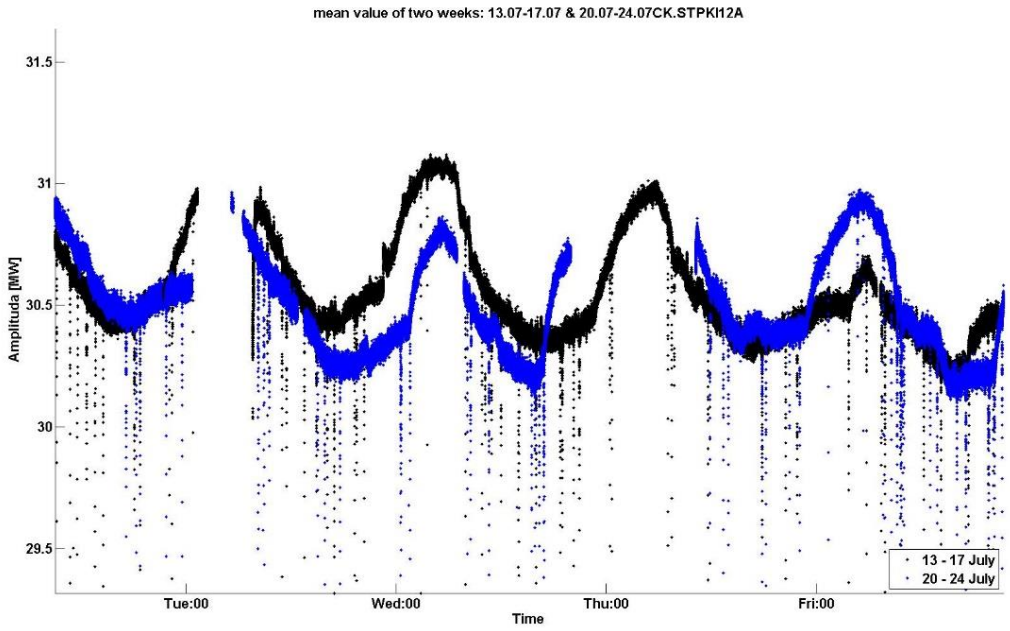
Stability and Reproducibility in CTF3

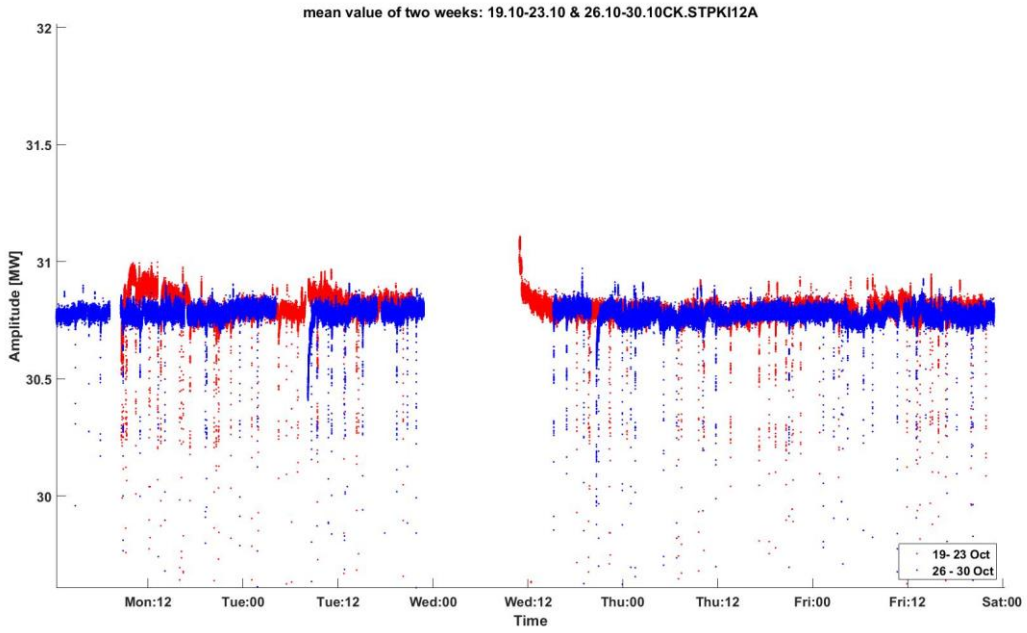
Presenter: Lukáš Malina

Klystrons as thermometers

Summer



Autumn



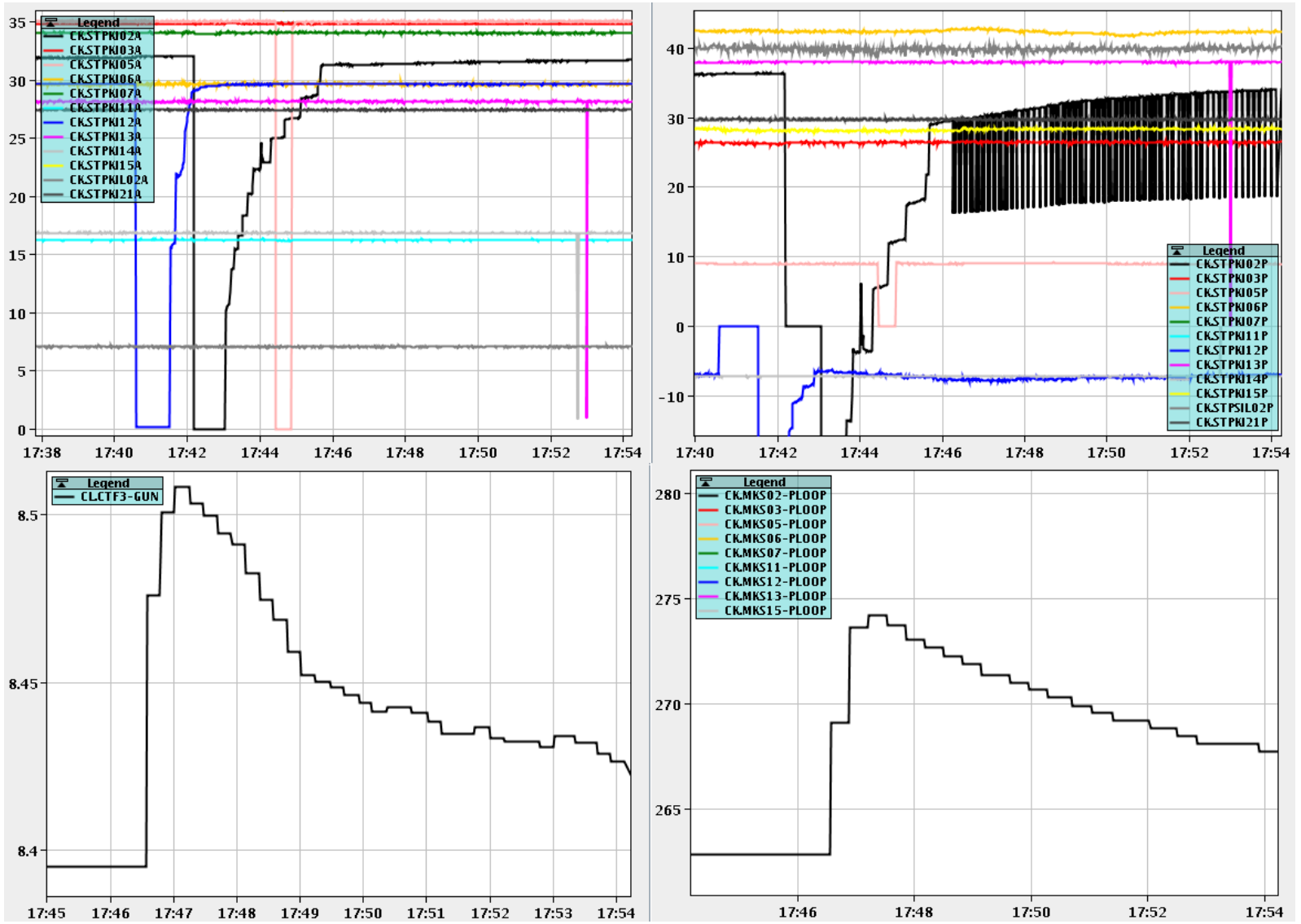
Monika Nisiewicz

Feedbacks

- RF Feedbacks
  - Pulse compressor temperature feedbacks
  - Klystron power flattening feedbacks
  - Phase-loops
- Beam-based feedbacks
  - Gun Current feedback NEW
  - TWTPhase feedback
  - Injector feedback
  - Loading feedbacks - Improved
  - Energy flattening feedback

