Digitizers in CCR for transverse wide-band pick-ups

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Acknowledgement:
T. Bohl, G. Kotzian, G. Papotti, U. Wehrle

SPS Exponential couplers (BPW)
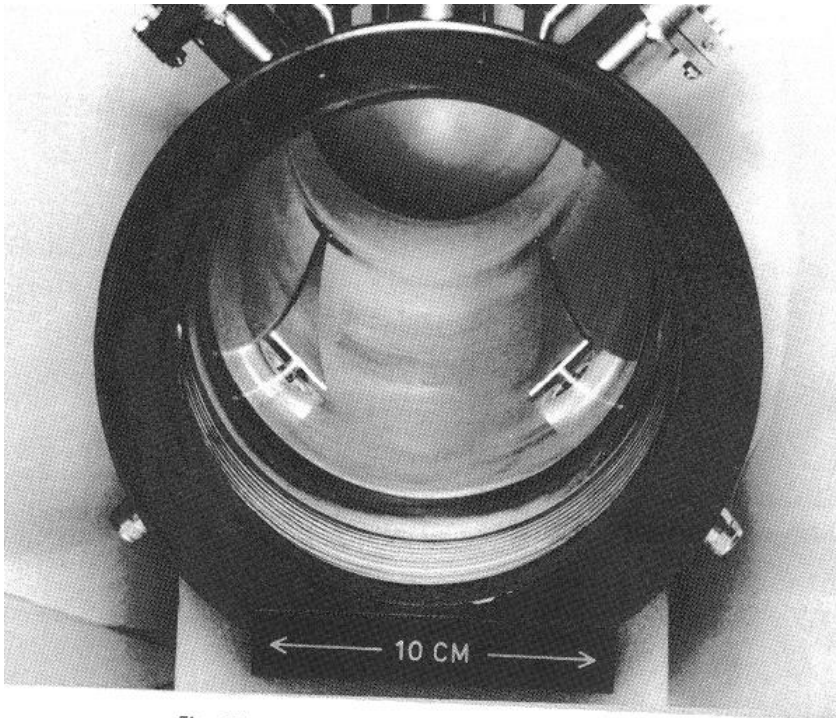

Fig. 3lb – Interior of directional coupler pick-up

Fig. 27 – Response of couplers with different decay constants
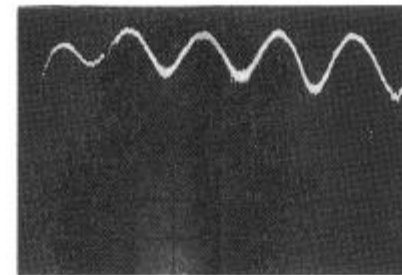
Fig. 37 – Frequency response of sun signal from directional coupler pick-up
200 MHz/div   2.5 dB/div

Four such couplers installed in SPS (four electrodes at 45 degrees)
hybrids and cables checked and their transfer functions measured in March 2008
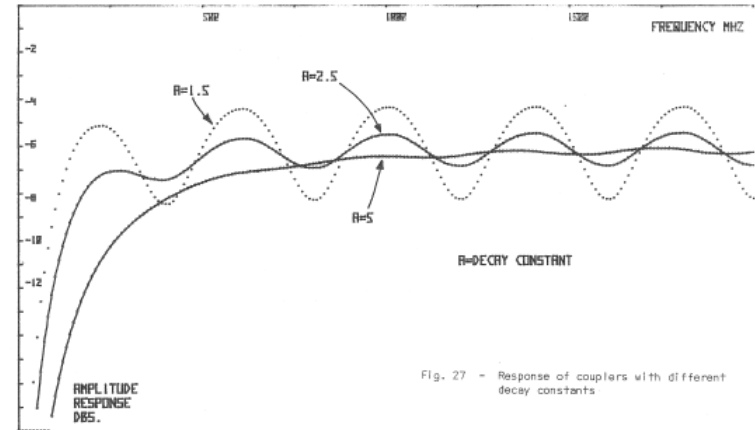(R. de Maria, Gerd Kotzian)

Developed for SPS by T. Linnecar,
Reference: CERN-SPS-ARF-SPS/78/17

phase response not linear frequency !

