

Tune and Chromaticity Tracking at CERN

C.Y. Tan

People working on this

- Rhodri Jones (Leader)
- Ralph Steinhagen (PID parameters optimization)
- Marek Gasior (Analogue design)
- Andrea Boccardi (FPGA design)
- Krzysztof Kasinski (Labview frontend)

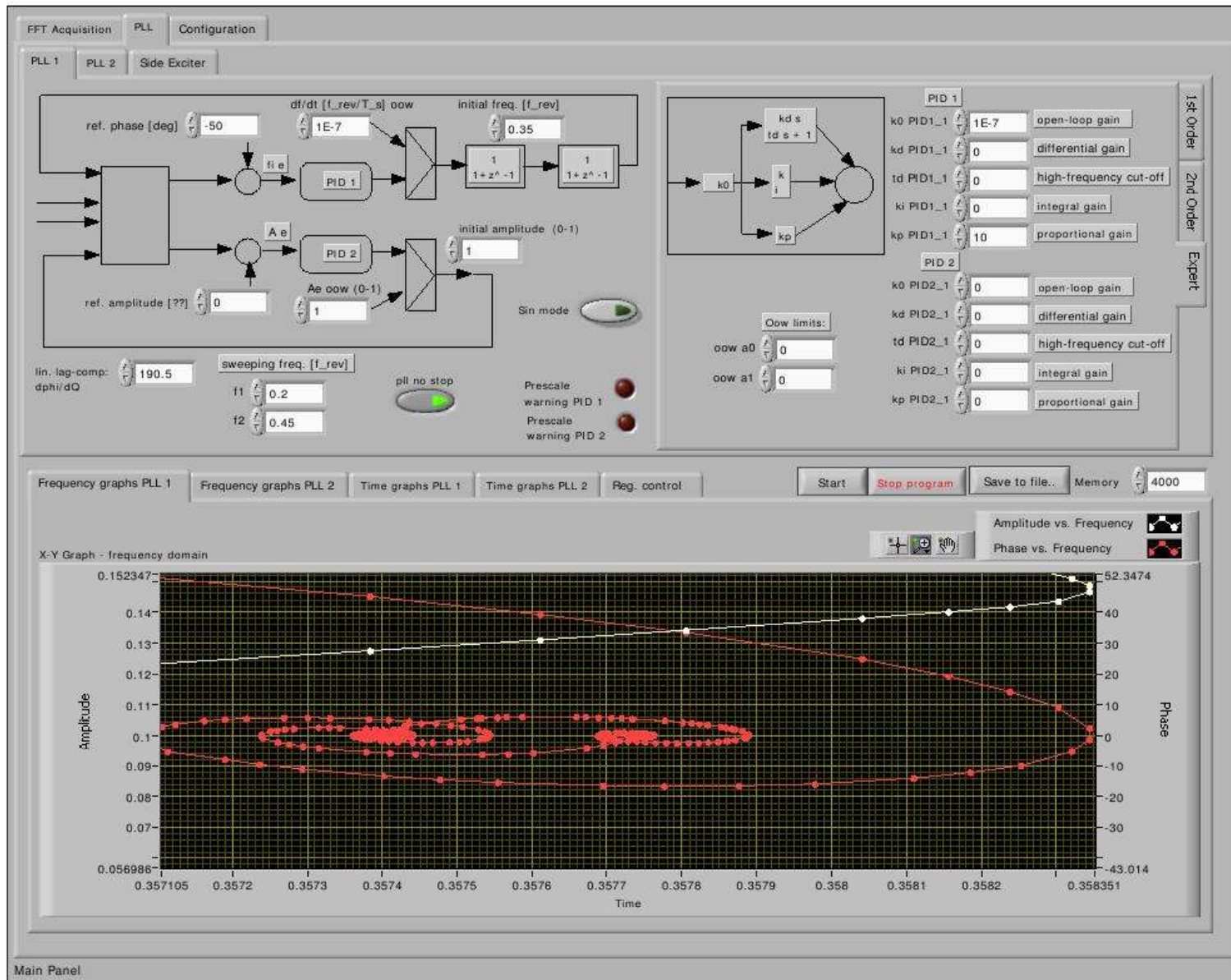
Tracking on the bench



Phase of the
tune tracker as it
spirals into lock

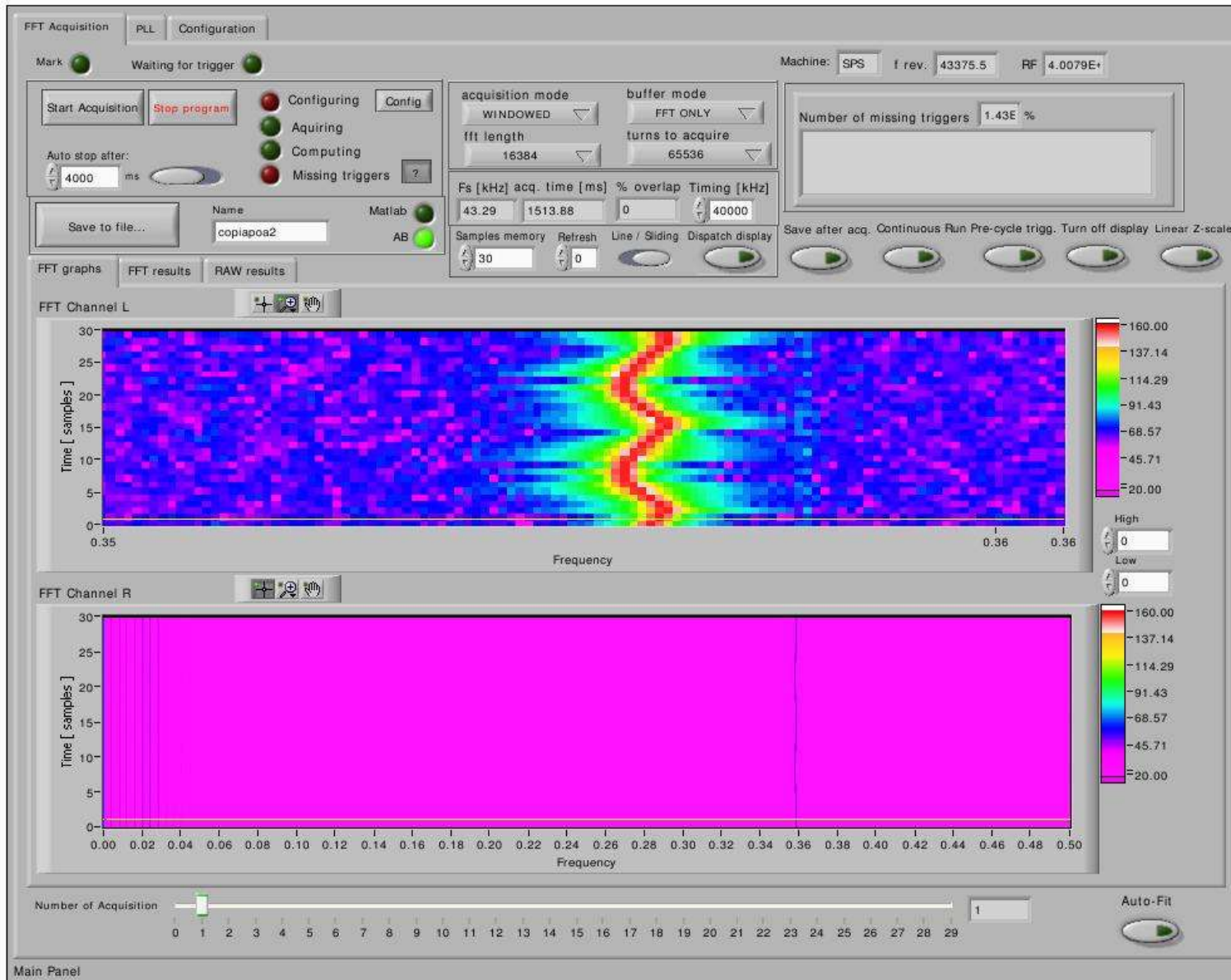
Tracking on the bench II

Spiralling in when there is a frequency jump in the resonance.