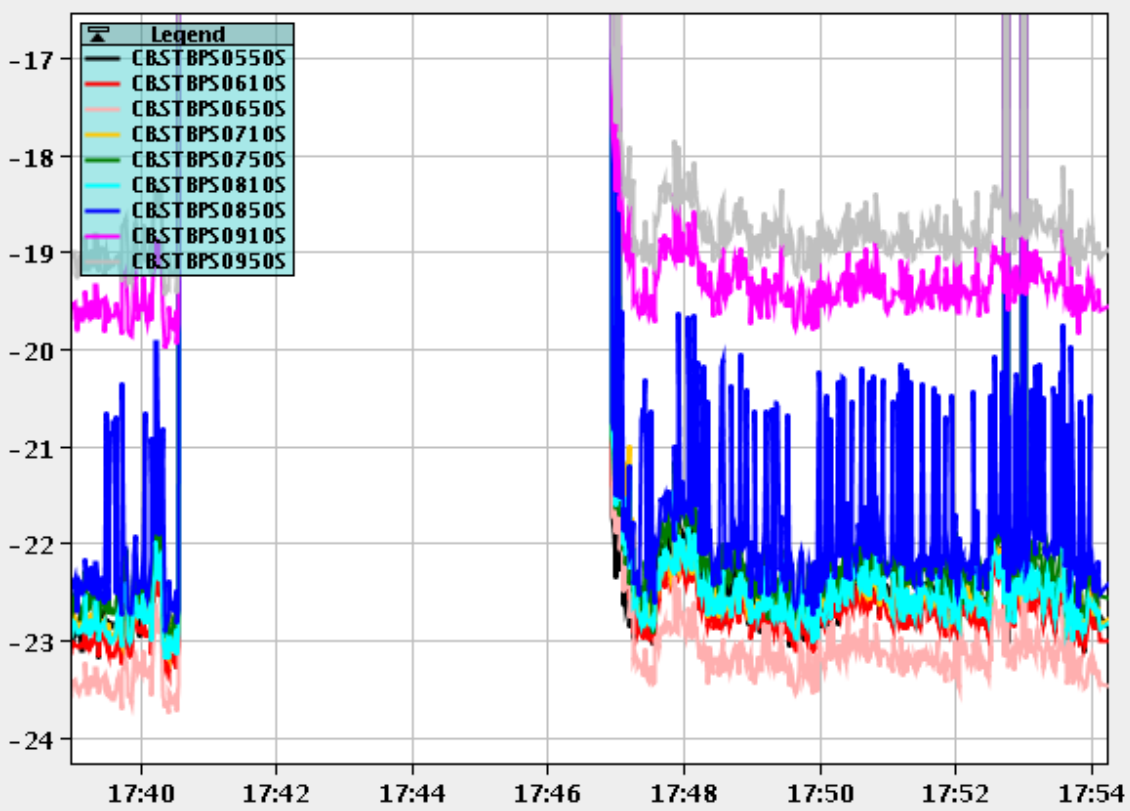
Klystron 2 trip

- Came back with different characteristics
  - power (0.7 MW lower)
  - Phase (off 12° @ 3 GHz)
- Machine sort of stable anyway
- Klystron recovered after cca 30 minutes
  - Should we extend the automatic restart time?

