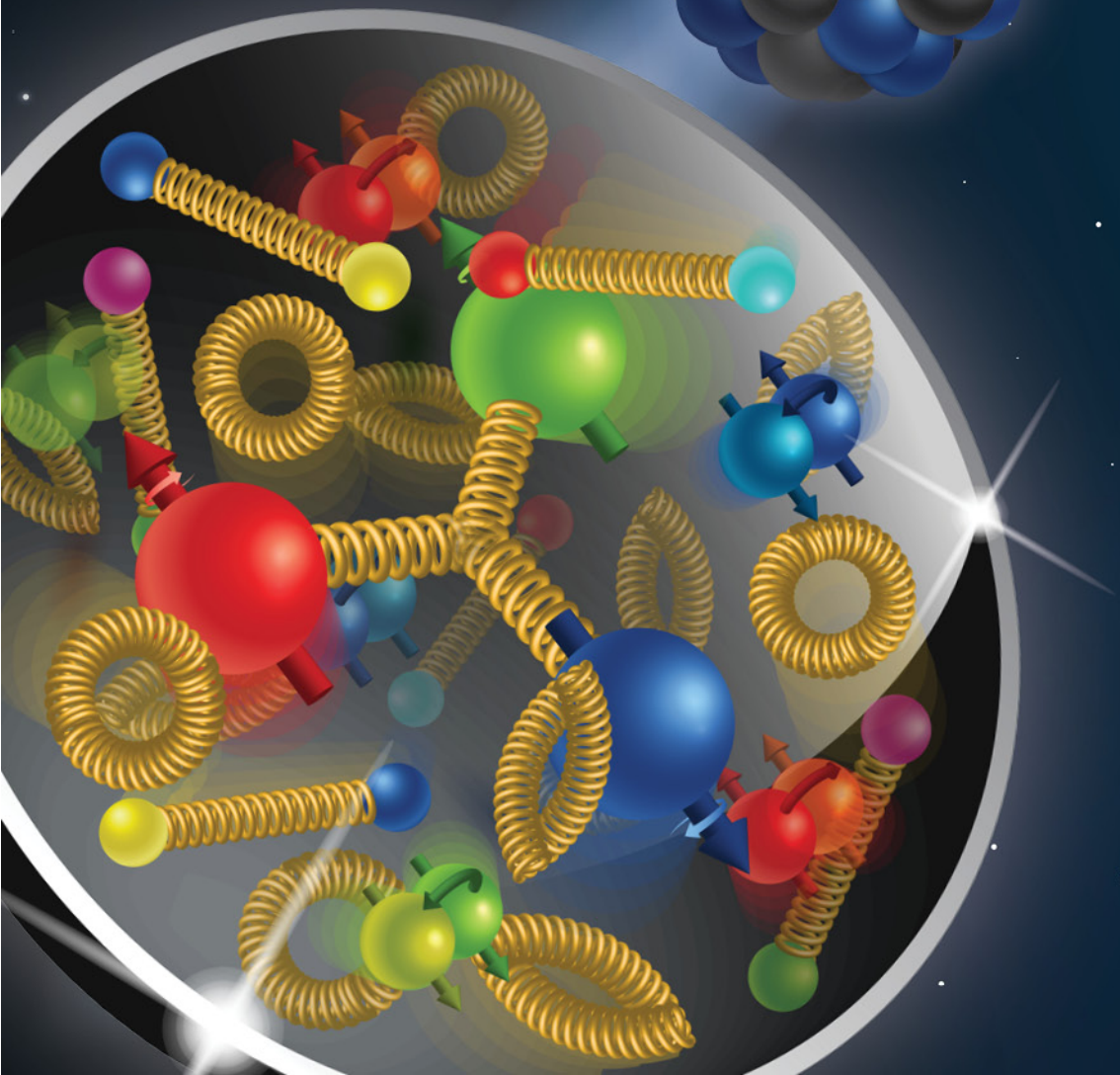
TUPAB235



Dynamic Aperture Optimization in the EIC Electron Storage Ring with Two Interaction Points

