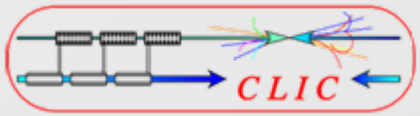
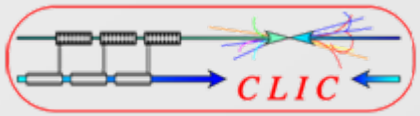


Beam Dynamics in the CTF3 Linac

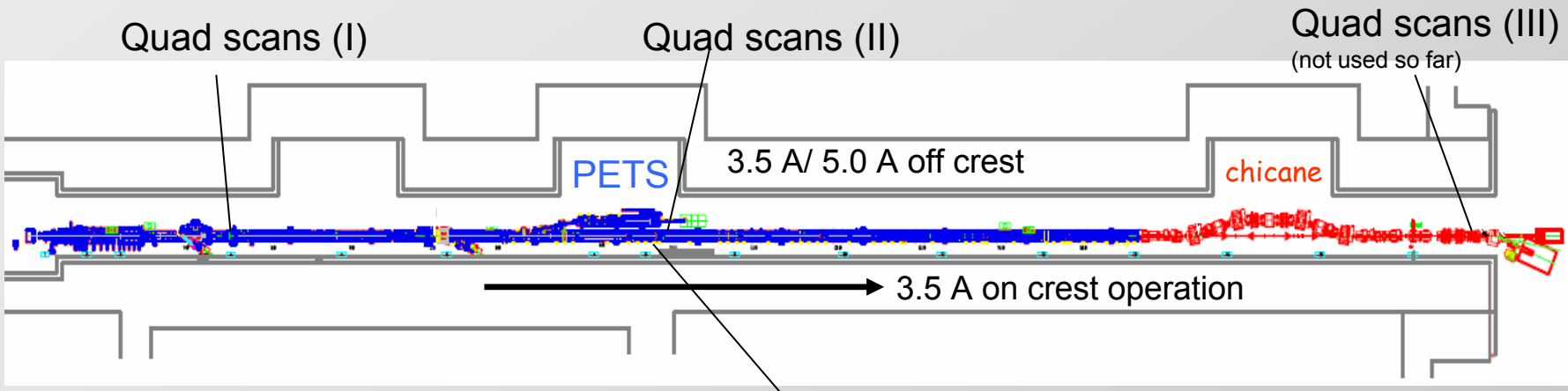
Urschütz Peter

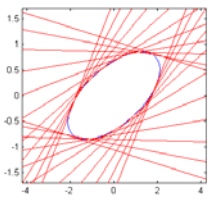


Outline

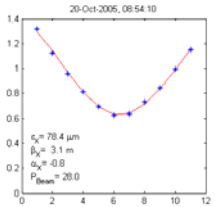
- **Measurement of the transverse beam emittance and Twiss parameters:**
  - **Different modes of operation (on/off crest acceleration)**
  - **Different beam currents (3.5 A/ 5 A)**
  - **Comparison with simulations**
- **Machine operation with delayed filling**