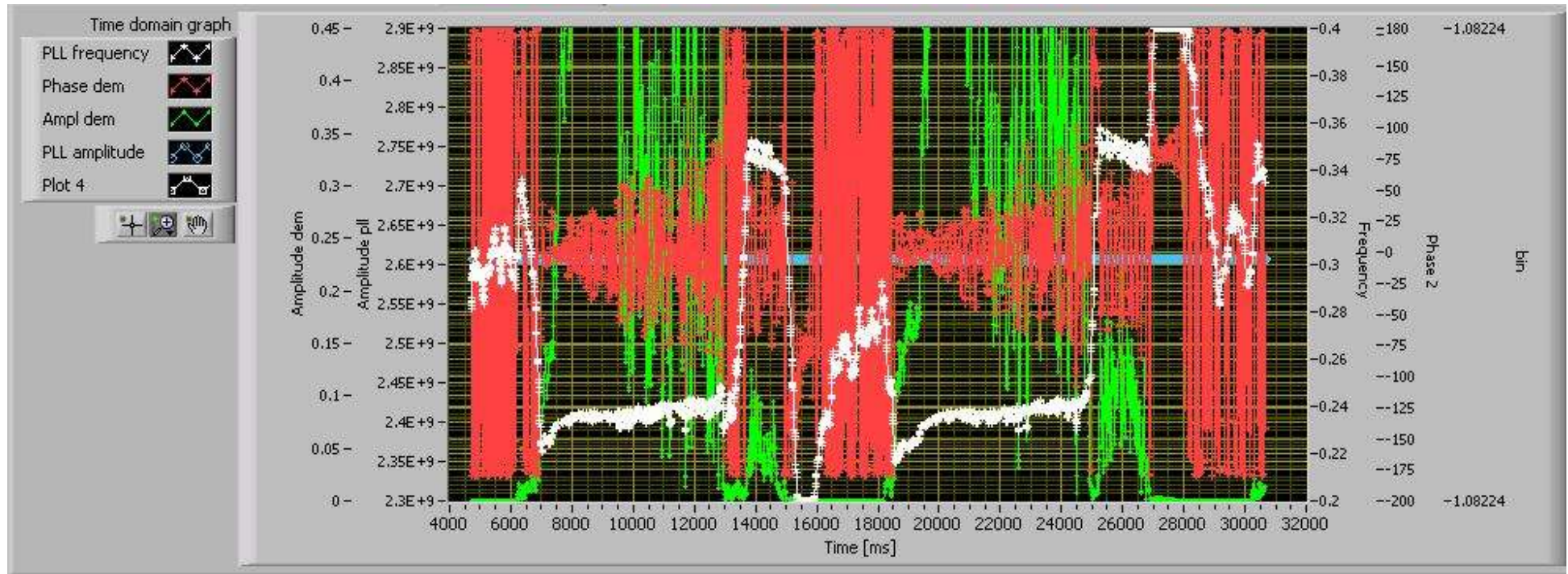


Tracking on the bench III

Tracking
when
resonance
moving
sinusoidally.



