

# Jitter sources stability existing beam interlocks



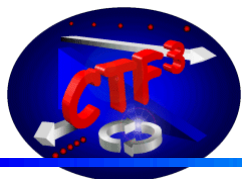
Frank Tecker - AB/OP  
for the CTF3 Team

- Stability

- Trajectory
- Gun
- RF

- Interlocks

- Valve protection
- RF inhibit
- Repetition rate
- Vacuum level
- Beam loss

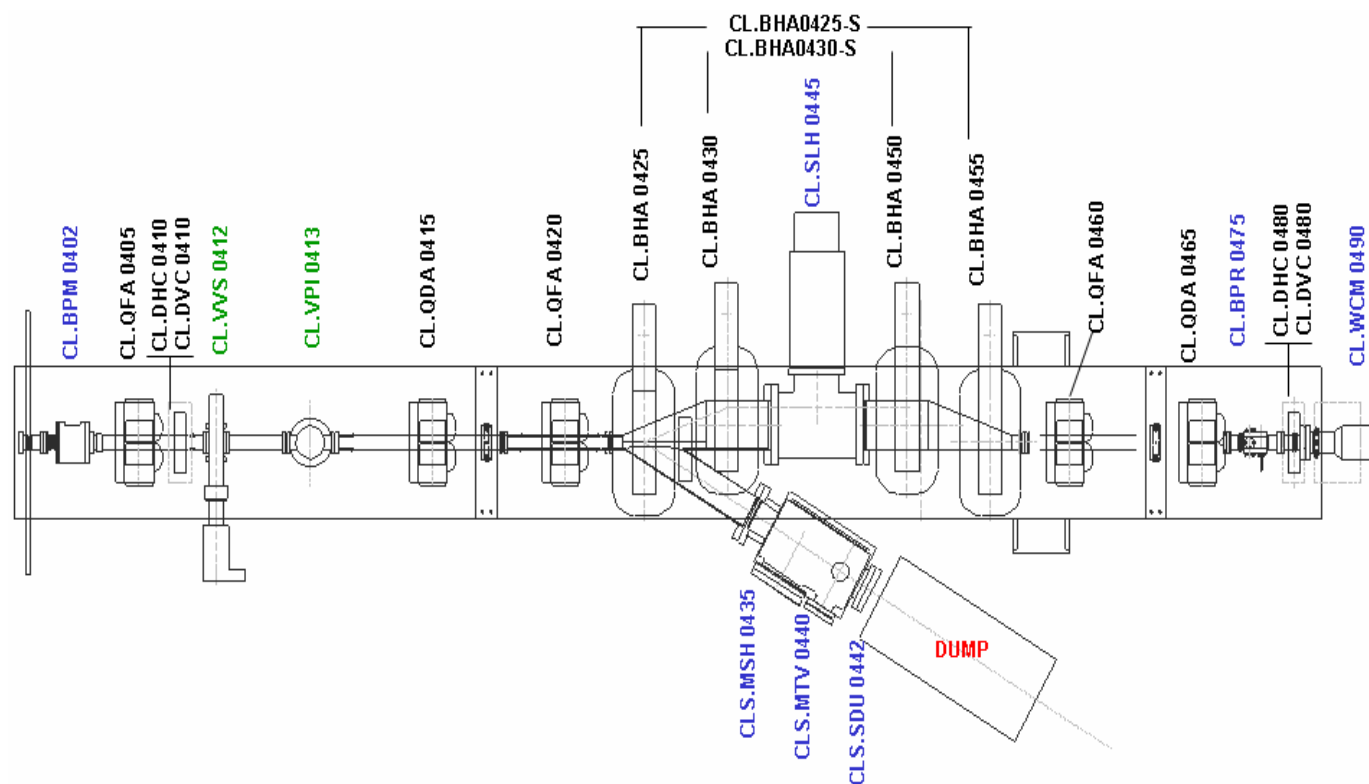


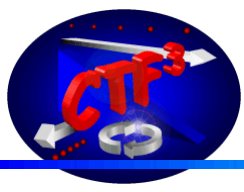
# Trajectory Jitter



- **Trajectory jitter** observed in first run 2005  
=> difficult tuning, varying PETS power, reduced efficiency
- **Slow variations**  
=> limited conditioning time w/o specialist support

- **Jitter** originating in girder 4
- Difference orbit study shows 3 mm peak-peak

