



## Commissioning and Status

Results of the preliminary commissioning from  
1<sup>st</sup> to 13<sup>th</sup> of December 2008.

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A. Curtoni, F. Peauger, D. Bogard,**

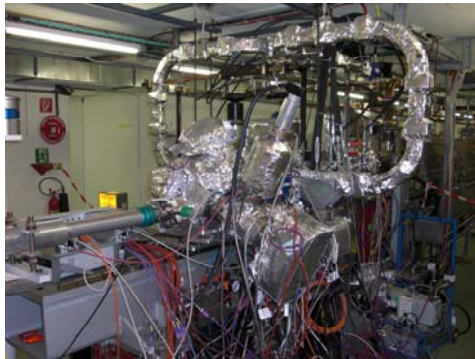


A complete commissioning was not possible, considering:

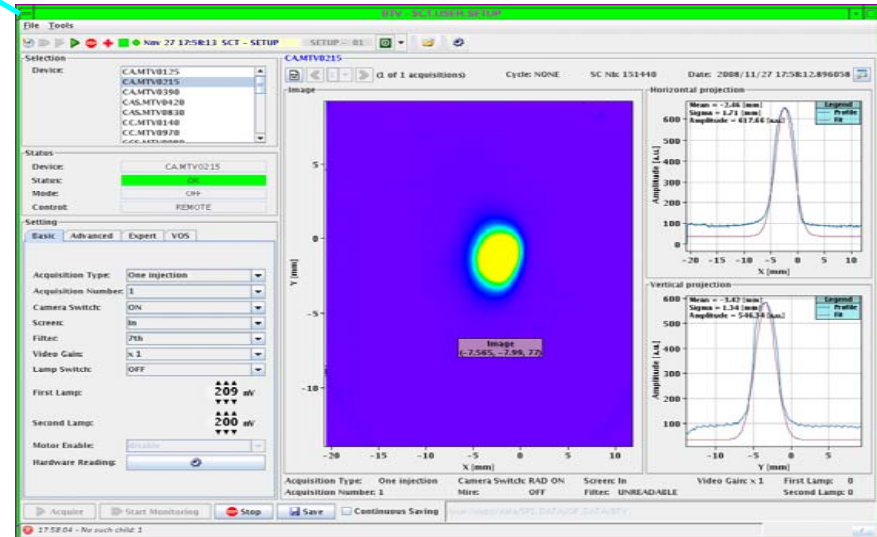
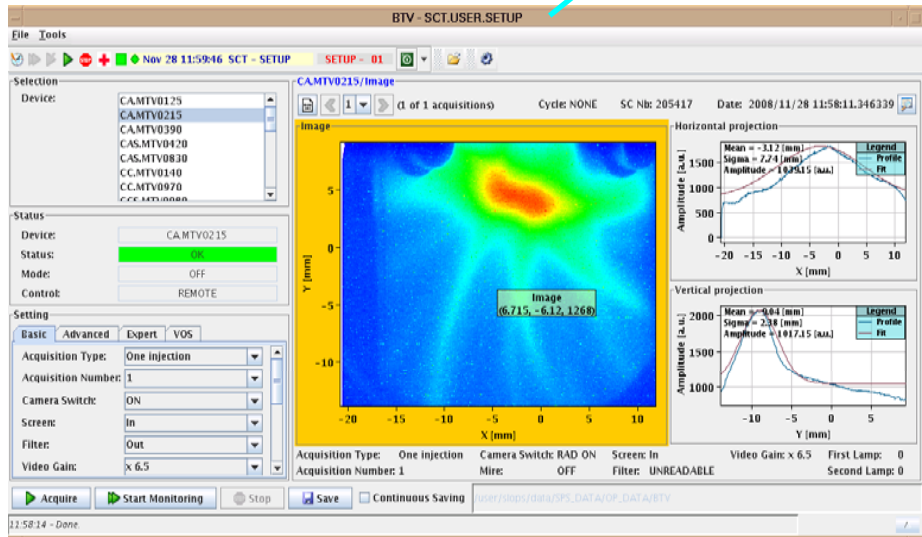
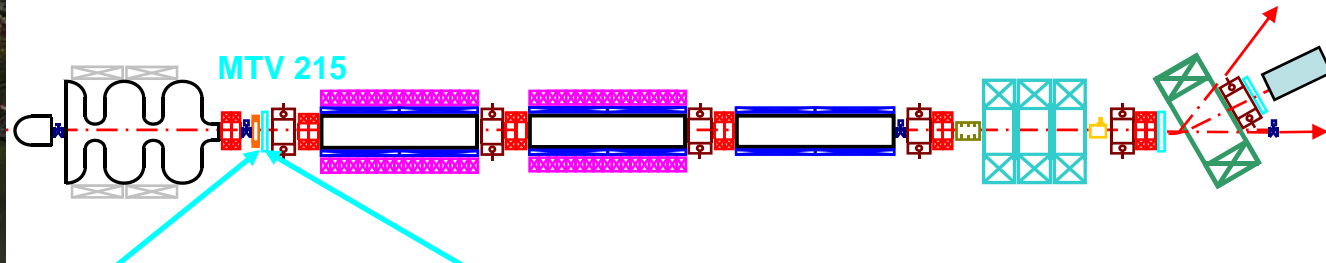
- the short remaining time before the winter shutdown,
- the lack of some essential equipments like the power phase shifter, the deflecting cavity...
- the non yet achieved C/C for some equipments from the control room,
- the still improving laser performances,

However a first run of CALIFES was strongly expected to:

- Validate the actual construction of the accelerator (mechanical alignments, laser line, RF power distribution, photo-injector...),
- Check the diagnostics availability,
- Establish a list of actions to be performed during the shutdown,
- Show a first beam before the end of 2008.



