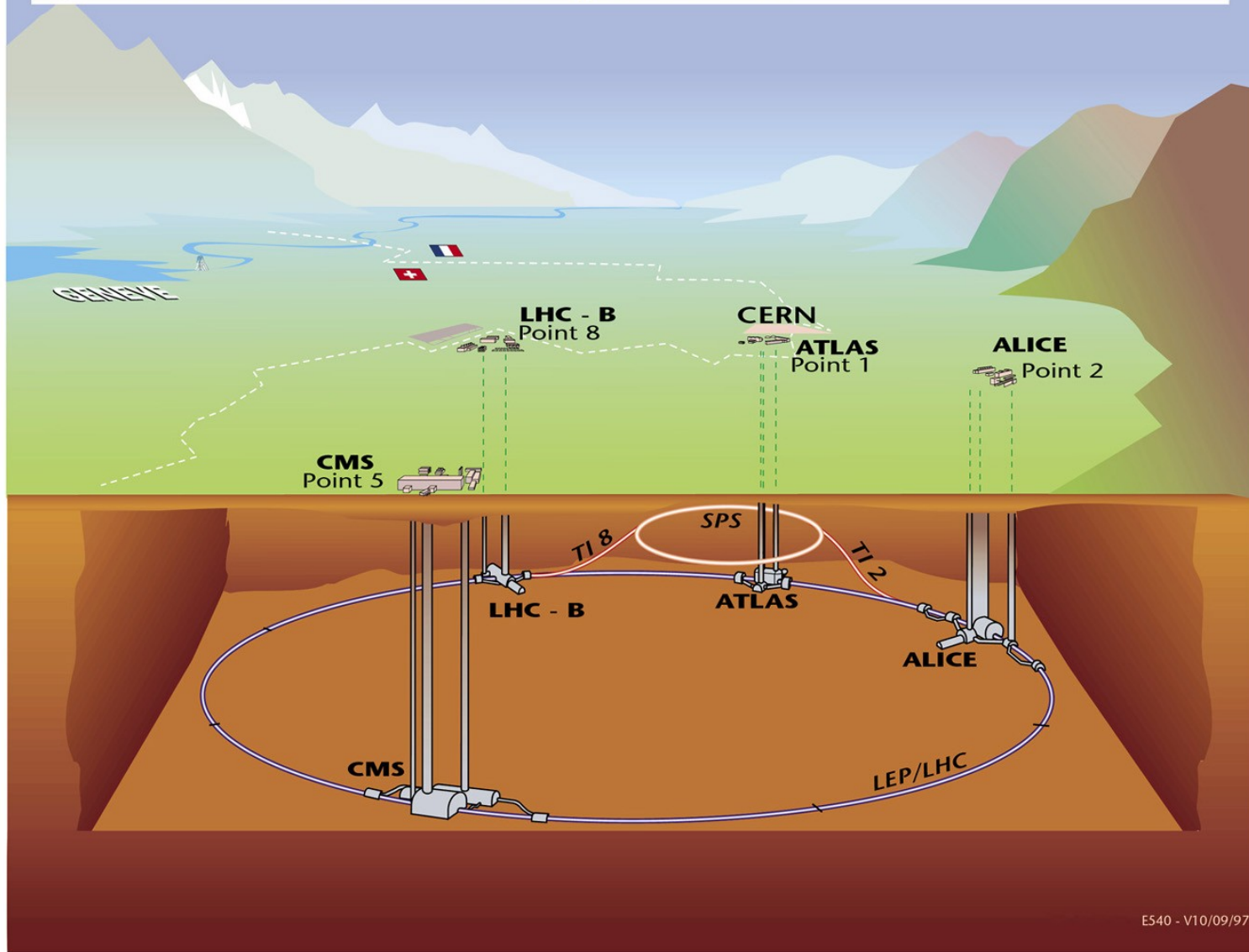


Commissioning of the LHCb Outer Tracker readout electronics

Jan Knopf
*Physikalisches Institut
der
Universität Heidelberg*

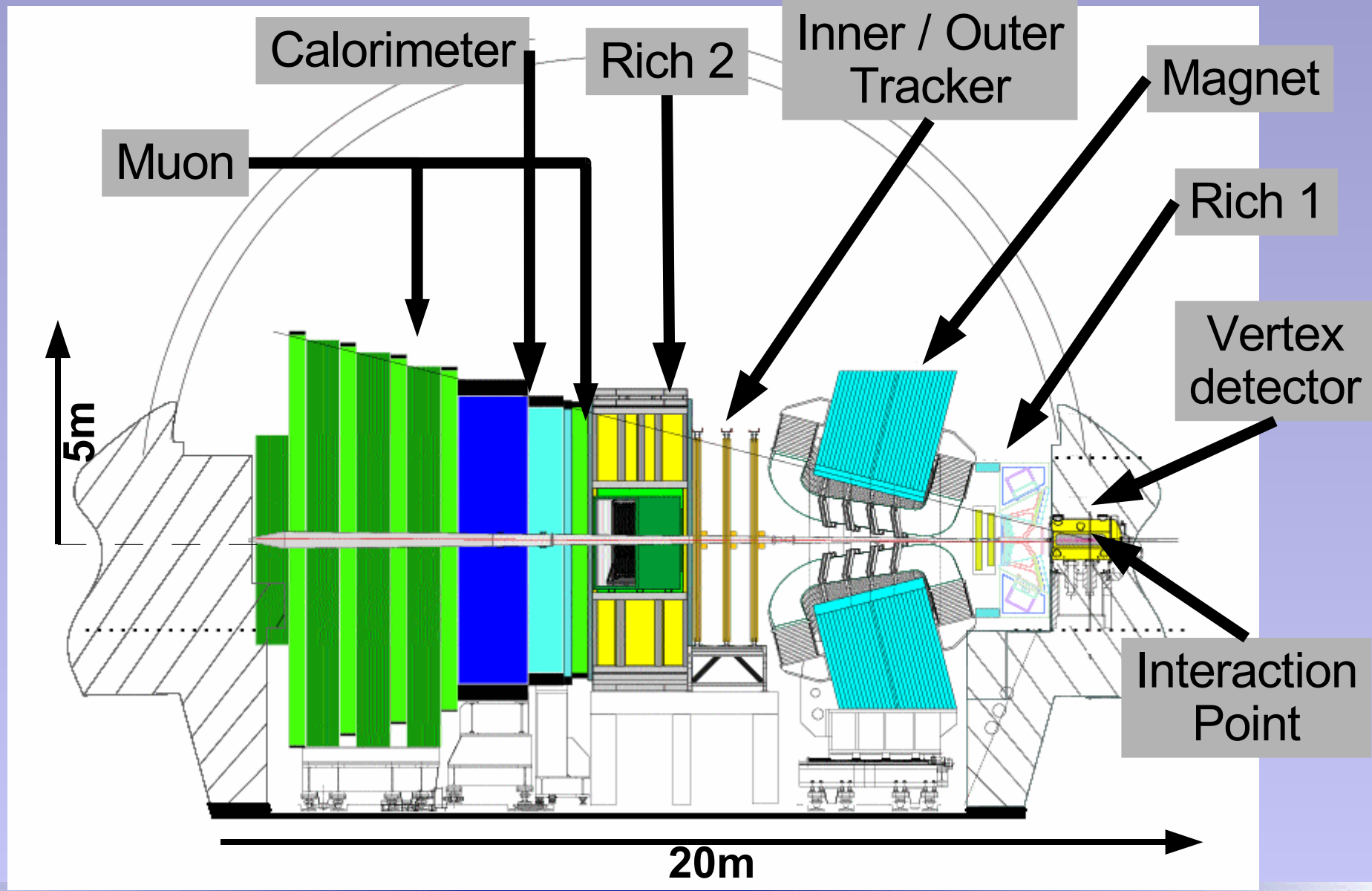
LHC

Overall view of the LHC experiments.

