XFEL Optics Considerations

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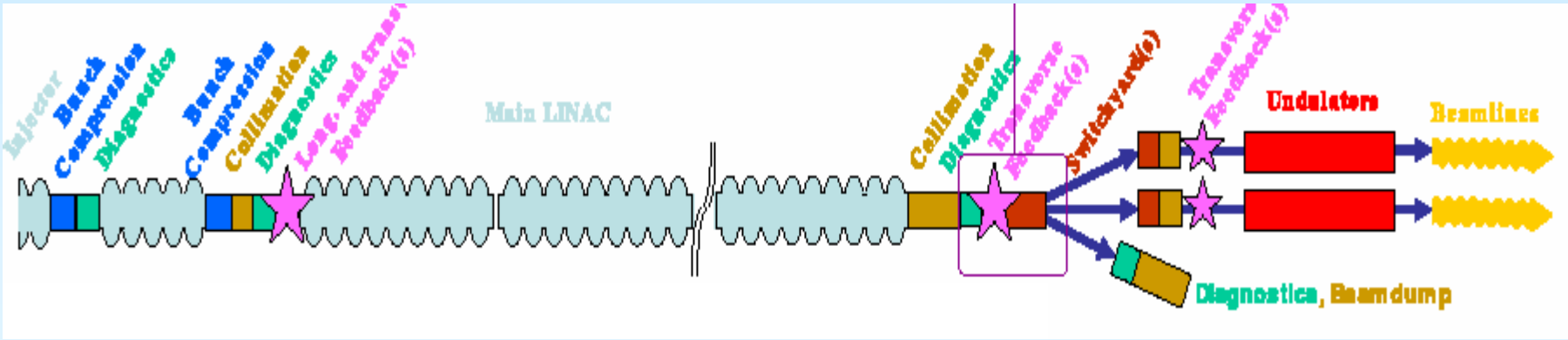
TESLA Collaboration Meeting

Zeuthen 01/04

Optics Issues



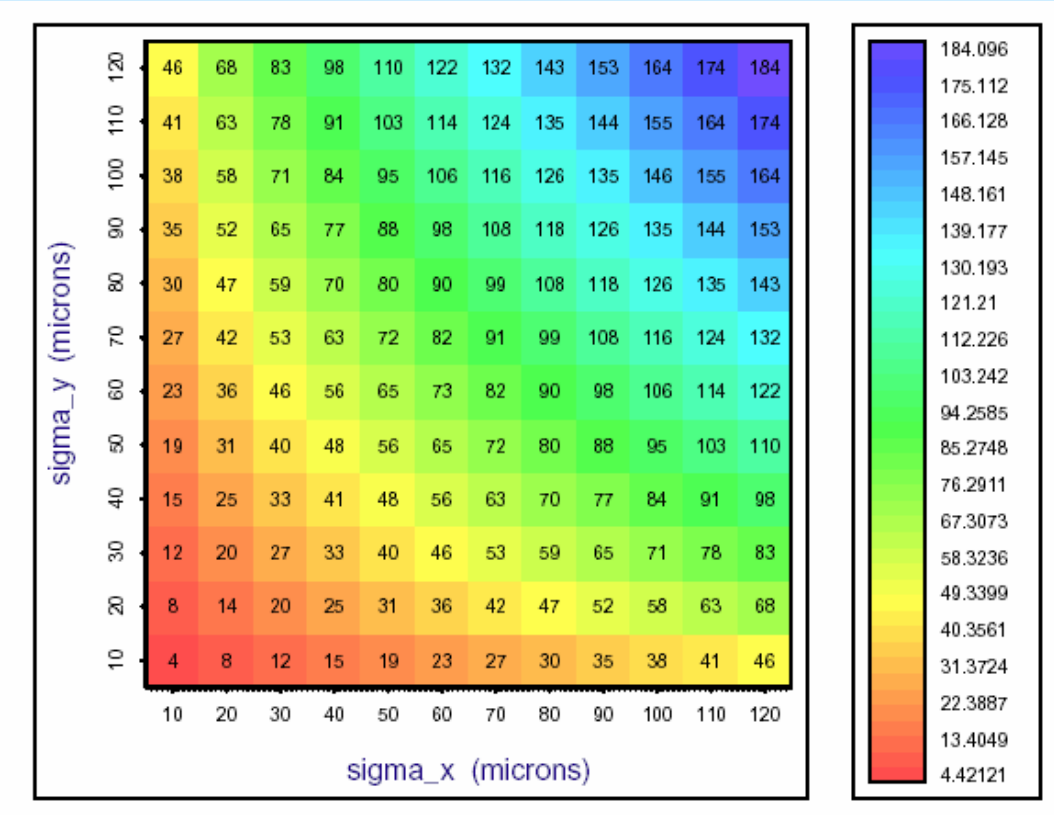
Injector
Bunch compressor 1
Diagnostics 1
Bunch compressor 2
Diagnostics 2
Orbit Feedback 1
Collimation 1

Linac
Low energy extraction

Diagnostics 3
Collimation 2
Orbit Feedback 2
Fast Beam switch

Beam transport to Undulator
Collimation 3
Orbit Feedback 3
Undulator optics
Beam transport to Dump