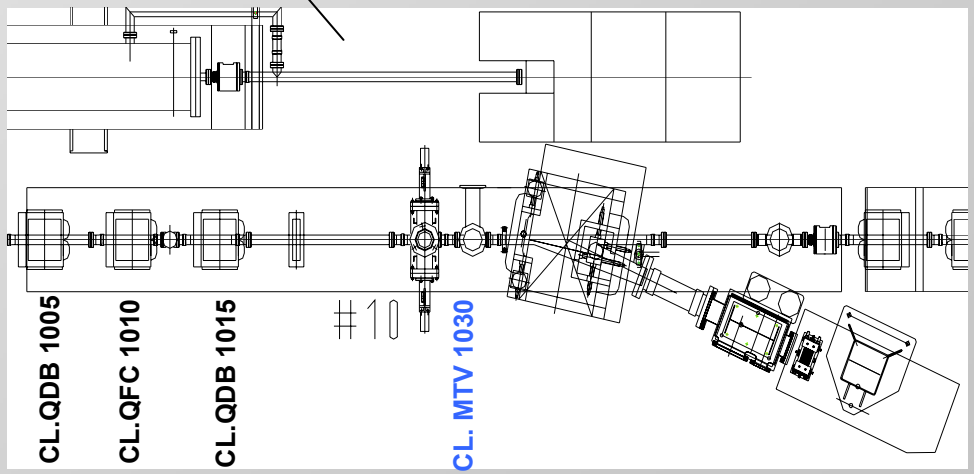
Layout





Typical quadrupole scan

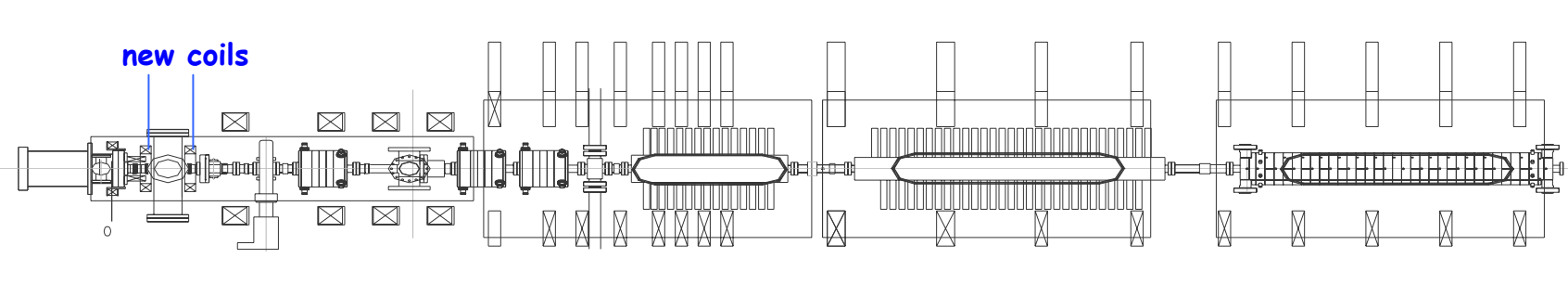




- **Comparison of simulated and measured emittances in girder 5.**
- **Re-matching of the optics from girder 5 to 10 or PETS.**

Results I

CTF3 Injector in 2005, new coils (decrease of emittance by a factor 2 (Parmela Simulations))



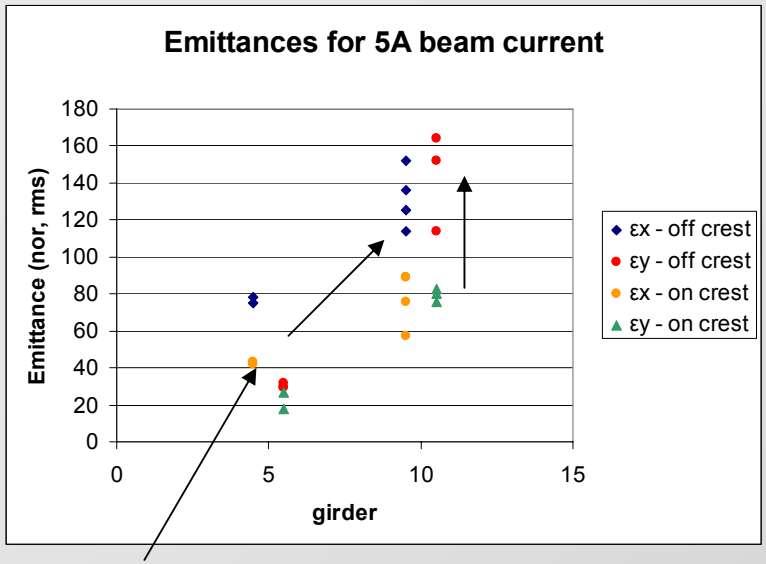
Overview on results (For the first time intensive studies in the CTF3 Linac performed, 5A)

