Impact of Magnet Gaps on Lattice Performance

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Method

- First estimate of the impact of a more “realistic” lattice
  - Based on first estimates of hardware restrictions
    - Maximum magnet length about 10 m
    - Separation between magnets about 30 cm (about 3%)
- Implementation in SAD
  - Replace magnets that are longer than 10 m with equivalent sequences
    - Made of dipoles and drifts
    - Same overall length and angle
  - Used tt 217 lattice
- Properties to check
  - Geometric properties: How it affects the layout
  - Beam properties: Change in optical function and emittance (due to smaller bending radius and beating)

Example of Method

- Original:

BEND **BC1** = (L = **40.832107574489 59** ANGLE = **.0017798918054935 94** E1 =.5 E2 =.5);

- Split:

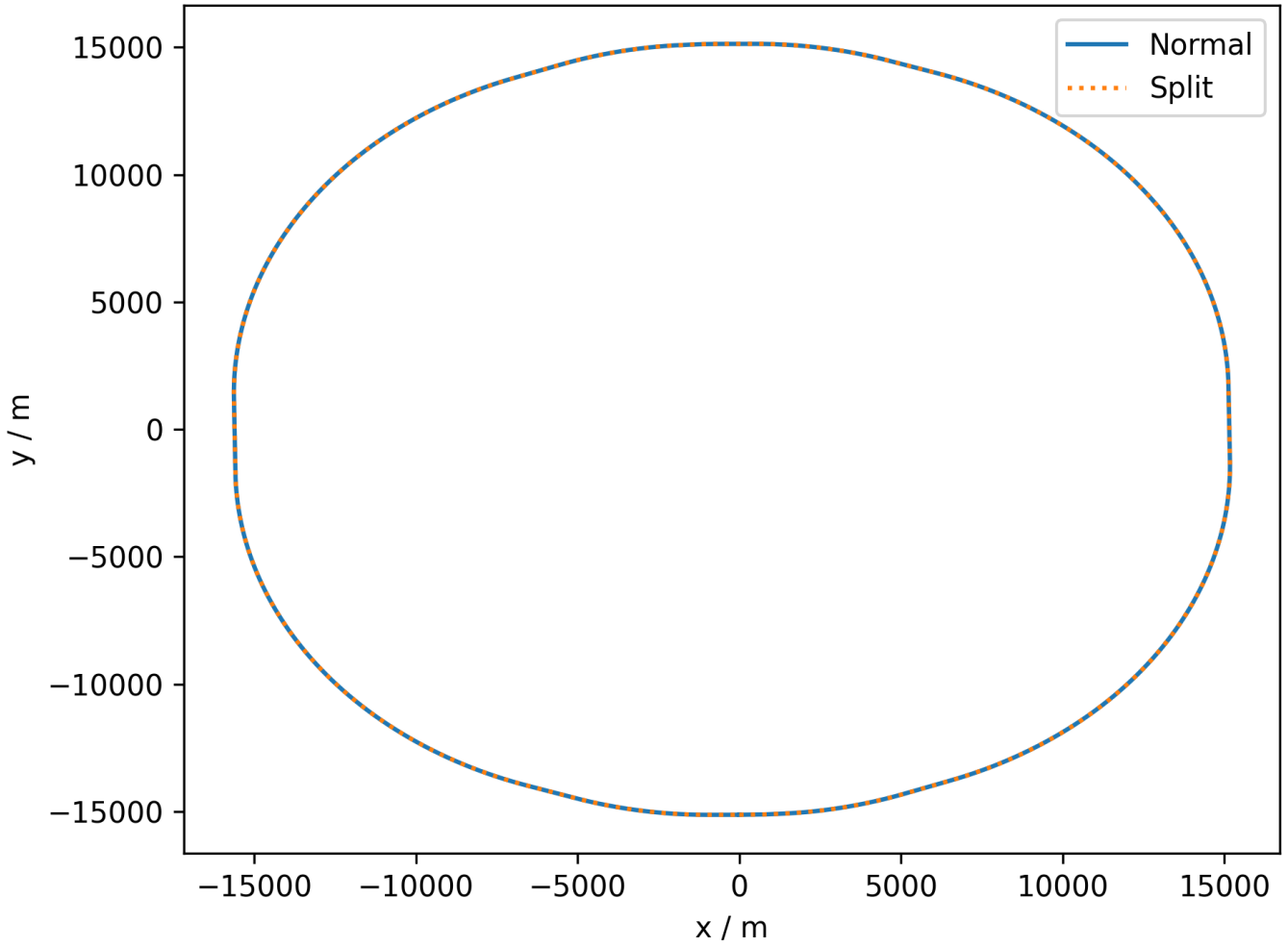
DRIFT **LSEP** =(L =**0.3**); ! Separation drift