EGS Simulations for Ti Spoiler

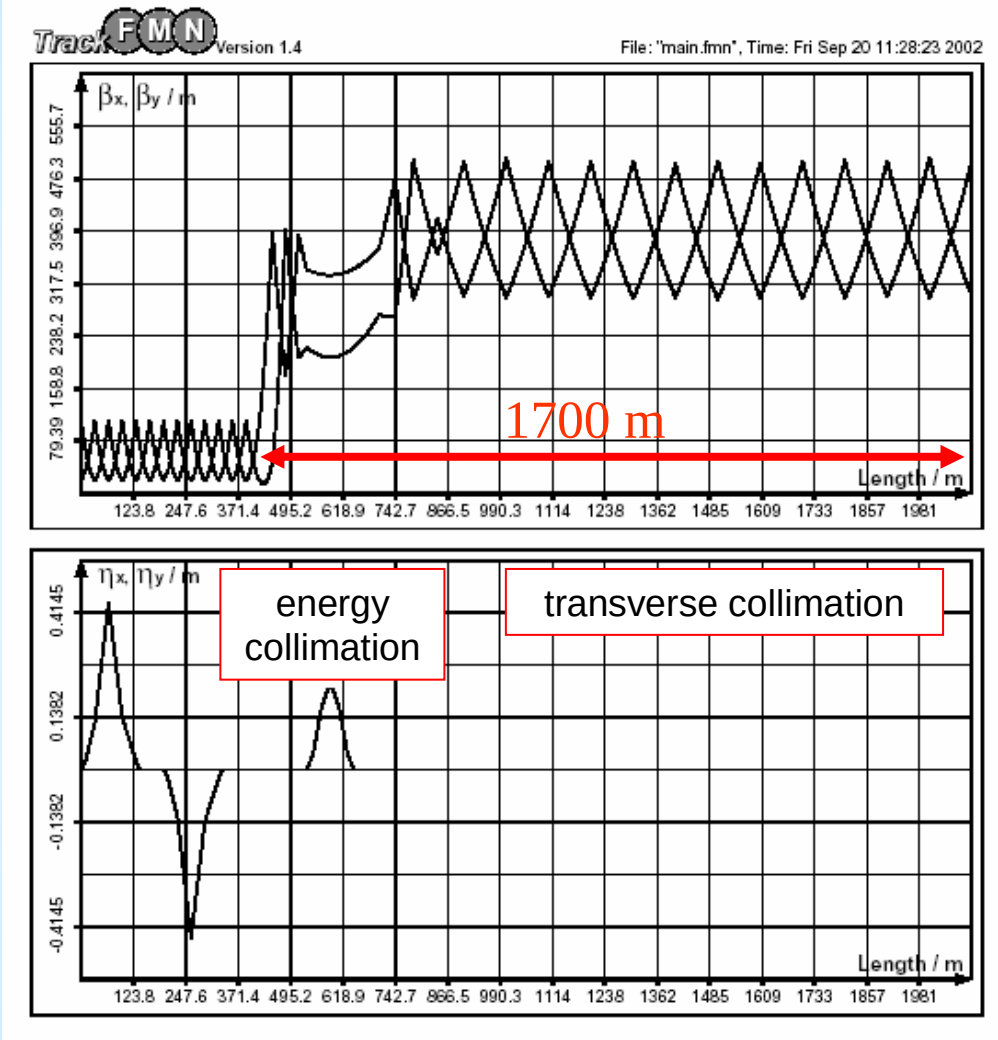


- Spoiler has to withstand 100-200 bunches
- Number of bunches for instantaenous temperature rise < 1670^{o} C
- TDR supplement: $\beta \approx 350 - 380$ m for Ti spoiler
- Other spoiler material (graphite T = 3520^{o} C) ?
  - Resistive wall wake an issue ??

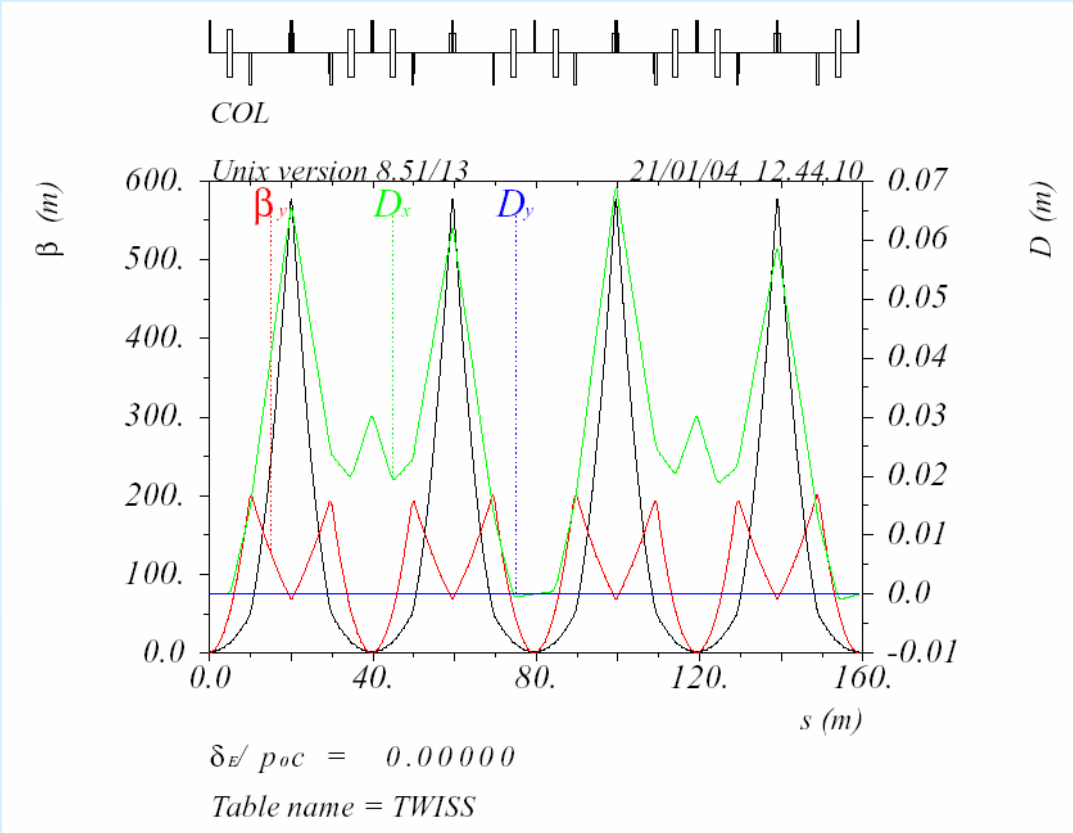
Collimation – TDR Layout

Optimized for:
- ≈ 200 bunches impact on spoiler (time to switch of gun)
- Diagnostics within collimation
- Large energy acceptance and bandwidth (3 % resp. 9 %)

Too long for XFEL
Alternatives:
- Learn from LC designs
- Revive emergency dump



LC like Collomation System (R.B.)



