

4D Transverse Coupling measurements of an 18 MeV Photo-Injector Electron Beam

Poster THPO10

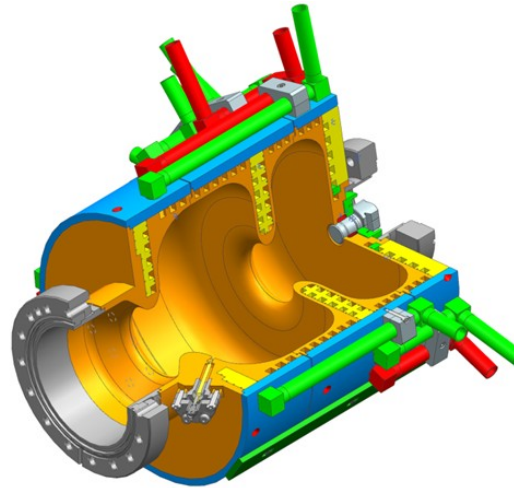
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LINAC26

PITZ: Photo Injector Test facility at DESY in Zeuthen

A flexible L-band test stand used for a wide range of research topics

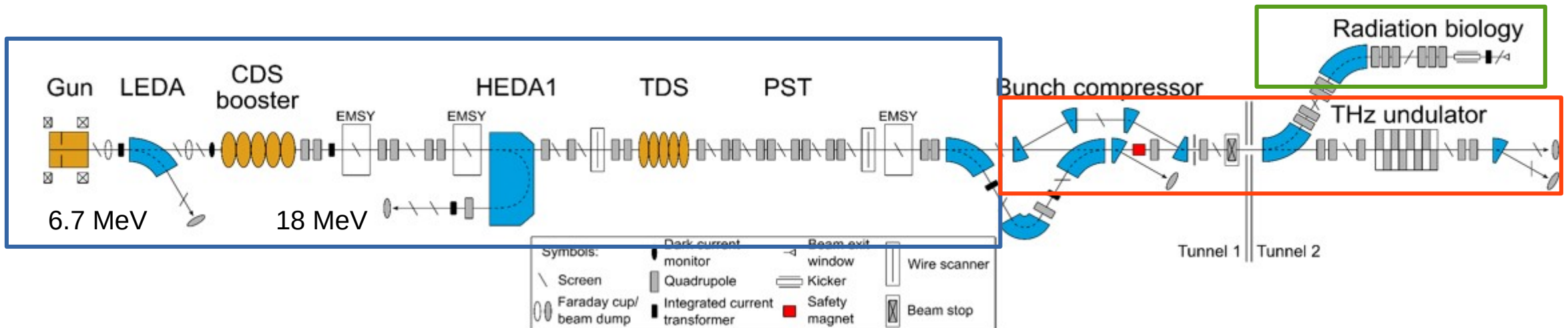
Four primary topics

- Construction and conditioning of guns for EuXFEL and FLASH
- Radiation biology (Poster THPO061)
- THz radiation source
- Beam diagnostics and characterization



PITZ Main Parameters

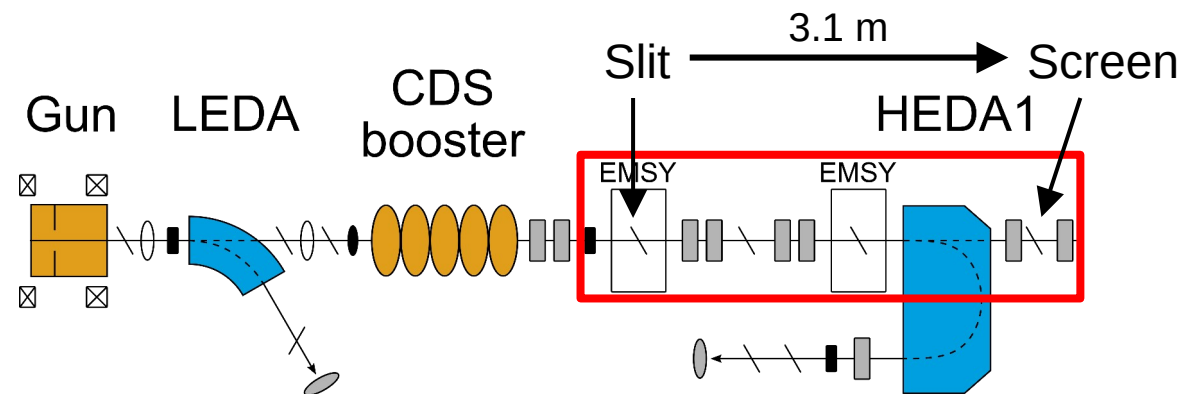
Gun momentum	< 7 MeV/c
Final momentum	< 22 MeV/c
Bunch charge	Up to 6nC
Bunch length	2 ps ... 22 ps
Laser profile	Standard: flattop, but arbitrary is possible
Rep rate	10 Hz
Bunch frequency	Arbitrary patterns up to 4.5 Mhz



