

eRD21 Progress Report: EIC Background Studies and the Impact on the IR

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BNL

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ODU

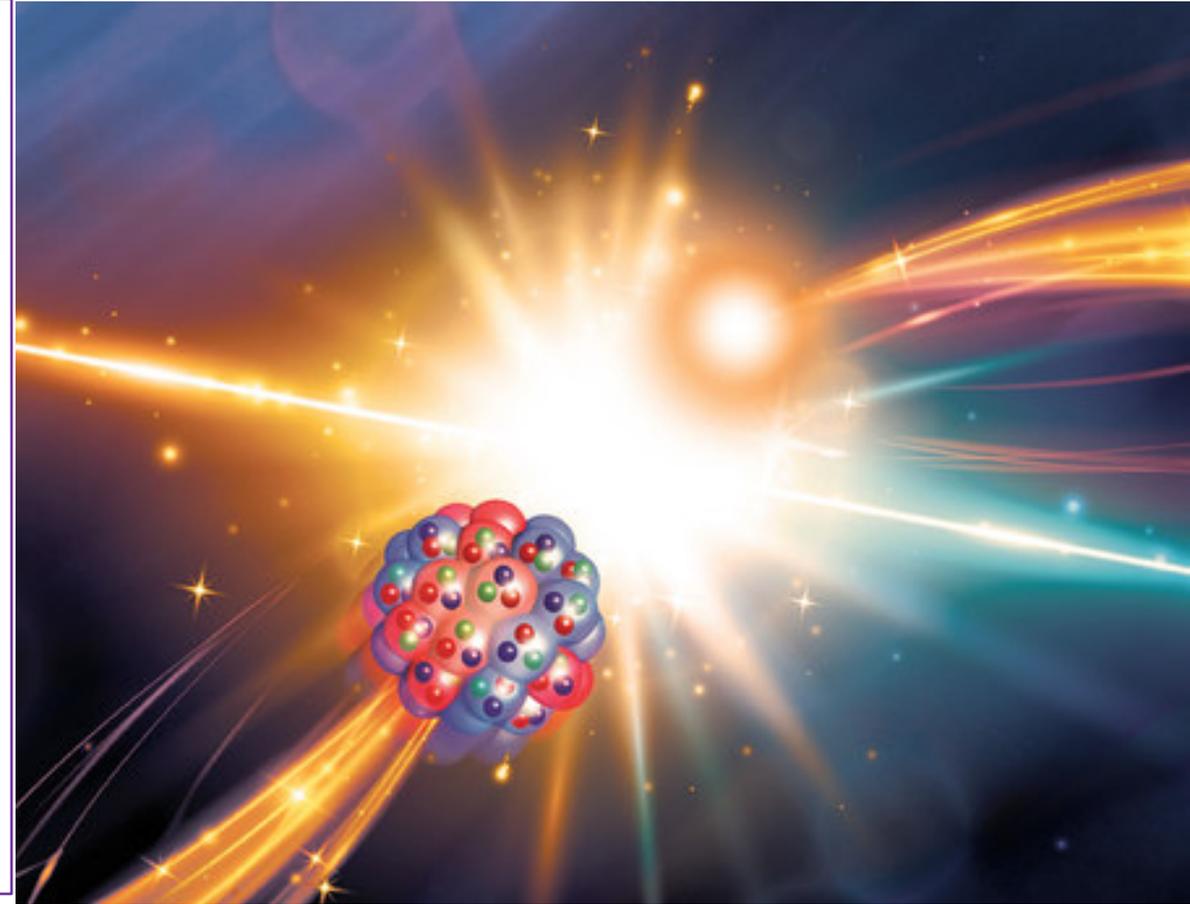
- Charles Hyde
- Christine Ploen
- PostDoc Feb'19

UConn

- Nikolay Markov

SLAC

- Mike Sullivan
- eRD21 partial support



Generic Detector R&D for an EIC Meeting

25 Jan 2019

Activities

- Synchrotron Radiation studies from electron FFQ (Mike Sullivan)
 - Flux calculated for JLEIC66
 - Beam Pipe, Mask, updated
- Beam Gas interactions (Ion Beam)
 - Benchmarked to HERA (C. Ploen, N. Martov,)
- Realistic Vacuum profiles (M. Stutzman: JLEIC)
- Updated IR Design for JLEIC @ $\sqrt{s} = 100$ GeV (V. Morozov)
 - New Beam \otimes Gas background studies in preparation (Y.Furletova, C.Ploen)
- Neutron Flux (A. Kiselev)