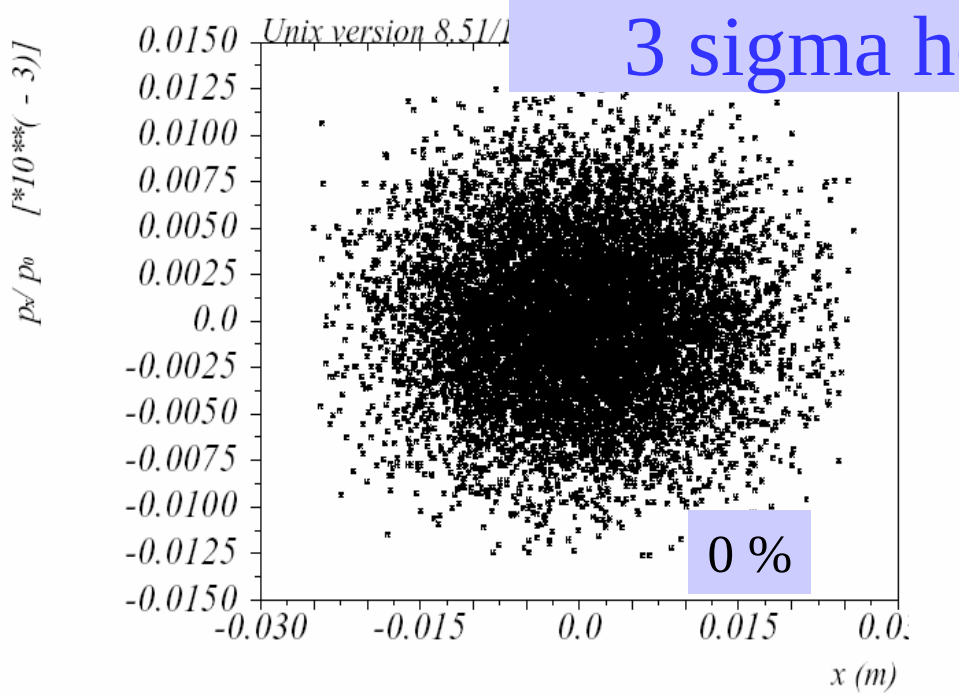
Mismatched 90 deg FODO leads to large betas

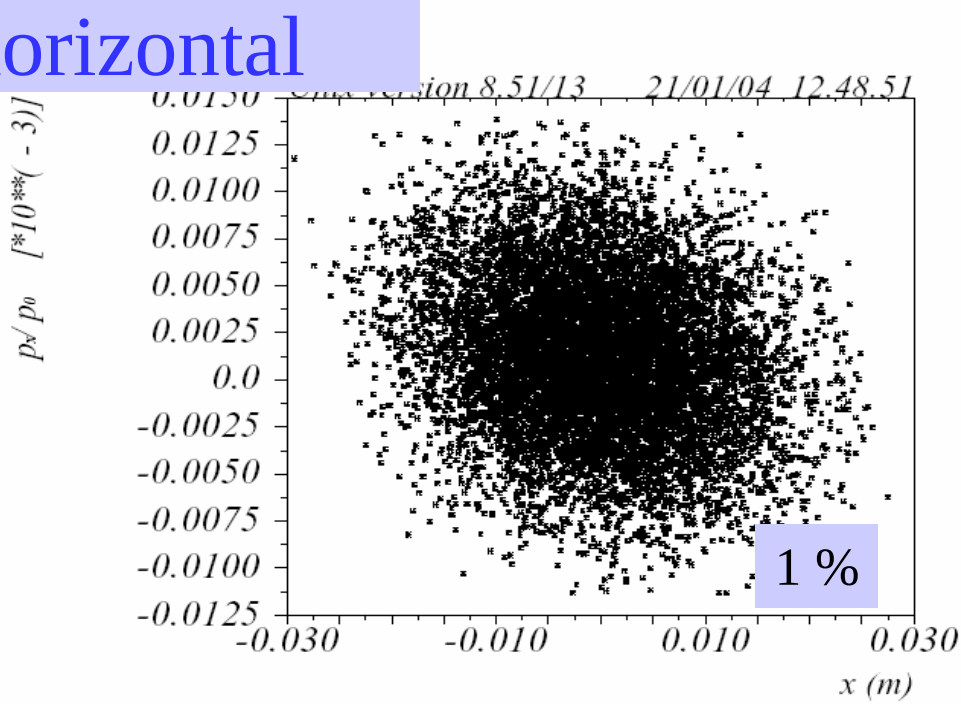
Combine longituidnal and transeverse collimation