BEND **BC1_s** =(L =((**40.832107574489 59** - **3***0.3)/**4**) ANGLE = (**.0017798918054935 94**/**4**) E1 =.5 E2 =.5); !4 segments, 3 drifts

LINE **BC1** = (**BC1_s**, **LSEP**, **BC1_s**, **LSEP**, **BC1_s**, **LSEP**, **BC1_s**); ! Equivalent sequence

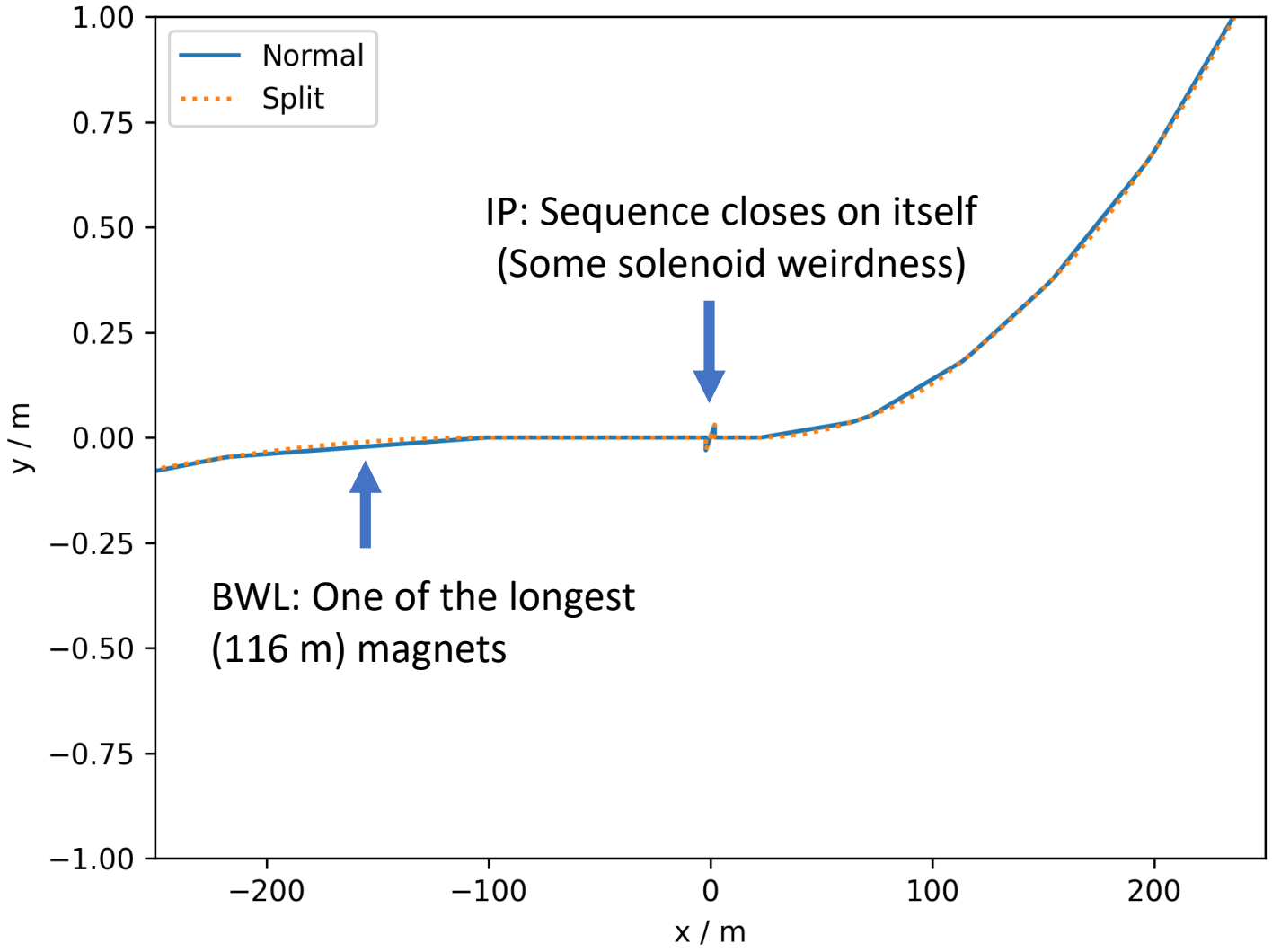
Geometrical Check

- Obtain survey from original and modified lattice
  - Plot on top of each other as a first check



