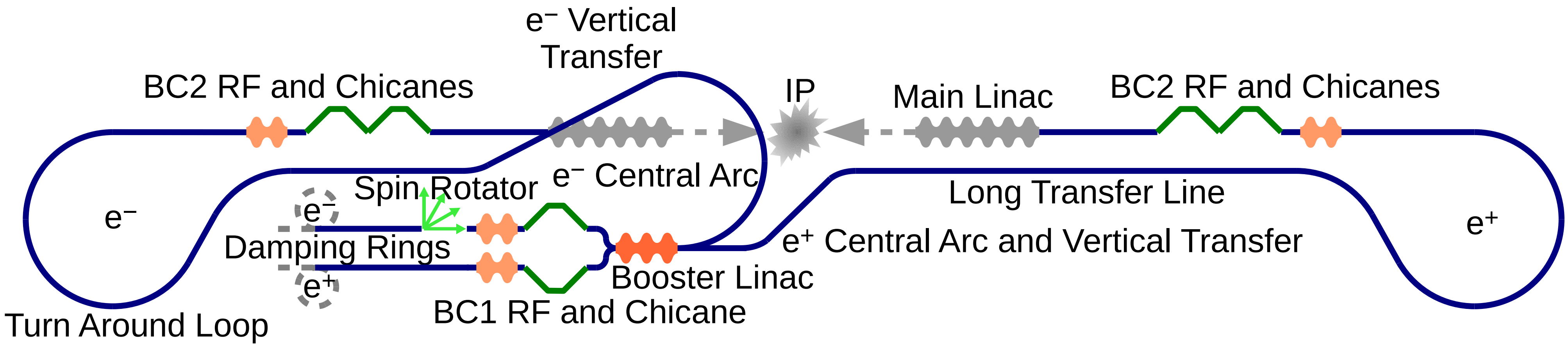
Update on the CLIC RTML

Status at IWLC10:

- complete set of lattices
- ISR, CSR and short range wakes studied
- good performance, i.e. within specs
- rough idea of misalignment tolerances,
  micron range, tightest in turn around loops,
  DFS works for pre-alignment of ~100µm (sextupoles ~50µm)
- sufficient for CLIC CDR

All we had to do was to write the RTML section for the CDR...



Updates

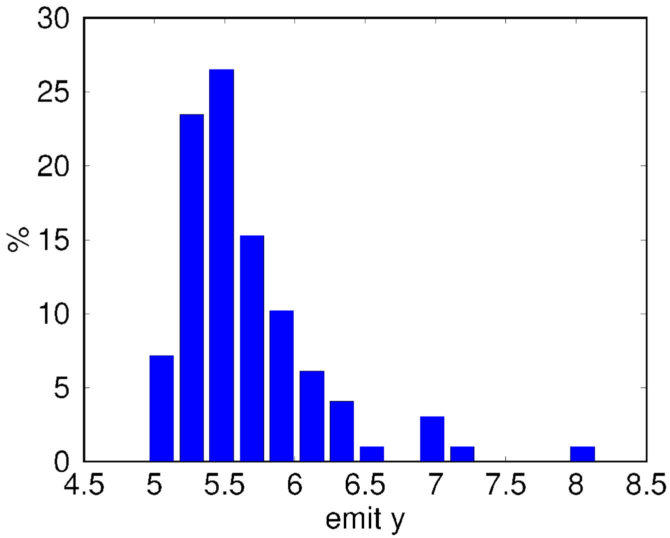
Since the CDR has been delayed, we had the time to perform more studies:

- misalignment has been studied in more detail, but not in every detail
- long range wakes in the booster linac have been simulated
- impact of incoming beam jitter and the resulting specs have been evaluated