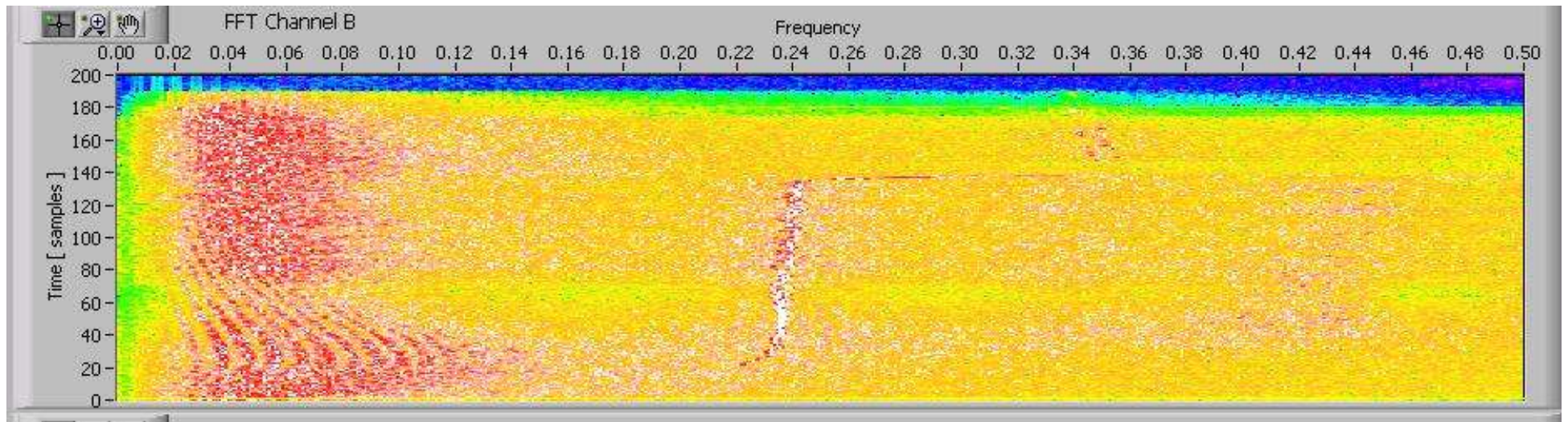
First Successful Tracking on 21 Sep 2006



Demonstration of tracking horz tune on a fast ramp (~ 10 s). (white trace)

26GeV and ramped to 450GeV. The total beam intensity was about 3×10^{12} protons. The initial tunes were about $Q_h = 26.76$ and $Q_v = 26.83$. The PLL tracked the tunes well throughout the whole cycle, including the slow extraction at top energy that was performed by moving the horizontal tune first fast across and then slowly towards the third order resonance (26.66). The fastest tracked tune changes were about $\Delta Q = 0.1$ within a few ten ms - much faster than the maximum expected tune drift in the LHC! - R Steinhagen

Another View



Water fall view

Chromaticity Tracking

- Many ways to do this
 - Traditional slow RF frequency modulation
 - McGinnis Method (phase modulation)
 - Head tail using
 - strong kicks and stripline
 - Weaker kicks with 3D-BBQ
 - Continuous head tail
 - 3 tone method. (R. Steinhagen)