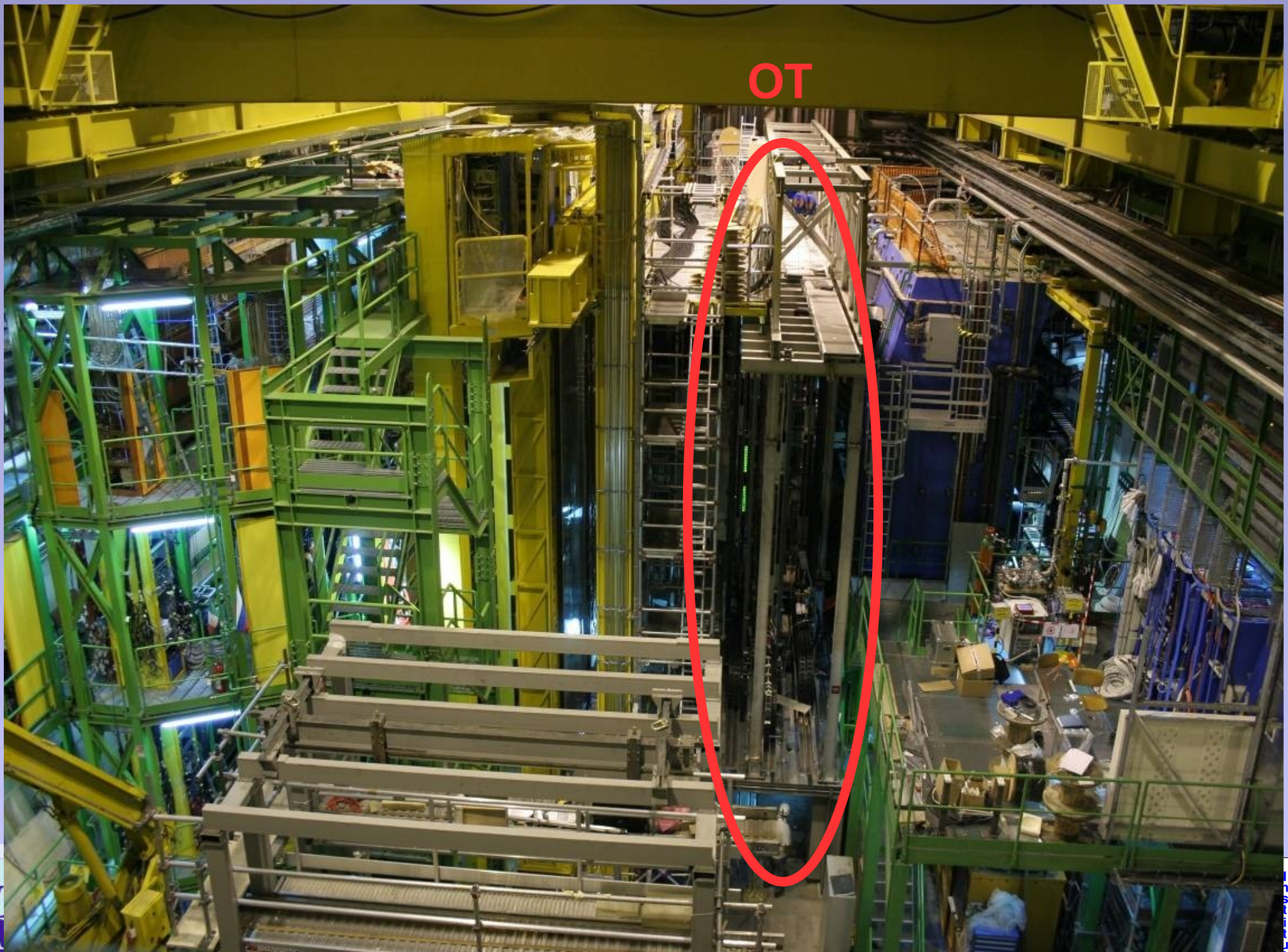


E540 - V10/09/97

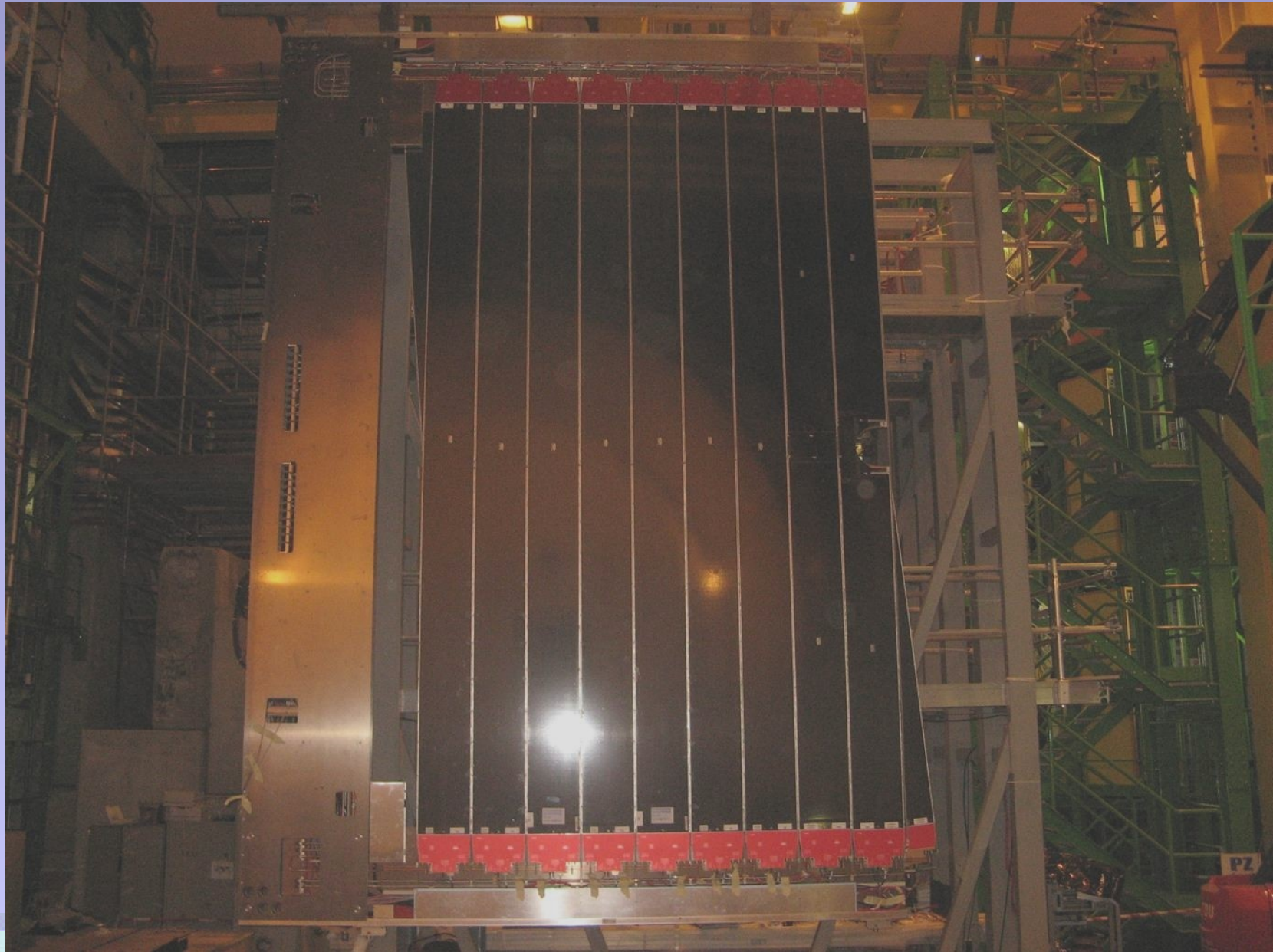
LHCb detector



OT



C-Frame



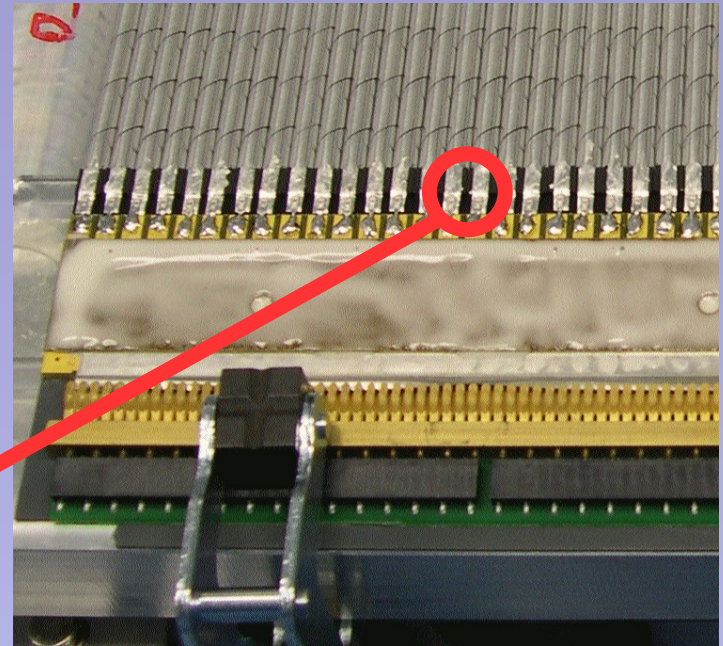
IRTG Seminar 27.07.2007

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Outer Tracker

Drift chamber technology:

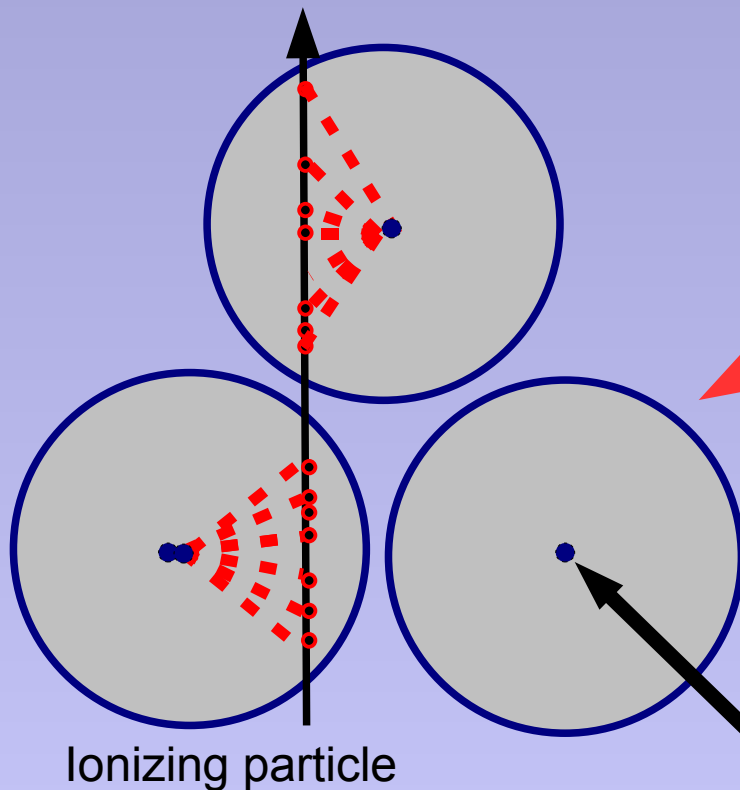
- ~ 55'000 channels
- tube: 5 mm diameter, 2.5 m length
- Gas mixture: ArCO₂



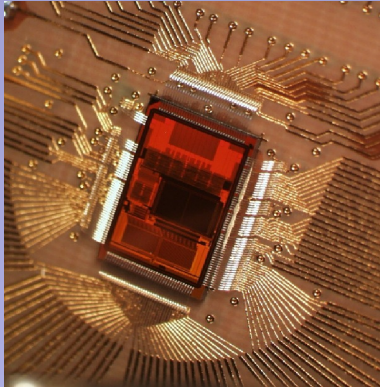
Measure the time between particle transition and signal from the wire

Kapton XC-160 + Laminated Kapton-Al (106 μm)

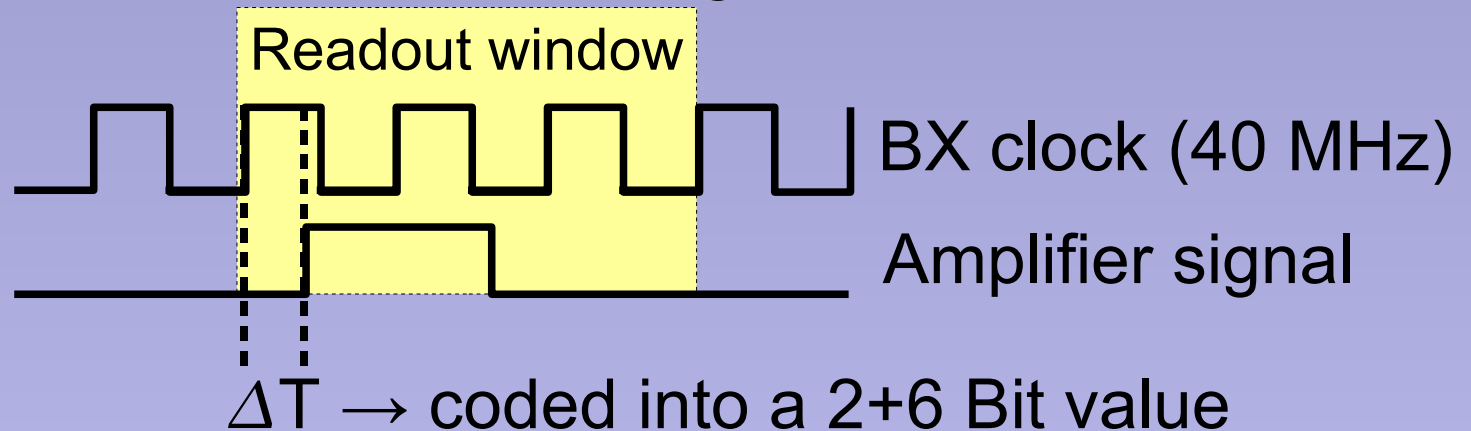
Gold plated tungsten (25 μm)