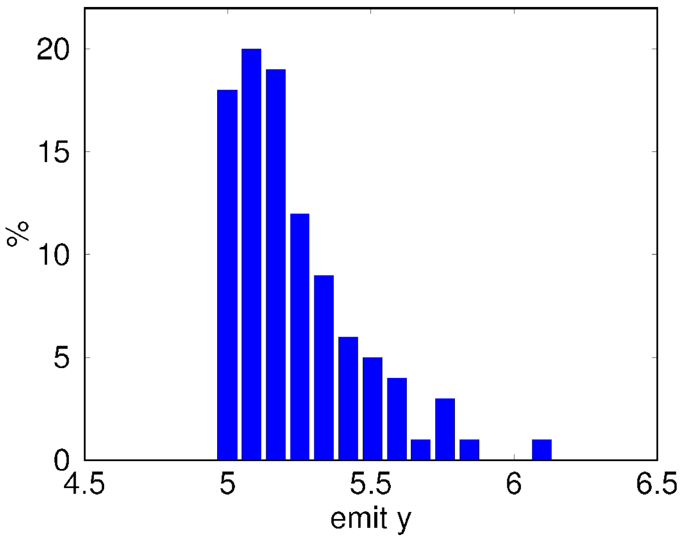
Following these studies we might want to revise some lattices, but not for the CDR.
That also means, I do not believe it makes any sense to study misalignment a lot further.
We will revise the lattices of the turn around loops (incl. central e- arc) and the booster linac. Afterwards we will come back to misalignment.

Misalignment in the turn around loops

- TAL lattice should have small ISR emittance dilution and should be isochronous, i.e. strong quads are required (the strongest ones are at maximum dispersion...) => many strong sextupoles needed to correct chromaticity,
- each turn around loop consists of 822 magnets and is ~2 km long
- outgoing beam position has to stay within 10% of beam size, in vertical plane ~1 µm beam size => 100 nm tolerance => 100 nm BPM resolution



100 µm rms quads and bends,
50 µm rms sextupoles,
1 µm rms BPMs, 100 nm BPM resolution
=> p90 = 6.2 nm rad after DFS

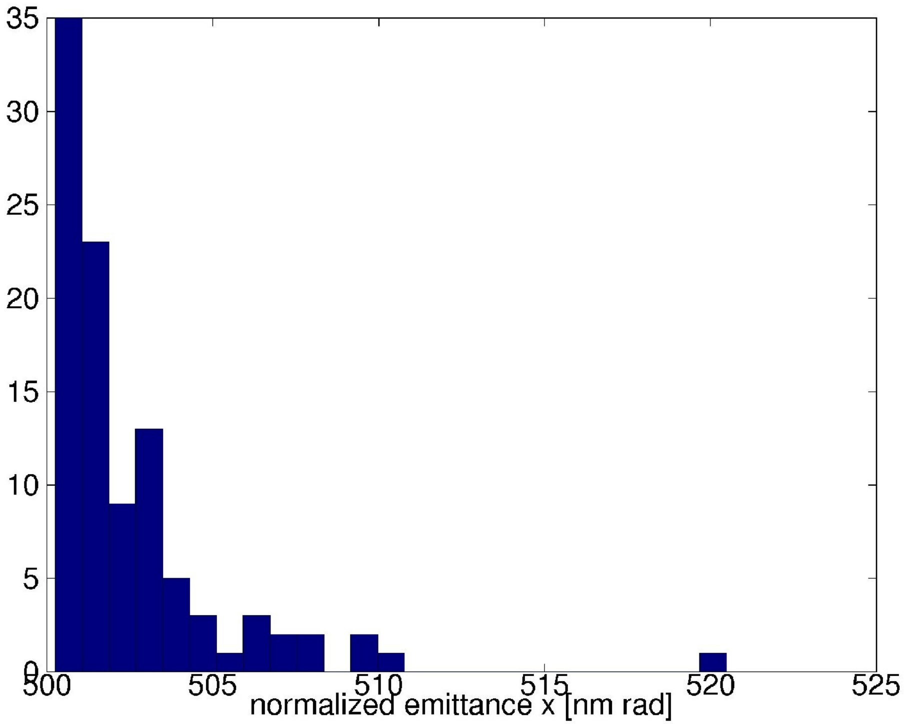


1 µm rms all magnets,
1 µm rms BPMs, 100 nm BPM resolution
=> p90 = 5.6 nm rad after SVD