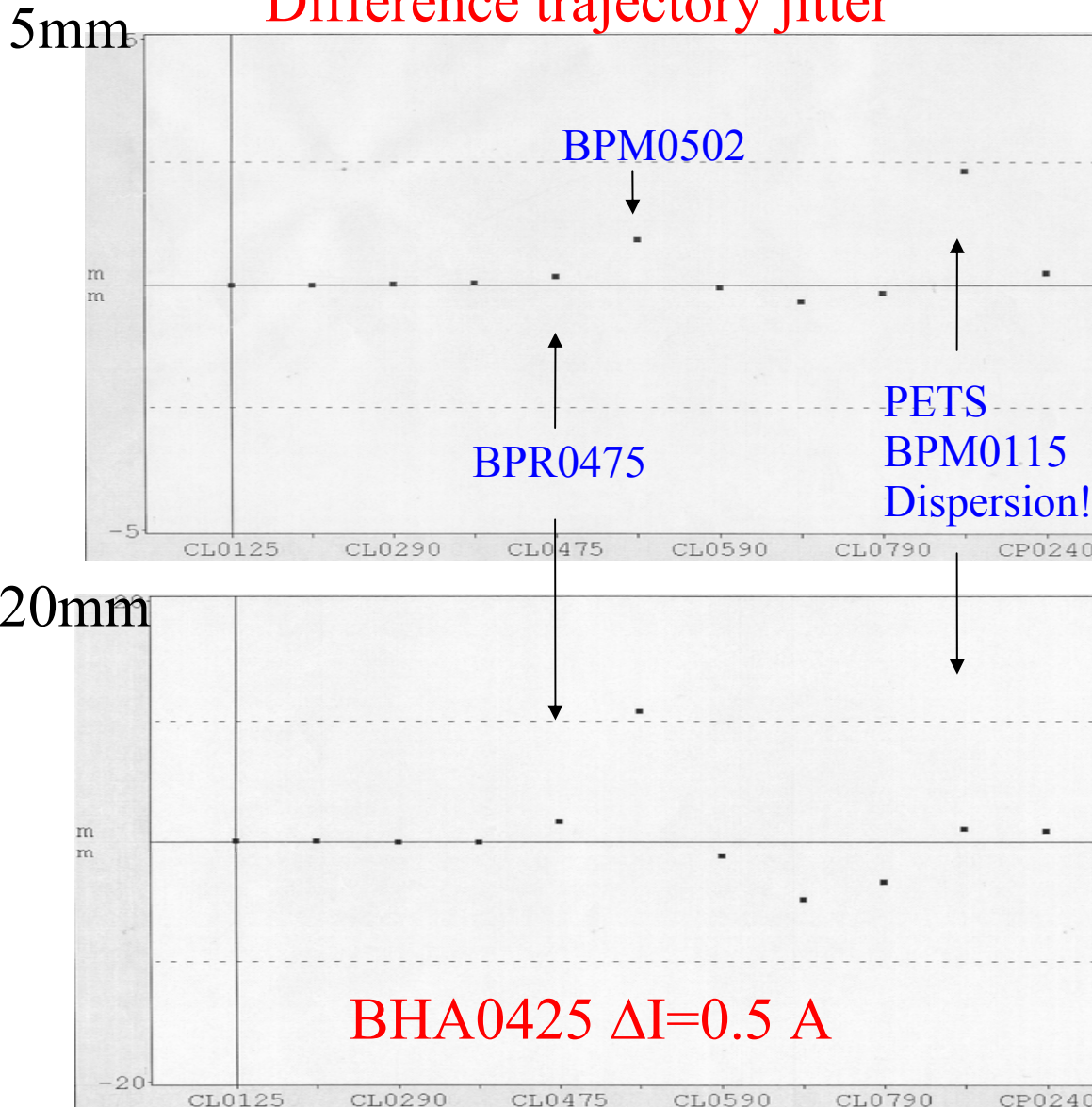




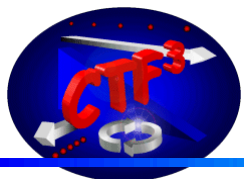
# Chicane Bend Variation



## Difference trajectory jitter



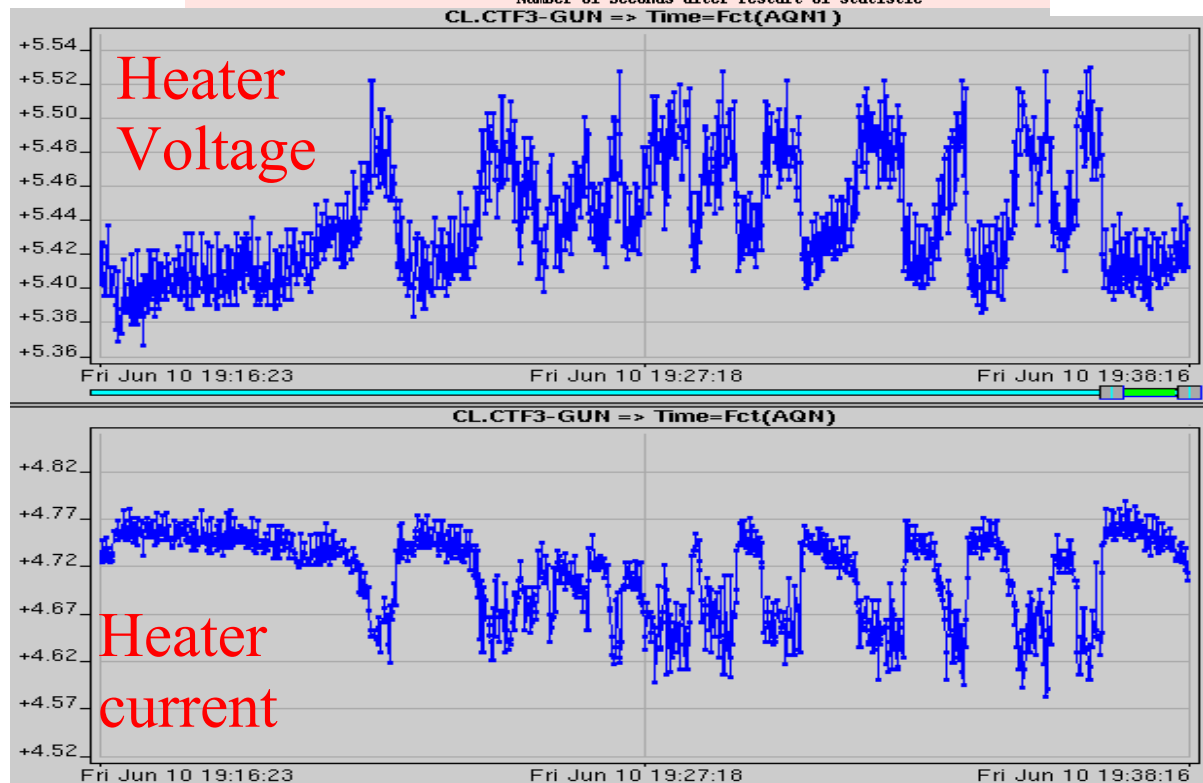