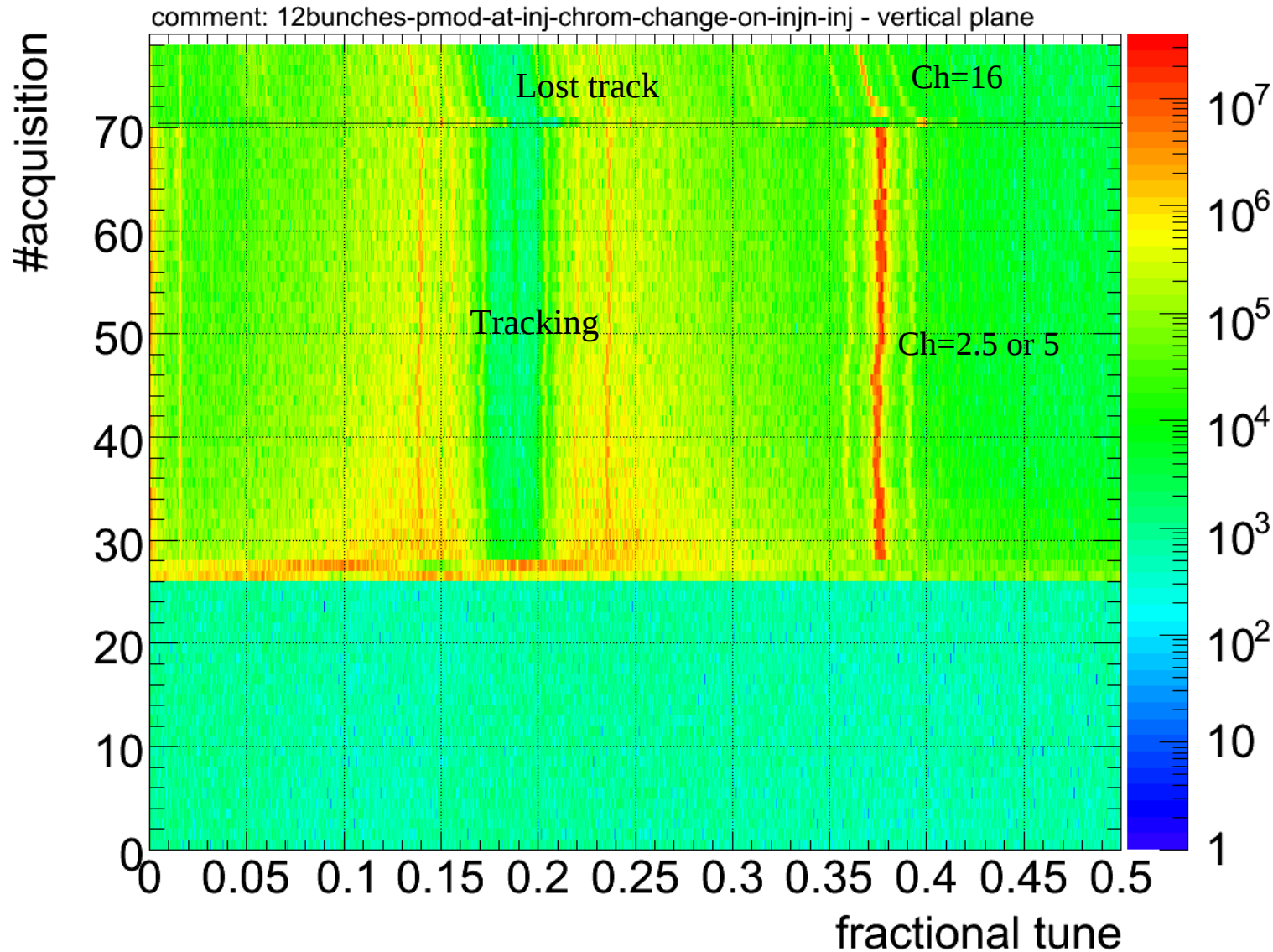
Chromaticity Tracking with McGinnis Method

- Vert chromaticity used
 - Changed chroms by 2.5, 5, 13.
- Using McGinnis Method: Seems to be a factor of 3.5x to 4x too small.
 - Problems: experiment done with ramping machine. Chromaticity changes were rather fast --- ms jumps and 1.5s at that chrom. Too fast and therefore not settling.
 - At higher chroms, TT did not have enough gain to track correctly.

