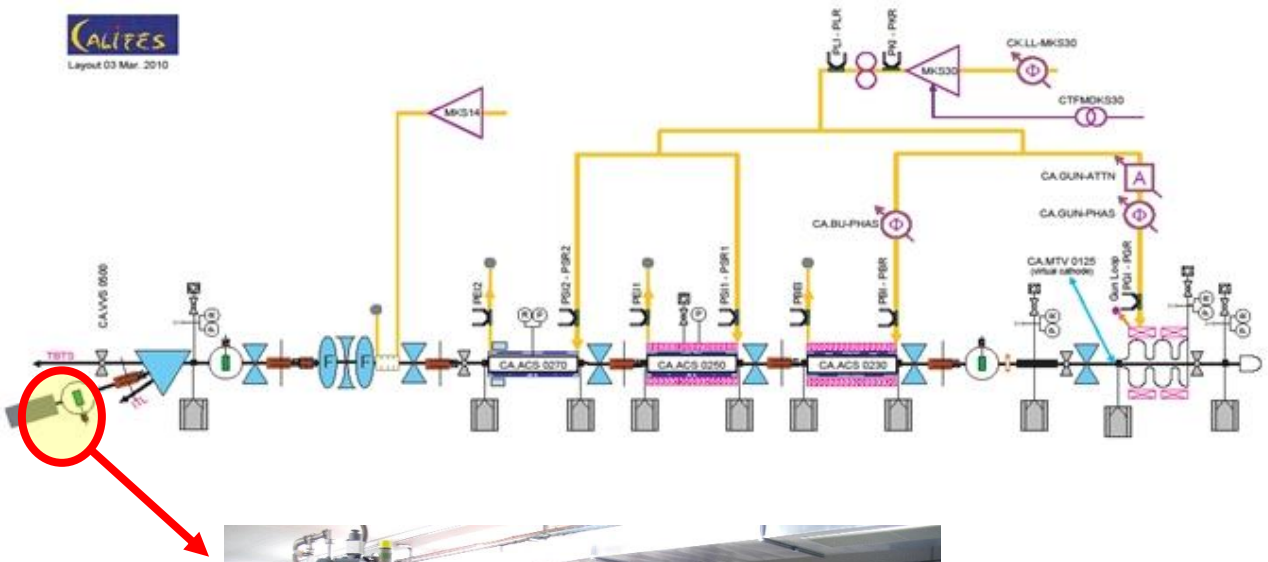
Irradiation tests in the CALIFES beam line - Beam Conditions

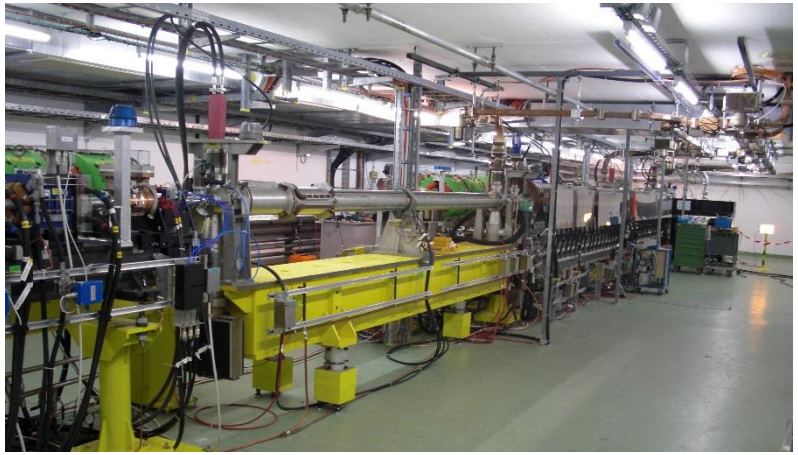
W. Farabolini, R. García Alía, M. Tali, M. Brucoli, S. Danzeca

Beam specifications for irradiation test

Requirement	Nominal CALIFES beam
• Beam energy from 200 MeV down to 50 MeV	203 to 100 MeV
• Very low charge per bunch, < 0.1 pC	1 nC to 10 pc
• Long train of bunch	1 to 300 bunches
• Very high stability during long periods of time (hours)	charge fluctuations
• Large and flat beam size: 3 x 3 cm	30 μm to 4 mm
• Unmanned operations during night	beam and laser manned
• No risk of irradiation outside of the controlled period	Limited CLEX access