OTIS TDC chip

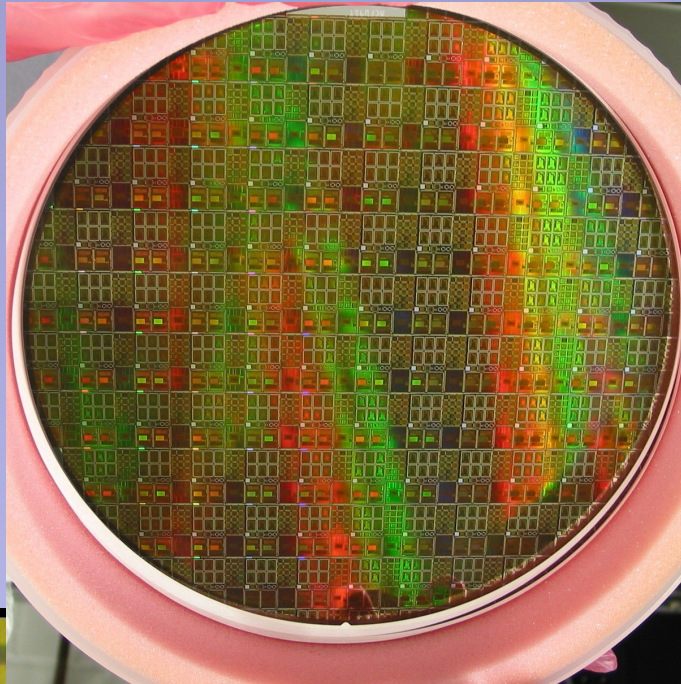


TDC = Time to Digital Converter



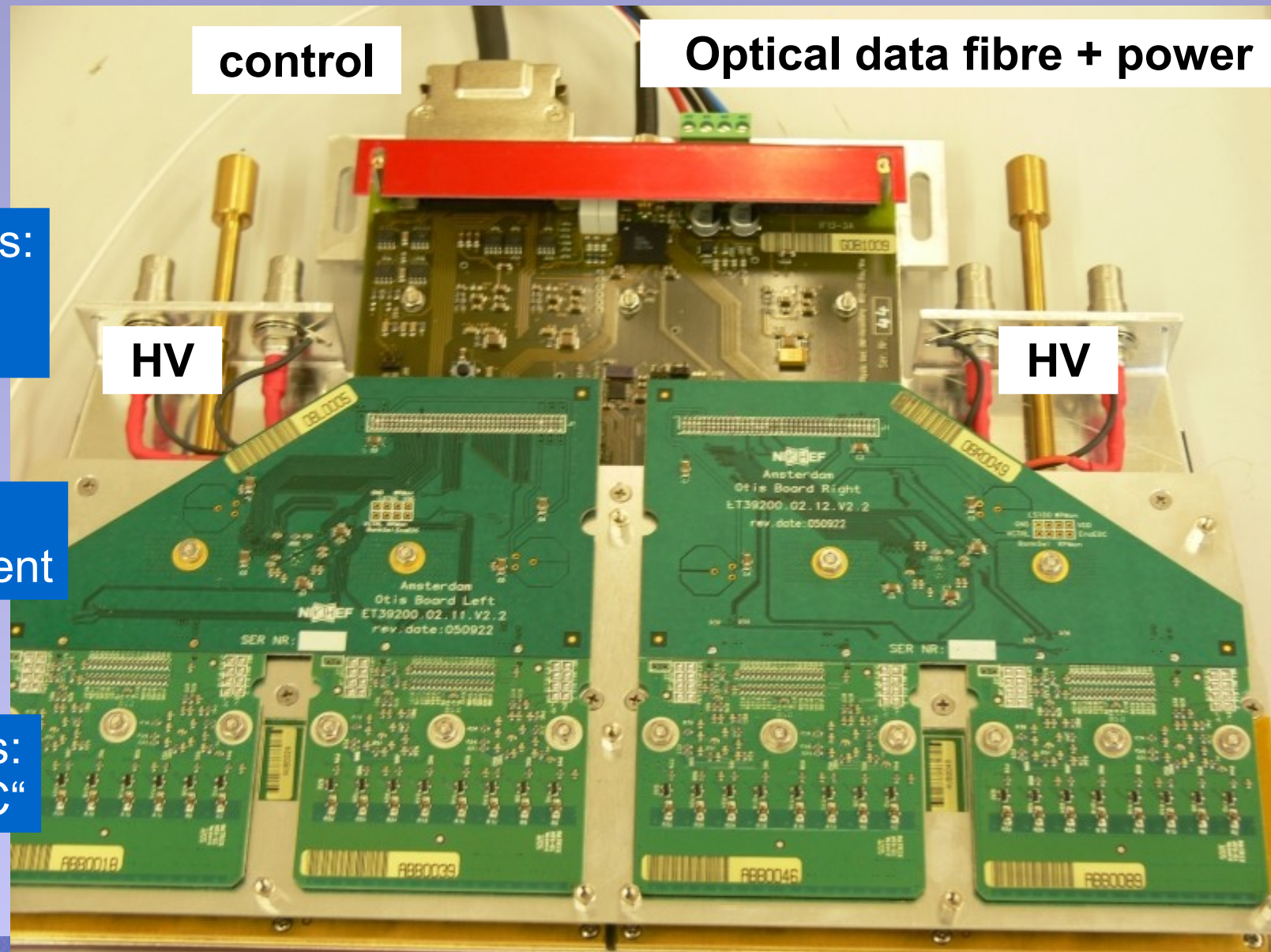
- Measures 32 channels simultaneously
- resolution 6 Bit (390ps @ 40 MHz)
- Readout window: 75ns
- ASIC Labor Heidelberg
- CMOS 0.25 μm process

OTIS wafer tests



Yield: $\approx 90\%$ (6606 / 7332)
See my last talk for details

Outer Tracker FE-Box

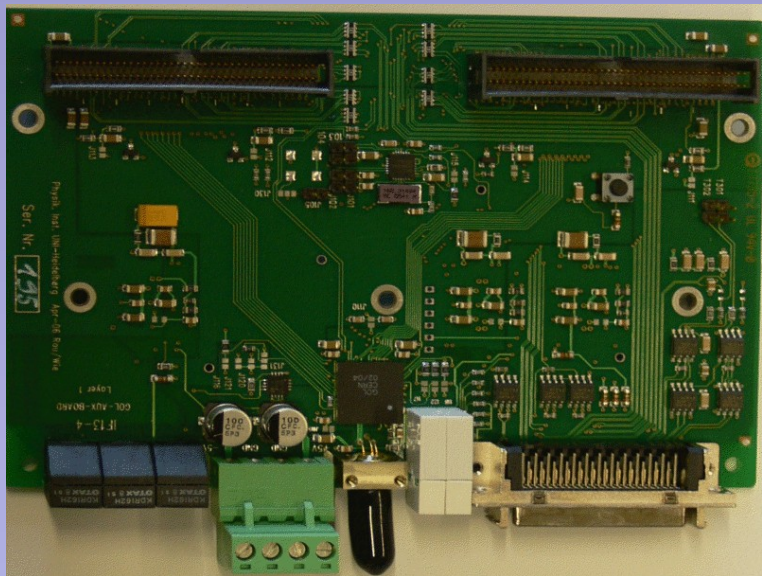


GOL-Aux boards:
infrastructure +
data handling

OTIS boards:
time measurement

ASDBLR boards:
amplifier + „ADC“

Test of the GOL-Aux boards

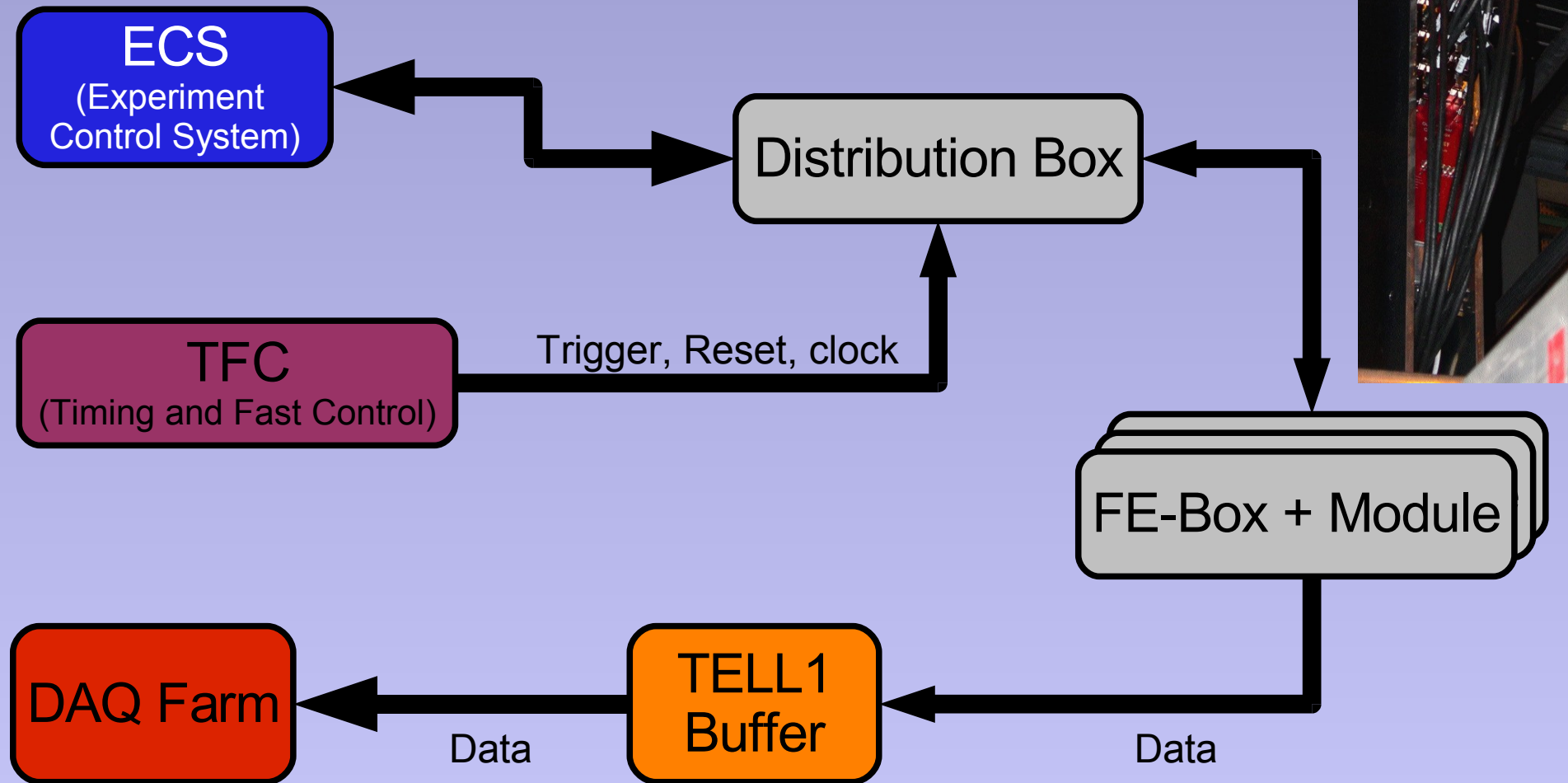


Developed and tested in HD:

- 496 boards produced
- 466 passed the tests
- 432 needed for the FE-Boxes (without spares)