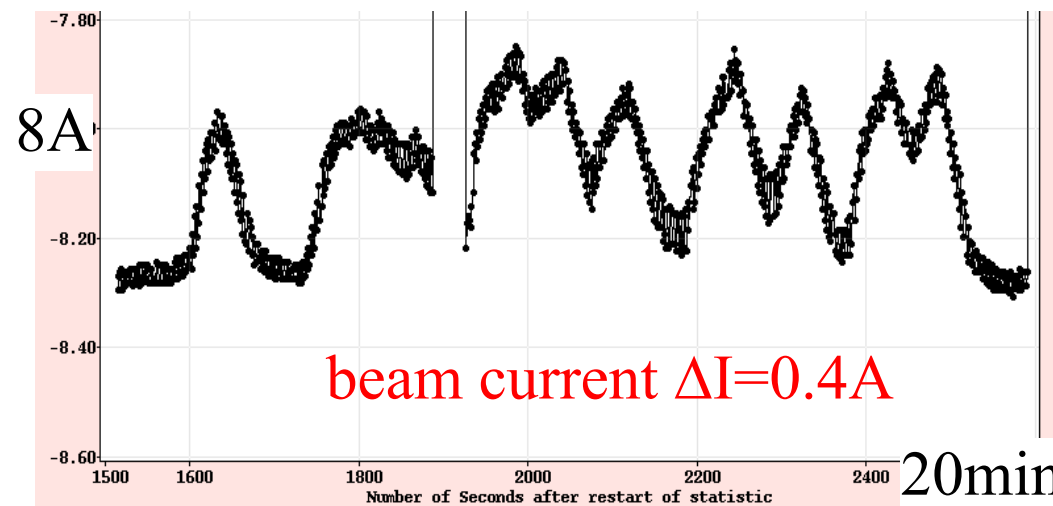
- Pattern => chicane bend  
0.15 A pk-pk  
0.3%  $\Delta I/I$
- Additional **energy jitter**
- Check in CTF3  
=> **external bend** supply
- Power supply changed  
=> **jitter gone**