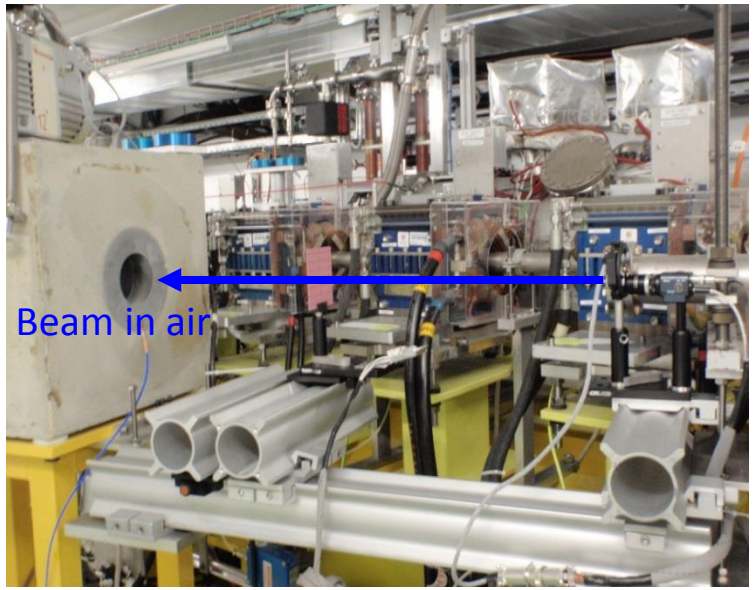
Installation of a dedicated test bench





Accelerating structures and diagnostics section

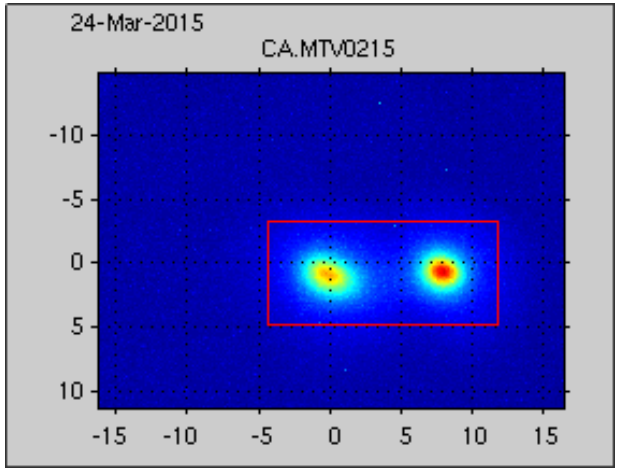
Spectrometer line before installation



New Irradiation Test Bench (E. Del Busto)