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Electron-Ion Collider

BROOKHAVEN NATIONAL LABORATORY

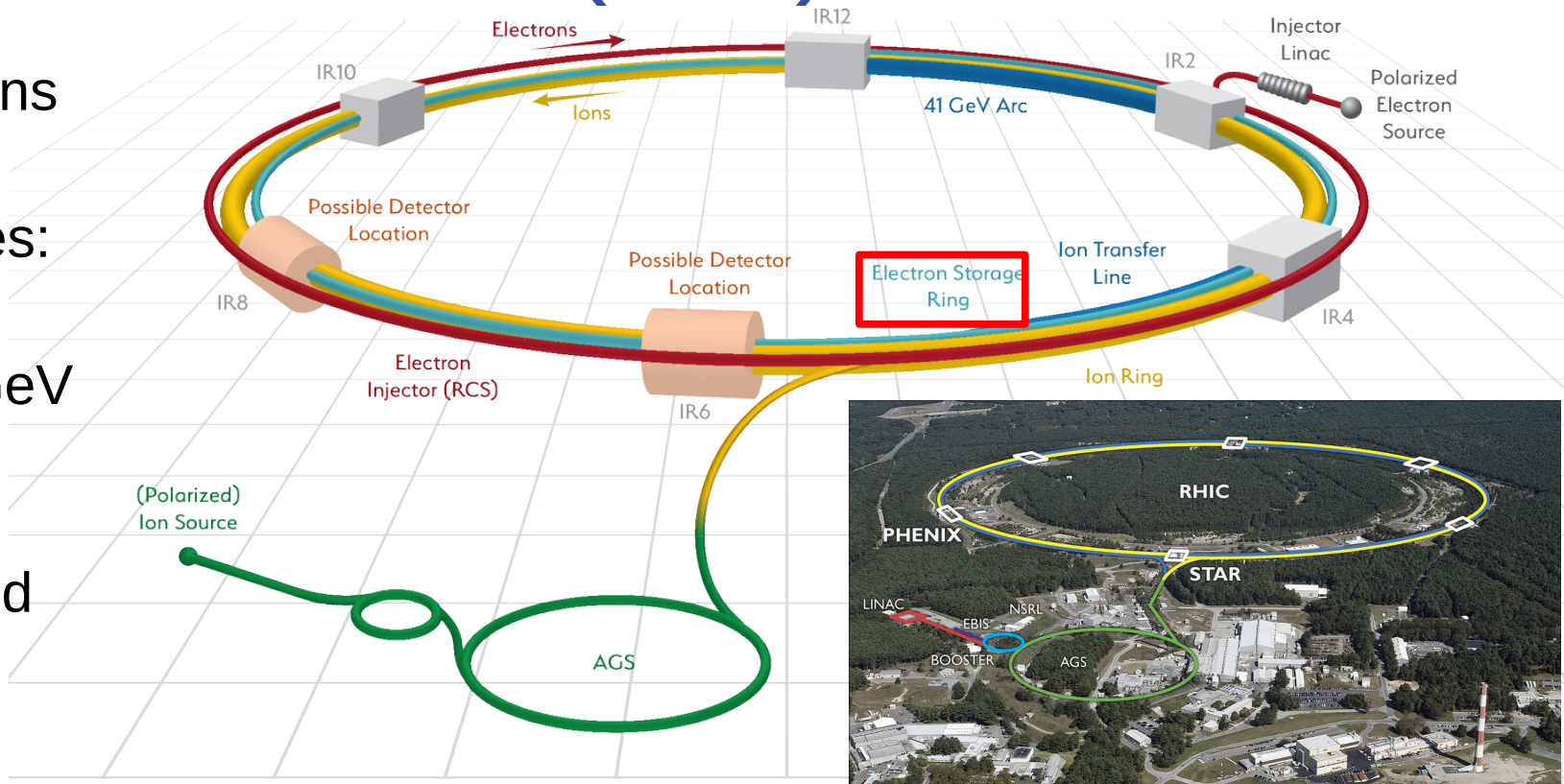
Jefferson Lab

U.S. DEPARTMENT OF ENERGY | Office of Science

The Electron-Ion Collider (EIC)