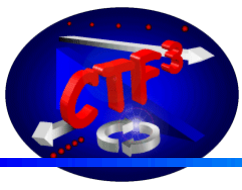


# Beam Current Variations

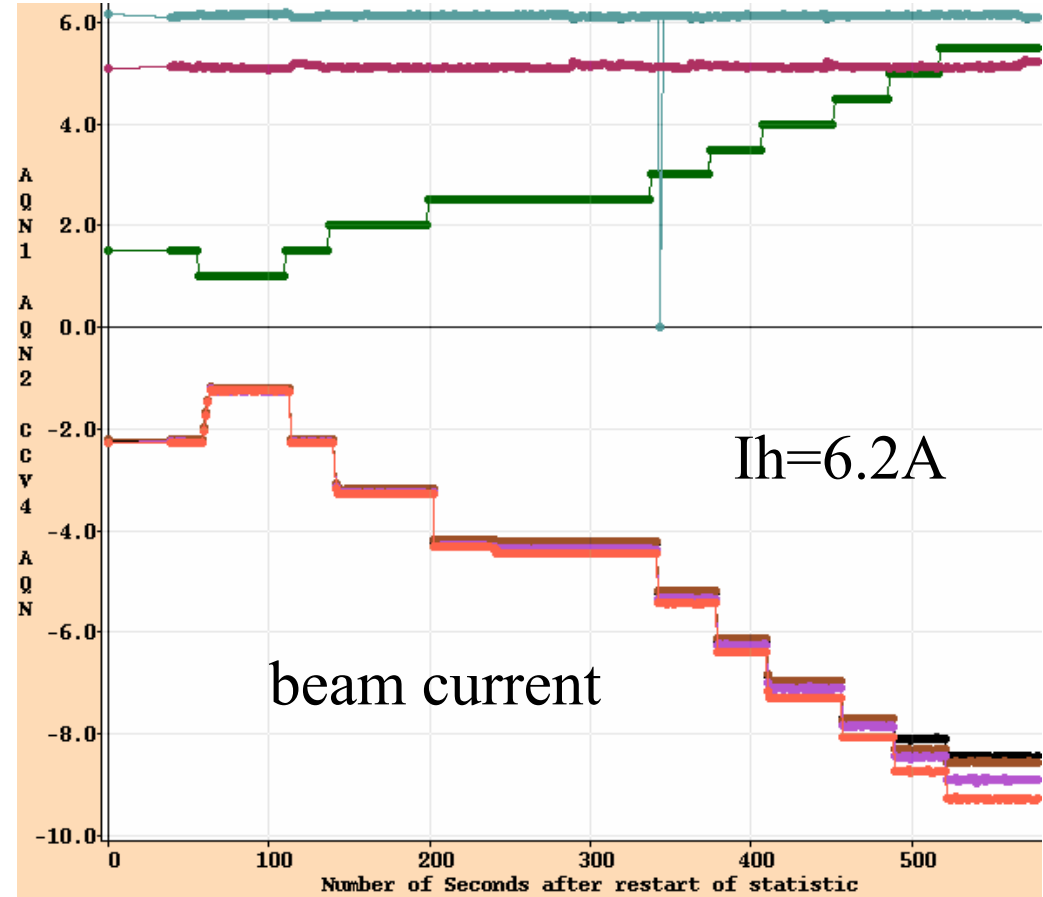
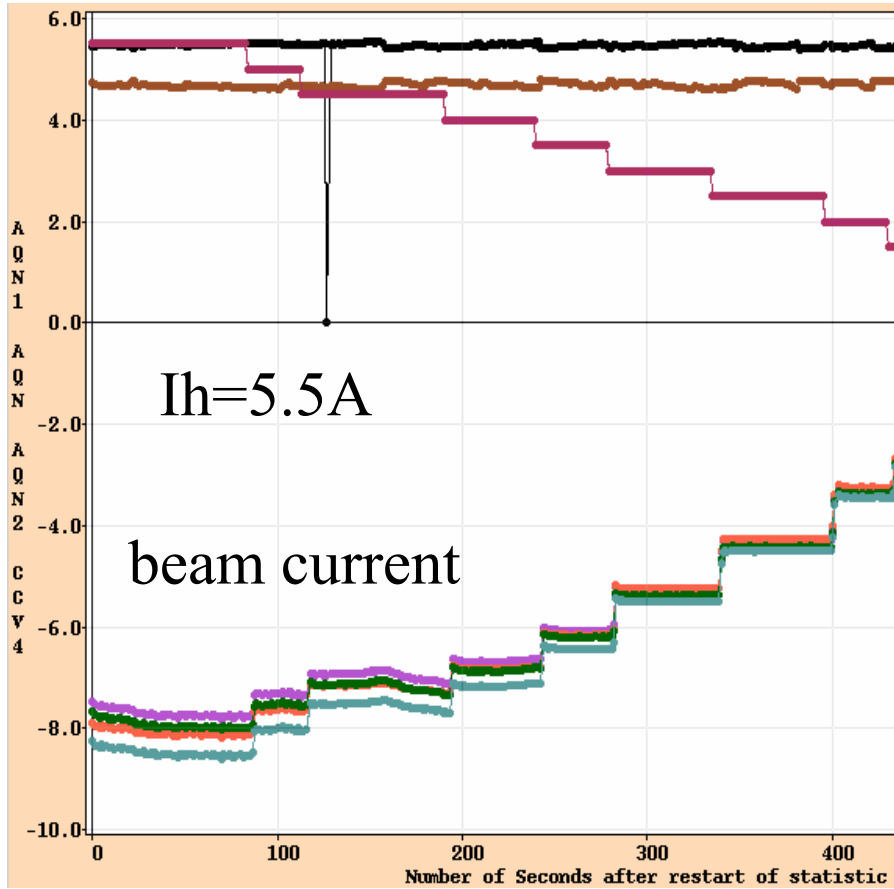


- Slow beam current variation of  $\sim 5\%$  in 1<sup>st</sup> run 2005
- Correlated to heater current
- Emission limited
- Several fixes:
  - Different working point
  - Heater power supply
  - Current regulation

