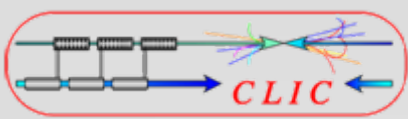


Commissioning status of CTF3

P. Urschütz

- Review status of commissioning at the end of 2006
- Schedule and goals for 2007
- Present status of the commissioning (Combiner ring)
- Conclusions

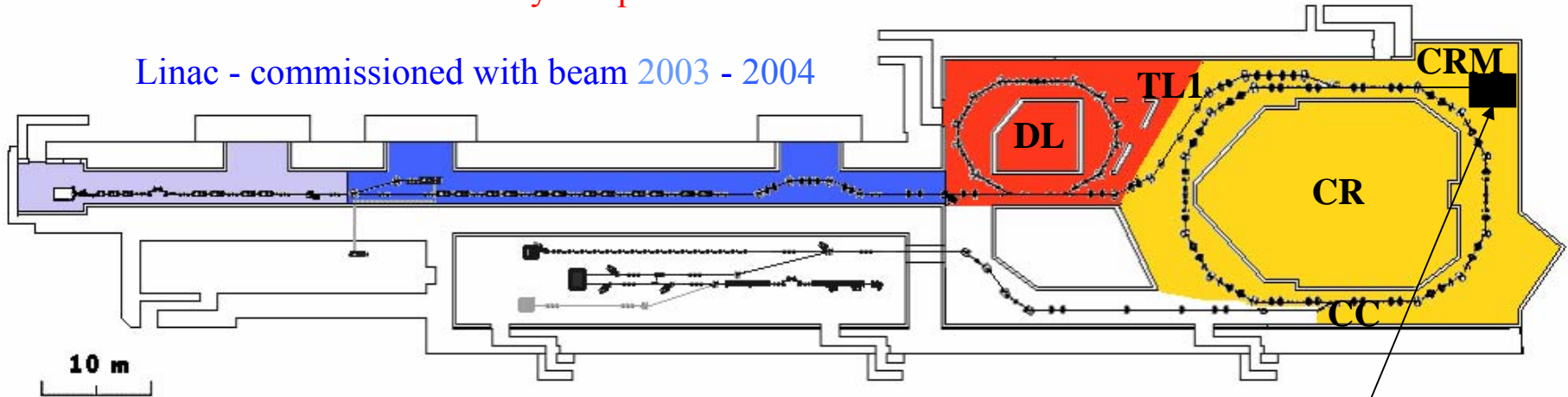


CTF3 overview



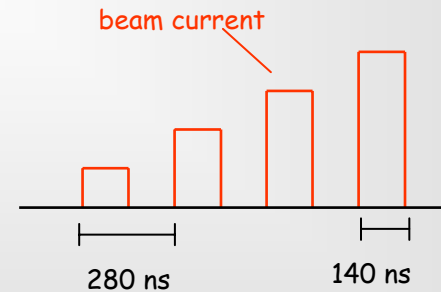
Delay Loop - commissioned with beam 2005-2006

Linac - commissioned with beam 2003 - 2004

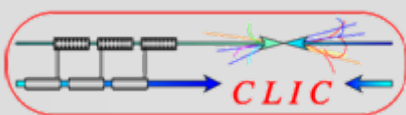


TL1 & CRM commissioning – end of 2006

Goal for 2007: Combiner ring commissioning with factor 4 re-combination with nominal beam parameters and extraction to CC.