Synchrotron Radiation

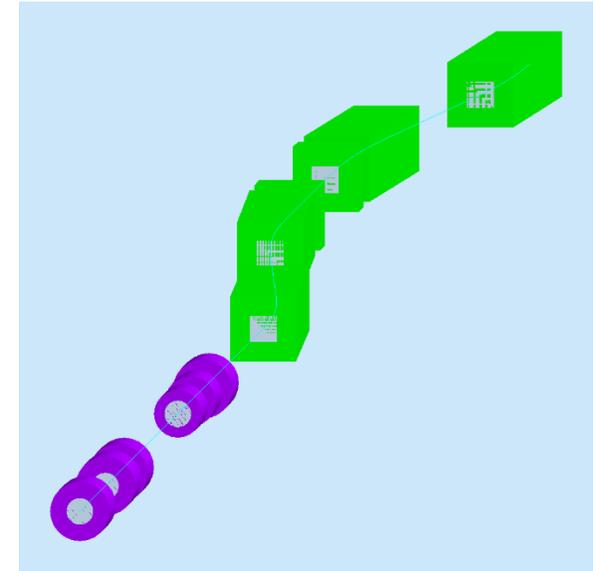
- Radiation from electron quads
 - SLAC codes SYNC_BKG and MASKING
 - Semi Analytic, fast
 - GEANT4
 - Full Propagation, slow
- Benchmarking done

Second half of FY2019:

- Software Integration (ODU Post-doc, Y. Furletova, N. Markov, C. Ploen ...)
 - Use output from SYNC_BKG and MASKING in GEMC (& other detector simulations) and propagate photons through beam pipe and detector
 - Generate detector hits, especially Central Vertex Tracker
 - Compare with full GEANT4 on limited basis
- Synchrotron induced outgassing impact on IP vacuum (M. Stutzman, M. Sullivan)