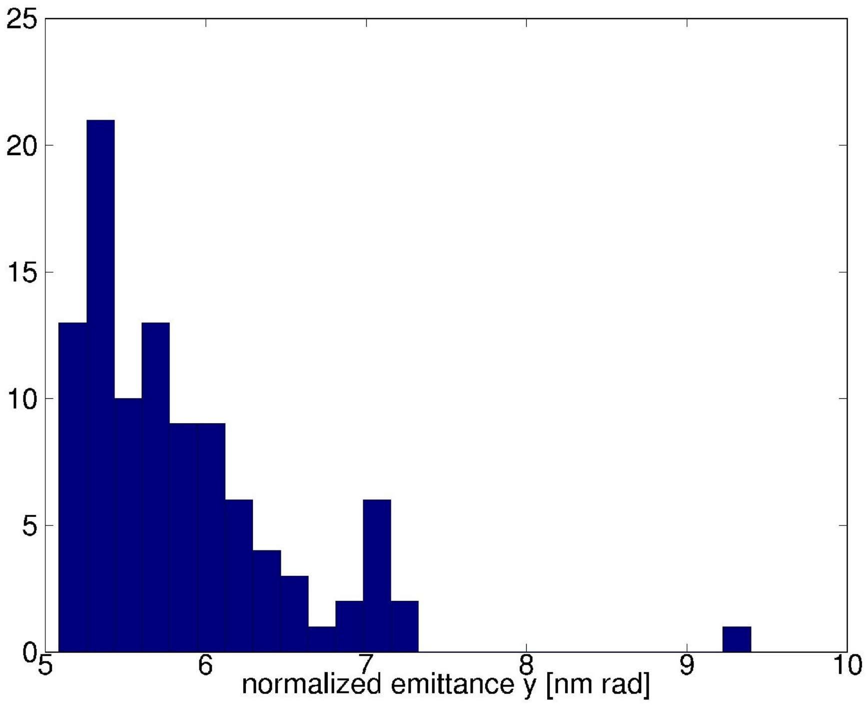
A trivial but important remark: Outgoing beam position jitter depends only on our knowledge of BPM position and BPM resolution at the end of the loop!

Long range wakes in the booster linac

100 µm / 100 µrad RMS cavity and quadrupole misalignment,
10 µm BPM misalignment with respect to quadrupole axis, 1 µm BPM resolution,
no incoming beam jitter, after applying dispersion free steering,
with single and multi bunch wakes, no HOM damping



RMS = 502.6 nm rad
90th percentile = 506.1 nm rad



RMS = 5.9 nm rad
90th percentile = 6.9 nm rad

Long range wakes in the booster linac

Amplification factors for incoming beam jitter according to
Daniel's PAC09 paper “Multi-bunch calculations in the CLIC main linac”

no HOM damping:

$F_c = 3.8$
$F_{rms} = 1.7$
$F_{worst} = 62$

=> too strong jitter amplification, even worse than main linac

with HOM damping (Q=30):

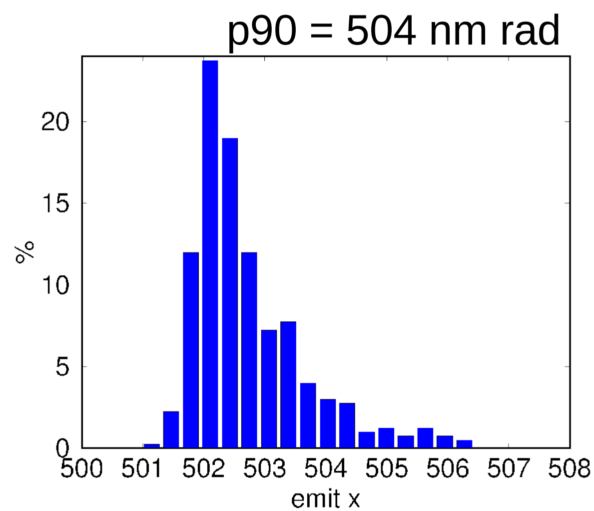
$F_c = 1.0$
$F_{rms} = 1.1$
$F_{worst} = 5.0$

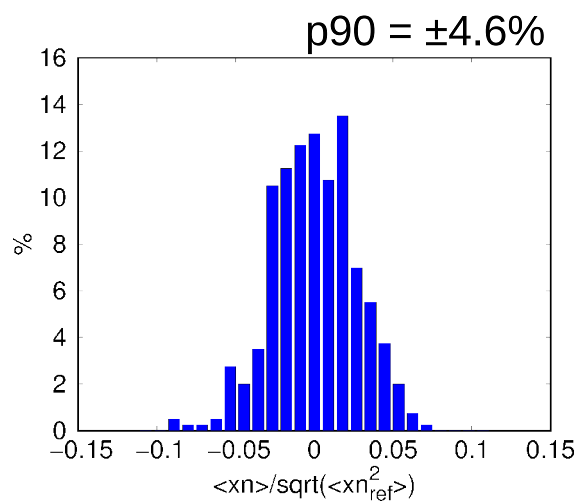
=> within specs:

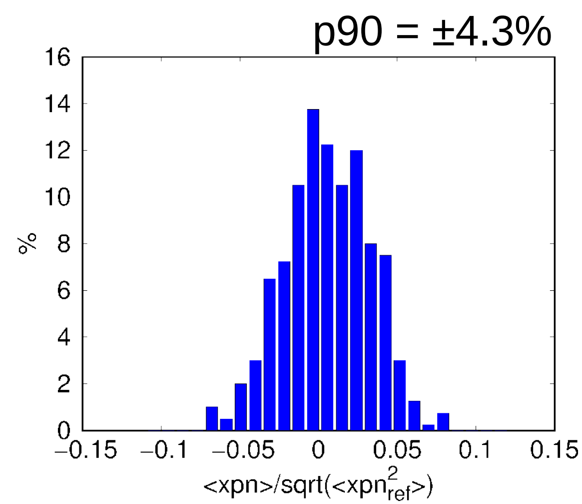
$F_c < 1.5$
$F_{rms} < 1.5$
$F_{worst} < 5$

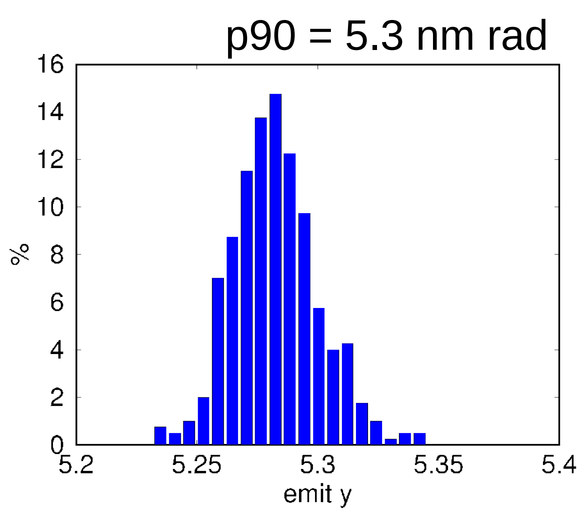
Incoming beam jitter

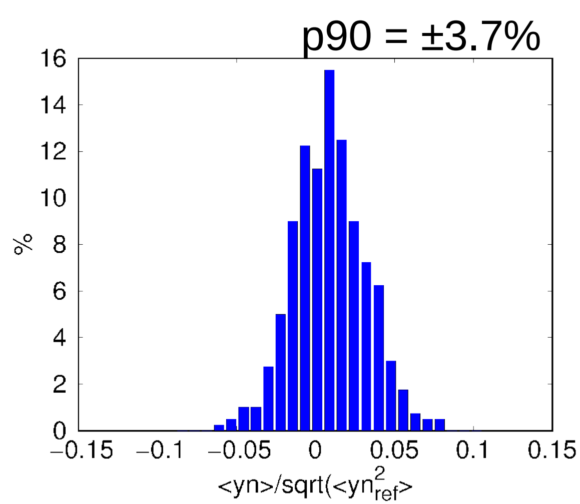
5% rms incoming electron beam jitter (Gaussian) ≈ 90% of cases within ±8% jitter,
no correction, no misalignment, plots show final distribution in normalized phase space,
no ISR, no wakes

