CODD and measurement precision

Trajectory measurement versus Orbit measurement

- Follows a single bunch
- Wideband measurement
- Noisy

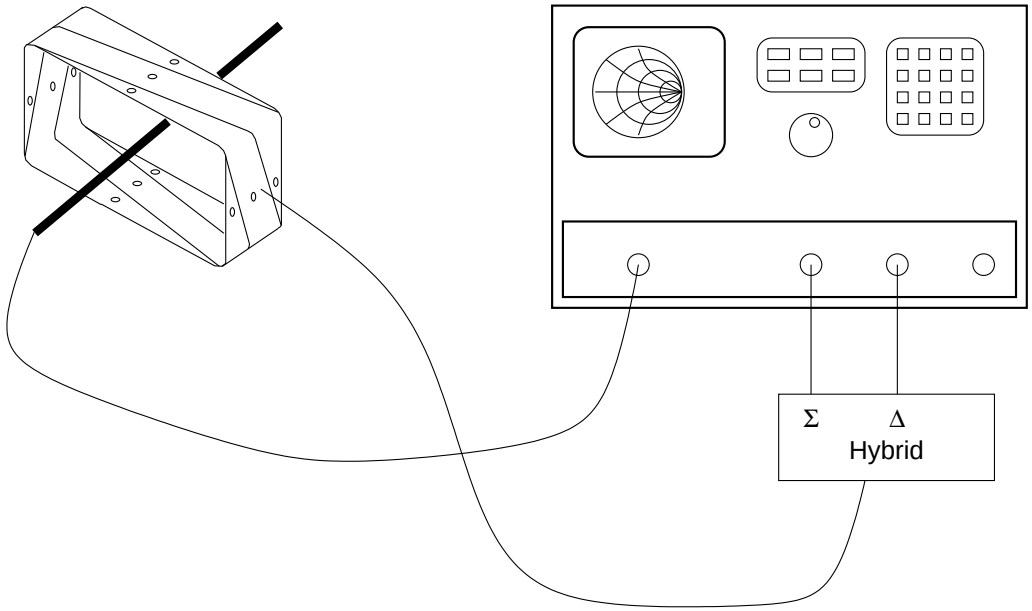
- Average over many bunches
- Narrow band measurement
- Should be much quieter

... but is only a little

CODD and measurement precision

On calibration ...

- Antenna
- Fixed frequency sinewave
- Well known positions
- Resolution ~5µm
- Accuracy ~50µm