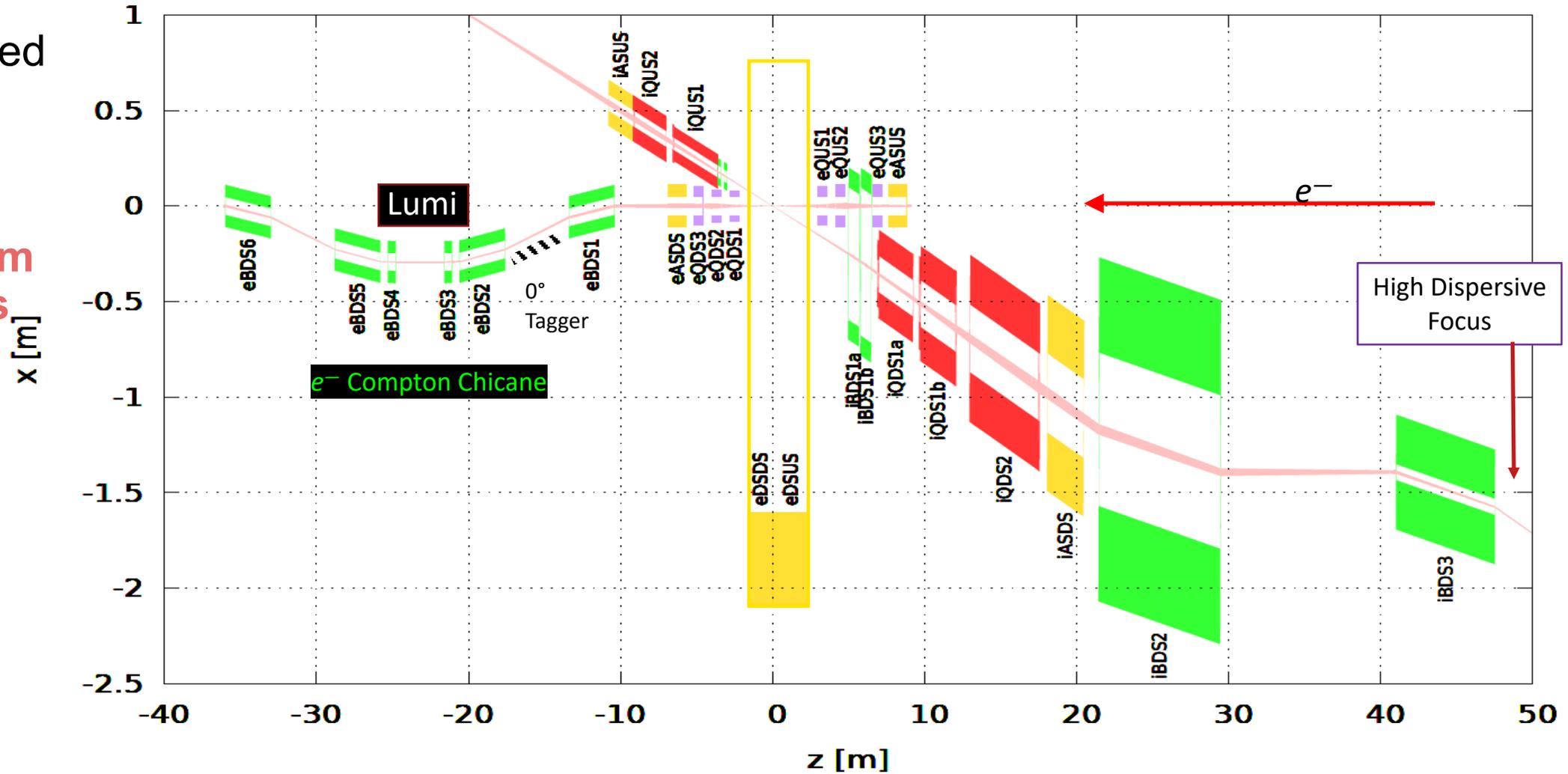
Ion Beam ⊗ Residual Gas

- Benchmarking to HERA done. Publication in progress.
- Fast Integration/Update of Accelerator Design to Physics Simulation
 - Idealized magnets in MAD-X from accelerator group
 - Python script converts to GEANT4 → → →
 - Engineering designs in CAD. Script converts to GEMC
- New work for second half of FY2019
 - Update studies with updated vacuum profiles
 - Update studies with new IR layout: JLEIC100
 - Use projected beam lifetimes to estimate beam halo interactions with beam pipe