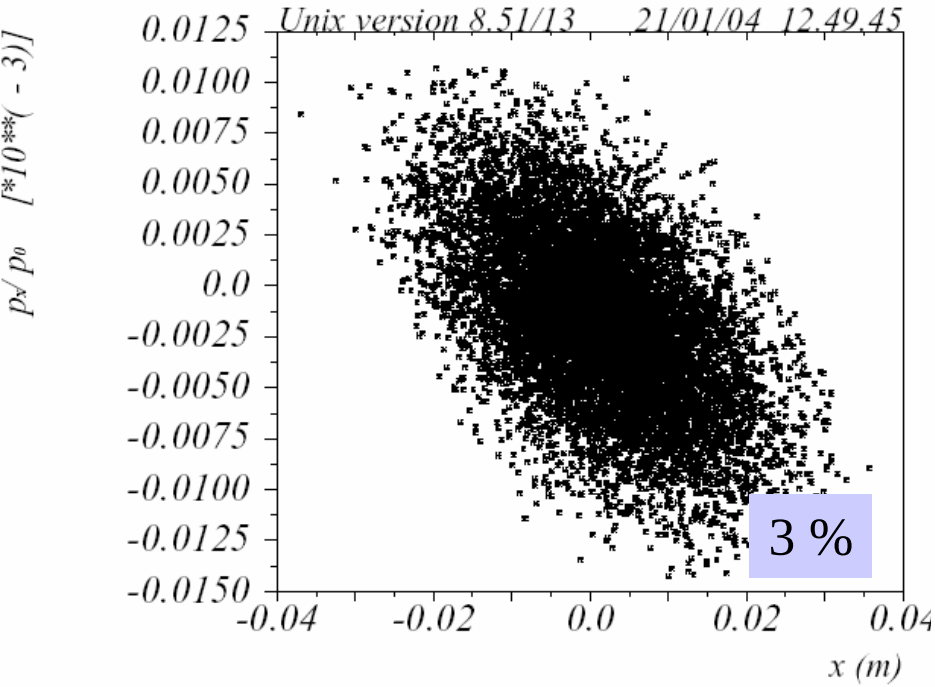
Sextupoles for chromatics correction

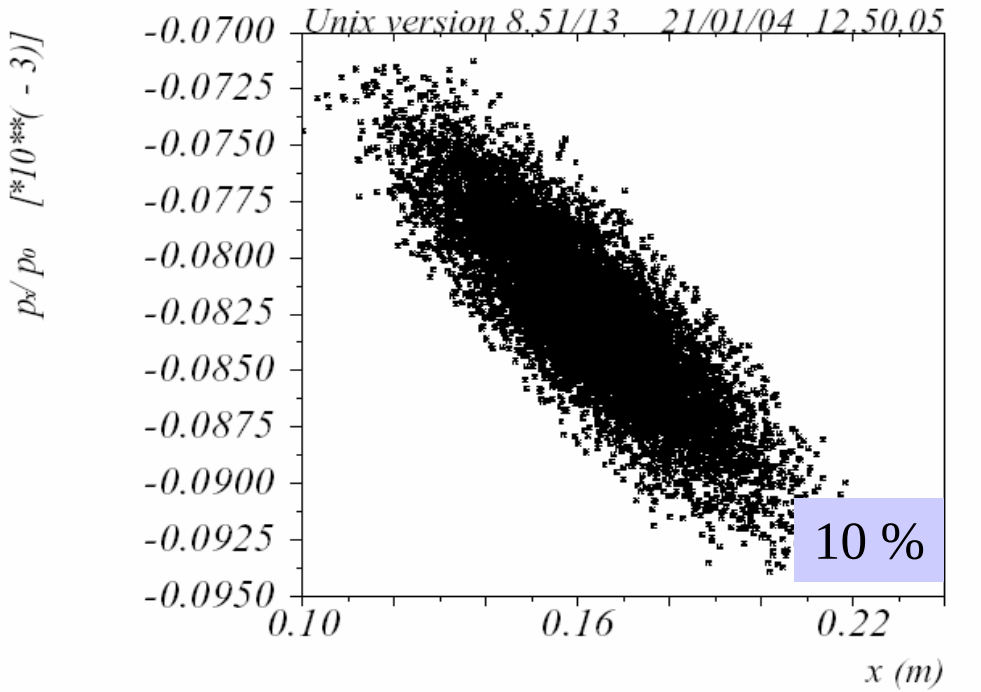
Bandwidth ???

