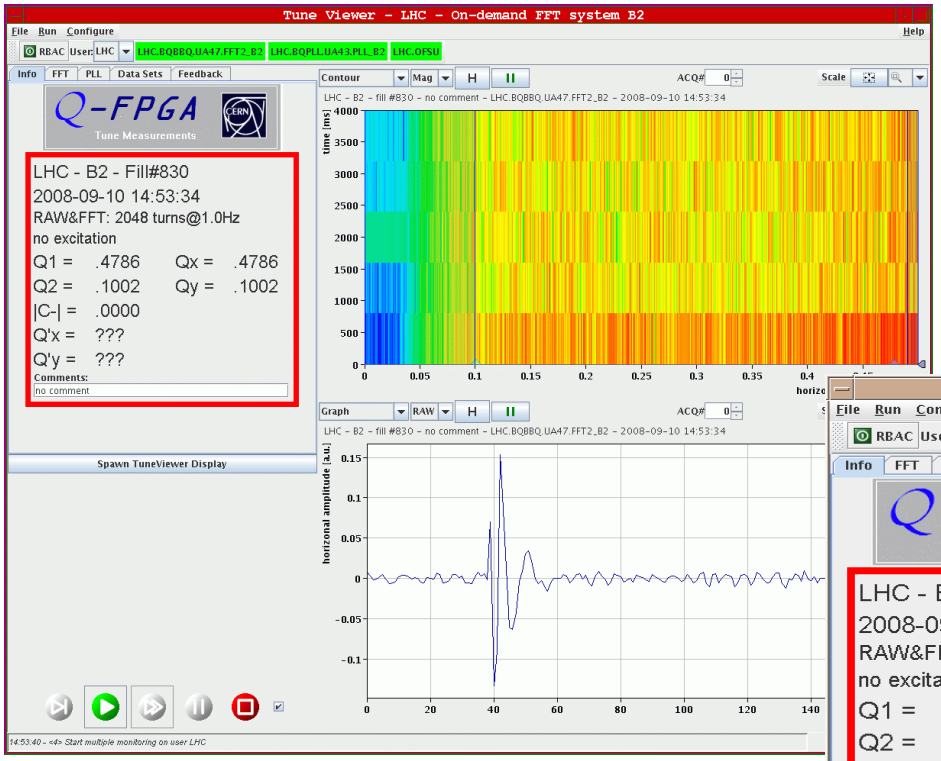
LHC Orbit Feedback
- Tested data concentration of 120 front-end systems

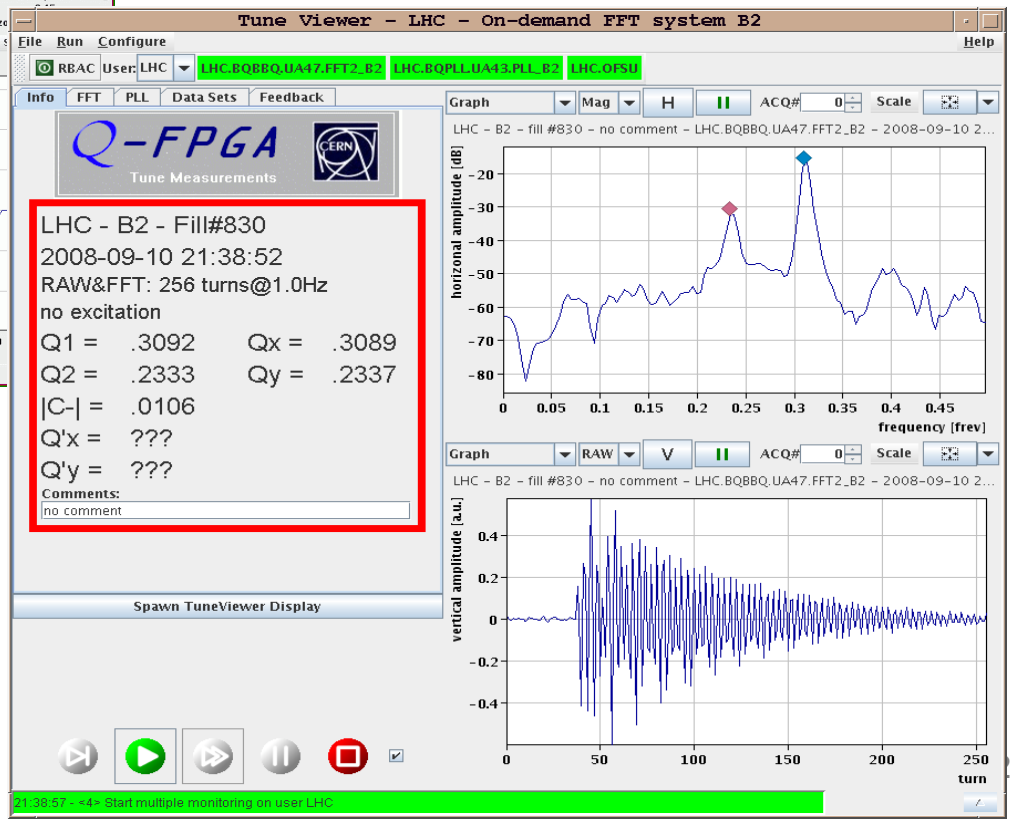
Present Commissioning State

- BBQ systems for B2 include excitation and correction fully commissioned!