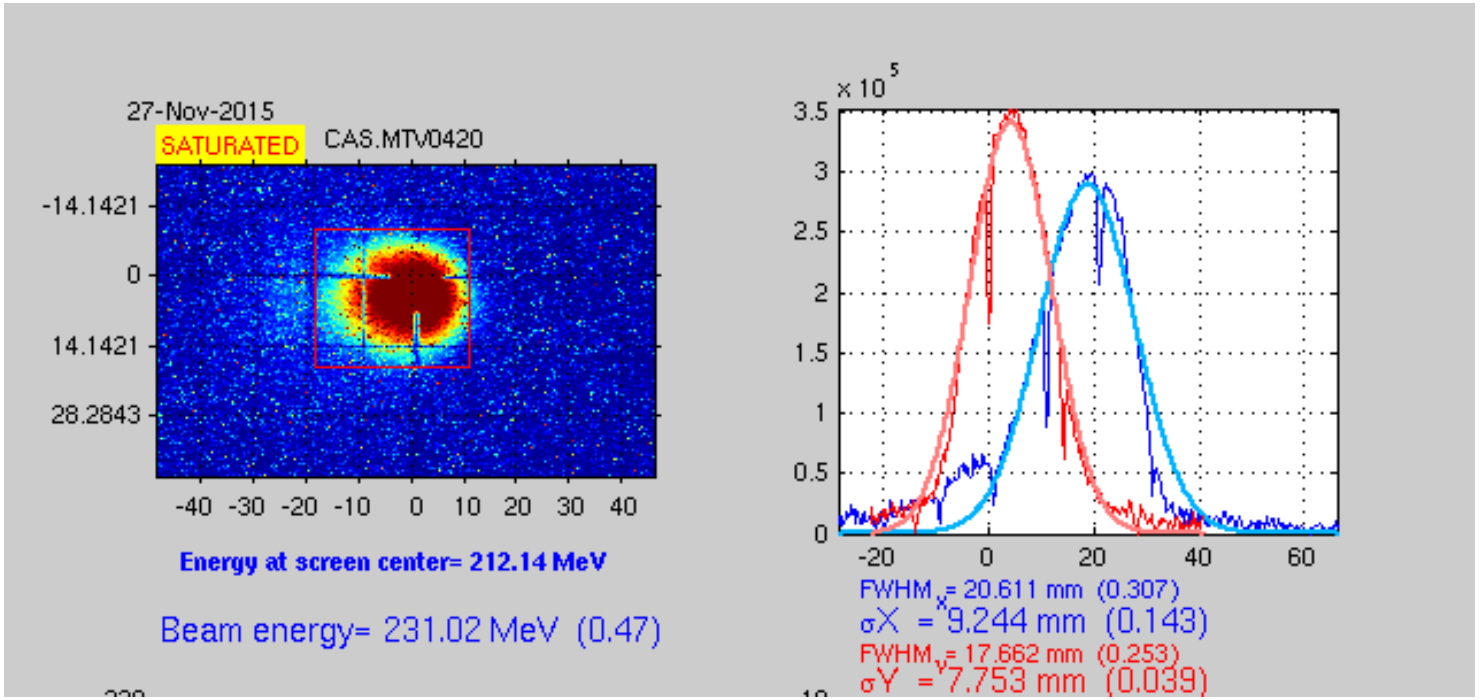
Choice of a dark current beam

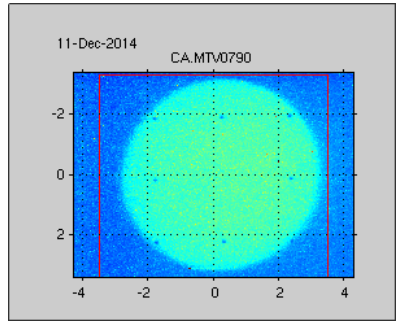
- Naturally low bunch charge (~ 0.1 pC).
- Long train of bunches (~1 μs @ 3 GHz: 3000 bunches).
- Long bunch length, not yet measured but certainly longer than laser generated bunches (> 10 ps).
- Higher emittance than laser generated beam (naturally larger beam size).
- Very high stability of the klystron over long time (no trips, no drift).
- Easy unmanned operations during nights and week-ends.

