

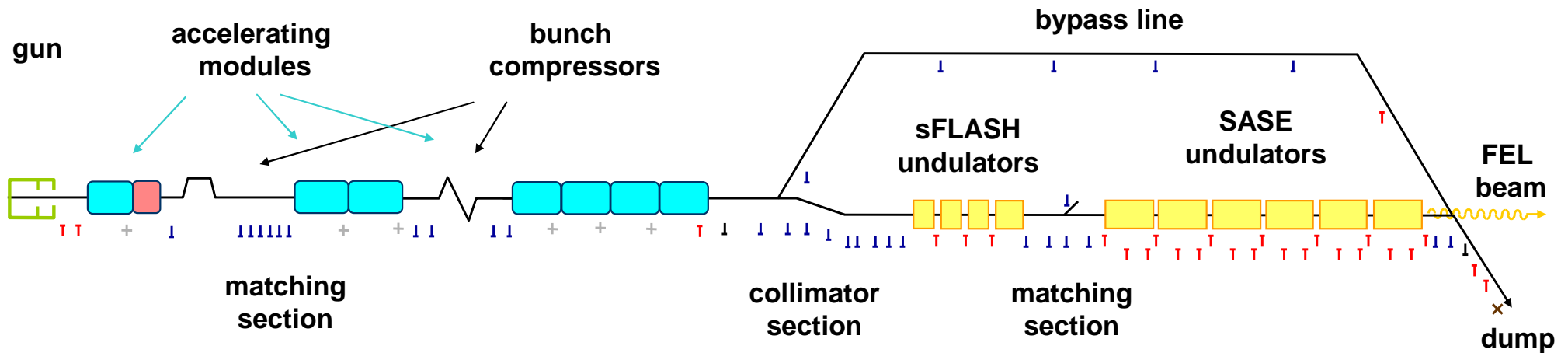
# The Status of the FLASH-BPMs

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- Overview of BPM-system
- Resolution
  - algorithm
  - single and multi-bunch BPM resolution
  - dependence on bunch charge
- Summary and Future Plans

# Overview of BPM System



*(drawing may not correspond exactly to the real situation)*

- T button BPM
- L stripline BPM
- L Zeuthen stripline BPM
- + cavity BPM
- X magnetic-coupled (in-air) BPM

# Status of BPM System

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- Stripline BPMs

- two apertures: 34 and 44mm (BYP+ECOL)
- quite similar to each other
  - mostly „pauschal“ calibration factors
- 2 Zeuthen BPMs (16ACC7 + 9DUMP)

- Button BPMs

- several types
- large differences from BPM to BPM
  - need individual calibration
- sensitive to timing jitter

- Cavity BPMs (in cold modules ACC1-6)

- influenced by changes in timing
- phase jump around zero
  - can be somewhat reduced by electronics adjustments

