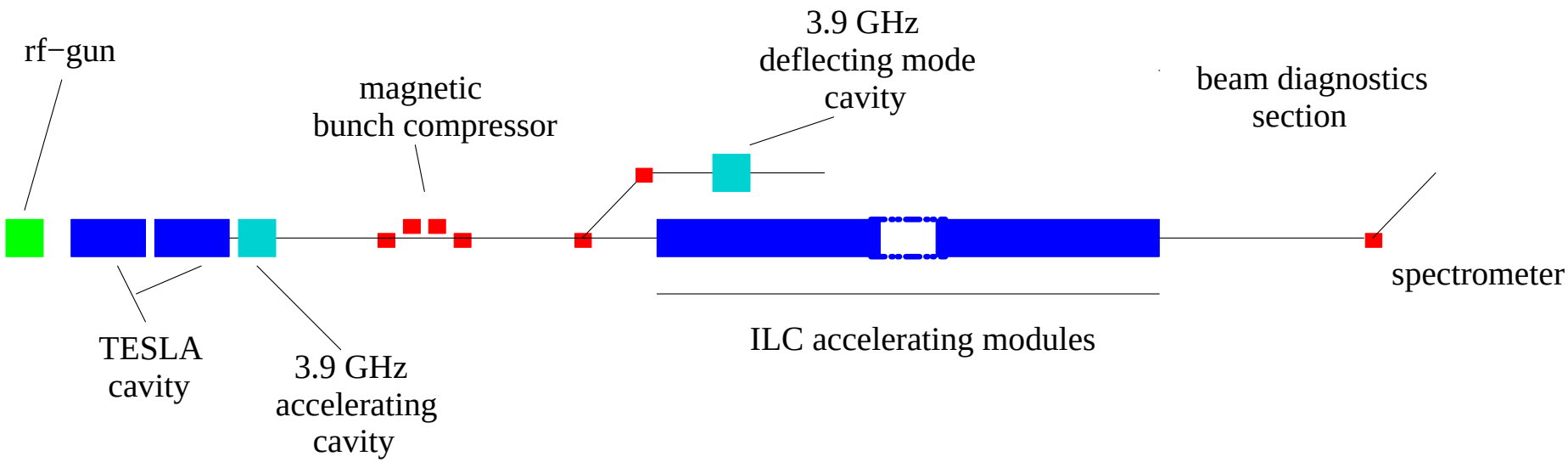
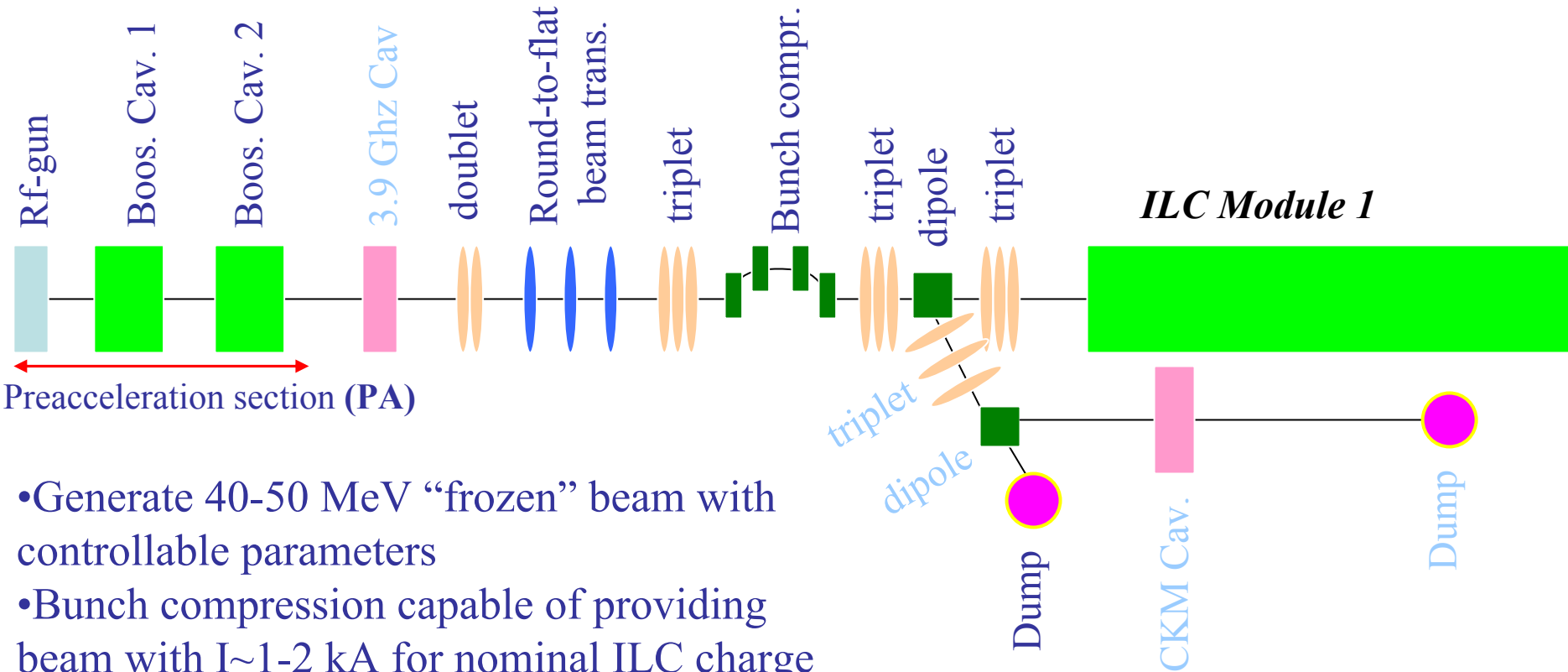
Status of ILC module test facility beam dynamics studies



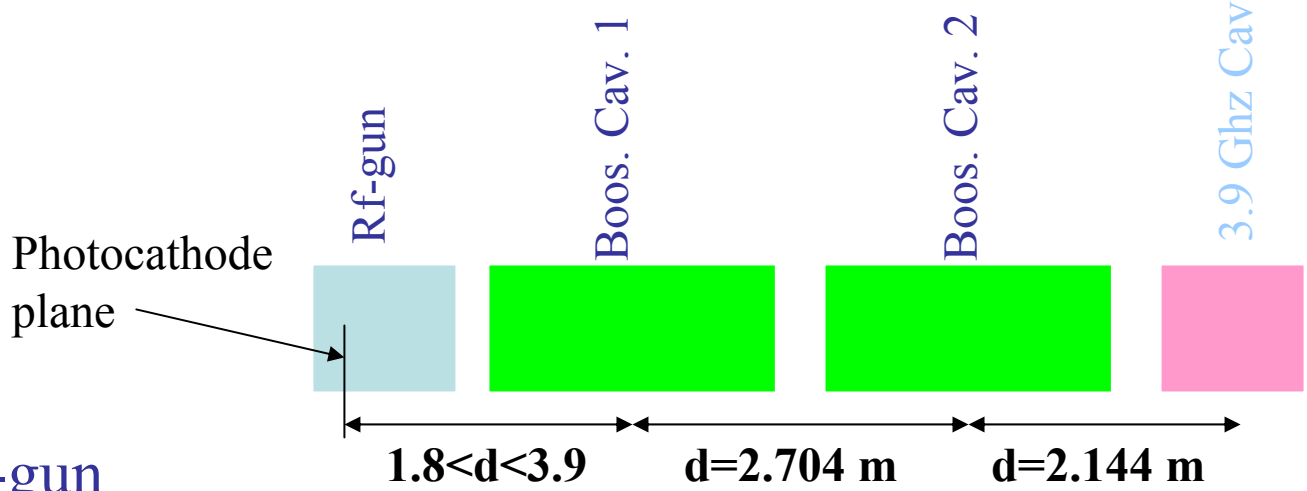
Comment: Reference zero ?