Electronic components



CRack

User Terminal

L1 Buffer

ECS

Farm PCs (DAQ)

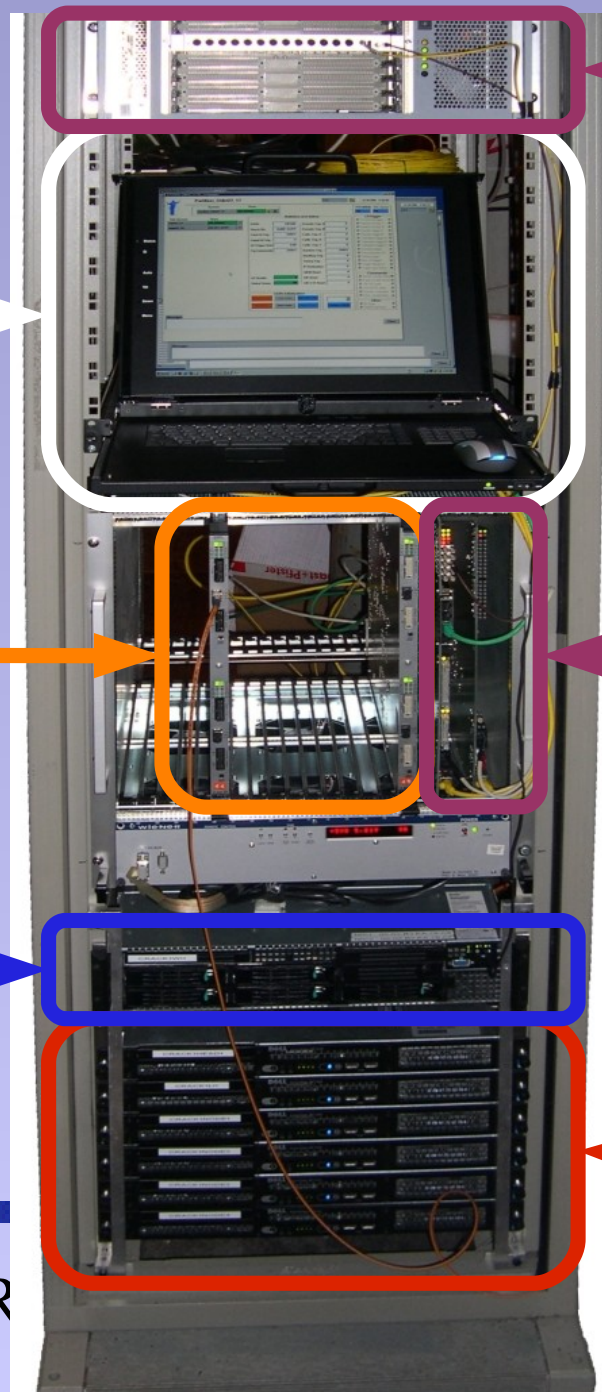
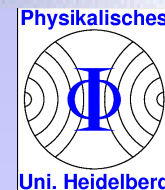
(TFC)



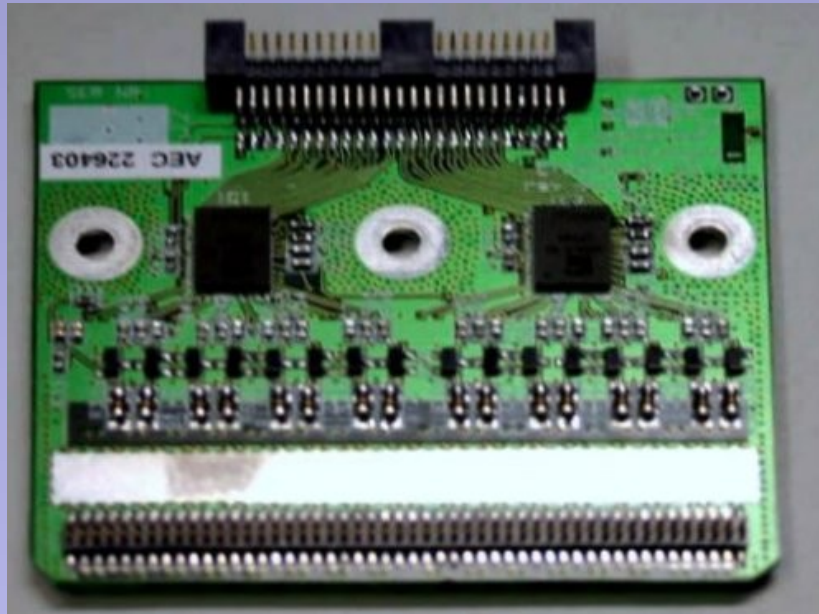
IR

07

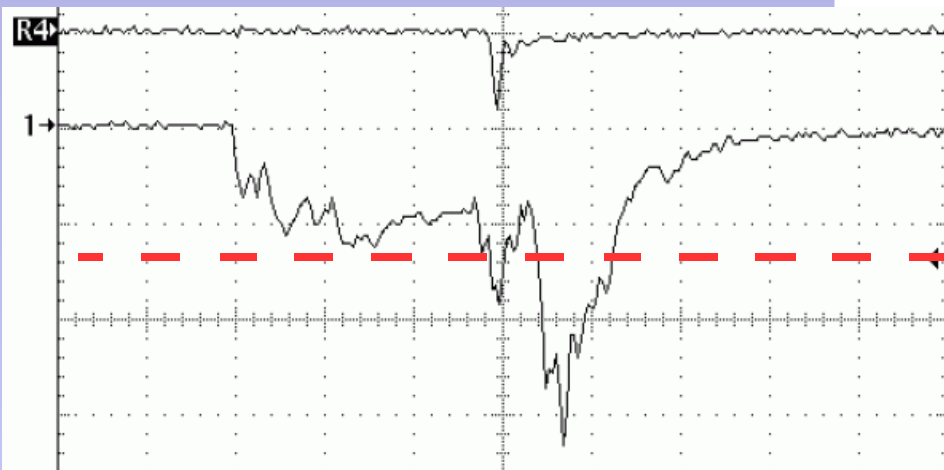
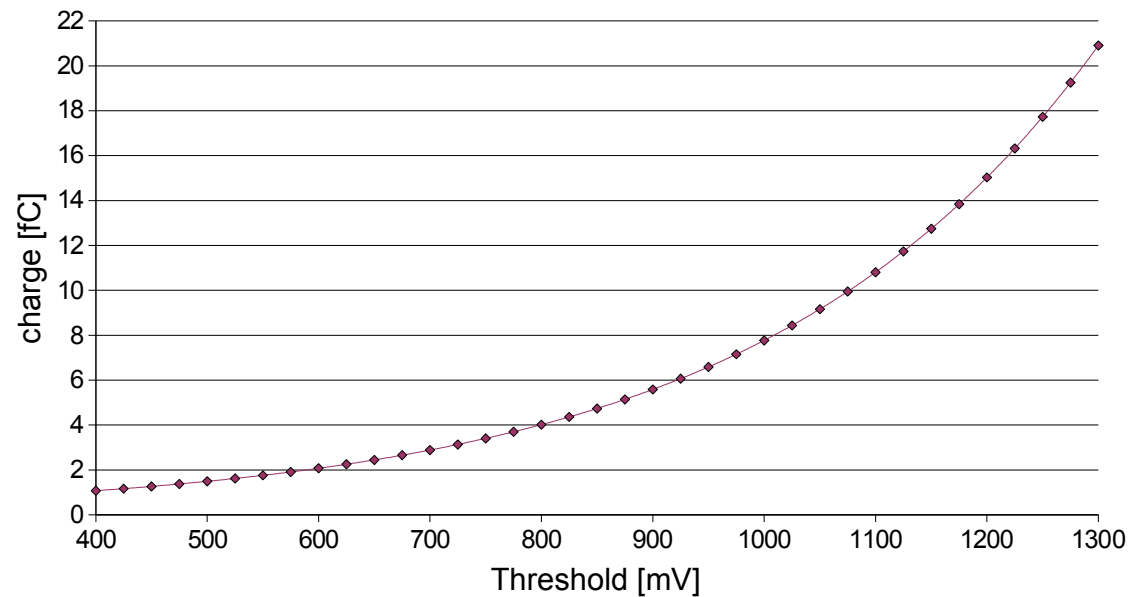
12