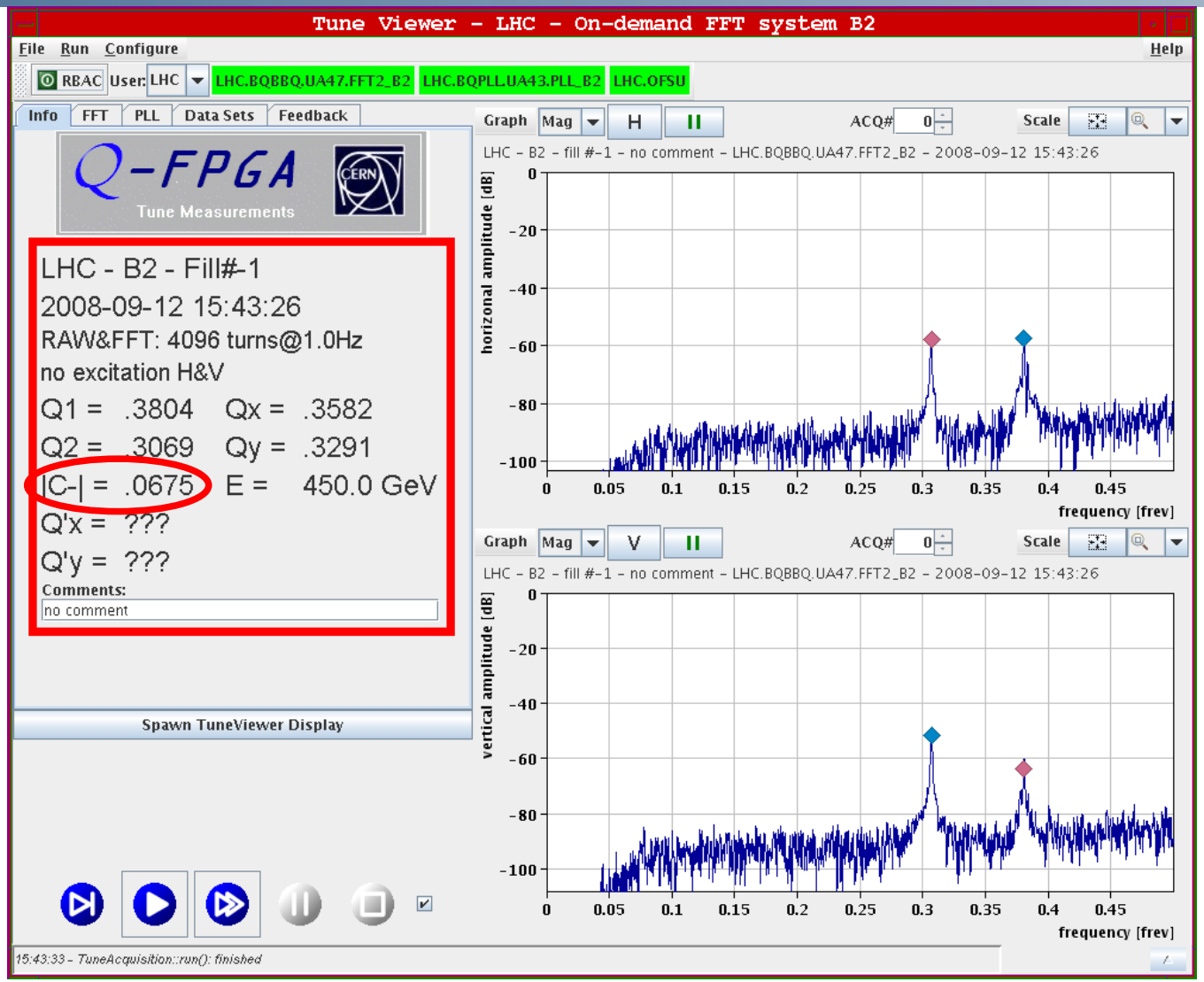


Very first turn!

first circulating beam...