- Nominal emittance (normalised, rms): 100 π mm mrad (for 3.5 A on crest operation)
- Simulation: 15 - 20 π mm mrad (3.5 A/ 5 A, on/off crest, after magnetic chicane)

current [A]	on/off crest	girder	$E_{x,n,rms}$ [π μm]	$E_{y,n,rms}$ [π μm]
5.0	on	5	45	25
5.0	off	5	75	30
5.0	on	10	85	80
5.0	off	10	130	140

- Measured emittance values for on crest operation are smaller than the nominal emittance (even for 5A beam current).
- In girder 5 the measured emittance is not too far from the simulations.

Results II



Larger emittances for off crest operation (~ factor 2).

Beam itself (larger energy spread, shorter bunches…)

Emittance growth from girder 5 to 10, but same emittances in both planes.

Beam related or measurement system (different magnification, resolution problem…)?

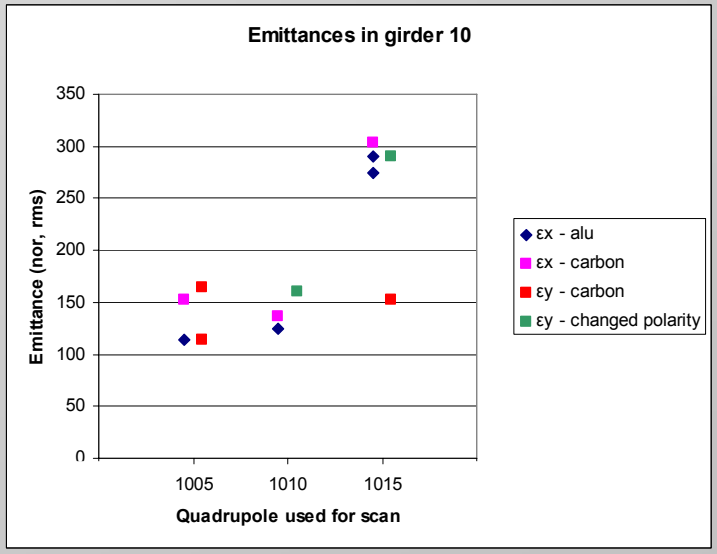
Girder 5: $\varepsilon_x \sim 2 \times \varepsilon_y$

Problem with the screen (tilt)?

Beam is round in girder 10.

Large emittance values when measured with QDB1015.

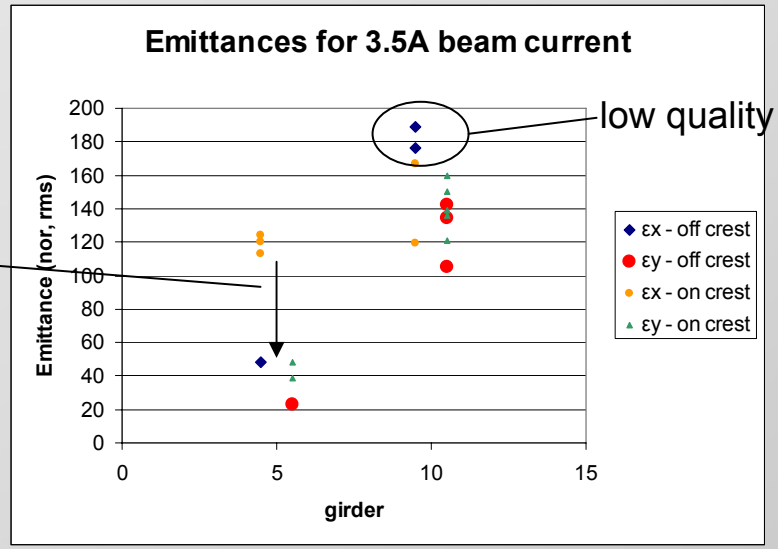
Resolution problem for some scan ranges (small beam waist)



Results III

Injector was not optimised at the beginning.