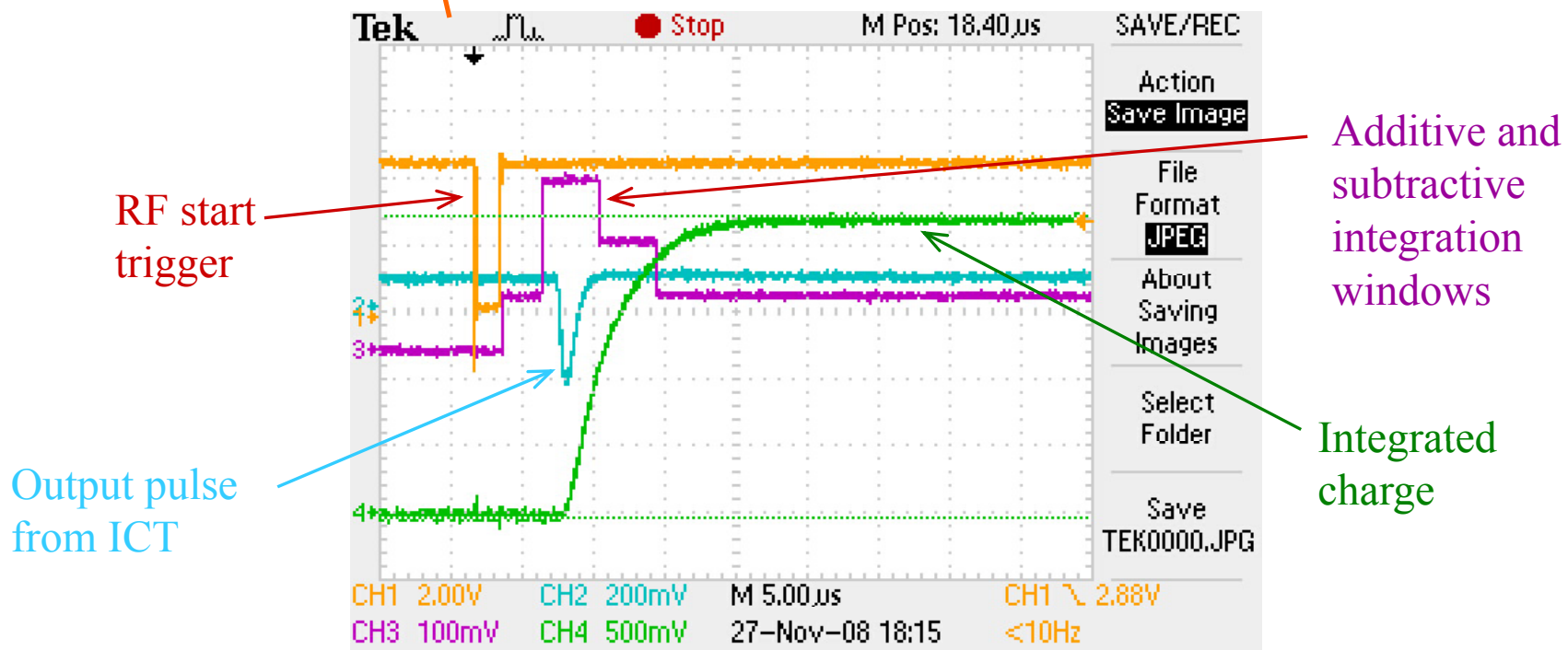
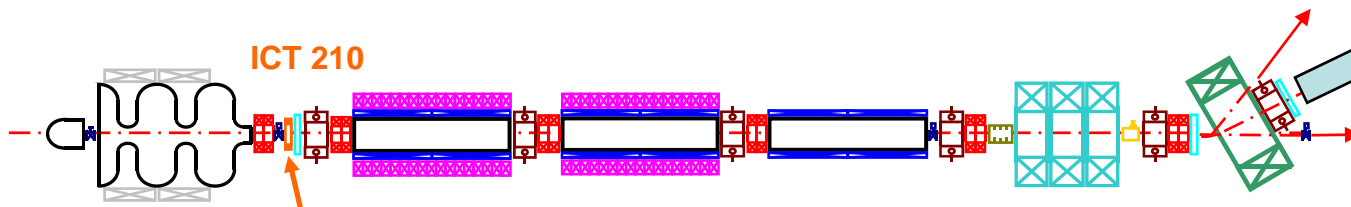
Beam was immediately seen at the gun output



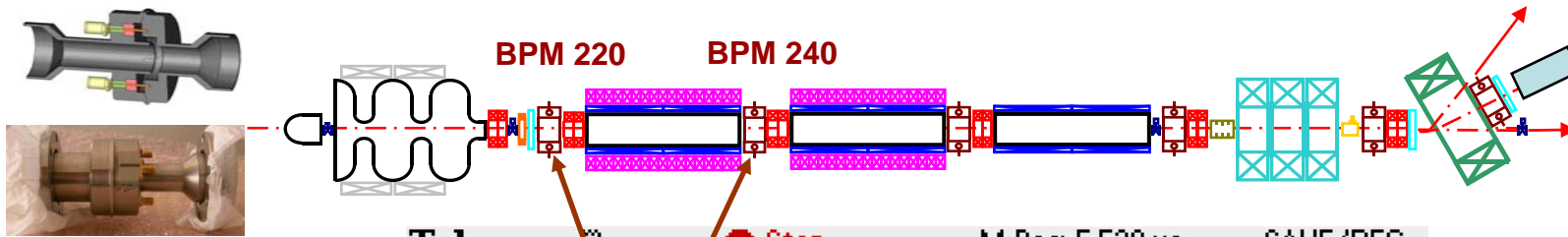
- **Dark Current** with 68 MW at the RF compression cavity output  
 → around 6.5 MW in the gun → ~70 MV/m on the photocathode  
 (notice: video gain is pushed at x 6.5, no filter)

- **The beam** with laser pulse train of 100 ns length (150 bunches)  
 (video gain x 1 and optical filter inserted)

# Beam Current Monitor

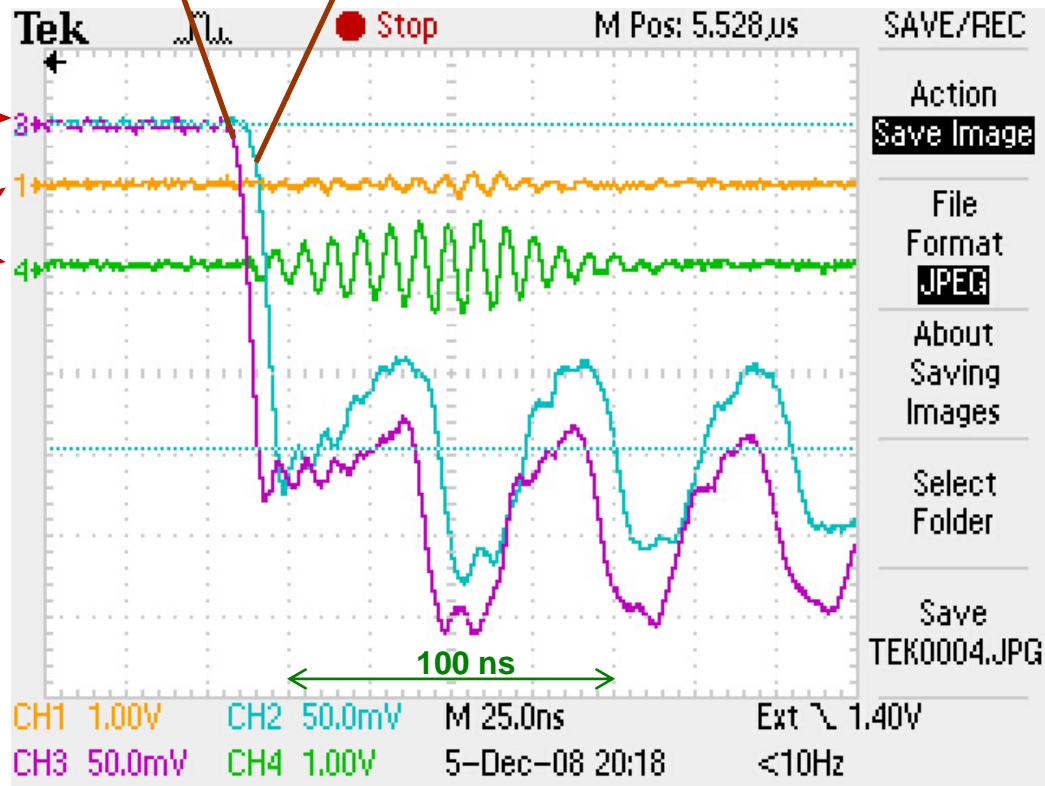


- Beam Charge Monitor signal : 2.2 V corresponding to 11 nC → 0.073 nC per bunch
- Dark current was measured around 0.1 nC during the whole RF pulse (1.5 μs)
- QE has been evaluated to approx. 1% at the beginning of the photocathode live



