BPMs and HOM-BPMs for the XFEL Linac

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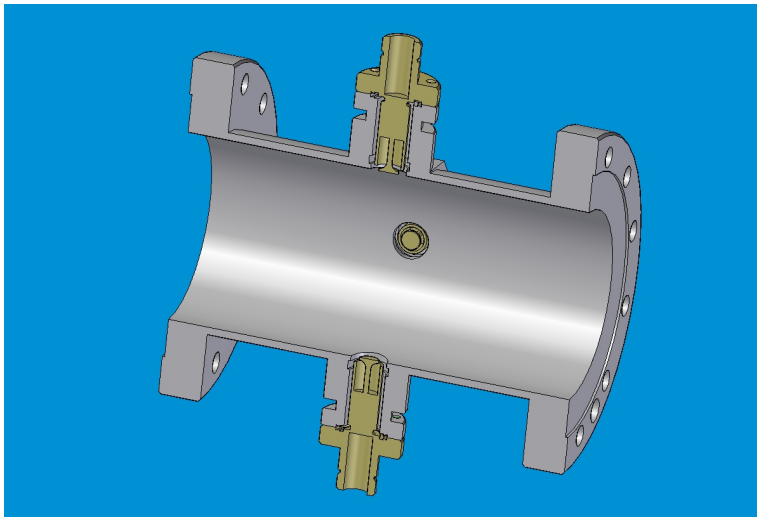
Cold BPM: ButtonType

- Main parameters
  - charge: 0.1 – 1 nC
  - bunch spacing: ≥ 200 ns
  - rep. rate: ≤ 50 Hz
  - pulse length: ≤ 650 μm
  - resolution: < 50 μm
  - position range: ± 20 mm
  - coupling: < 1 %
  - interbunch interf.: < 1 %
  - drift max.: < 10 μm/month



  - button diameter: 16 mm
  - diameter: 78 mm
  - length: 170 mm

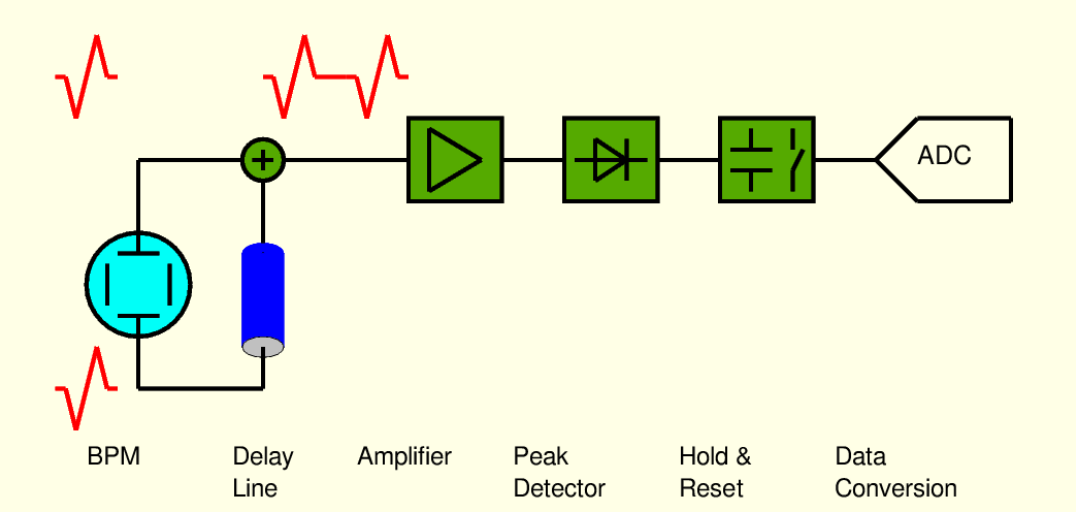
- More info
  - "Update on the Cold BPM"
    - presentation of Dirk Noelle at the XFEL meeting on March 21, 2007: http://xfel.desy.de/projectgroup/meetings/e811
  - XFEL-Wiki
    - http://ferrari10/mediawiki/index.php/ColdBPM_EOI

Cold BPM: Mechanics and Cables

- Mechanics
  - fabrication process defined and under discussion
  - 3 BPM-prototypes under construction
    - XFEL-design except feedthroughs (8 mm instead of 16 mm)
    - 2 sent out for copper plating; one will be built in a cryo-module for the test stand
  - feedthroughs
    - 4 types of feedthroughs from 2 companies under-went cryo-tests
      – all were ok
    - XFEL design for feedthroughs under finalization, 16 mm
- Cables
  - double-shielded Suhner cables (MHF-SL)
    - length and assembly under discussion