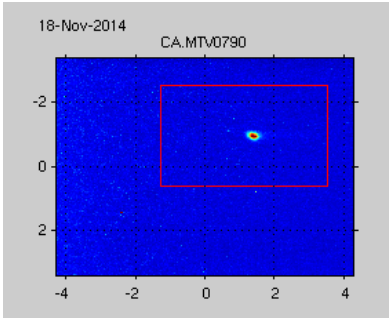


Laser generated (right) and dark current beam (left) at the gun output

Dark Current Beam characteristics: size







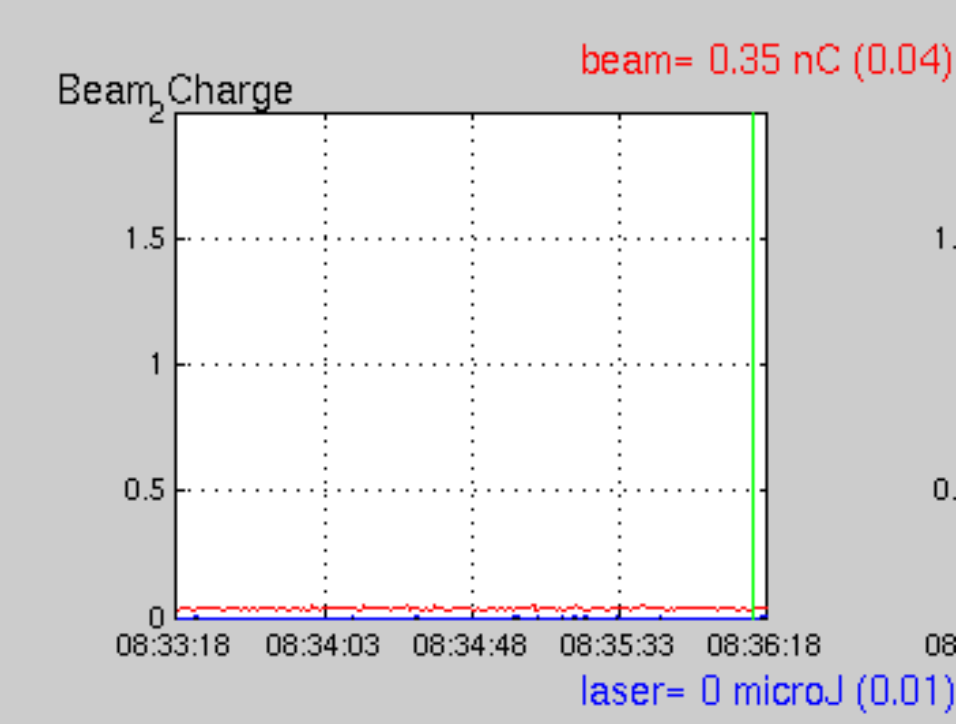
Flat beam (6 x 6 mm^2) after collimation
And nominal beam (100 μm)

20.6 x 17.7 mm^2 FWHM. But Gaussian not flat

Presently some difficulties to make the beam larger

- collimation by some low diameter equipment ? → a BPM will be removed during the shut-down
- Possibility to insert an upstream silicium screen to scatter the beam
- Possibility to paint a pattern using a steerer

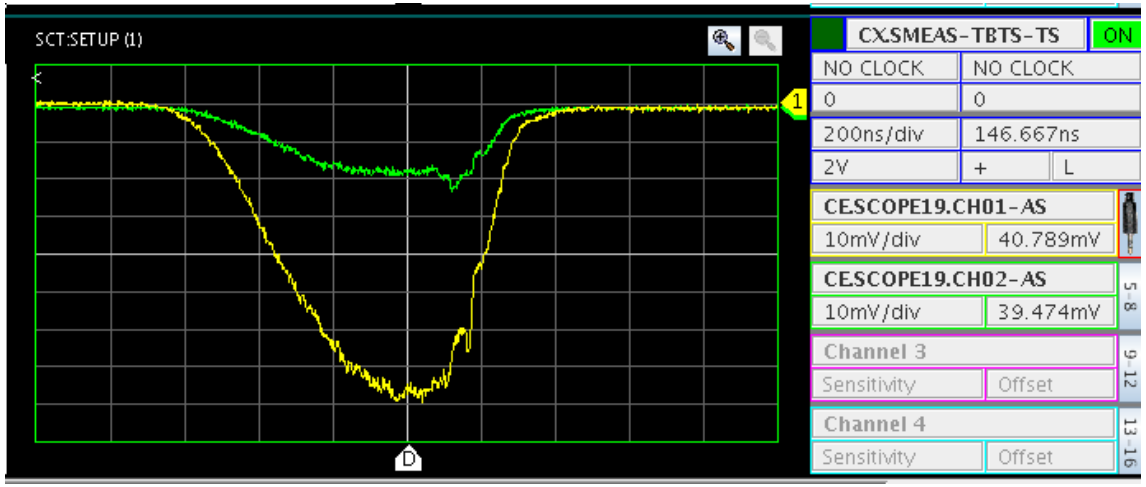
Dark Current Beam characteristics: charge