Potential of BPW pick-ups (1)
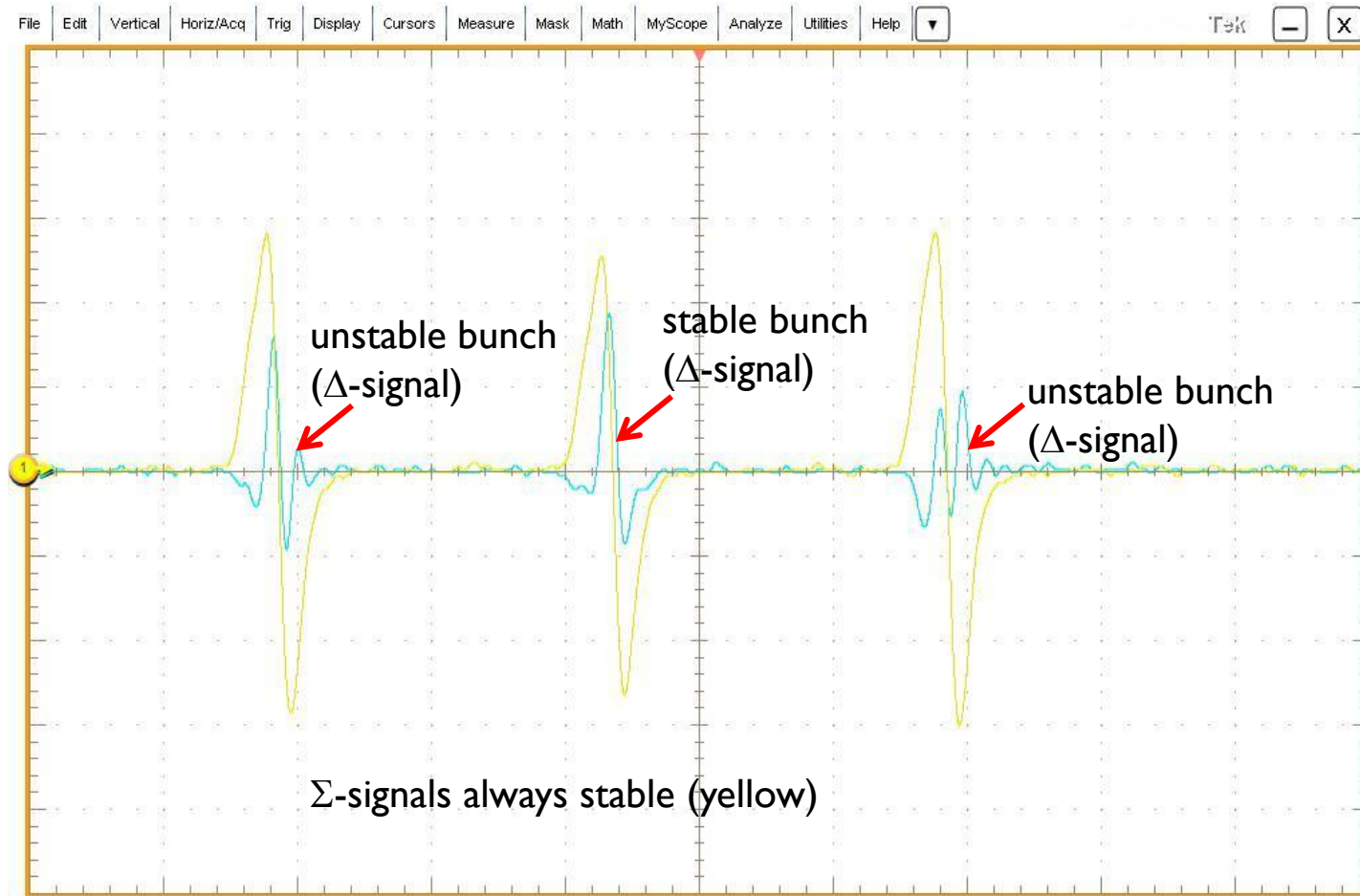
Instability at injection of 5th batch (2008 scrubbing run)   10 ns/div   BPW 319.01
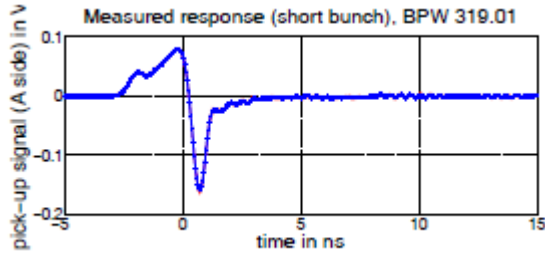
Potential of BPW pick-ups (2)

