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# ERROR AND CORRECTION SIMULATION OF CEPC BOOSTER AND DAMPING RING

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## *Error Set*

| Parameters | Dipole | Quadrupole | Sextupole |
|---|---|---|---|
| Transverse shift X/Y (μm) | 100 | 100 | 100 |
| Longitudinal shift Z (μm) | 100 | 150 | 100 |
| Tilt about X/Y (mrad) | 0.2 | 0.2 | 0.2 |
| Tilt about Z (mrad) | 0.1 | 0.2 | 0.1 |
| Nominal field | $1\times10^{-3}$ | $2\times10^{-4}$ | $3\times10^{-4}$ |

| Parameters | BPM (10 Hz) |
|---|---|
| Accuracy (m) | $1\times10^{-7}$ |
| Tilt (mrad) | 10 |
| Gain | 5% |
| Offset after beam based alignment (BBA) (mm) | $30\times10^{-3}$ |

## *Correction Process*

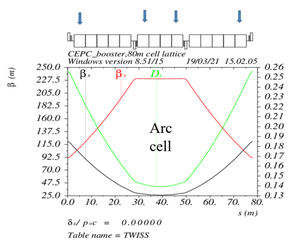
Orbit Correction + Horizontal dispersion
- Response Matrix
- 2-level iteration：
  - 1st Loop: 20%~100% Corrector
  - 2nd Loop： 30%~80% SVD
- Dispersion correction
- Energy adjustment by corrector

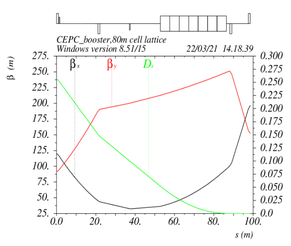
Optics correction
- RM + LOCO
- Based on 30GeV simulation
- All quadrupole independent
- Dispersion correction included

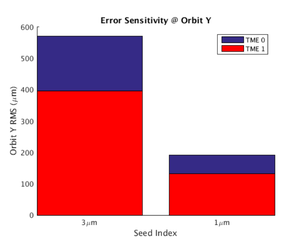
Dispersion correction included
- Coupling and vertical dispersion correction
- Skew quadrupole magnets are arranged in both the dispersion free section and the arc section.

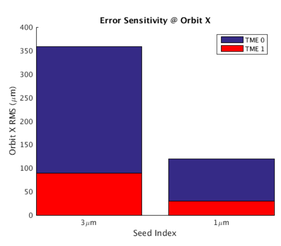
## *Booster Design update*

To reduce emittance, costs and sensitivity
- TME like structure (cell length=78m)
- Interleave sextupole scheme
- Overall idea: uniform distribution for the Q
- Combined magnet (B+S) scheme possible
- Phase advance/cell: 100° (H) / 28° (V)
- Emittance@120GeV=1.26nm



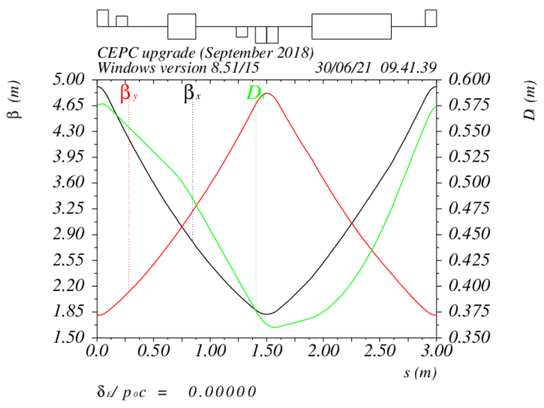




## *Booster Beam parameter with correction*

| RMS@30GeV | X | Y |
|---|---|---|
| Orbit (mm) | 0.080 | 0.080 |
| Beta Beating(%) | 0.8 | 0.38 |
| Δ Dispersion(mm) | 2.7 | 3.5 |