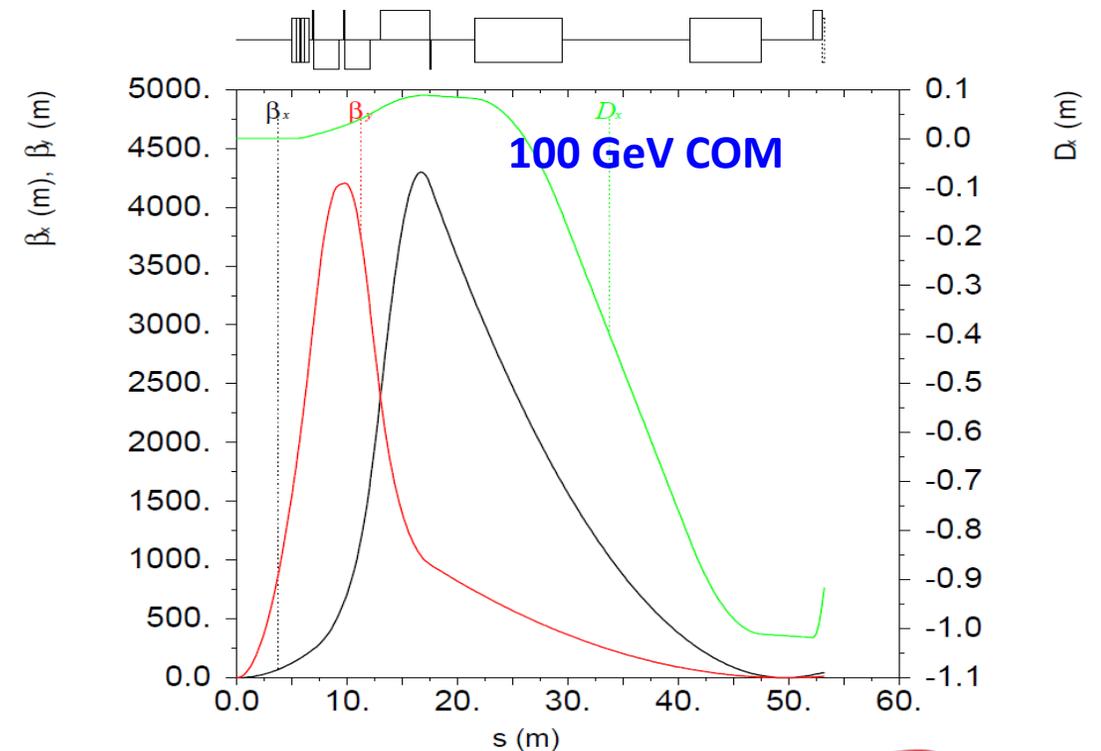
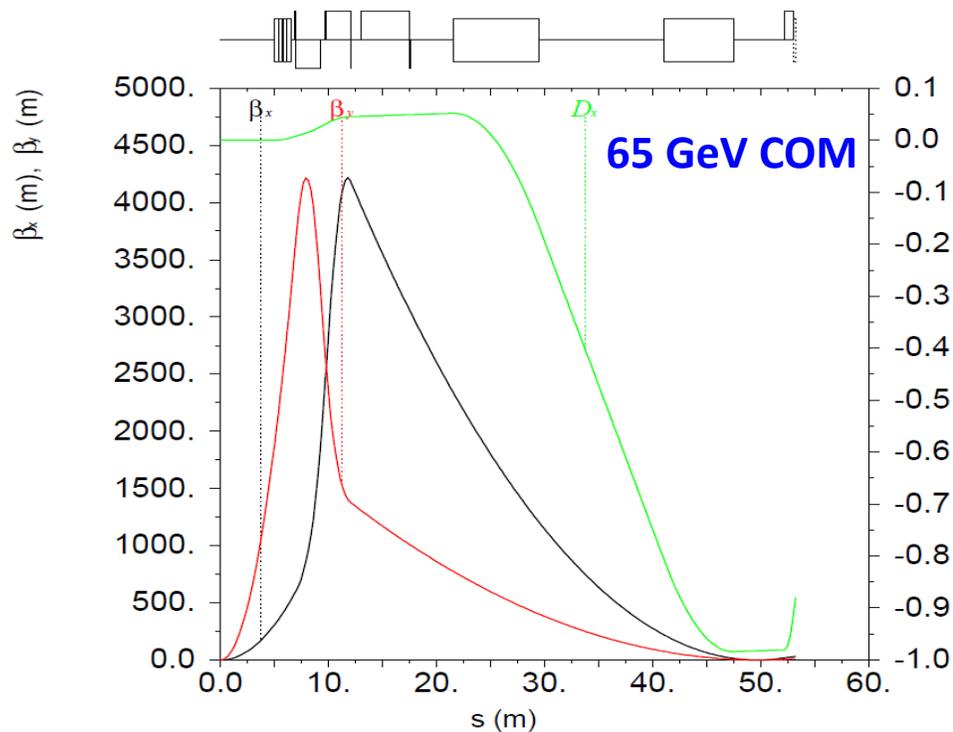
JLEIC $\sqrt{s} = 100$ GeV IR Layout: New Baseline (12 GeV $e^- \otimes 200$ GeV p)

- Design implemented in GEMC detector simulation
- $\pm 10\sigma$ beam envelopes
- **Dipole**
- **Solenoid**
- **iQuad**
- **eQuad**