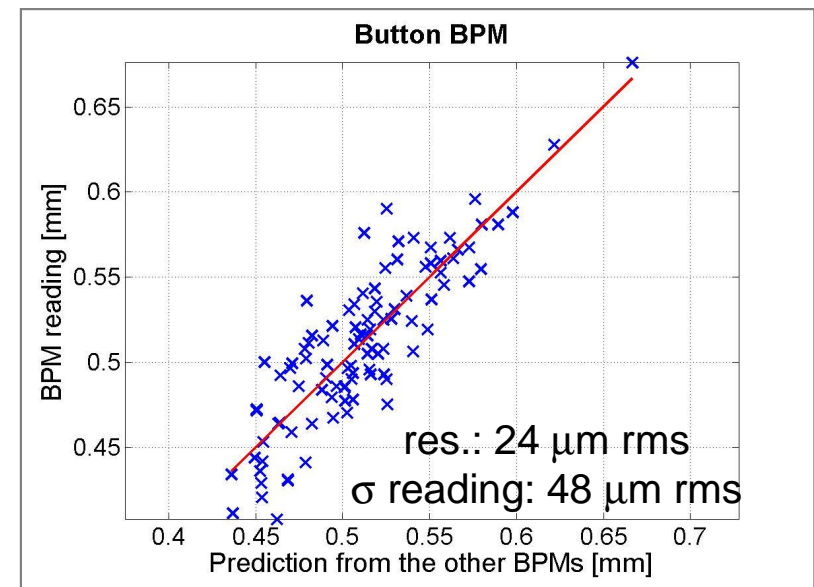
# BPM Resolution: Estimation Method

- linear regression

- between one BPM (index m) and all others (1...m-1) for p measurements

$$\begin{pmatrix} \mathbf{X}_{1,1} & \mathbf{X}_{1,2} & \dots & \mathbf{X}_{1,m-1} \\ \mathbf{X}_{2,1} & \mathbf{X}_{2,2} & \dots & \mathbf{X}_{2,m-1} \\ \dots & \dots & \dots & \dots \\ \mathbf{X}_{p,1} & \mathbf{X}_{p,2} & \dots & \mathbf{X}_{p,m-1} \end{pmatrix} \cdot \begin{pmatrix} \mathbf{a}_1 \\ \mathbf{a}_2 \\ \dots \\ \mathbf{a}_{m-1} \end{pmatrix} \rightarrow \begin{pmatrix} \mathbf{X}_{1,m} \\ \mathbf{X}_{2,m} \\ \dots \\ \mathbf{X}_{p,m} \end{pmatrix}$$

- $\Rightarrow$  prediction for BPM m
- resolution = uncorr. noise  
=  $\sigma$  of  $(x_m - x_{\text{pred},m})$



# BPM Resolution

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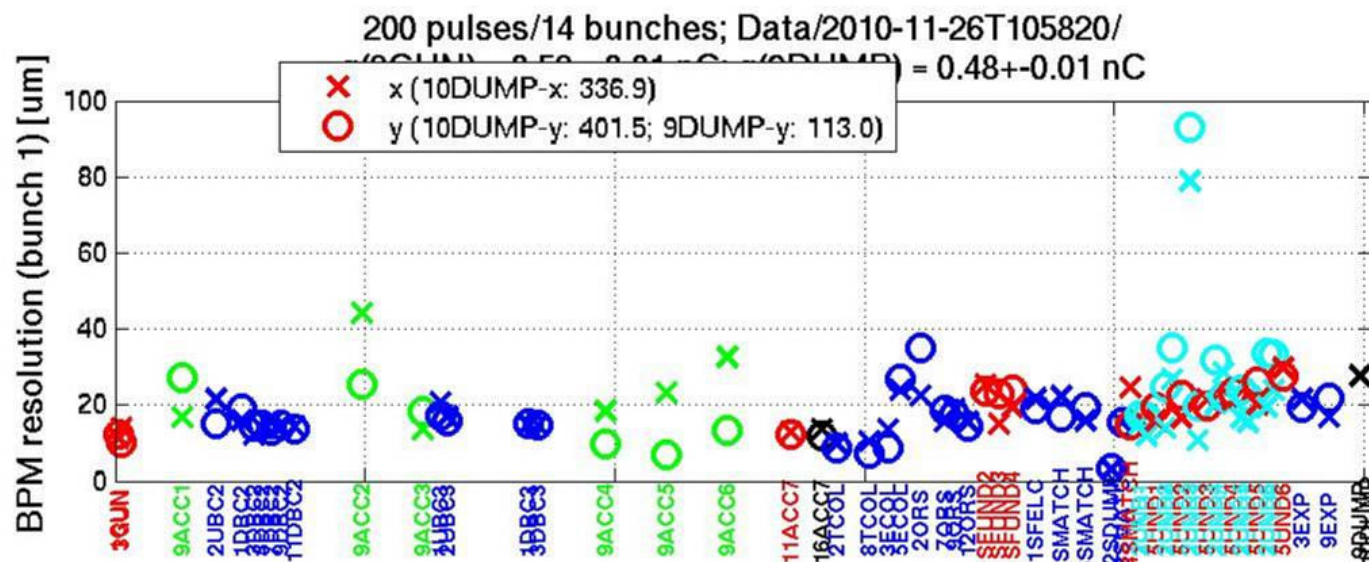
- Comments