See WEPAB005 for more on EIC

- Will collide polarized electrons & hadrons
- Large range of CoM energies: 29 to 140 GeV
- Electron energies: 5 to 18 GeV in Electron Storage Ring (ESR)
- Considering option of second interaction point (IP)



Chromaticity & DA requirements for ESR

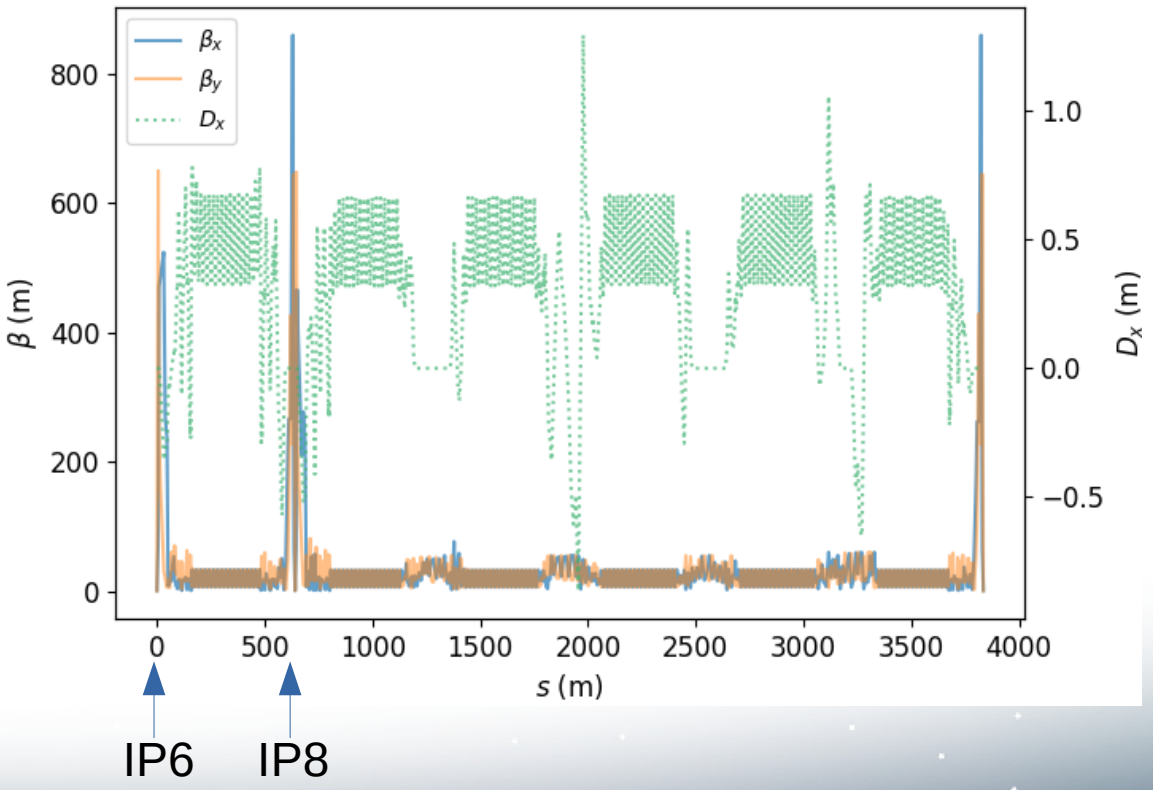
1) Set global linear chromaticity to +1 in both planes
2) $\pm 10\sigma$ dynamic aperture at nominal energy in both transverse planes
3) $\pm 10\sigma_\delta$ momentum acceptance

Each electron bunch is replaced every six minutes to mitigate depolarization, but charge variation must be kept small to reduce transient beam-beam effects