Evolution of beam current circulating in the ring over 4 turns

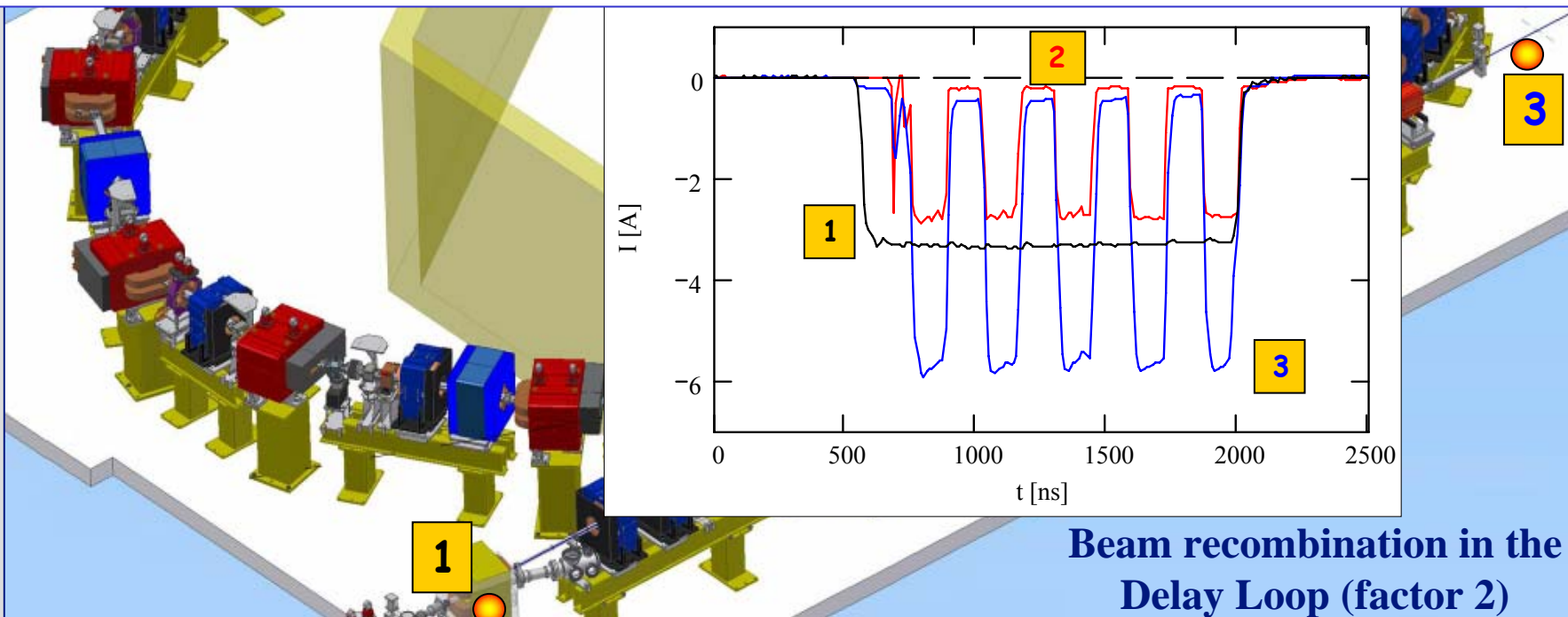


Delay loop commissioning

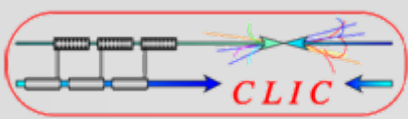


QUASI NOMINAL BEAM PARAMETERS

- Beam current (7 A after DL) 3.3 A max after chicane - ≤ 6 A after combination (satellites)
- Energy (150 MeV) ~ 100 MeV - still miss MKS 15 - can gain something from others
- Emittance (100π mm mrad) now consistently below nominal ($50 - 80 \pi$ mm mrad)
- Pulse length ($1.4 \mu\text{s}$) "just" nominal ($1.4 \mu\text{s}$ after chicane, 5×140 ns pulses after DL)
- Bunch length (up to 2.5 mm) 1.4 - 2.7 mm (nominal and natural R56 of chicane)
- nominal isochronous optics



Beam recombination in the Delay Loop (factor 2)

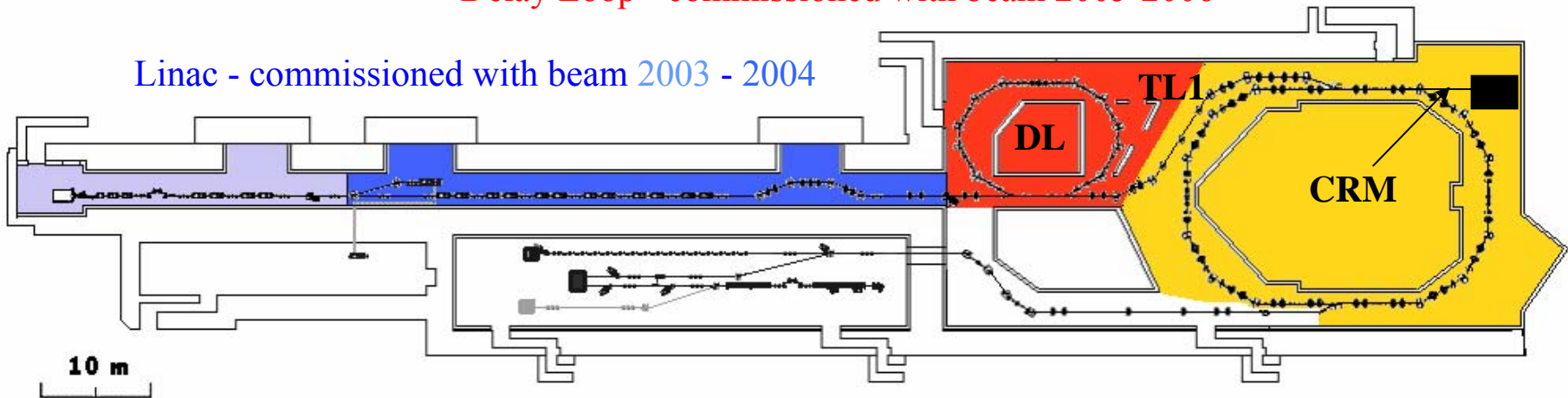


Commissioning of TL1 & CRM



Delay Loop - commissioned with beam 2005-2006

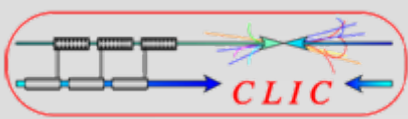
Linac - commissioned with beam 2003 - 2004