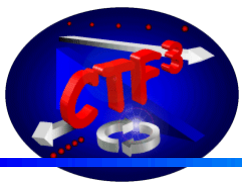




# Gun heater calibration



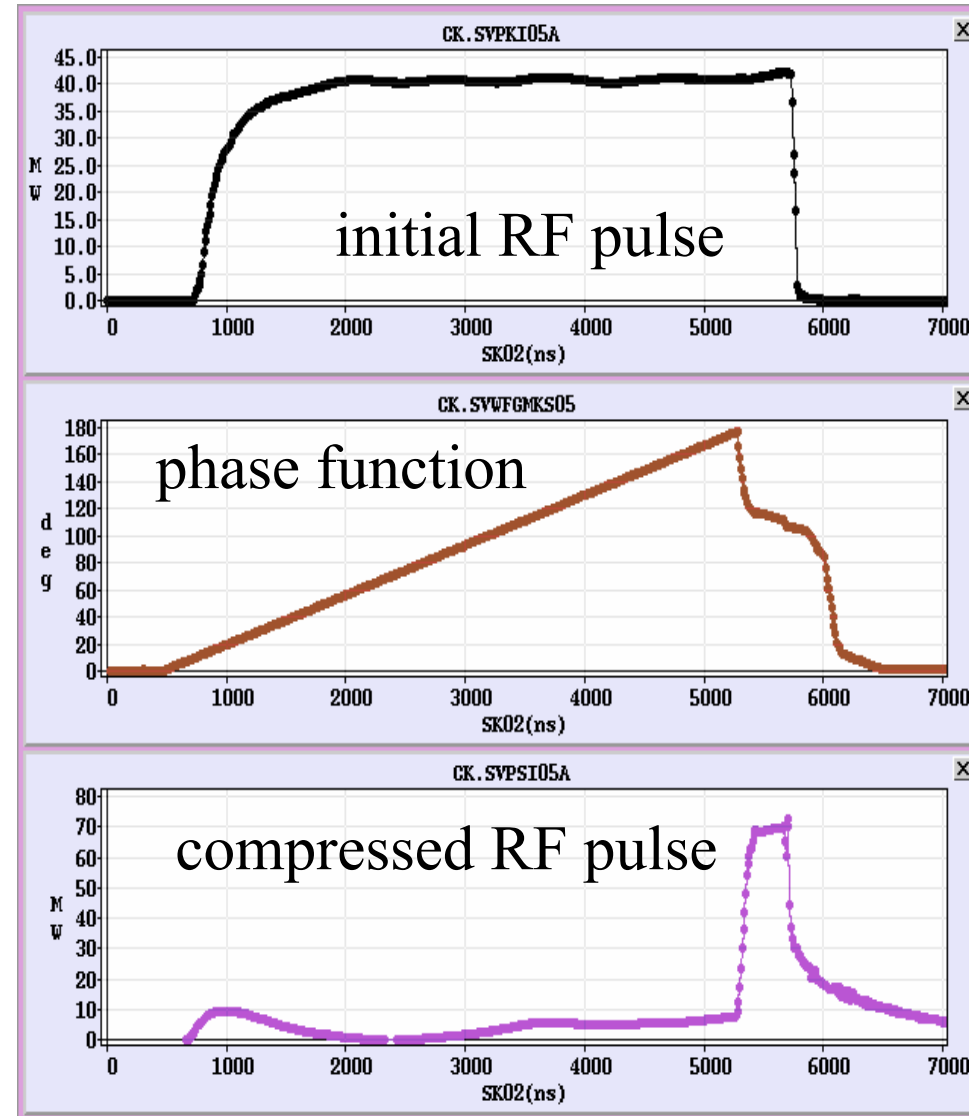
● heater current adjusted to have stable output current

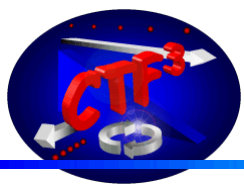


# RF Jitter



- Delayed filling time-critical
- Phase function generated by waveform generator  
@ 96 Mhz external clock
- **jumps** by **10 ns** observed (1 cycle)
- trigger  $\leftrightarrow$  clock relation
- could be fixed by cable delay
- occasionally reappeared
- small hardware addition needed