Geometrical Check

- Obtain survey from original and modified lattice
  - Plot on top of each other as a first check
- More informative when zooming into IP1
  - See local layout of segments
  - Check that the sequence closes on itself



Geometry Check II

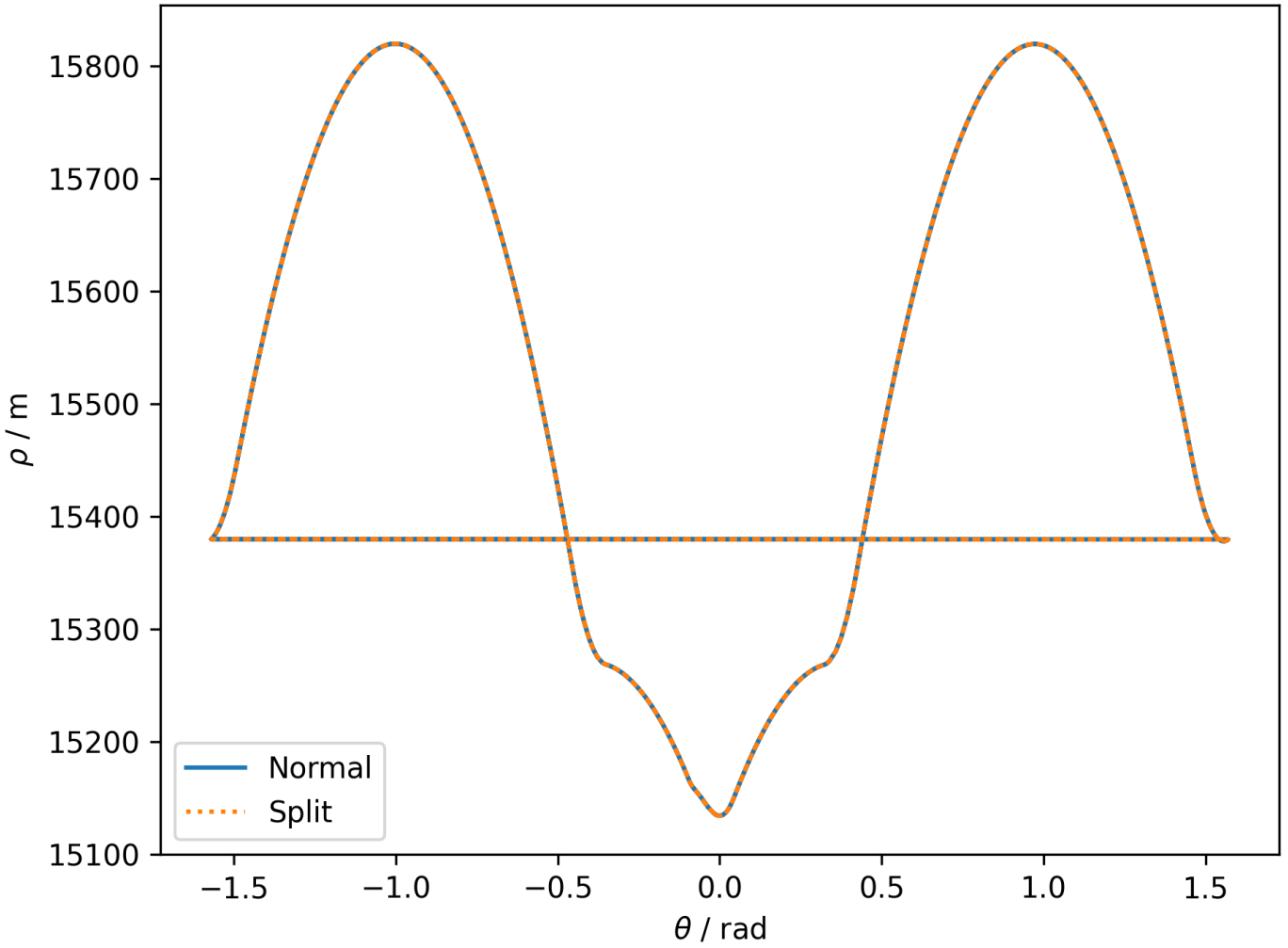
- Cannot “zoom in” everywhere and check by hand
- More natural to plot in polar co-ordinates
  - Two orders of magnitude smaller length scales

