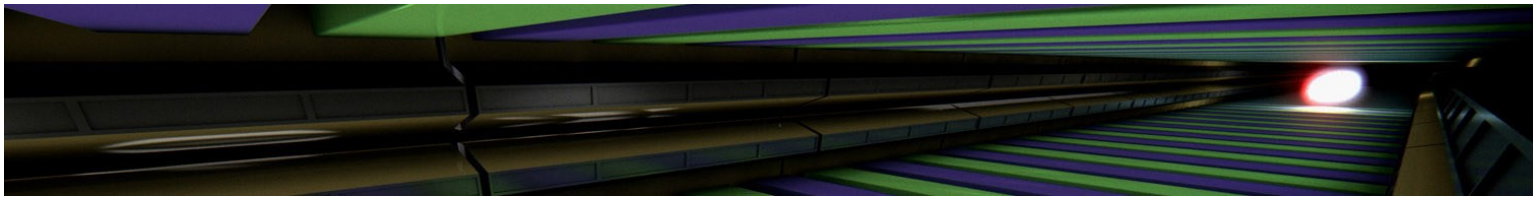
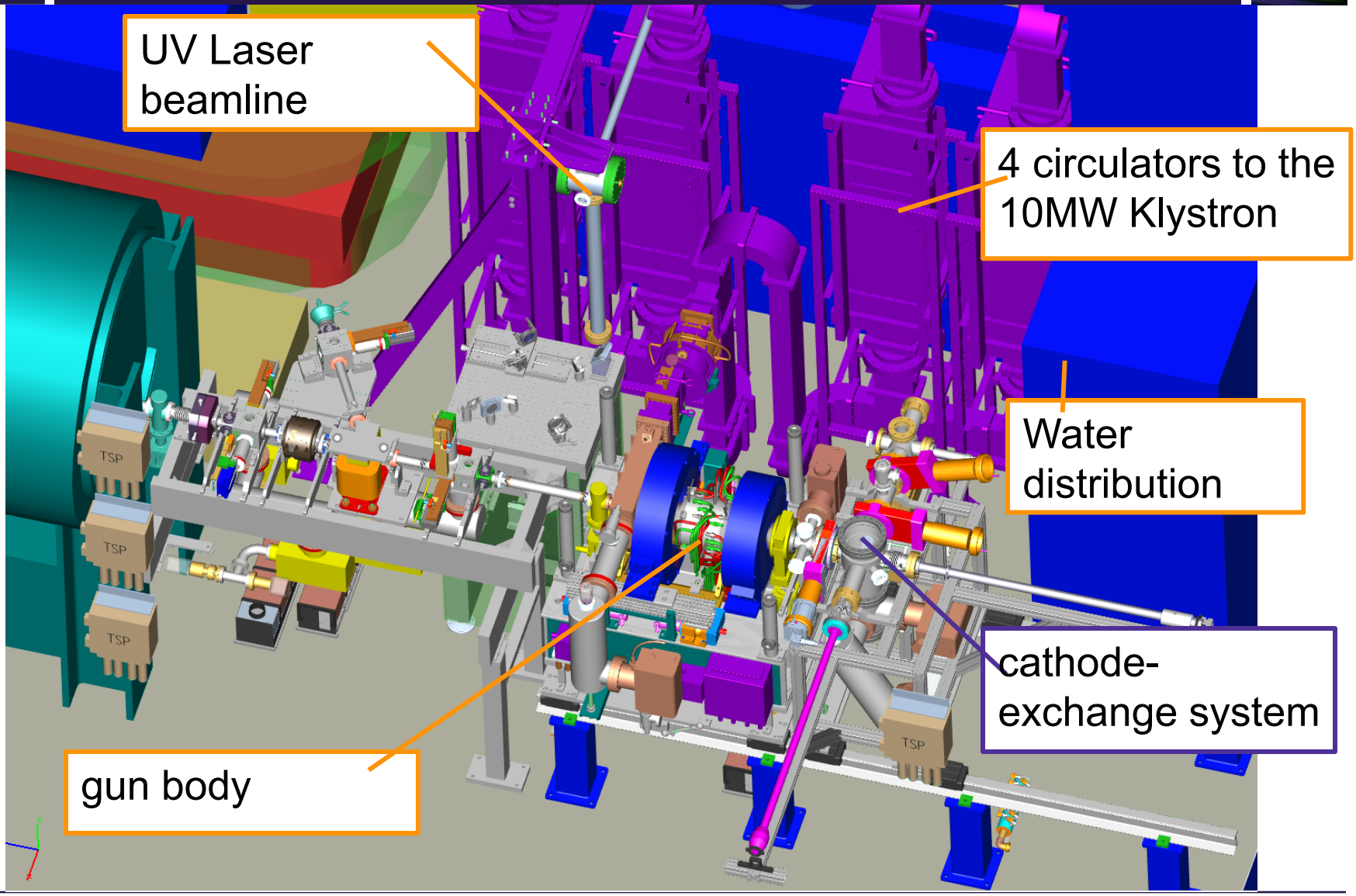


XFEL-Gun

F.Brinker

European XFEL

Actual view to the XFEL gun



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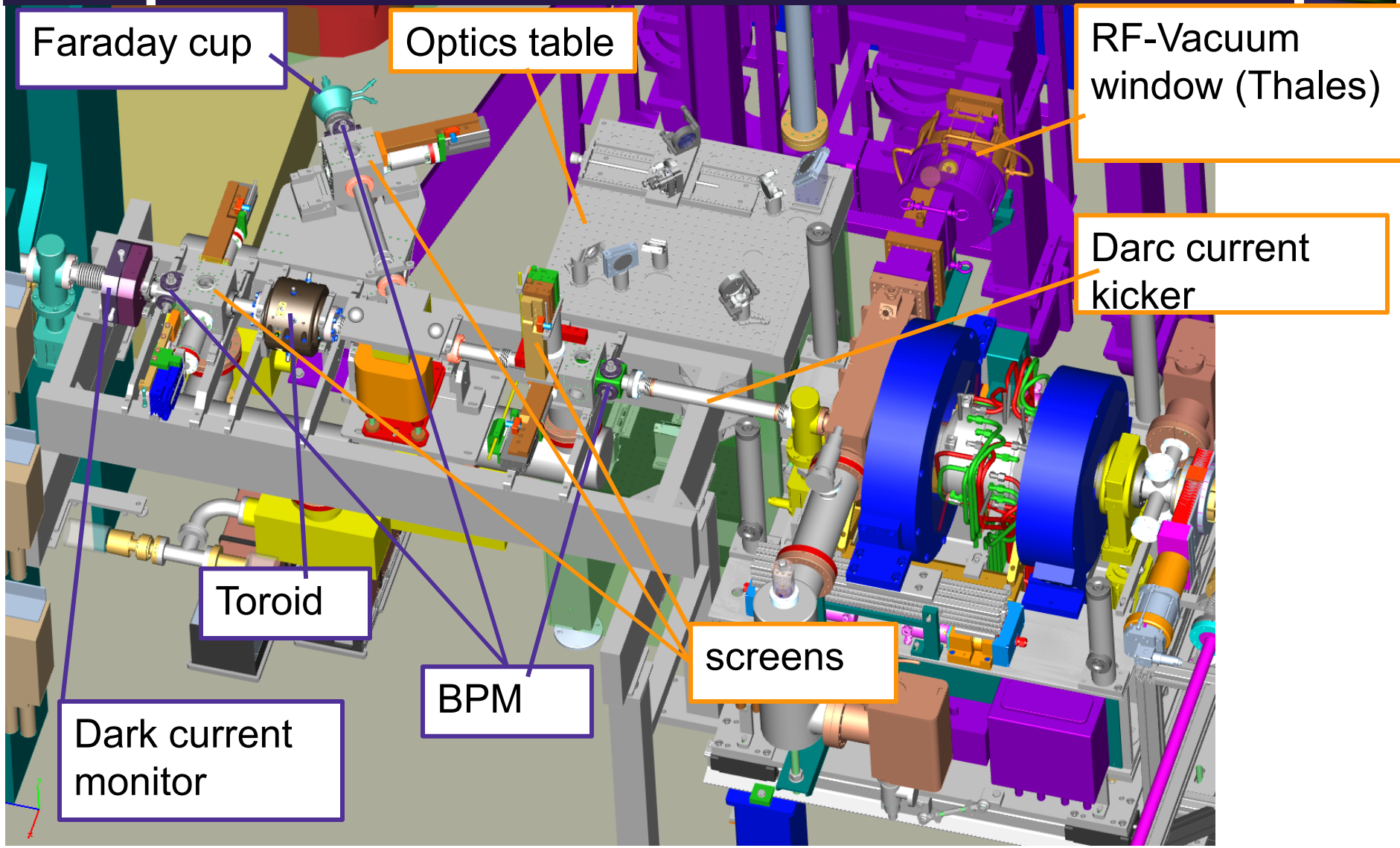
European XFEL

Actual view to the XFEL gun



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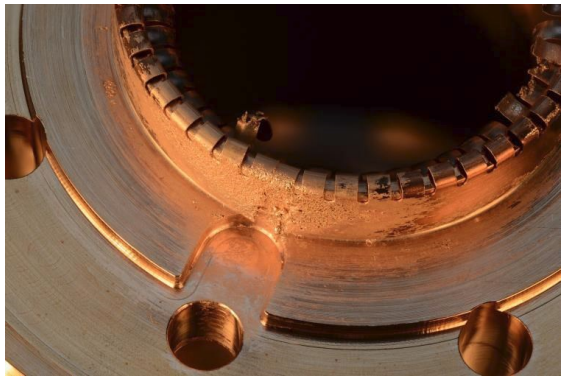
Short History of the XFEL Gun in HH

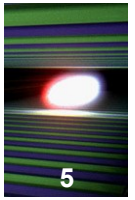
- 1. RF operation Dezember 2013
  - Successful test of RF-system
  - 5.5 MW, 650 us reached
  - Limit : light at the window
  - Massive damages on the cathode RF spring
- 2. RF operation September 2014
  - Successful test of the improved cathode spring system
  - 4.8 MW, 400us reached
  - Limit : vacuum leak at the window
- 3. RF operation Dezember 2014
  - Short test of glued window
  - 4.8 MW, 400us reached
  - Limit : vacuum leak at the window



(See last years talk)

- 1. Beam operation February 2015
- 2. beam operation April/May 2015

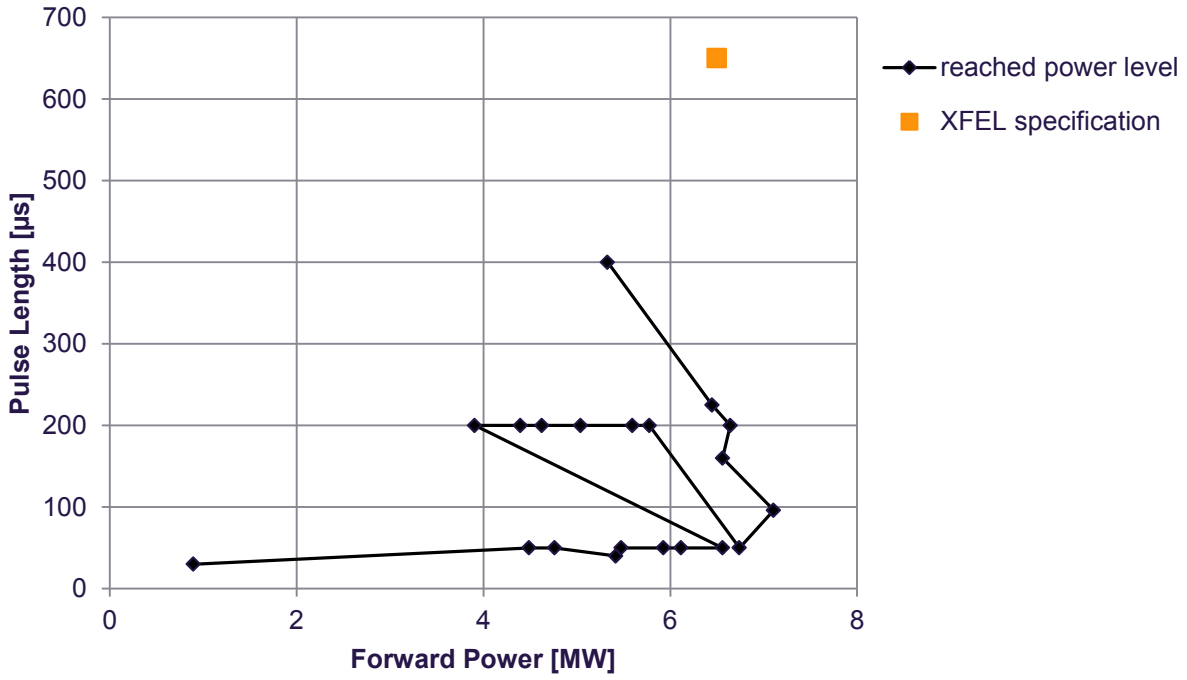
Massnahmen um den Kontakt zwischen Kathodenstempel und –feder zu verbessern