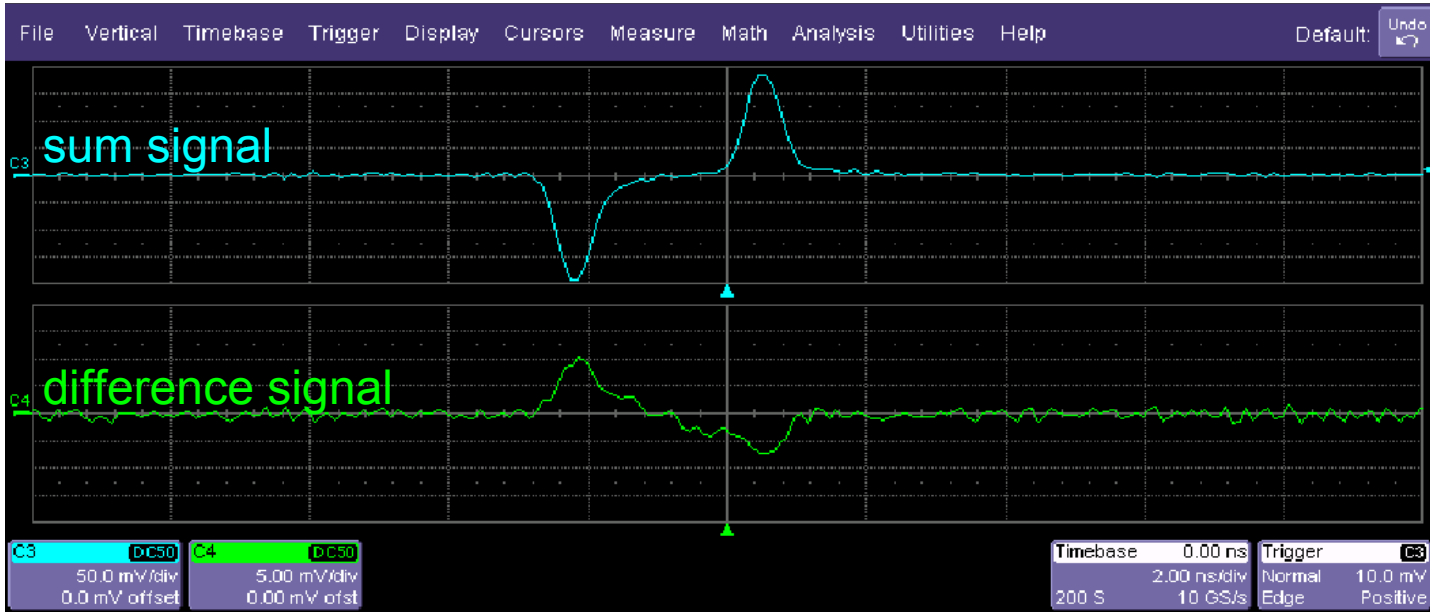


Present Commissioning State
... lots of first: coupling measurement



BI's Wall-Current and Head-Tail Monitor

- Tested that detectors are alive and trigger on given timing event
  - Some software tests/adjustments pending
    - one full acquisition presently results in about 1 GByte of data
    - optimisations in the pipe-line (lower priority)
      - optimised memory usage
      - optimised/simplified GUI for the WCM
    - Otherwise: same functionality/state as SPS Head-Tail system



Conclusions I/II – Things done

- Base-line FFT tune acquisition commissioned for B2
  - used to establish circulating beam (tunes were off by up to 0.5)
  - tested polarities, gains, timing
  - tested RF damper polarities, rough amplitude calibration
    (used about 10% of one out of two damper driver modules)
    - Now LHC's baseline exciter for Q measurements
  - tested semi-automatic Q and Q' correction schemes (via LSA)
  - tested MKQ trigger & kicker response (synchro-delay adjustments pending)

- Orbit Feedback:
  - good BPM readings, permitting fast commissioning of circulating beam
    - practically all BPM triggered with intensities down to ≈10^9 protons
    - no obvious polarity, calibration or mapping errors found!
      - We are very lucky and should all play the lottery more often!
    - BPMs revealed that machine optic non-linearities above ≈15 mm are non-negligible w.r.t. optic and orbit correction.
  - Data concentration and error/fault filter operational

Conclusions II/II
- Things to be (Re-) Done

- Full commissioning of B1 FFT1 & FFT2 BBQ systems
  - first turn works (all detectors alive), plane pending
  - otherwise same procedure as for B2:
    - damper polarities, amplitude calibration, ...
- Full commissioning of B1 and B2 BBQ Phase-Locked-Loop Systems
  - pre-requisite for first ramp!
- Test of (semi-) automated Q' & C^- measurement and correction procedures
- Feedbacks
  - 750/1060 COD polarity and optic checks with beam pending
  - Quadrupole & sextupole circuit mapping/polarity checks with beam
  - test of > 1300 power-converter real-time inputs (AB/PO)
- Training of LHC operators & EIC's
  (ongoing, some have never seen/measured/corrected Q/Q' and even less C-)

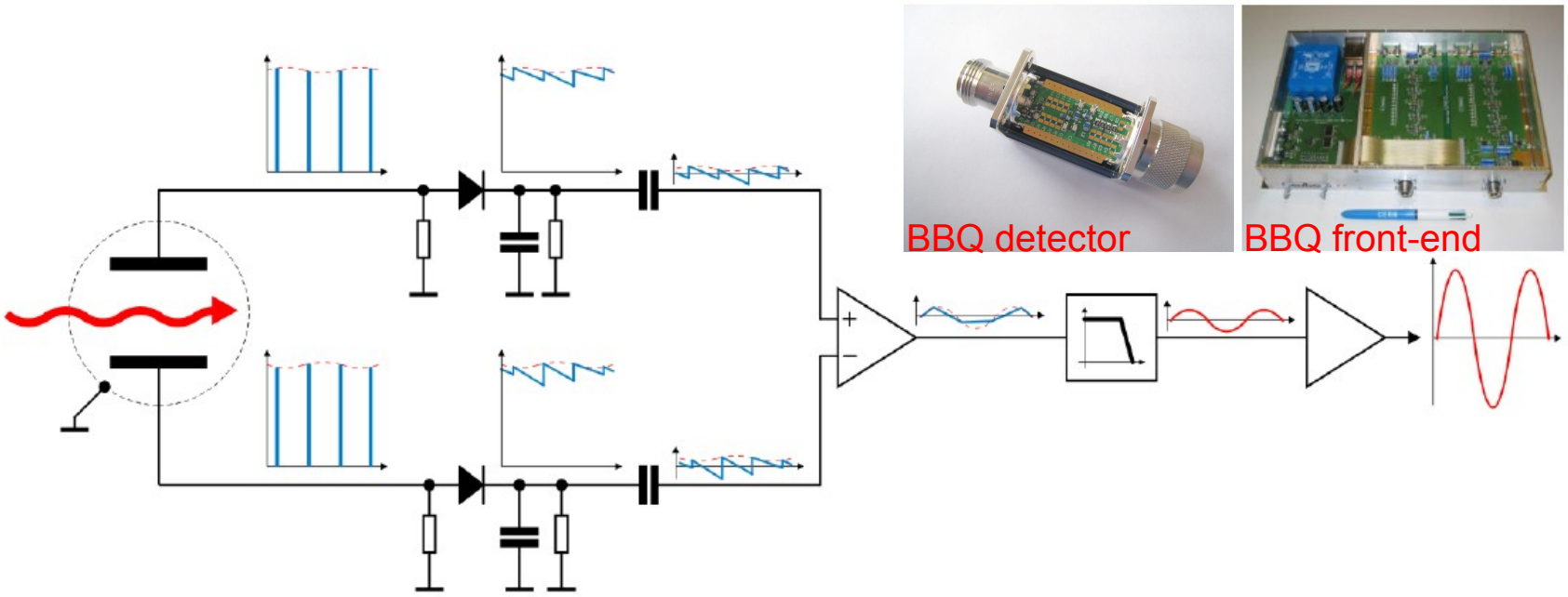
Additional slides for info and future presentations