$\Sigma$  BPM 220  
and BPM 240

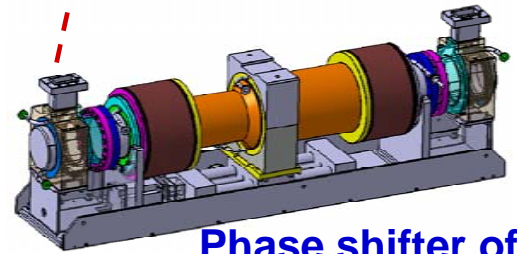
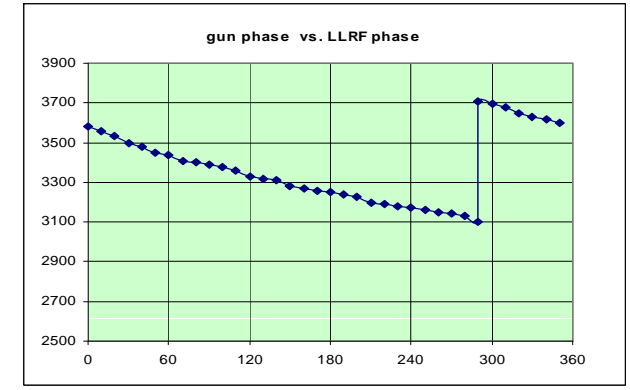
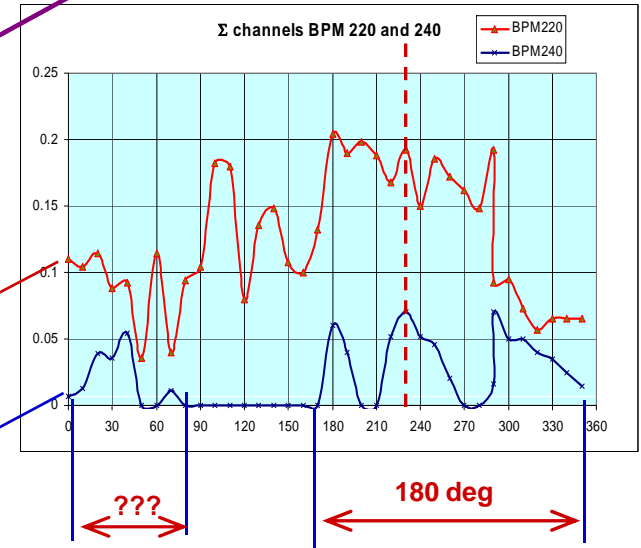
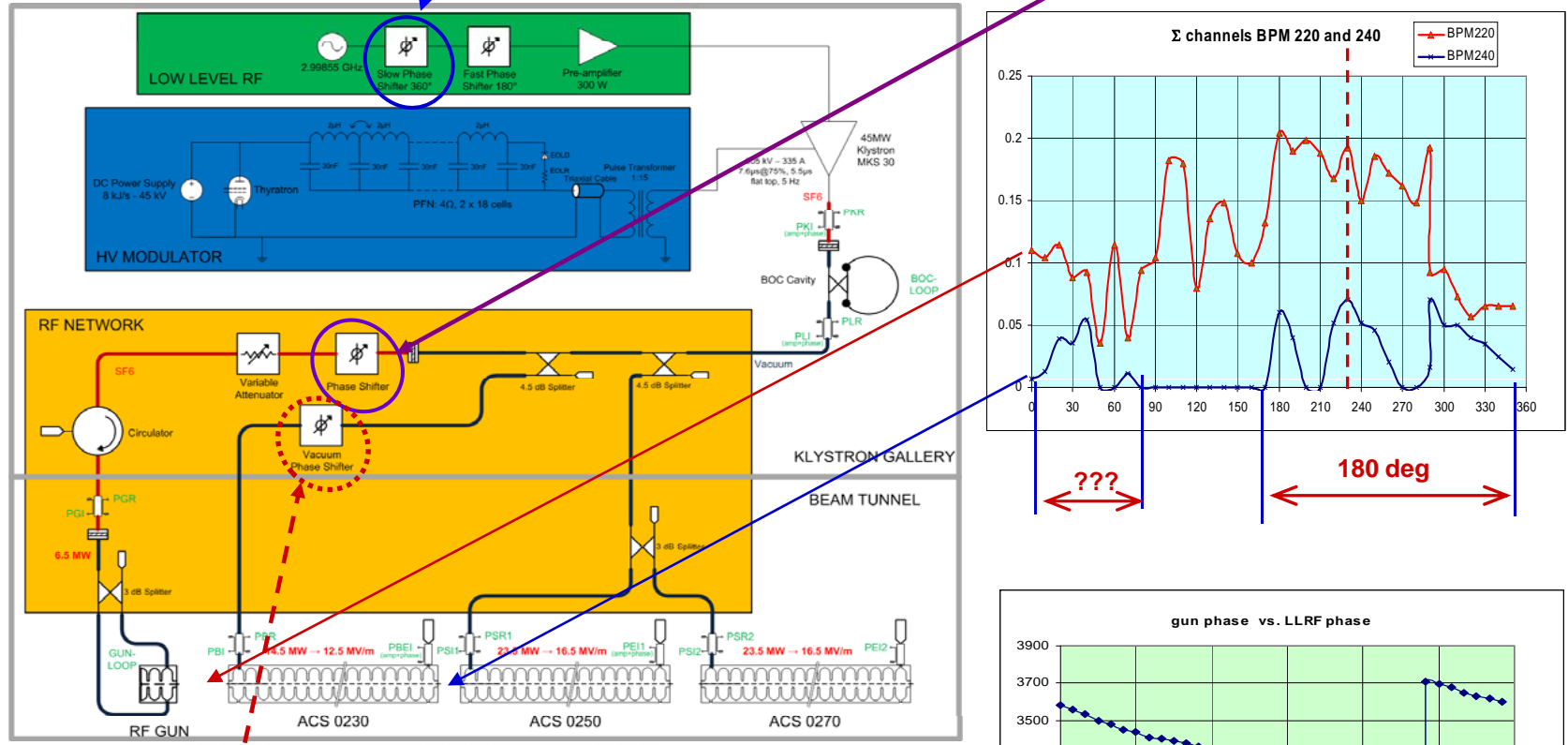
$\Delta y$  BPM 240  
I and Q



**Nearly 100% transmission was obtained through the first section (bunching),  
But not yet further downstream.**

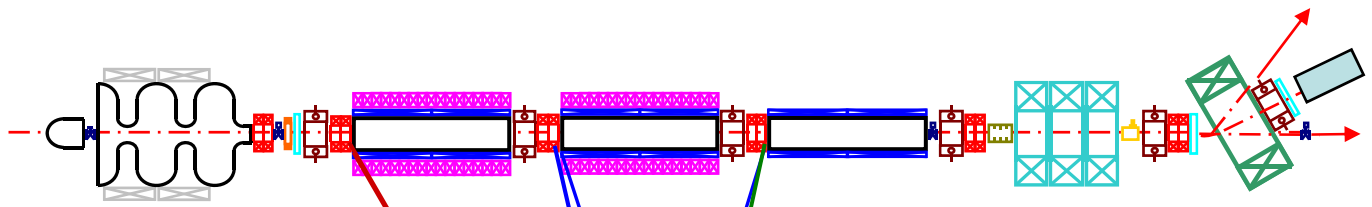
# cea First attend to pass through the 2 accelerating sections

Sweep the general phase (LLRF) and compensate with the gun phase shifter to maintain constant the beam current at the gun output (laser trigger does not change).