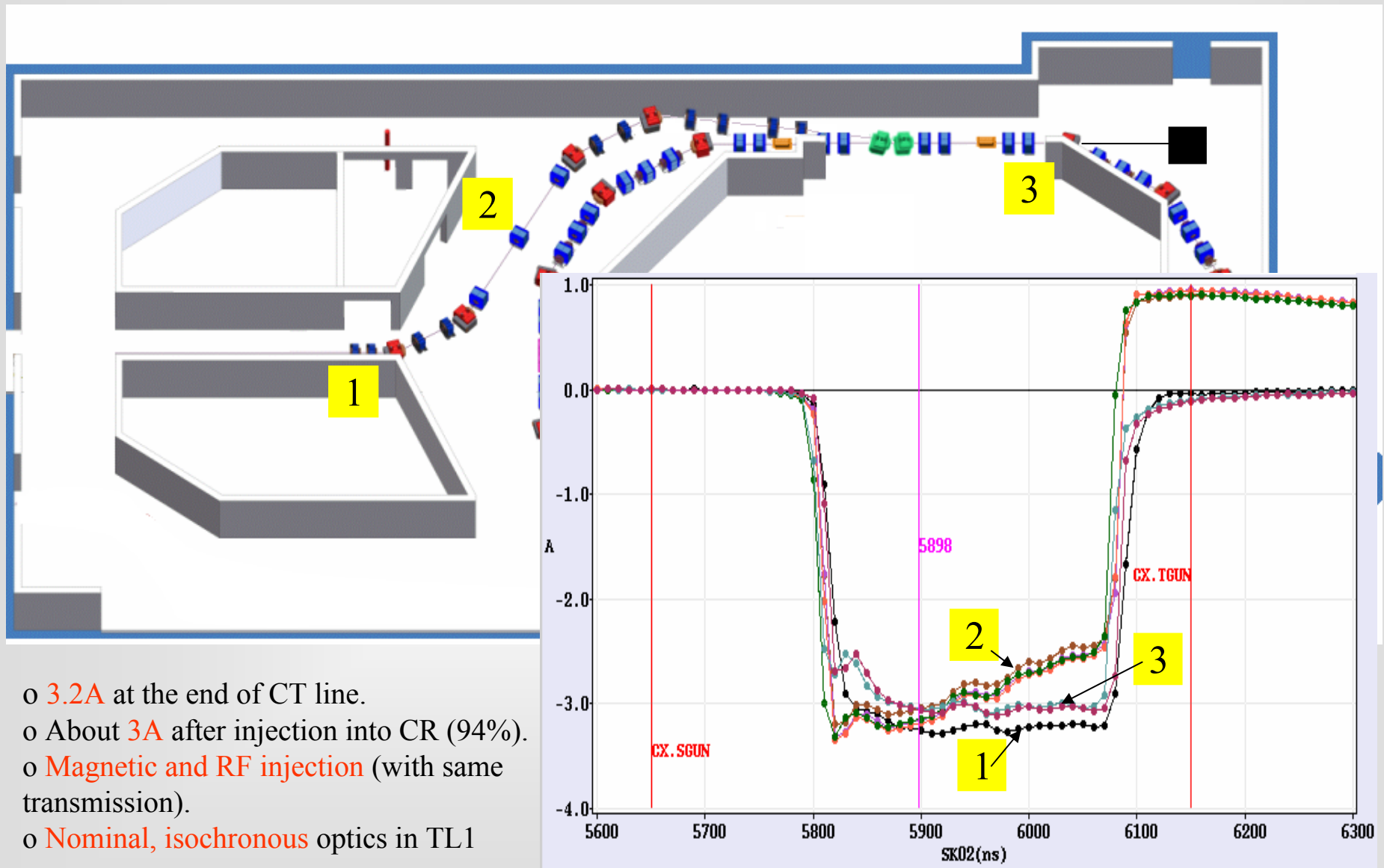
CRM commissioning – end of 2006

- Bypassing the Delay Loop
- low gun repetition rate (1 Hz)
- No sub harmonic bunchers - 3 GHz beam
- beam current: 3.5 A
- short pulse length: ~ 200 ns
- one additional Klystron (MKS15), higher energy: ~ 125 MeV

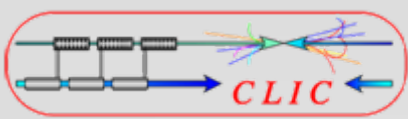
Just 3 weeks of commissioning – effective 80 hours!