Gain due to the optimisation of the injector (solenoid currents, steering)



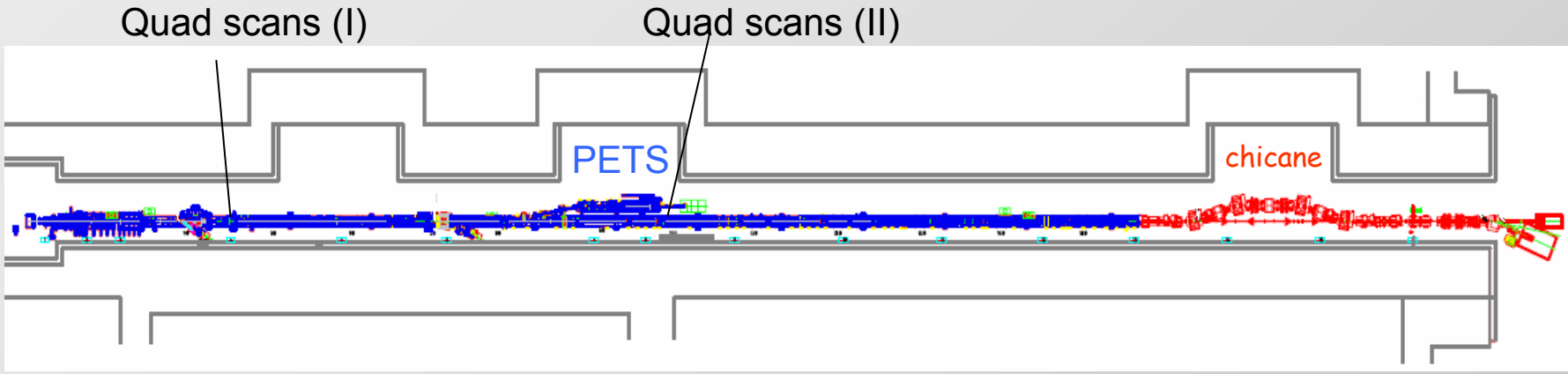
How to obtain a better understanding of the measurement results?

(I) Girder 5: Scans with opposite polarity of quadrupoles to distinguish if the difference in horiz. and vert. emittance is a beam property or related to diagnostics.

(II) - same magnification for beam diagnostic instrumentation in girder 5 and 10.
- use quadrupoles in girder 9 for quad scans.

(III) Quadrupole scans at the end of the Linac, to obtain a better understanding of the measured emittance values.

Re-matching of the optics



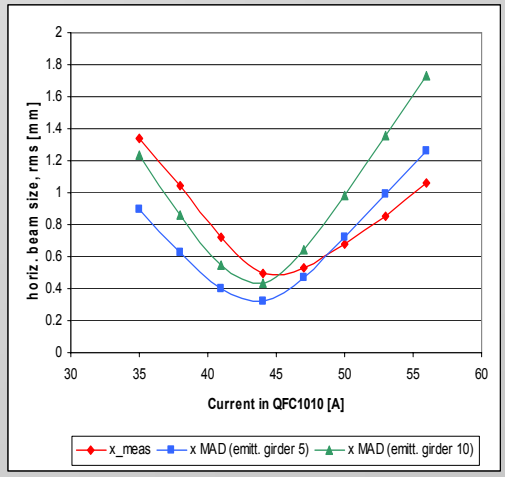
Setting up procedure:

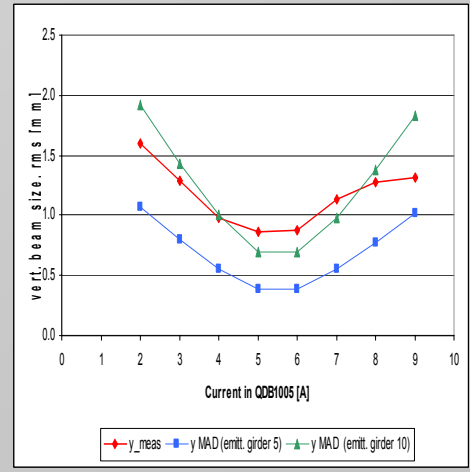
- Quad scan (I) in girder 5
- Re-matching of the optics to girder 10 using MAD
- Quad scan (II) in girder 10

