

# The PS Trajectory Measurement System

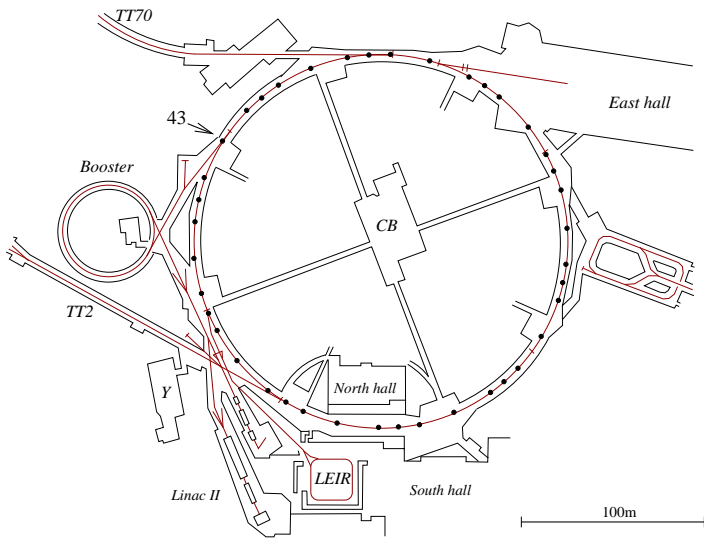
Jeroen Belleman

CERN

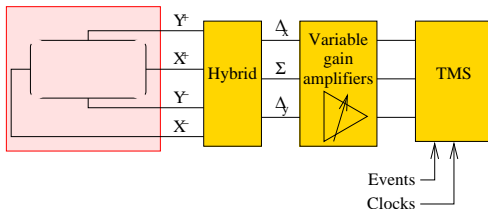
January 18, 2012



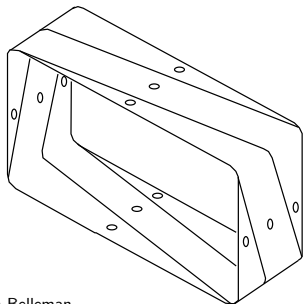
# The CERN 26 GeV PS



# Beam Position Monitor

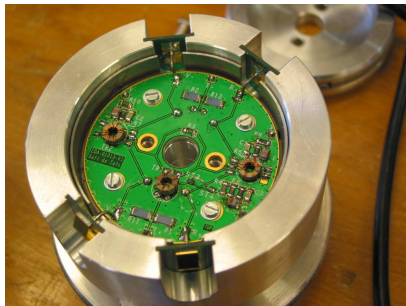
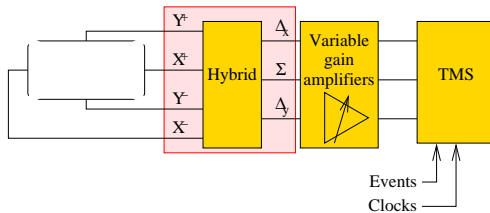


Electrostatic pick-ups with X and Y axes in one device



## Electrode properties

- $C_{el}$ : 100 pF
- Aperture: 166x80 mm
- $R_t$ : 0.52  $\Omega$
- $S_x$ : 126 mm
- $S_y$ : 60 mm

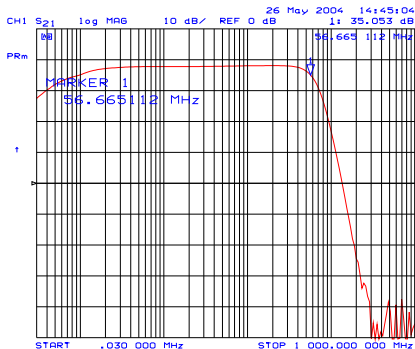
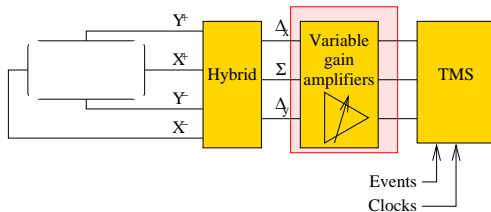


## Head assembly

- $\Sigma$  and  $\Delta$  signals
- Impedance transformation
- Calibration positions
- Filter