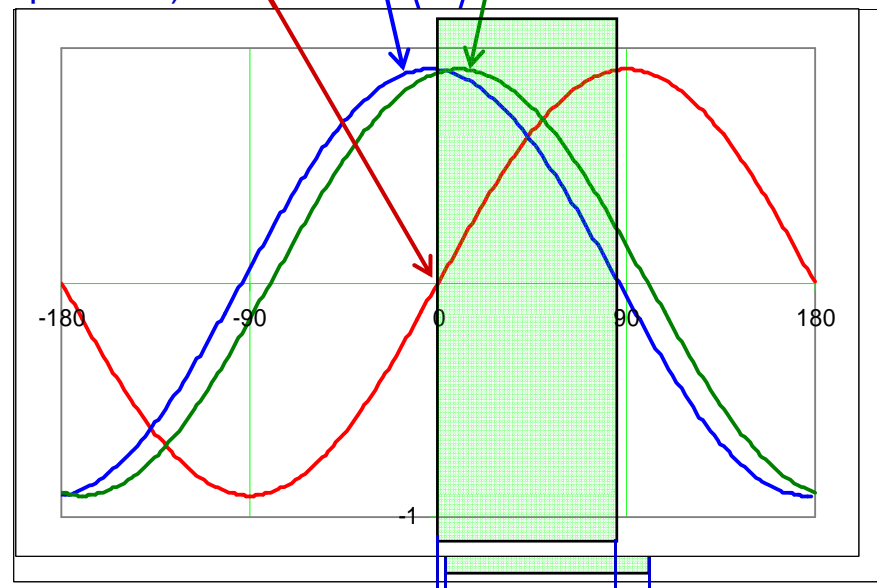


Phase shifter of the compression section is missing

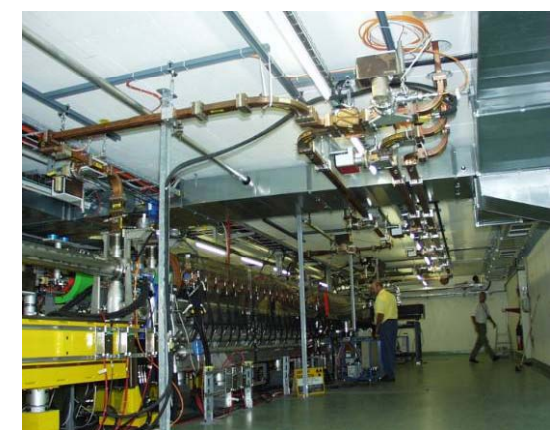
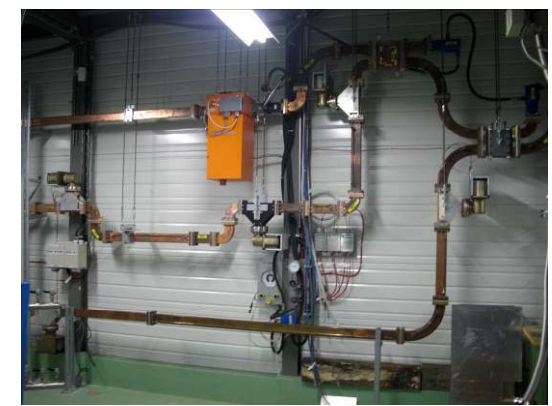
Gun phase shifter steps



Theoretically:  
 S2 and S3 (acceleration) at  
 184 deg from S1  
 S3 at 80 deg from S1 (compression)  
 (Required to add a  
 waveguide length of  
 only 5.4 mm)



Expected transmission slot

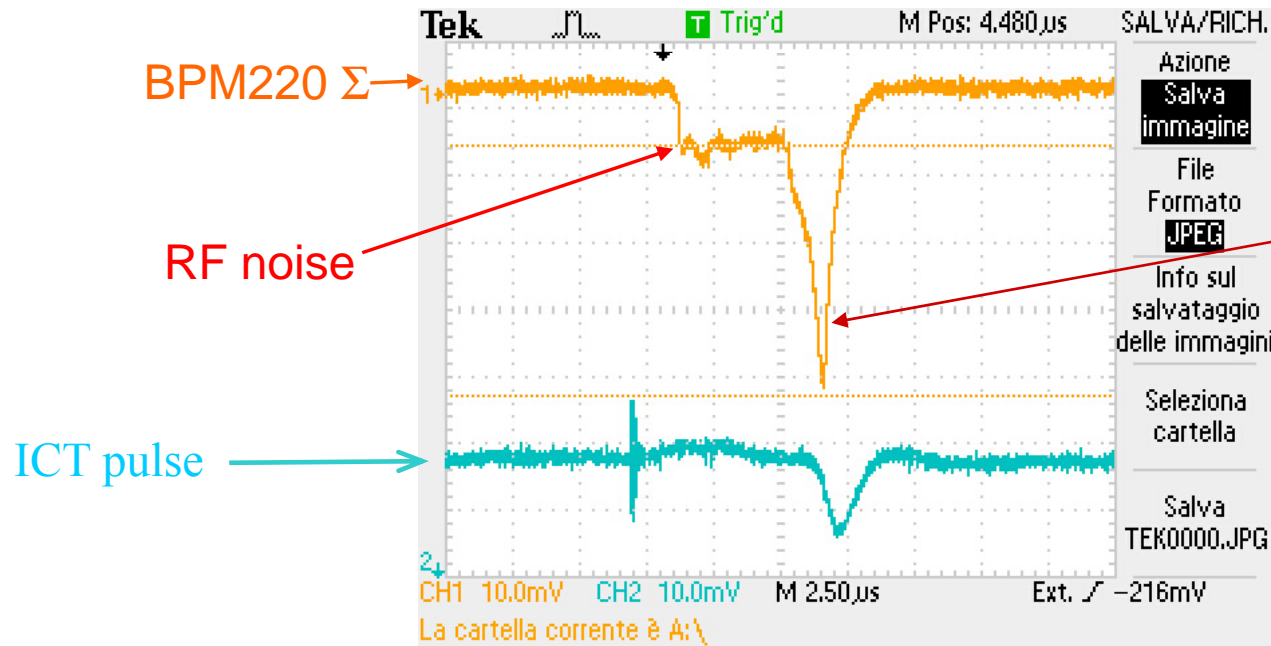
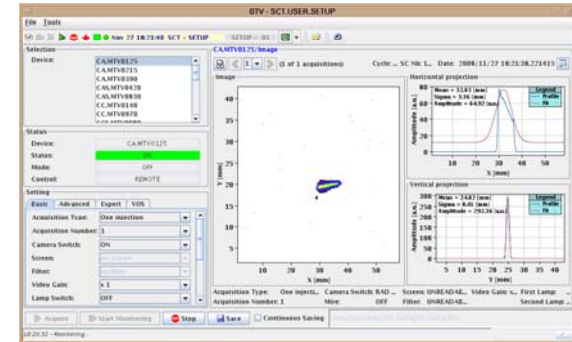


RF distribution network



It has worked without interruption for more than one month !

We decide to try to carry on with the dark current only.