Σ-signal (equilized)

Δ-signal (equilized)

selected bunch
subject to
e-cloud instability
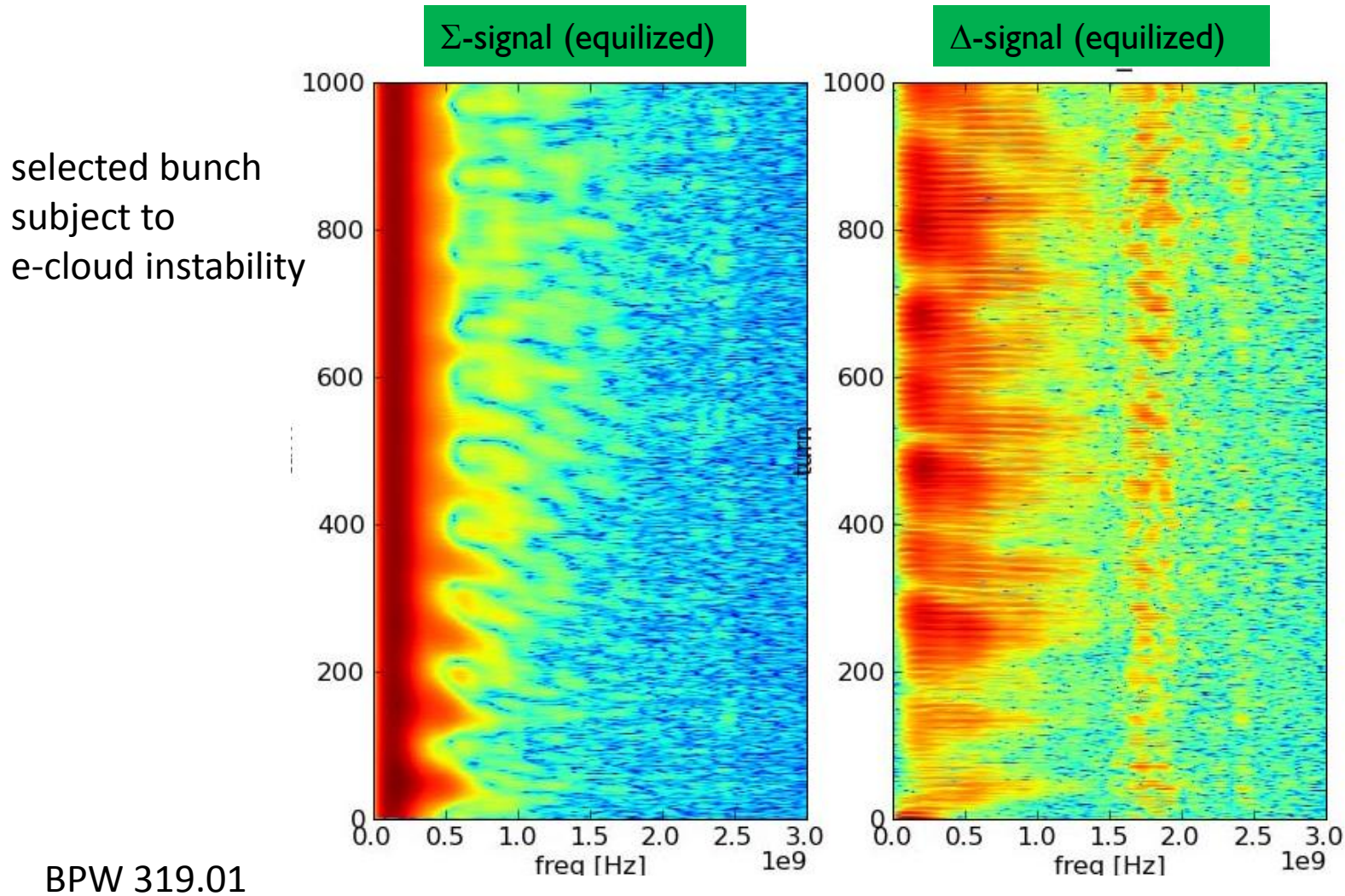
BPW 319.01

(data from scope, 2008-2009)