Amplifier



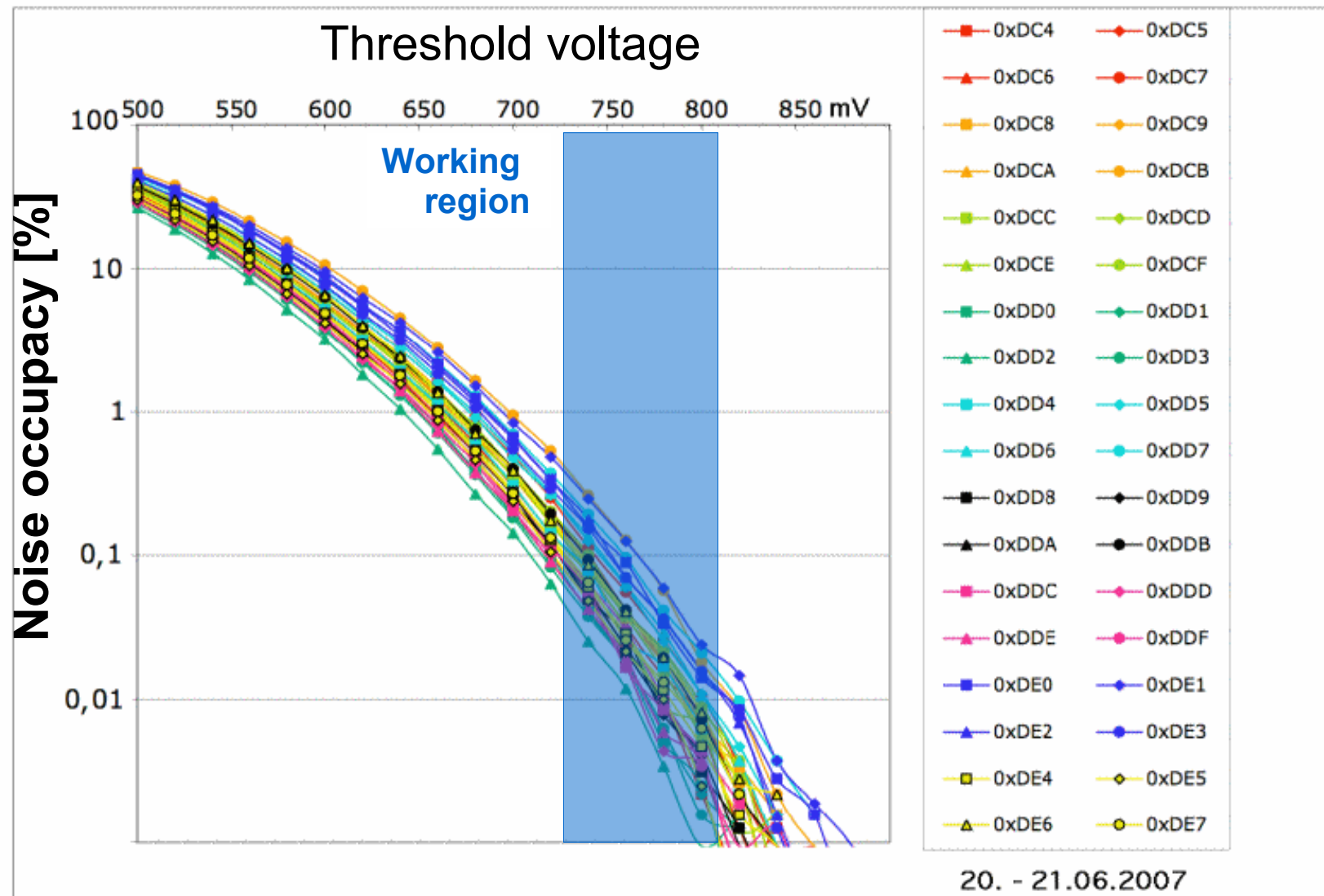
Charge vs. Threshold voltage



The threshold voltage is a parameter to fix the charge which is necessary to produce a signal for the TDC

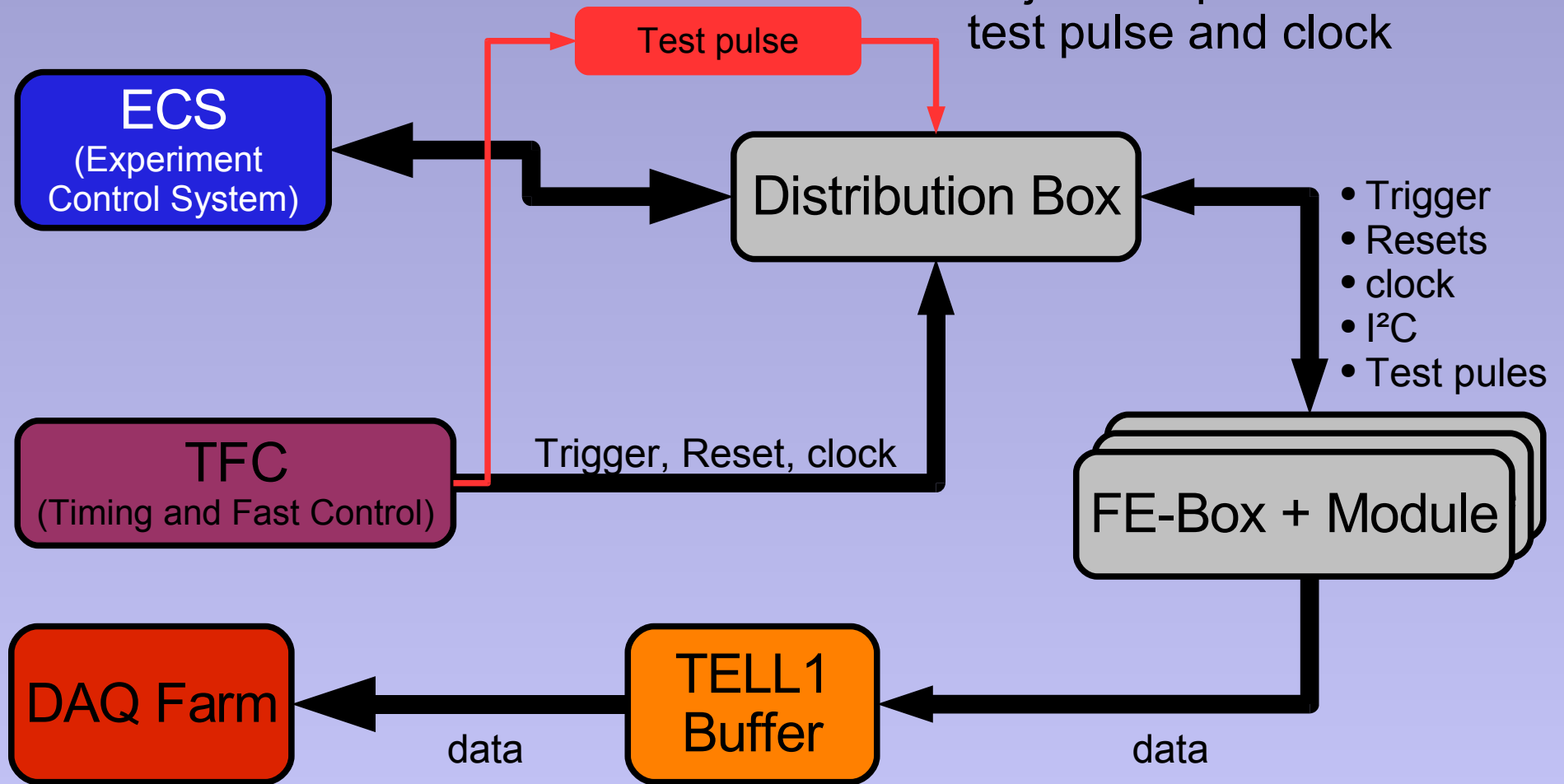
Noise measurement

Threshold scan of T3-Q3-L1(U)