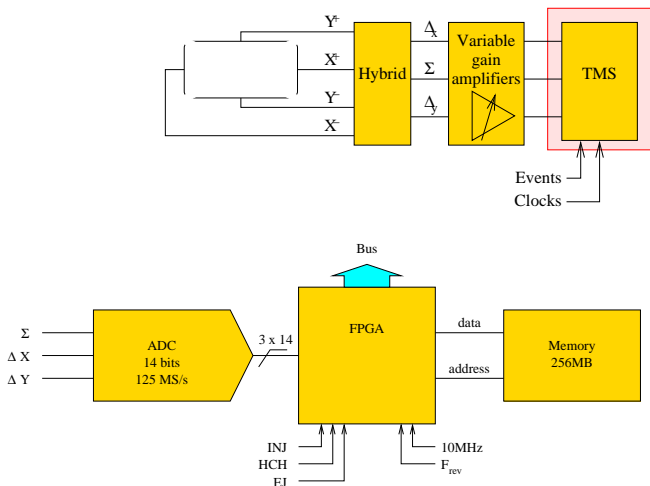
# Variable gain amplifiers



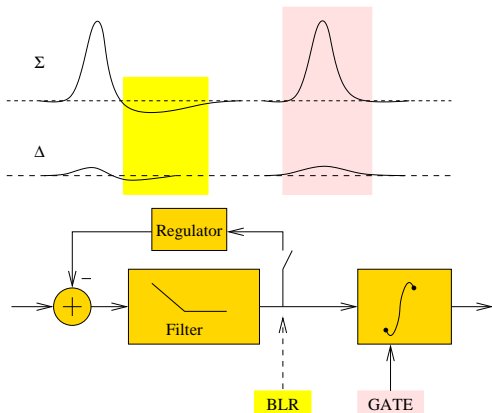
- $>80$  dB gain range
- $300 \text{ pV}/\sqrt{\text{Hz}}$  input-referred noise
- 150 kHz - 35MHz Bandwidth



# TMS architecture for one BPM station



# Position Measurement Principle

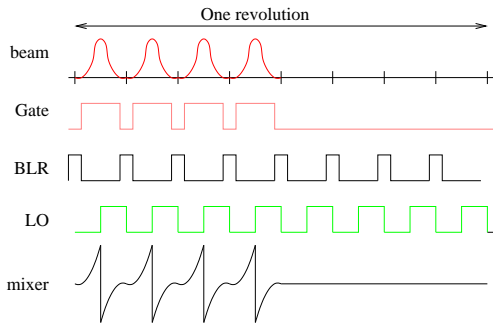


- Restore baseline
- Integrate to find centre of charge

$$X = S_x \frac{\Delta_x}{\Sigma} + E_x$$



# Beam-synchronous signals

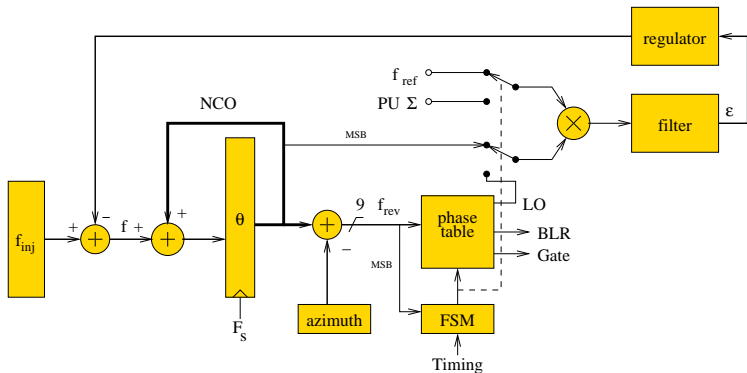


- Gate selects samples belonging to a bunch
- BLR selects samples from baseline
- LO serves to derive a phase correction
- A mixer creates a phase error signal