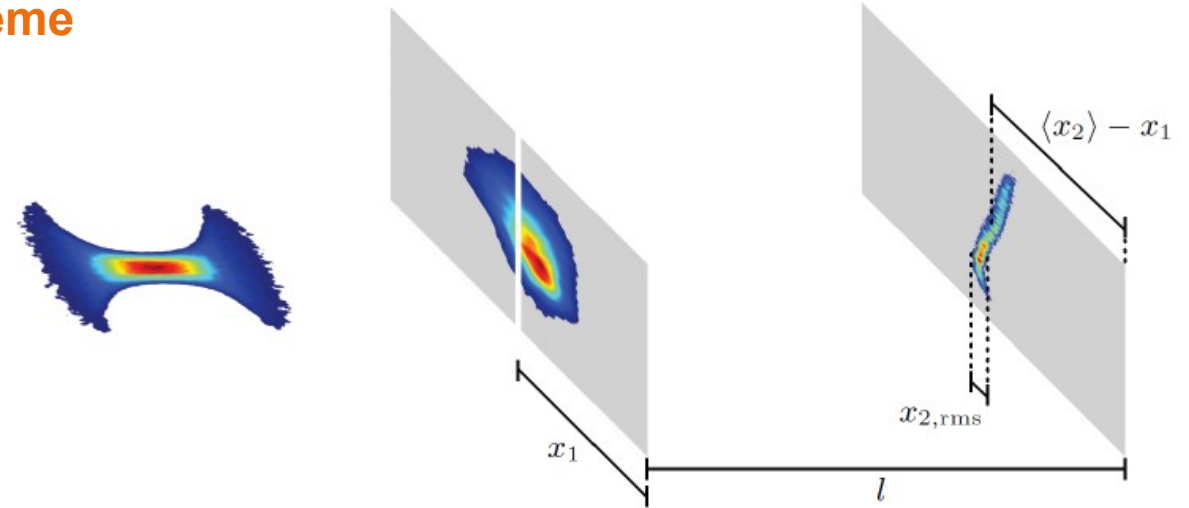
Emittance measurements

Measure emittance with slit scan after the booster to characterize gun performance with emittance compensation scheme

