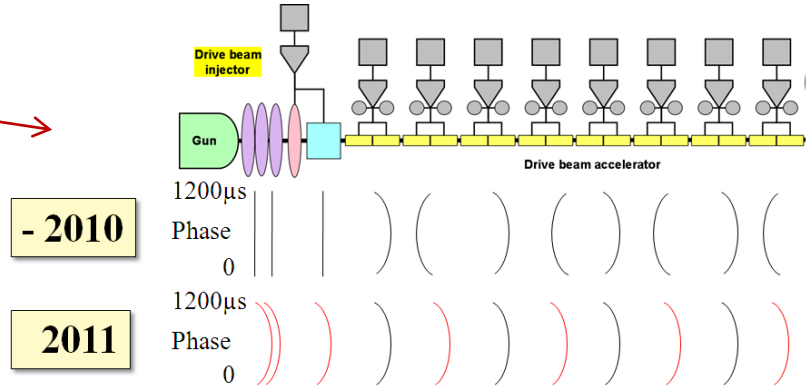
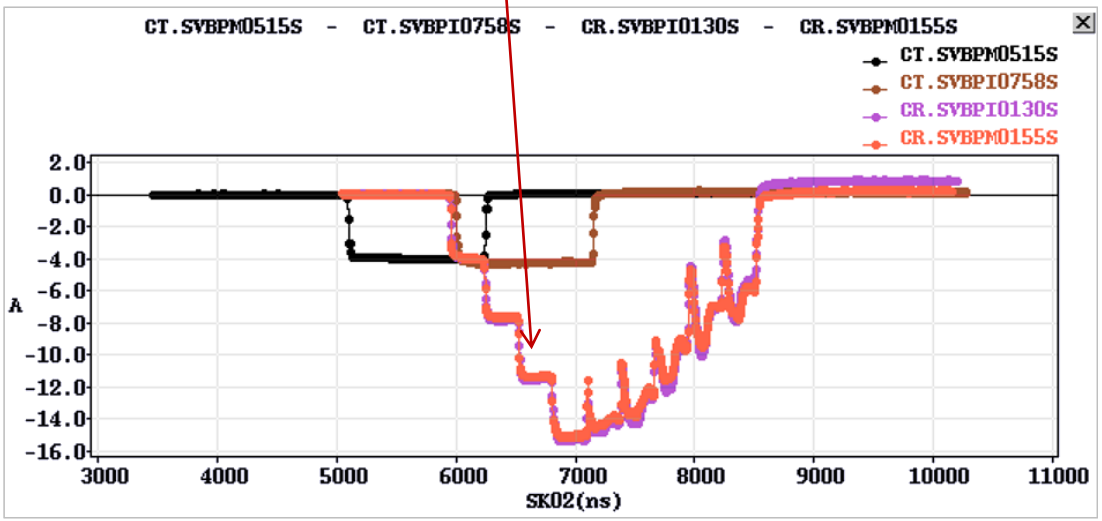
Last two months' chronology

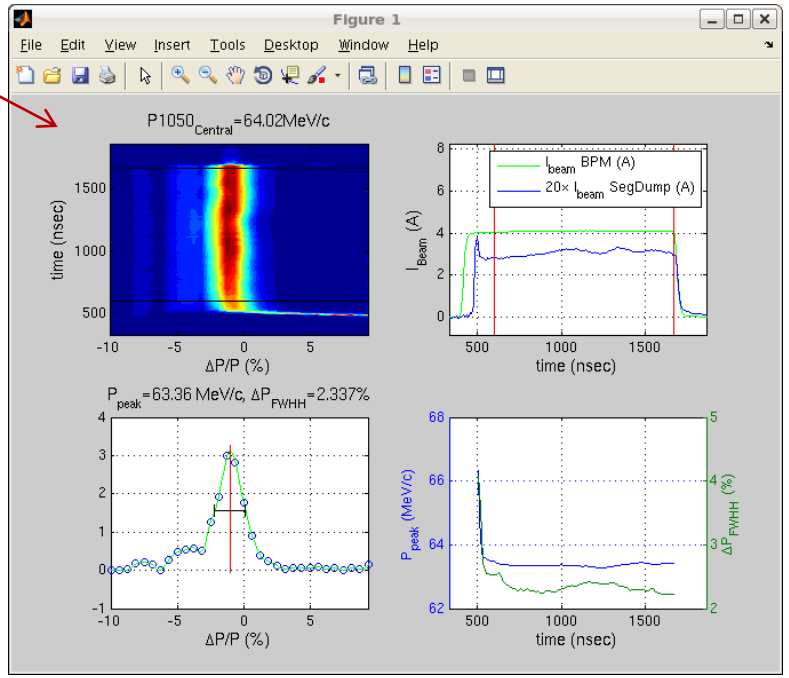
- Wed 23/03: first beam to end of TL1
- Mon 28/03: beam to CR + factor 4 combination
- Thu 31/03: "near miss" incident on MKS02 + gun problems
- Fri 29/04: smoke detection installed + tested, restart RF
- Mon 02/05: gun high dark current
- Tue 03/05: cathode changed
- Fri 06/05: cathode changed again
- Wed 11/05: first beam to spectrometer girder 4 + 10
- Tue 17/05: first beam to TL2
- Thu 19/05: problem with MKS11 fixed => higher power setup
- status today: optimized beam up to CR injection

Excellent 3 GHz setup

- careful new RF setup
- good beam quality
- easier and faster set-up
  (only one day from end of linac
  to first factor 4 combination!)







"Near miss" – MKS02 fault 31/03

Memo 1/04/2011

Subject: - Summary of the fault in MKS02 on the 31st March 2011 and consequent actions being taken.

At around 13H30 on the 31st of March Stephane Curt who was present in the klystron gallery smelt an odor coming from the faraday cage of MKS02, he immediately pushed the local emergency stop for this equipment and also noticed some small traces of smoke coming from the ventilation of the faraday cage. The fire service was alerted by telephone and by the activation of the smoke detection system in the building.

While waiting for the arrival of the fire service we made sure that the building was clear of personnel and that no one would enter the building.

When the fire service arrived they sent some of their team to where the incident occurred and did a visual inspection noting that there were no flames and that the smoke levels were decreasing. After consultation with the TSO it was decided that a close surveillance of the equipment was necessary but it was not necessary to immediately put any fire prevention products in the modulator. The smoke extraction was put into operation and after half an hour the fire service deemed it safe to open the faraday cage under their surveillance to do a visual inspection of what the cause was.

On first appearance, and later confirmed after demounting the source of the problem was from a capacitor in the pulse forming network that had failed.

After one hour the fire service deemed it safe for them to leave the premises.

It is now clear that by pushing the emergency stop as quickly as it was done, hence stopping depositing any more energy into the faulty capacitor reduced immensely any further problems.

Taking this into consideration and the fact that individual fire detections systems for each faraday cage were foreseen (prototype was to be tested next week) we will not restart any modulator until this system is implemented (estimate delay end April 2011). These individual detectors will be linked with the existing building level 3 alarm system with the additional functionality of stopping the modulator in question and removing all power from it (as was done manually in this occasion)

For information the capacitors in this pulse forming network have been installed in the MKS02 since 2003 running at approximately 5000 hours per year with a repetition rate of 50 Hz giving a total number of pulse to be approximately 8.1×10^8 pulses.

The specification for the capacitors working in the pulse forming network asks for a lifetime of 50000 hours with a 95% survival rate for the capacitors.

Future procedures foreseen will be implemented this year once the klystron gallery extension is finished that will give us extra testing and storage area in the gallery. We will have one or two spare pulse forming networks (PFN) that will become rolling stock which will allow us to change a PFN once a month (approximately half a day downtime) and allow us to control the capacitors offline during the machine operations rather than in the compressed shutdown time.

Some software 'alarms' will be implemented to give precursor alarms to the operators, which may alert us to potential problems.

The annual shutdown will be longer for the maintenance to allow for careful checking of all components and to do preventative maintenance although this will be significantly reduced once we have a rolling stock in operation.

