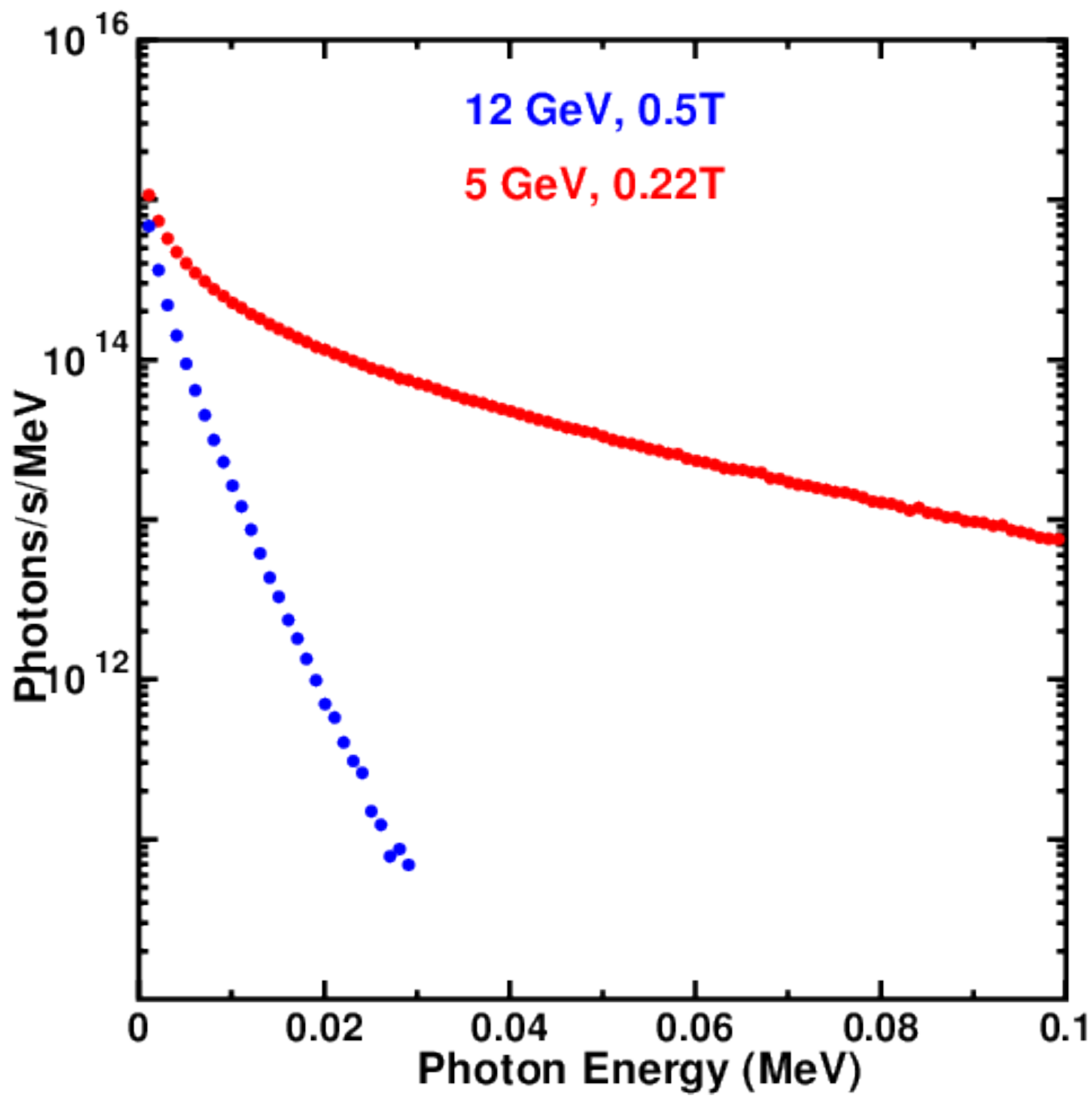
New Challenge

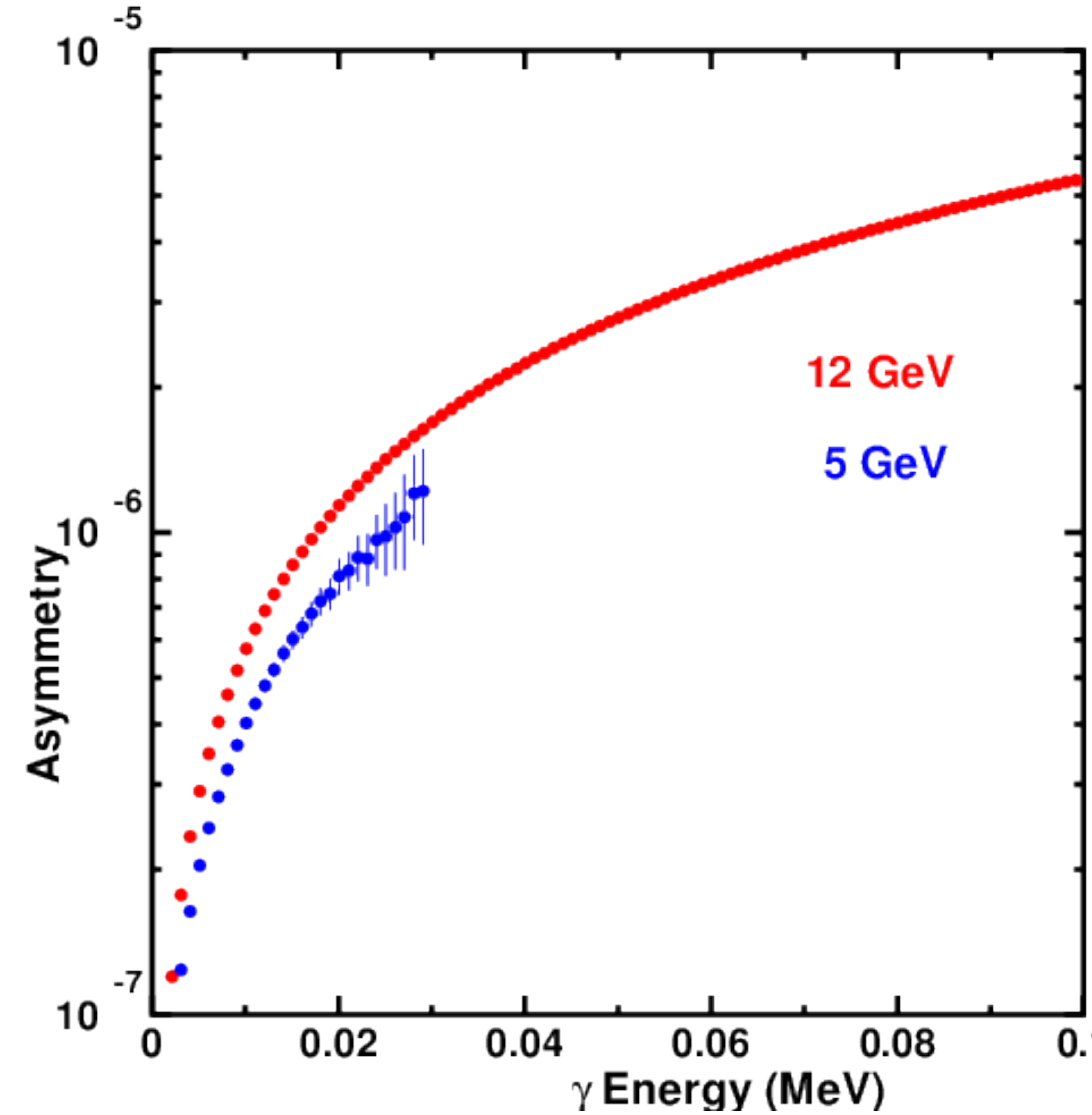


Asymmetry is at least one orders of magnitude smaller

Geant4 Simulations

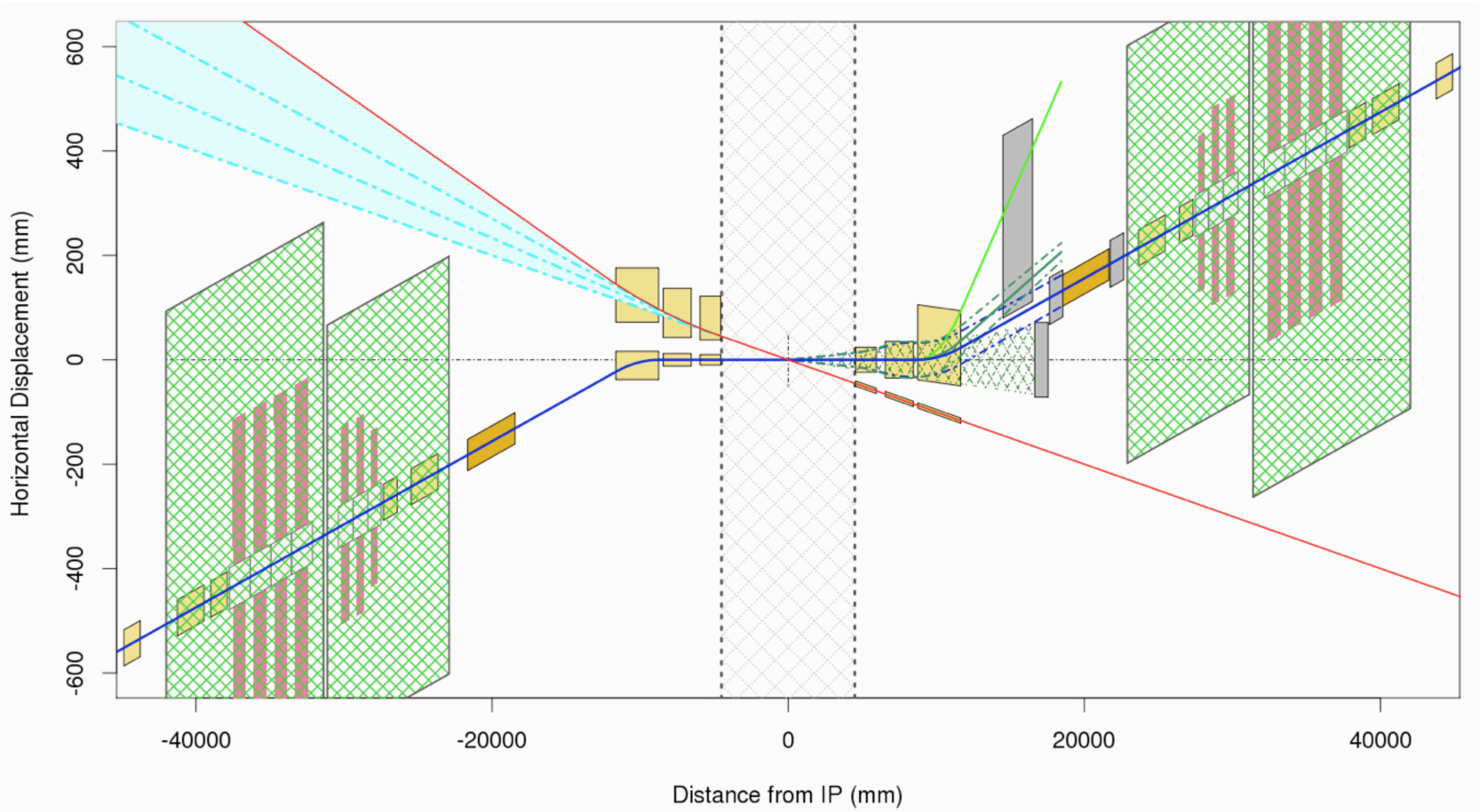
Simulation reproduces photon spectrum and asymmetry





We are exploring the possibility to measure the small asymmetry with the new detector options

eRHIC Options



Consulting BNL experts to determine possible locations in the eRHIC lattice.

Summary

- We have identified a lattice location for a spin-light polarimeter which would use existing magnets rather than a wiggler.

- This option opens up new detector options and would not interfere with accelerator operations.

- But the asymmetry is a order of magnitude smaller and will be challenging to measure.

- We are continuing with Geant4 simulations to study the feasibility and also looking for options in the eRHIC design.