Details

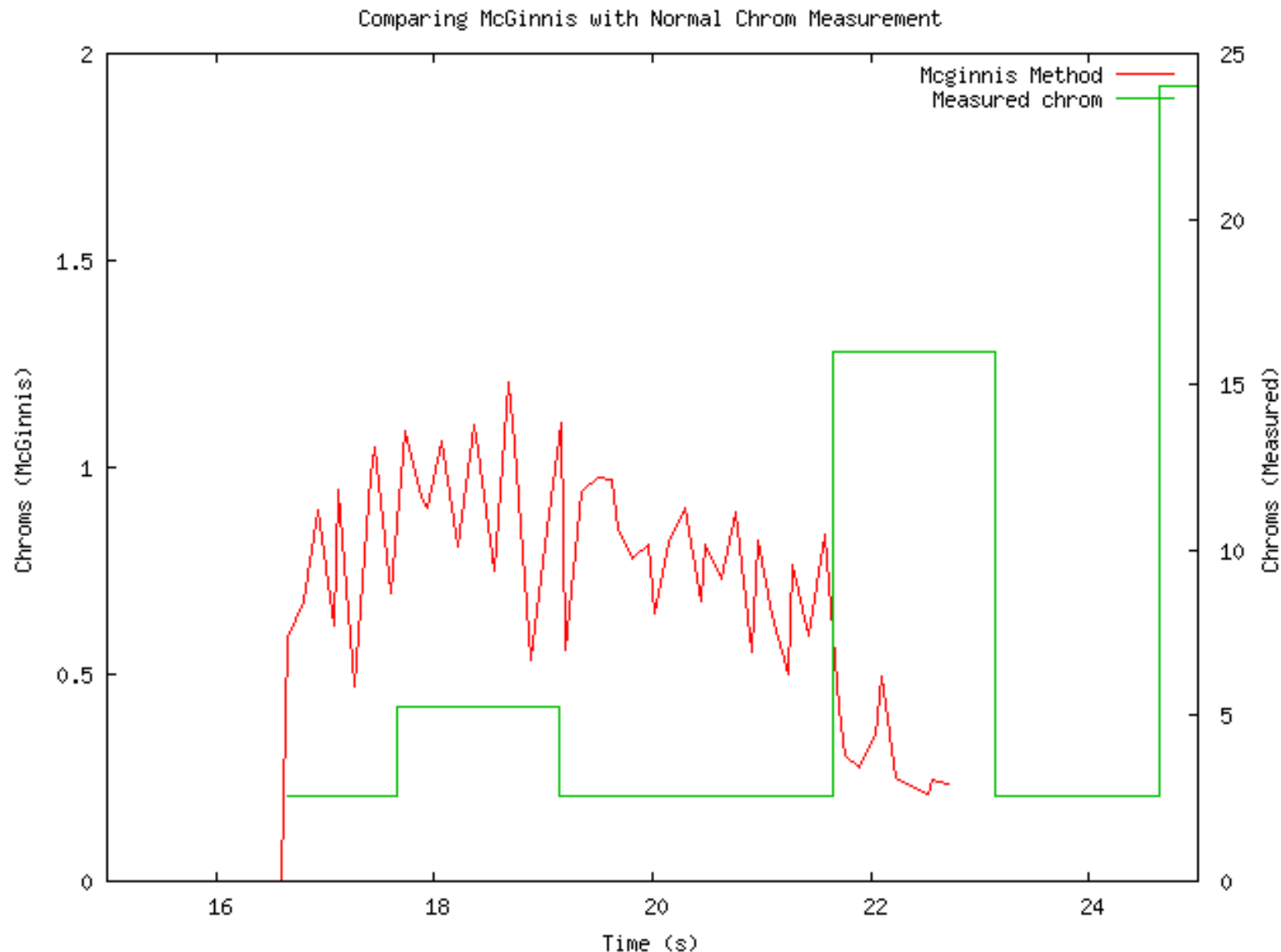
- Modulated RF at 700Hz with $\phi_{\text{max}} = 1$ deg.
- Betatron tune demodulated using $\sin \phi$ rather than ϕ , so there is at least a 4% error.
- SPS Parameters:
 - $h=4611$
 - 0.0062

Waterfall Plot



Note that high chromaticity ~ 16 units, TT is not tracking well for high chroms, because it was optimized for low chromaticities

McGinnis and Traditional Compared



McGinnis
too small!

Conclusion

- Tune tracker in good hands at CERN
 - Small bugs here and there but in general working.
- McGinnis method
 - Not so successful
 - At least we see a peak at the modulation frequency.
 - We want to try it again in November. Perhaps using LHC@FNAL.