Gunther Geschonke (CTF3 Project Leader)

Gerry McMonagle (GLIMOS CTF3)

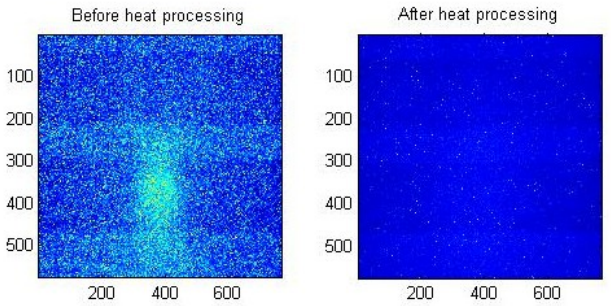
- Smoke from a capacitor bank in MKS02
- Quick emergency stop – firemen intervention
- Very limited damage
- Many capacitors quite old, close to their lifetime limit
- Likely mechanism: oil leak > sparking > combustion
- Local smoke detectors in place (already planned) > 1 month delay
- Other measures: periodic inspections, gradual replacement, software interlock

Selected issues

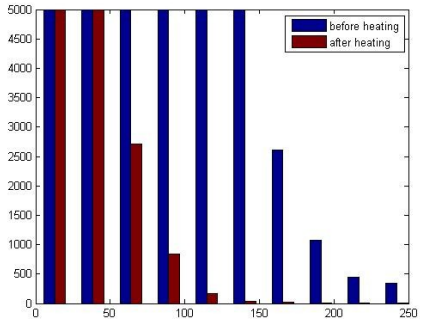
- Controls upgrade of BPMs to ‘virtual samplers’:
  - solves problem of overloaded front-ends
  - 4/05: DCTFUMAL, 13/05: DCTFUMAD, 17.5: DCTFUMAR
  - works very well, no connection problems
  - issue with signal length to be solved => no multi-turn orbit
- MKS02 (rebuilt after PFN damage)
  - needed PFN adjustment => gives higher power now
  - other PFNs also needed adjustment
    => new beam setup for higher energy
- two TWT broken, only one left => no 1.5 GHz beam
  - return from repair uncertain (repair has started …)

Long shut-down period

- From December 14th last year (106 MV/m result)
  - MTV's cameras at the end of Probe and Drive beam lines have been regenerated after irradiation damages. Shielding reinforced (lead and neutron absorber)



MTV830 pictures before and after thermal processing



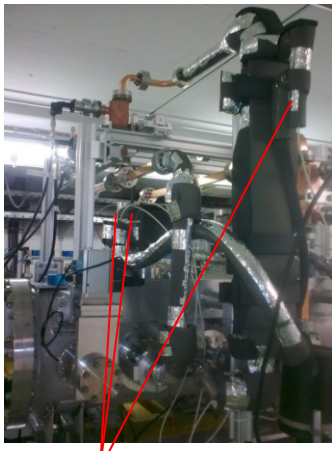
Bright points histogram

  - BHB 400 and 800 spectrometer magnets cross checked:
    => no discrepancy found in their magnetic fields
  - Thermal control of the ACS tanks water installed
  - Much more stable laser beam (no drift in time thanks to the use of optic fibers), automatic resynchronization…
  - And of course a lot of work on ACS tank: structure retuned, RF network simplified, pumping improved, RF diagnostics recalibrated…

ACS tank water temperature control

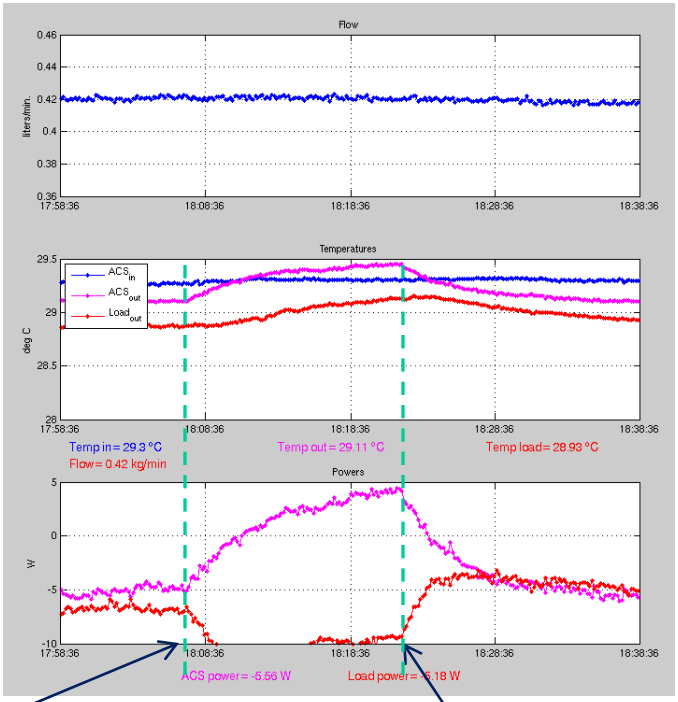
- Two independent water distributions installed for PETS and ACS tanks
- Three PT 100 temperature probes and one flow meter for the ACS
- First results obtained by warming the ACS structure with the probe beam are promising (real tests to be done with the RF power)

Water distribution



ACS tank probes and thermal insulation

Turbine flow meter



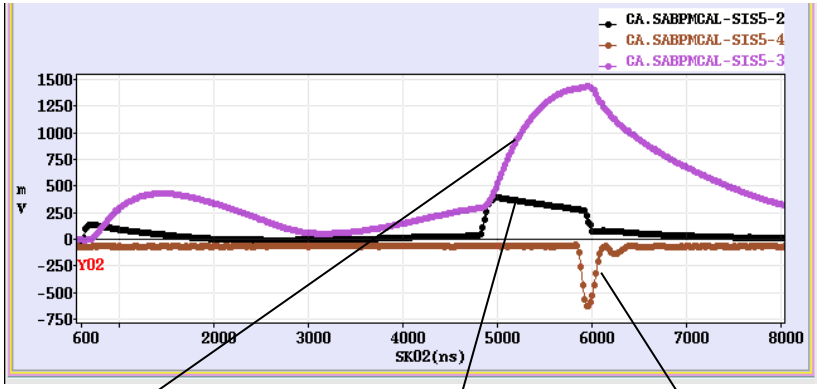
ACS intercepts the beam

Beam goes through ACS

Beam charge 22 nC - Energy 186 MeV - Repetition rate 5 Hz
Total beam energy 20 W - Energy deposited in ACS = 10.5 W (half !)

Laser pulse vs. RF pulse timing

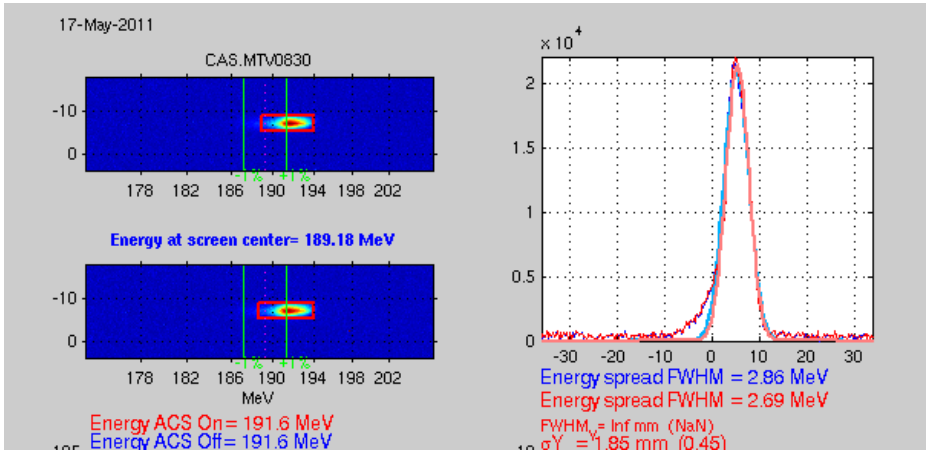
- Much better QE (0.5 % instead of 0.3%)
- Smaller emittance
- Higher energy – 192 MeV