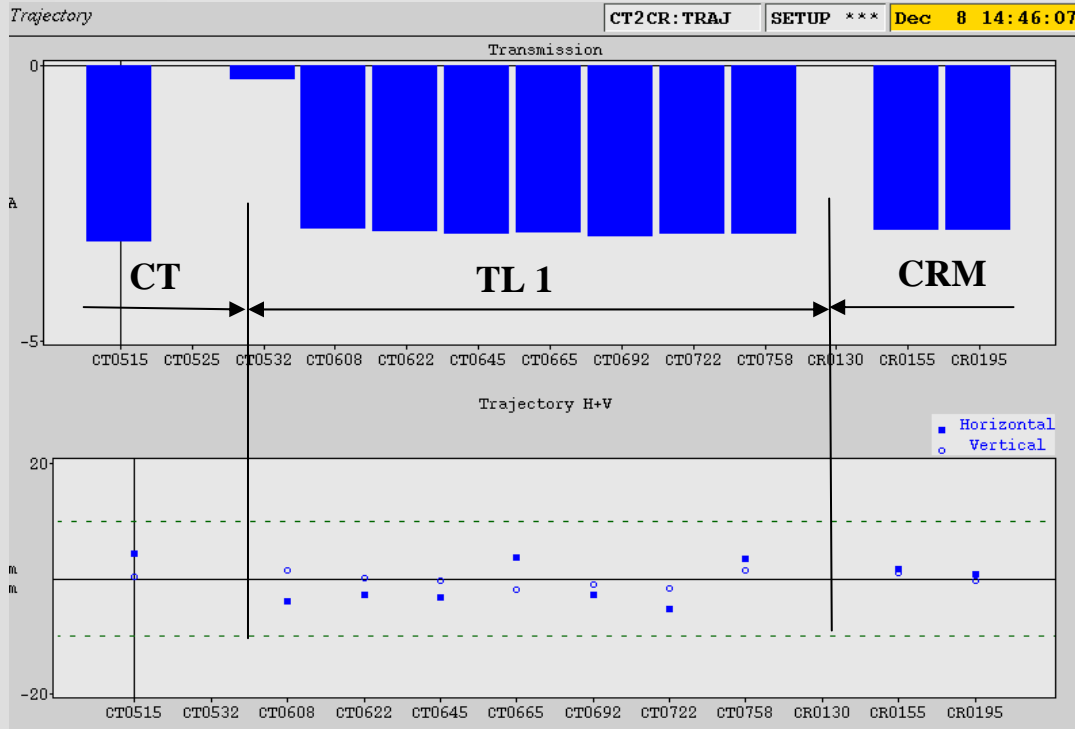
Transmission in TL1 & CRM



- o 3.2A at the end of CT line.
- o About 3A after injection into CR (94%).
- o Magnetic and RF injection (with same transmission).
- o Nominal, isochronous optics in TL1

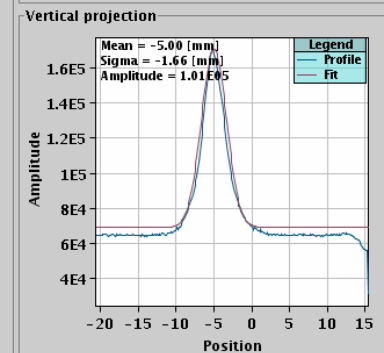
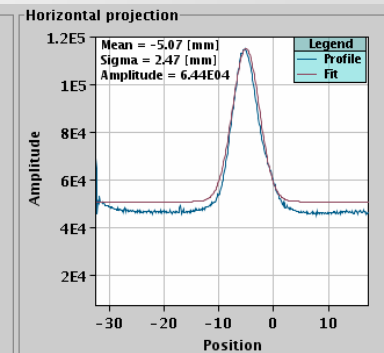
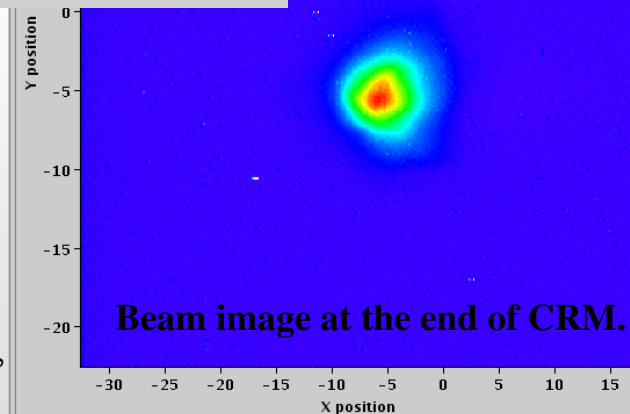


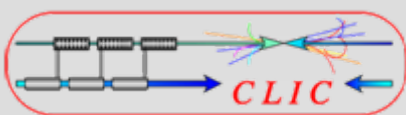
Transmission & trajectory in TL1 & CRM



Transmission and trajectories from end of CT line to CRM

- Dispersion measurement (good agreement between model and measurements in first part of TL1, worse later on)
- Quad scans (Twiss parameters from measurement and MAD prediction disagree, small emittances in both planes)



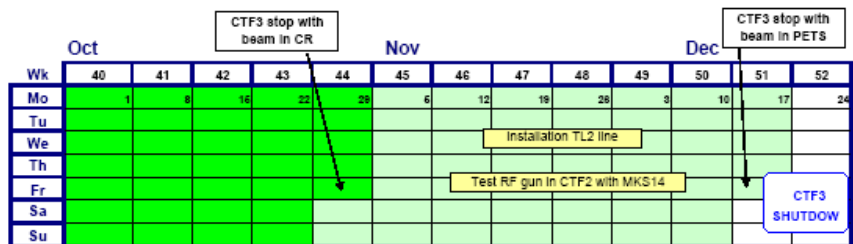
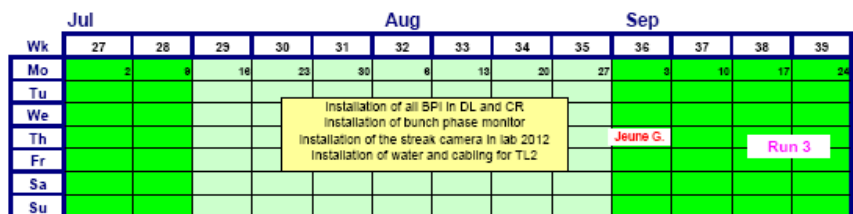
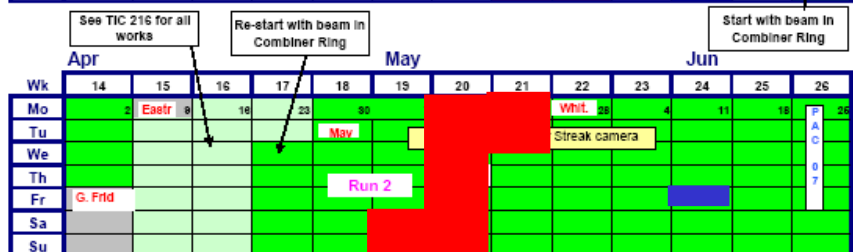
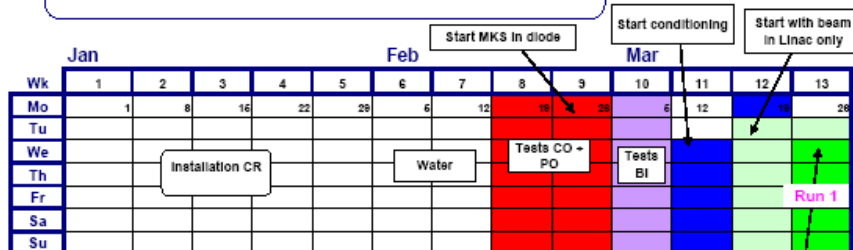