- Vor dem nächsten Run wurden die Kathodenstempel und Kontaktfedern ersetzt. Die neuen Stempel haben eine deutlich glattere Oberfläche
- Federhalter wurde vergoldet
- Die Kontaktfedern sind jetzt vergoldet rhodiert
- Alle Schrauben erhalten Federscheiben

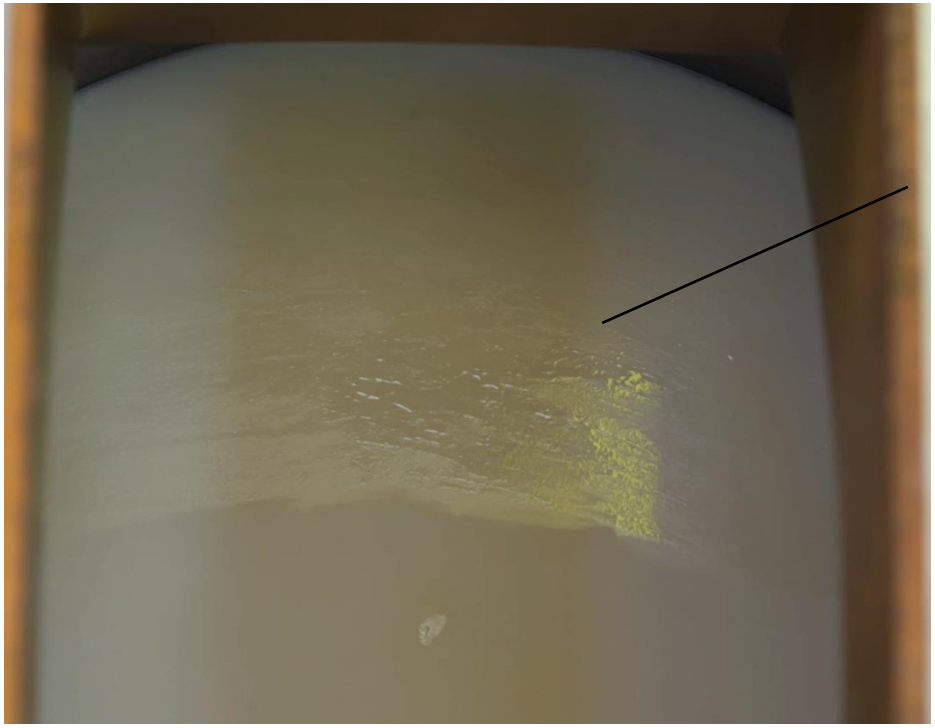
Test run September 14

- The cathode spring system had been replaced by a system where all contact surfaces had been polished and gold plated
- These improvements were successful : We don't see any damages up to now
- Unfortunately the RF-window developed a leakage after some days



Examination of the leakage:

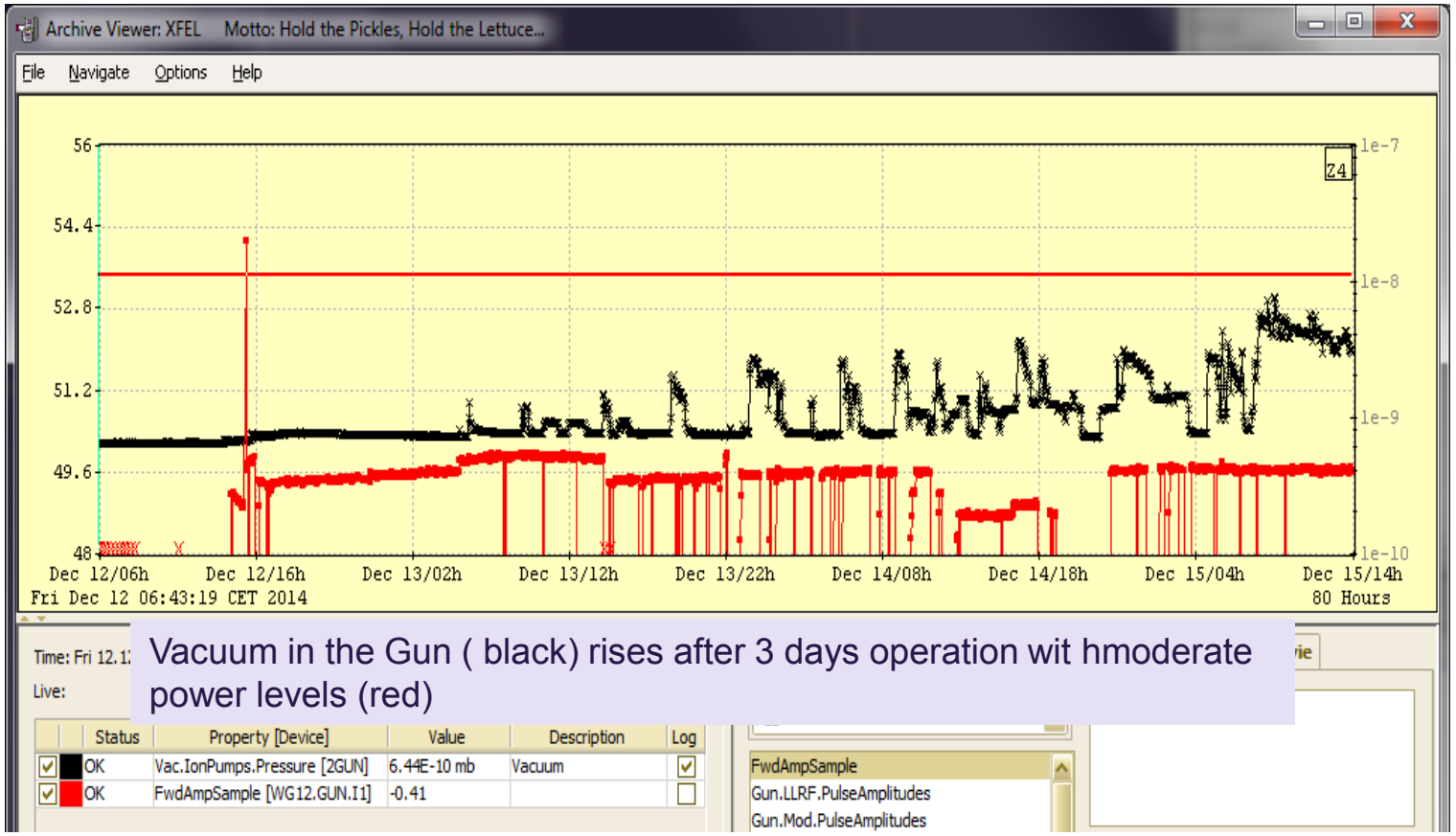
- Since a new Thales window was not available at that time it has been tried to localize and fix the leakage
- Surprisingly it was not the brazing but the ceramics which got leaky



Ceramic disk from air side

Testrun Dezember 2014

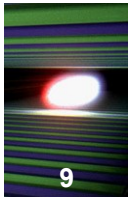
- During a short run in december ’14 we verified that gluing of an RF-window does not work at high power levels



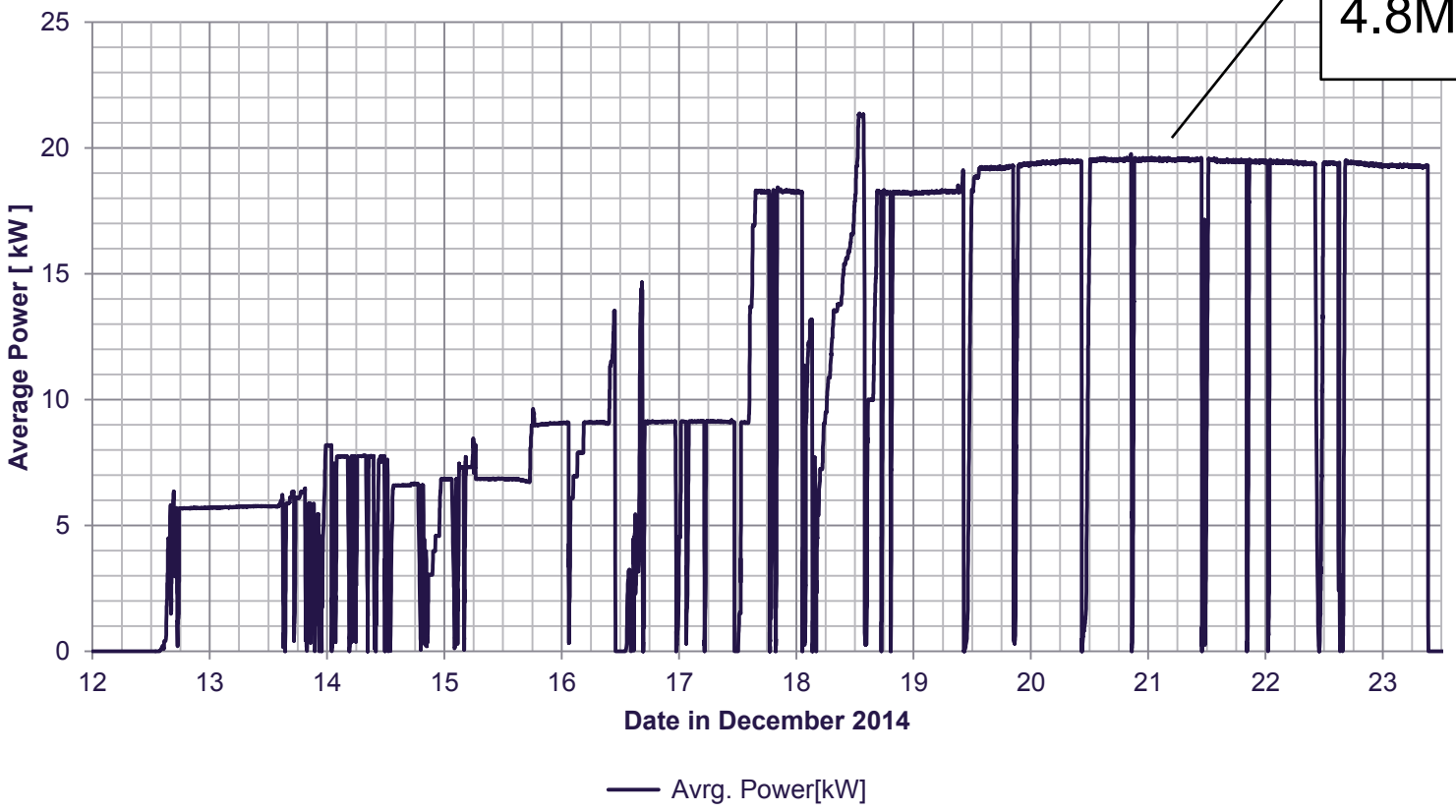
Vacuum in the Gun (black) rises after 3 days operation wit hmoderate power levels (red)