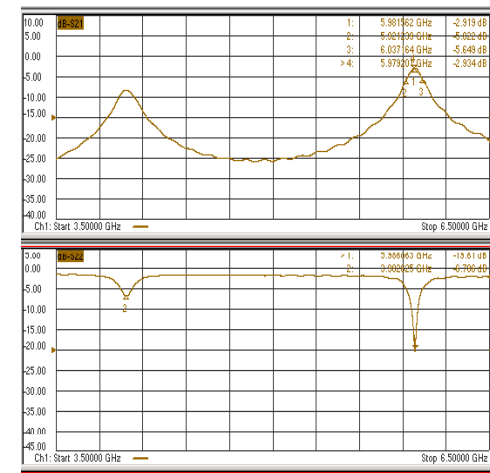
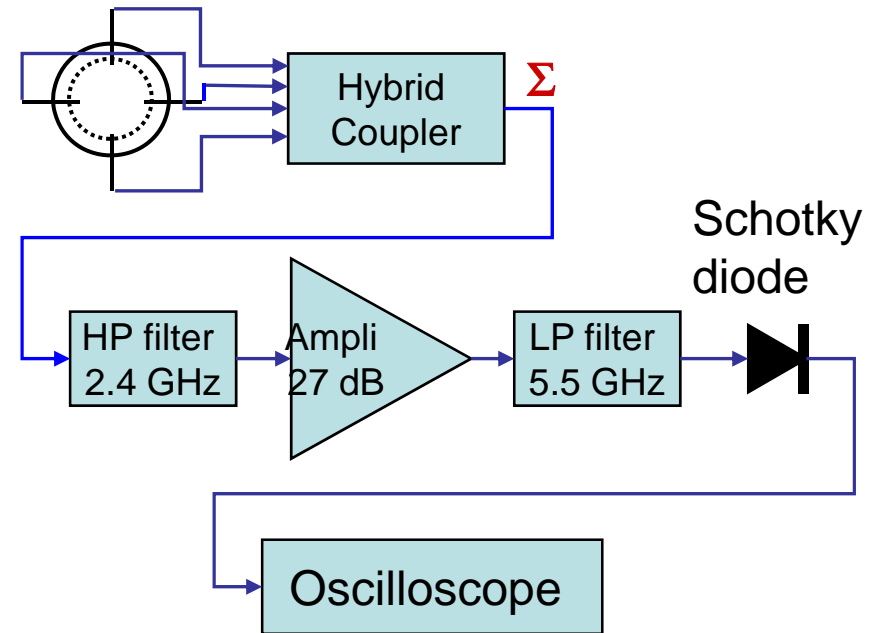
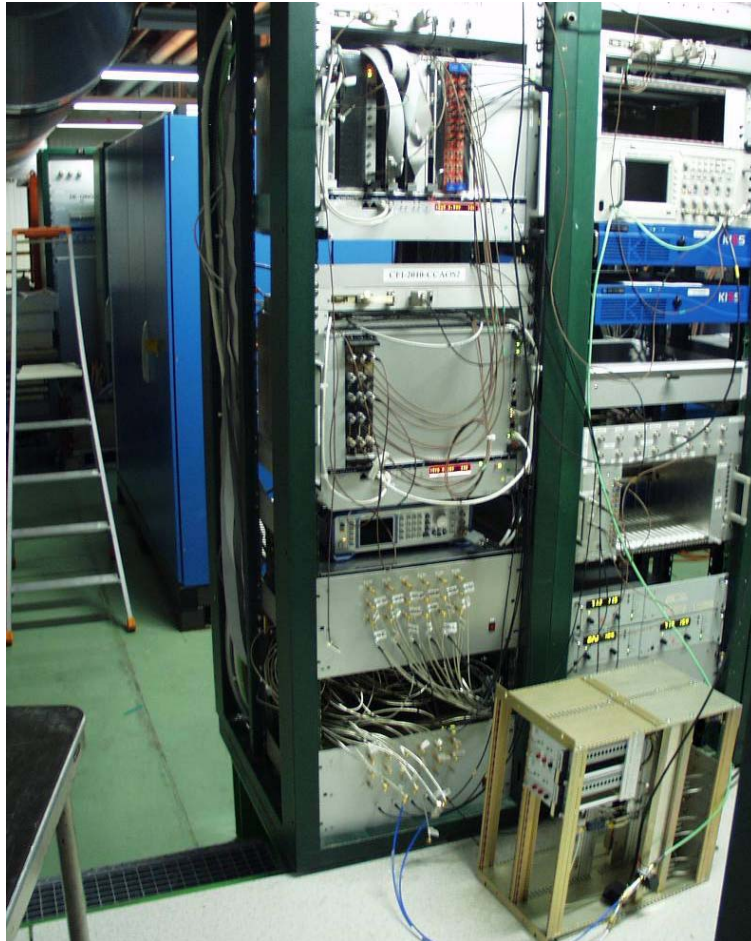


Dark current bunches (sensitive to steering)

Weak beam signal on the first BPM, however completely loss in the noise on the following BPMs attached to the sections.



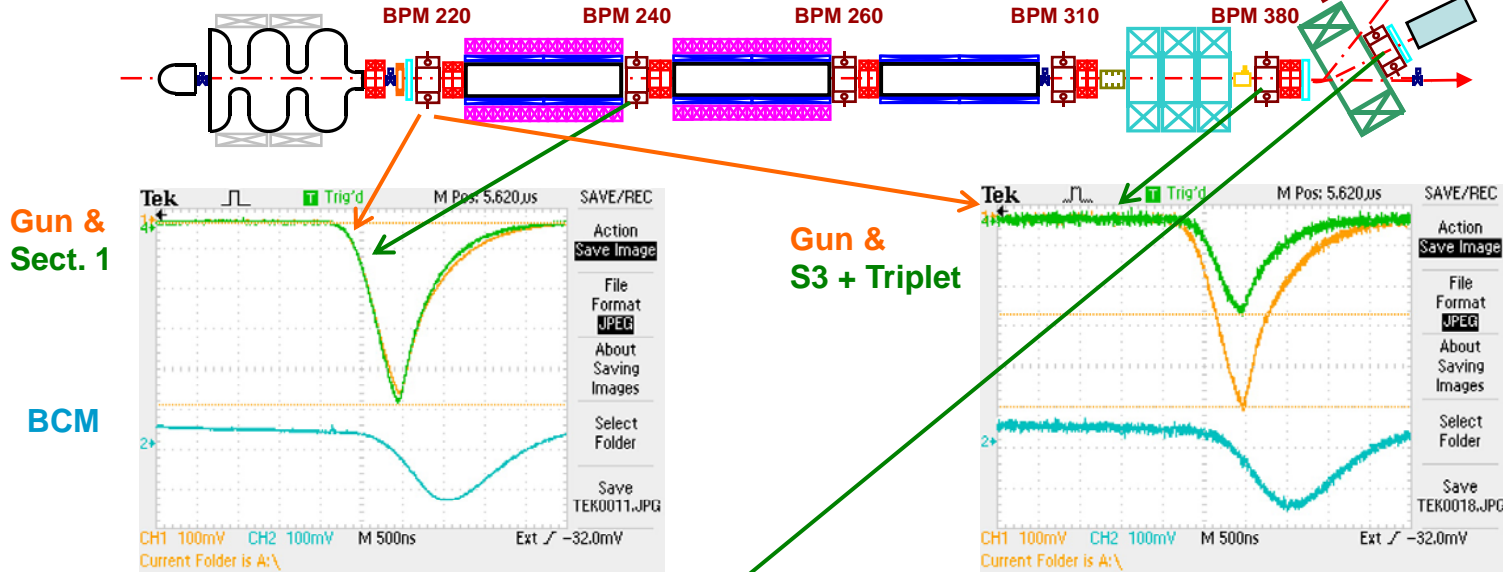
# Filter and amplify the sum signal



Monopole and dipole transmission and reflection measured by the network analyzer (Claire Simon)