Injector overview



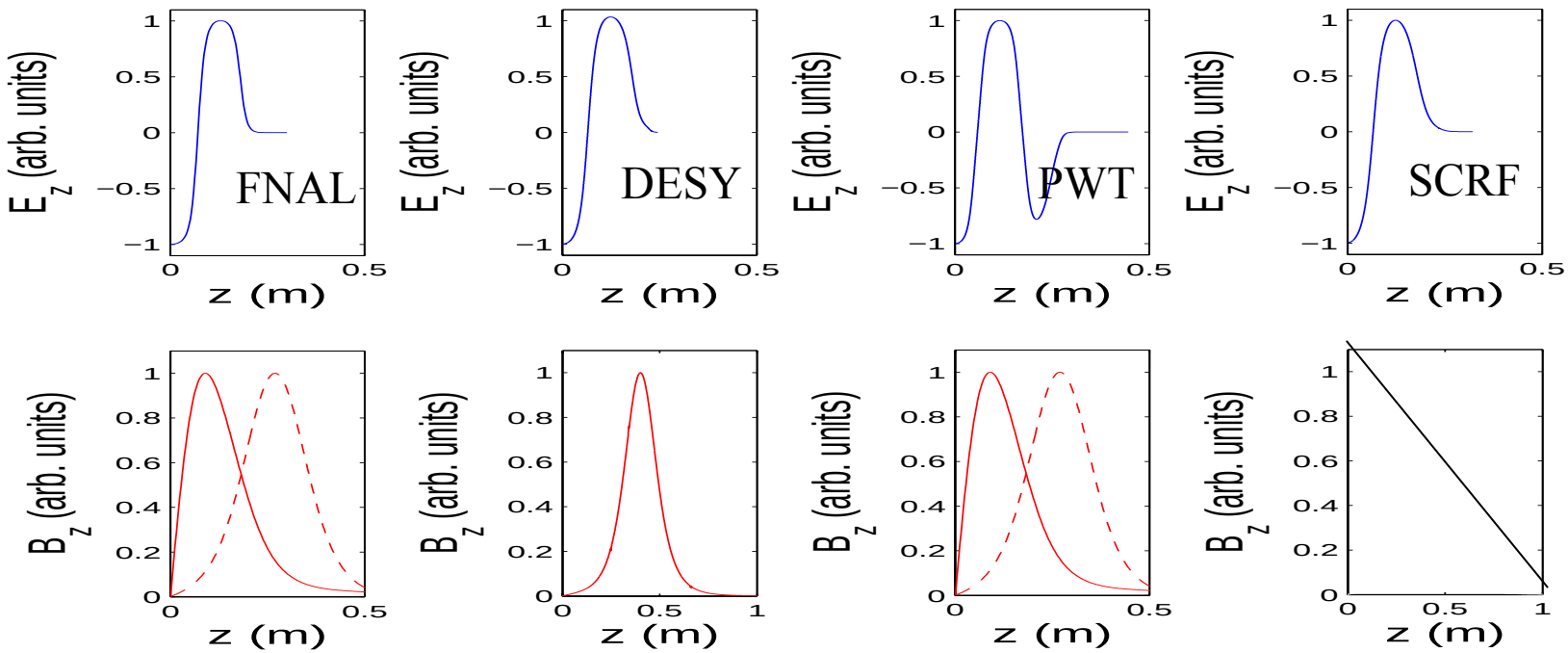
- Generate 40-50 MeV "frozen" beam with controllable parameters
- Bunch compression capable of providing beam with I~1-2 kA for nominal ILC charge
- Possibility to generate asymmetric emittance beam (ideal to study emittance growth in one-plane in cryomodules)
- Incorporate diagnostics + room for proper instrumentation (e.g. for HOM measurement)
- **Possibility of an off-line beamline for other test (CKM-based bunch length meas., or other advanced instrumentation/beam physics experiments)**

Pre-acceleration section



- Rf-gun
  - FNAL gun with TTF-1 solenoids
  - DESY gun (co-axial) with DESY-type solenoids
- Two booster cavities
  - Cavity 1: peak-field: 25 MV/m
  - Cavity 2: peak-field: 50 MV/m (conservative)
- Eventually 3.9 GHz accelerating cavity
  - Need to provide a decelerating voltage = 5 MV for linearization of the longitudinal phase space (assume total energy after cavity 2 is 45 MeV)