European XFEL

HF Testrun Dezember 2014



average power in the Gun



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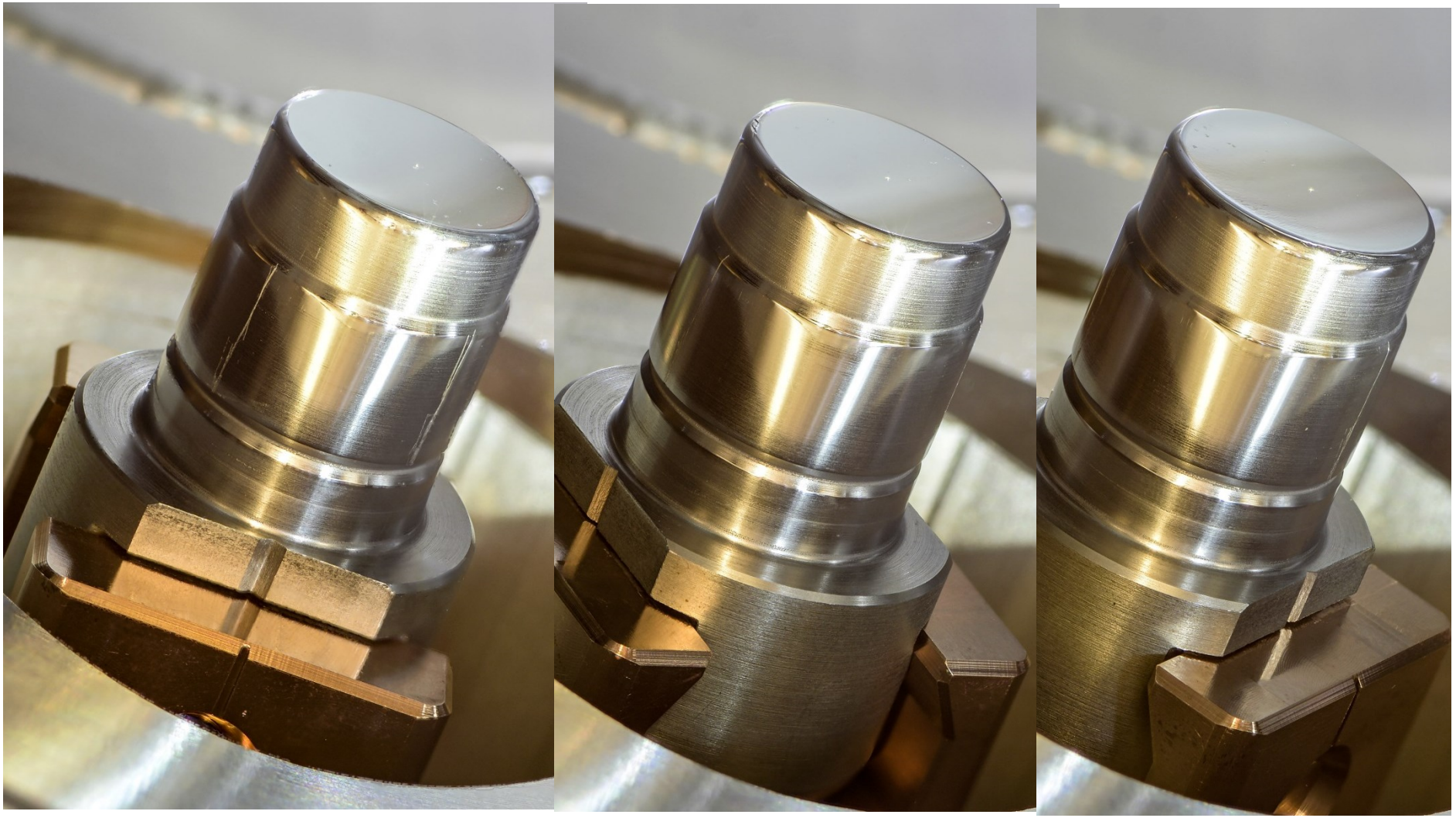
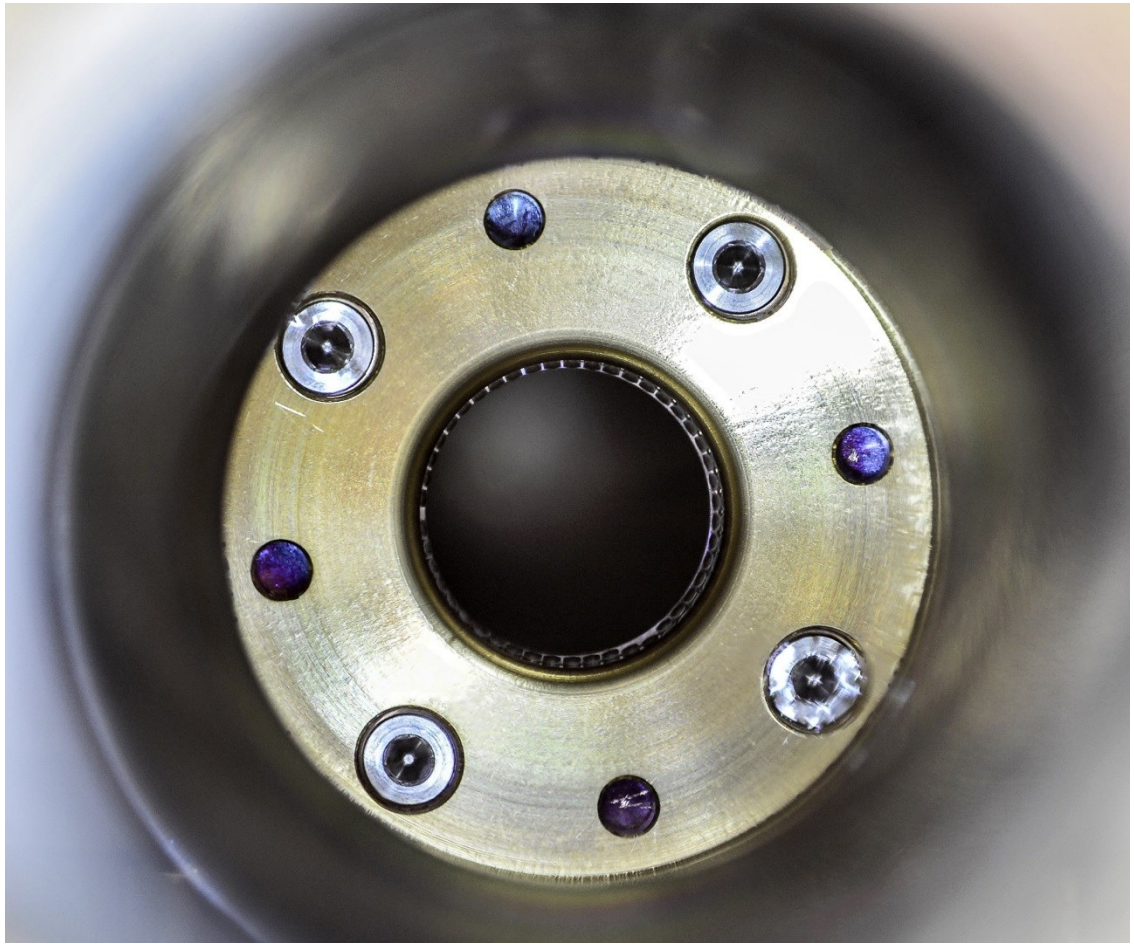
RF Window with vacuum glue before (left) and after (right) operation in Dez. 14 und February 15

Cathode plug without any damages or marks after the December run

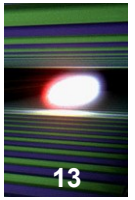


View from the backside into the cathode holder with the spring (still under vacuum)

No signs of damage



Finaly : First beam operation in February 2015

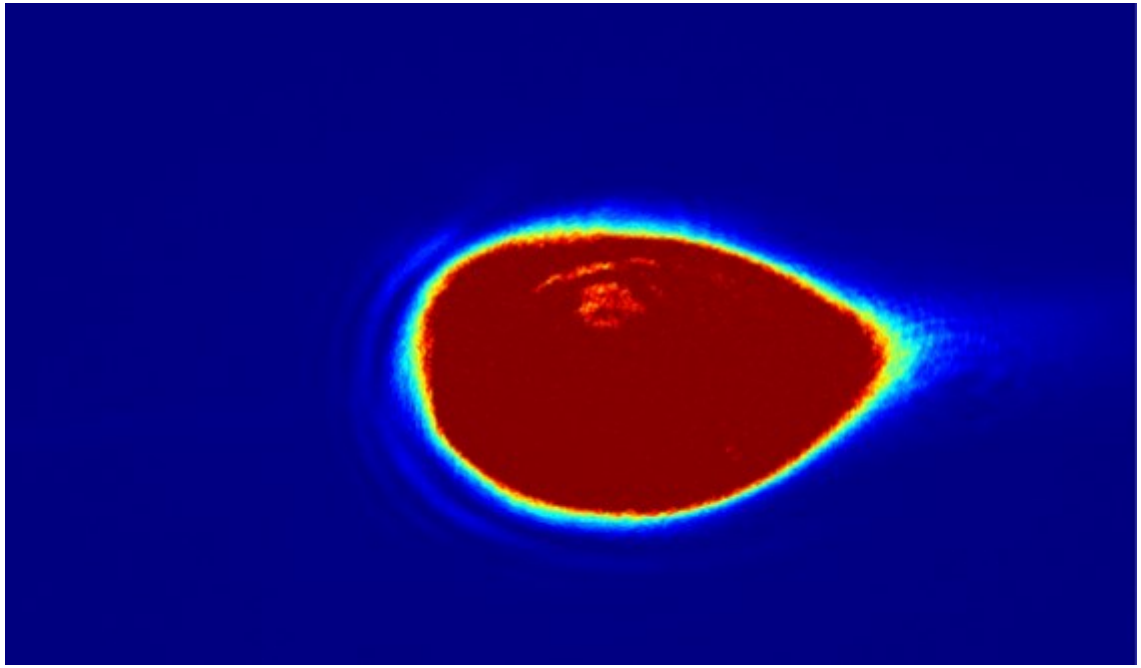


Considering that the window was intact we restricted ourself to short pulses (ca. 50 us) and moderate power of 3-5 MW

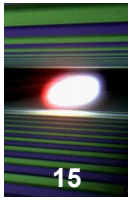
With these parameters the gun was running practically without failures

The time was used for a first complete system test including UV-laser, diagnostics, LLRF, timing, machine protection etc.

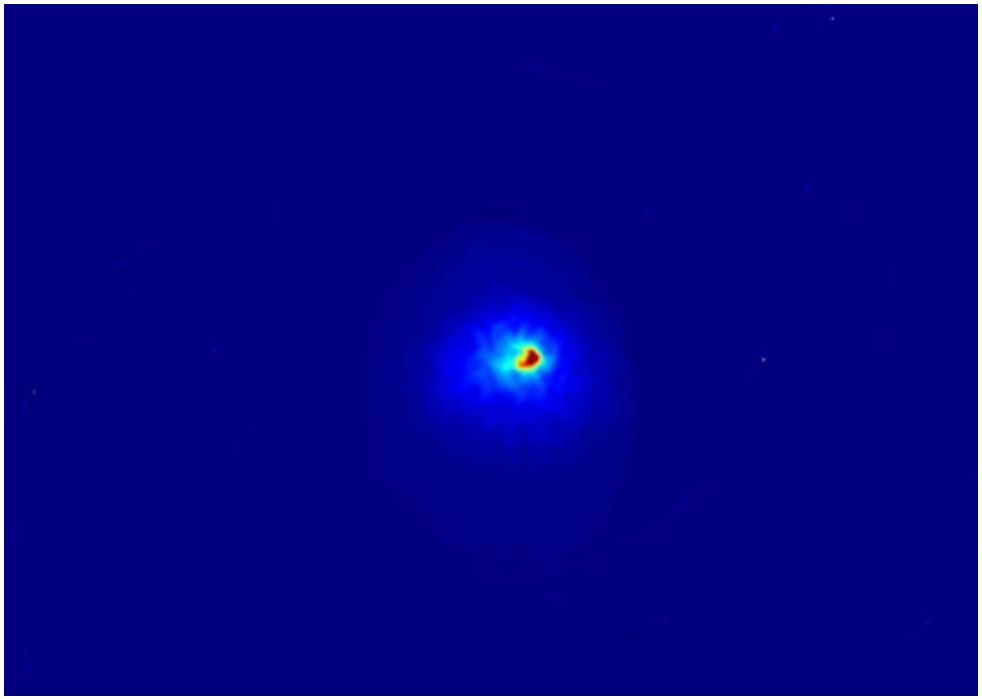
Februar 6th : UV Laser Installation finished – first UV Laser Spot on the cathode



Picture of the UV Laser Spot on the virtual cathode –
3mm Aperture, 2700 pulses, 10 Hz

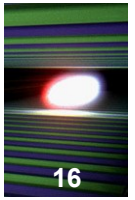


February 10th : First photo elektrons at XFEL !