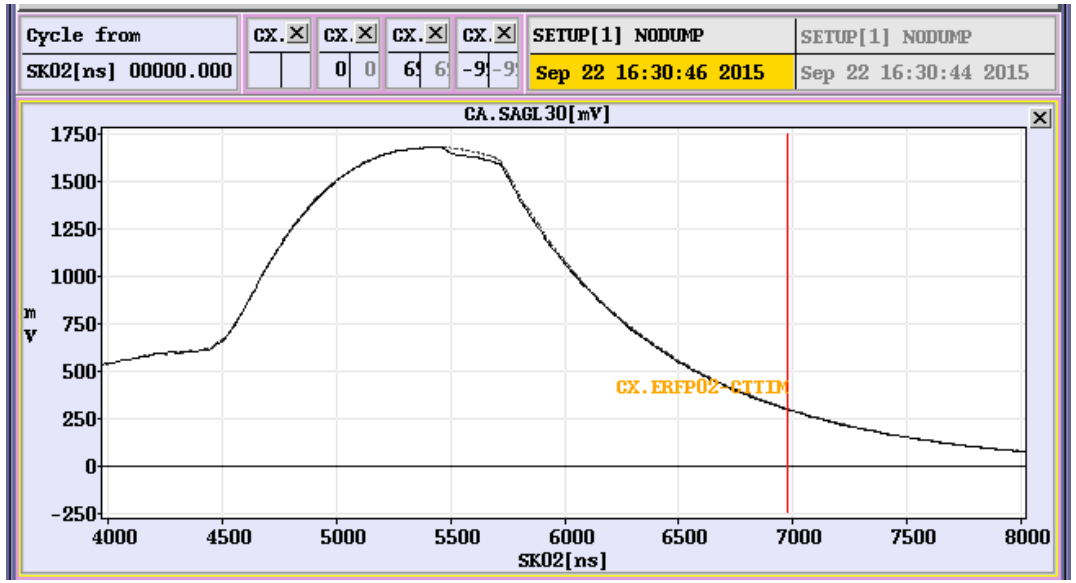
- A new ICT has been ordered to measured the beam charge at the exit of the chamber.
- Possibility to reduce the beam charge using the RF gun attenuator.

0.35 nC for the integrated pulse. Repetition rate 5 Hz
But measured at the gun output (risk of beam losses)

Dark Current Beam characteristics: time profile

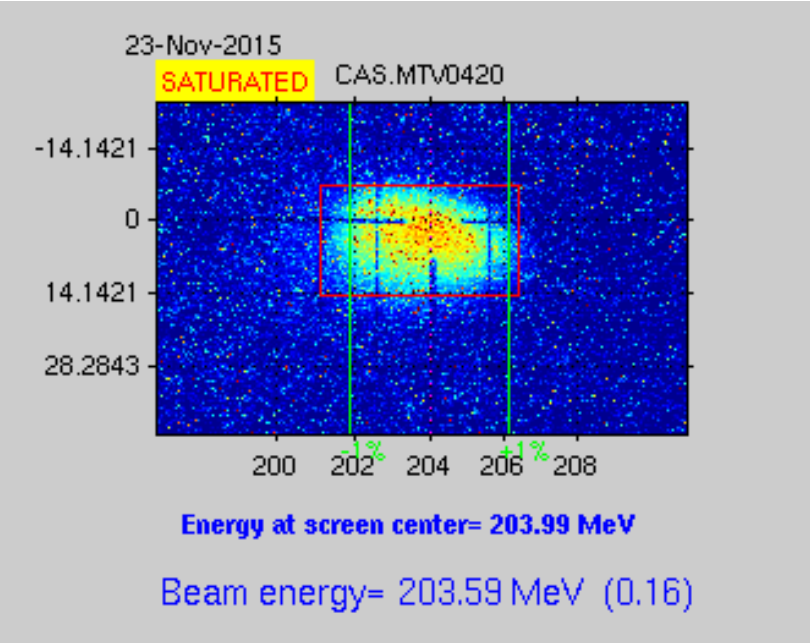


Pulse length 600 ns FWHM (1800 bunches)
Measured with Beam Loss Monitor (photomultipliers) since other beam sensors are not fast/sensitive enough