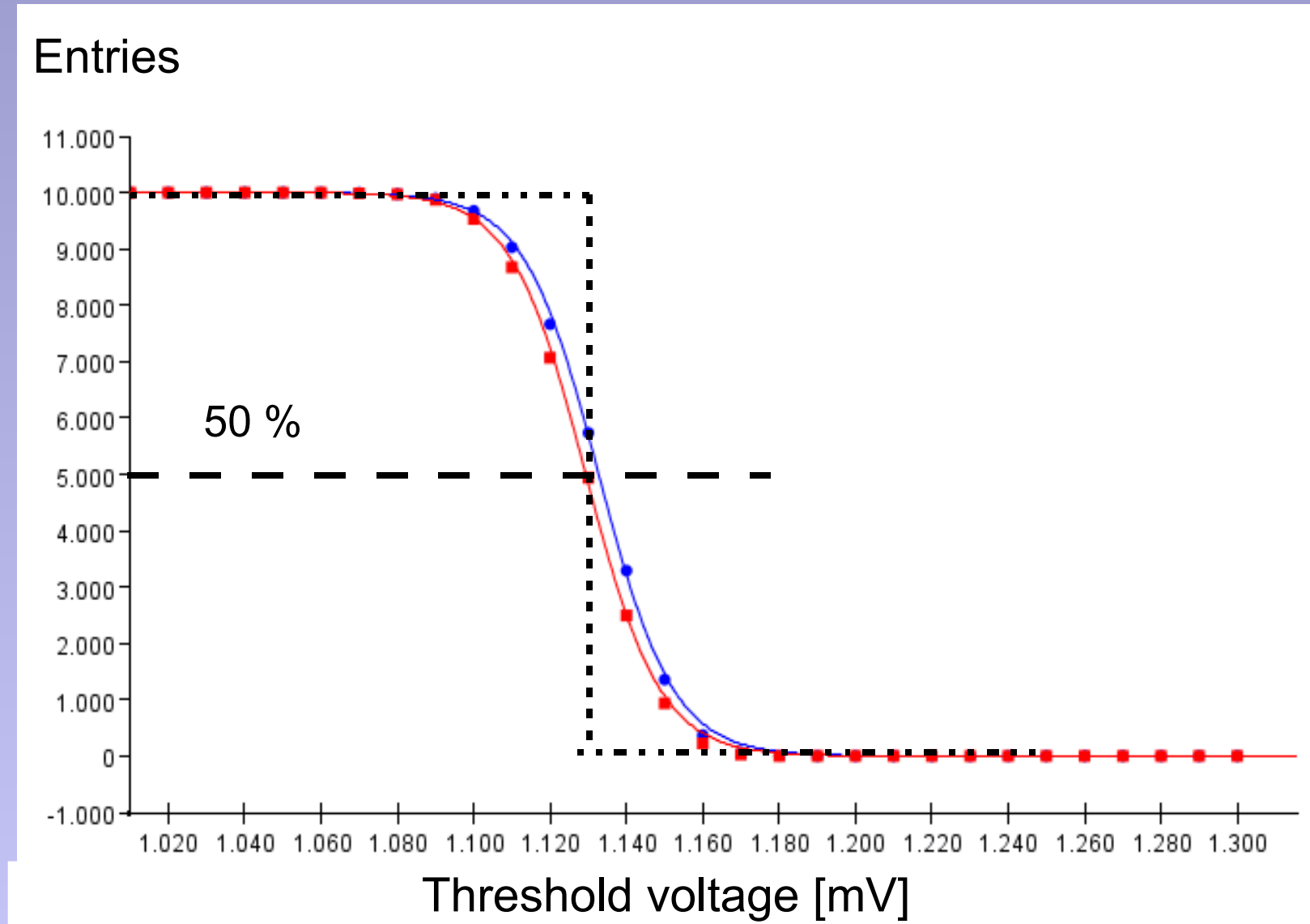


Test pulse

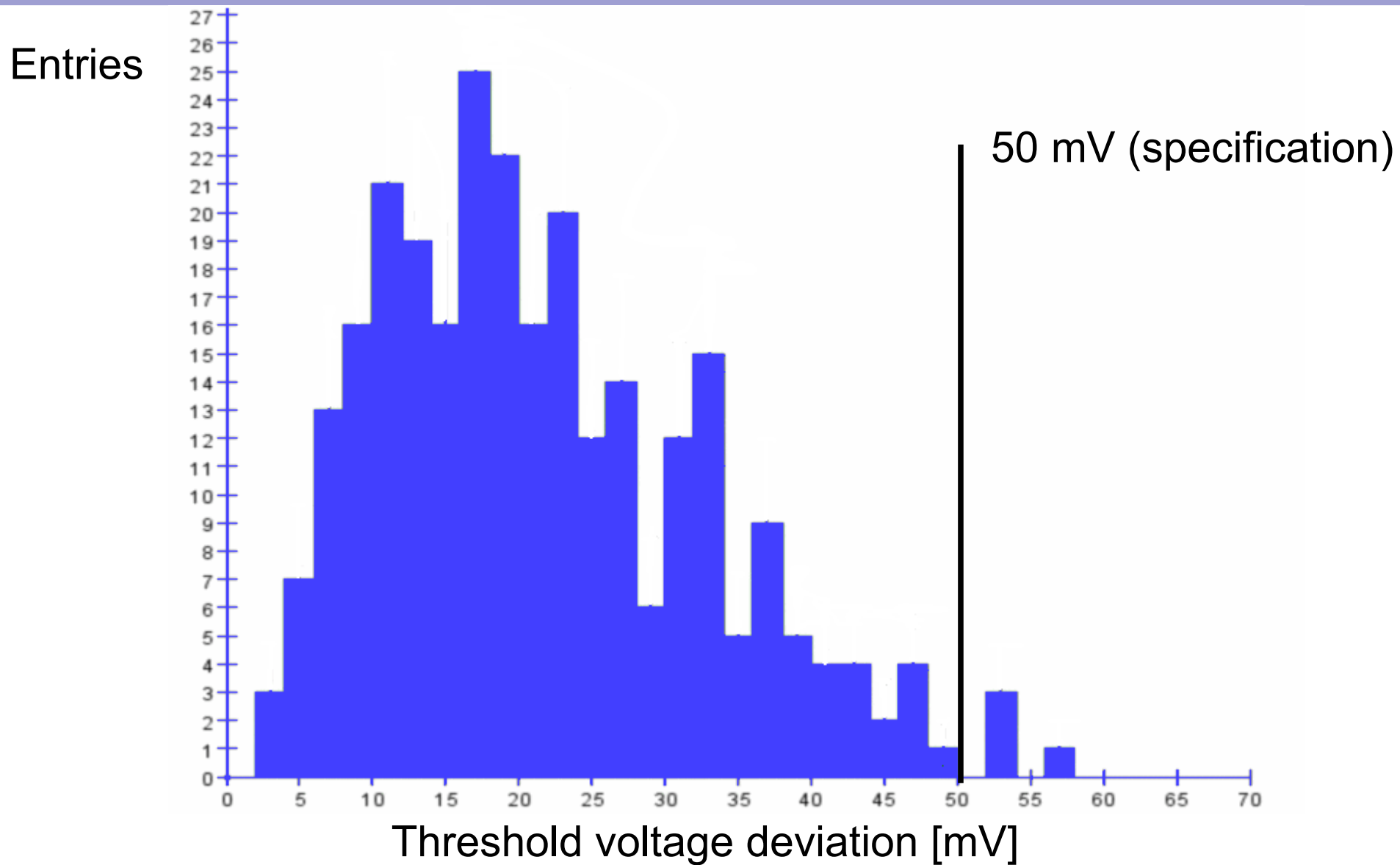
Adjust the phase between test pulse and clock