- assume that to each BPM, other BPMs correlate
  - non-periodical lattice
  - worse resolution estimated when no good correlation
- too good resolution calculated when correlation through other effects than beam related (e.g. timing jitter)

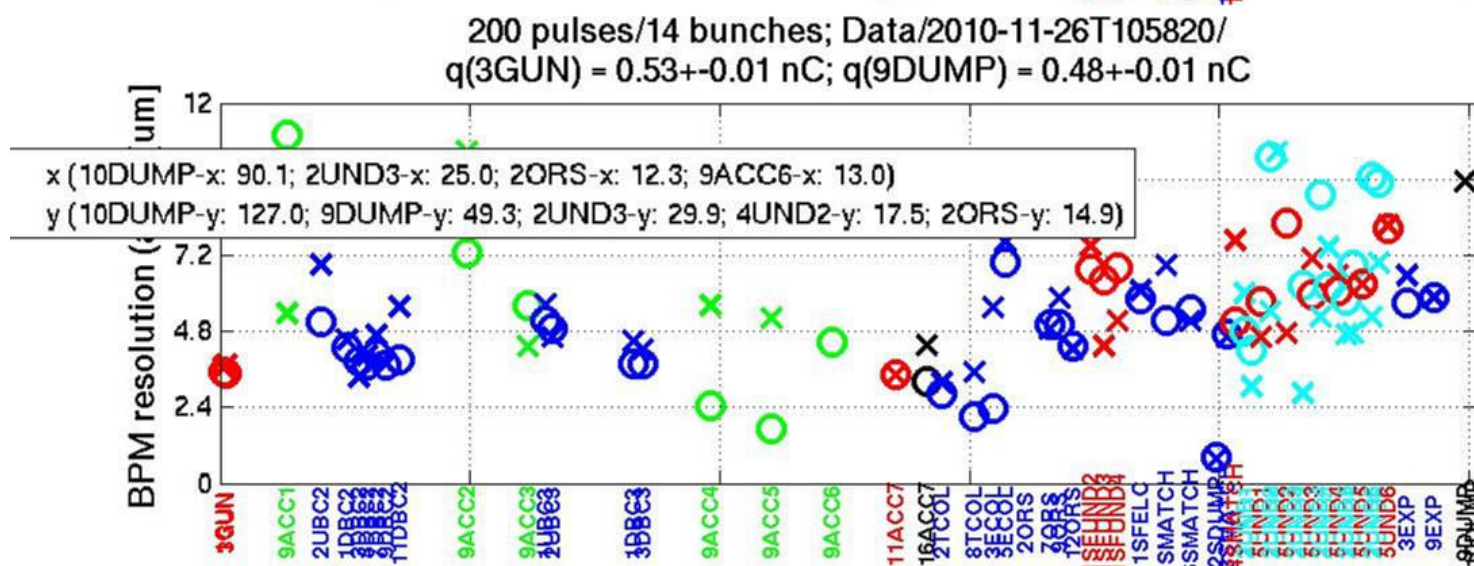
- Multibunch