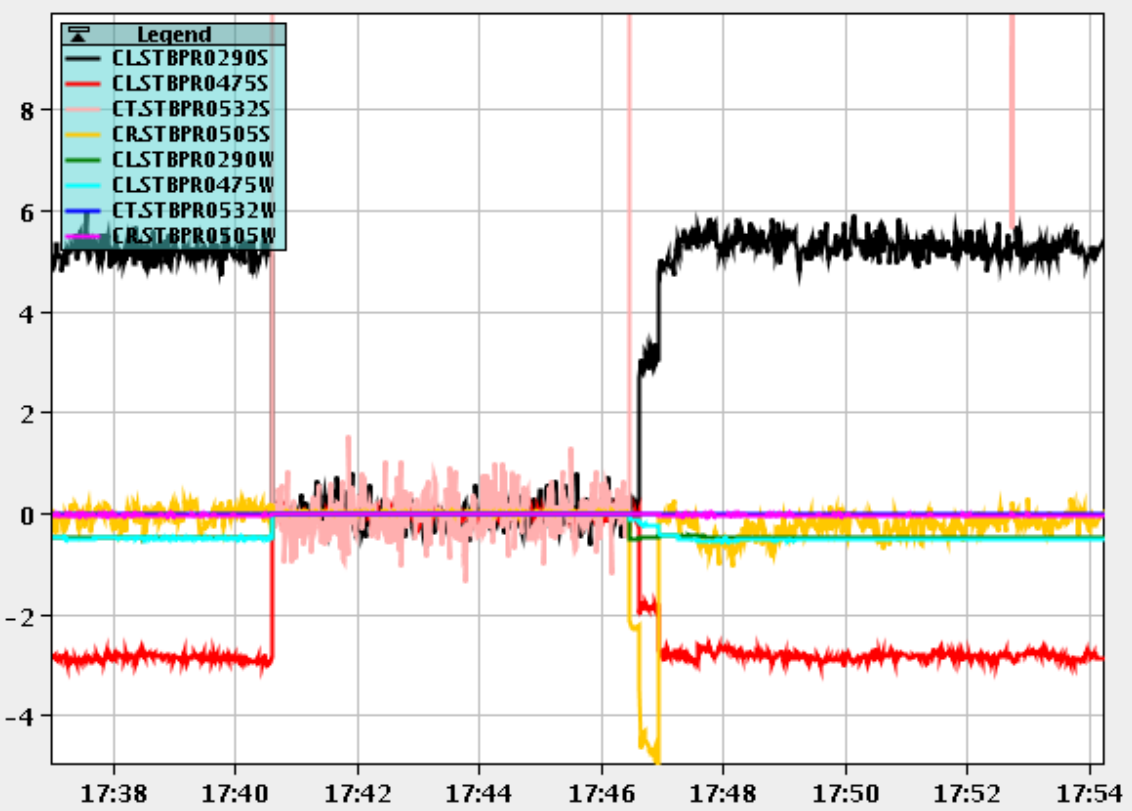


Klystron 2 trip

Current in TBL

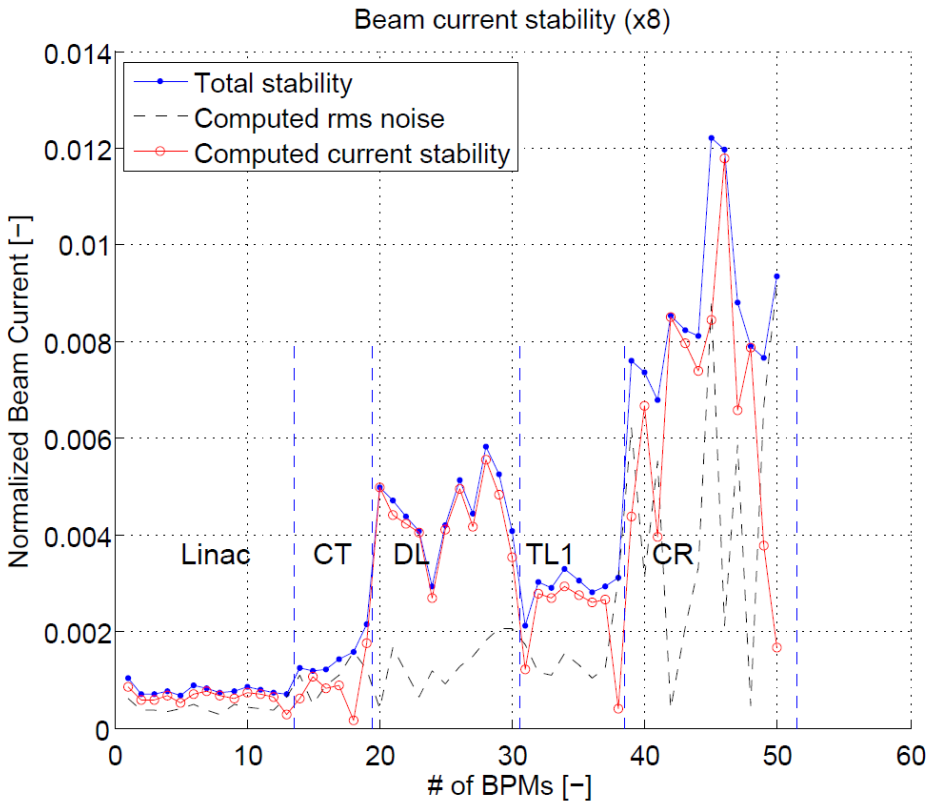


BPRs in linac

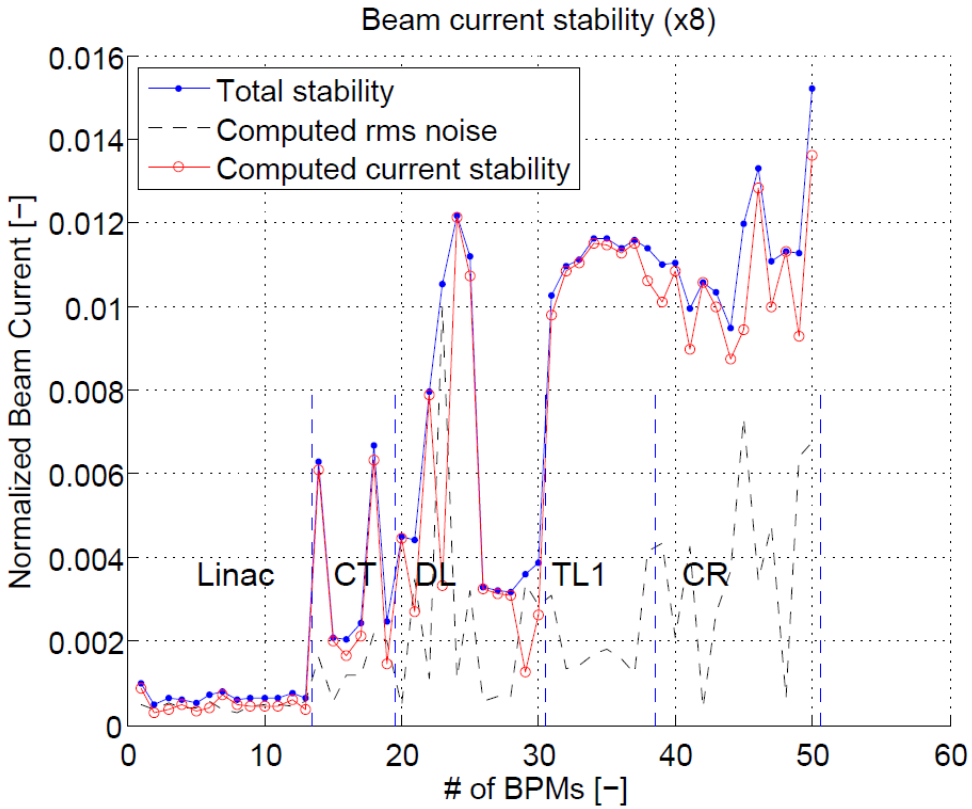


2014 factor 8 stability

Good day

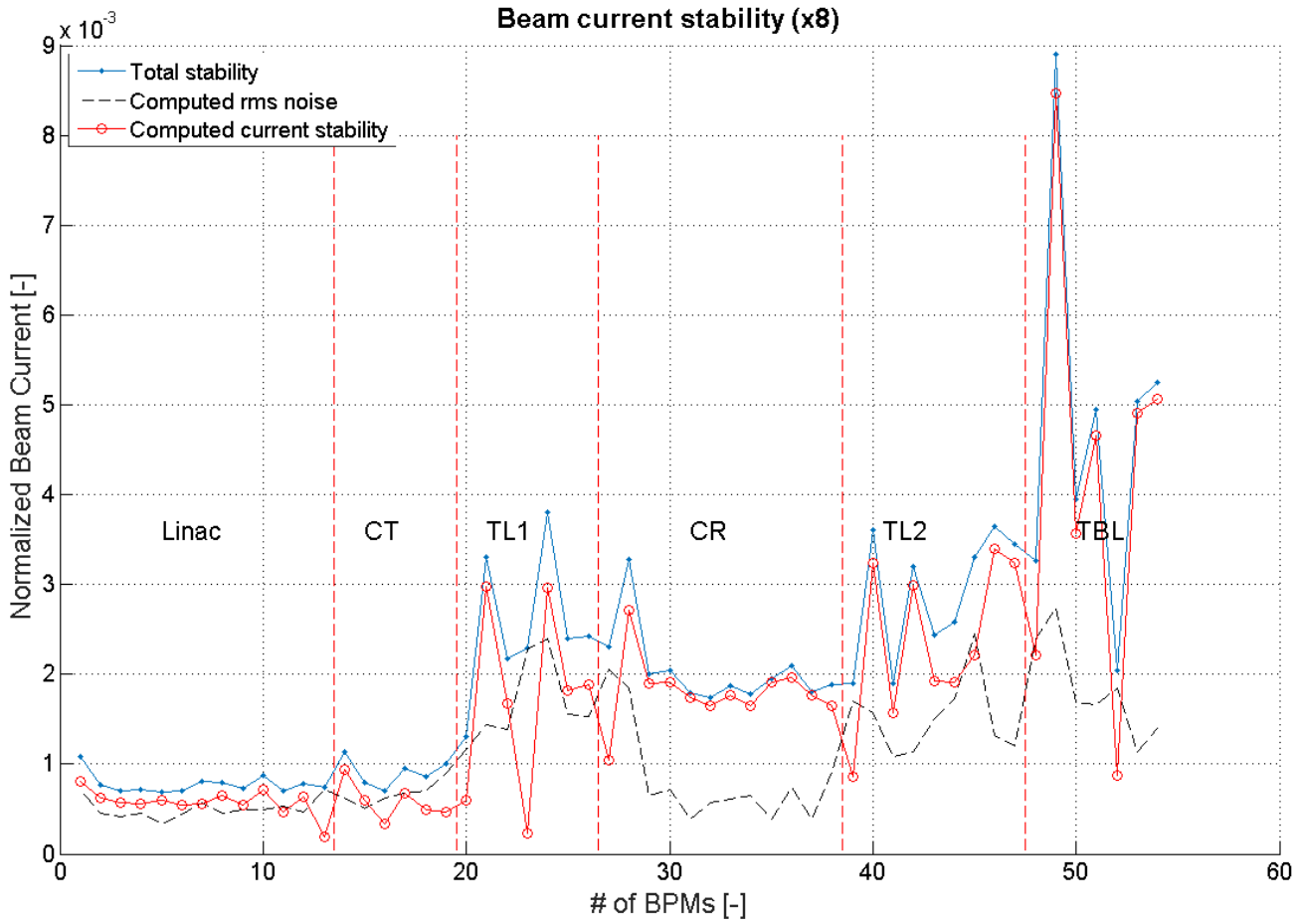


Usual day