Gun loop

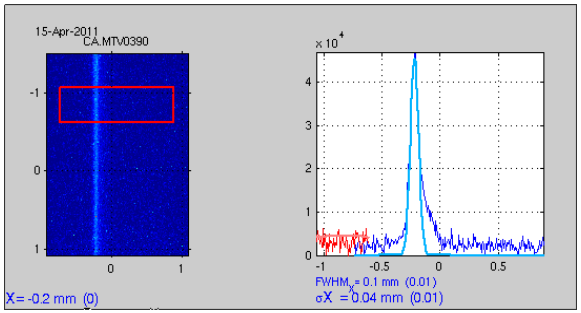
Compressed RF pulse

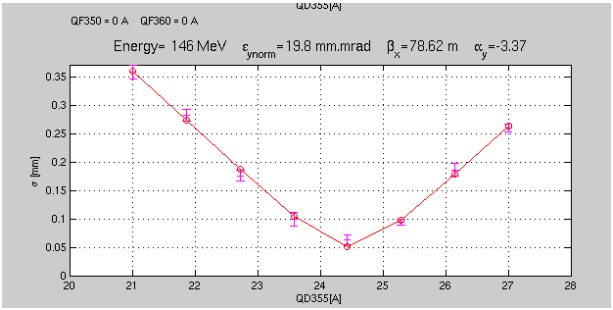
Beam

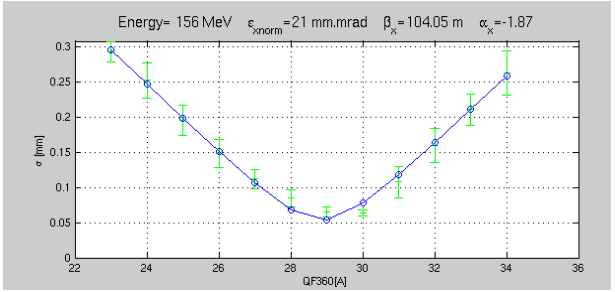


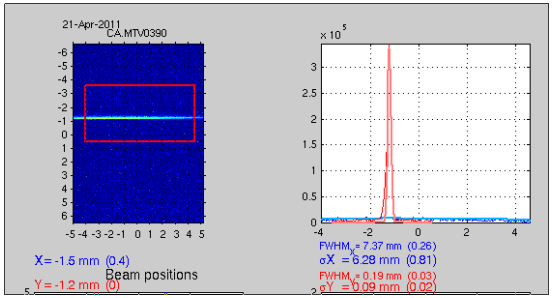
High energy and low energy spread

Quad scan results



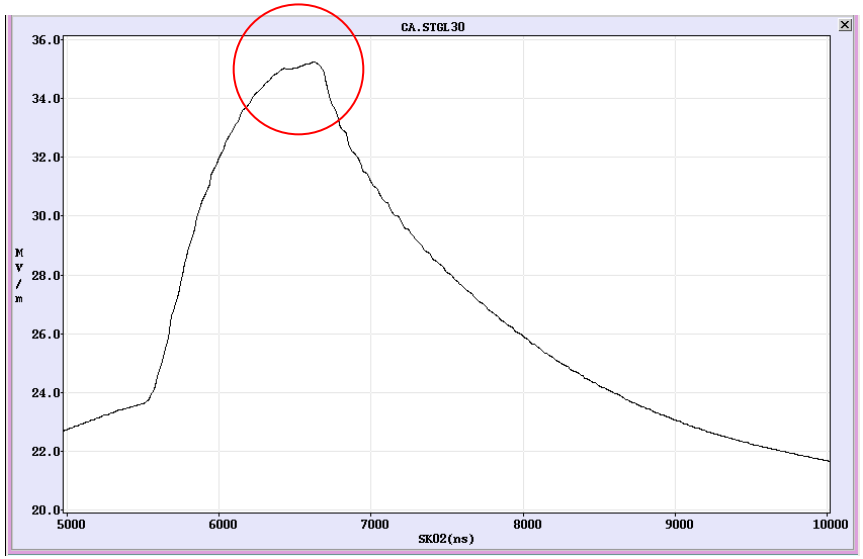




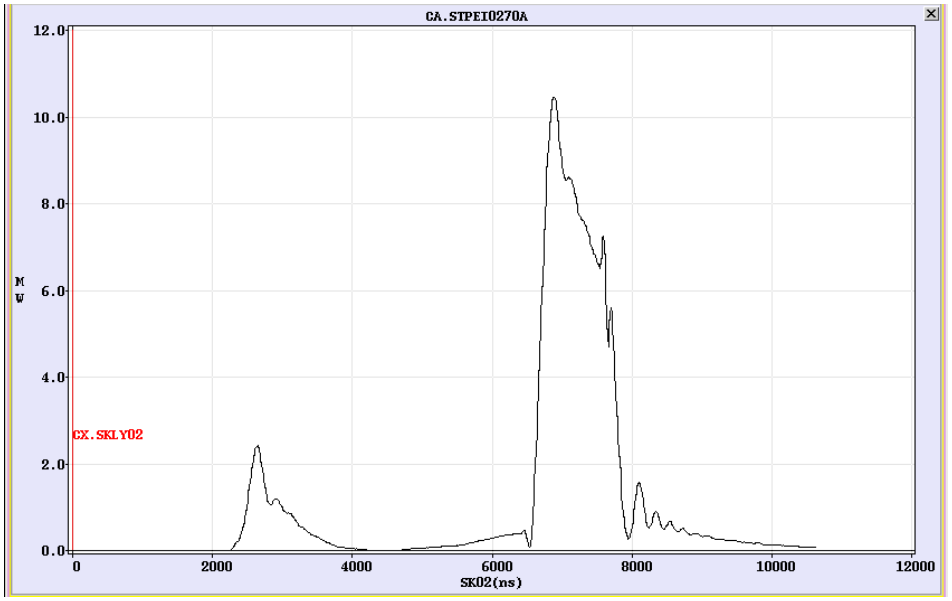


First evidence of beam loading

- Obtained with long pulses : 200 ns – 300 bunches – 21 nC



Gun loop loaded

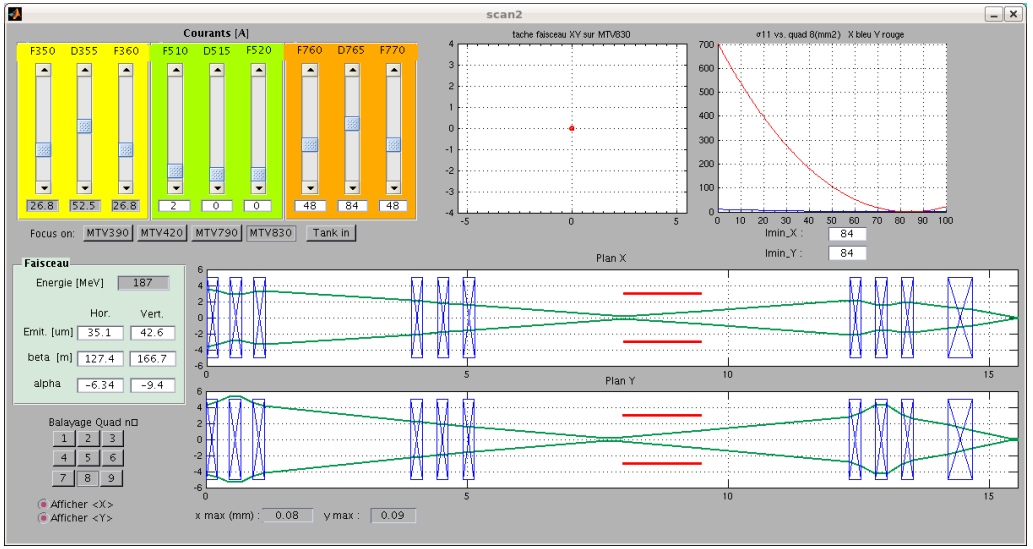


RF Structure Output loaded

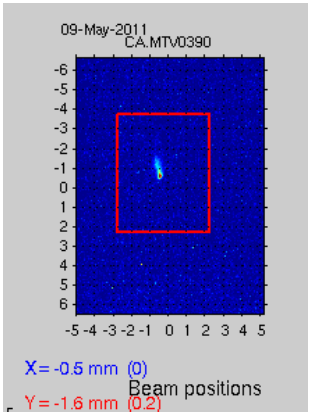
Beam envelope interactive model (flight simulator)