Outline

- Please, also have a look on recent Q/Q' CARE workshop, in particular the following presentations:
  - BI-SW LIDS:
    - FFT: click here or here (non-LHC systems)
    - PLL: click here
    - Radio LHC: http://cs-ccr-samba1.cern.ch:8001/
  - Base-Band-Tune (BBQ) principle:
    http://adweb.desy.de/mdi/CARE/chamonix/071212_chamonix_bbq.ppt
  - LHC PLL principle:
    http://adweb.desy.de/mdi/CARE/chamonix/LHC_PLL.ppsx
  - LHC Tune/Chromaticity (FB) Control:
    http://adweb.desy.de/mdi/CARE/chamonix/2007-12-12_Qp_workshop_Chamonix_FB_Architecture.pdf

... Feedback Diagnostic Tutorial will come at a later stage

LHC Q Base-Line Q Instrumentation
Back-bone: Base-Band-Q Principle on a Slide

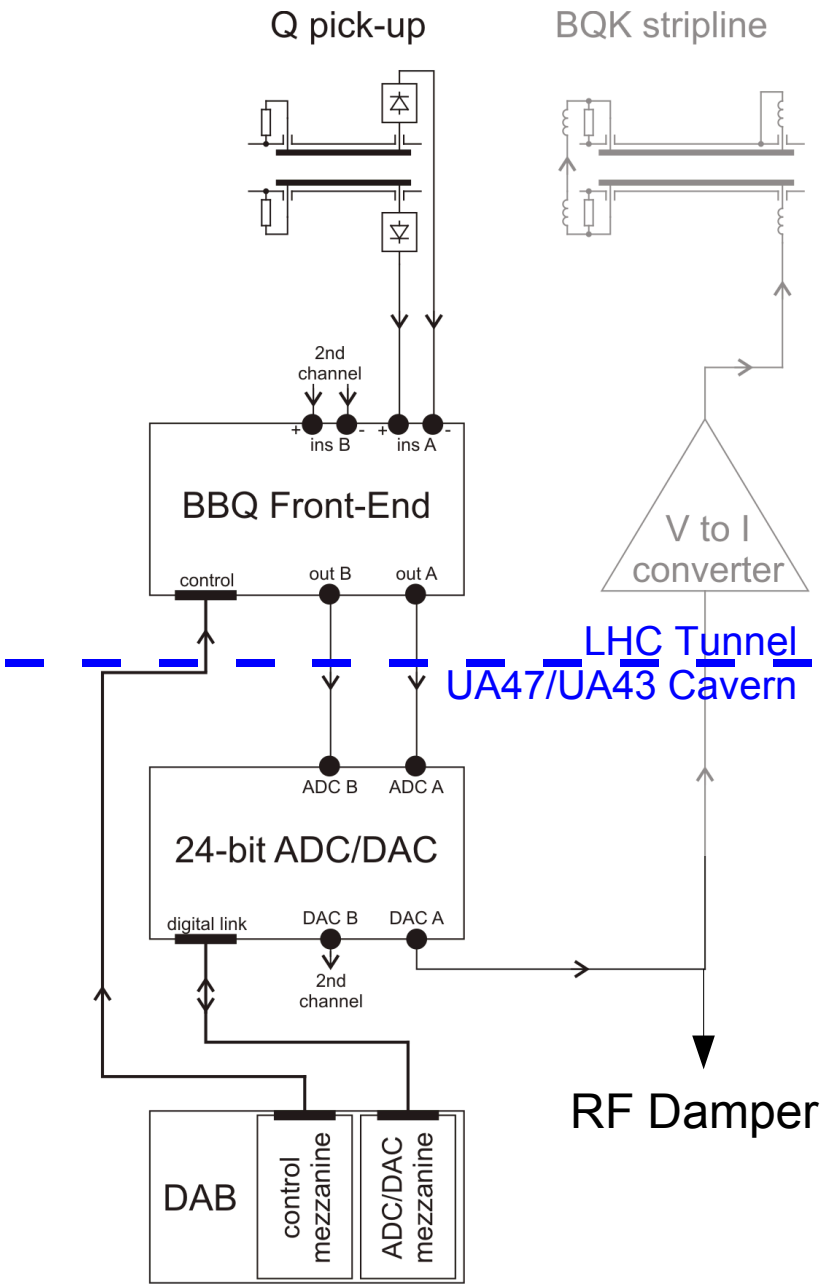


- Basic principle: AC-coupled peak detector
  - no saturation, self-triggered, no gain changes between pilot and nominal
  - intrinsically down samples spectra: ... 6 GHz → 1kHz ... f_{rev}
    - Base-band operation: very high sensitivity/resolution ADC available
    - Measured resolution estimate: < 10 nm → ε blow-up is a non-issue
- One of the few turn-key systems in the LHC
  - easy/very fast commissioning – done in parallel with RF capture

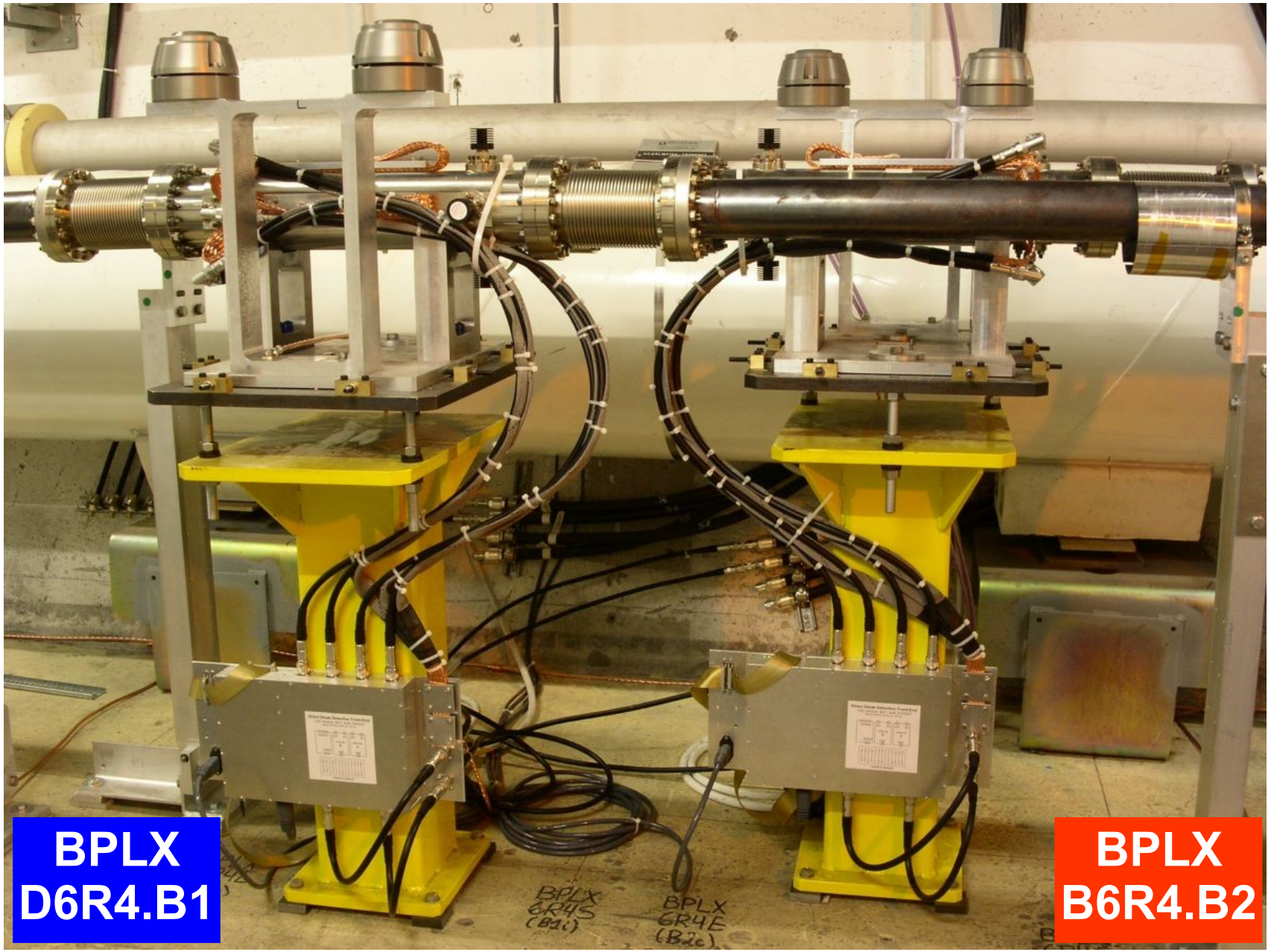
LHC Q Base-Line Q Instrumentation
BBQ System Overview