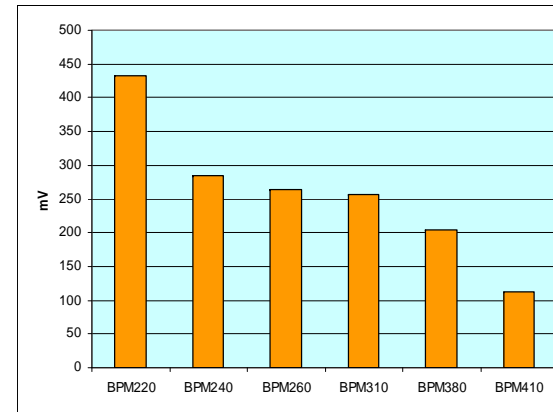
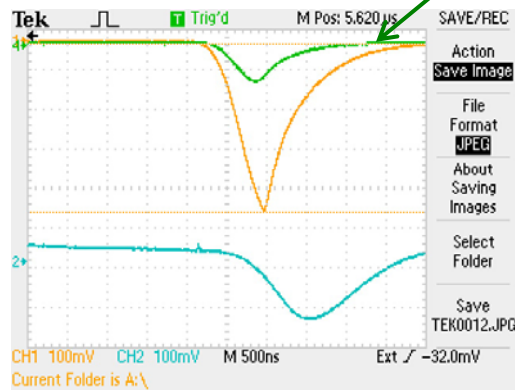
## Beam can progress through CALIFES line



100 % transmission through Sect. 1

~ 50 % (non linearity of diodes) through Sect. 2 et 3

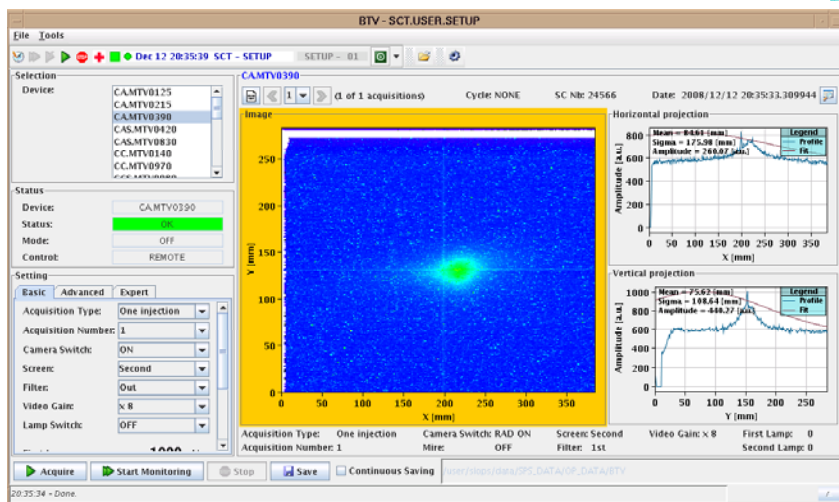
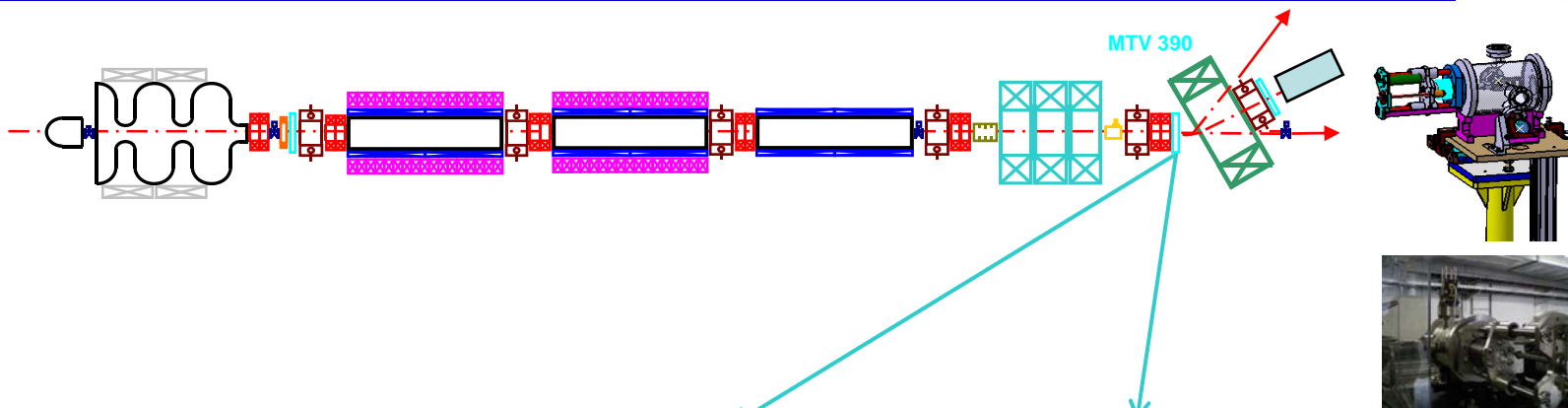
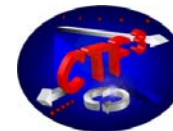
**Gun & Dipole**



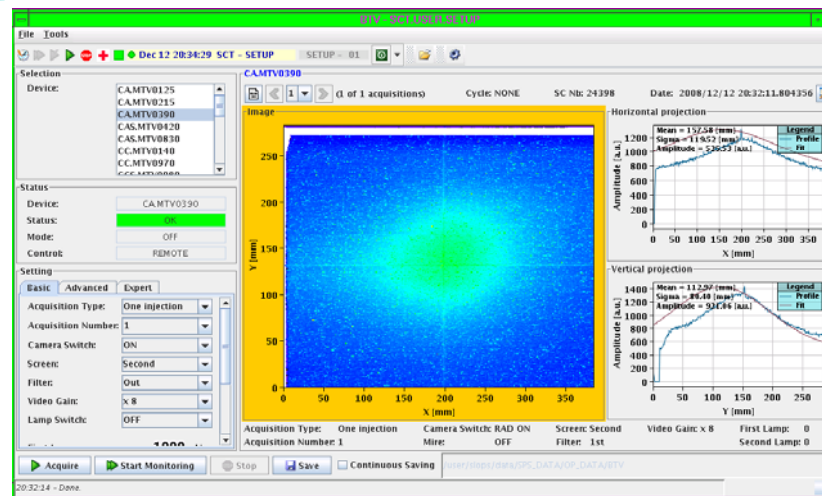
Dipole output pour  $I_{dipole} = 28.4$  A: **114 MeV**