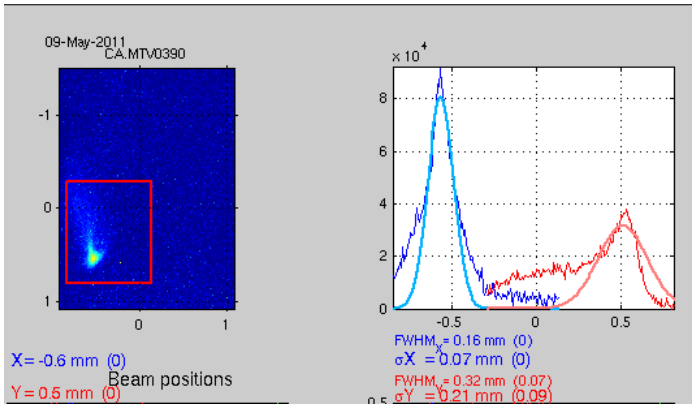
- Knowing the Twiss parameters it is easy to draw the beam envelop downstream according to the quad settings.

Predictions :



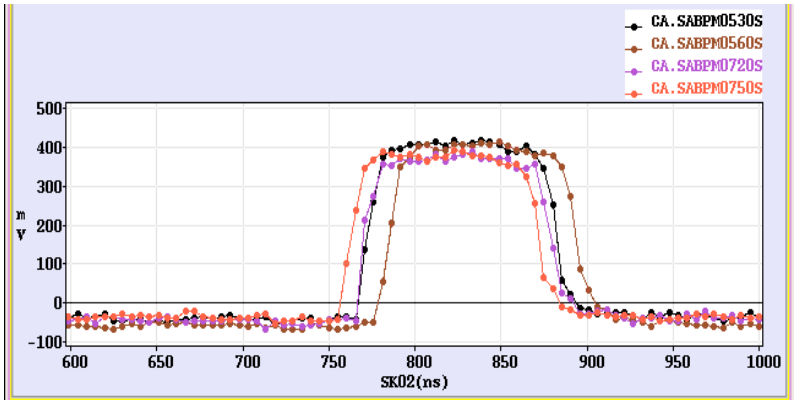
Results :





MTV390 with low and with high optical magnification

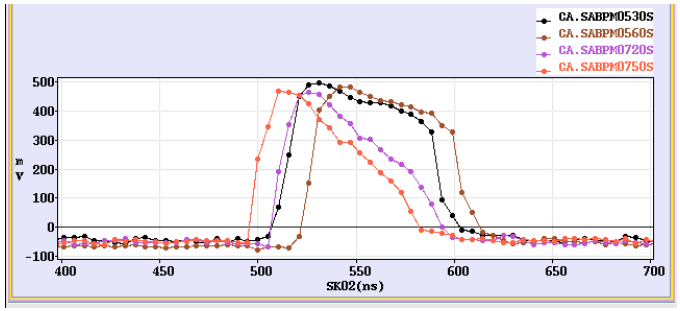
(very small waist)



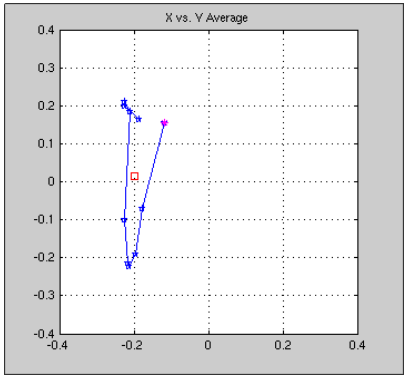
TBTS BPMs showing good transport even for long pulses

CALIFES BPMs work

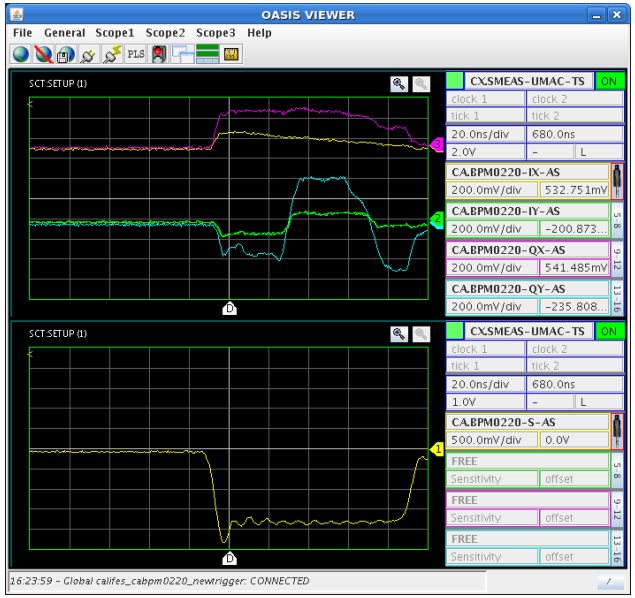
- BPMs difference signals have been calibrated
- Position drift seems to occur during long pulses (>100 ns) or maybe phase



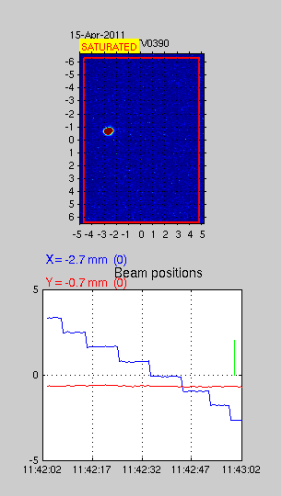
Transport problem during pulse through ACS