- Back-bone: Base-Band-Q Meter[1] (BBQ)
  - well tested and proven solution:
    SPS, LEIR, PSB, RHIC, Tevatron, ...
- Pick-ups: 40 cm strip-lines
- Shakers: 1 m strip-lines
  - magnetic deflectors driven ± 3 A max.
  - working bandwidth: 1 - 6 kHz
  - maximum kick angle: 0.1nrad@7TeV
    → 23 nm@β = 180m per turn
- RF Transverse Damper (W. Höfle)
  - 2 modules beam/plane
  - timing (MTG) for on/off
  - Monitoring via "RadioLHC"
- 3 x 2 (nearly) identical installation (tunnel
  (2 development/hot-spare systems on the surface)
- ... some redundancy:
  8 systems available vs. 2 needed

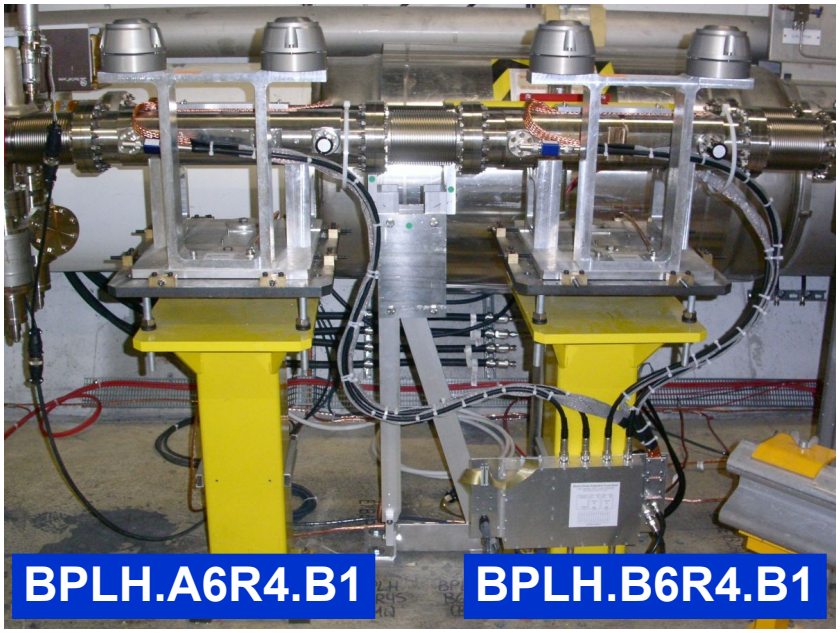
[1]M. Gasior: LHC-Project-Report-853

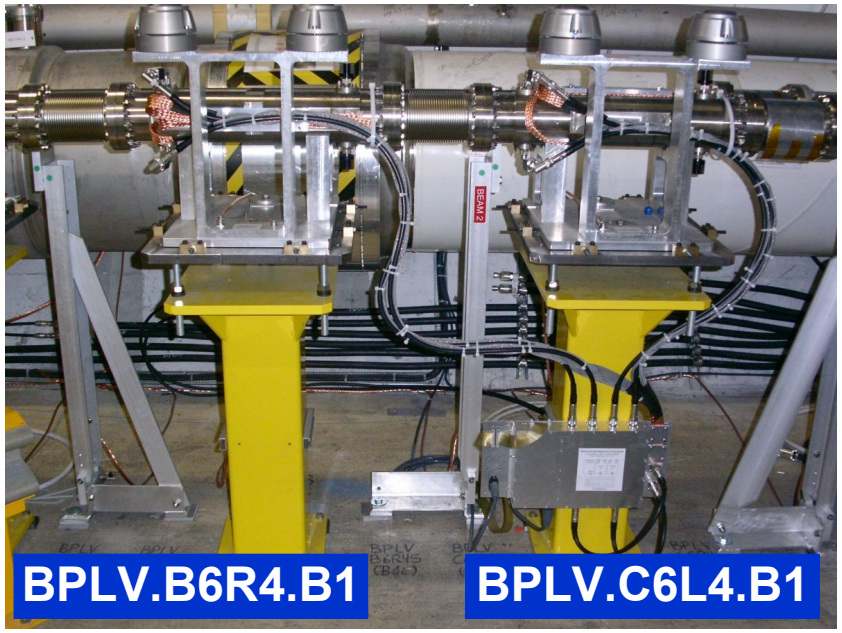


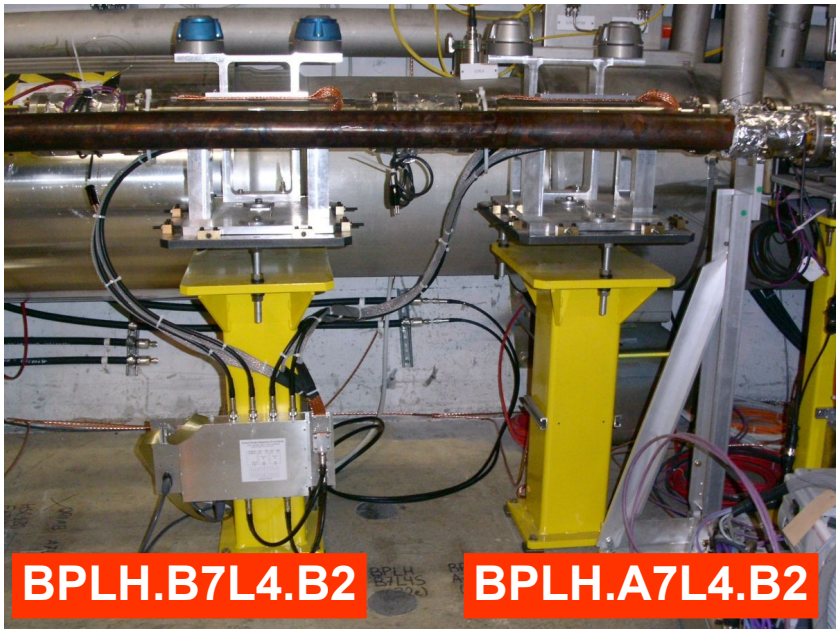
LHC On-Demand B1 & B2 Systems