- better resolution than for single bunch

# BPM Resolution



stripline  
 button  
 button  
 (inside UND)  
 cavity  
 other

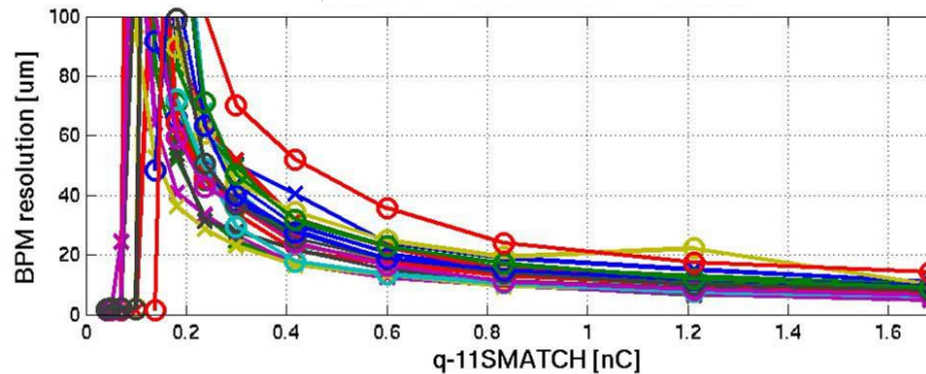


14 bunches /  
 pulse  
 ~ 0.5 nC

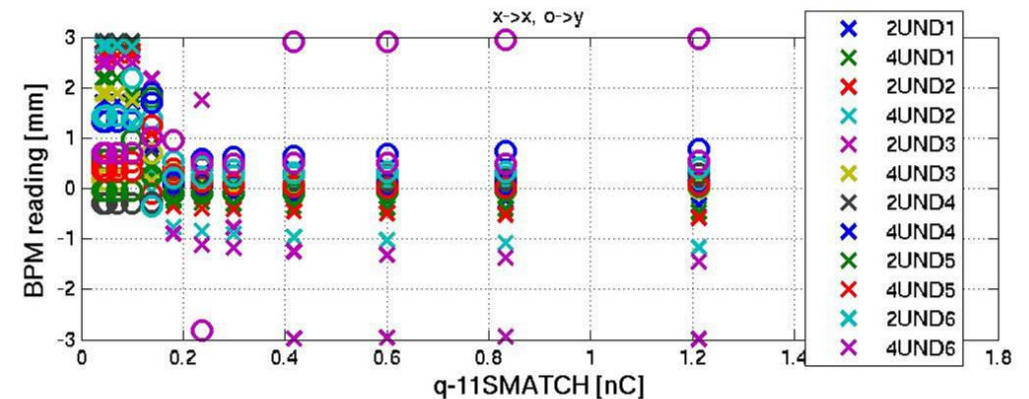
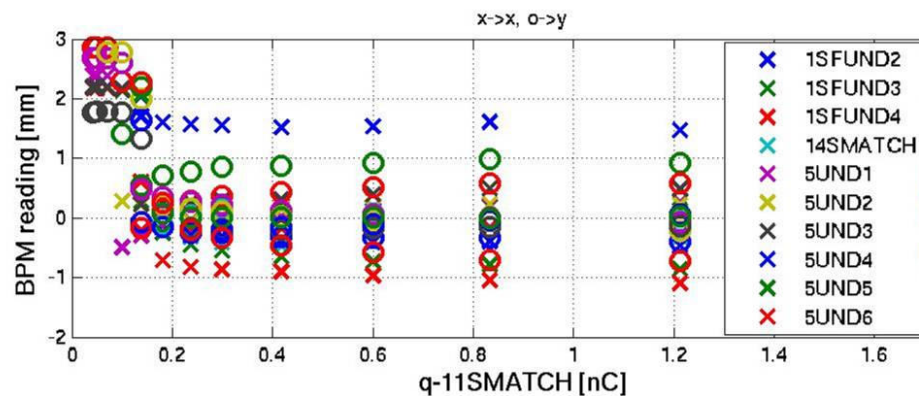
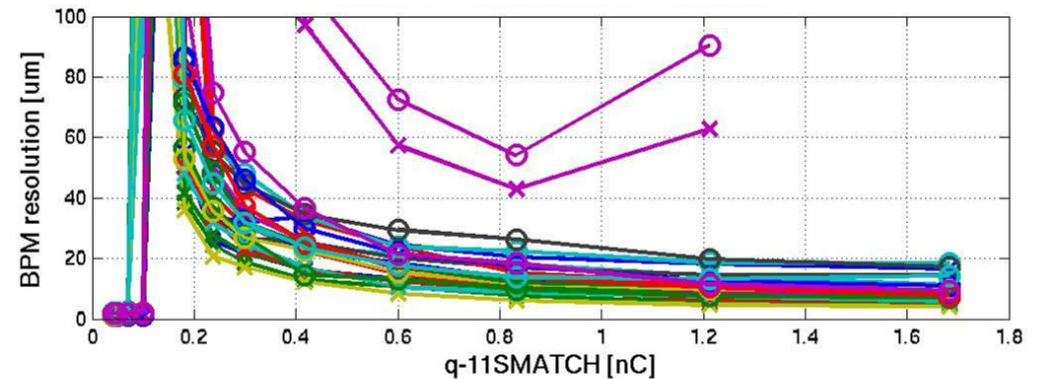