Piotr's presentation last year

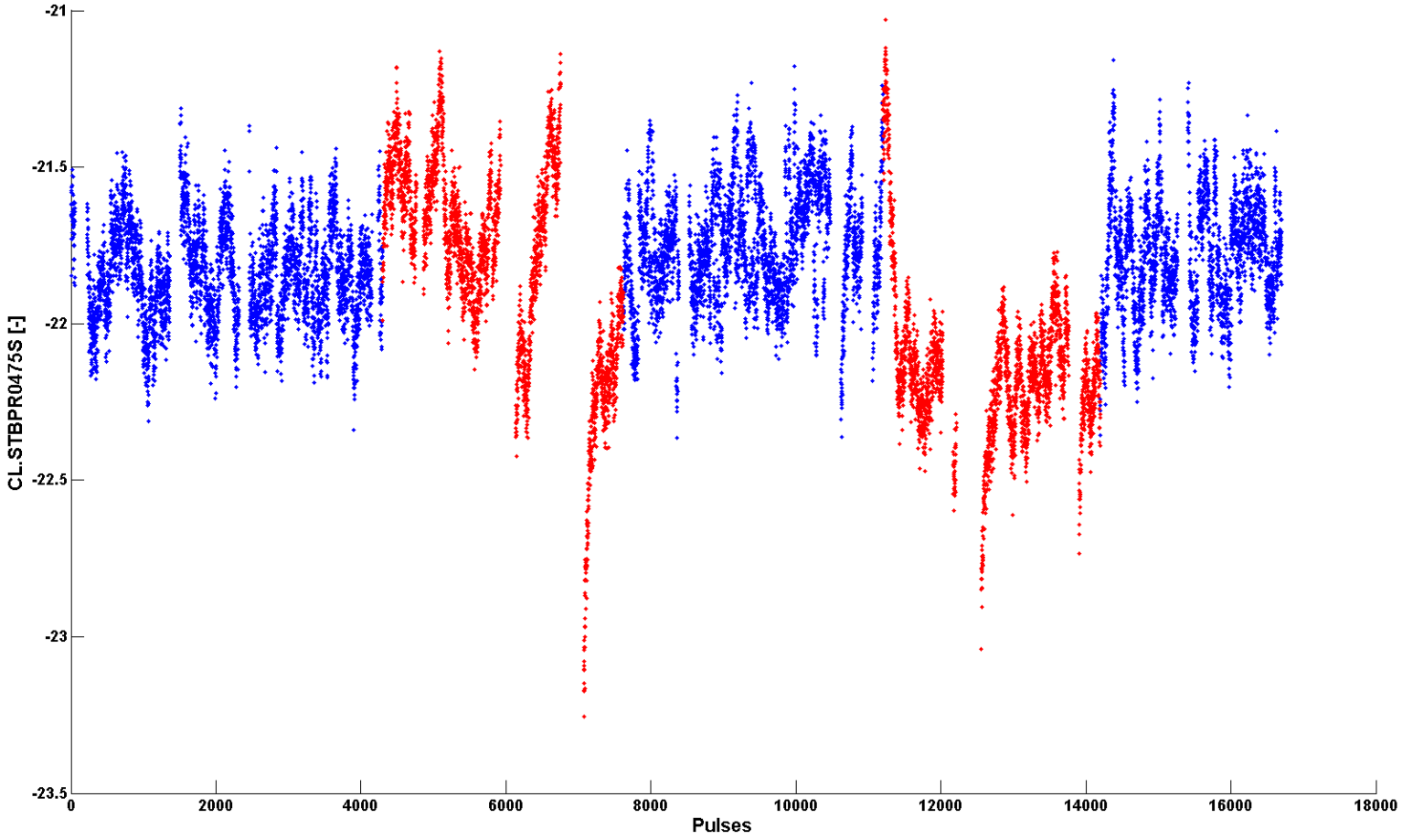
2015 factor 8 stability



Tobias Persson

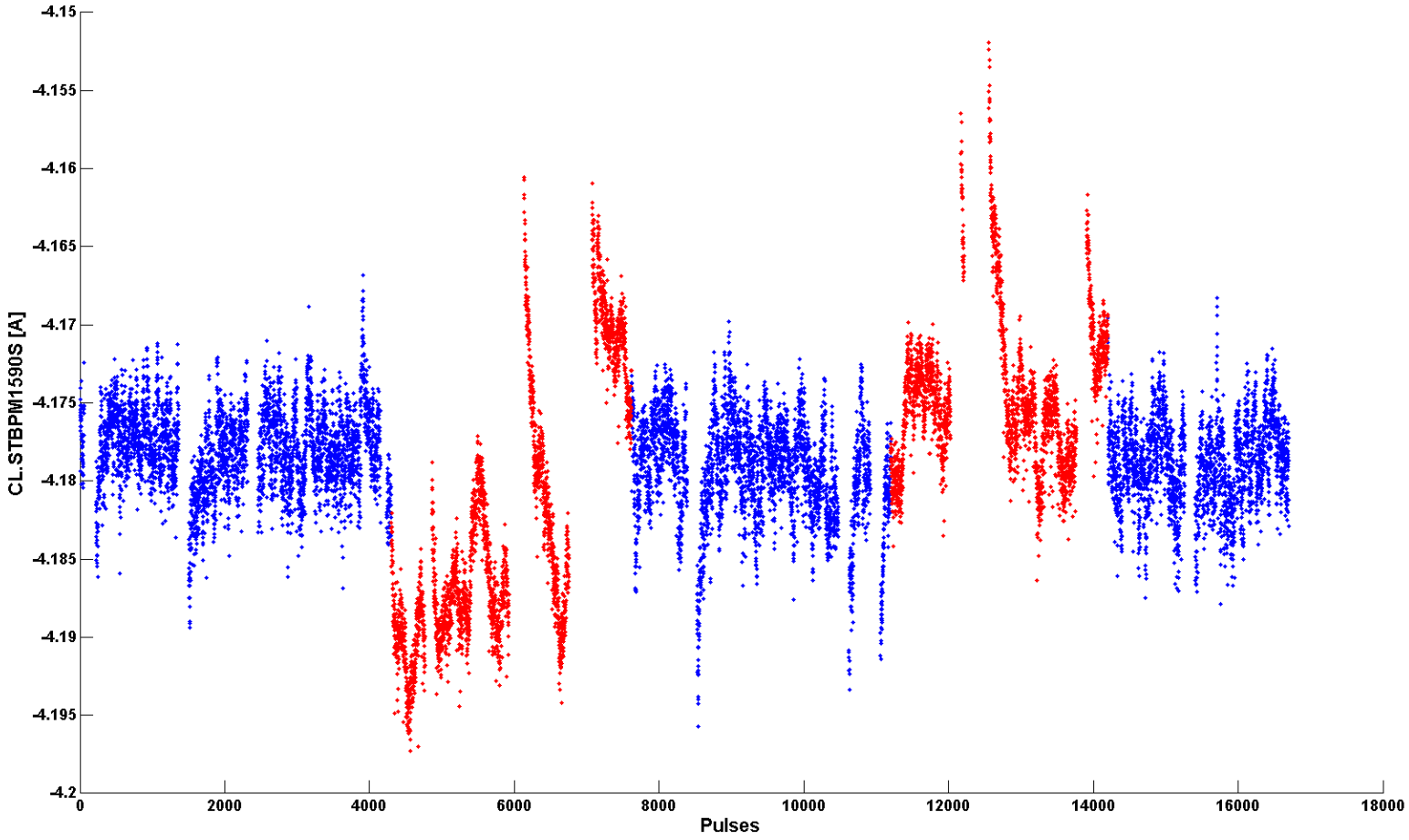
Last day of the run - phase

- Beam to CRM: Feedbacks ON Feedbacks OFF



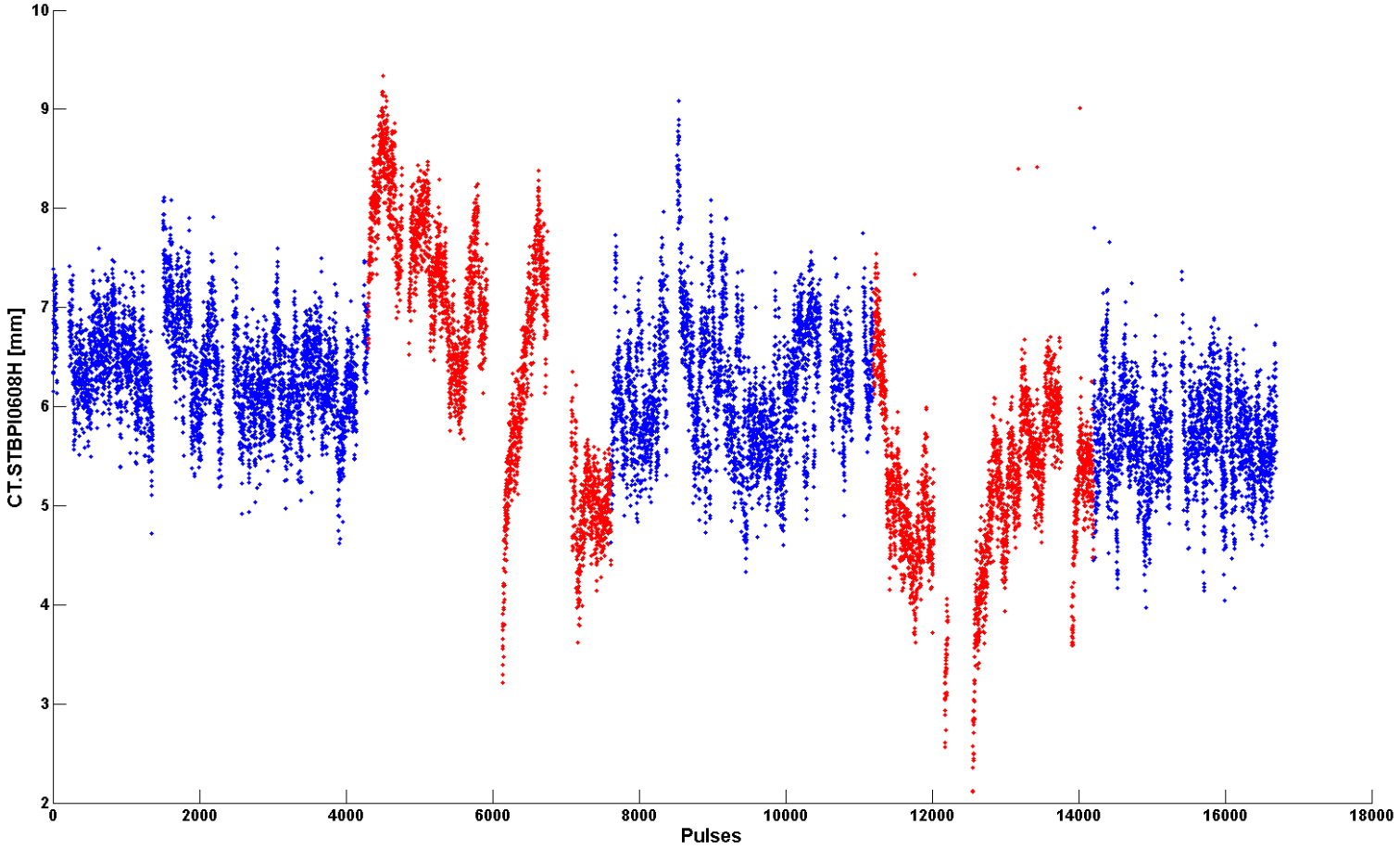
Last day of the run - current

- Beam to CRM: Feedbacks ON Feedbacks OFF



Last day of the run - energy

- Beam to CRM: Feedbacks ON Feedbacks OFF



Last day of the run - stability

- **Beam to CRM**
- **Phase ~ 0.25°**
  - Limited by hardware
- **Current ~ 5-9·10^{-4}**
  - Or less in the linac
  - Limited by hardware
  - Noise of BPM0402S ~8·10^{-4}
- **Energy ~ 2-5·10^{-3}**
  - Both hardware and software improvements ongoing

- **CTF3 Stability Goals**
- **Beam phase ~ 0.2 °**
- **Drive Beam Current ~ 7·10^{-4}**
- **Energy ~ 10^{-3}**