Screen picture of the first photo electrons at XFEL –
3mm Aperture, 20 Bunche, 10 Hz, ca. 2nC

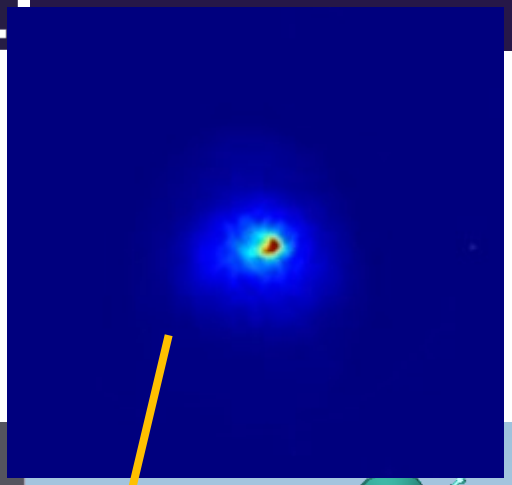
Commissioning Run Februar 2015

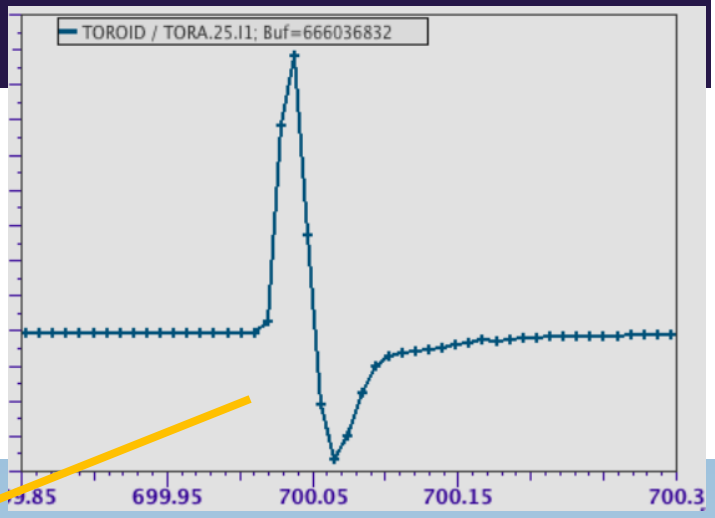


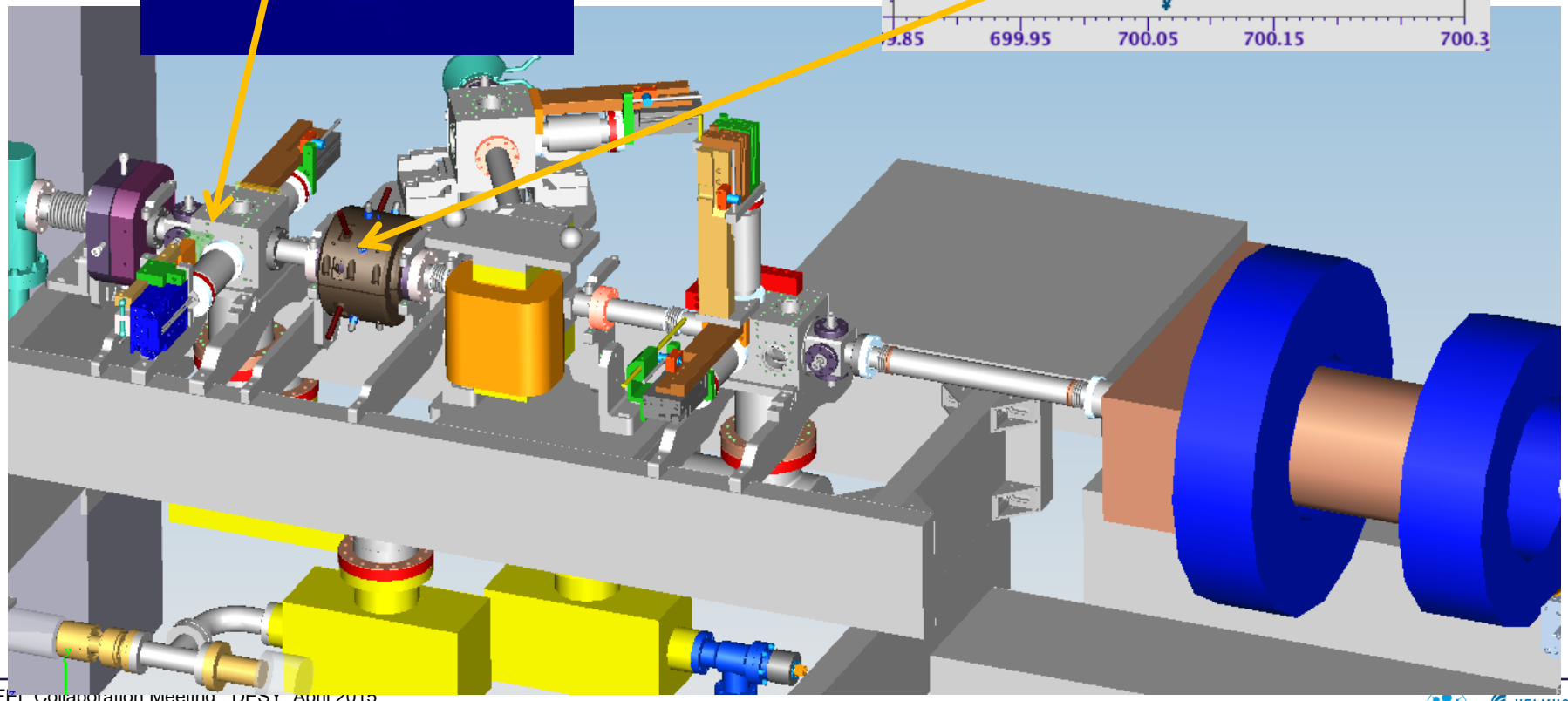
All available diagnostics successfully operated (Hardware, Firmware und Software)

- 3 BPMs
- 1 Toroid
- 3 screen stations with cameras
- 2 Faraday Cups
- 1 Dark current monitor
- 3 BLMs (beam loss)