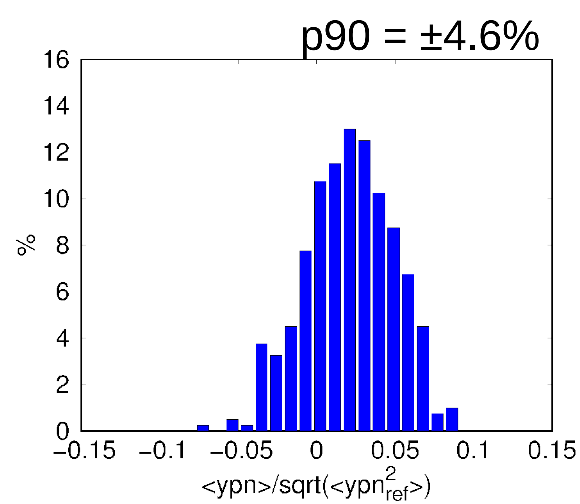






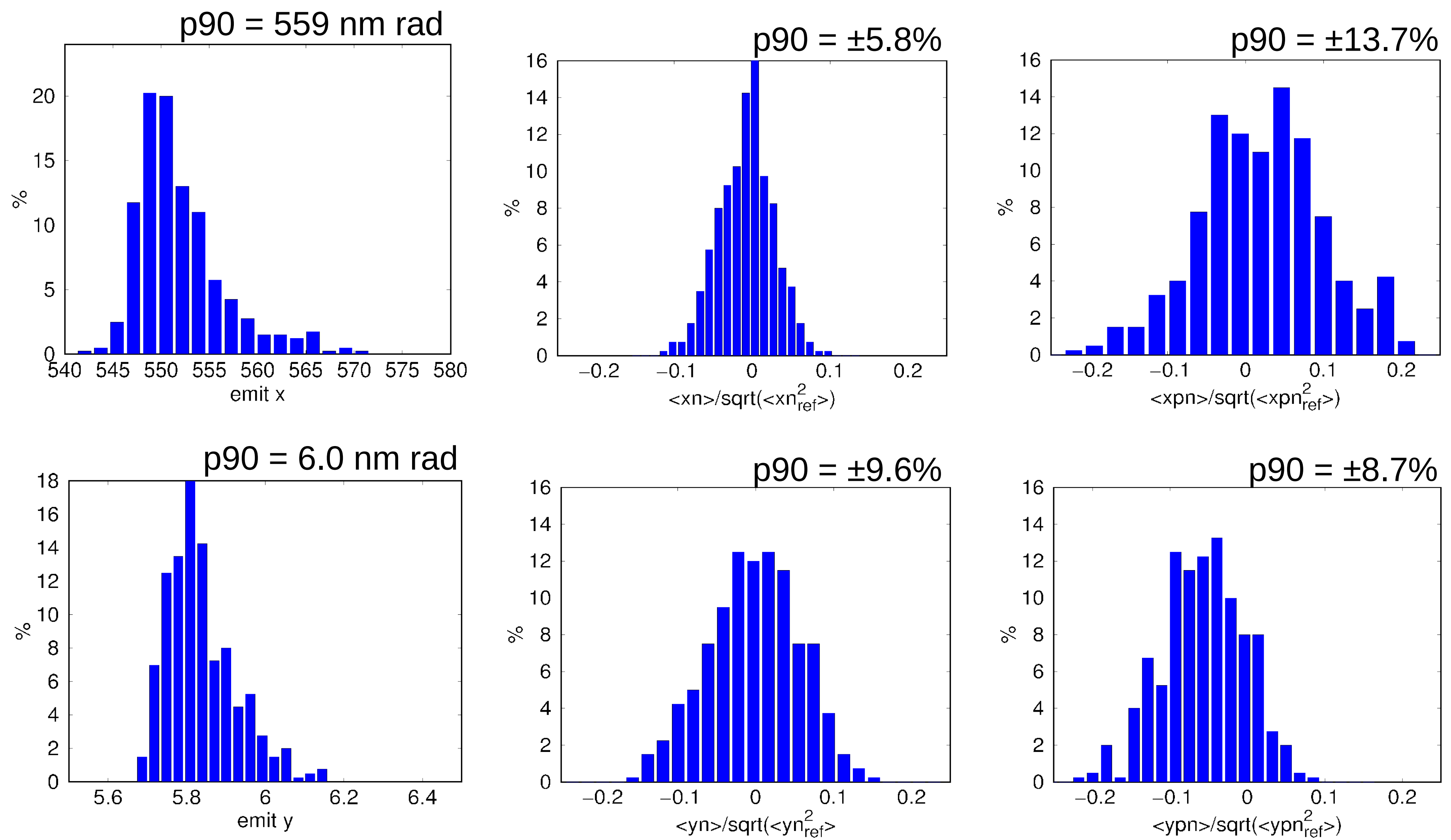






Incoming beam jitter

5% rms incoming electron beam jitter (Gaussian) ≈ 90% of cases within ±8% jitter, no correction, no misalignment, plots show final distribution in normalized phase space, with ISR and short range wakes



Summary / Outlook (post CDR)

- RTML performance studies improved.
- Some critical issues are better understood.
- Turn around loop lattice should get another ;-) revision to relax alignment tolerances further.
- Booster linac currently relies on strong HOM damping (for CLIC500 it will be even worse due to doubled charge), we will have to see what can be done by improving the lattice.
- Improving turn around loop and booster linac should also help for the incoming beam jitter.
- Not yet studied: long range wakes in BC2 RF, they will be damped and there are only 96 of them (=24m), but it's 12 GHz...