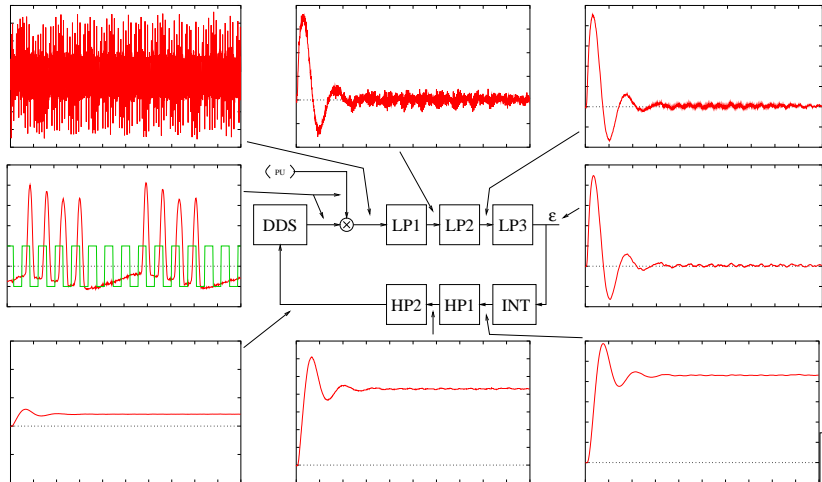




# Beam-synchronous signal generation



# PLL loop frequency step response



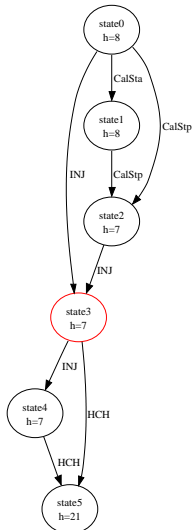
# State Machine

Each state has associated with it:

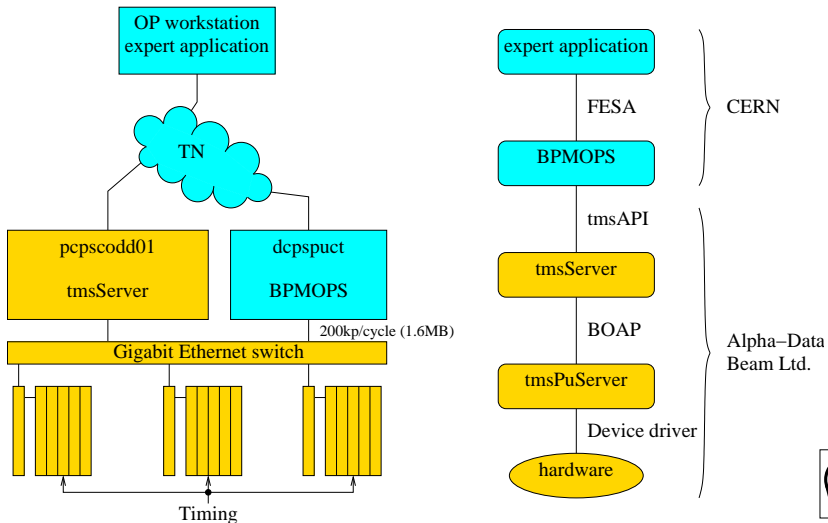
- Signal routing
- Beam-synchronous signals (LO, Gate, BLR)

Every event can have a distinct effect

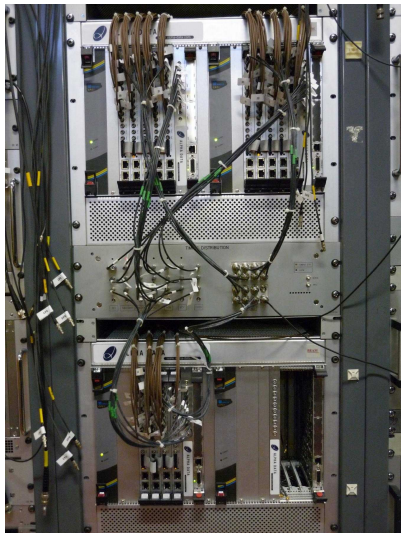
E.g., for SH21 beams in state 3, a 2nd injection yields state 4, but a harmonic change goes to state 5.