$$\bar{x} = x - \frac{x_{max} - x_{min}}{2}$$

$$\bar{y} = y - \frac{y_{max} - y_{min}}{2}$$

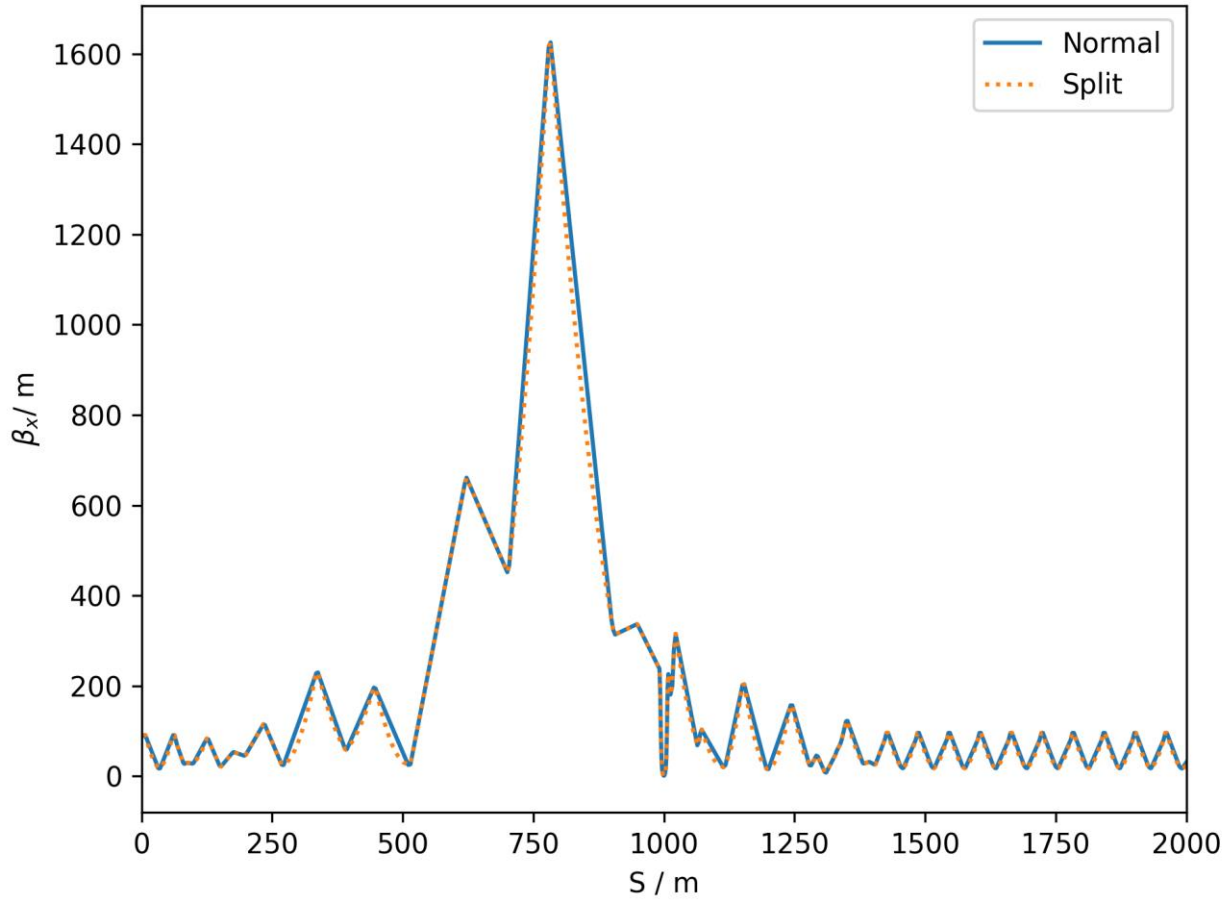
$$\rho = \sqrt{\bar{x}^2 + \bar{y}^2}$$

$$\theta = \arctan\left(\frac{\bar{x}}{\bar{y}}\right)$$



Optics Check

- Check how robust this method is for simulating realistic lattices
- Check that emittance growth etc. isn't due to beating
- IP β-beating
  - $0.01\ \%$ in the vertical plane
  - $10^{-4}\ \%$ in the horizontal plane
- Change in tune:
  - $\Delta Q_x = \ 0.00027$
  - $\Delta Q_y = -0.00024$