3 sigma horizontal

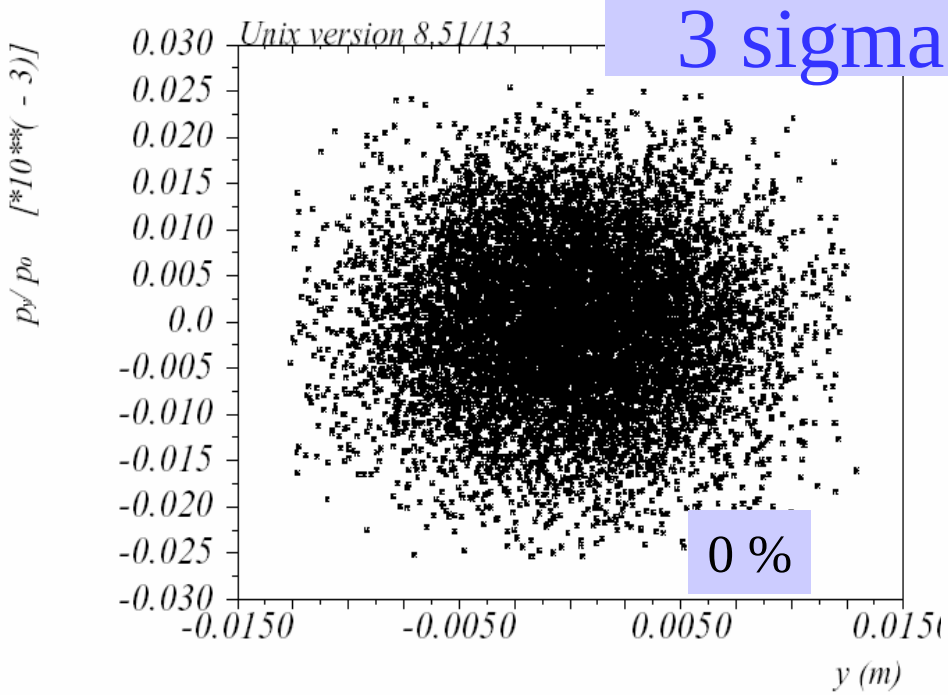


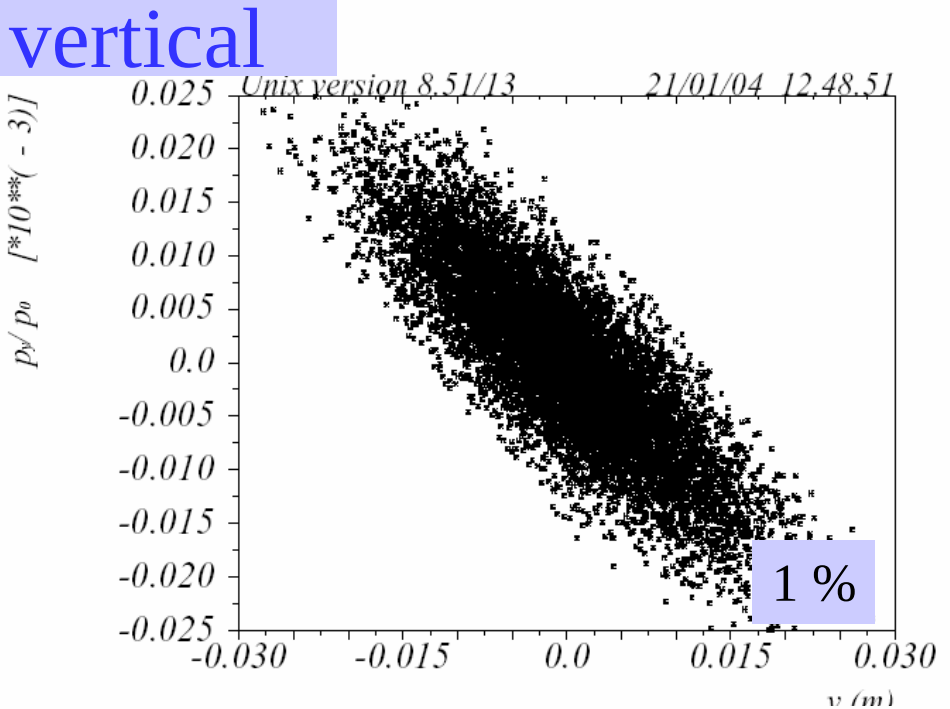


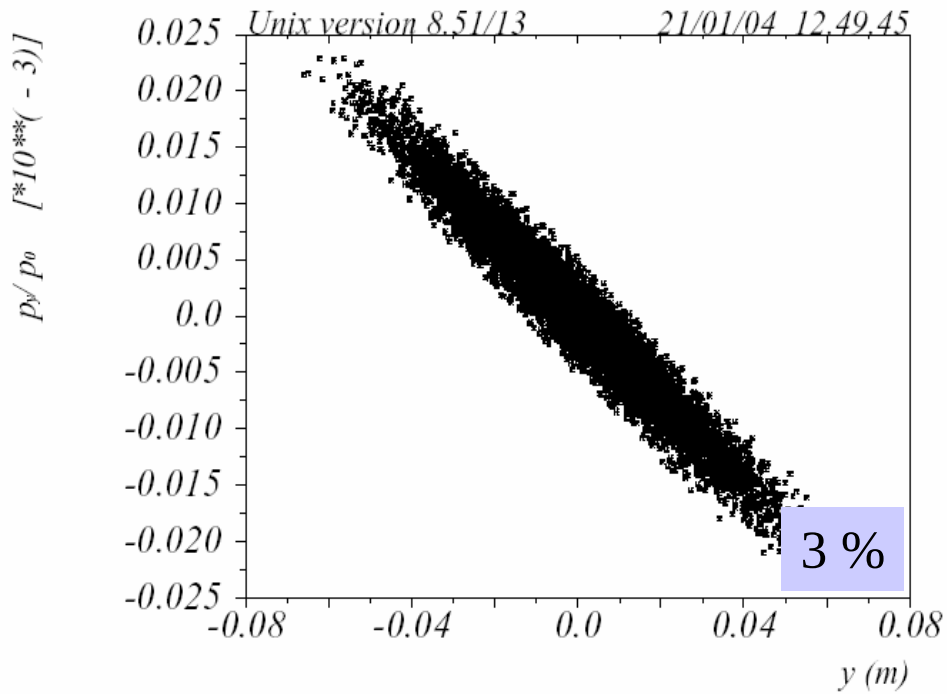


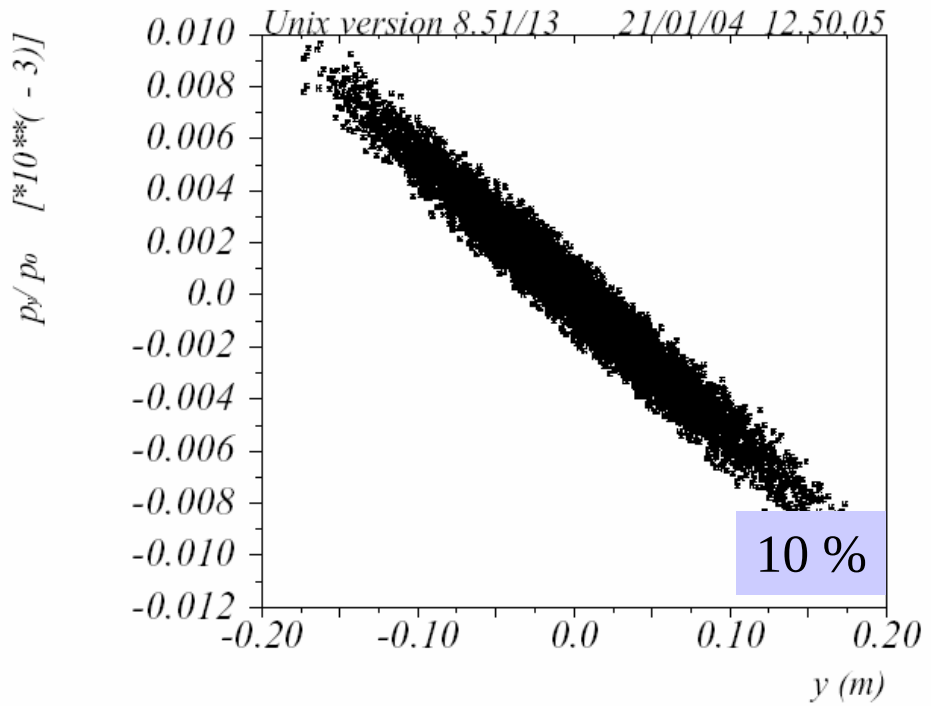


3 sigma vertical