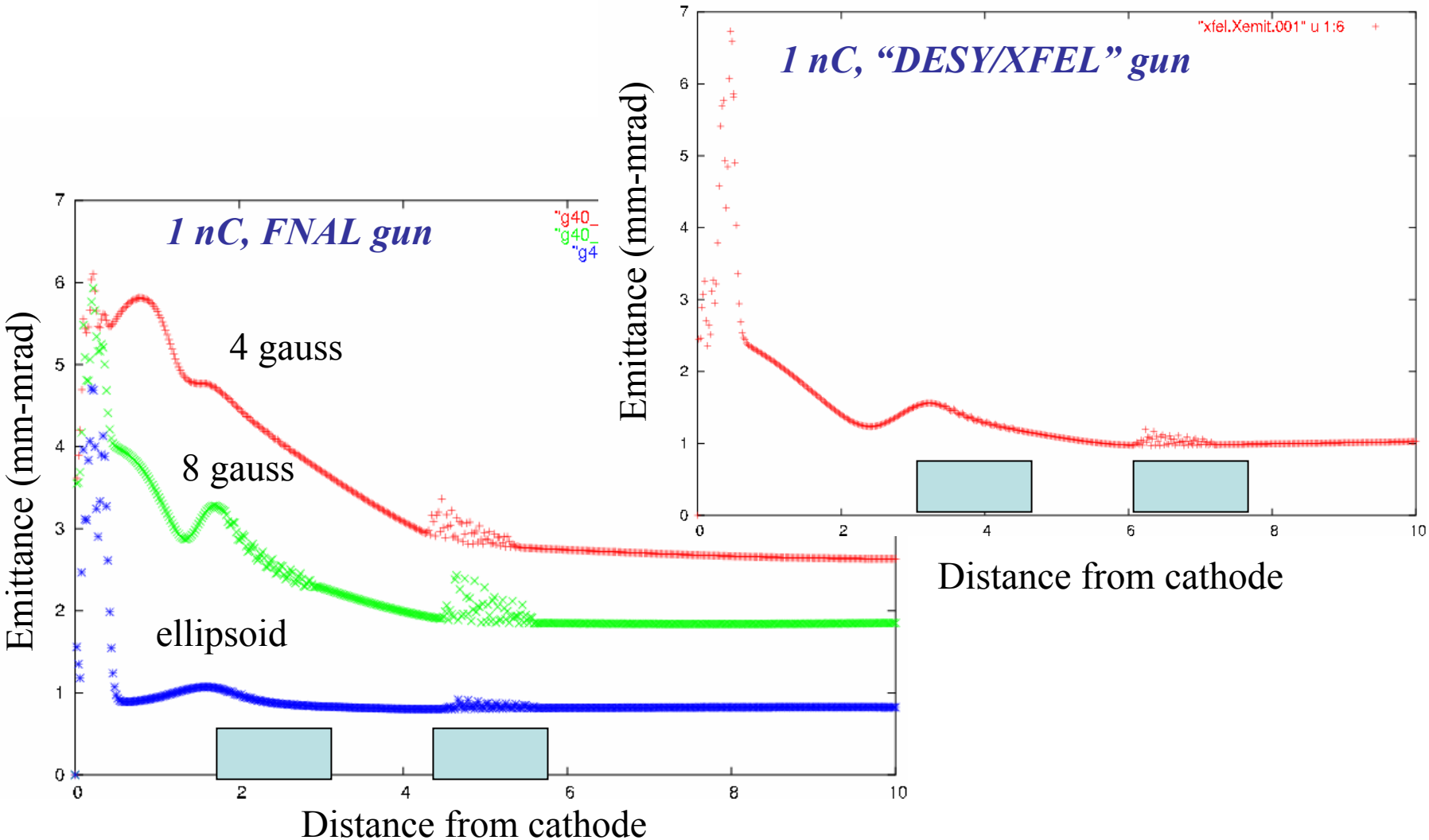
Pre-acceleration section



- Distance between gun and cavity 1 will change as gun is upgraded
  - Start with something close to current distance (d=1.8 m)
  - Depending on gun availability (d=3.9 m is needed still more work needed),
  - we need to allocate room

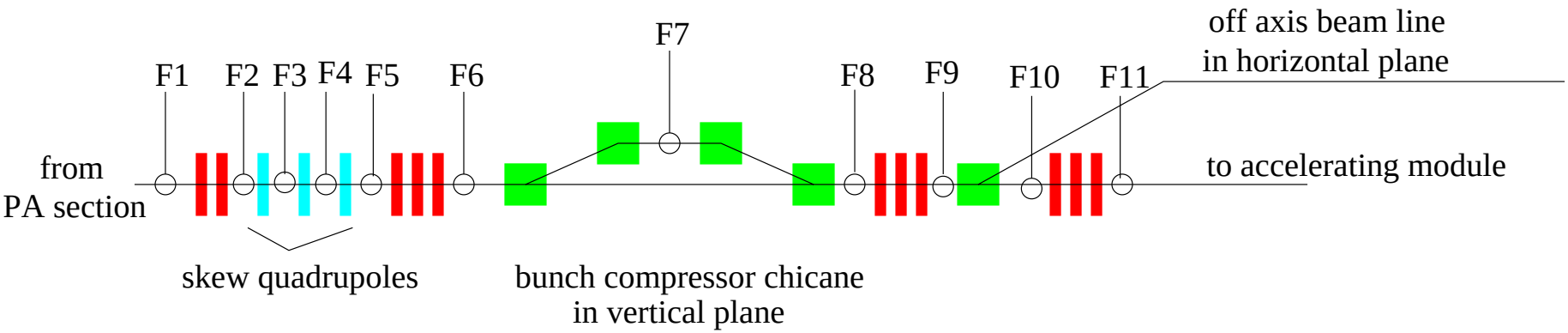
Pre-acceleration section

- Example of optimum working point of the injector (Q=1 nC in this example)



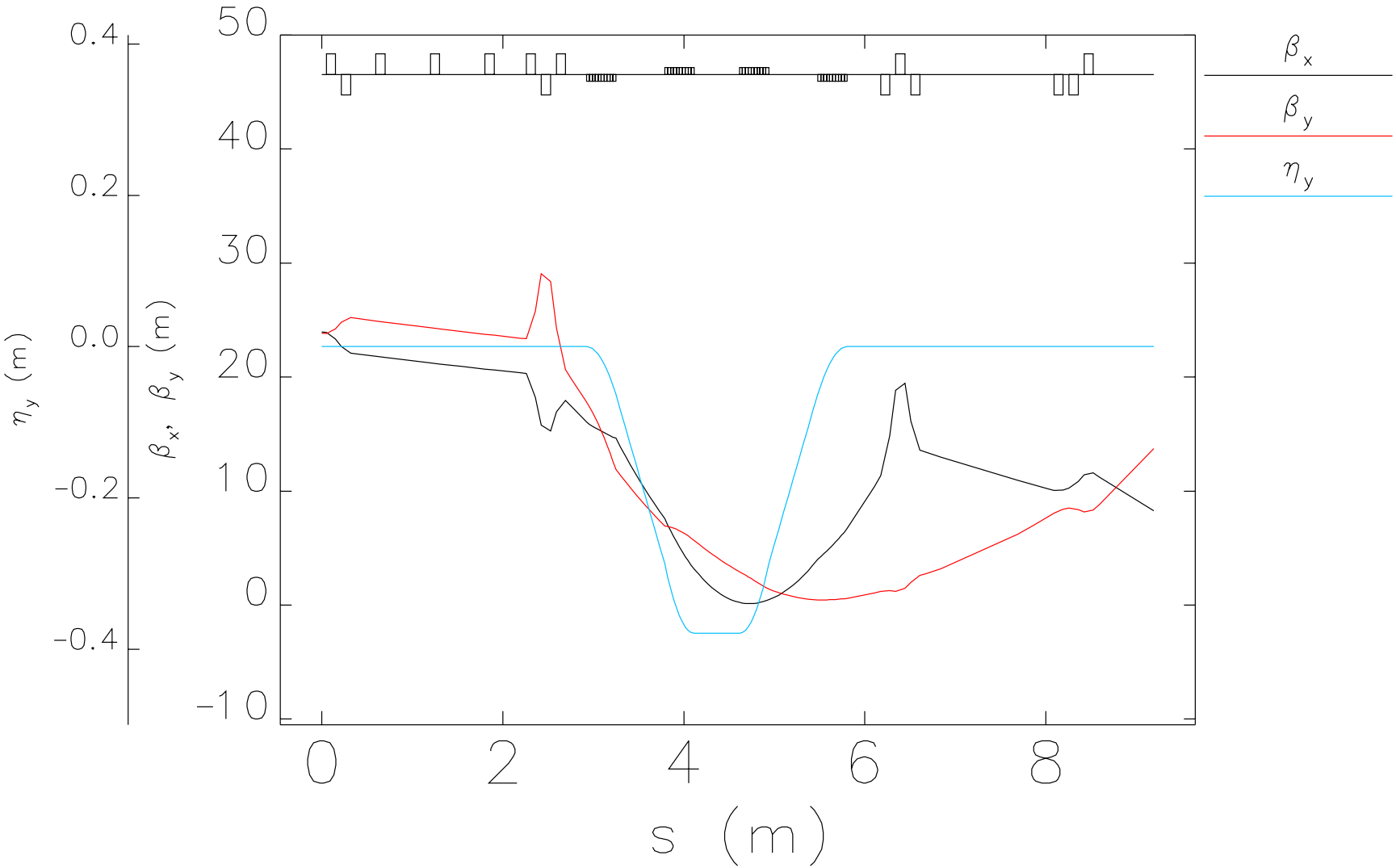
Transport section (straight ahead)

- Re-use FNPL components (quad/double cross assembly, dipoles)
- Compressor is re-configured to provide higher R56 to avoid having to go too far off crest in cavity 2 for maximum compression