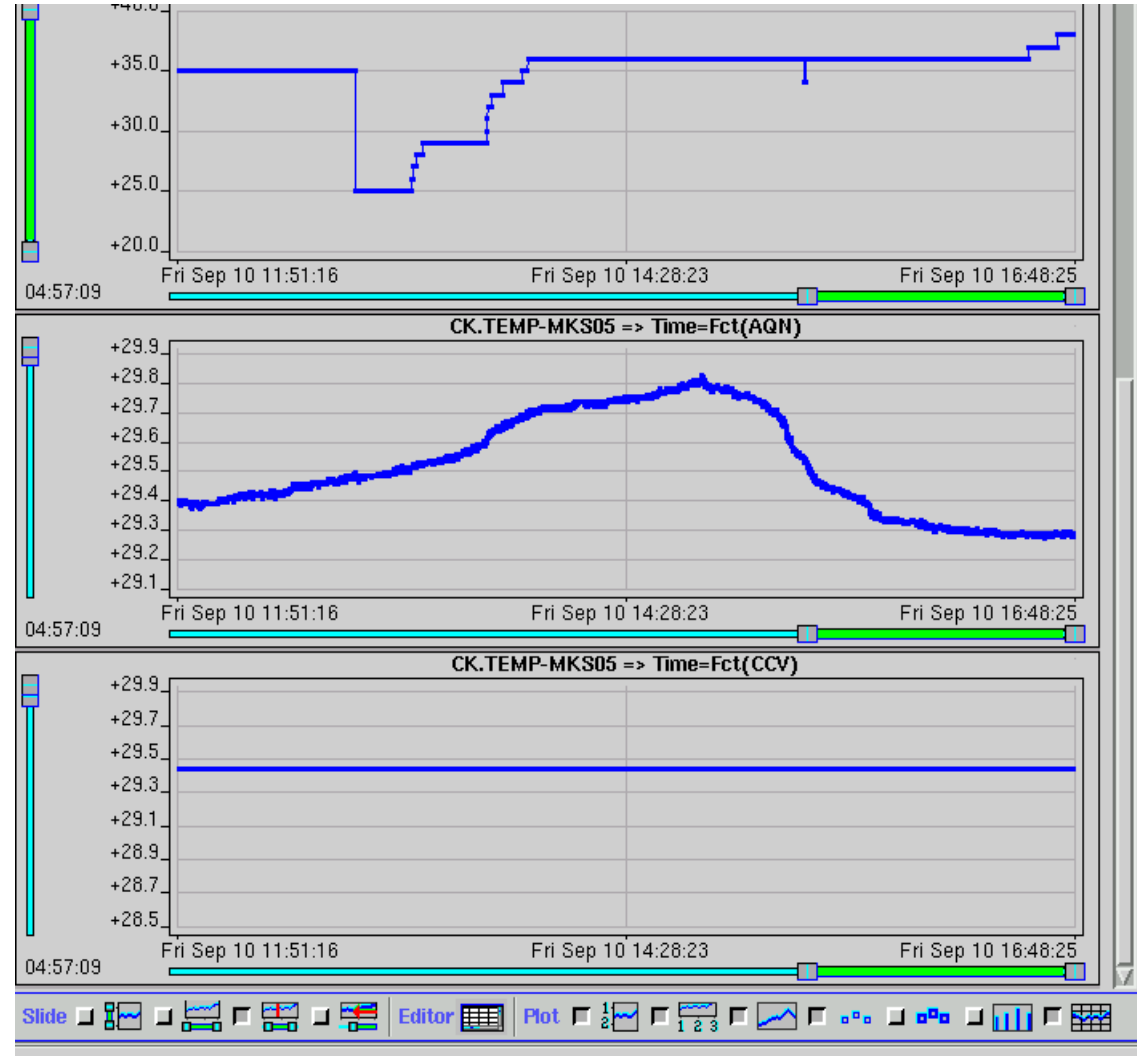


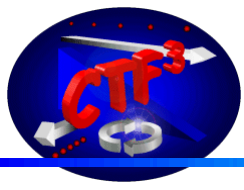


# Water Temperature



- RF pulse compression needs stable temperature ( $0.1^{\circ}\text{C}$ )
- large temperature variations observed
  - mainly after switch-on
  - without any changes
  - primary water circuit oscillations
- temperature regulation did not work properly



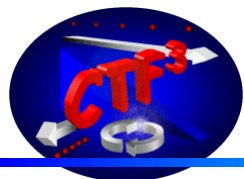


# Water Temperature (cont.)



- old **water stations not well adapted**
  - existing hardware (from LPI)
  - over-dimensioned
  - designed for stable running conditions
- **new water station** installed in summer shutdown
  - reaches set-point within  $0.05^{\circ}\text{C}$  in 2 minutes
- => temperature regulation is **not an issue any more!**
- compressed RF pulse shape **stable**
- **fast recovery after power level changes, klystron trips**
- permits stable PETS running

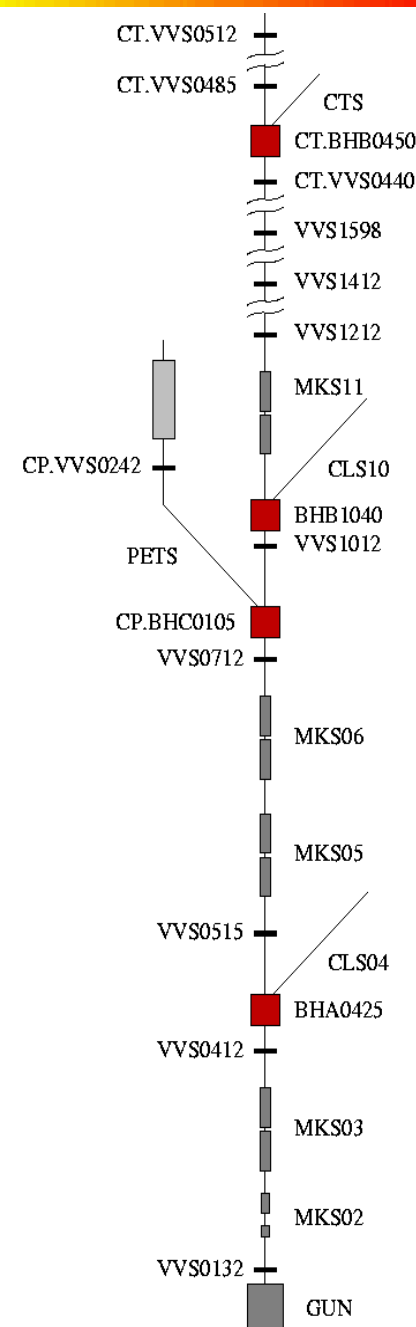


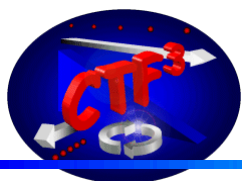


# Interlocks: Vacuum Valve Protection



- Avoid vacuum valve destruction and irradiation
- interlock
  - checks valve and bend magnet status
  - disables gun pulse when valve in the beam path is closed
  - hardware logic/PLC based (obsolete software version)
  - extended for DL this run
- works reliably
- new part not yet tested