Schedule for 2007

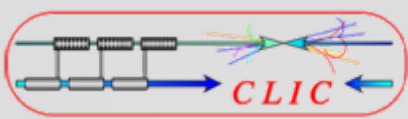


2007 - CTF 3 - Schedule

15th May 2007



- start with beam on 20.03.2007 in Linac (setting up PETS operation)
- TL1 and CR region from 28th march (Run 1)
- PETS only and finishing installations in CR and DL region for two weeks.
- 25th april start of Run 2
- Vacuum leak in PETS line on 12th may (no beam for more than a week)
- restart of run 2 on 23rd may
- where we are today, so far 6 weeks for Run 2 (4 weeks left)
- PETS only for 7 weeks
- Run 3 for 9 weeks



Objective: **Combiner ring**

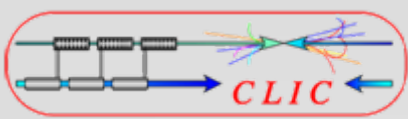
- make one turn in CR
- debug CR, discover main obstacles, if any existing
- identify problems which have to be addressed during stop

PETS

- set up of PETS beam, PETS operation

Time: 7 days for CR, 13 for PETS

- Comments:**
- Compression system for MKS06 (BOCS) was exchanged, not ready for this run (conditioning).
 - Energy scaling of an old archive for the machine

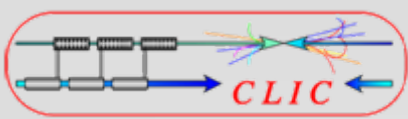


2 weeks stop of CR commissioning.

- Installation and alignment of 6 BPIs in the Delay Loop
- Work on BPI electronics to get rid of overcompensation
- Alignment of optical lines in DL and CR
- geometer network established between CR and CLEX
- ...

in parallel:

- PETS operation
- Optimizing RF pulses downstream girder 10 (using Hameds pulse compression program)

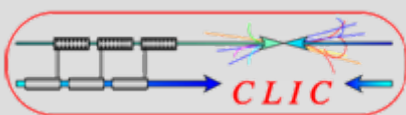


Objective: full commissioning of the Combiner Ring

- Steps:**
- 1) Full transmission in CR (4 turns), 3 GHz beam, DL bypassed
 - 2) Extraction of the beam to CC
 - 3) Optics and dispersion studies
 - 4) Switch to 1.5 GHz beam, recombine with DL (factor 2)
 - 5) Final recombination in CR (factor 4)

Time: 10 weeks (6 weeks so far)

- Comments:**
- Conditioning of BOCS for MKS06 done, higher energy
 - Only 2 SHB (out of 3) for 1.5 GHz

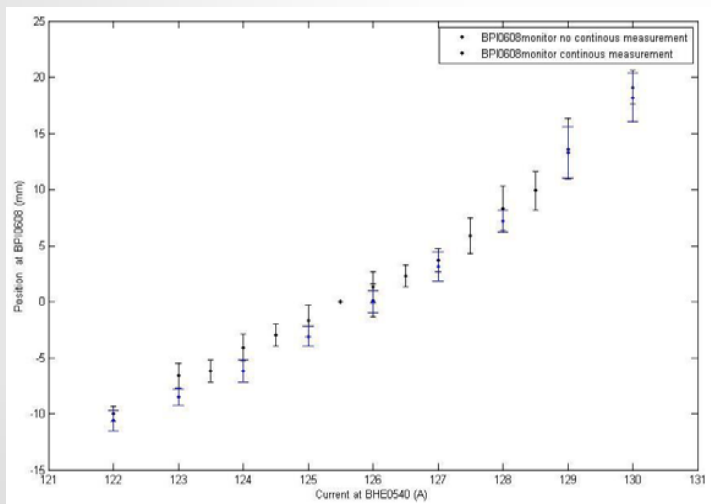


Matching of Linac, CT line and TL1 (Quad scans):

- Girder 10: no scans possible, crumpled aluminium screen, not enough light from the carbon screen (radiation hard camera).
- Before (MTV0435) and after DL (MTV0550): Lattice functions used for re-matching the Linac, CT line and for matching into TL1.
Emittances: $\epsilon_{n,x,y,rms} \sim 100 \pi \mu\text{m}$

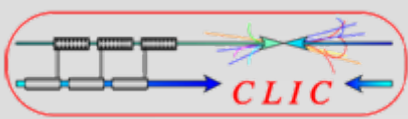
TL1 studies: (With the help of INFN Frascati crew)

- Linearity check of the BPIs (beam position).