After iterative tuning to maximize beam signal in the BPM after the dipole

# Beam profile from MTV 390



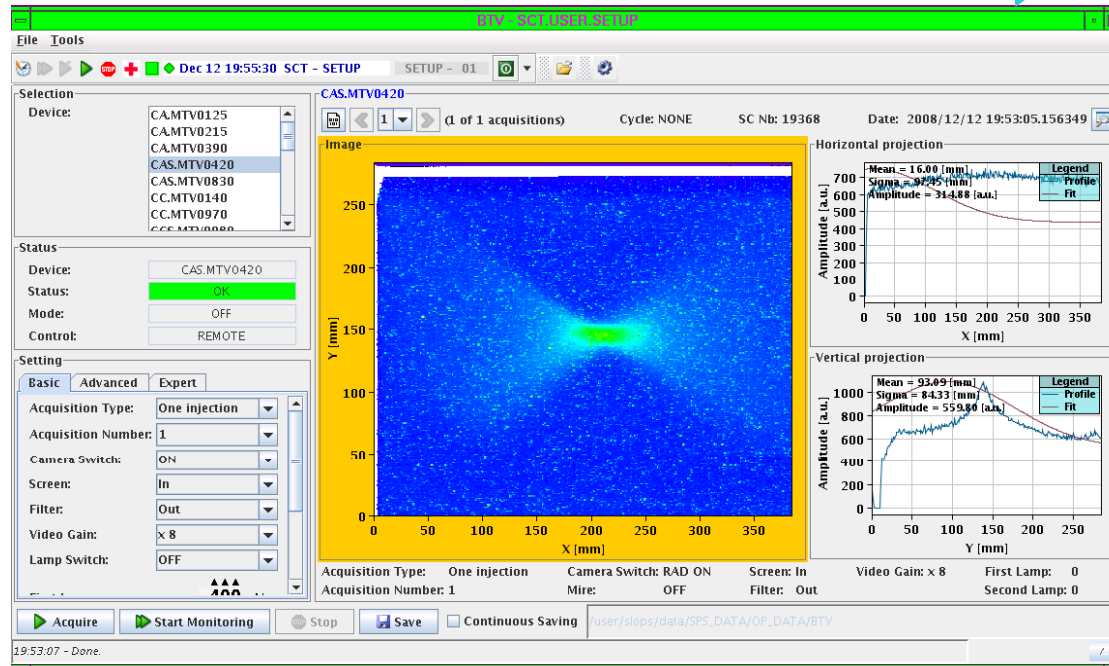
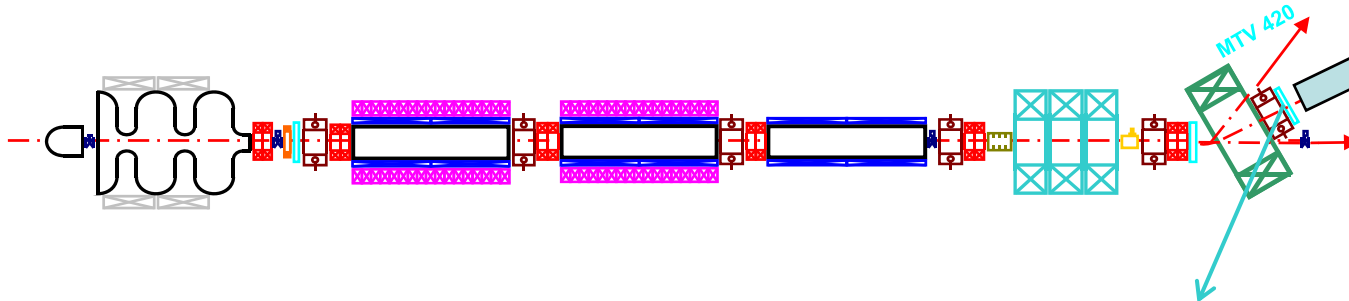
Low magnification (X 0.36)  
Ceramic screen  
Video gain x 8



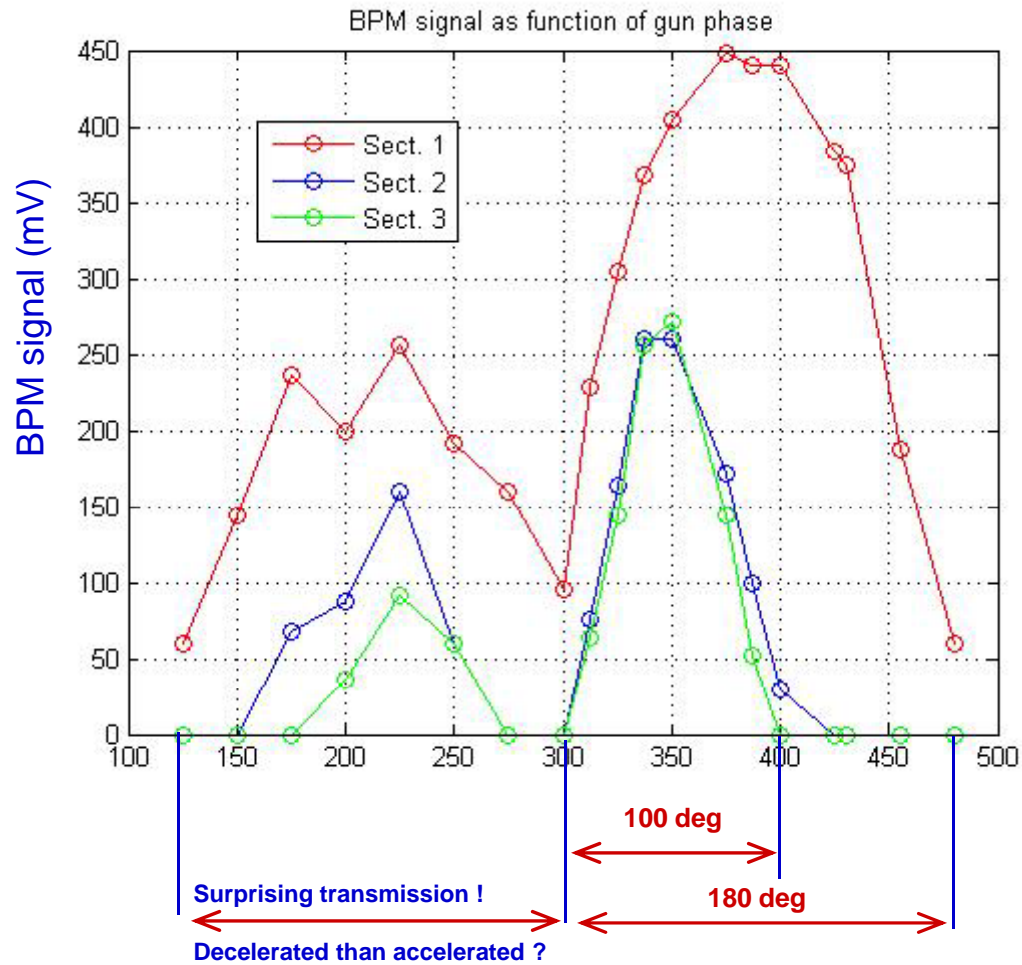
High magnification (X 1.73)

Beam diameter 1mm approx.

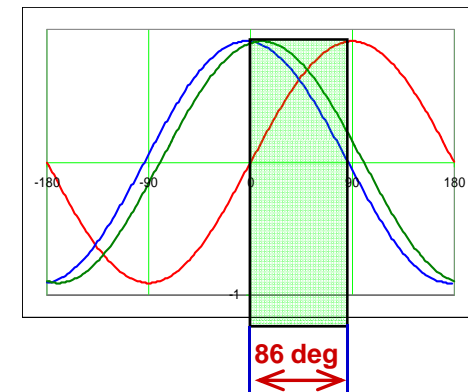
# Beam spectrum from MTV 420



**Dipôle current 28.4 A : 114 MeV**



Phase (deg)