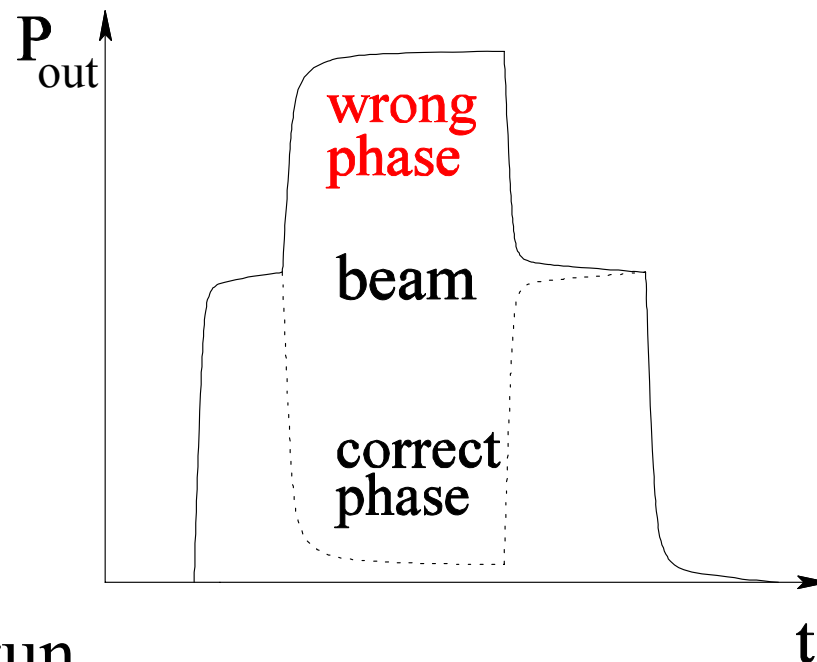


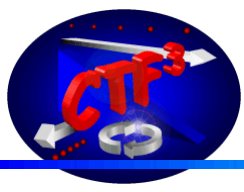


# RF (-> Gun) Interlocks



- avoid **beam loading** with **wrong phase!!!**  
=> overpower on RF loads
- RF phase depending on klystron output power
- modulators ramp up
- **interlock** to inhibit beam from the gun
  - during RF problems
  - when overpower detected at the load (needs manual reset)
  - (vacuum valve interlock)
- PLC/hardware based, working **reliably**
- Specialist application to enable/disable individual klystrons

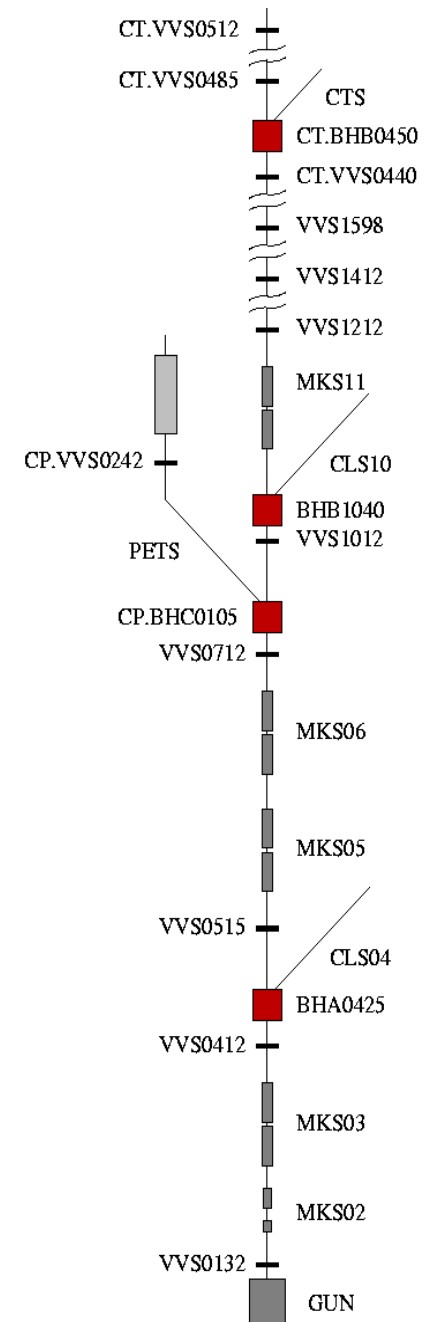


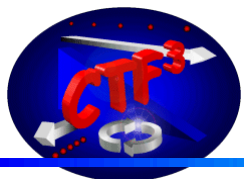


# Repetition Rate Interlock



- limit the radiation levels
- allow only  $\leq 5$  Hz except for PETS running
- Hardware:
  - check PETS and spectrometer 4 bend currents
  - gun: 200 ms gate to inhibit new pulse
  - no indication in control system
- Software:
  - bend currents and repetition rate check on timing front-end
  - disables gun start timing