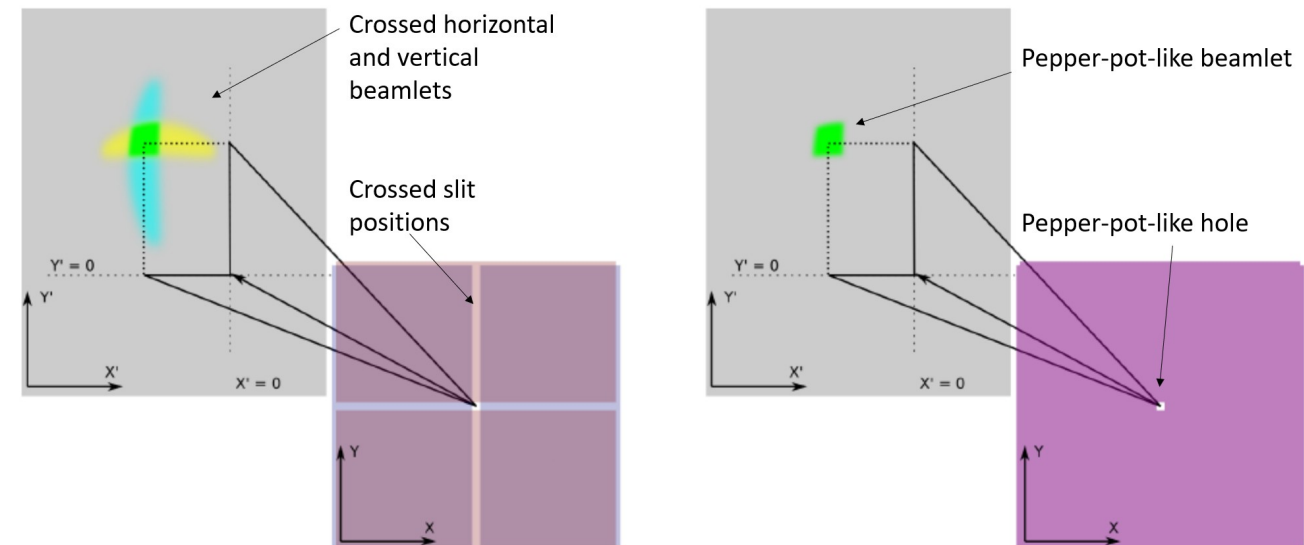
- 2D X and Y phase space measurements are taken using slit-screen measurements
- 4D phase space reconstructed using Virtual Pepper pot (VPP)
 - Virtually crosses slits and beamlets from 2D measurements to create a virtual pepperpot mask and beamlet image