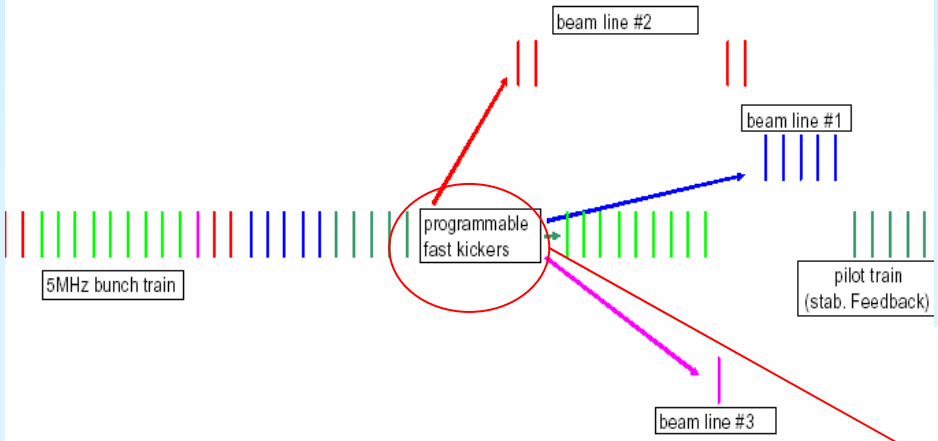


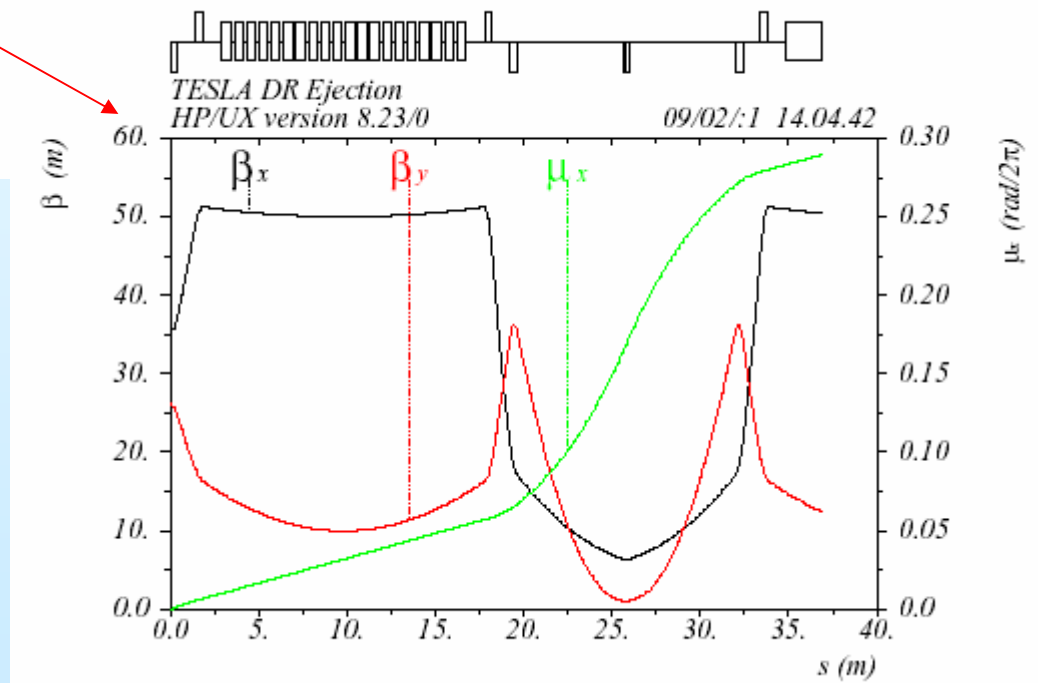




Fast Beam Switch

Programmable, large bandwidth fast kickers

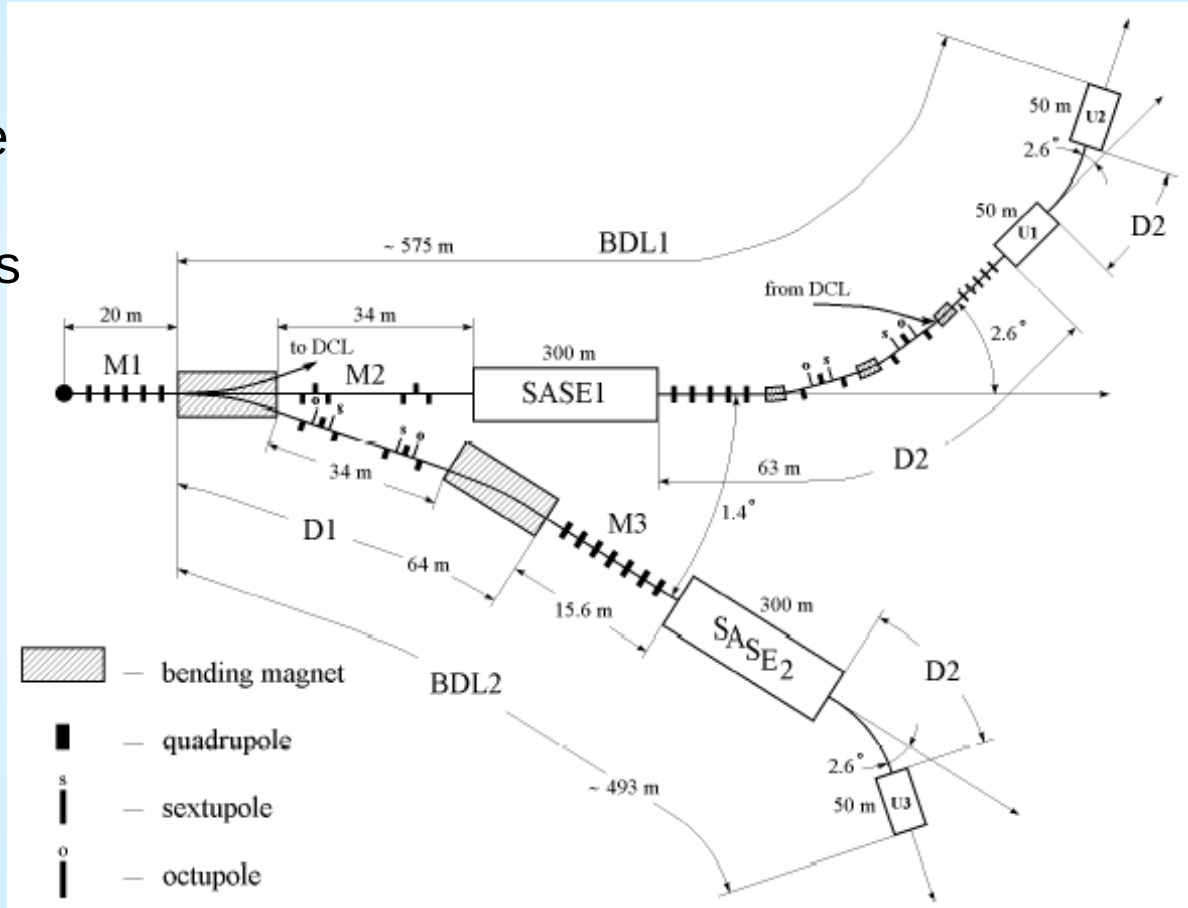