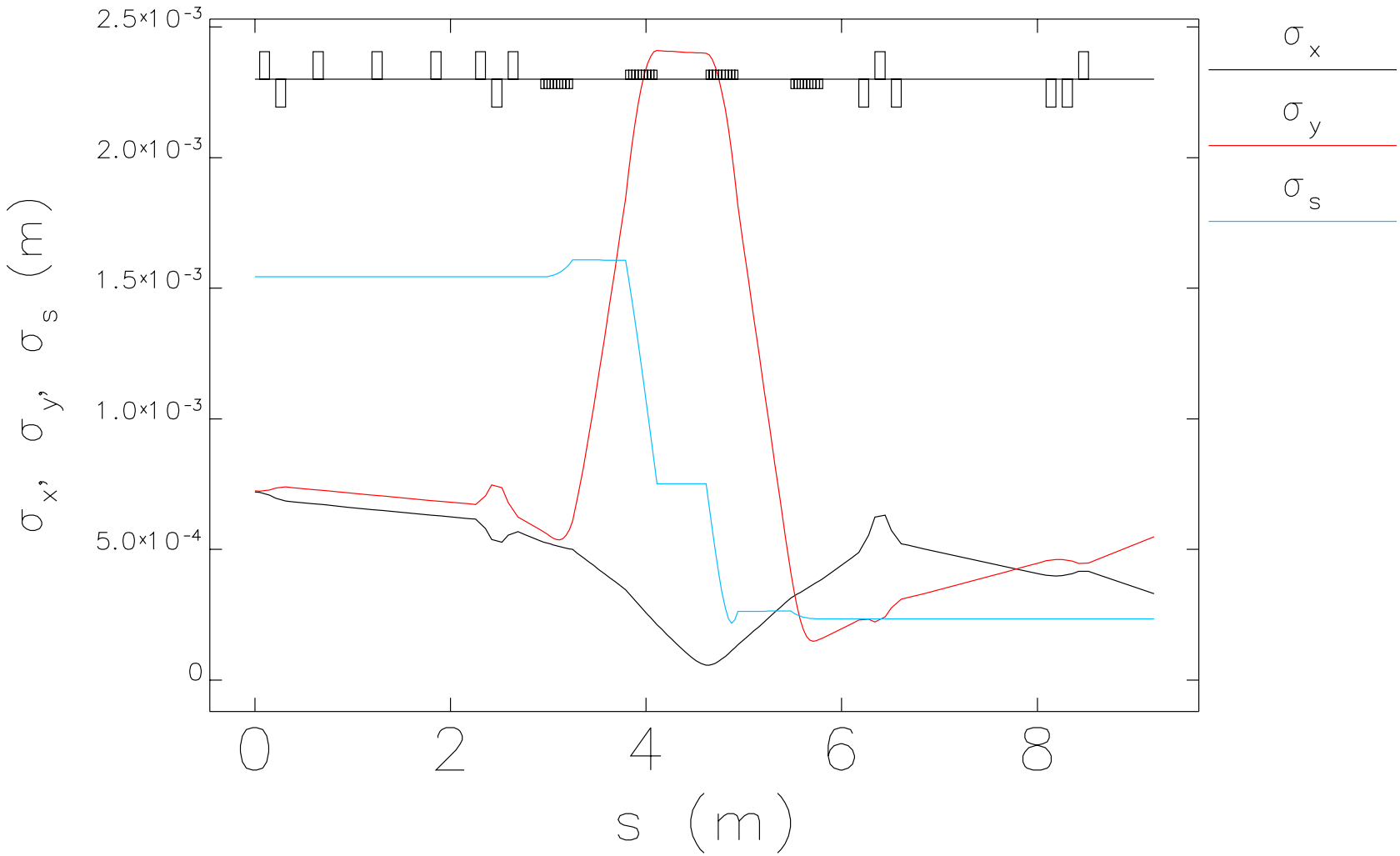


- Compressor should still bend the beam in the vertical plane,
  - Space between inner dipole should be long enough to be able to incorporate the 5-cell (warm) 3.9 GHz deflecting cavity
- Off-axis beam line should be in the horizontal plane
- Compressor axis orthogonal to spectrometer beamline can provide a way to correlate beam energy spread with bending plane of the compressor

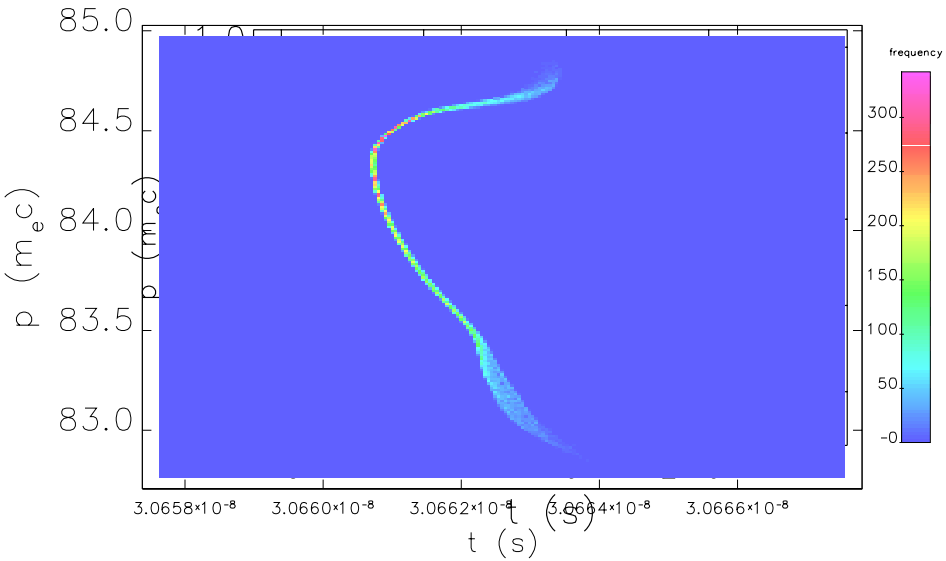
Transport section (straight ahead)

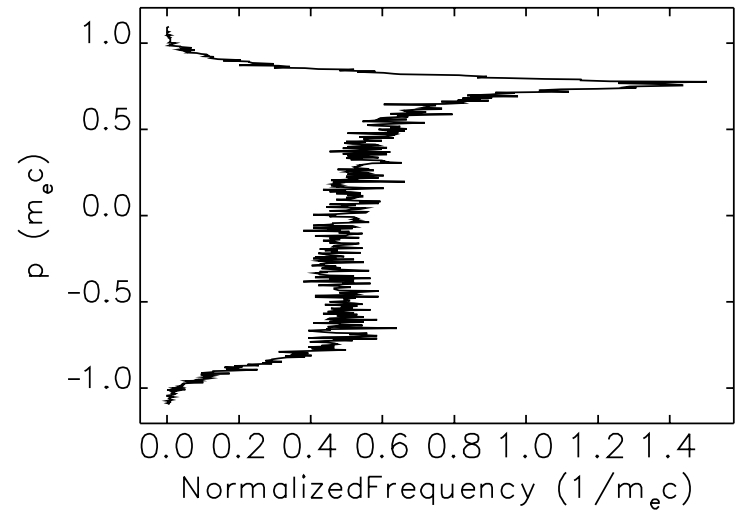


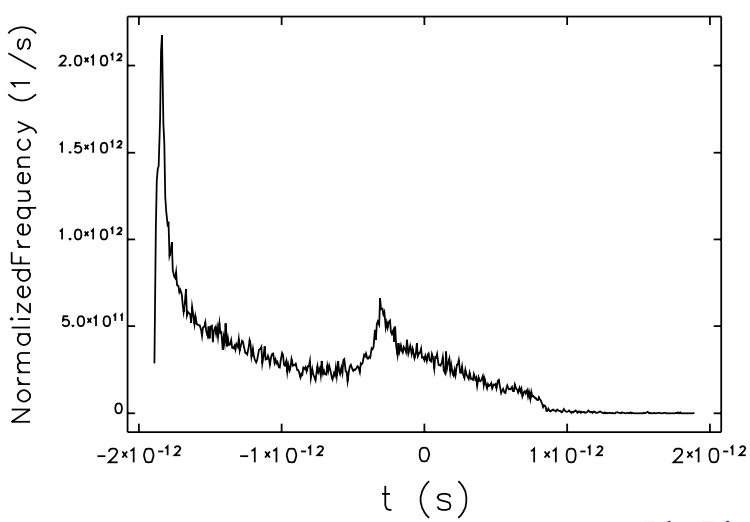
Compression Performance (1 nC example)