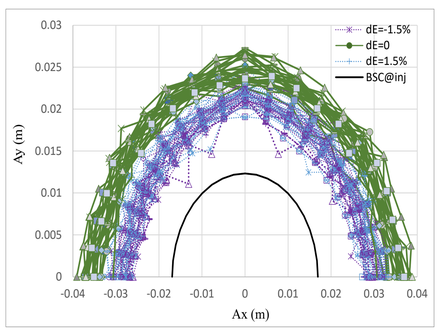
## *Damping RING Design*

Phase/cell: 60° /60°
Interleave sextupole scheme
2 sex. families



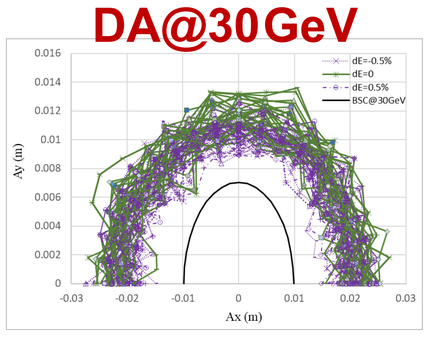

## *Damping Ring parameter with correction*

| RMS@30GeV | X | Y |
|---|---|---|
| Orbit (mm) | 0.58 | 0.56 |
| Beta Beating(%) | 1.1 | 2.0 |
| Δ Dispersion(mm) | 6.4 | 2.4 |

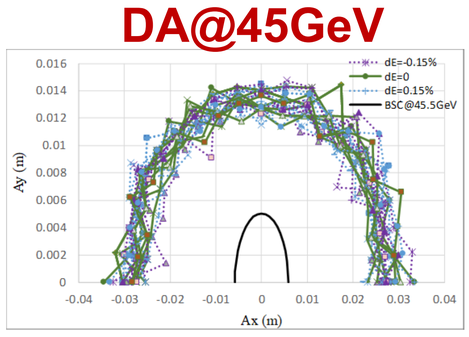



- $BSC_{x,y}=5\sigma_{inj\_x,y}+5mm$
- Energy acceptance: $8.3\delta_{inj}=1.5\%$

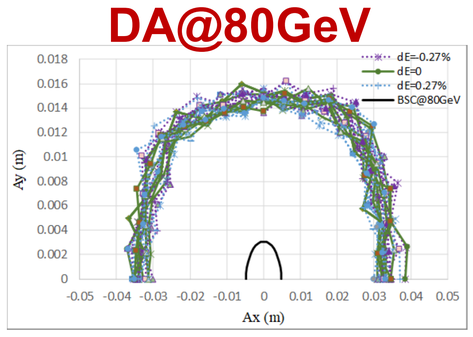
**DA@30GeV**



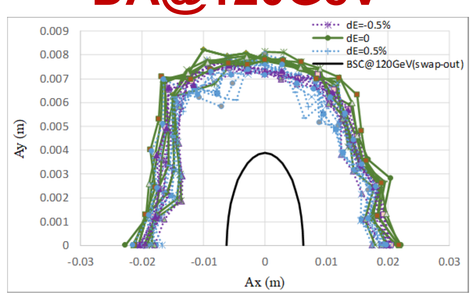

**DA@45GeV**



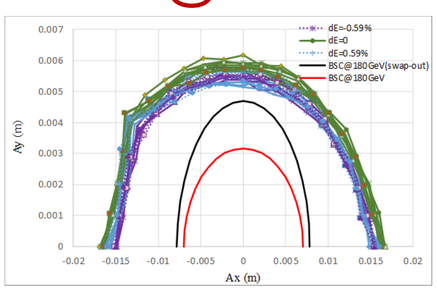

**DA@80GeV**




**DA@120GeV**




**DA@180GeV**




## Summary

The TME structure (TDR) has combined magnets to reduce mounts, minimize beam emittance, optimize error sensitivity, simulate error effects and corrections, and determine hardware system requirements, with a clear simulation process showing that linear parameters and DA meet the requirements. Further studies will prioritize actual commissioning requirements..

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