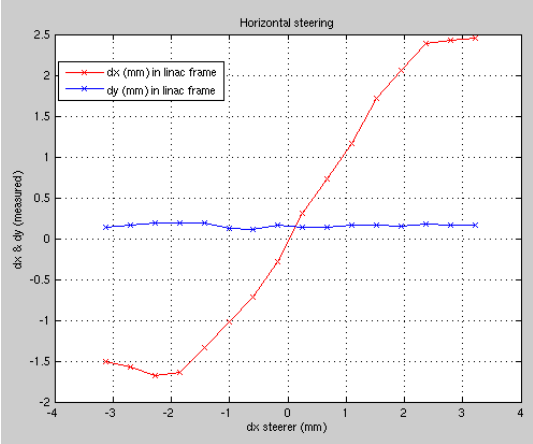


Beam position vs. time at the gun output



Raw IQ and Sum signals



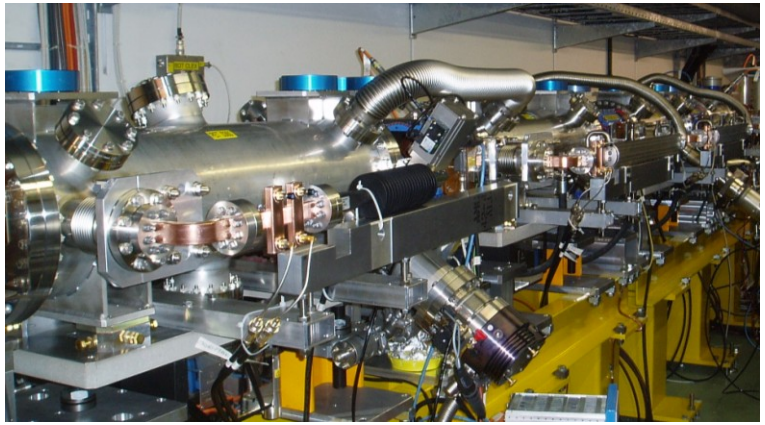


BPMs calibration procedure

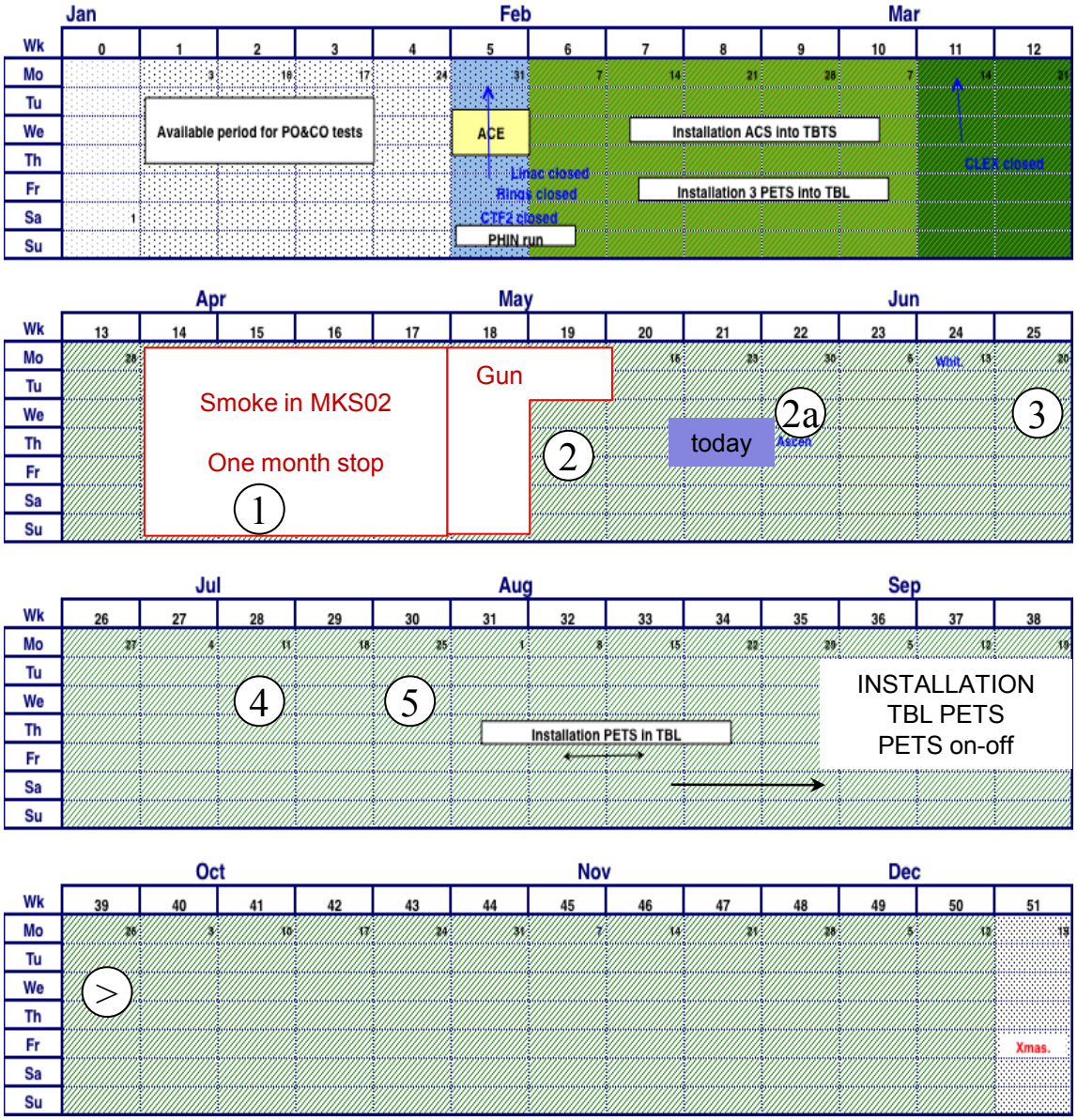
CLEX: TBTS - TBL

- TBTS probe beam BPM studies in view of kick measurements
  - transverse signals not functioning after gain increase last year
  - drive beam amplifiers installed temporarily
  - gain not sufficient
  - LAPP amplifiers repaired with initial (low) gain
  - additional amplifiers to be installed in gallery
  - gain improvement is studied

- TBL: 3 new PETS installed
  – waiting for beam
  => see Steffen's presentation



Planning 2011



1. 3 GHz beam setup to CR ✔
   initial beam to CLEX
   CALIFES setup ✔

2. CR x4 combination
   emittance studies
   combined beam to CLEX

2a. 1.5 GHz beam setup
    x8 combination
    (if TWT is available – only 1 operational)

3. 100 MV/m acceleration
   breakdown kicks
   TBL deceleration
   (1-2 days for DB beam studies)

4. ε < 150 mm mrad
   longitudinal studies
   stability x8 combination
   (night running for BDR)

5. breakdown rate measurements
   PETS / ACS

> Test of new PETS on-off scheme
  TBL deceleration up to 8 PETS

Beam phase
rep. rate / losses

CSR
night supervision

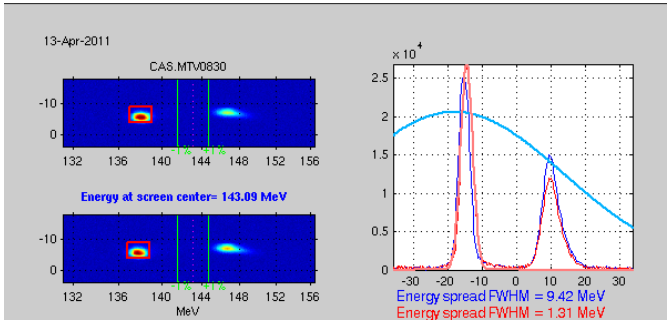
Conclusion

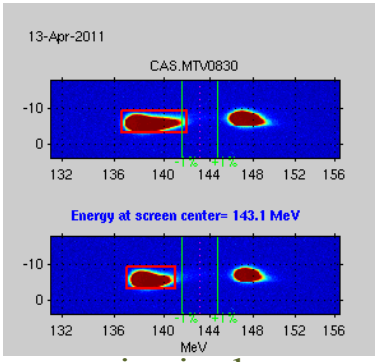
- Progress relatively slow due to
  - “near miss” on MKS02
  - subsequent careful RF setup + adaptation of the beam
  - => lost about 2 month (including gun problem)
- excellent 3 GHz beam setup
  - first 4x combination and beam to TL2 – redoing for present energy
  - next: setup combination in CR and send uncombined beam to CLEX
  - can profit from the good beam quality for easier setup
- 1.5 GHz setup will depend on return of TWT
- CALIFES was able to operate during the stop, very good set-up, waiting for the drive beam…
- Many thanks to all involved, especially to Wilfrid for material!

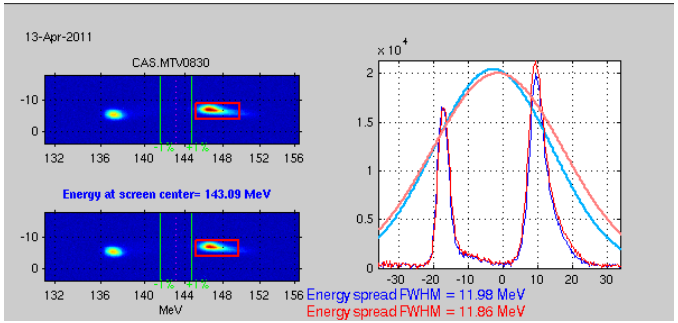
Conclusions - Wilfrid

- Ready to resume exciting experiments on Two-Beam Acceleration

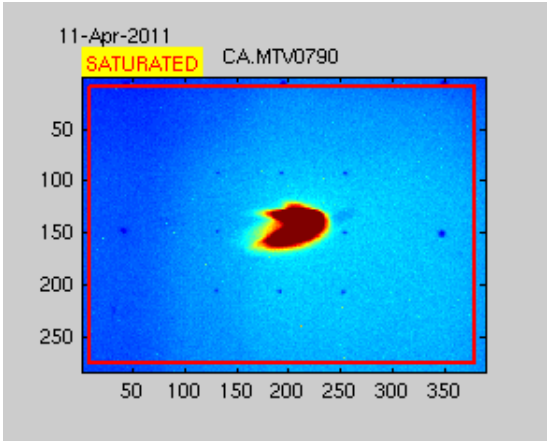
And to produce some strange beam pictures