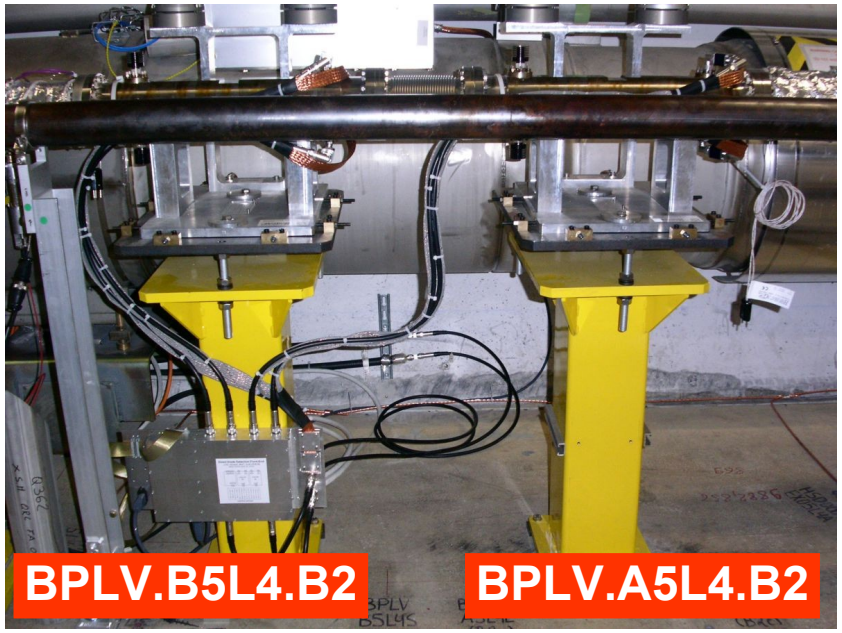


LHC Continuous and Development B1 & B2 Systems

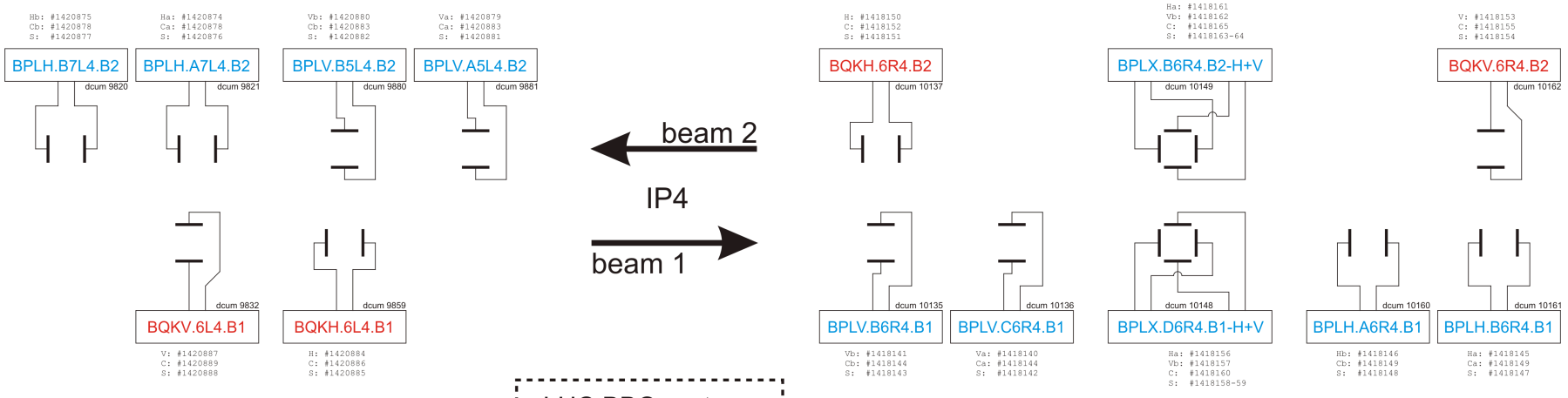








BBQ-Front-End/FESA Layout



LHC BBQ systems

Diagram v. 7/07/08, M. Gasior, AB-BI-QP

Legend:

2c	- 2 Coaxial cables
m48	- 48-wire multiwire cable
H (V)	- Horizontal (Vertical) signal
Ha (Hb)	- Horizontal signal on digitizer channel A (B)
C	- Control
S	- Spare

BY09.UA43

BQKH.6L4.B1 (2c+m26)
H: #1420884
C: #1420886
S: #1420885

BQKV.6L4.B1 (2c+m26)
V: #1420887
C: #1420889
S: #1420888

BY11.SX4 (2c+m48)
- not used
S: #1420959-60
C: #1420961

damper tunnel UX45 (2c)
- not used
AYADT24.UX45: #1420952
AYADT19.UX45: #1420953

BY10.UA43

BPLH.A7L4.B2 (2c+m26)
BPLH.B7L4.B2 (2c)
Ha: #1420874
Hb: #1420875
C: #1420878
S: #1420876-77