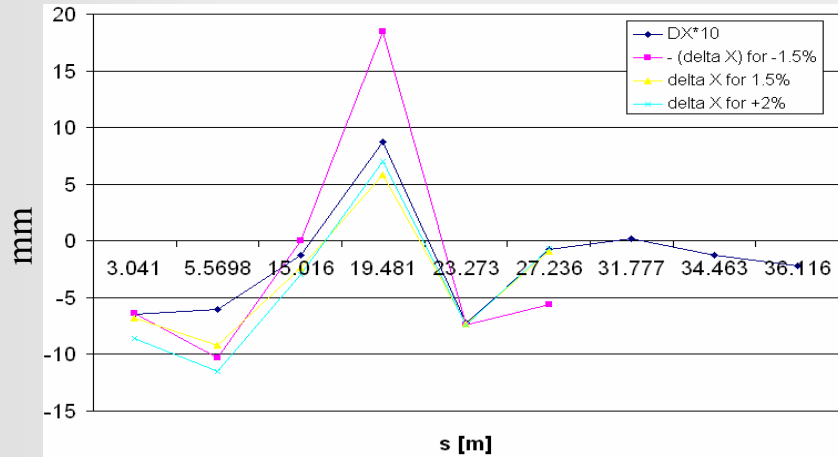


Horizontal position vs. dipole current

- position jitter (pulse to pulse energy variation)
- averaging over several pulses
- **looks pretty much linear**



- Dispersion check: by magnet scaling (+/- 1.5%)

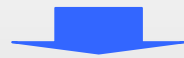


- overall agreement between model and measurement is ok.
- 2nd order dispersion visible.

Horizontal position vs. BPI location in TL1

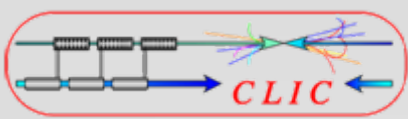
- Matching and injection into CR (with and without RF deflector)

- ❖ Full transmission through the first arc, up to the wiggler
- ❖ Large losses in the second arc

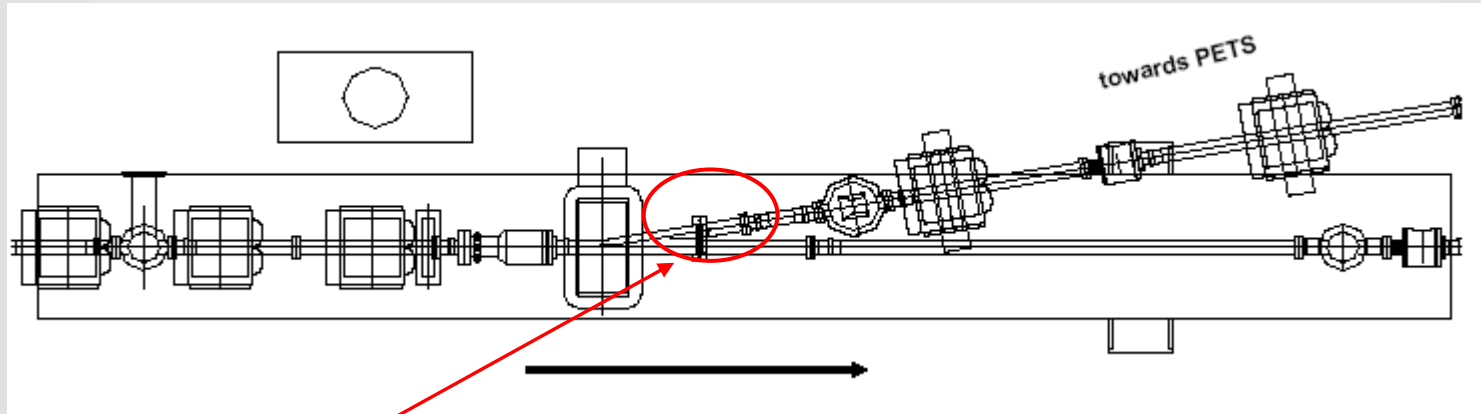


- ❖ Check of all CR quadrupole currents → two control cables were mixed!

We were on a good way, but...

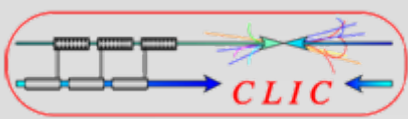


Vacuum leak in PETS line



Region of girders 8 and 9 in the Linac

- On 12th of may: Vacuum leak in PETS line at a flange
- Girders 7 to 10 and region up to PETS were vented
- Stop of operation/commissioning
- Fortunately the intervention to fix the flange was successful
- Restart on 23rd of may for commissioning, PETS operation re-starting this afternoon only.