Measured rms normalised emittance (5A on crest operation):

$\varepsilon_x = 45 \Rightarrow 85\ \pi$ mm mrad

$\varepsilon_y = 25 \Rightarrow 80\ \pi$ mm mrad





Conclusions for the transverse beam parameters

- The new coils in the injector improved clearly the emittance.
  → facilitated beam set-up for PETS operation and improved transmission through the PETS (up to 90%).
- For on crest operation the measured emittances are smaller than the nominal.
- Measurements in girder 5 show that we are not too far from simulations.
- The agreement between the MAD model and machine is convincing.

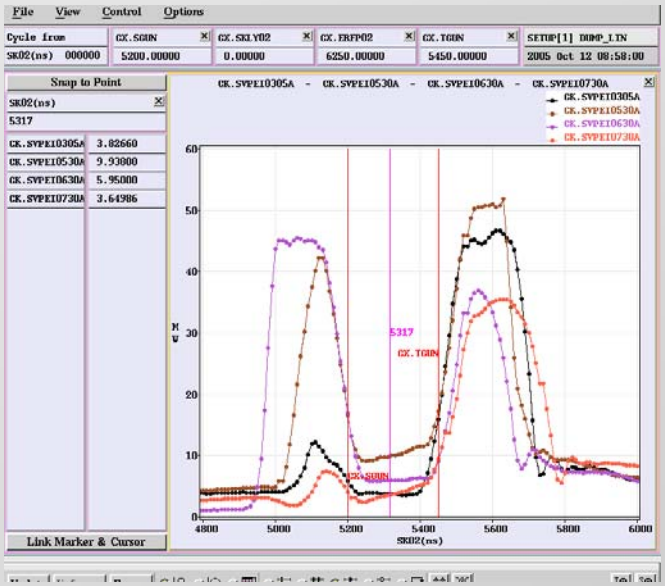
but

- There are still some problems to understand (emittance growth,…)
- We need more time for a detailed study!

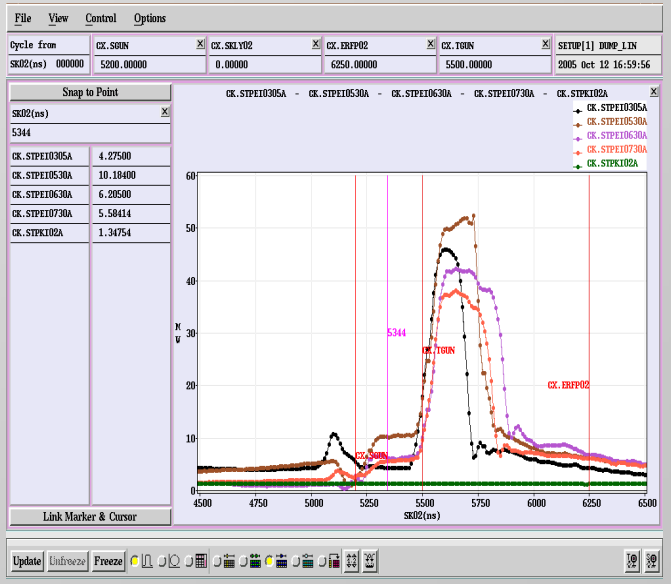
Delayed filling

The beginning of the beam pulse (transient, ~ 100 ns) has a higher energy than the steady state.

The timing of the RF pulses is shifted in order to compensate this effect.