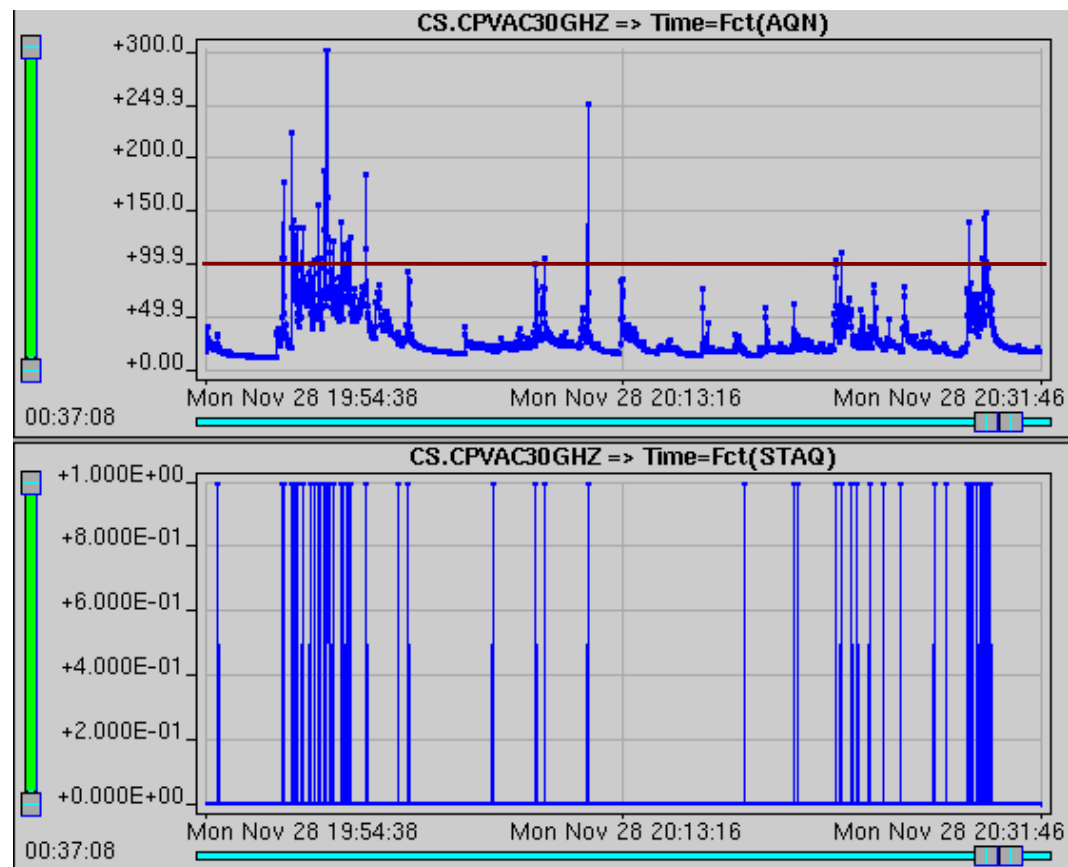
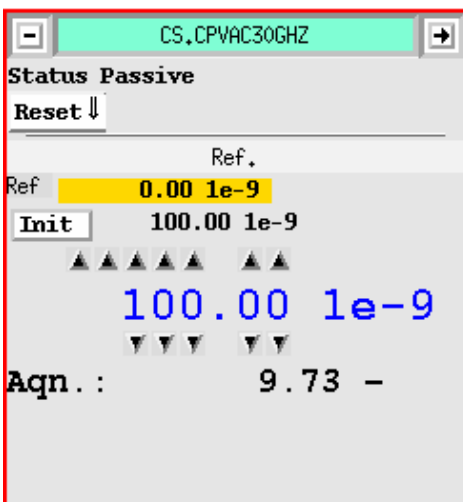


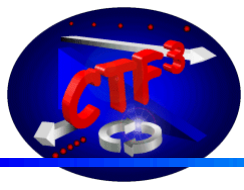


# Vacuum Level Interlock



- Used for 30 GHz RF conditioning
- Based on **vacuum gauge acquisition** for PETS, high power line and 30 GHz structure
- Low-level **software** on timing front-end
- Adjustable set-point
- Disables gun start trigger

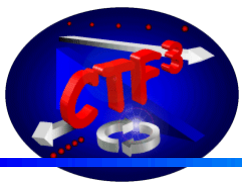




# Beam Loss Interlock



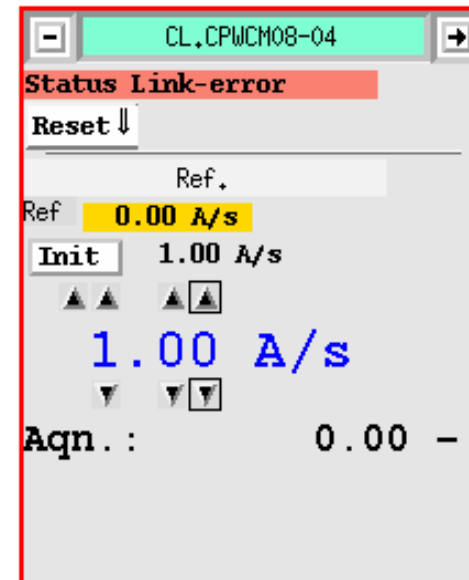
- based on **W**all **C**urrent **M**onitors
- detects current difference
- fast **electronics** inhibits the gun pulse (within the pulse!)
  
- present state:
  - WCM0490 and WCM0823 connected
  - tests performed and connected to the gun
  - occasional false triggers detected
    - lead to pulse length fluctuations for short pulses
- needs further development

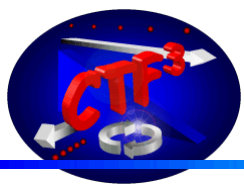


# Beam Loss Interlock (Software)



- based on WCM + BPM acquisition by sampling ADC's
- running on timing front-end
- low-level **software** calculates difference  $\times$  repetition rate
- disables gun start timing
  
- basic test set-up done
- but no systematic tests yet





# Conclusions



- a lot of progress
  - Power supply jitter
  - Gun stability
  - Water temperature regulation!!
- Interlocks
  - Work well
  - Need better visibility

Thank you all  
for your  
collaboration!!!