2D measurements scheme



Crossing 2D beamlets to make VPP beamlet

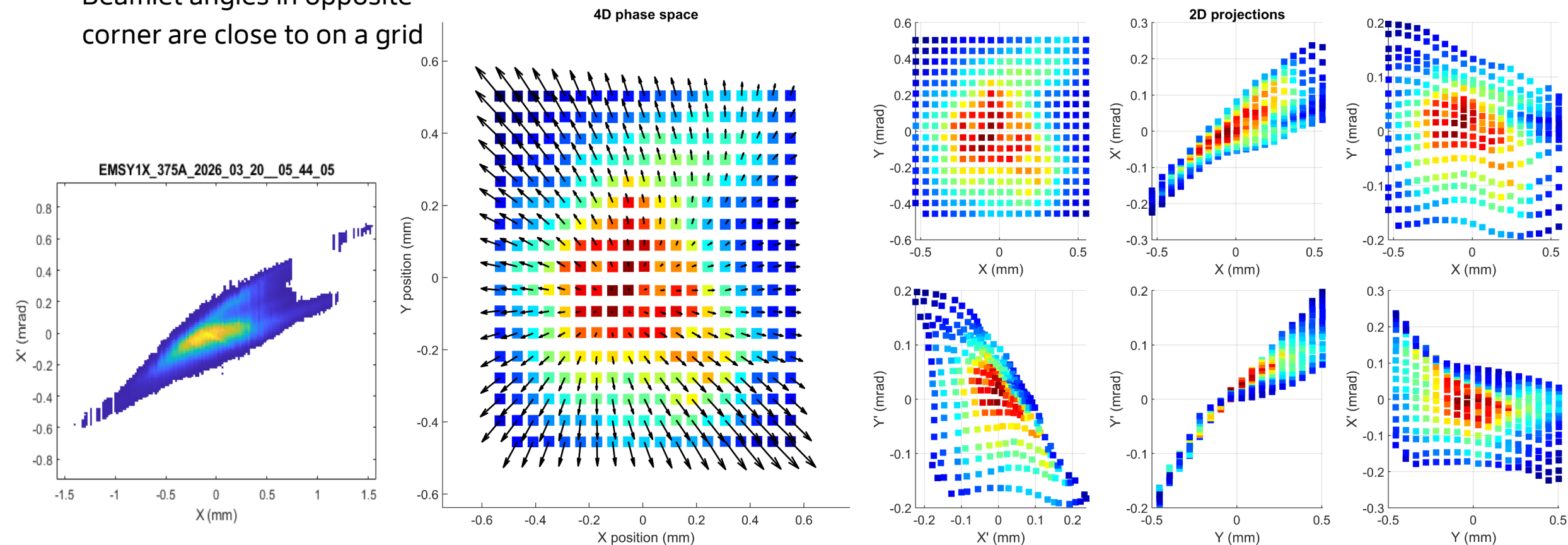


Characteristic 4D phase space

Down sampled number of VPP beamlets for clarity

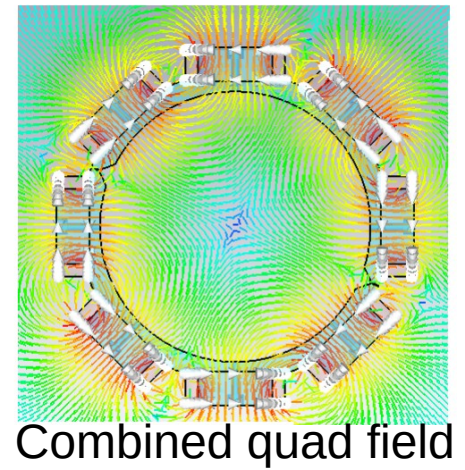
Strong asymmetric coupling

- Asymmetric x - x' and y - y' projection $\rightarrow$ agrees with 2D measurements
- Beamlet angles in one corner of the beam are suppressed
- Beamlet angles in opposite corner are close to on a grid



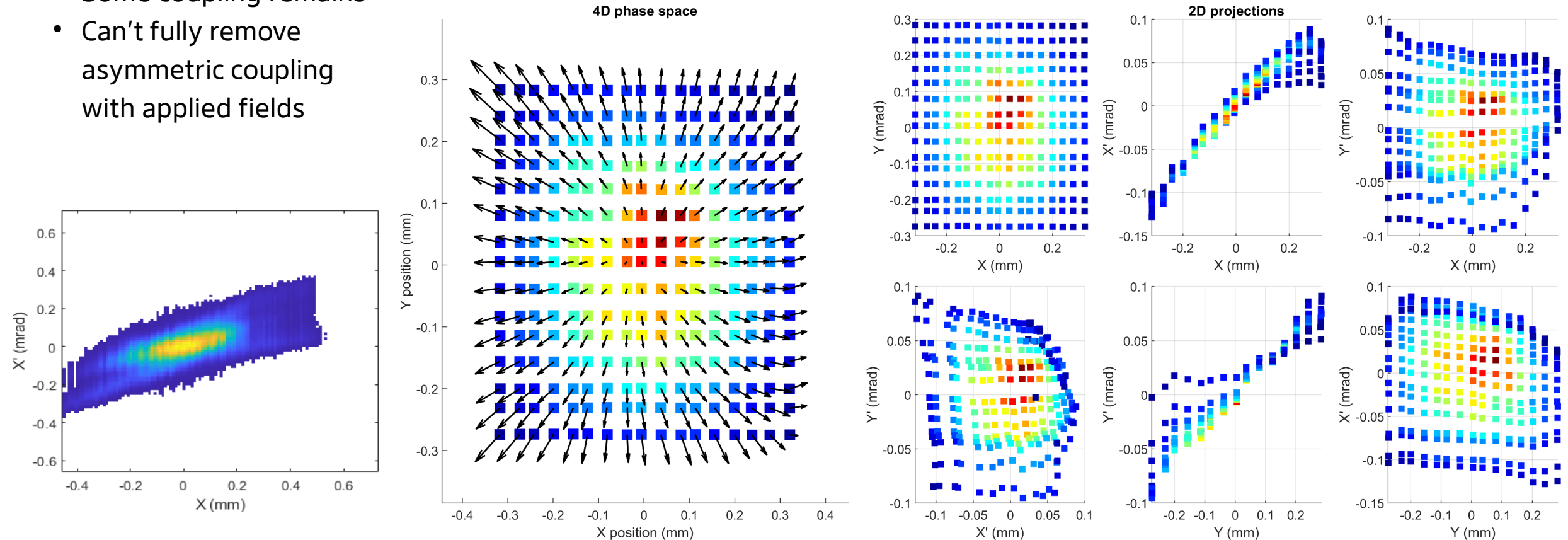
Removing X-Y coupling

Use combined normal/skew quad at exit of the gun to remove coupling



Coupling significantly reduced

- 2D phase spaces are more symmetric
- More uniform x' - y' projection
- Some coupling remains
- Can't fully remove asymmetric coupling with applied fields