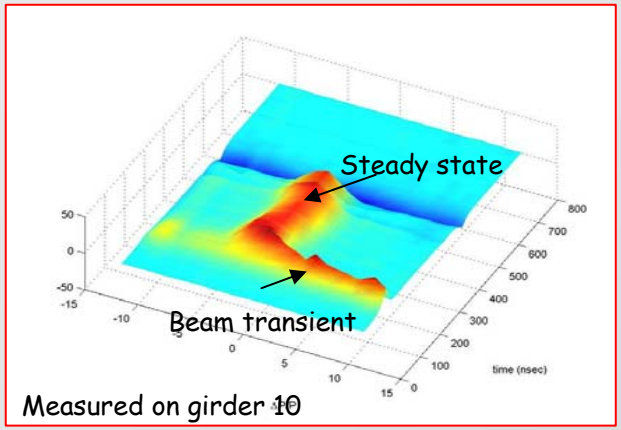
"normal" filling



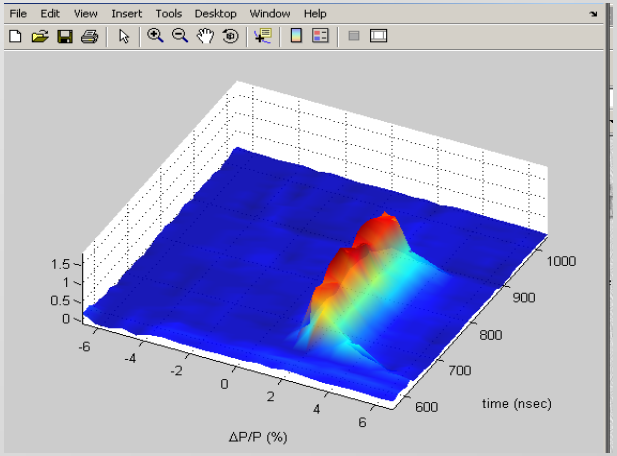
delayed filling
(beam is earlier in time)

Success of the delayed filling

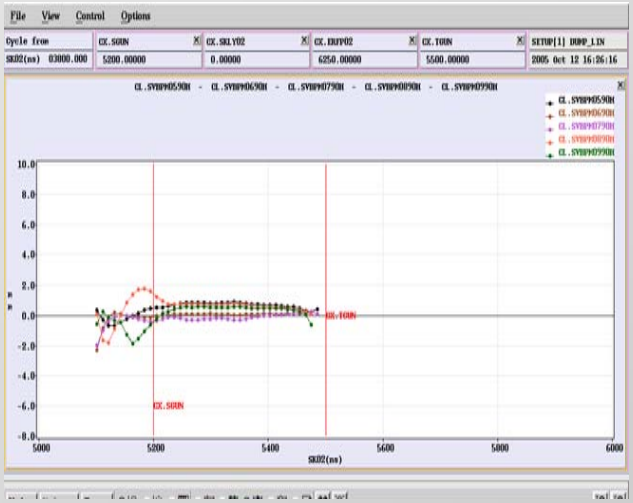
Time evolution of the beam energy spread



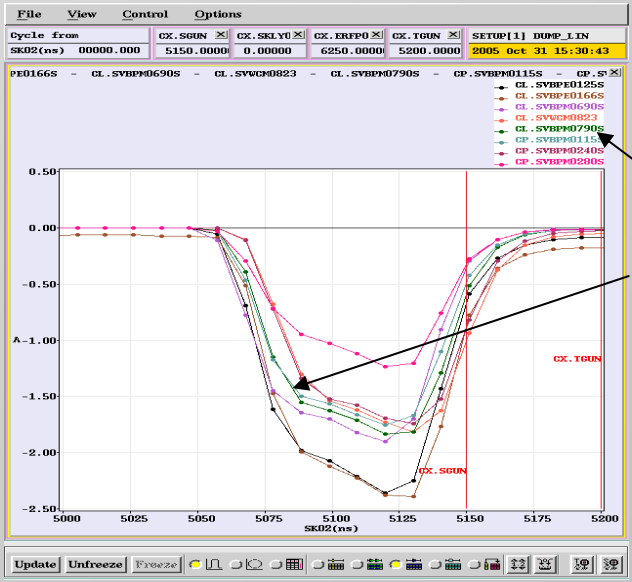
"normal" filling



delayed filling



Horizontal beam position constant over the pulse.



No losses in PETS chicane!