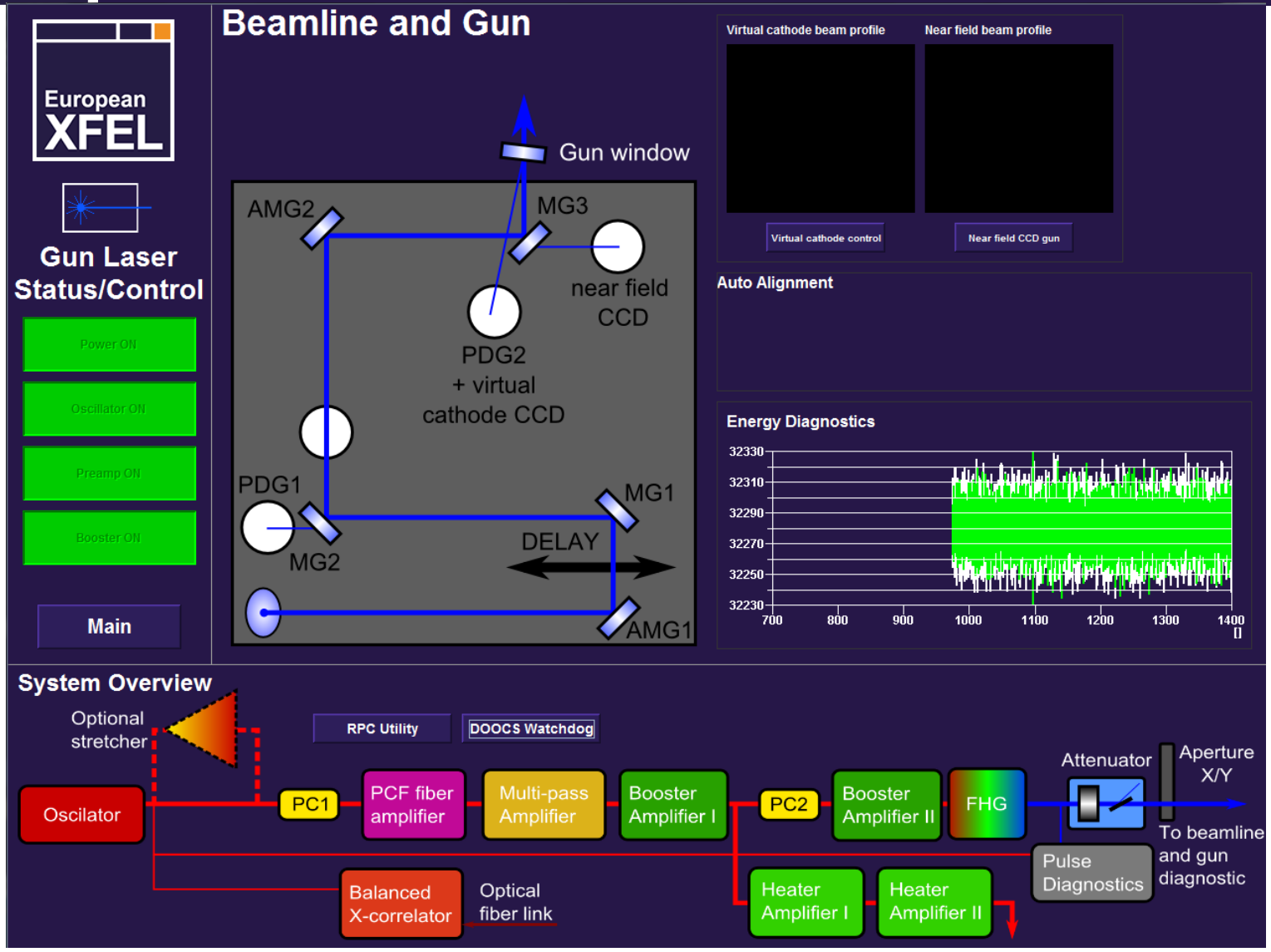
Calibration of the devices started



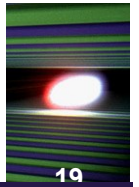

TOROID / TORA.25.I1; Buf=666036832
699.95
700.05
700.15
700.3



Interface to the UV laser (MBI) from the DESY laser group

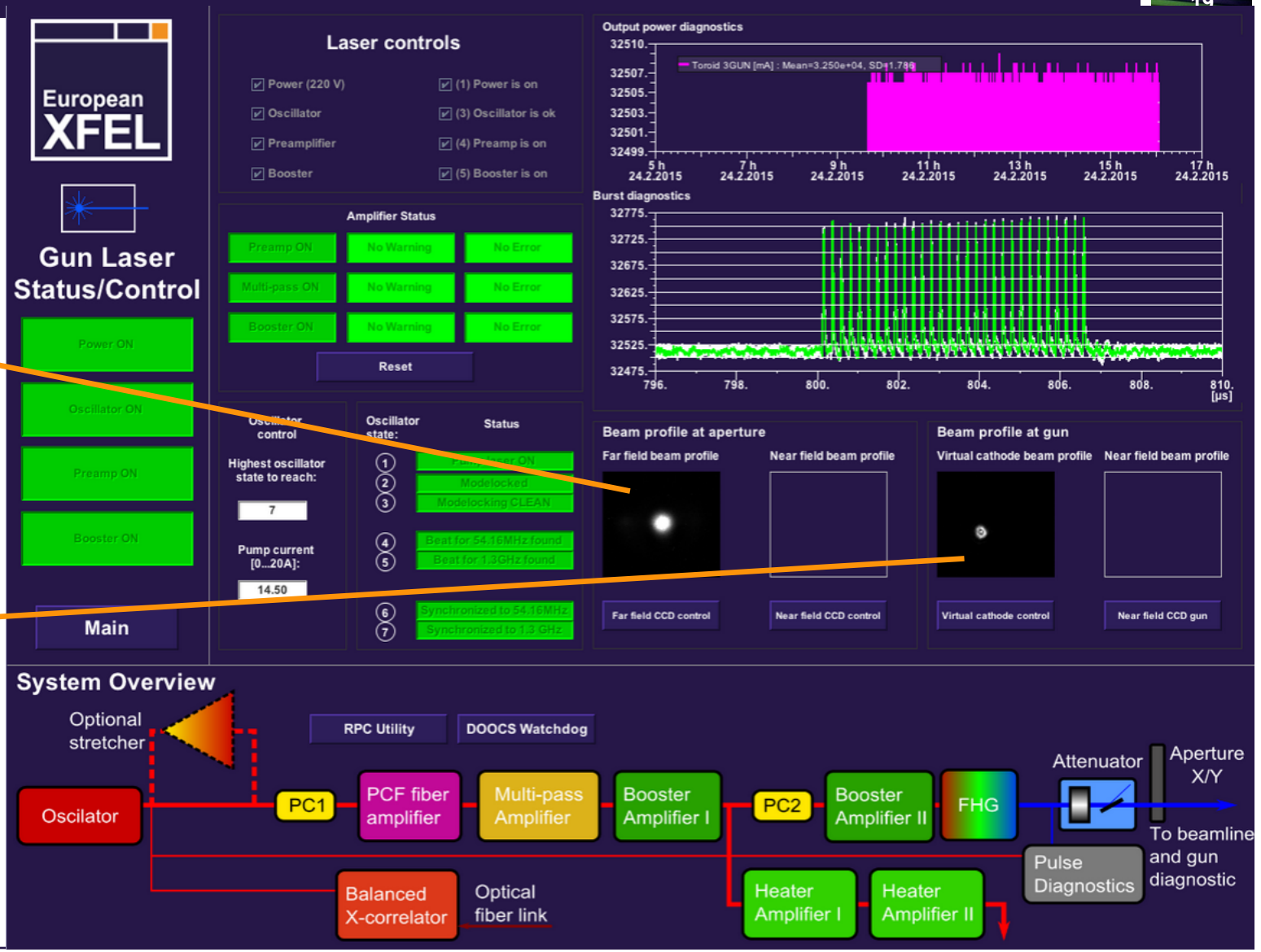


30 Laser pulses

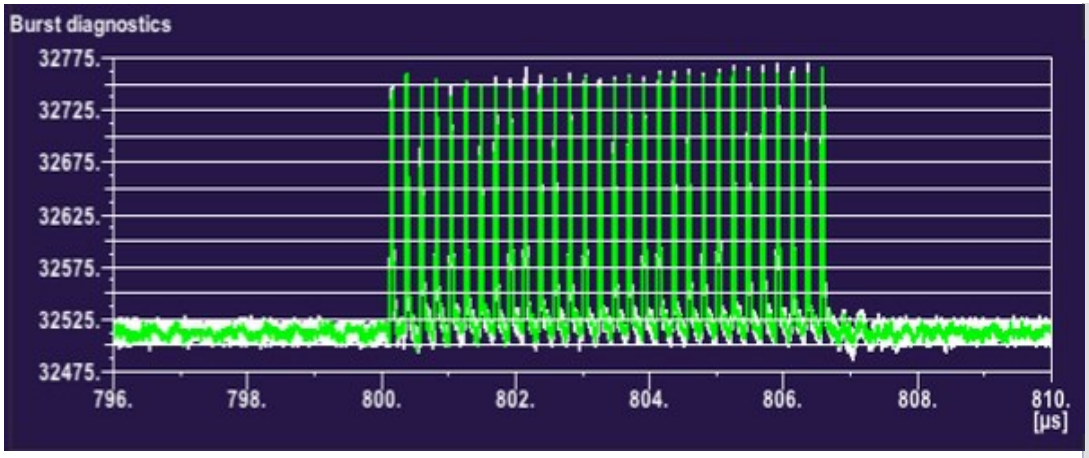


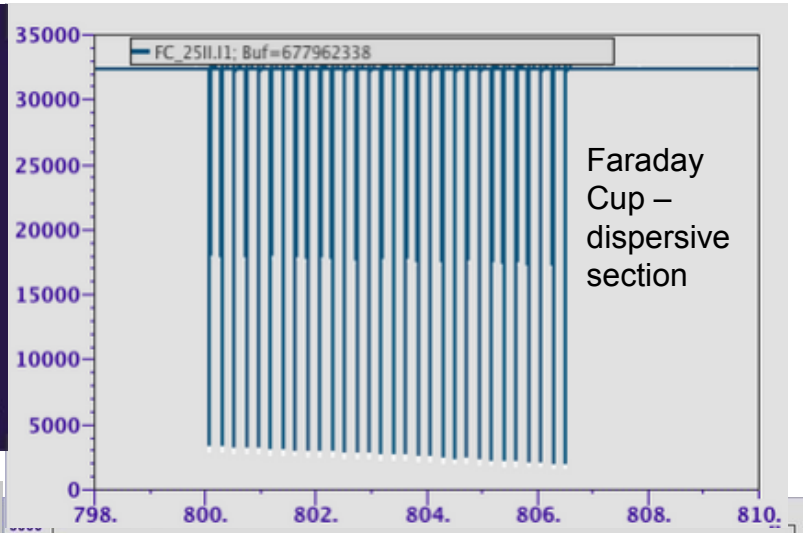
Laser profile before the aperture

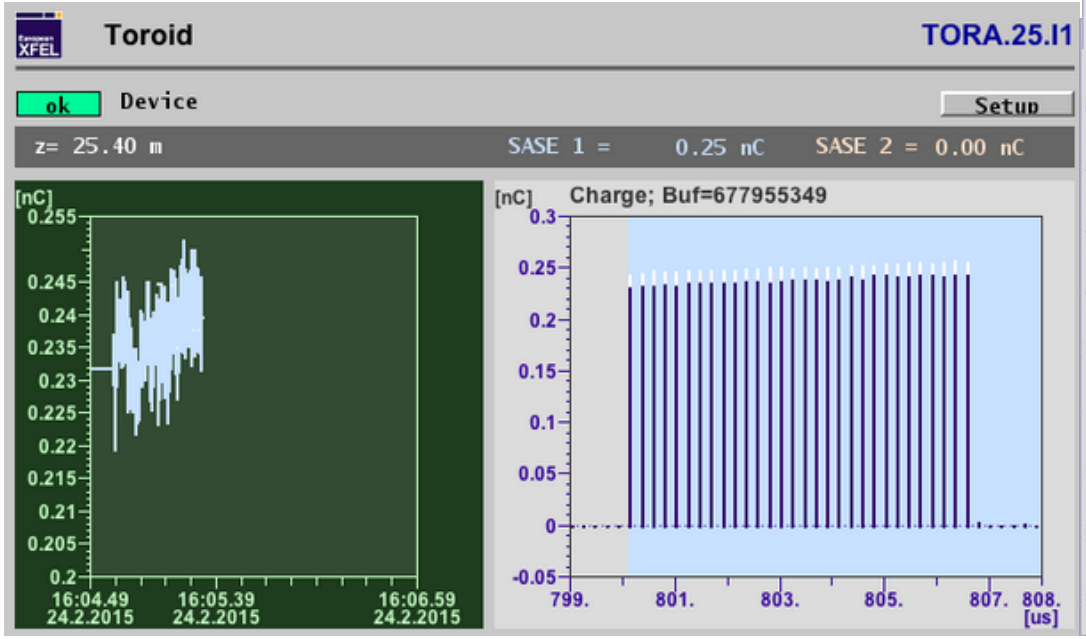
and on the virtual cathode

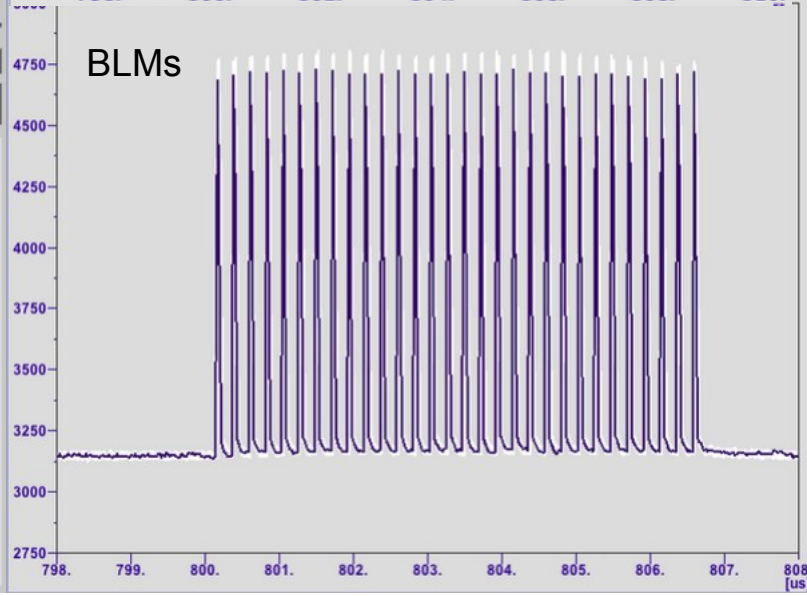


30 laser pulses -> 30 electron bunches

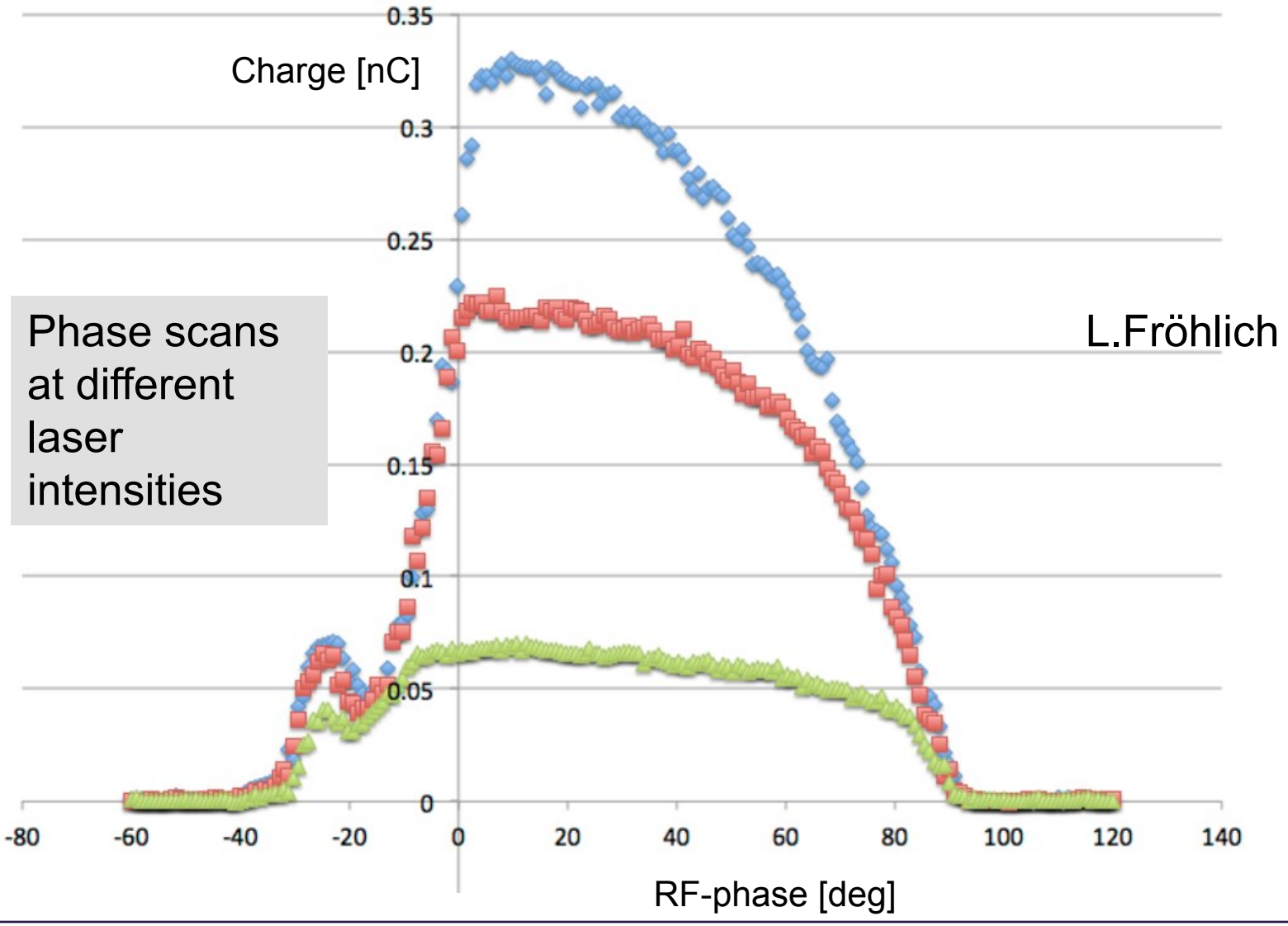








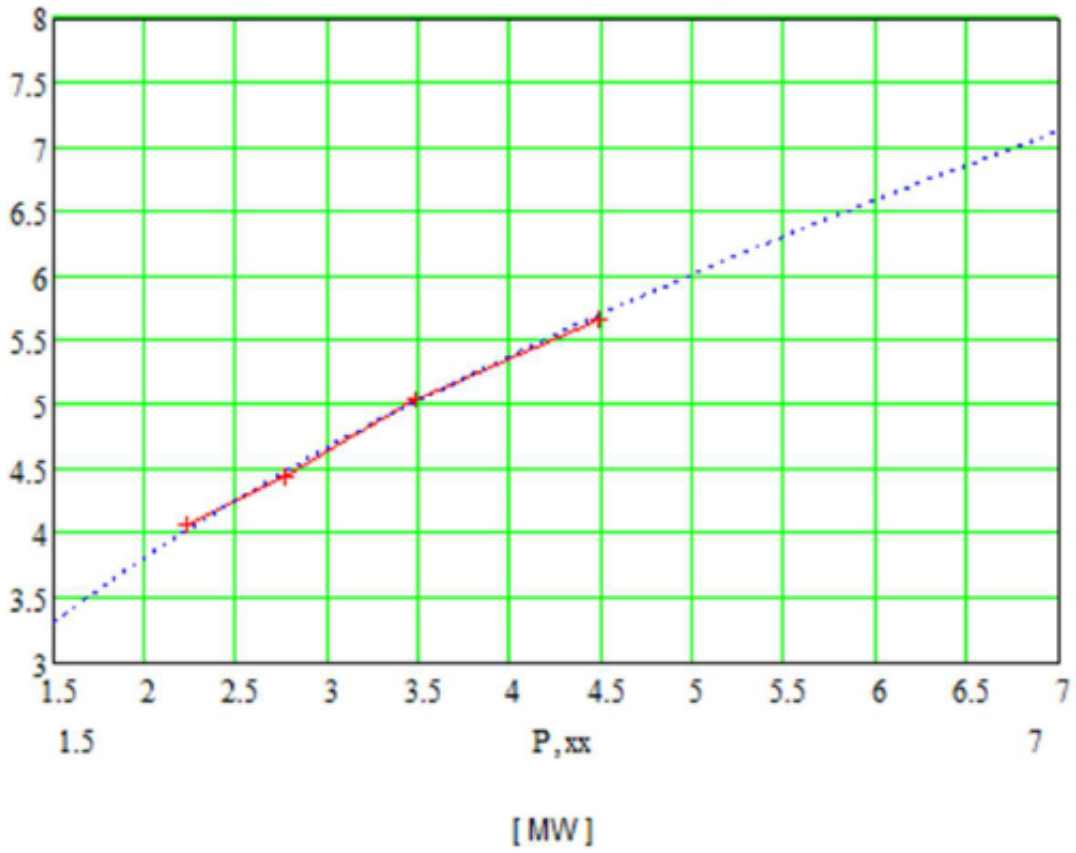
First measurements with beam:
Phase scan for different laser intensities