ESR: 18 GeV with 2 IPs

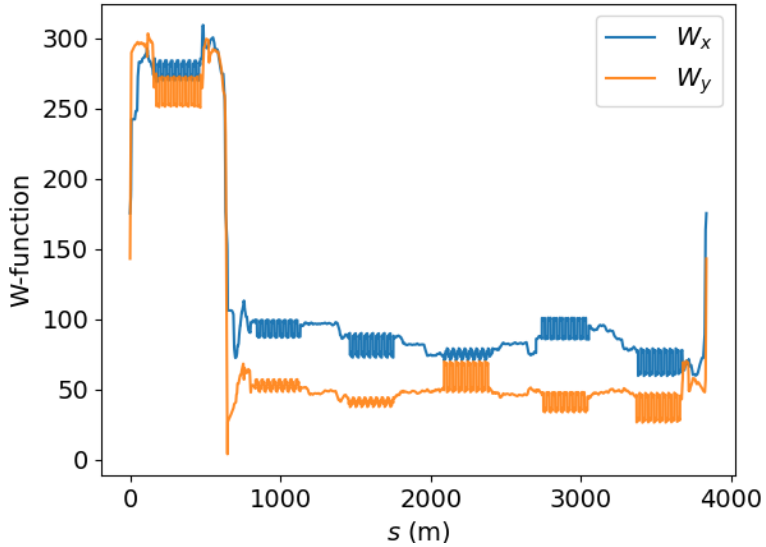
Parameter	Value
Beam energy	18 GeV
Circumference	3834 m
Emittance	30 nm
Energy spread, σ_δ	9.8×10^{-4}
Synchrotron tune, Q_s	0.056
Betatron tunes, Q_x/Q_y	51.12 / 42.1
Nat. chromaticity, ξ_x/ξ_y	-107 / -125
β_x^*/β_y^* at IP	0.42 / 0.05 m

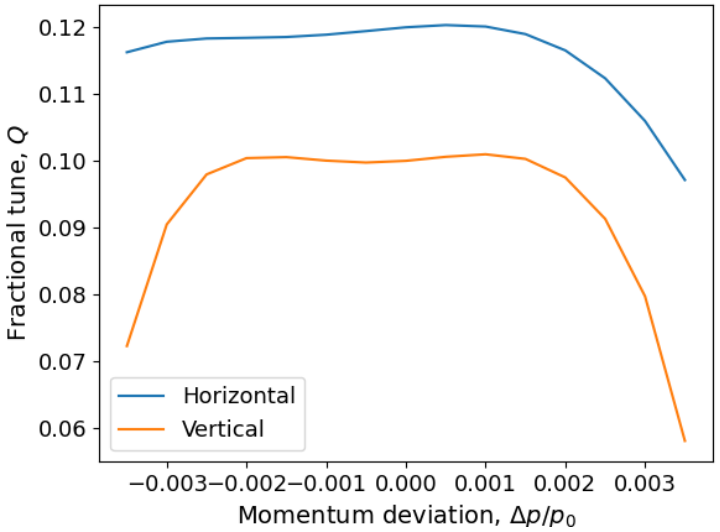
$10\sigma_\delta \approx 1\%$



Set the phase between the IPs

- Phase between IPs is odd multiple of 90°
- Confine β-beat wave to arc between IPs
- Two global families of sextupoles
- Momentum acceptance still very small