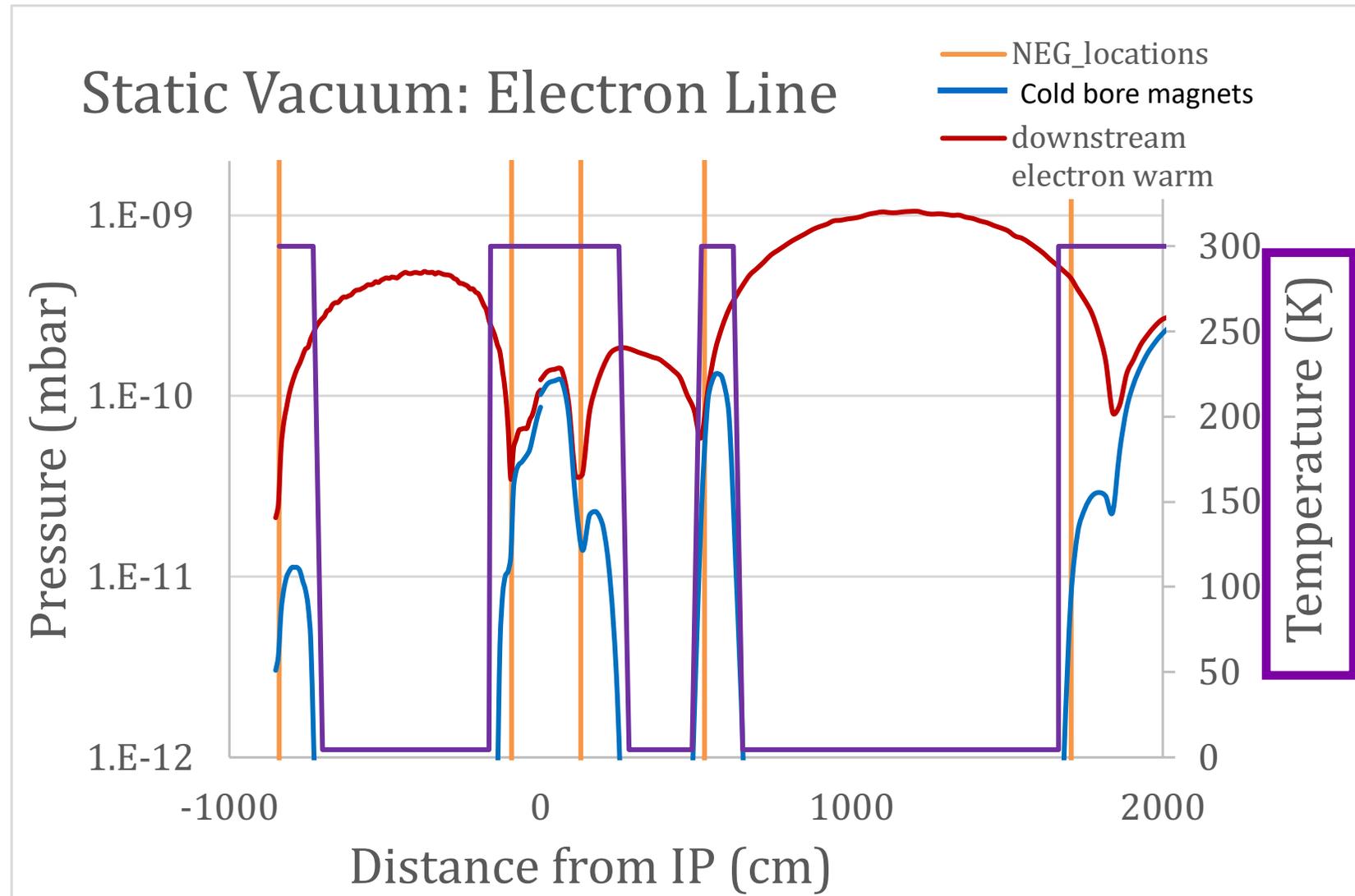
JLEIC 100 GeV COM Design

- **± 10 mrad angular aperture acceptance** in the whole energy range up to 100 GeV COM with a high dispersion secondary focus 50m point downstream of IP (after 3FFQ & 3Dipoles)
- Conventional **Nb-Ti technology** Final-Focusing Quadrupole technology
- Same **high luminosity and detection performance** as the 65 GeV COM design
- **Shorter- and longer-focus configurations** at lower and higher energies, respectively