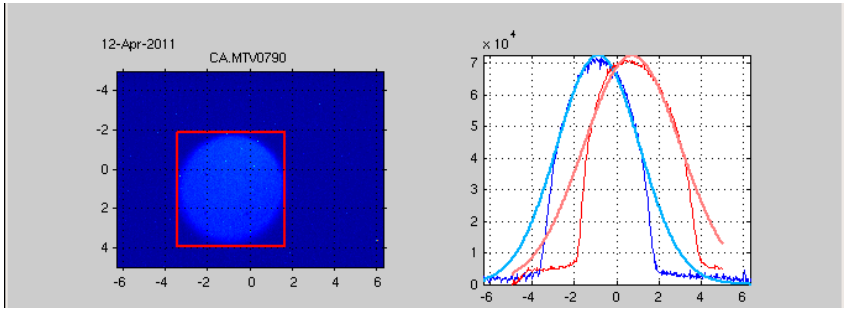




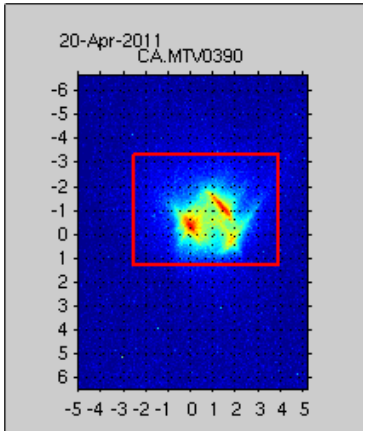
Two different energies in the same beam



Beam and calibration pattern



ACS shadowing the beam



Three spots in the same beam

Spare slides

DB generation – mid 2011

- Bunch train recombination
  - Consolidate results, routine operation, stability of fully combined beam
- Transverse rms emittance
  - Complete TL2, TL2', TBTS commissioning – full transport to CLEX
  - < 100 π mm mrad after ring, combined beam
  - < 150 π mm mrad in CLEX, combined beam
- Bunch length control to < 1 mm rms (combined beam)
  - Measurement campaign with different meas. systems (RF defl.& screen, fast streak-camera, RF monitors)
  - R_{56} tuning experiments in Frascati chicane and TL2
- Beam current stability: improve slow variations, obtain ~0.2 % for combined beam
  - Full measurement campaign (find correlations, jitter sources)
  - Gun pulse flatness, "slow" feedback
  - Improve overall klystron stability (at least up to best performing klystrons)
  - Slow RF feedback (temp. in pulse compressors)

RF structures – mid 2011

- Consolidate RF measurements
- Variable power splitter between PETS and ACS taken out
- PETS TBTS
  - Goal: nominal power / pulse length inside PETS with recirculation (135 MW, 250 ns total pulse length, 170 ns flat-top)
  - Breakdown rate measurements (at high BD rate - extrapolation to lower rates)
  - Operation w/out recirculation – may have different breakdown rate…
  - Test of new PETS on-off scheme (from summer)
- Acc. structure in TBTS
  - TD24, initial reconditioning in the shadow of PETS operation
  - Goal: nominal power / pulse length delivered to structure (65 MW, 250 ns total pulse length, 170 ns flat-top)

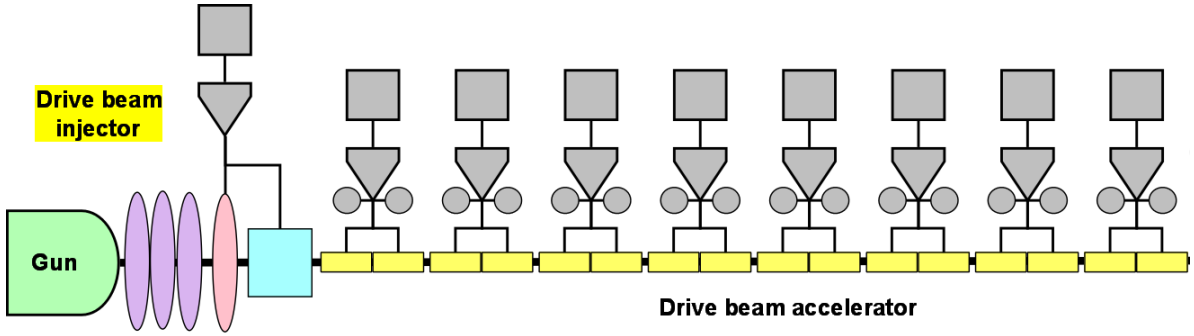
Two beam issues – mid 2011

- TBTS
  - Two-Beam test – 100 MV/m, with correctly tuned structure
  - consistency between power & beam energy gain
  - Drive beam, deceleration, power produced
  - Probe beam, power delivered to accelerating structure, energy gain
  - Beam Loading compensation experiment - by varying fast phase switches – check control of RF pulse shape with probe beam acceleration
  - Measurement of breakdown kicks
  - Measurement of effect of beam loading on breakdown rate (???)
- TBL
  - Measurement of deceleration / produced power
  - Measurement of energy spectrum
  - Optics, steering algorithm studies

Other issues – mid 2011

- CALIFES
  - Fully reach nominal parameters (total charge ?)
  - Bunch length measurements (RF defl. & screen)
- Other
  - First measurements of phase stability (PETS output, RF pickups…)
  - Operation at 5 Hz
  - Control of beam losses
  - Coherent Diffraction Radiation (RHUL collaboration)
  - …

new RF phase setup



- 2010

1200µs
Phase
0

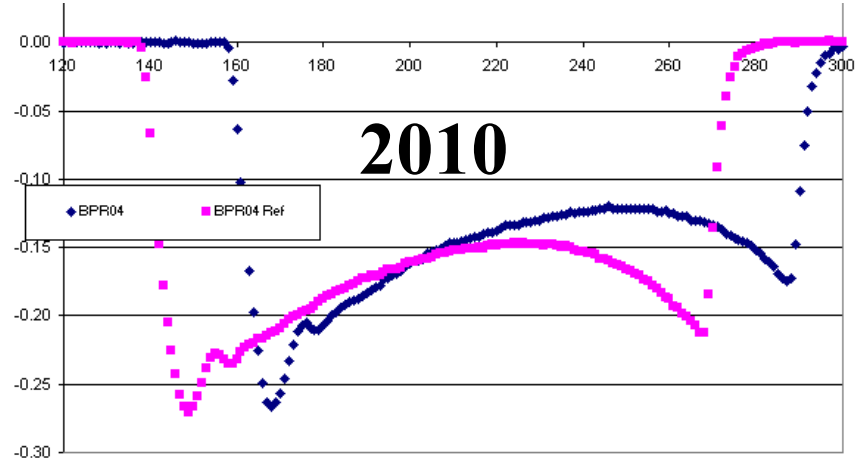
2011

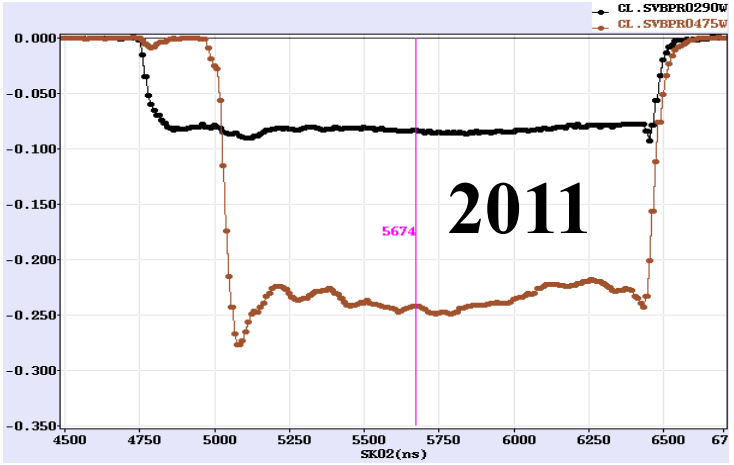
1200µs
Phase
0

- same sag for SHBs and pre-/buncher + accelerating structures
- => ΔE/E = 0 along the pulse, no bunch length / energy spread variation
- => tuning all along the pulse identical
- still: bunch phase variation – could be compensated in Frascati or TL2 chicane (slight energy shaping along the pulse)
- much less sensitive to phase errors [cos(~few deg)]