# TMS architecture: Hardware and Software



# cPCI crates

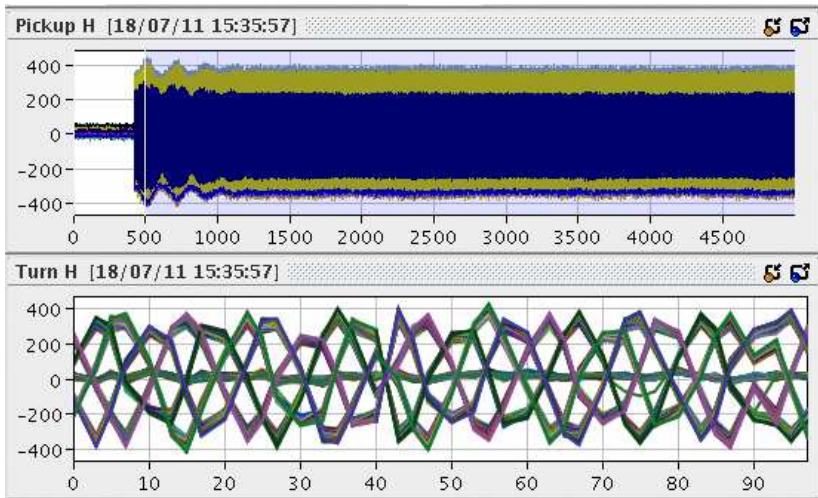


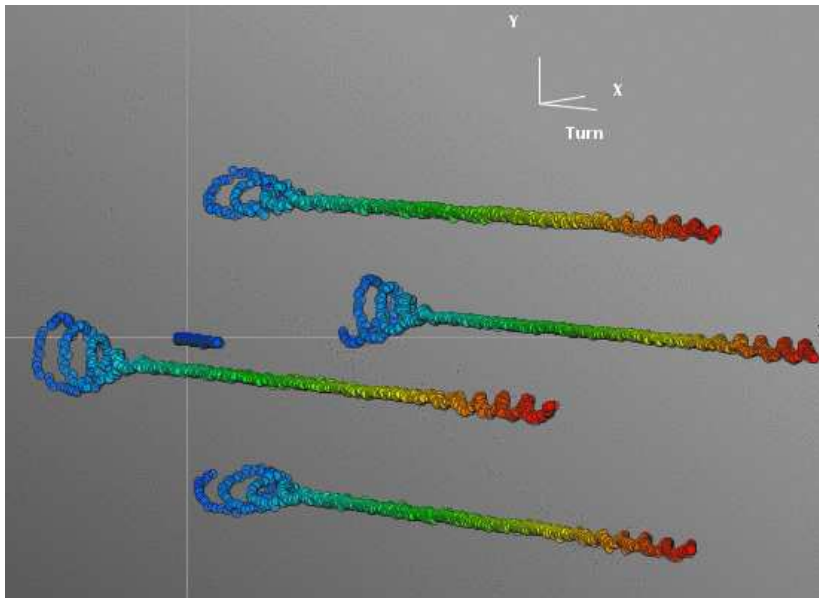
## Hardware

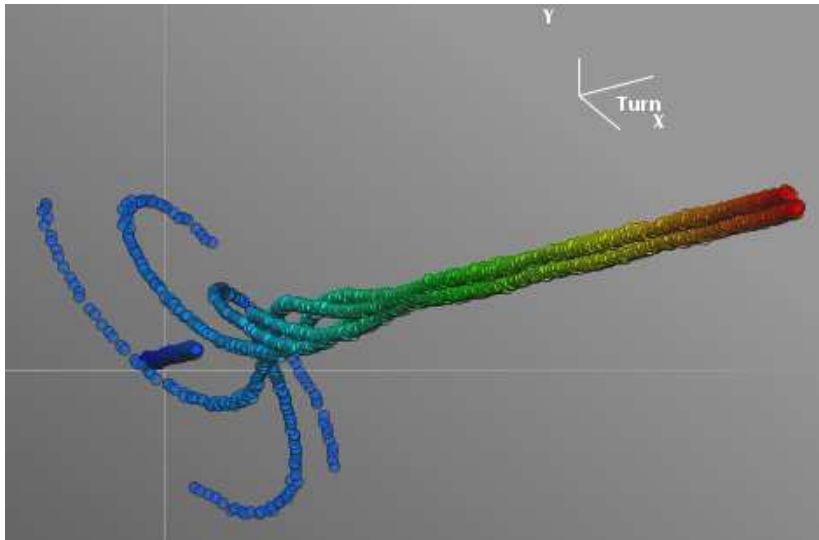
- Three half-width cPCI crates
- Three Concurrent Technologies PP410 processor boards
- Fourteen custom acquisition modules
- 120 14-bit, 125MS/s ADC channels