# Resolution vs. Charge - Button BPMs

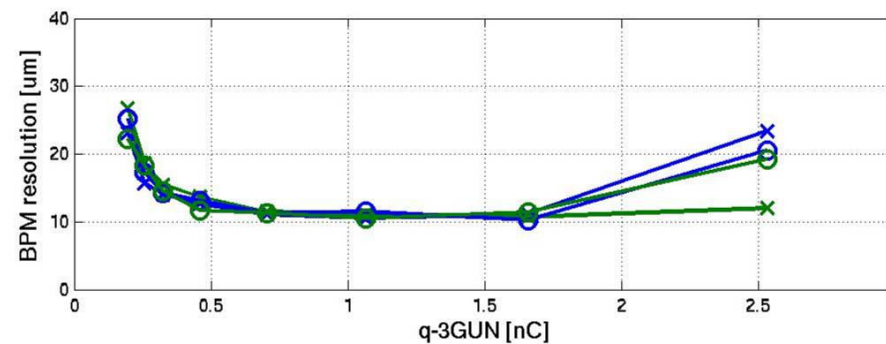
UND – diag. stations



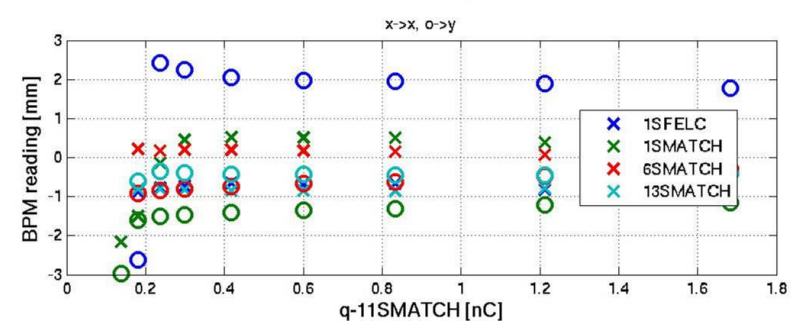
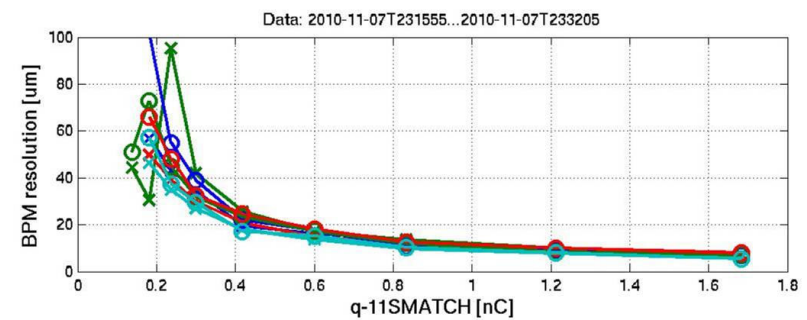
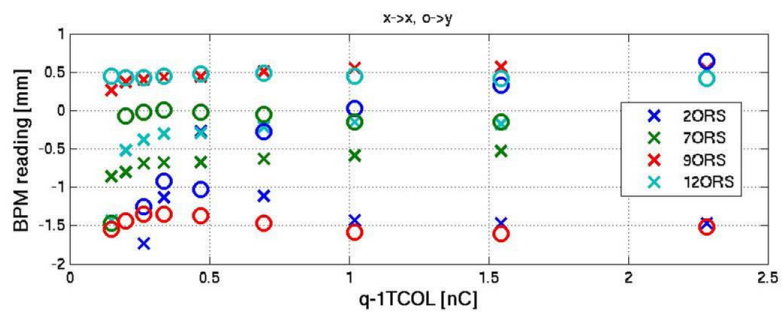