R. De Maria et al., DIPAC '09 MOPD17

Equalization of response

Measured response (short bunch), BPW 319.01

measured with
short bunch

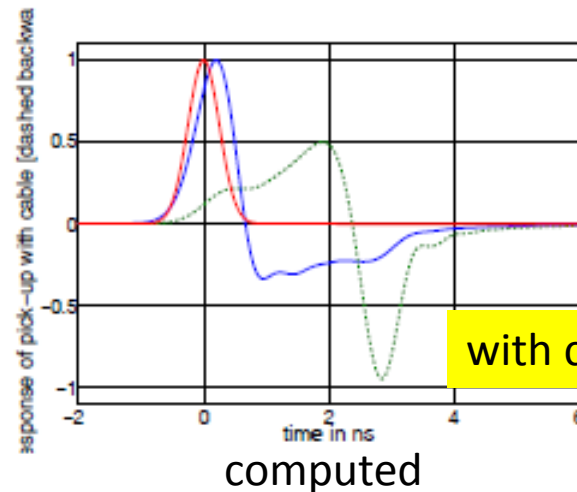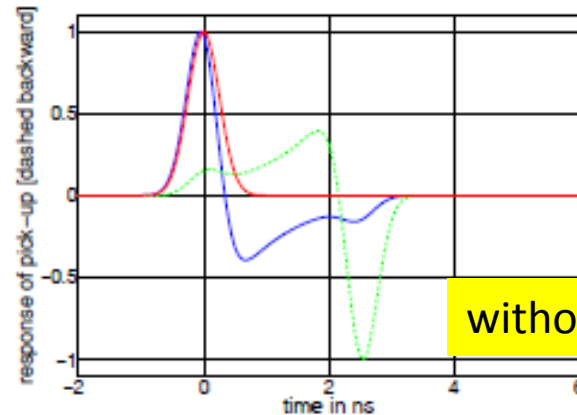BE-RF-FB provides algorithms
for analysis (equalization)

implementation for online diagnostics t.b.d.