MolFlow Vacuum Study

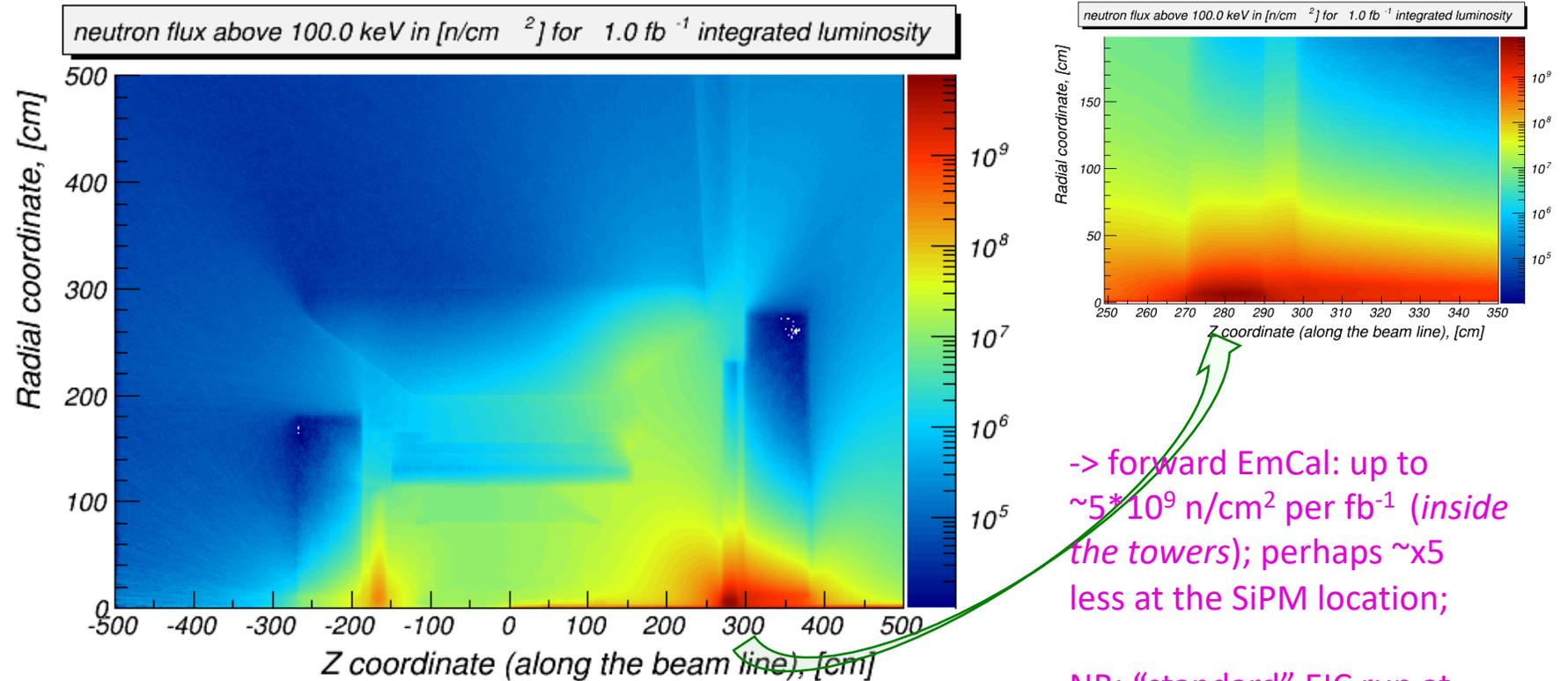
- Realistic Pumping
 - Blue is vacuum (left-axis) with cold-bore magnets(right axis, magenta line)
 - Red is vacuum with warm beam pipe