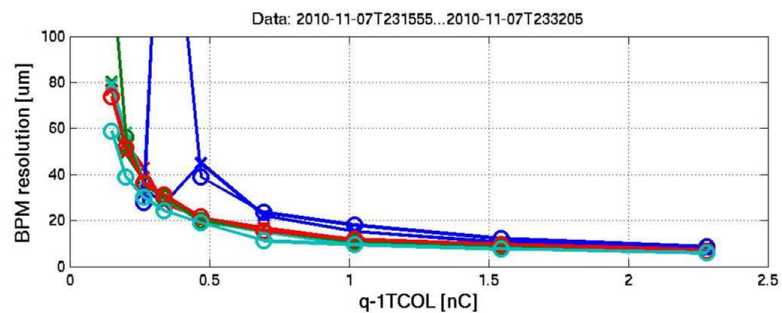
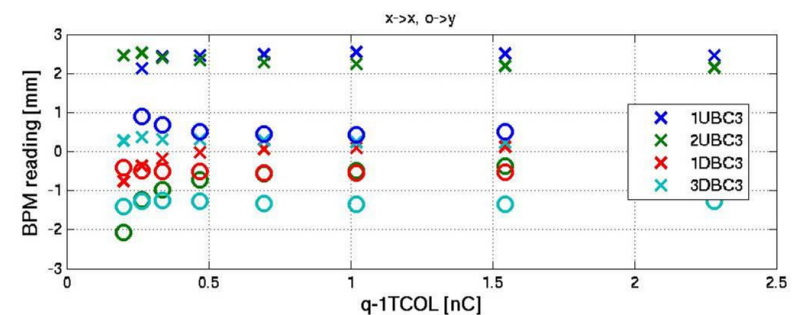
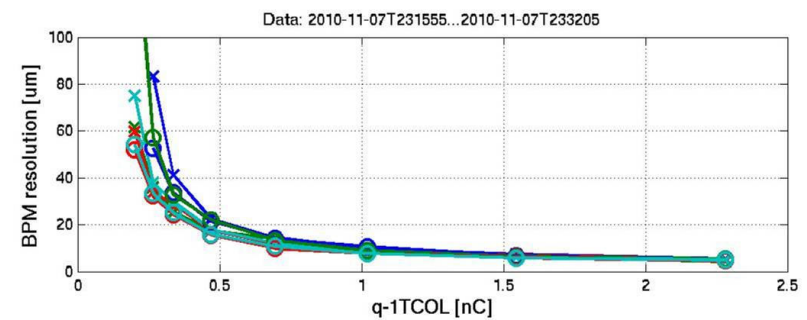
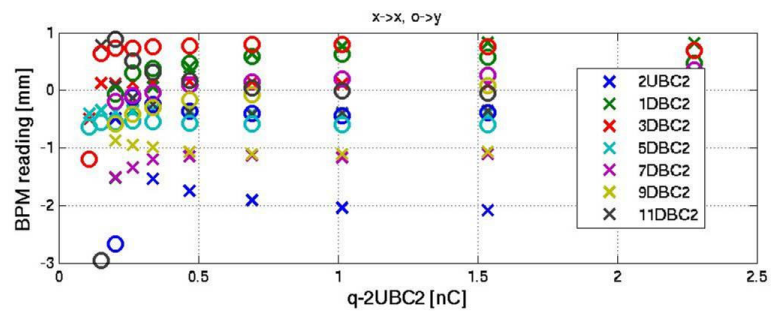
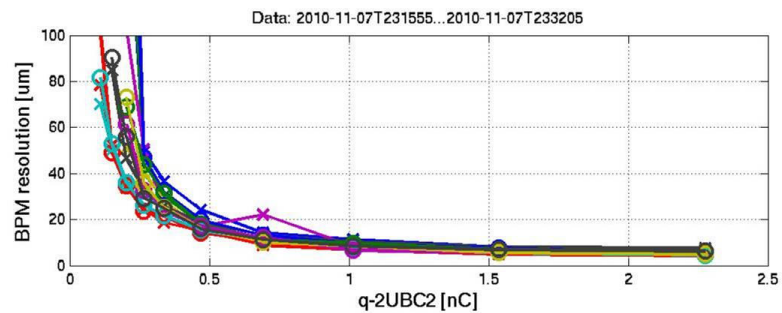
UND – inside