Phase scans at different laser intensities

L.Fröhlich

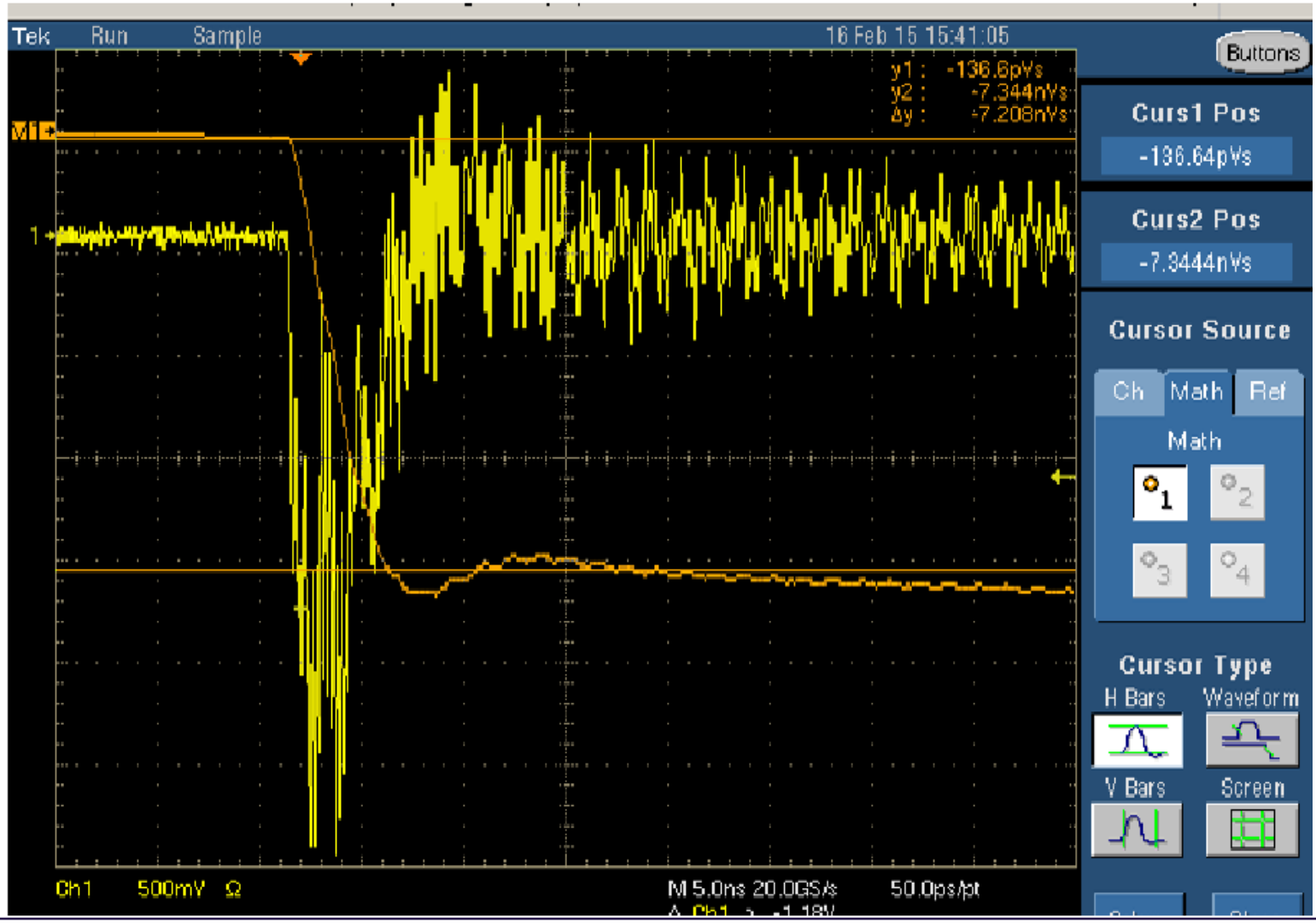
First measurements with beam: Energy measurement



16.2. :

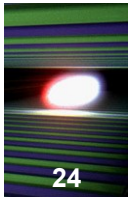
Measurement of beam energy depending on RF-power