BPW   319.01 to FC: (reverse installation) → now kicker HBFB
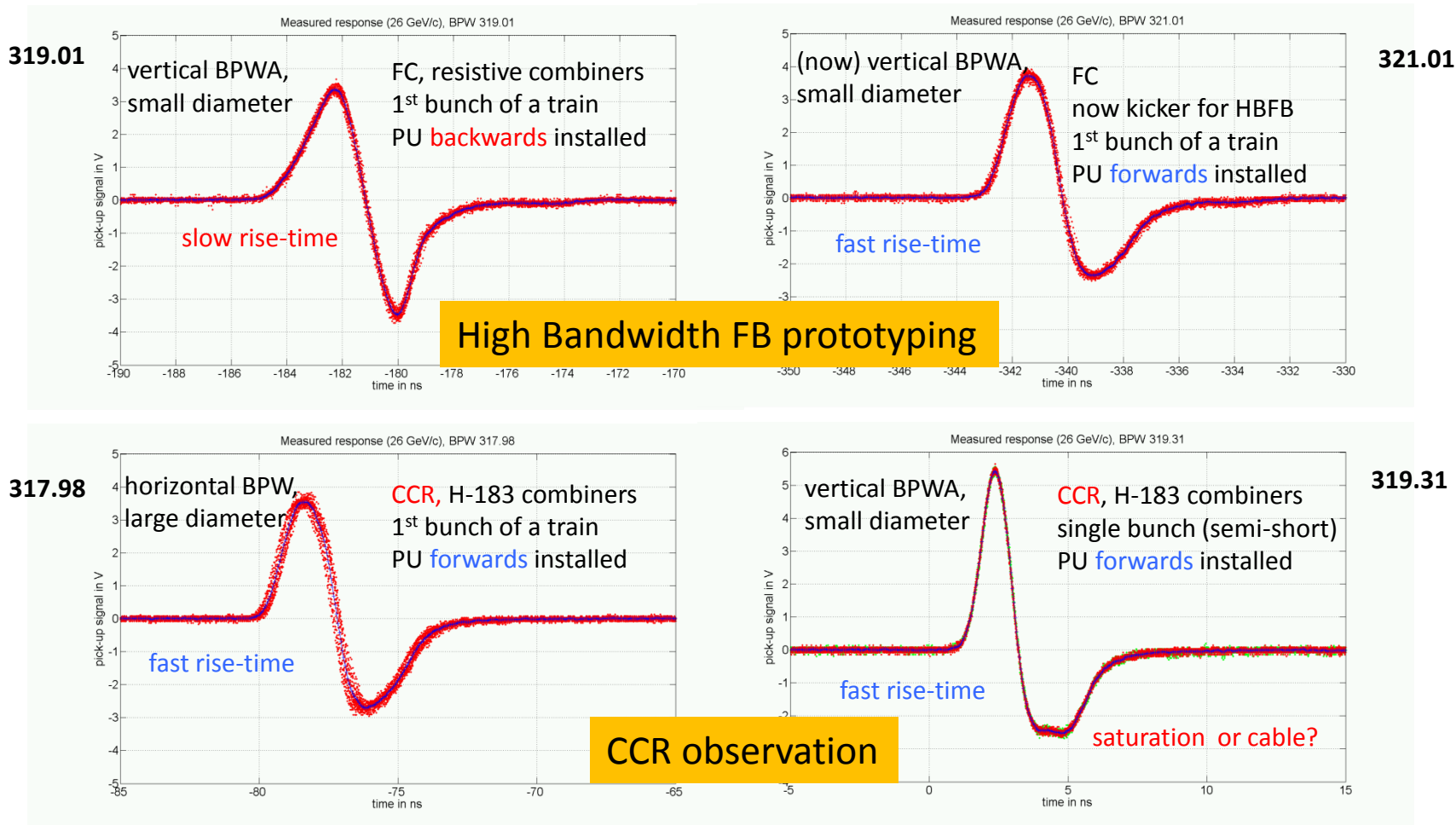BPW   321.01 to FC: PU for HBFB
BPWA 317.98 PU H observation CCR (larger diameter)
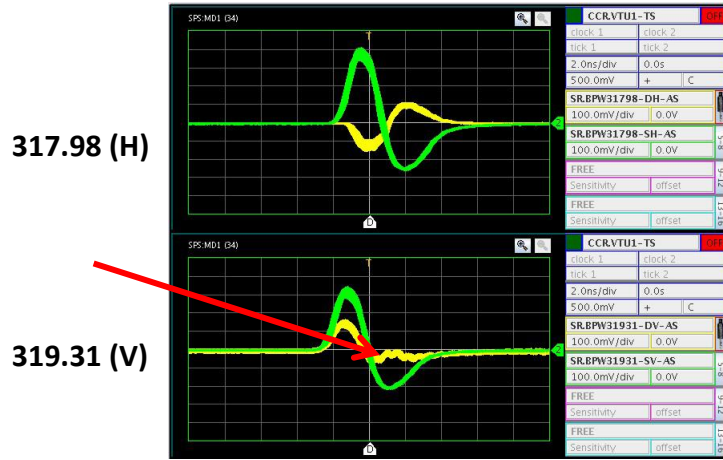BPW   319.91 PU V observation CCR → moves to 311.01 in LS1

without cable

with cable

computed

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Measurements on all four exponential couplers in the SPS (data from November 4th, 2008)

319.01 vertical BPWA, small diameter / FC, resistive combiners / 1st bunch of a train / PU backwards installed / slow rise-time

321.01 (now) vertical BPWA, small diameter / FC now kicker for HBFB / 1st bunch of a train / PU forwards installed / fast rise-time

High Bandwidth FB prototyping

317.98 horizontal BPW, large diameter / CCR, H-183 combiners / 1st bunch of a train / PU forwards installed / fast rise-time