GUN



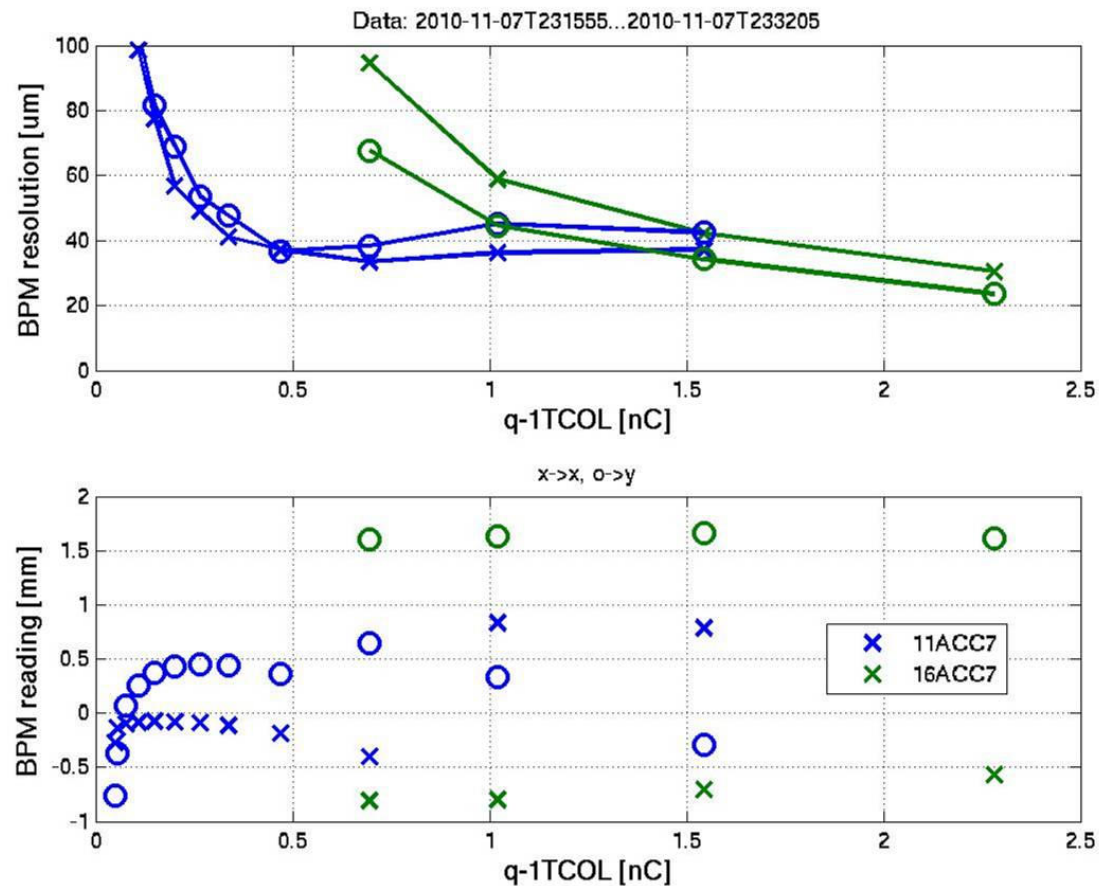
# Resolution vs. Charge - Stripline-BPMs