Compression Performance (1 nC example)



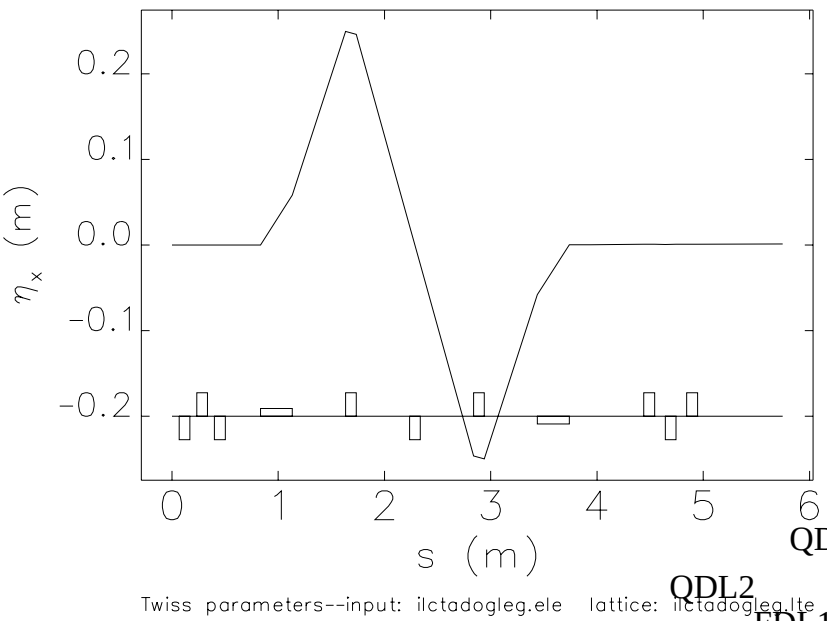


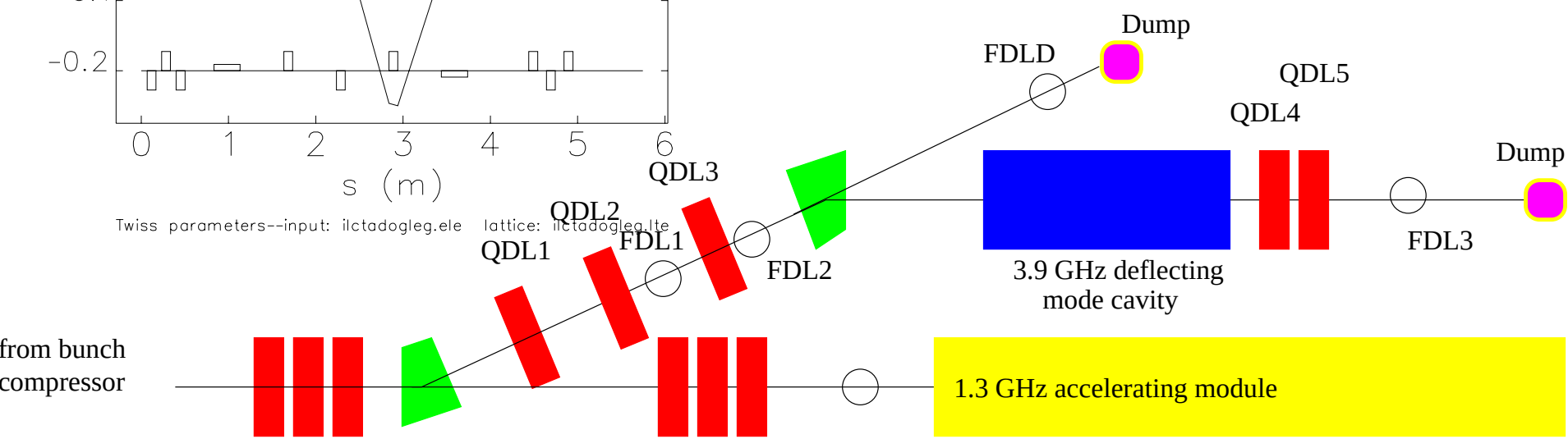


Peak current at 1 nC: 2 kA!

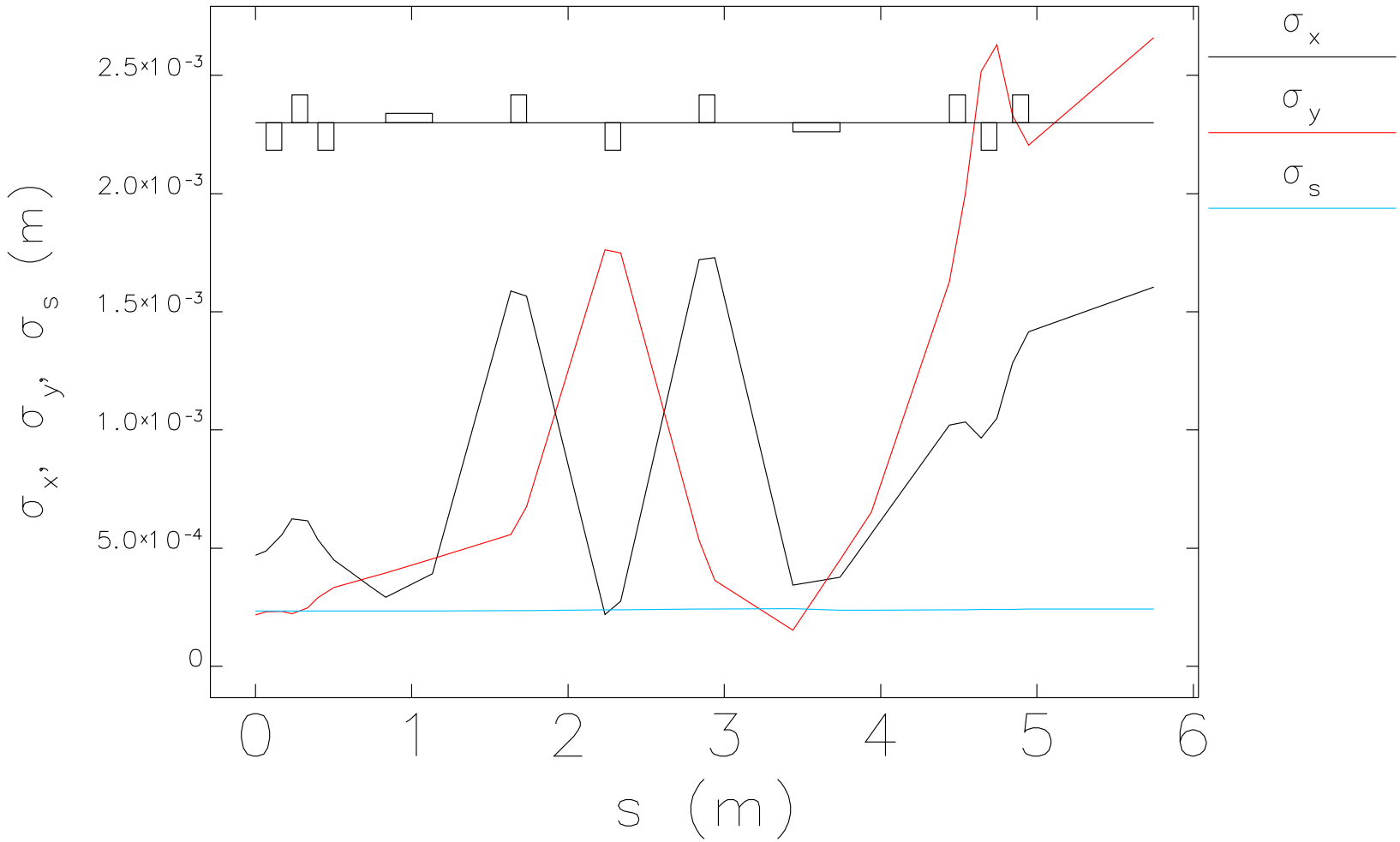
Dogleg and off-axis beamline

- Double bend achromat to offset the beam in an off-axis dispersionless beamline
- R56 should be small to avoid influencing the bunch length
- Bending angle + effective length of dipole (=curvature radius) still need to be chosen; right now 22.5 deg, Leff=0.3 m (current offset if 1 m)