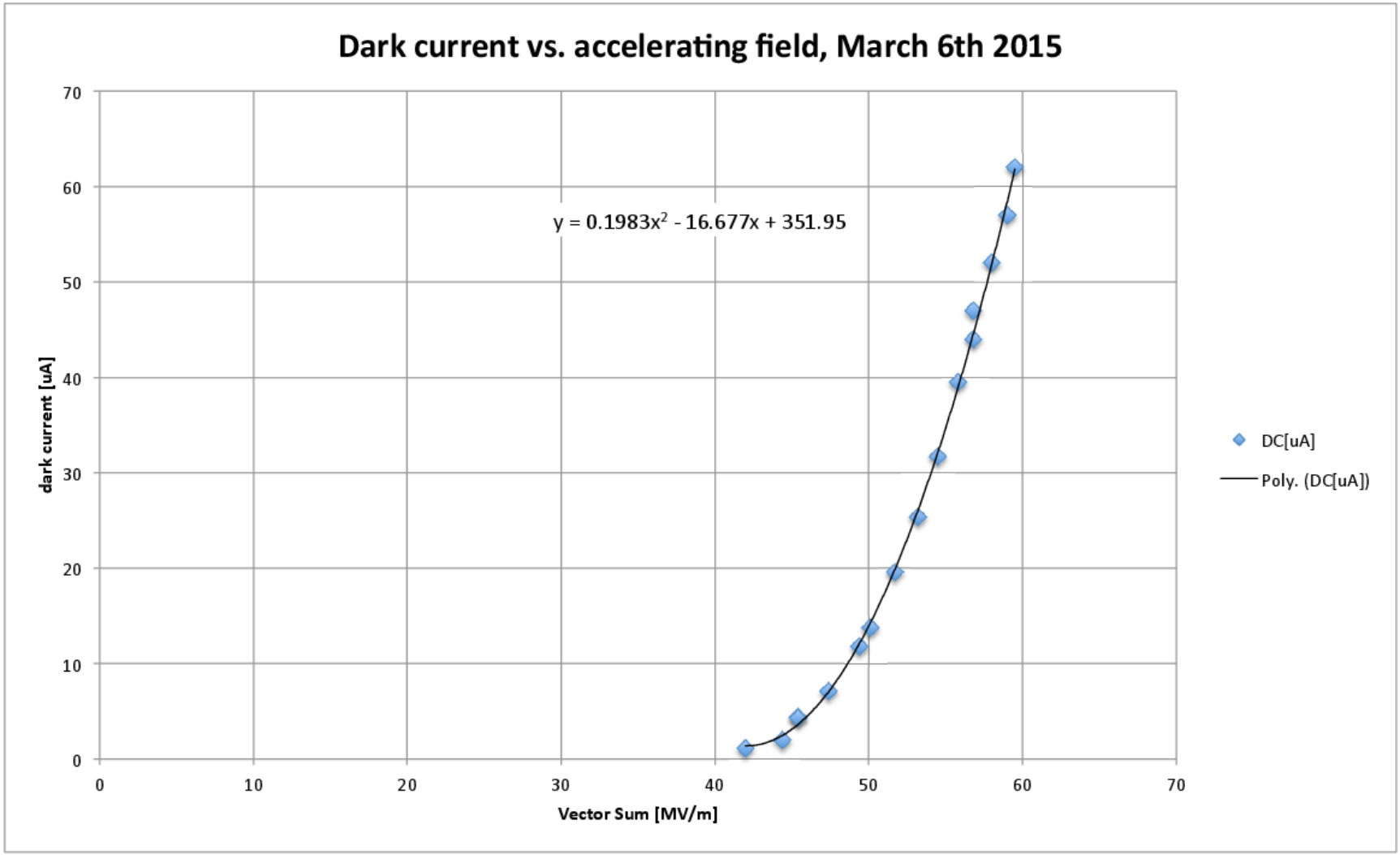
Signal of the Faraday Cups



European XFEL

Measurement of dark current





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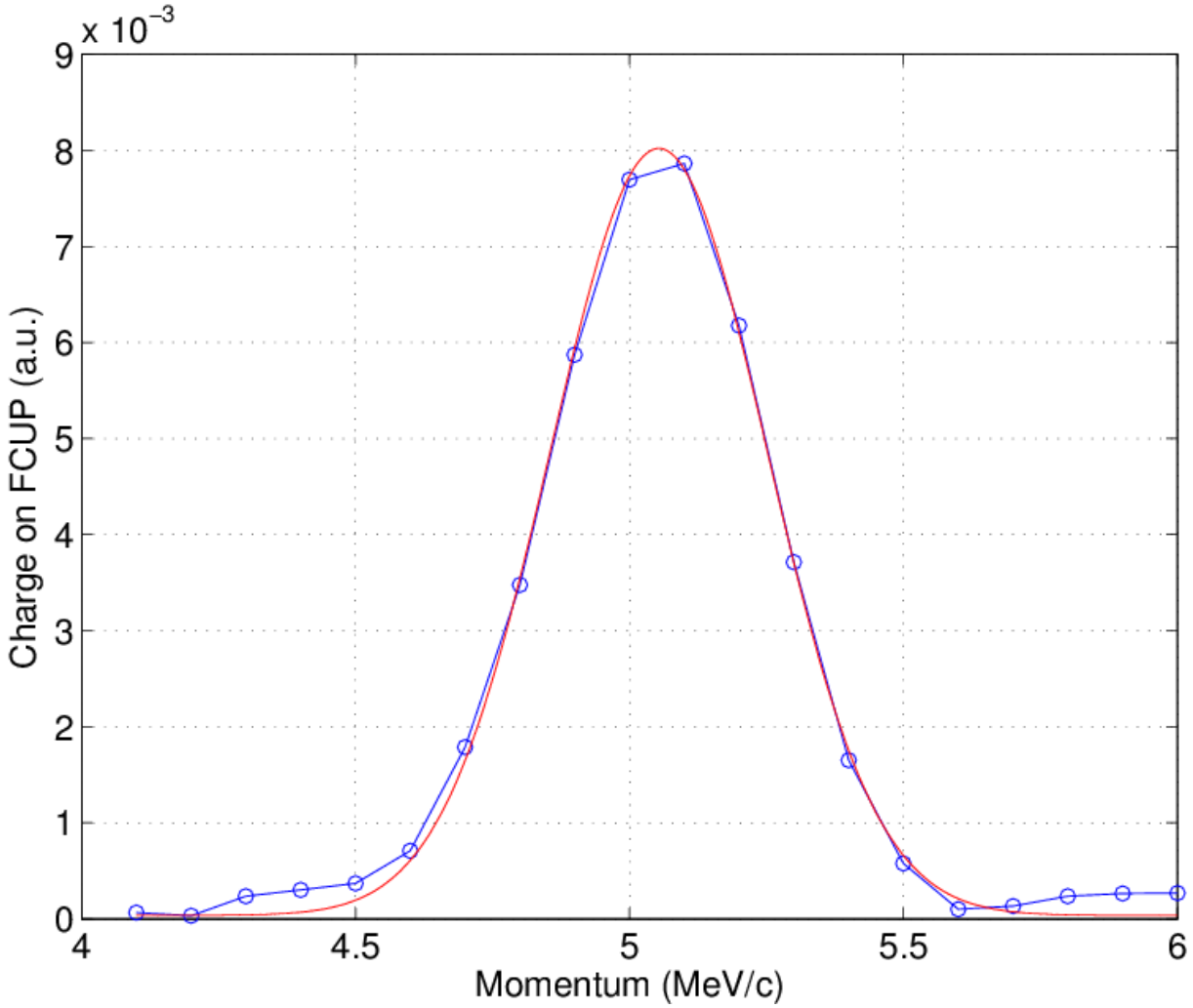
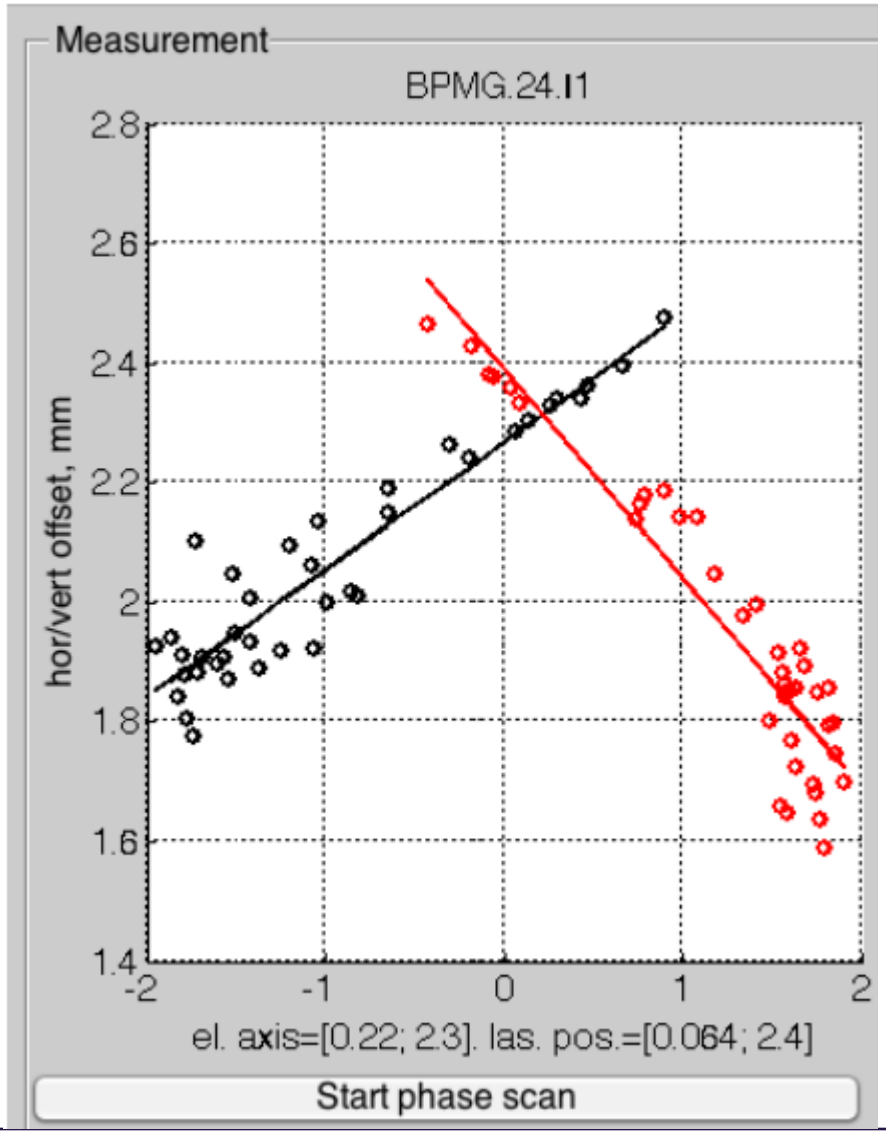
Automized energy measurement with the “Scan Tool” [L.Fröhlich]

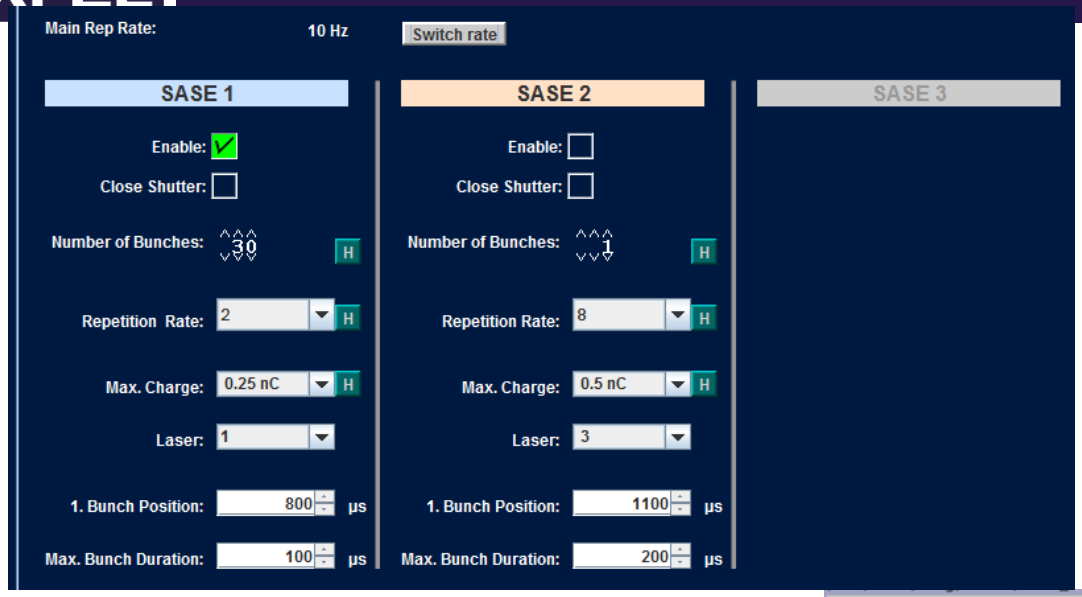


Test of the Laser alignment [E.Kot]



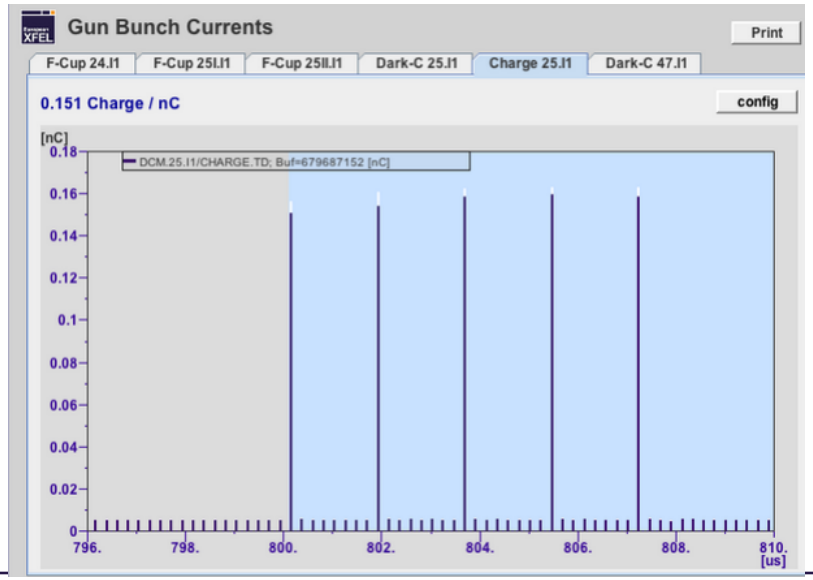
Scan beam position vs. Gunphase for different laser positions on the cathode

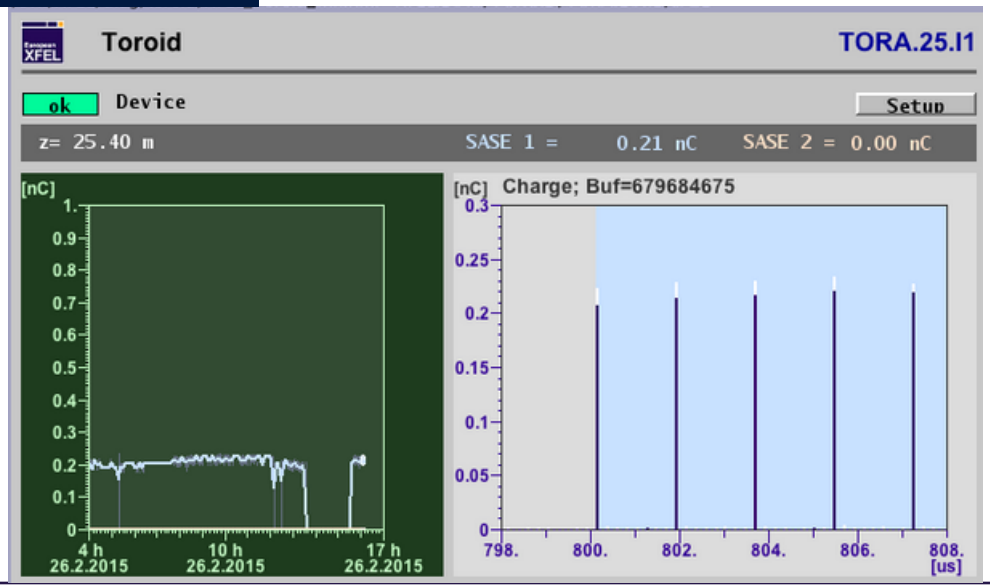
Timing



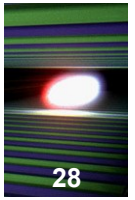
Successful test of the different repetition rates:

9/2 = 4.51MHz
9/8 = 1.13MHz
9/16 = 550KHz





After this first commissioning : exchange of RF window

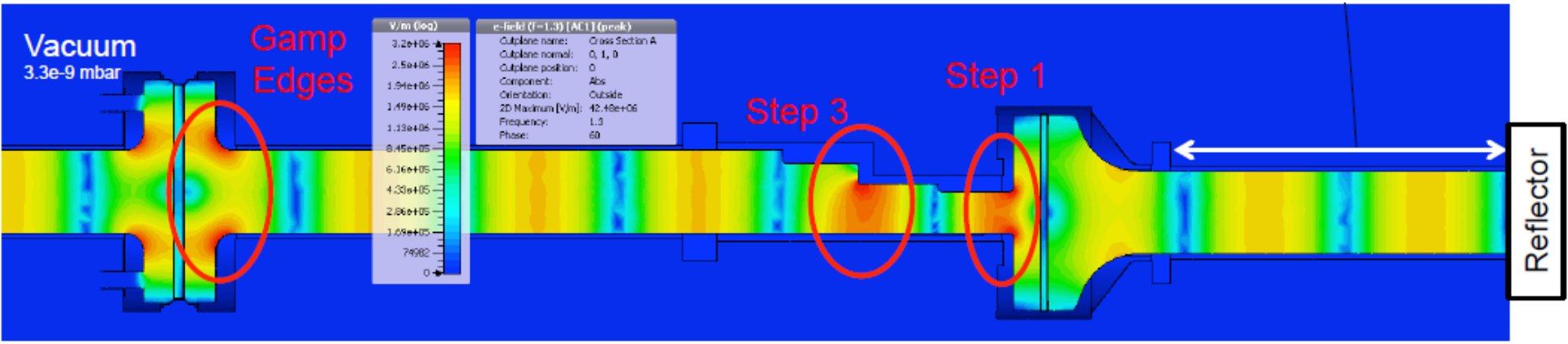


In the meantime a new Thales RF-window had been tested

To improve the reliability simulations (M.Bousonville) and measurements with a special designed directional coupler at FLASH have been done to find the optimal postion of the window.