Cold BPM: Electronics

- Electronics Concept
  - use concept from HERA-e BPMs
  - differences to TTF2-type electronics
    - use same processing channel for all 4 signals ⇒ less drift
    - provides also charge measurement
    - also the monitor is different
  - integrated test and calibration
    - can be used between bunch pulses (≥ 200 ns spacing)

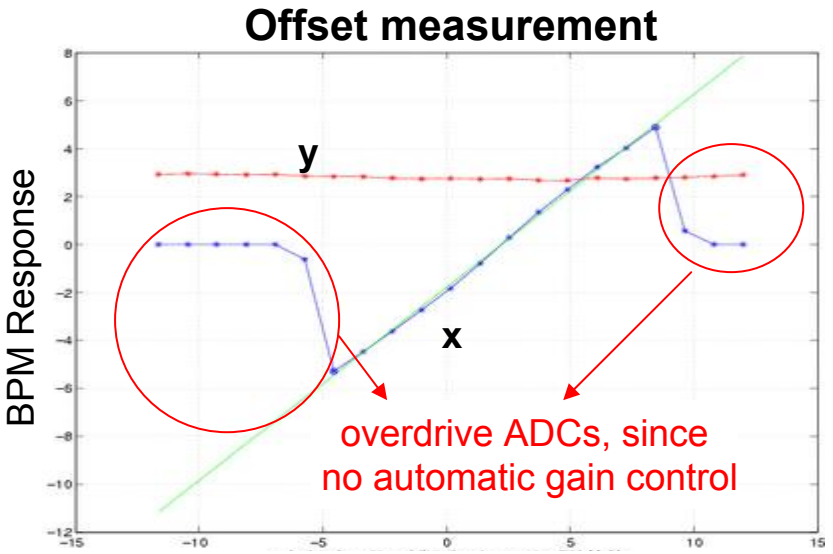


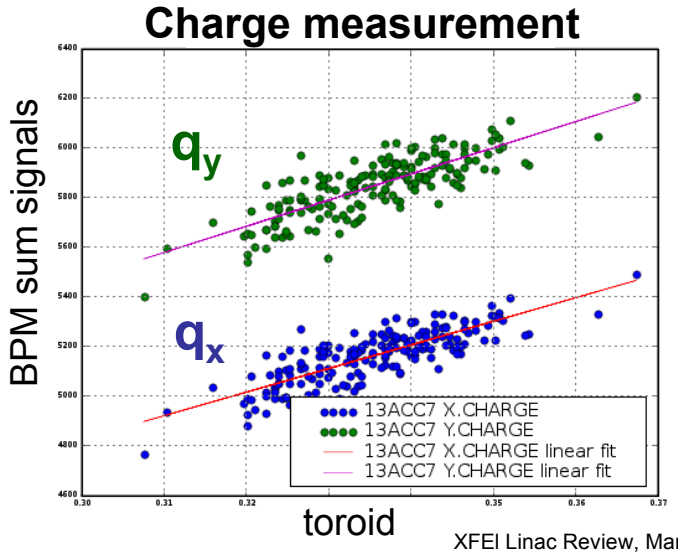
Cold BPM: Electronics (2)

- Electronics Status
  - under design
  - goal: use similar electronics/ software for all BPMs (e.g. 'warm' BPMs from PSI)
- Measurements at TTF
  - linearity
  - resolution

q [nC]	Button	Re-ent. cav.
1.1	29.2	5.6
0.5	24.6	11.8
0.4	24.6	16.0
0.3	23.0	23.1
0.2	30.7	30.1