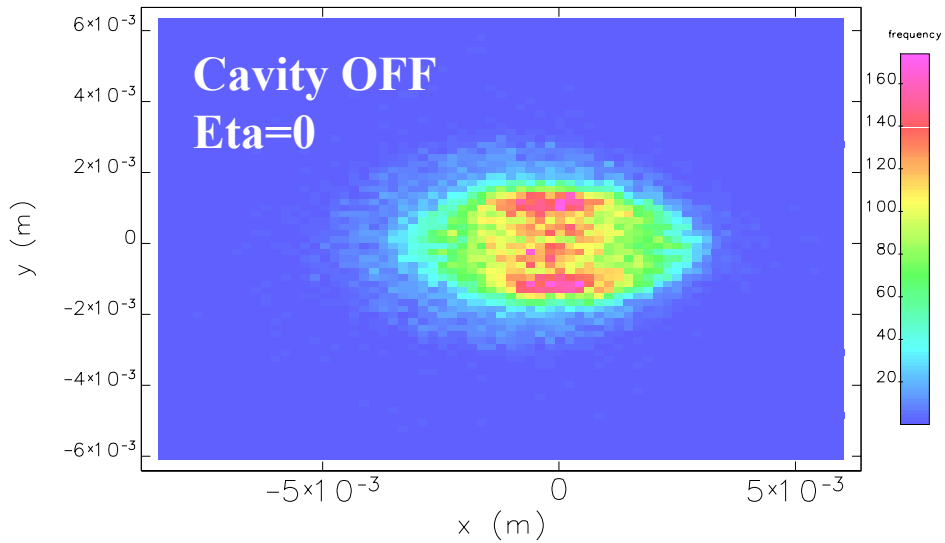


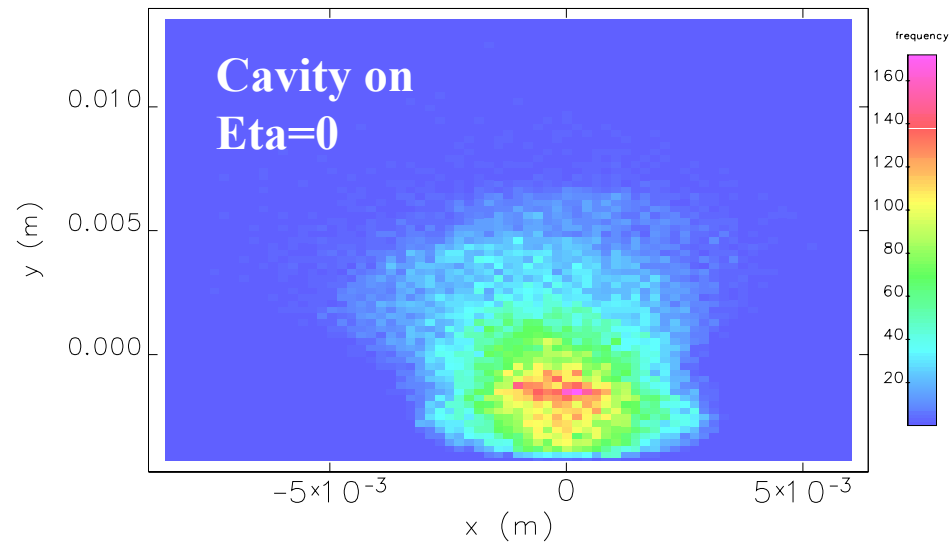
Diagnostics using the DMC

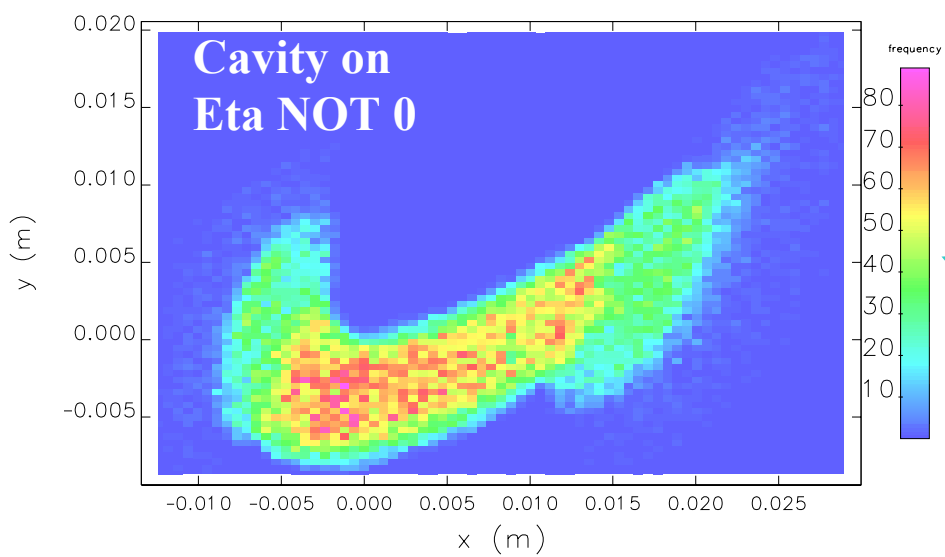


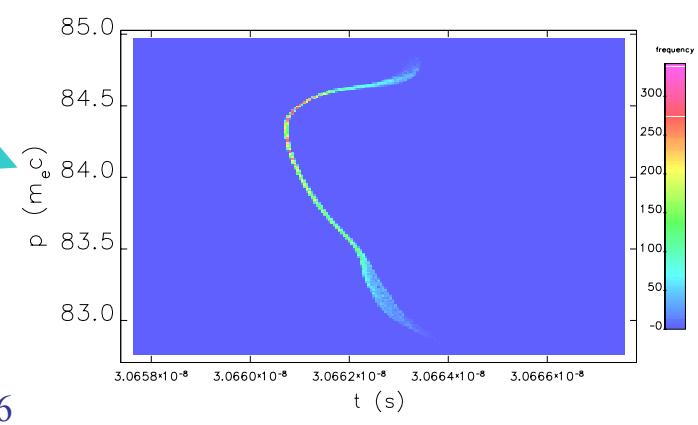
Diagnostics using the DMC

Beam spot on FDL3 for various scenario:
Cavity ON: cavity vertically deflecting
Eta NOT 0: dispersion leak in the horizontal plane.