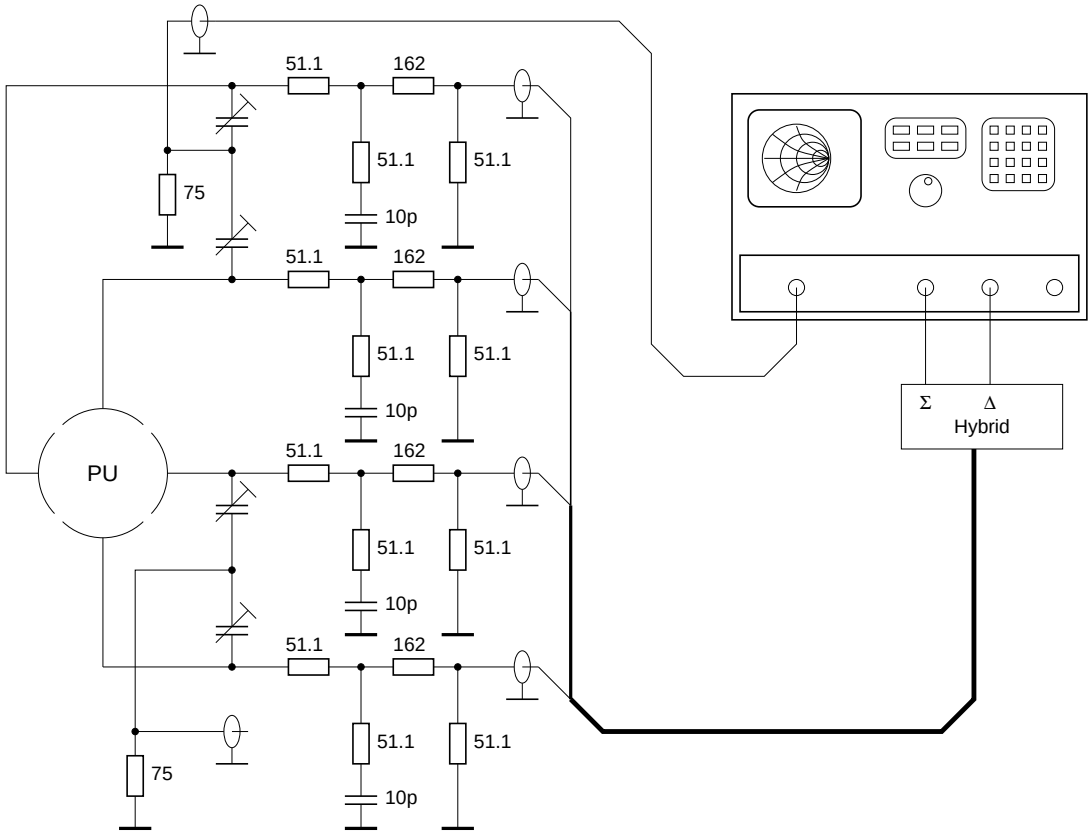


$$X_R = S_x \frac{\Delta}{\Sigma} \quad \Rightarrow \quad S_x = X_R \frac{\Sigma}{\Delta}$$

This measurement yields displacement sensitivity and electrode zero error

CODD and measurement precision

More on calibration ...



- Test capacitors
- Simulated position
  (X=58mm, Y=53mm)
- Fixed frequency
- Sine wave
- Accuray ~70µm

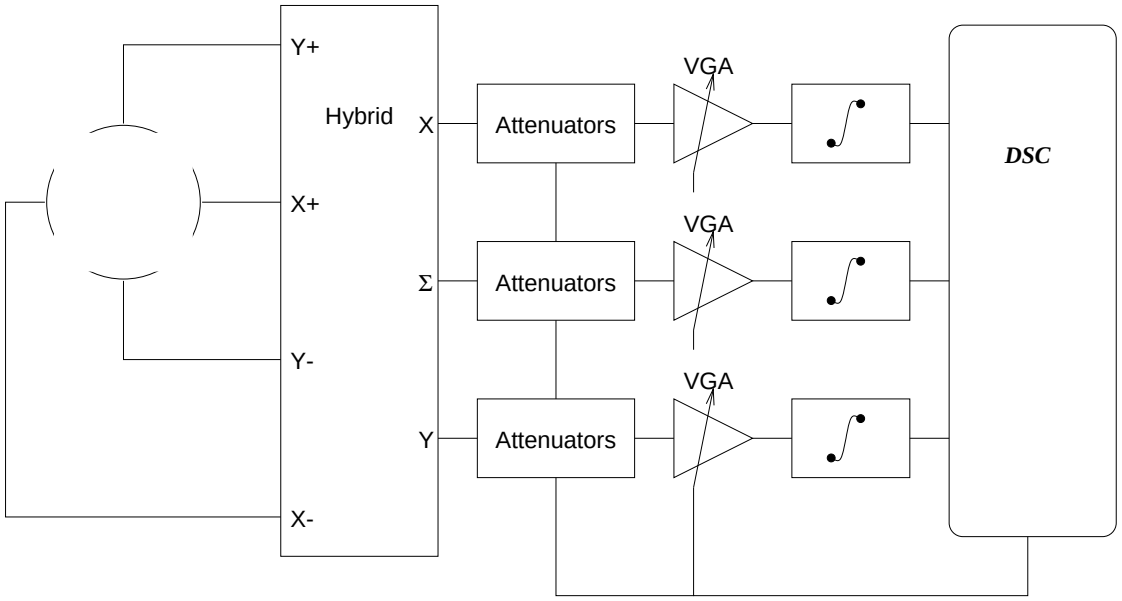
$$X_s = S_x \frac{\Delta}{\Sigma}$$

This measurement gives the simulated beam positions during calibration

CODD and measurement precision

Still more on calibration ...

- DSC adjusts gain values to obtain target S_x=40mm
- Calibration generator simulates beam



Problems:

- Lack of gain
- Some gain values are noisy
- Gain can't be set accurately
- Gain control curve is non-linear
- It's not even monotonic!

CODD and measurement precision

This is getting lengthy ...