BPLV.A5L4.B2 (2c+m26)
BPLV.B5L4.B2 (2c)
Va: #1420879
Vb: #1420880
C: #1420883
S: #1420881-82

BY11.SX4 (4c+m48)
- AFE chBs (direct)
BPLH.B7L4.B2 #1420954
BPLV.B5L4.B2 #1420955
- copies of chAs (buffer amp)
BPLH.A7L4.B2 #1420956
BPLV.B5L4.B2 #1420957
- control of chBs (slave)
pin 1-26/48 of #1420958

BY06.UA47 (4c+m48)
- PLL DACs/tickler signals
B1-H: #1420892 (R->L)
B1-V: #1420893 (R->L)
B2-H: #1420894 (L->R)
B2-V: #1420895 (L->R)
- not used
C: #1420896

FFT1.B2 ("continuous")
slot #15, codec slave, AFE control

PLL.B2 ("PLL system")
slot #17, codec master, BQK control

CFV-UA43-BQPLL

BY10.SX4

BY12.UA47 (4c+m48)
- copies (buffer amp)
B1-H: #1418187
B1-V: #1418188
B2-H: #1418189
B2-V: #1418190
- control m48
not used #1418191

damper surface SR4 (8c)
- not used
S: AYADT44.SR4: #1418204-11

DEV.B1 ("development")
slot #4, codec master, gain control

DEV.B2 ("development")
slot #15, codec master, gain control

CFV-SX4-BQ

BY11.SX4

BY09.UA43 (4c+m48)
- AFE chBs (direct)
BPLH.B7L4.B2 #1420954
BPLV.B5L4.B2 #1420955
- copies of chAs (buffer amp)
BPLH.A7L4.B2 #1420956
BPLV.B5L4.B2 #1420957
- control of chBs (slave)
pin 1-26/48 of #1420958

BY07.UA47 (4c+m48)
- AFE chBs (direct)
BPLH.A6R4.B1 #1418182
BPLV.B6R4.B1 #1418183
- copies of chAs (buffer amp)
BPLH.B6R4.B1 #1418184
BPLV.C6R4.B1 #1418185
- control of chBs (slave)
pin 1-26/48 of #1418186

BY10.UA43 (2c+m48)
- not used
S: #1420959-60
C: #1420961

BY06.UA47 (2c+m48)
- not used
S: #1418192-93
C: #1418194

BY06.UA47

BQKH.6R4.B2 (2c+m26)
H: #1418150
C: #1418152
S: #1418151

BQKV.6R4.B2 (2c+m26)
V: #1418153
C: #1418155
S: #1418154

BY11.SX4 (2c+m48)
- not used
S: #1418192-93
C: #1418194

BY10.UA43 (4c+m48)
- PLL DACs/tickler signals
B1-H: #1420892 (R->L)
B1-V: #1420893 (R->L)
B2-H: #1420894 (L->R)
B2-V: #1420895 (L->R)
- not used
C: #1420896

BY07.UA47

BPLH.A6R4.B1 (2c+m26)
BPLH.B6R4.B1 (2c)
Hb: #1418146
Ha: #1418145
C: #1418149
S: #1418147-48

BPLV.B6R4.B1 (2c+m26)
BPLV.C6R4.B1 (2c)
Vb: #1418141
Va: #1418140
C: #1418144
S: #1418142-43

BY11.SX4 (4c+m48)
- AFE chBs (direct)
BPLH.A6R4.B1 #1418182
BPLV.B6R4.B1 #1418183
- copies of chAs (buffer amp)
BPLH.B6R4.B1 #1418184
BPLV.C6R4.B1 #1418185
- control of chBs (slave)
pin 1-26/48 of #1418186

damper tunnel UX45 (2c)
- not used
AYADT02.UX45: #1418176
AYADT08.UX45: #1418177

FFT1.B1 ("continuous")
slot #4, codec slave, AFE control

PLL.B1 ("PLL system")
slot #6, codec master, BQK control

CFV-UA47-BQPLL

BY12.UA47

BPLX.D6R4.B1-H (2c+m26)
BPLX.D6R4.B1-V (2c)
Ha: #1418156
Vb: #1418157
C: #1418160
S: #1418158-59

BPLX.B6R4.B2-H (2c+m26)
BPLX.B6R4.B2-V (2c)
Ha: #1418156
Vb: #1418157
C: #1418160
S: #1418158-59

BY10.SX4 (4c+m48)
- copies (buffer amp)
B1-H: #1418187
B1-V: #1418188
B2-H: #1418189
B2-V: #1418190
- control m48
not used #1418191

damper tunnel UX45 (4c)
- DAC outputs to the damper
B1-H: #1418178 (AYADT02.UX45)
B1-V: #1418179 (AYADT08.UX45)
B2-H: #1418180 (AYADT25.UX45)
B2-V: #1418181 (AYADT19.UX45)

FFT2.B1 ("on demand")
slot #4, codec master, gain control

FFT2.B1 ("on demand")
slot #15, codec master, gain control

CFV-UA47-BQ