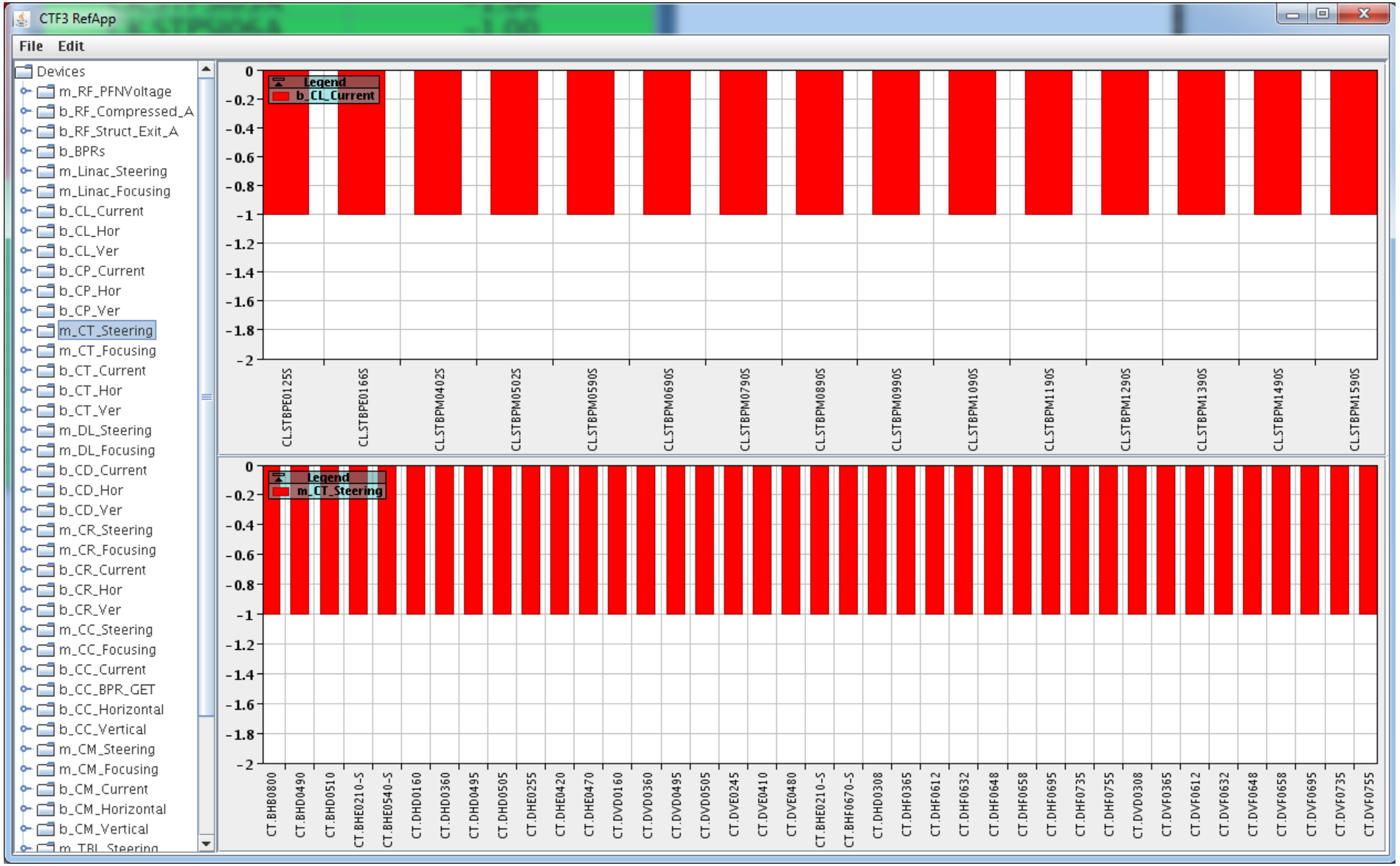
Reproducibility

- New reference watchdog application implemented
- Swap between 1.5 GHz and 3 GHz is just a matter of SHBs and PhaseSwitchers
- Same optics for beam to TBL and TBM
- Unfortunately not constant number of working TWTs
- Starting the beam in the morning is (ussually) easier as the feedbacks are keeping the reference
  - Getting back to the correct working point is matter of less than a minute

Reference Watchdog Application

- The core of the application is based on the Monitor from Tobias
- Shows the difference between current situation and the loaded reference
  - Based on predefined deviation measures
  - References saved by the Monitor
    - autosave every ~5 minutes (readout takes ~3 minutes)
- Possible to compare two different references
- GUI very similar to the Monitor
  - Useful for quick investigation
    - Acquisition not working, detailed view of groups of devices …
  - Just the view is split (example on next slide)
    - "Beam related" signals : b_
    - "Machine related" signals: m_

Reference Watchdog Application



Reference Watchdog Application

- Single value control values (typically current in magnets)
- Signals with structure along the pulse
- Groups of signals (excluding the parts of the machine without beam)

Machine

Machine: device name	ChiSquare
CK.MKS03	10008.00
CK.MKS13	10008.00
CK.MKS07	10008.00
CK.MKS15	10000.00
CK.MKS02	9983.61
CK.MKS05	9983.61
CK.MKS06	9983.61
CK.MKS11	9960.04
CK.MKS12	9934.91
CT.QFD0130	649.65
CT.QFD0150	204.46
CT.QFD0310	0.03
CT.QDD0110	0.00
CL.BHA0430-S	0.00
CL.BHB1040	0.00
CL.DHA0120	0.00
CL.DHA0150	0.00
CL.DHA0230	0.00
CL.DHB0270	0.00
CL.DHB0315	0.00
CL.DHB0340	0.00
CL.DHC0410	0.00

Beam

Reference: 2015_12_14/_2015_12_14_19:13:23.ref

Beam: device name	ChiSquare
CK.STPKI02A	-1.00
CK.STPSI03A	-1.00
CK.STPSI05A	-1.00
CK.STPSI06A	-1.00
CK.STPSI07A	-1.00
CK.STPSI11A	-1.00
CK.STPSI12A	-1.00
CK.STPSI13A	-1.00
CK.STPSI15A	-1.00
CK.STPSIL02A	-1.00
CK.STPEI0134A	-1.00
CK.STPEI0204A	-1.00
CK.STPEI0214A	-1.00
CK.STPPBEI2A	-1.00
CK.STPBEIA	-1.00
CK.STPEI0305A	-1.00
CK.STPEI0530A	-1.00
CK.STPEI0630A	-1.00
CK.STPEI0730A	-1.00
CK.STPEI1130A	-1.00

Groups

Groups: device name	ChiSquare
b_RF_Compress...	0.00
b_RF_Struct_Exit...	0.00
b_BPRs	0.00

Hardware improvements (checks)

- Attenuation from power signals at exit of structures 6 and 12 was removed
- Plan to use finer step phase shifter in klystron 2 and 3
- Use the whole dynamic range of CL.BPR0290S – beam phase measurement
- CL.STBPM0402 in the linac is one of the noisiest BPMs
  - We could possibly swap the electronics with some better one
  - There might be 12-bit electronics
- Gun current control value (limited to 10 A !!!)
  - Used to be ~6.5 A
  - After the cathode change gradually increased to maintain the same beam current
  - Now is > 9 A @ 3 GHz and > 8 A @ 1.5 GHz
  - Will it survive or we need to do something?

Conclusions

- The setup of the machine is improving – not a "push the button", but we are getting closer
- Current stability better than previous year, but the goal hasn't been reached yet
- Hardware improvements are ongoing during shut down

Thank you for your attention