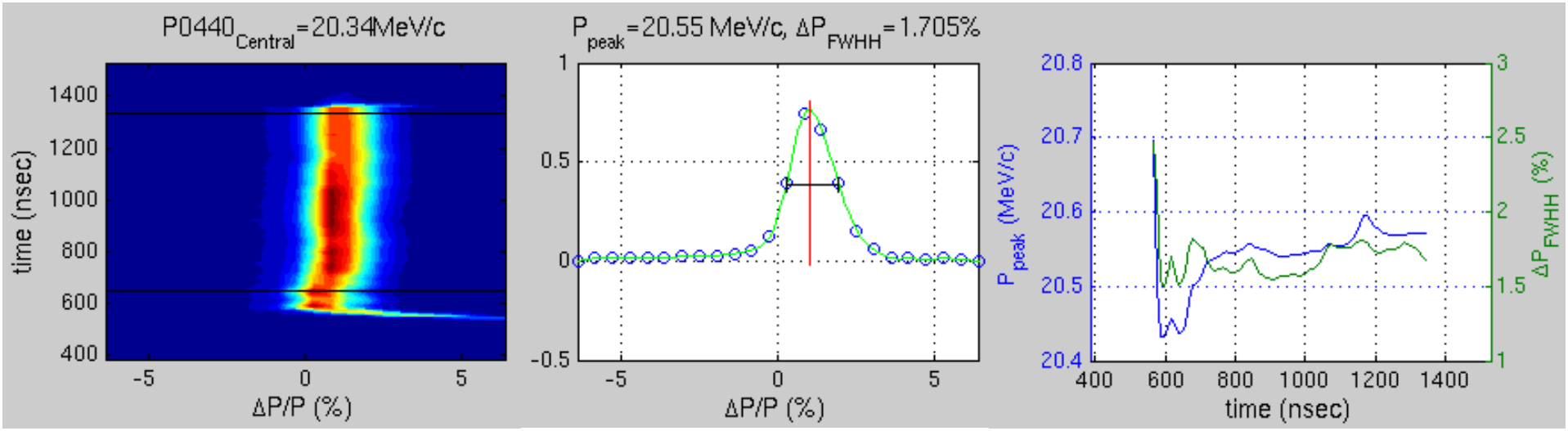
Beam status

- ~constant BPR signal along the pulse => constant bunch length



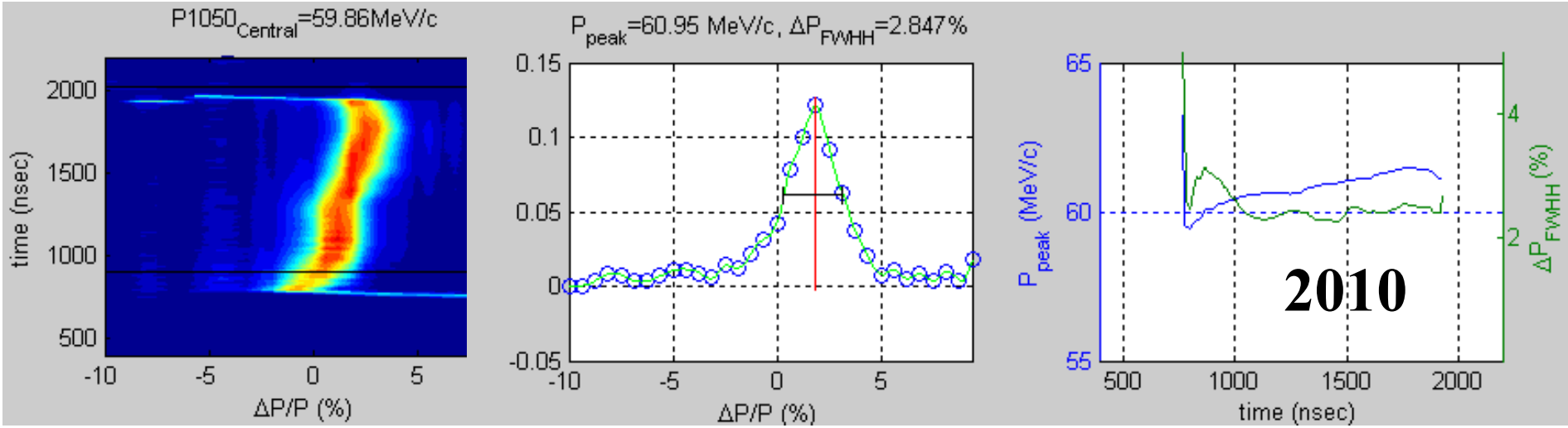


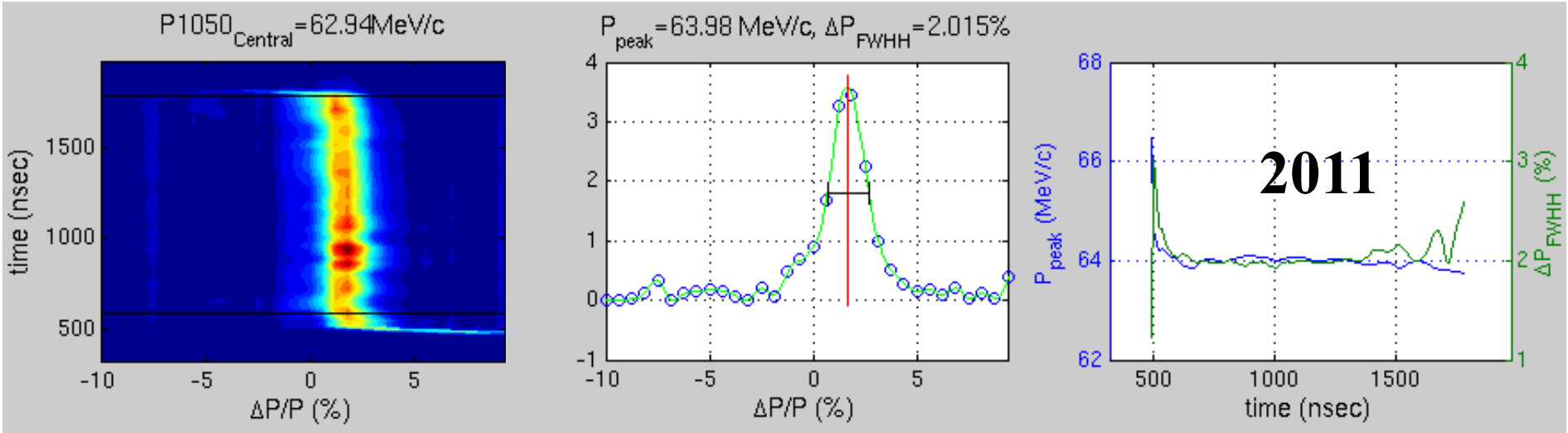
- => constant energy + energy spread



Beam status (cont.)