Behavior of the beam

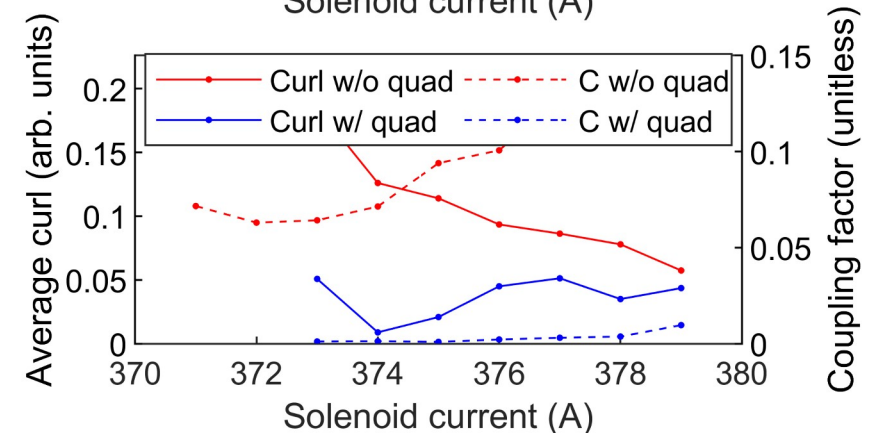
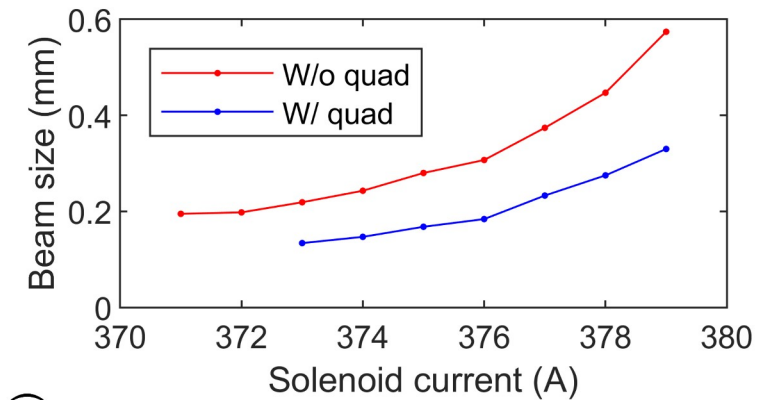
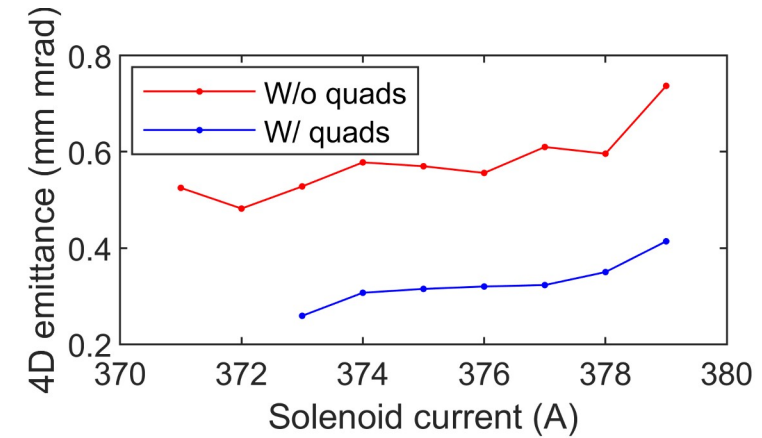
Coupling is dependent on solenoid current

Measures of coupling

- Average curl of phase space
 - Measure of deviation from a diverging beam
 - Reduces with increasing beam size
- Coupling factor $C = \frac{\sqrt{\epsilon_x \epsilon_y}}{\epsilon_{4D}} - 1$.
 - Measure of relative strength of coupling terms
 - Increases with increasing beam size

After removal with combined quads

- Significant reduction of 4D emittance and beam size
- Coupling factor is near zero
- Less variation in the average curl



Thank you

Contact

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