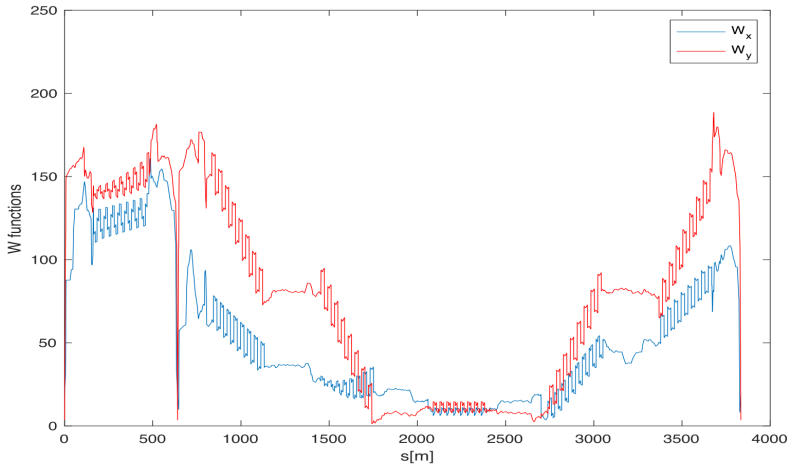


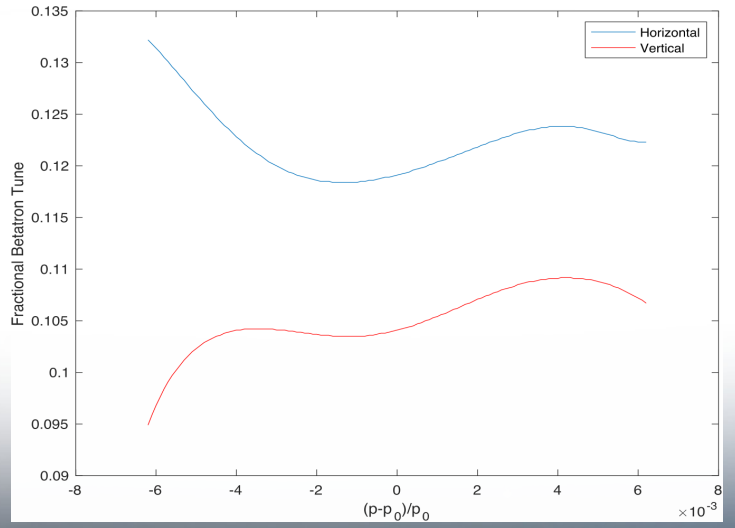
$$b = \frac{1}{\beta}\frac{\partial \beta}{\partial \delta} \qquad a = \frac{\partial \alpha}{\partial \delta} - \frac{\alpha}{\beta}\frac{\partial \beta}{\partial \delta}$$

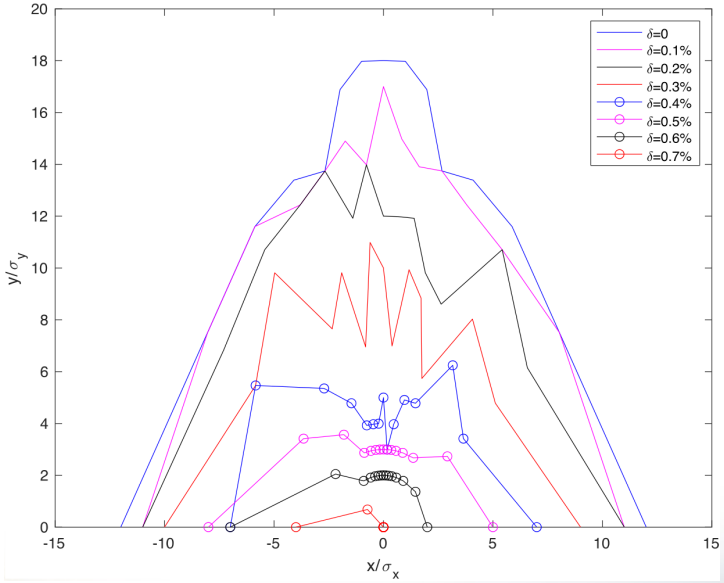
$$W = \sqrt{a^2 + b^2}$$

Increasing the momentum acceptance

- Use fourteen independent families of sextupoles in total
- Solution obtained through combination of numerical optimization & manual adjustment
- Momentum acceptance of ±0.7% obtained