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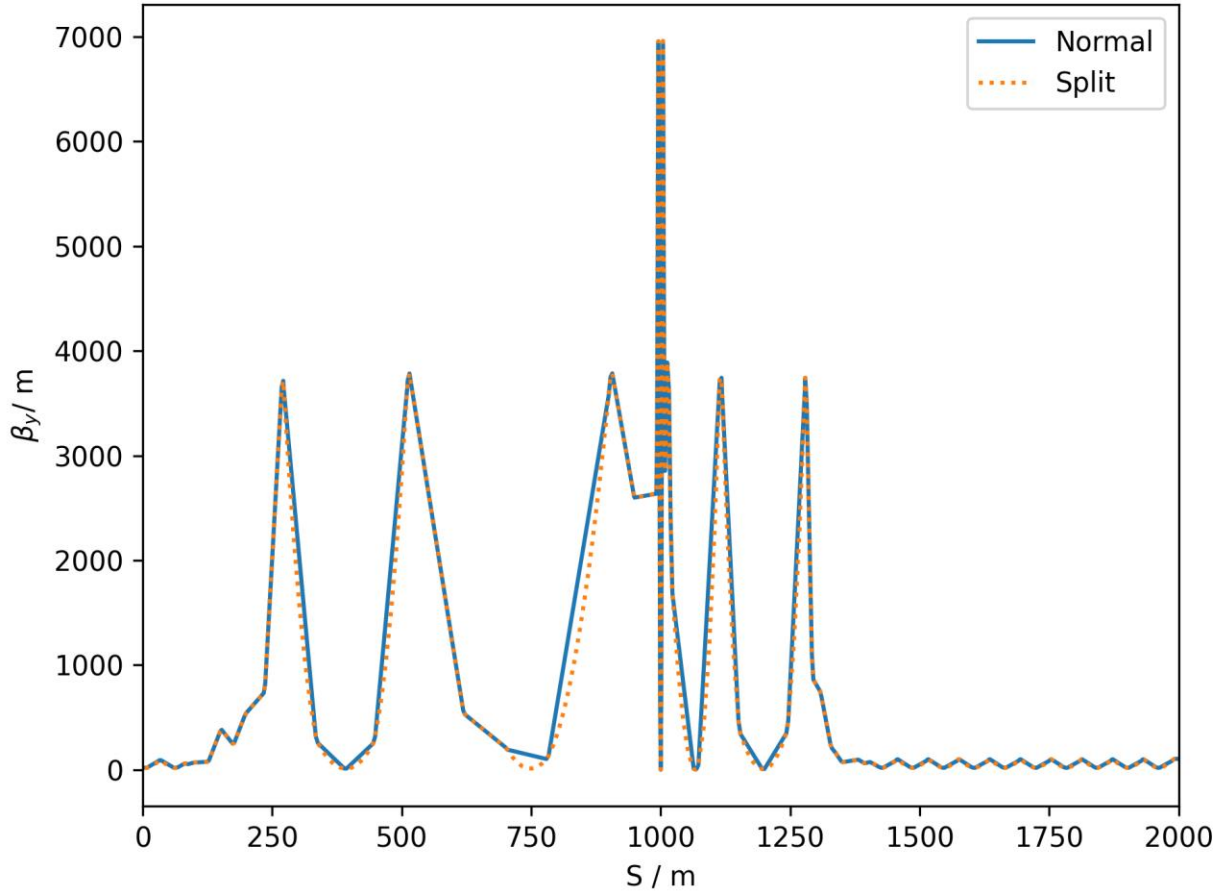
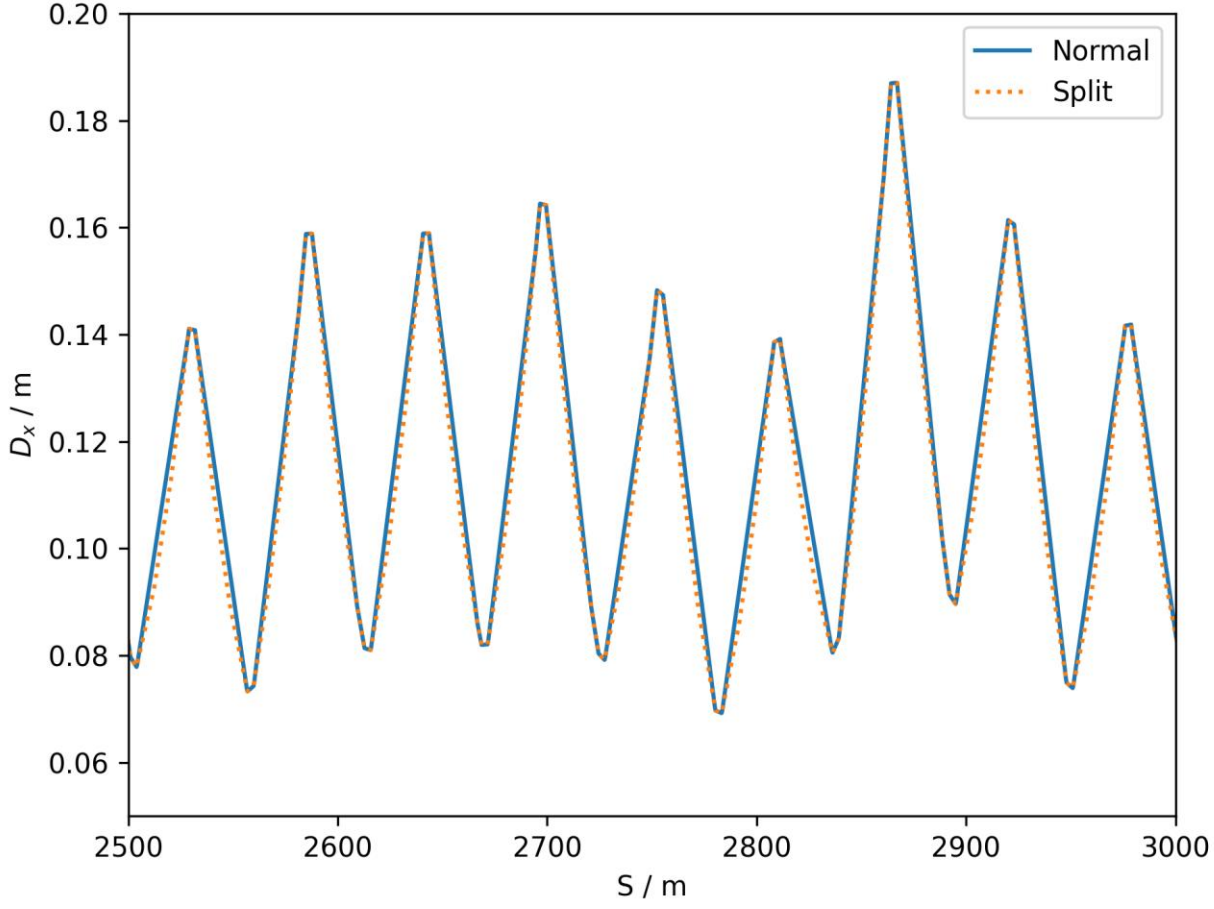


Impact on Radiative Effects

- Significant increase in radiation:
  - Original: 9194.7366 MV
  - New: 9441.7543 MV
  - 3 % increase
- Increase in ϵ_x
  - Original: 1.45448 nm
  - New: 1.49490 nm
  - 3 % increase
  - Probably not due to dispersion (very similar in both cases)
- Bunch length increase also about 4%



Conclusions

- Established an effective method of easily introducing realistic features into FCC-ee lattices
  - Replace element definitions with more realistic subsequences
  - No need to change the actual sequences
  - Can easily be extended to other requirements
    - Different lengths of magnets and gaps, introduction of instrumentation or correctors
  - No significant impact on linear optics and overall geometry
- Impact of dipole splitting with 10 m length and 30 cm gaps
  - About 3% increase in radiation and beam emittance
- Possible future steps
  - Implementation of other realistic features and updates of these ones
  - Translation to MADX (e.g. the same way current SAD lattices are translated)
  - Addition of realistic circuits and naming conventions