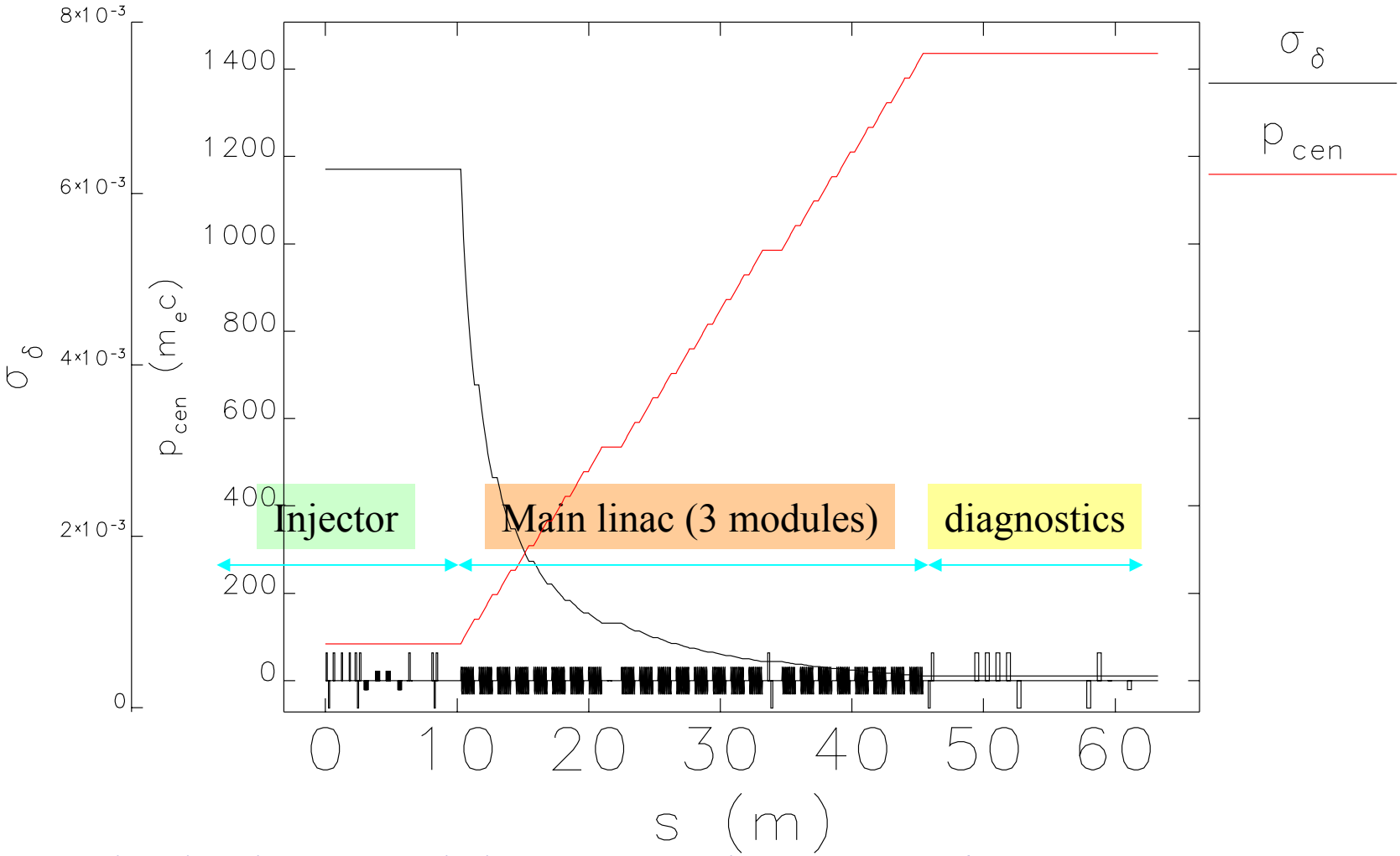






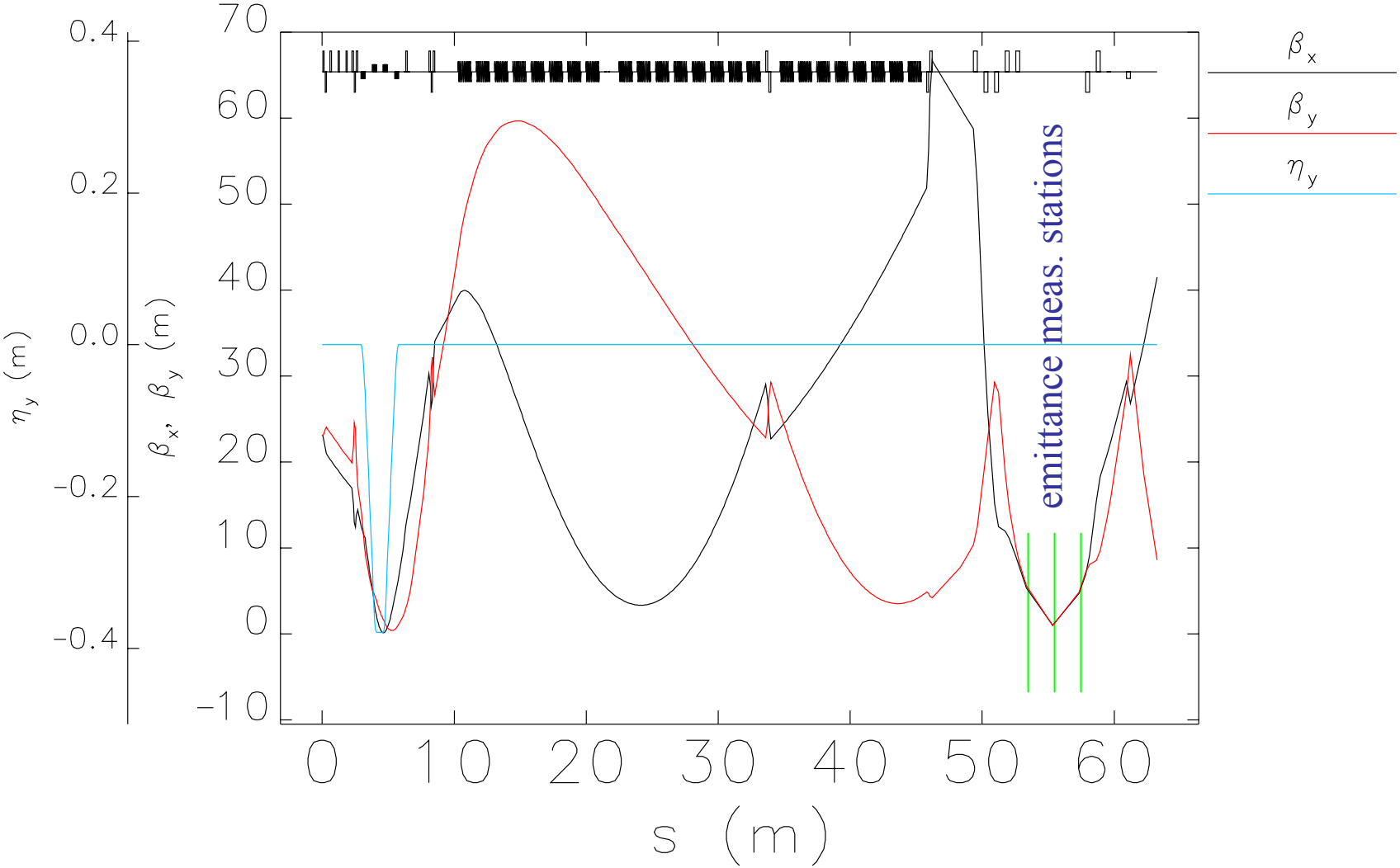


Main linac: 3 modules

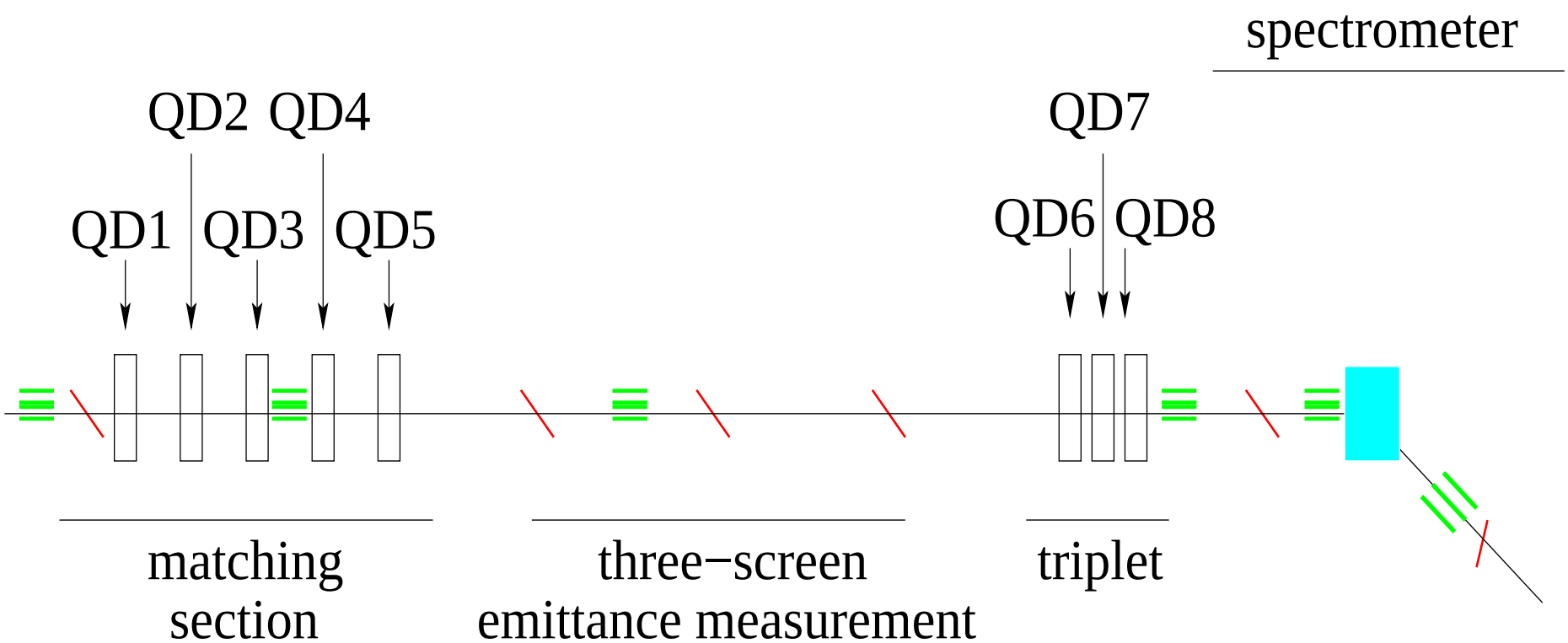


- Cavity in three modules operated at 25 MV/m average acc. Gradient
- $\gamma \sim 1400$ and $\delta\gamma/\gamma \sim 0.037\%$

Beta-functions



High energy diagnostics section



- Momentum (mean and rms) both single bunch and multi-bunch
- Transverse and longitudinal emittances