319.31 vertical BPWA, small diameter / CCR, H-183 combiners / single bunch (semi-short) / PU forwards installed / fast rise-time / saturation or cable?
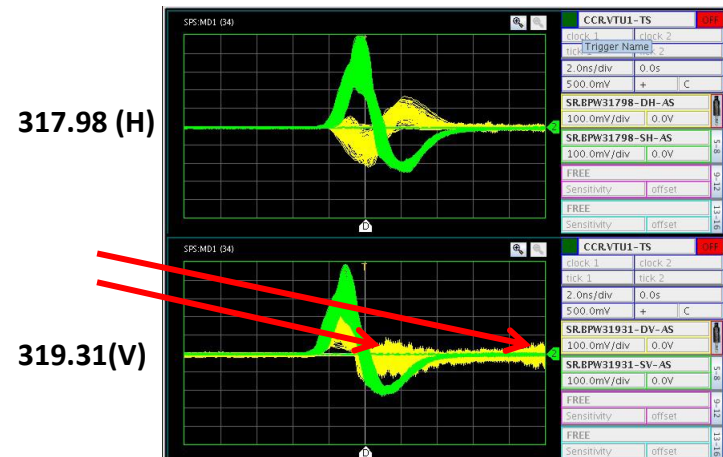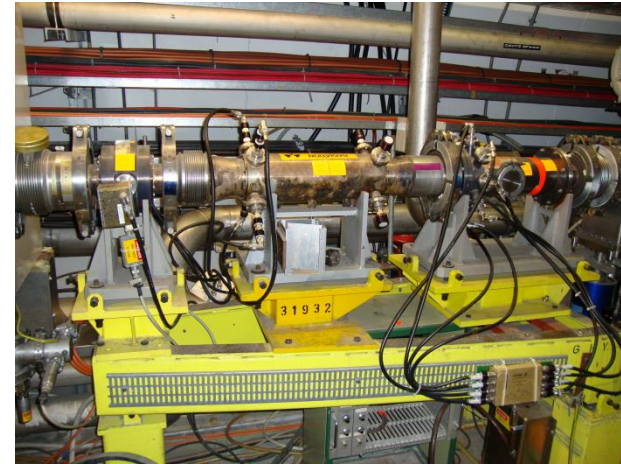
CCR observation

1st bunch of bunch train oscillates -> jitter in measurement; single bunch -> no jitter

Issue with BPW 319.31 fixed in LS1

317.98 (H)

319.31 (V)

after injection, stable beam

317.98 (H)

319.31(V)

injection

hybrid was faulty
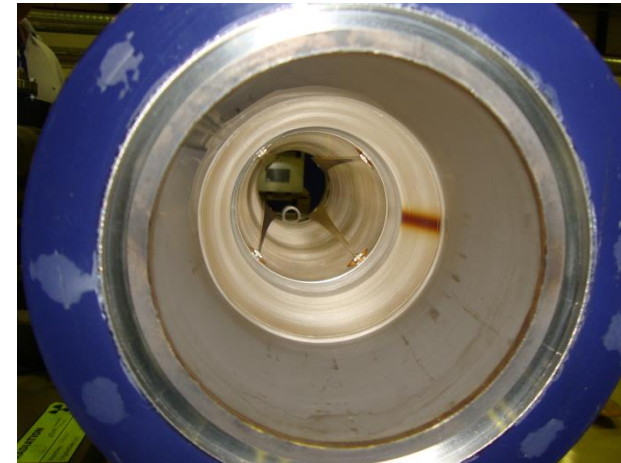
Courtesy: T. Bohl, U. Wehrle

LSS3 layout during LS1 - changes

BPW 319.31 to 311.01

AEWB 319.32 to 315.02

New delay loop in CCR

BC RA 7411

Delay equalization
(time of flight compensation)
BPWA 317.98
BPW   311.01

Digitizers and triggering in CCR

Digitizers in CCR (cPCI)

Trigger Generation in BA3 FC
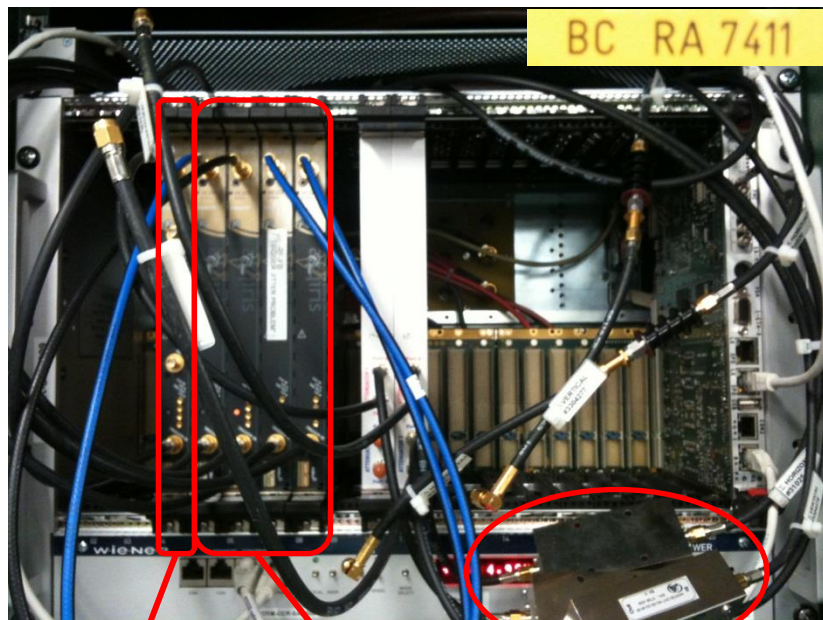
attenuators