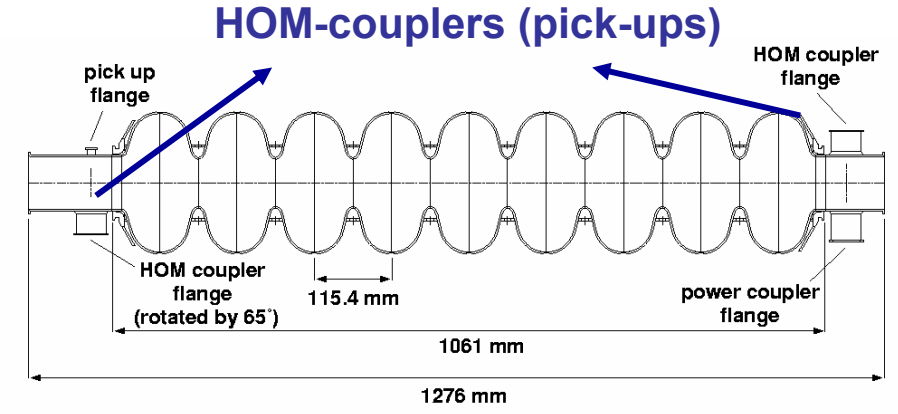
  - charge

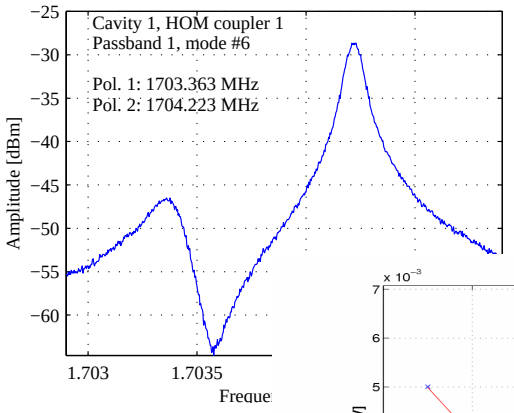


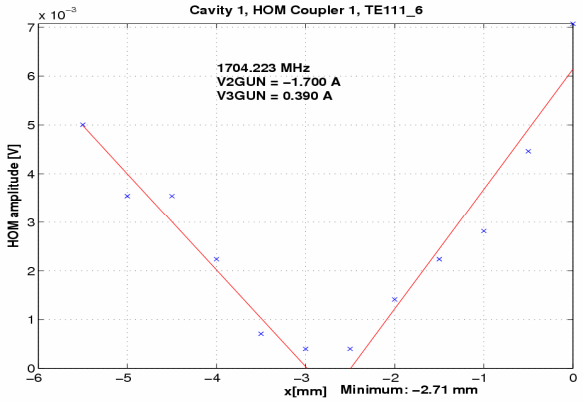


HOM-BPMs at FLASH

- Dipole modes
  - excited by off-axis beams
  - amplitude is proportional to beam position
  - $\Rightarrow$ can be used for beam position monitoring, similar to cavity monitors
    - more complicated calibration
- Advantages
  - no need for new design of vacuum components or extra beam line space
  - large proportion of the linac is occupied by the acc. cavities
  - HOM-signal already available