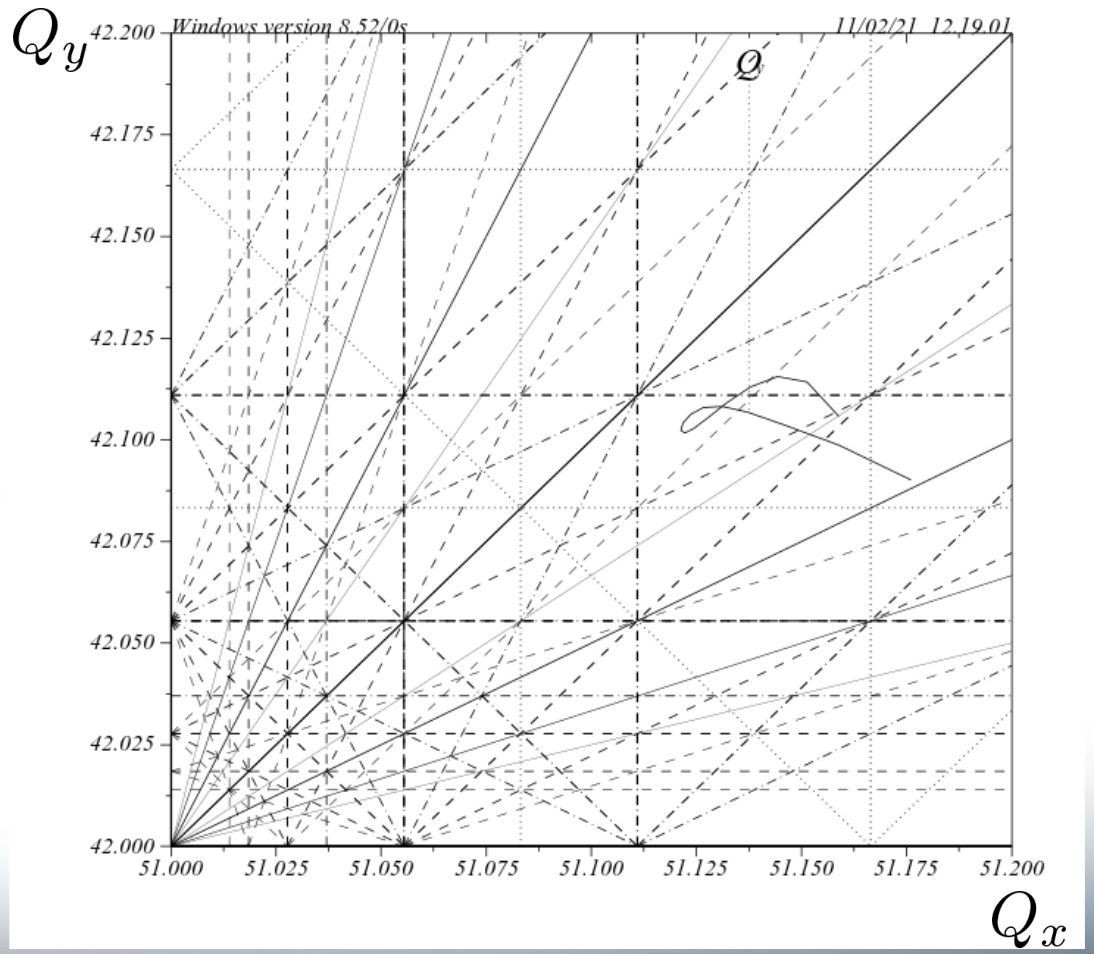






Synchrobetatron resonances

- Further optimization of tune function did not increase momentum acceptance
- Appear to be limited by synchrobetatron resonances, especially $Q_y - 2Q_s = p$
- Shifting nominal tunes a small amount away from this resonance helps



Conclusion & outlook

- ESR lattice at 18 GeV with 2 IPs is very challenging
- Significant progress made in extending momentum acceptance, although ±1% goal not yet reached
- Currently updating IRs and straight sections
- Results presented here do not take into account errors & misalignments

Live poster presentation: Tuesday 25 May

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