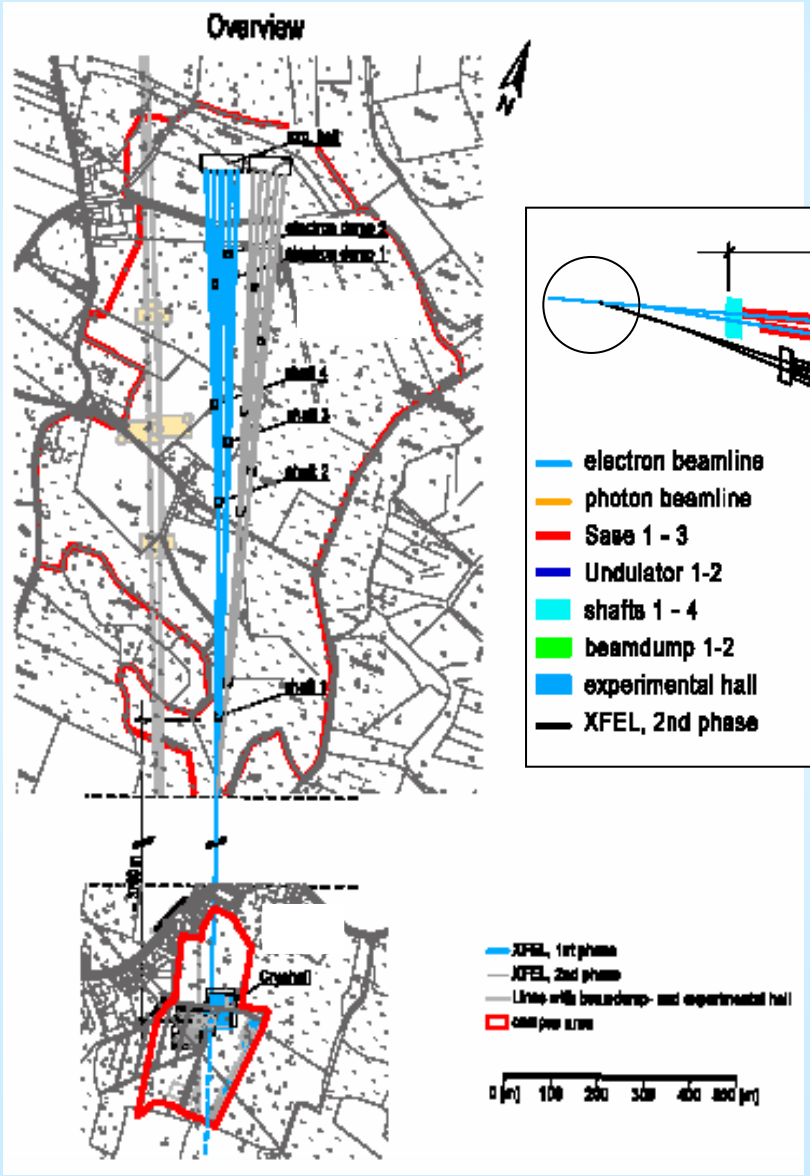
Switch Yard – TDR Layout

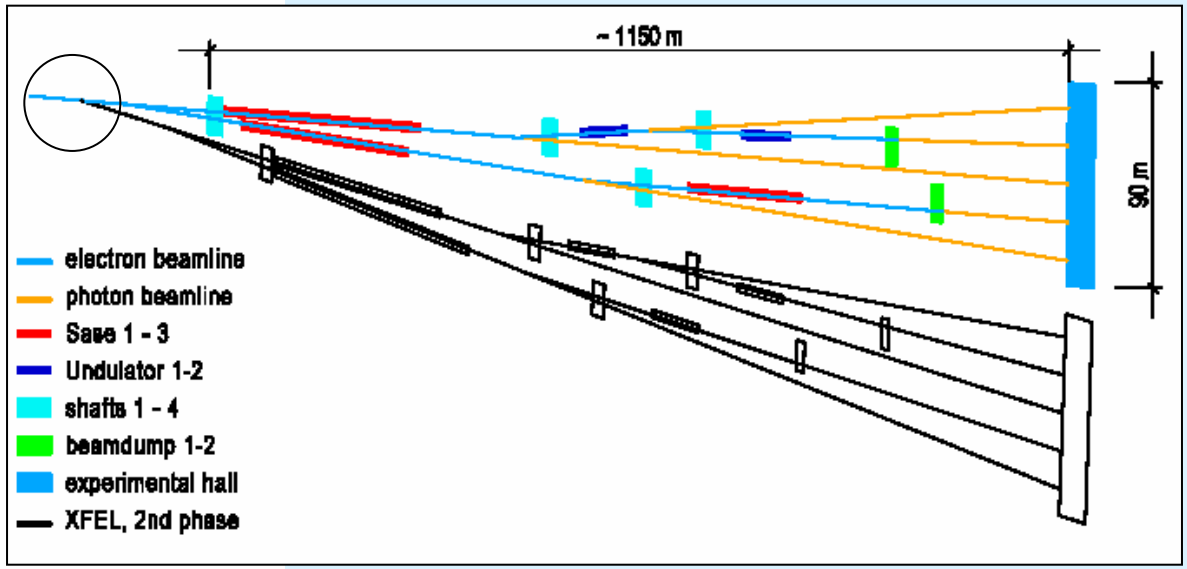
Optimized for:
- large energy acceptance
- 50 GeV max. energy
- Ellerhoop site constraints
- Includes orbit FB