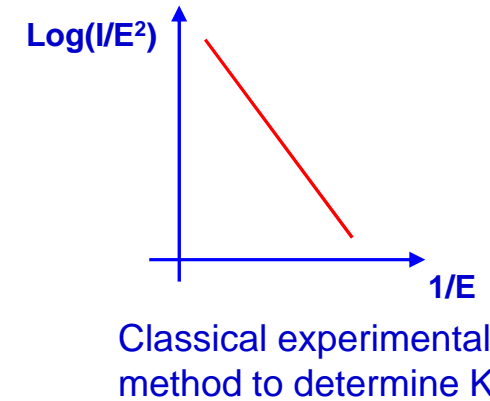
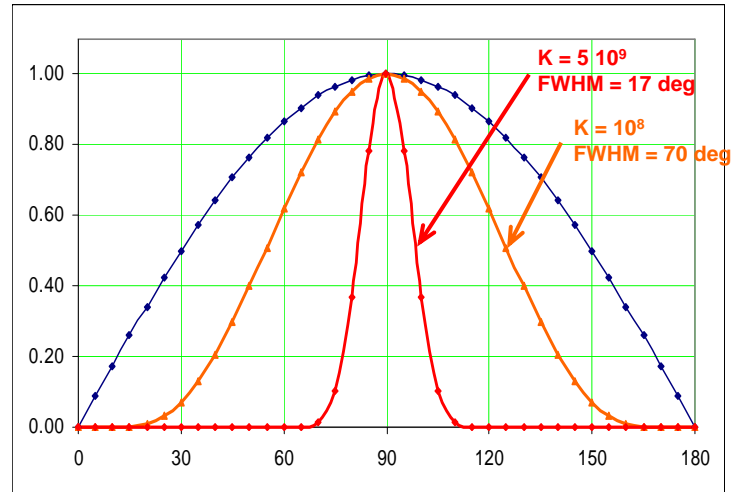


# How much phase extended is the dark current ?



Fowler-Nordheim equation governs the field emission:  
 E around 80 MV/m on the photocathode. But K ?

$$I = A E^2 \exp\left(-\frac{K}{E}\right)$$

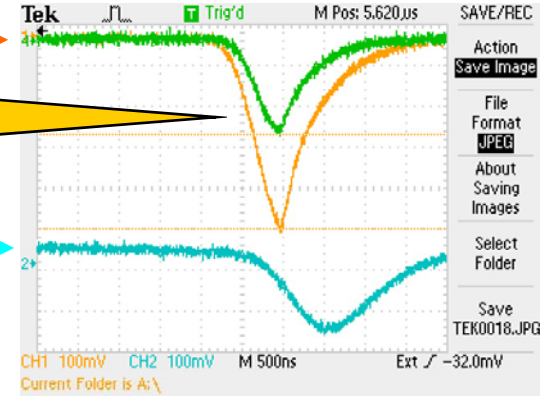


0.167 ns (3GHz)



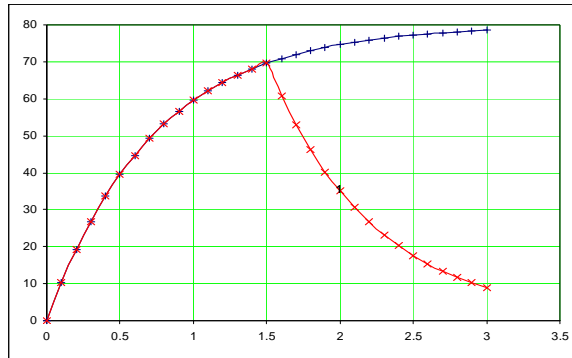
Gun loop measure

BPM on Schotky diodes

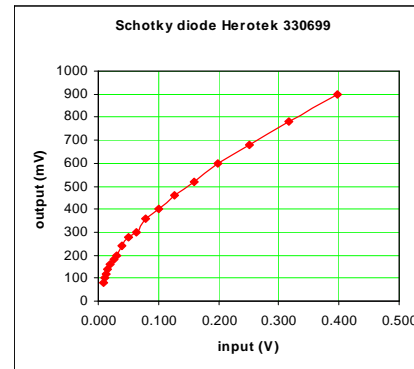


Time profile of dark current:  
 $\tau_{\text{rise}} = 0.6 \mu\text{s}$  ,  $\tau_{\text{fall}} = 1.3 \mu\text{s}$

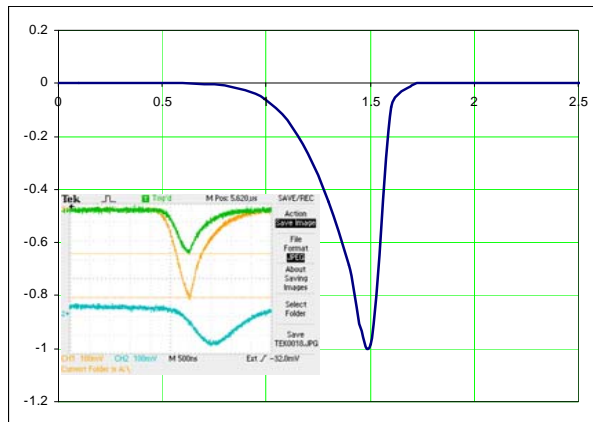
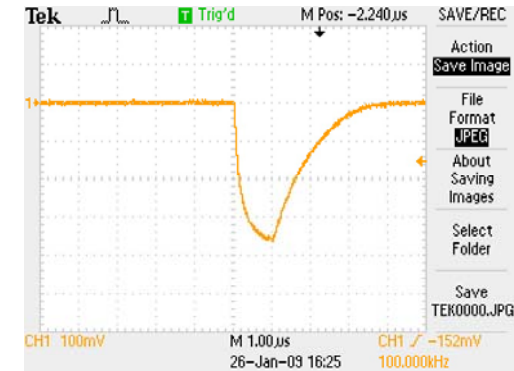
# Fitting the pulse to determine K



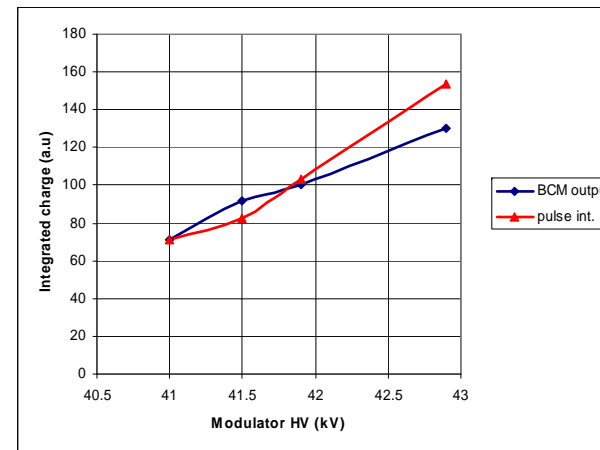
Gun filling time simulation,  $\tau = 0.73 \mu\text{s}$   
(Raphael Roux)



Schotky diode characteristics,  $\tau_{\text{rise}} = 0.44 \mu\text{s}$ ,  $\tau_{\text{fall}} = 1.75 \mu\text{s}$



“best” fit for  $K=10^9$



Other possible fit with the total charge  
as function of modulator HV

FWHM < 35 deg (32.5 ps) for the dark current  
To be compared to laser pulse 6 ps : (6.5 deg)



- We have reached our main objectives by the end of 2008
  - See the beam at the output of CALIFES line
  - Check the correct working of installed elements
  - Produce a list of actions to be conducted during shutdown
    - Regarding RF, Power, Laser, Diagnostics, C/C, Survey... (discussed during TIC meeting on 14<sup>th</sup> jan. 09)
  
- An original (?) method of commissioning has been used.
  
- We will now resume the commissioning with the laser on the 23<sup>rd</sup> march for 3 weeks, and then the complete commissioning with the power phase shifter installed on the 25<sup>th</sup> of may.

**All that work has only been possible thanks to the continuous support and excellent collaboration with CERN teams.**