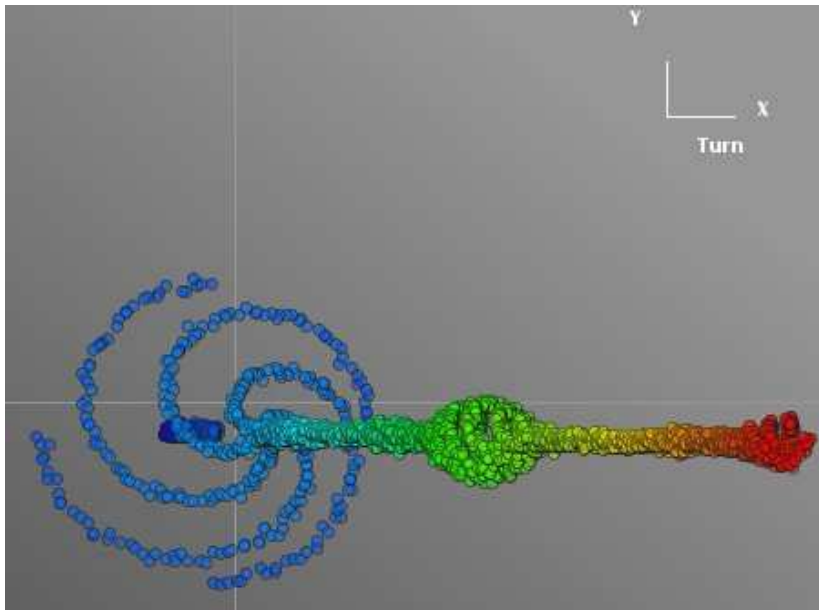
Some pictures of measurements made with the TMS









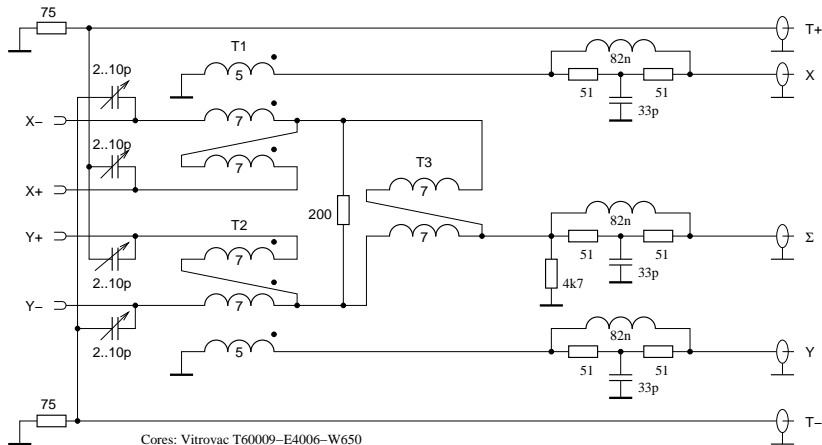


## Summary

- FPGA-based measurement systems offer unsurpassed flexibility and performance
- Good use of COTS hardware
- Only one application-specific electronics module in acquisition system
- System architecture caters for multiple independent clients
- **Sensitive to obsolescence**
- A similar system will soon equip the PS Booster
- ...



## Head assembly hybrid transformers



Cores: Vitrovac T60009-E4006-W650

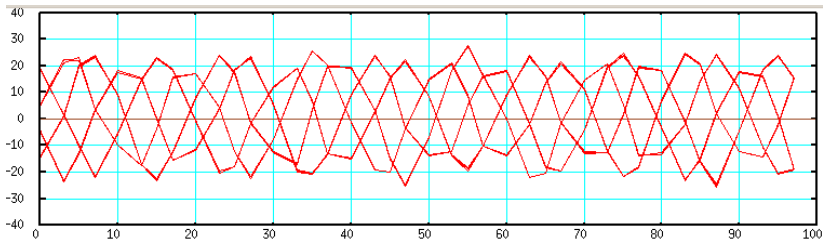
Variable capacitors: Johanson model 8052

75 Ohm resistors: Welwyn PWC size 2010, 2\*150 Ohm//

82nH inductors: Coilcraft 1008CS-820XGB



Pretzel trajectory



## Bunch splitting