- Test area for new ILC diagnostics development

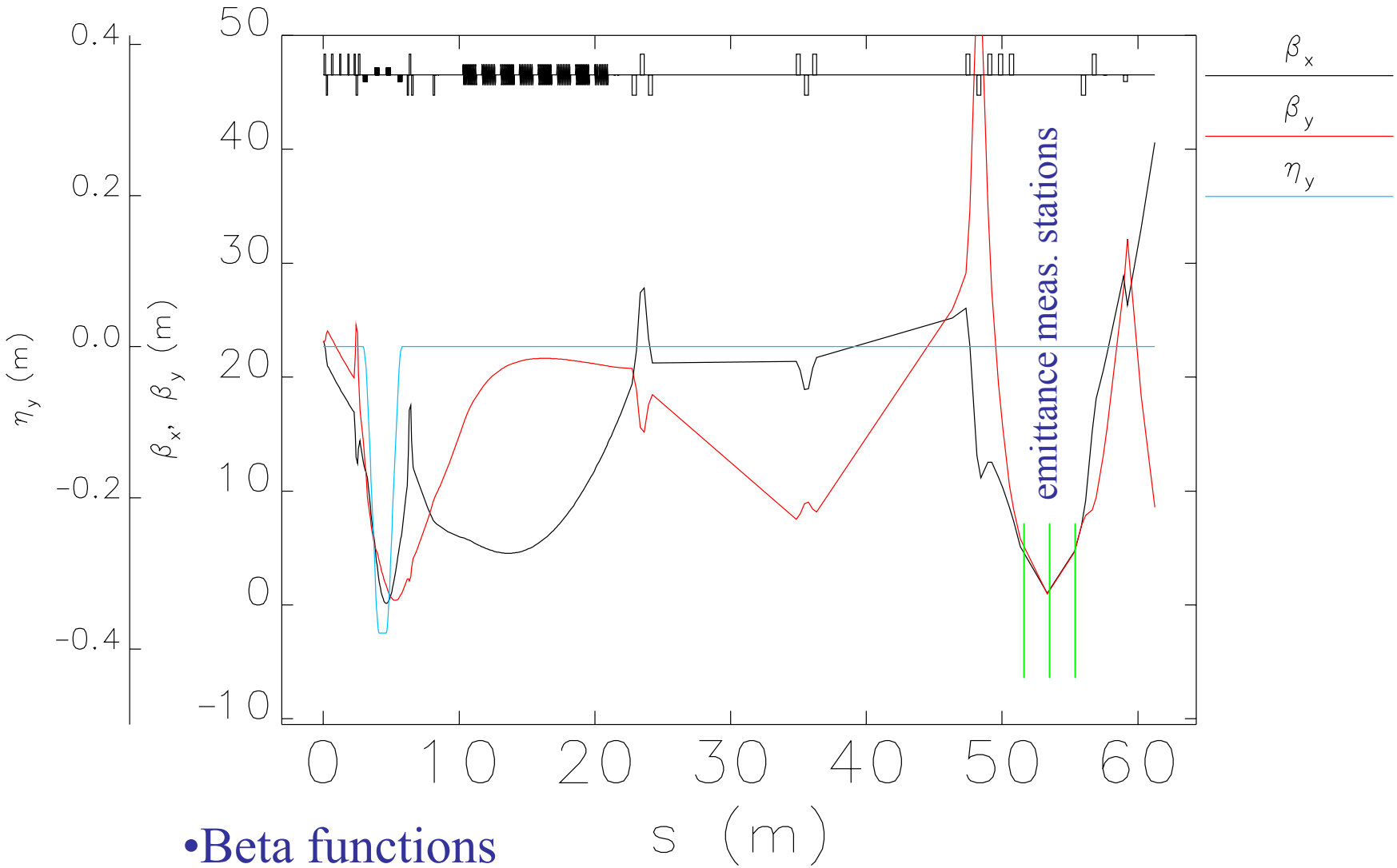
Main linac: 1 module

- The dump and diagnostics section will be installed at their nominal location (consistent with 3 modules linac)

- When only one module is installed beam needs to be transported for ~25 m up to diagnostics area and dump

- Present configuration, only use two triplets to transport the beam (not optimized)

Main linac: 1 module



•Beta functions