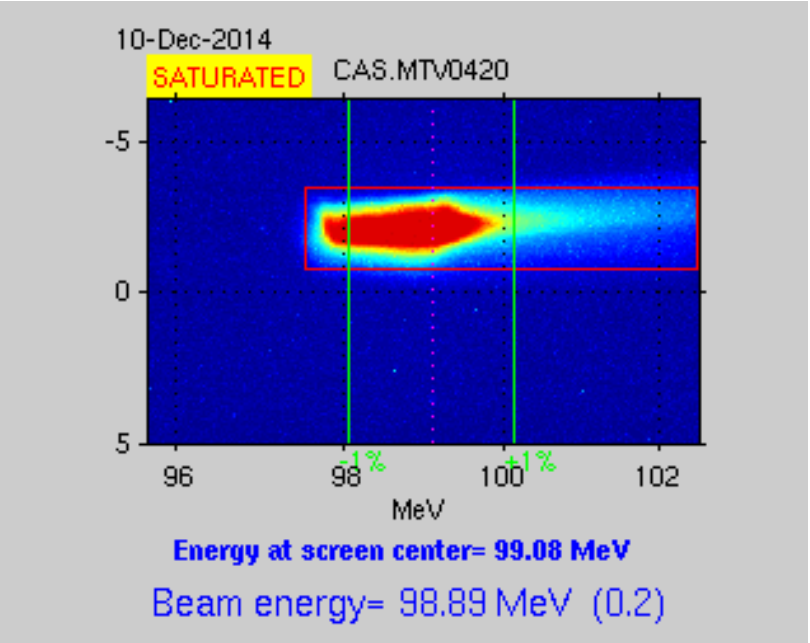


RF pulse length 1.2 μs
E field inside the gun (standing wave cavity) measured with gun loop

Dark Current Beam characteristics: energy



Beam energy: 204 MeV



Beam energy: 99 MeV

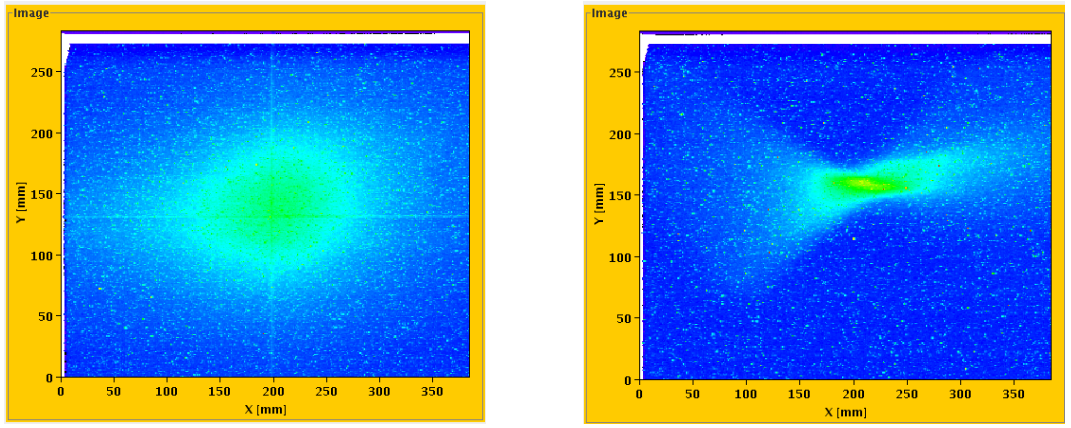
- So far energy range between 205 and 100 MeV accessible
- A new CALIFES using 2 klystrons would offer much lower energy capability

Irradiation Test Bench equipment

- Calibrated screen (beam alignment, beam profile)
- Optical rail to install DUT
- Patch panel with many available cables to the electronic hut (20 m)
- Foreseen
  - Integrated Current Transformer
  - Movable stages
  - Shielding to protect DUT once tested
  - Laser line to align the DUT

Conclusion

- An irradiation test bench was readily made available on CALIFES line to validate the feasibility.
- 11 days (or nights) have been dedicated to irradiation in 2015
- The choice of the dark current offer the better beam characteristics and operational easiness
- We are completing the equipment to better respond to the irradiation requirements



Very first CALIFES beam in December 2008 : was dark current !