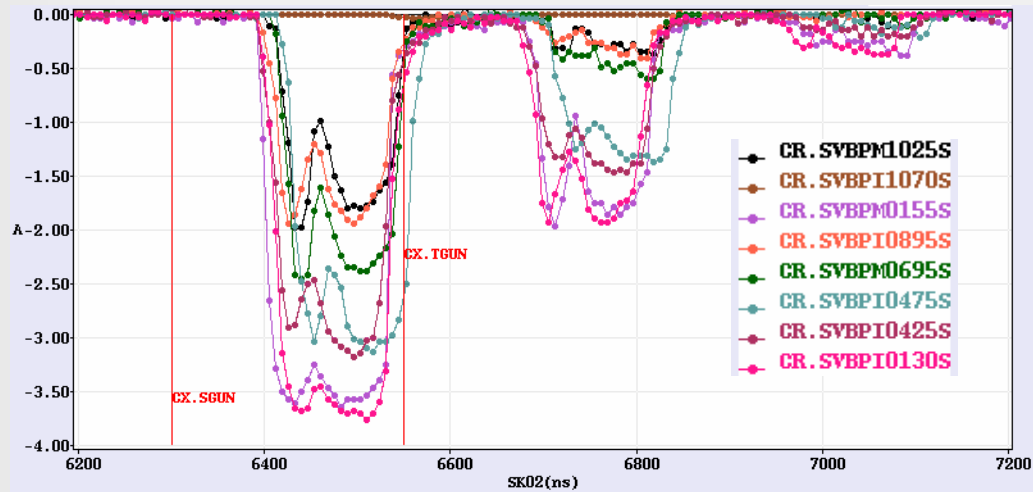


Run 2 - continuation (CR)



Beam back in the Combiner Ring on 25th of may.

We are able to make 3 turns (kind of)!

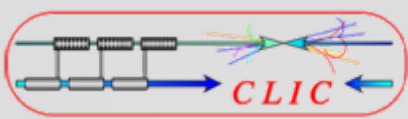


BUT: We still loose most of the beam in the second arc (after the wiggler)



Decision to measure polarities of all quadrupoles.

One quadrupole polarity was wrong (CR.QFJ0415), exactly the area where we lost the beam.

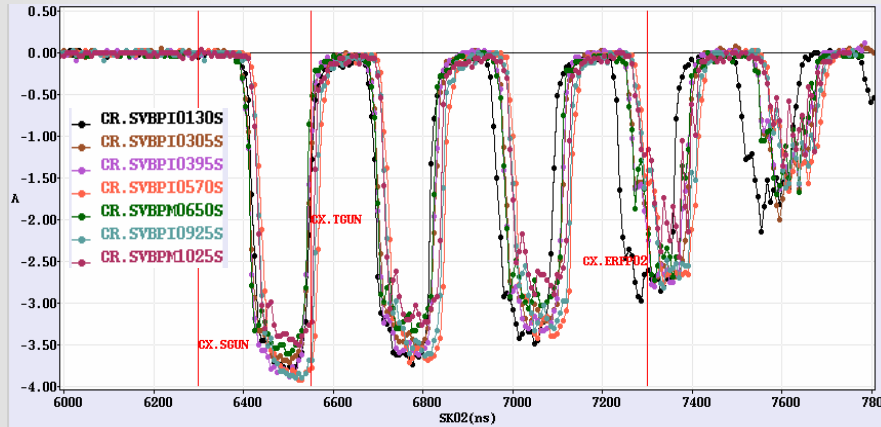


Run 2 - continuation (CR)

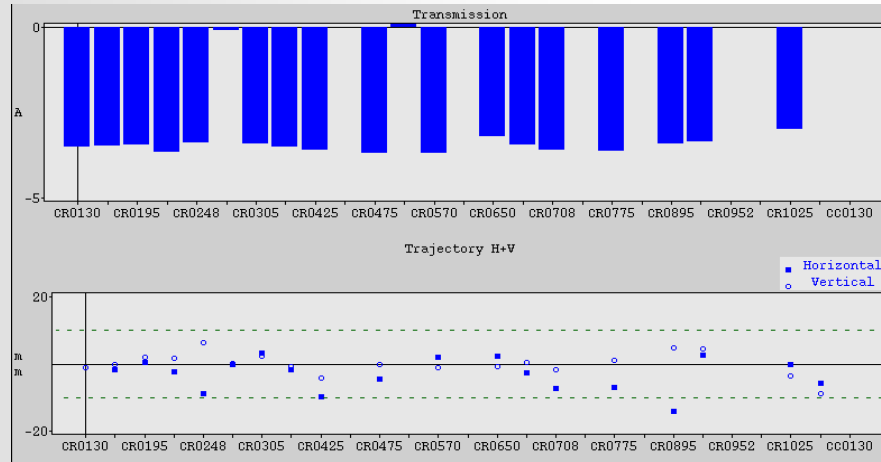


With right polarities life is much easier...

We make up to 10 turns!



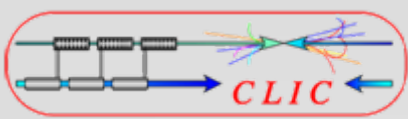
- Nominal isochronous optics
- RF injection
- RF pulse of deflector set up that it's only seen by the beam at injection.



Switching on the SHBS (2 out of 3)



We got immediately the same Transmission in CR!