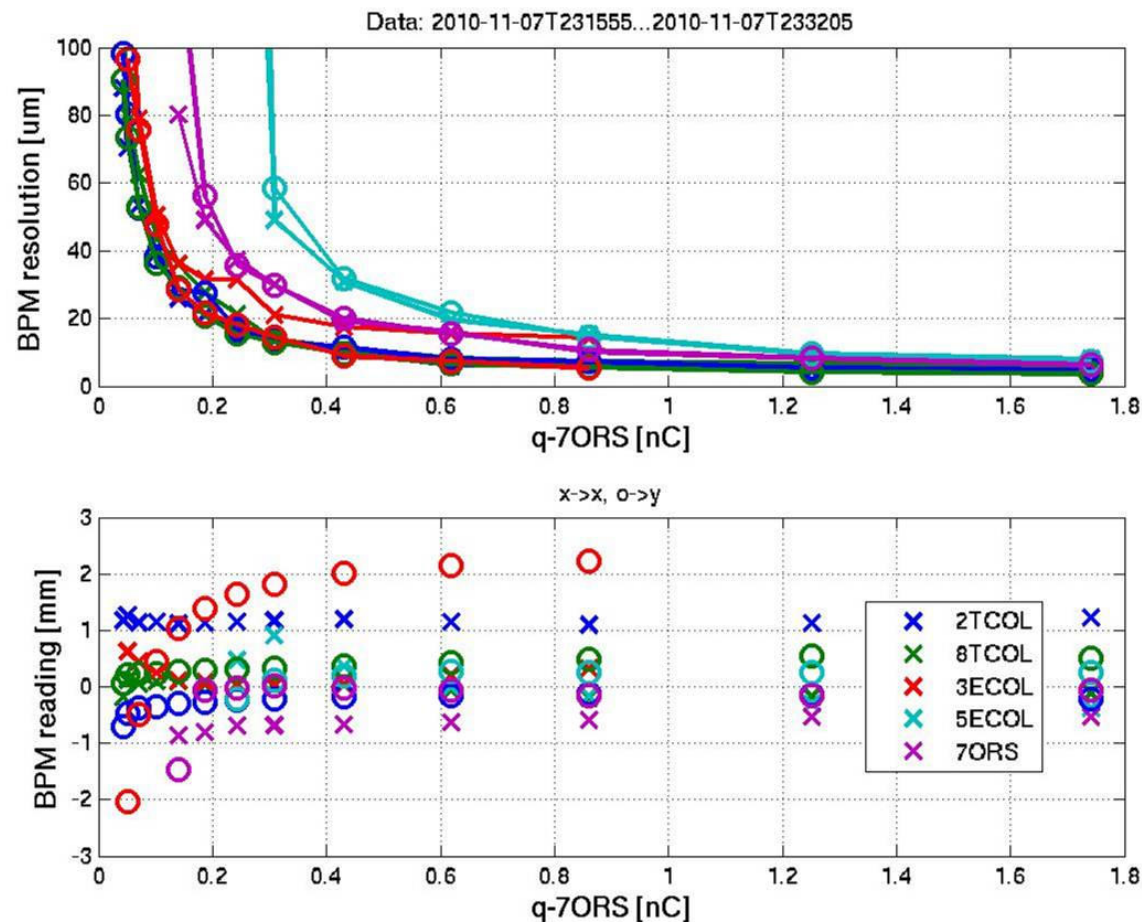
# Resolution vs. Charge - Other BPMs

- 11ACC7 → cold button BPM
- 16ACC7 → Zeuthen-stripline
  - both need additional amplifier



# Resolution vs. Charge - Stripline-BPMs at Low Charge

- 2TCOL, 8TCOL and 3ECOL (Ø44mm)
  - recently equipped with additional amplifier (factor ~5)
  - for comparison plotted together with 5ECOL (Ø44mm) and 7ORS



# More Remarks

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- 9ACC1

- Not calibrated

- Could not switch RF in ACC1 off
    - Different results with different gradients

- Zero offset

- has been checked for all buttons and some striplines
  - question mark on some striplines in quads
    - found different cable lengths for 2ORS → to be repaired

- Low charge

- button BPMs are at their limit with the current electronics
  - stripline BPMs (except Zeuthen type)
    - all can reach 0.1nC with 50um resolution rms
    - will test with more amplification (may loose high charge)

# Summary

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- **BPM status**

- 10um rms resolution for stripline and UND-BPMs @1nC
- multi-bunch resolution better than single bunch
- button BPM signals critical at lower charge
- striplines for energy measurement can meas. @ 0.1nC

- **Future plans**

- electronics similar to XFEL-electronics
- FLASH II: use XFEL components
- check zeros of some BPMs
- calibrate 9ACC1 with BC2 off