Neutron flux

The quantity: Flux = "a sum of neutron path lengths"/"cell volume" for N events

-> basically use Y. Fisyak's approach



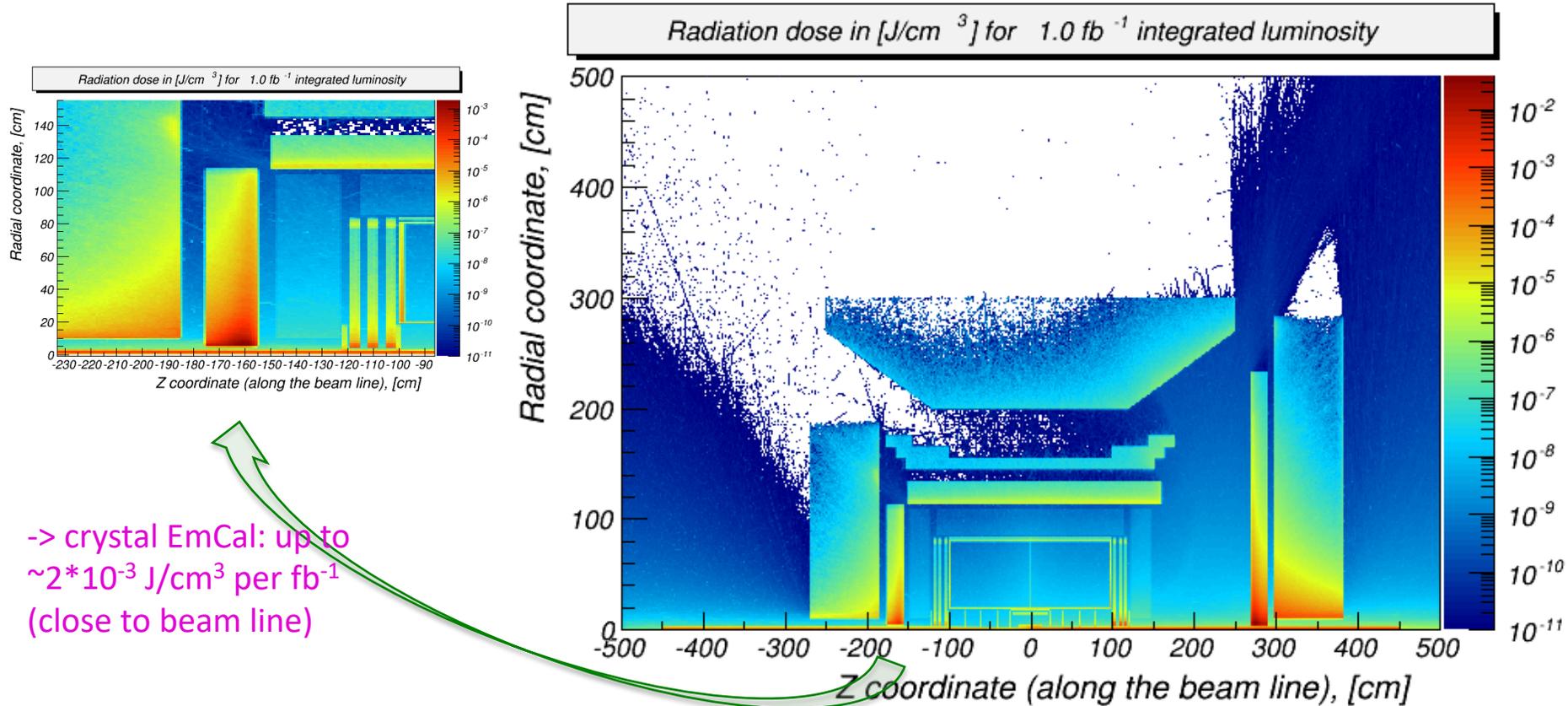
-> forward EmCal: up to
~5*10⁹ n/cm² per fb⁻¹ (inside
the towers); perhaps ~x5
less at the SiPM location;

NB: "standard" EIC run at
~10³³ cm⁻²s⁻¹ luminosity is 10 fb⁻¹

- Assume azimuthally-symmetric setup -> so build {R,Z} map

BEAST Radiation dose study

The (primary) quantity: $E_{\text{sum}} = \text{"a sum of } dE/dx\text{"}/\text{"cell volume"}$ for N events



1 rad = 0.01 Gy . [Gy] = [J/kg] & PWO density $\sim 8\text{g/cm}^3$ ->
 ~ 250 rad/year (at "nominal" luminosity $\sim 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$)

(Possible) next steps (BNL)

- Variable energies ...
- Other event generators (eA in particular) ...
- ... and/or other detector geometries (JLEIC, etc) ...
- ... and/or different calorimeter materials ...
- ... and/or some realistic beam line magnet layout ...

- Cross-check with GEANT4

Radiation Dose Rates Evaluation (Pavel Degtiarenko)

- ❑ The radiation source terms are input to beam transport simulation software, and Monte Carlo simulation of nuclear cascades
 - ❖ GEANT3
 - ❖ Geant4
 - ❖ FLUKA
 - ❖ MARS
- ❑ Reliability is achieved by multiple redundant cross-checks using different models and different methods, different people
- ❑ The plan is to investigate applicability of different model approaches to the calculations of the radiation environment at the JLEIC Interaction Points, with the emphasis on the model cross-comparison and (if possible) comparison with experimental data

ODU Plan for neutron thermalization study

- 2018 SULI project at JLab demonstrated most ion beam-loss happens at the collimators
- Build a simplistic model of the accelerator tunnel
 - Uniform concrete wall thickness
 - Iron (mostly, + air) distributed quasi-uniformly throughout tunnel.
- Generate hadrons
 - Uniform Beam-Gas interactions
 - Point sources at collimators
- Propagate / thermalize the `neutron gas' to estimate backgrounds at IP from distant sources.
- eRD21 + StonyBrook CFNS + ODU grant funding (DOE)
 - New Post Doc expected to start in Feb. ~75% on eRD21 studies