1 digitizer to OASIS
Acquiris DCS282
connected
to long. PU AEWA.309
(not discussed here)

4 digitizers to OASIS
Acquiris DC222
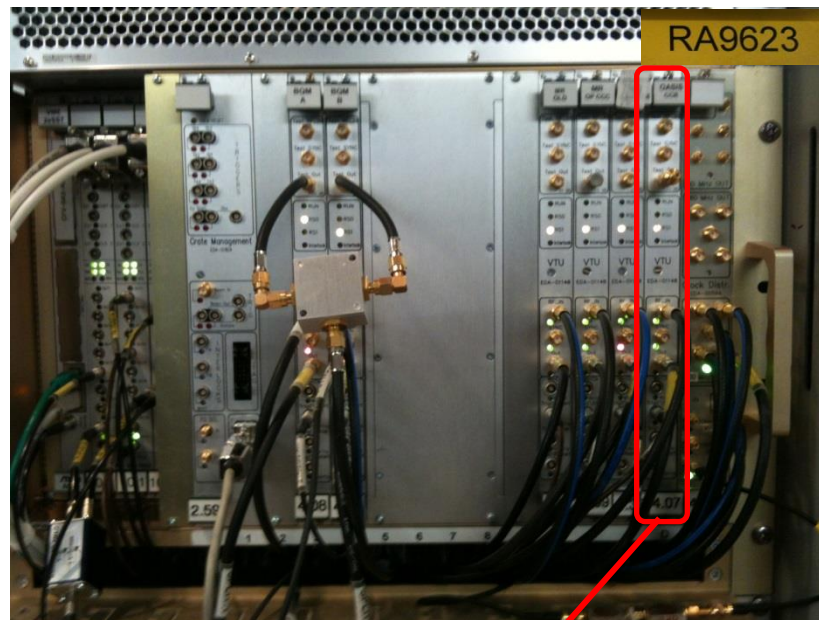for transverse plane
- **32 MPoints each**
- 10 bit (t.b.c.)

VTU, Fesa class (BE-RF-CS),
to select and adjust turn triggers
- which user
- which injection(s)
- azimuthal position of trigger (bucket)
- number of triggers, delays (every n^{th} turn)

Digitizers for transverse observation:
new proposal for their use

OASIS
- general purpose virtual scope
- same interface across machines
- some limitation in data handling

Dedicated Software
- to be tailored to digest 4x32 MPoints (Giulia checking data transfer through cPCI)
- equalize data and display "online"
- enable 10 bit resolution (?)
- interpolate between samples to align with respect to trigger
- display data shot-by-shot
- log data shot-by-shot during critical periods for MDs or for scrubbing
- invaluable data for injection transients statistics
  - → needed for high bandwidth damper specs
- fixed mode injection: ~12 µs / turn, 96'000 points per turn (8 GS/s), ~300 turns
  - → 6 batches of 72 bunches can be recorded with all bunches
- flexible operation for MDs with programming:
  - number of points per turn
  - number of turns
  - position of trigger with respect to injection

Follow-up and Actions

Agreement needed
- take out the four transverse digitizers from OASIS → enabling Giulia to develop dedicated application
- install additional single card cPCI crate for long. Digitizer (RF can pay, *if needed*)
- migrate OASIS for long. card to new crate (CO) *if needed*

Dedicated Software (Giulia et al.)
- define with users functionality
- agree where to log data (logging enable and disable function needed)
- agree with BE-RF-CS on support for programming if needed
  (for example for a small application to program the VTU and the attenuators)

Commissioning
- tuning of equalization following single bunch measurements
- calibration with orbit bumps (to get true mm)

Added value for operations and MDs
- transverse instability diagnostics for LHC beams at injection, in particular scrubbing
- independent observation during high bandwidth feedback studies
- injection transients and kicker spikes monitoring for operations

Let's Discuss
The next steps