- Calculation of final calibration coefficients:

- Measure zero error of integrators & ADCs
- Apply signals to simulate the two reference positions
- Derive coefficient

Slide 3

$$C = \frac{2 * X_{ref}}{\left| \frac{\Delta_1 - Z_\Delta}{\Sigma_1 - Z_\Sigma} \right| + \left| \frac{\Delta_2 - Z_\Delta}{\Sigma_2 - Z_\Sigma} \right|}$$

so that

$$X = C \frac{\Delta - Z_\Delta}{\Sigma - Z_\Sigma} + E_m + E_e$$

Geometers

Slide 2

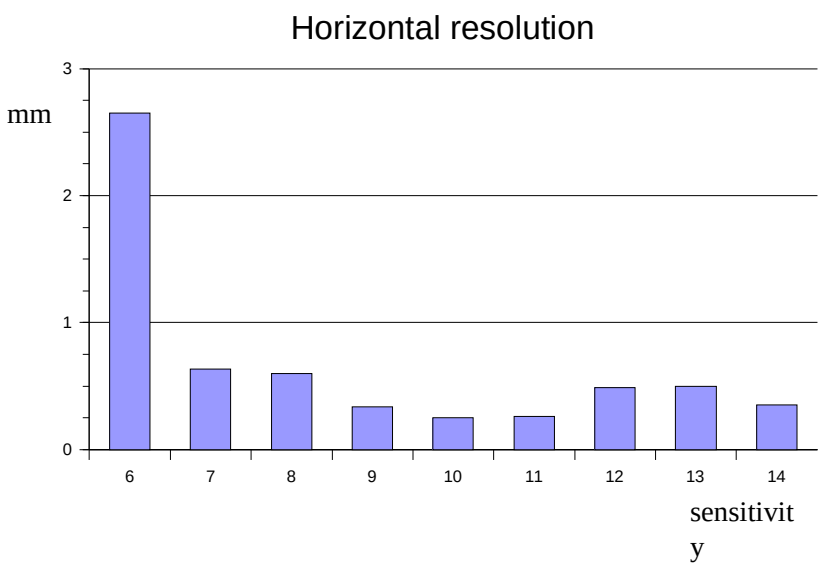
CODD and measurement precision

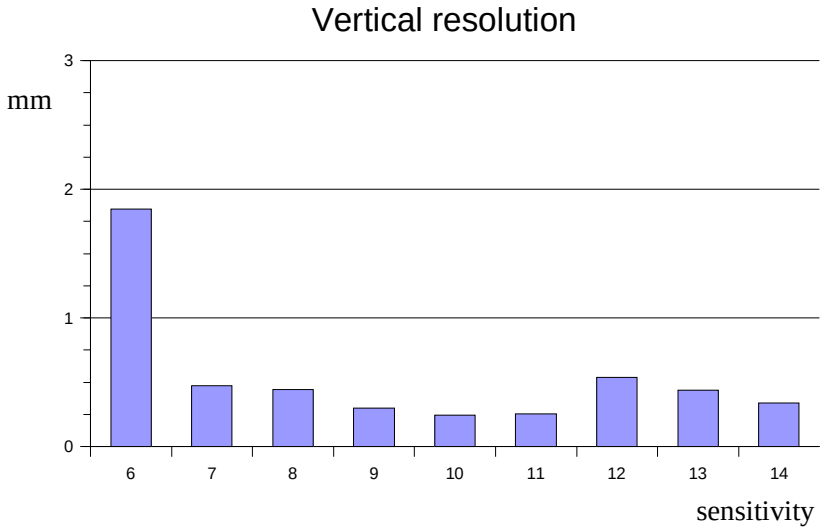
How to measure resolution

- Acquire some data using calibration generators
- Get μ and σ over 10 measurements
- Calculate position error

Lack of adequate software support makes this rather tedious

CODD and measurement precision





S	ppb
6	1E10
7	2E10
8	5E10
9	1E11
10	2E11
11	5E11
12	1E12
13	2E12
14	5E12

- Average over four PUs
- Hopeless at S6
- Noisy at S7 & S8
- Increased noise at S12 & S13 (attenuators)

Conclusions

- CODD is noisy
- Normalisers are only 2 to 3 times better
- New amplifiers should bring some relief

  (About 0.2 mm resolution for trajectories of beams with intensity >1e9ppb)
- New acquisition system would bring more...