Test run with the Thales6 and one Gamp-window

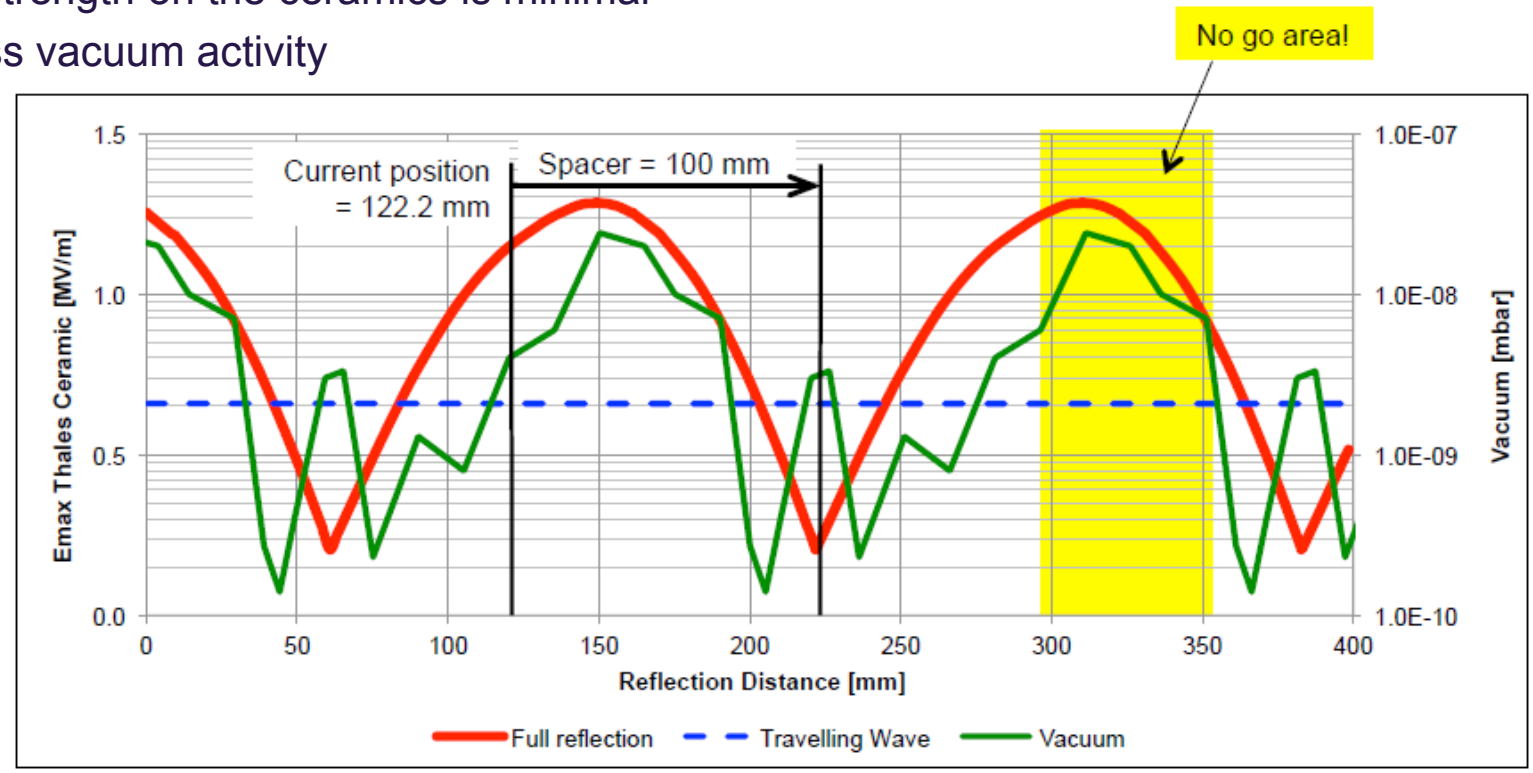
- Test with full reflection:
  - 20 µs pulse length (+ 35%)
  - 10 Hz
  - 2-6 MW RF-power
  - Distances to the reflector were varied



simulation: M.Bousonville

Thales window Position [M.Bousonville]

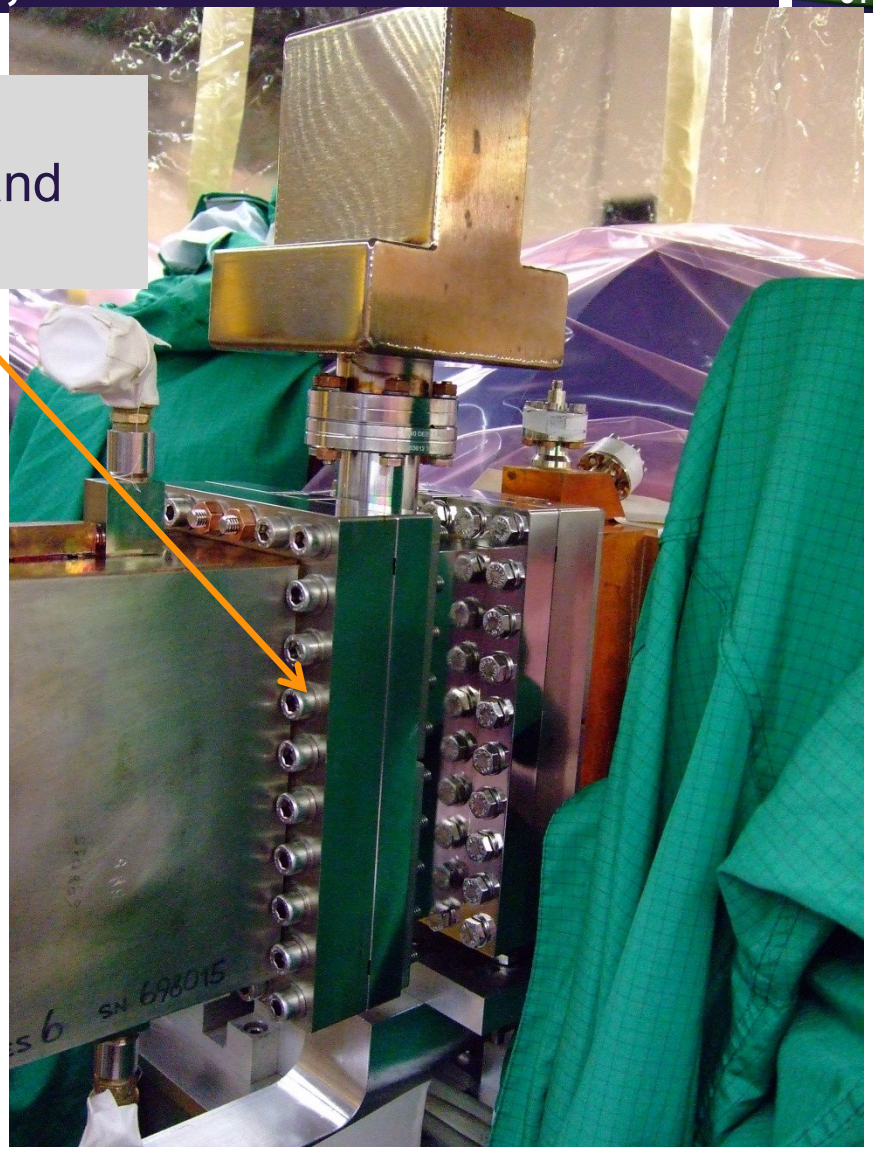
- Actual position
  - field strength on the ceramics is nearly at maximum
  - medium vacuum activity
- with 100mm shift:
  - field strength on the ceramics is minimal
  - bit less vacuum activity



Exchange of RF-window, March ‘15

100mm vacuum waveguide between Thales RF-window and coupler

- Massive reduction of field strength on the ceramic
- Significant improved pumping speed wit additional IGP



European XFEL

Thales RF-window with 100 mm Vacuum insert

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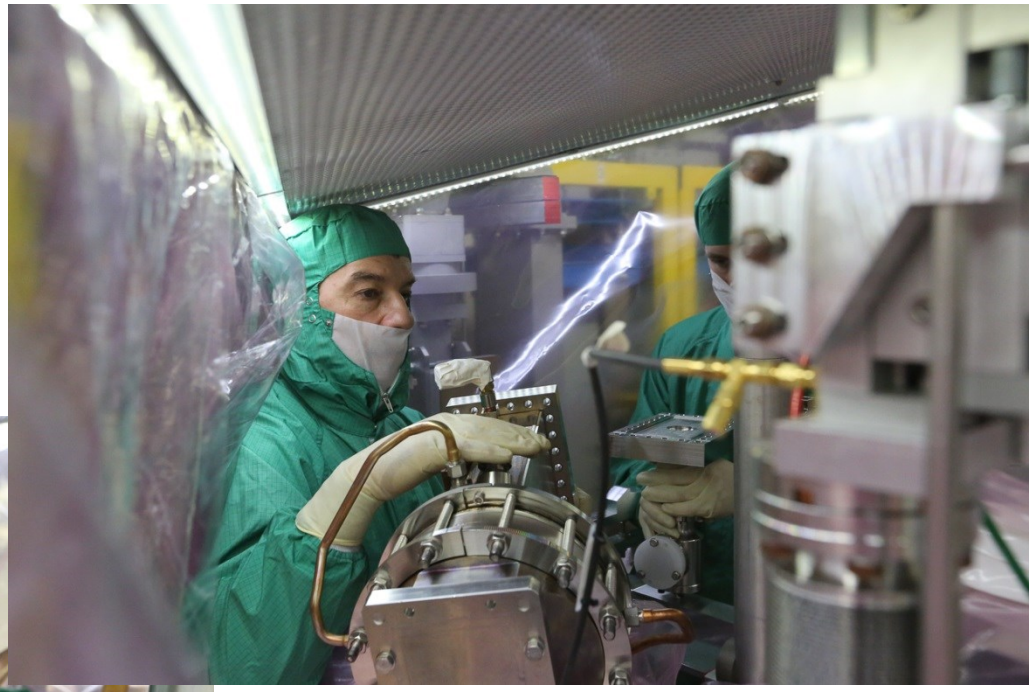
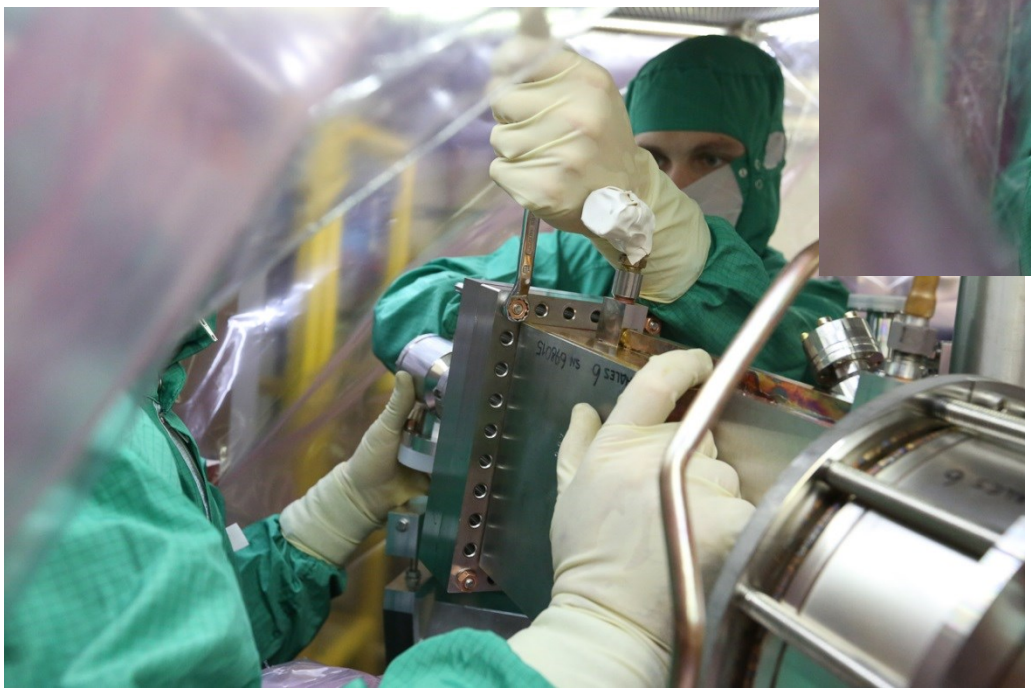
Vakuum-OP

Fotos: D.Nölle





Outlook

- After conditioning the new RF-window beam operation just started and will proceed until May 11th
- On the schedule are further commissioning for LLRF, diagnostics, temperature stabilization and high level controls
- Until summer the injector will be completed with the only exception of the 3.9 GHz module
- The third harmonic will be available mid of august – therefore the commissioning phase with beam up to the dump can only start in September.

Next Generation - GUN 45 ?

THANK YOU FOR YOUR ATTENTION !