- constant beam energy without special RF shaping



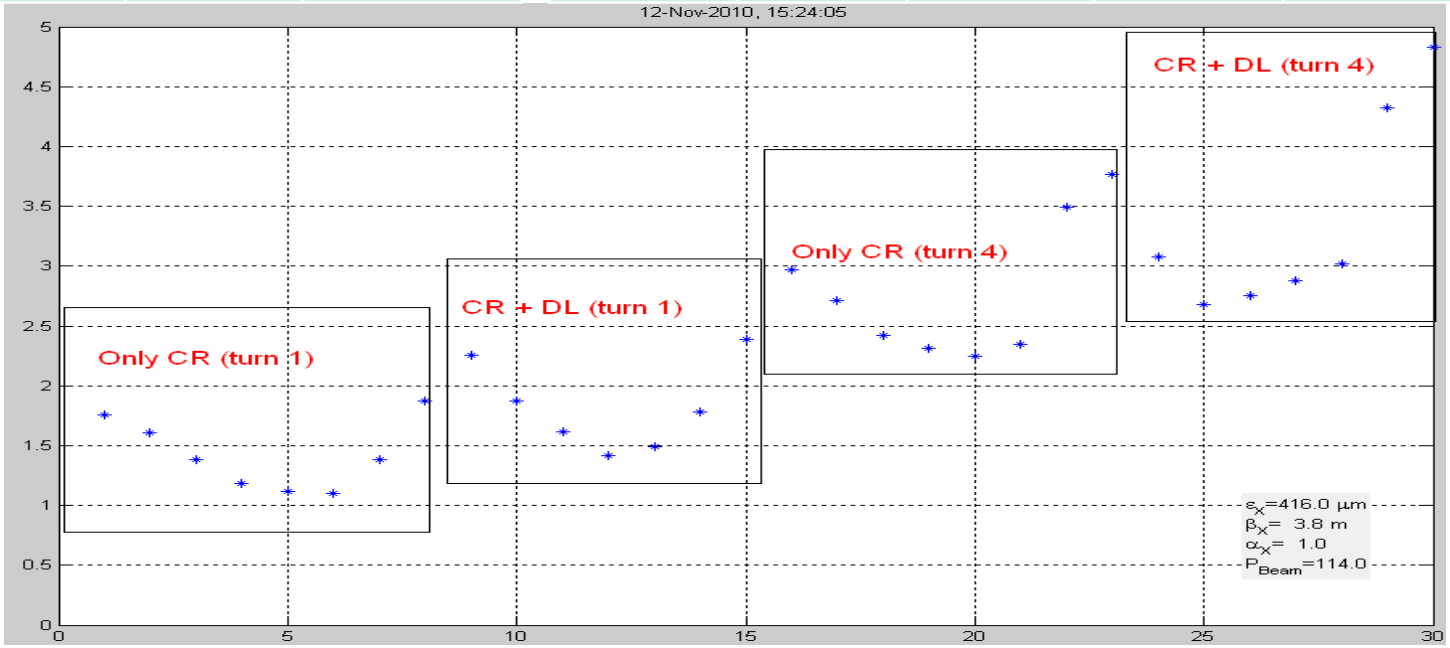


Emittance

- measured in H and V for various stages of combination
- emittance increase more from CR than from DL

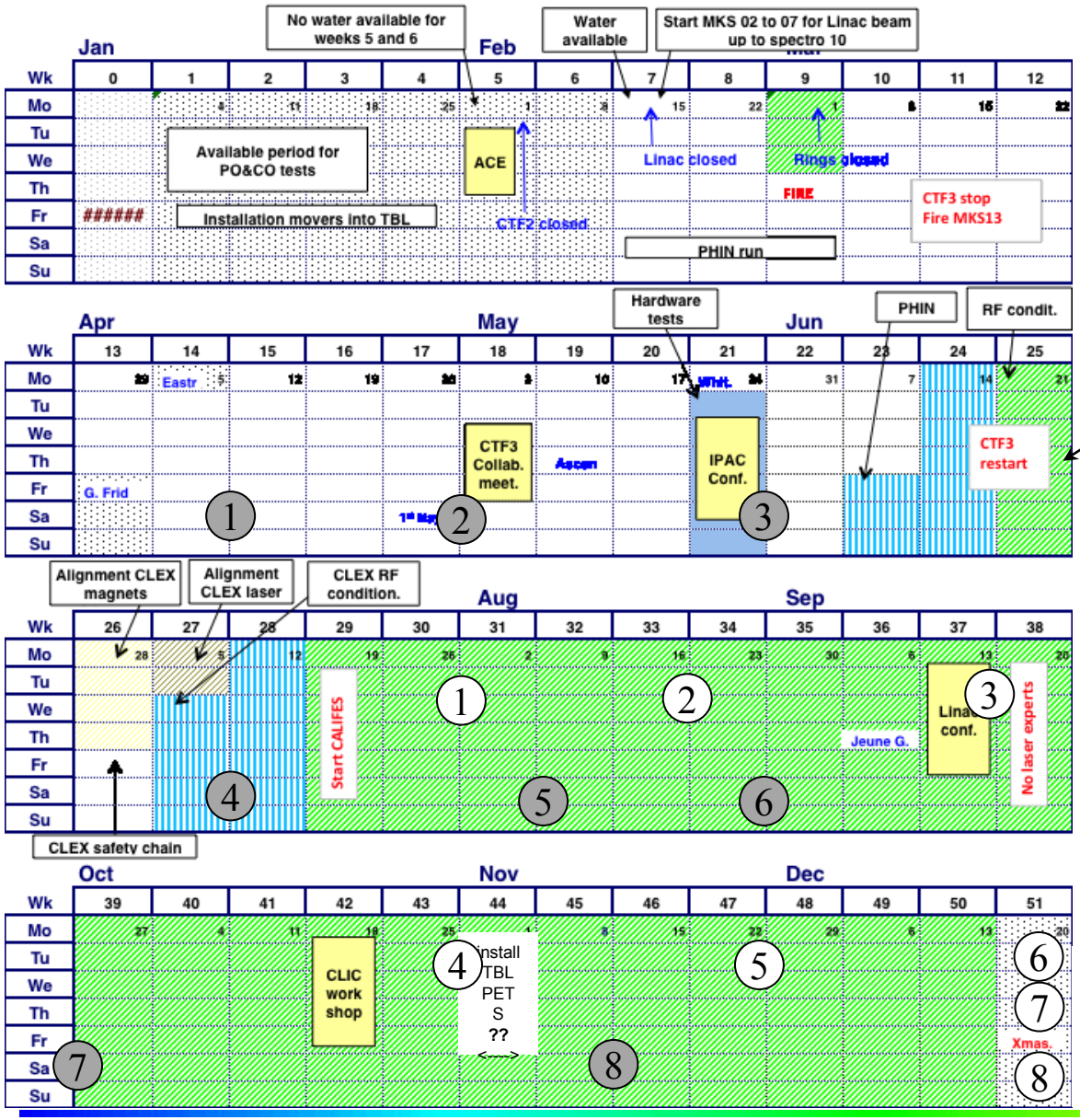
horizontal	CR 1st	DL+CR 1st	CR 4th combined	DL+CR 4th combined
emittance [mm mrad]	**148**	**262**	**532**	**682**
beta [m]	4.8	5.0	3.7	3.6
alpha	0.9	0.9	1.0	1.2

vertical	CR 1st	DL+CR 1st	CR 4th combined	DL+CR 4th combined
emittance [mm mrad]	**88**	**129**	**152**	**170**
beta [m]	17.2	11.0	7.3	9.9
alpha	-8.1	-5.1	-3.1	-4.3



Simona Bettoni

Schedule – restart 31/1/2011



1. Optics improvements (DL dispersion)
   Full transport to CLEX
   Bunch length control (first tests)
   TBTS initial PETS tests
   CALIFES setup
   ~~new setup when MKS13 available?~~
2. PETS conditioned to nominal power/pulse length
   TBL PETS tests
3. Accelerating structure conditioned to nominal power/pulse length — Two-Beam test power & energy gain, 100MV/m

Beam

4. TBL studies (limited) — PETS breakdown rate measurements???
5. Measurement of breakdown kicks — Beam Loading compensation experiment
6. Measurement of effect of beam loading on breakdown rate
7. Test of new PETS on-off scheme
8. TBL studies 30% deceleration ?

2nd TBL PETS installation

6 weeks PHIN phase-coding Laser preparation

- Stability studies & improvements
- PETS no recirculation
- Phase stability
- Operation at 5 Hz (or more)
- Control of beam losses
- Coherent Diffraction Radiation …