Next steps:

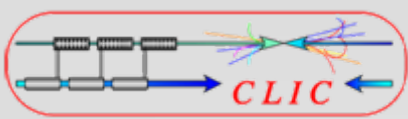
- Re-optimize the Linac and CT line, performing quad scans before and after the Delay Loop
- Measure bunch length with 1.5 GHz RF deflector (DL)

Study and analysis by Hamed... first results: $l_{\text{Bunch}} \sim 4 \text{ mm}$ (3 GHz)
 $l_{\text{Bunch}} > 4 \text{ mm}$ (1.5 GHz)



Decision to shorten bunches ... slightly off-crest in MKS03 and set Frascati to half natural R56 (~ 0.2)

- Set-up of the Delay Loop, matching to measured initial parameters
- Re-match TL1 and CR



Run 2 - continuation (DL)



Going into Delay Loop

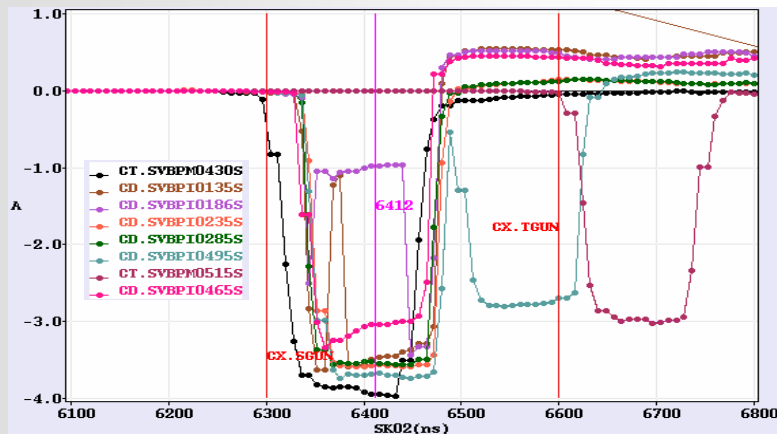
(should be straightforward...)

After one day of effort without success to send beam around the DL, we decided again to check Quadrupole polarities...

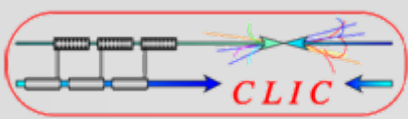


3 quadrupole families (CD.QFF0130, CD.QDF0140, CD.QDF0260) were wrong!!!
(Who was changing cables in DL during the shut down?)

Restarting after intervention...



Up to 80% transmission with nominal optics, has to be further optimized.

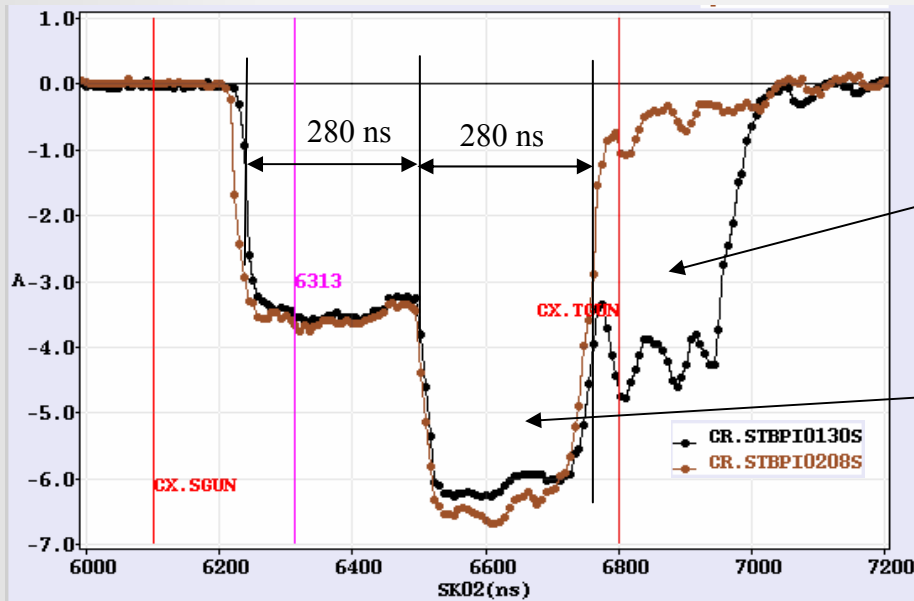


Run 2 - continuation (CR)



Back to Combiner Ring (we need results for PAC...)

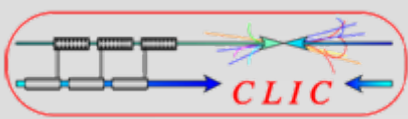
Latest results from yesterday give some hope... we recombine (factor 2)!



Second turn of second pulse
and partly third turn of
first pulse

Recombination – factor 2

- nominal isochronous optics
- energy ~ 115 MeV
- RF injection (2nd RF deflector off – so far)
- set up of the path length in CR with wiggler



Conclusions



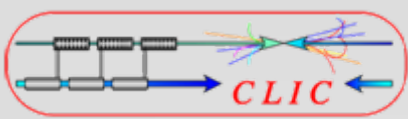
positive:

- there is progress, but a slow one.
- up to 10 turns in CR (10% losses per turn), with nominal optics
- re-combination of factor 2

points which should be considered in the future:

- **Please check polarities after a shut down from the control room to the magnet (including controls).**
- CTF3 is becoming more and more complex, one should think about the reliability of the equipment (Klystrons, power supplies, controls...).

Downtime is increasing!



private conclusions



As most of you know, I will leave CERN end of June... just two weeks left!

I will start in August working for Siemens close to Nuernberg, dealing with medical accelerators (proton and carbon ion synchrotrons for cancer treatment)

How does it look like there...



Where are the mountains?



According to this map, there should be some...

I was working 2 years and 9 month for CLIC/CTF3.

It was really a pleasure to work with you!

I want to wish you good luck and success with CTF3 and in the future with CLIC!

There will be a BBQ on Thursday, 28th of June, in Preveessin starting at 16:30.