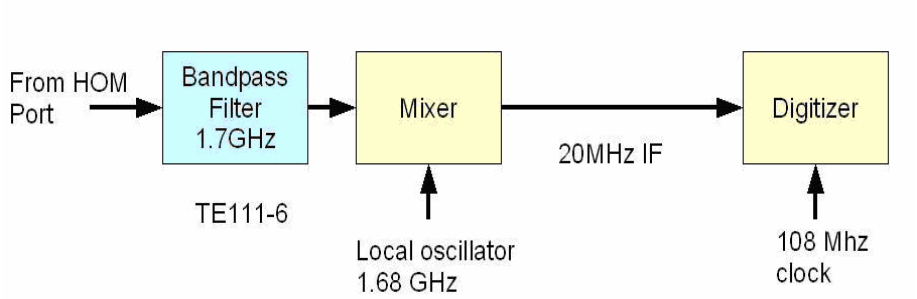


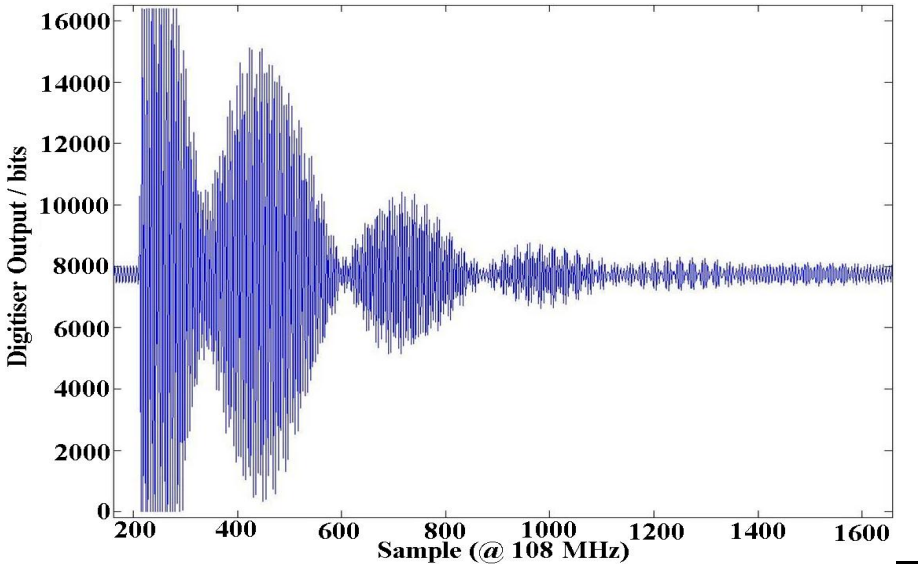




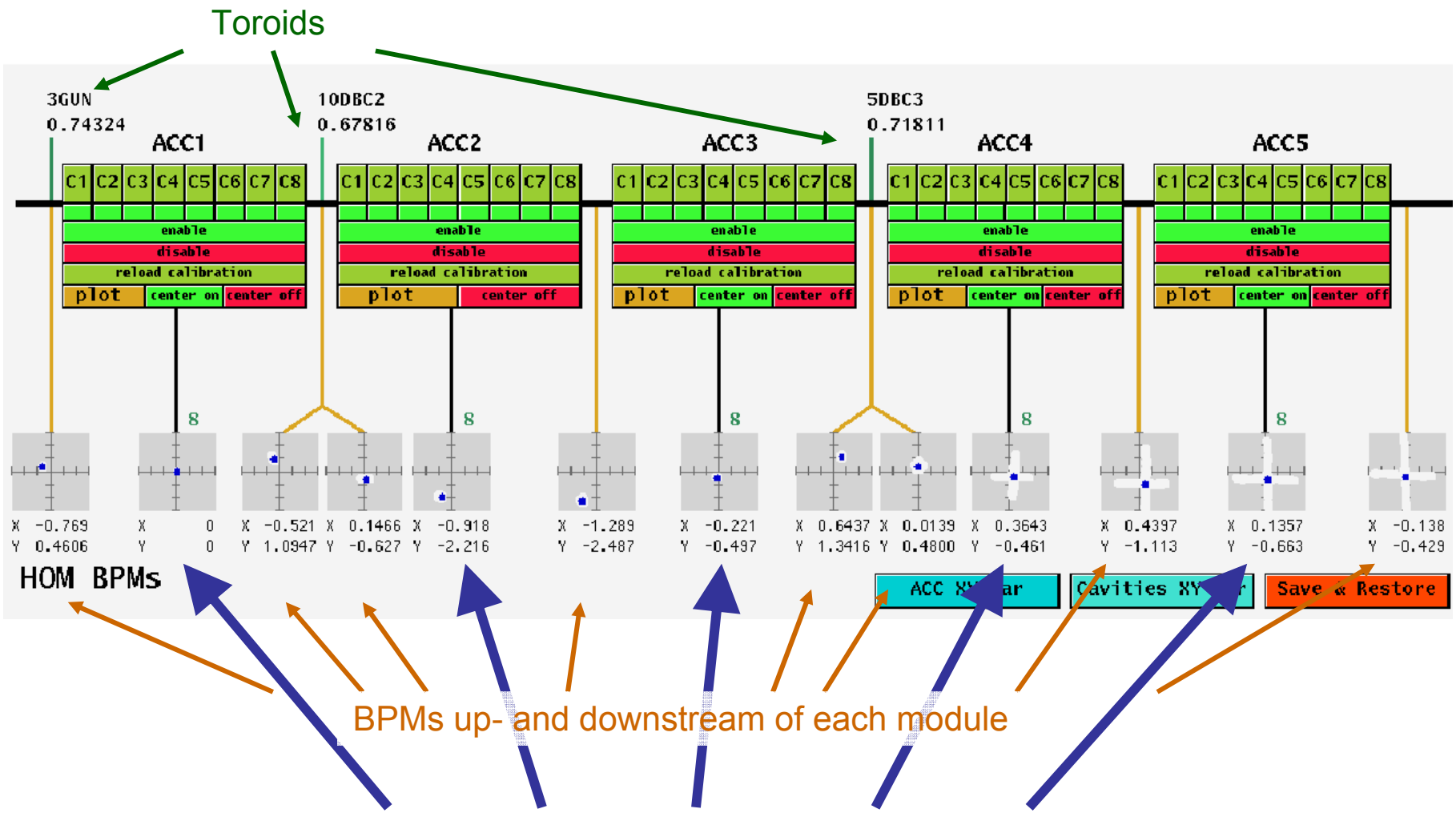
HOM-BPMs at FLASH: Electronics

- Electronics
  - similar to typical BPM electronics
  - filter one dipole mode at ~1.7 GHz (higher kick factor) out of HOM spectrum, convert to ~20 MHz, then digitize
  - installed at both HOM coupler of all 40 FLASH cavities (ACC1-ACC5)





HOM-BPMs at FLASH: Status



HOM-BPMs at FLASH: Status (2)

- Calibration
  - scan: ~30min for all modules
  - based on SVD
  - calibration procedure almost automatic
- Resolution
  - single bunch: 2-10 μm rms measured so far
  - potential to improve by changes in the LO oscillator
- Multi-bunch
  - capability demonstrated, with worse resolution

HOM-BPMs at FLASH: Comments

- XFEL design
  - HOM-BPMs not included yet
- Extra benefits:
  - can minimize HOM signals, i.e. align beam in the center of the module $\Rightarrow$ reduce wakes and emittance growth
    - e.g. at lower energy
  - can measure cavity alignment inside module
  - full modules have to be equipped with electronics
- 3.9 GHz
  - no challenge expected for electronics for higher freq.
- Other HOM-related topic
  - can use HOM-signals to measure RF phase wrt beam