Review:
- 20 GeV
- Switching device
- 2nd stage



TDR Layout


Overview
shaft 4
shaft 3
shaft 2
shaft 1
Cryohall


~ 1150 m
90 m
electron beamline
photon beamline
Sase 1 - 3
Undulator 1-2
shafts 1 - 4
beamdump 1-2
experimental hall
XFEL, 2nd phase

Whats next

- Work on collimation/fast switch section
- Orbit feedback by SLS
- Beam distribution ok for time being
- Work on transverse jitter budget

Beam Jitter - Tolerances Undulator

- From SASE process:
  - 0.1σ (whole undulator)
- User requirements
  - 0.1σ (last part of undulator)
  - pointing stability ?

Jitter Sources

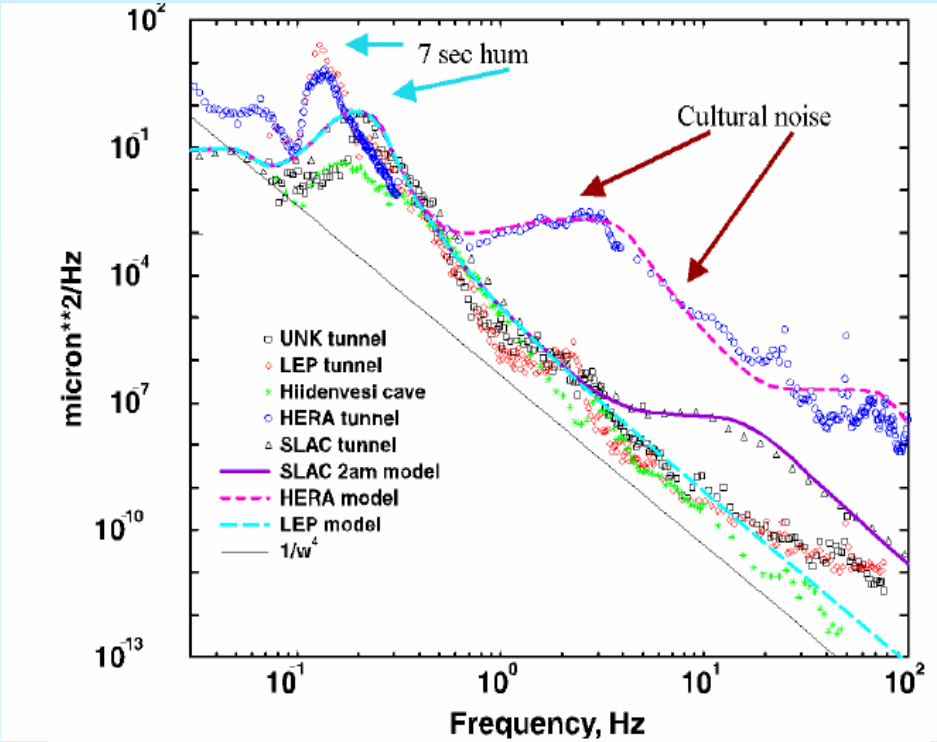
Before FB:

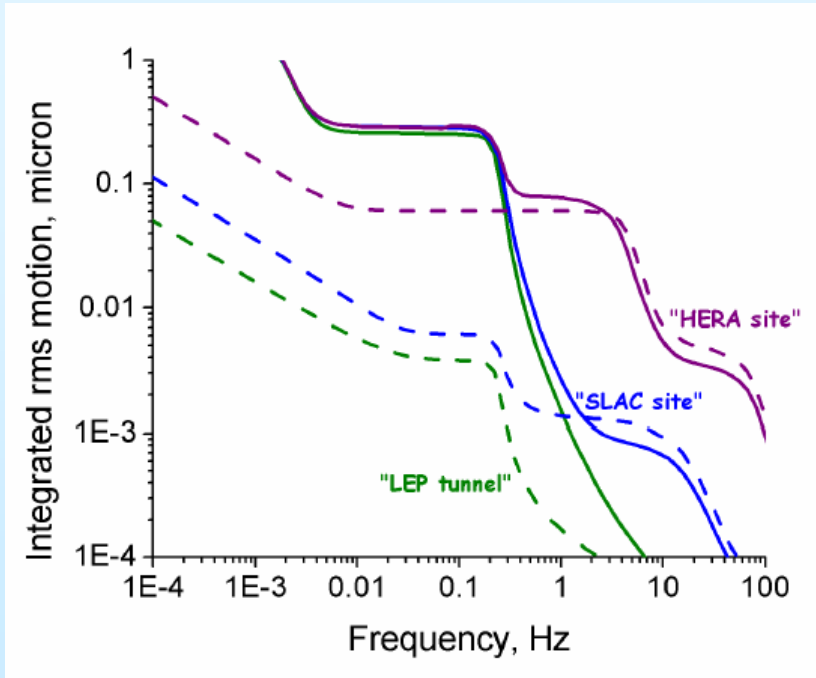
- Laser jitter
- Coupler kicks
- Wakefields
- Energy jitter
- Charge jitter
- Ground Motion
- …

After FB:

- Feedback
- Switch
- Ground Motion

Jitter Sources - Ground Motion





Watch out for girder/support enhancement

Jitter Sources - Ground Motion

- With 70 nm (rms) quad movement about 0.05σ at linac end
- **1:1 transfer ground to quad assumed**, may need redesign of present quad mounting in cryostat
- Measurements of quad vibration in cryostat not yet conclusive
- Additional jitter in undulator and switch yard, first estimate gives 0.02σ