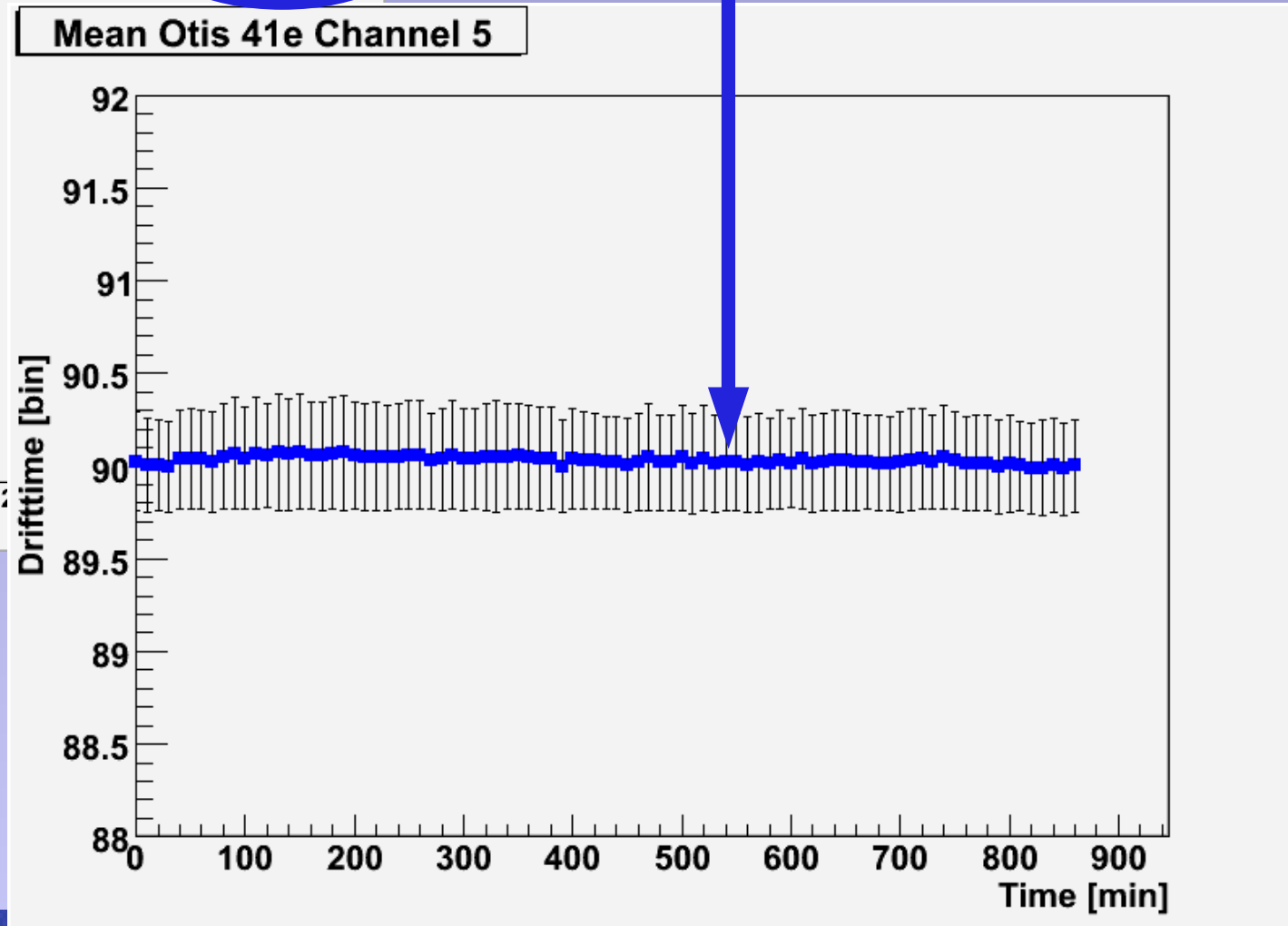
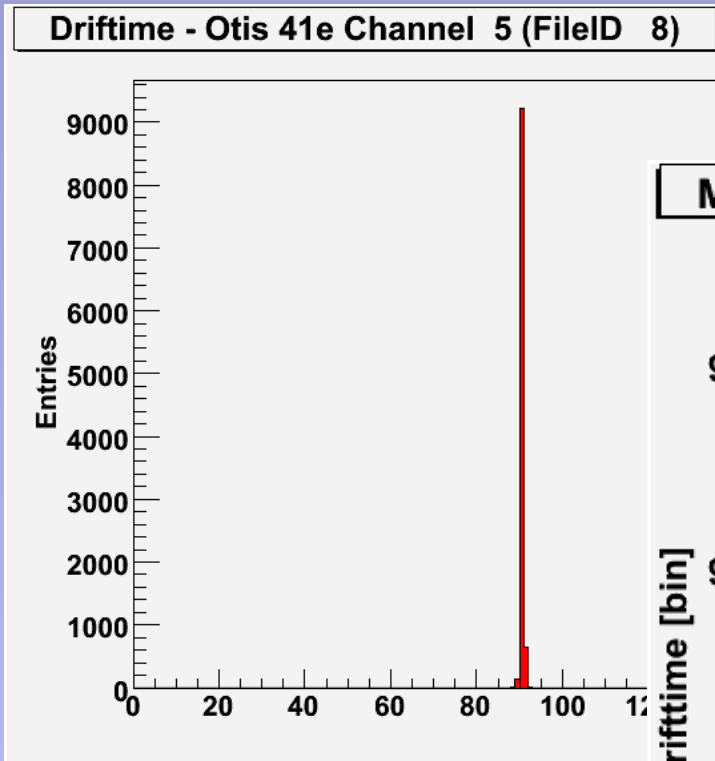
Test pulse vs. threshold voltage



Uniformity of the amplifiers

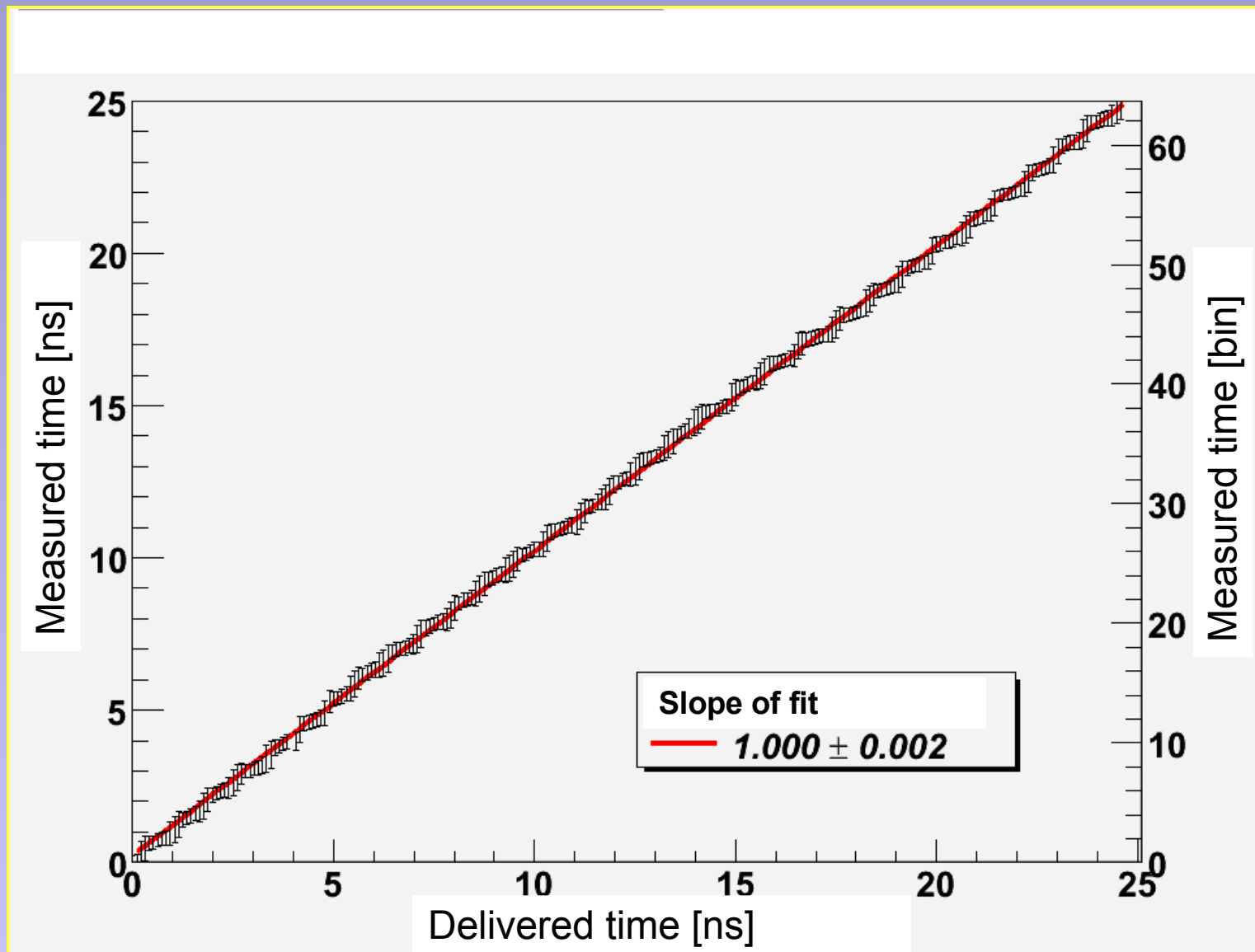


Time stability



Measurement every 10 min at a fixed delay.

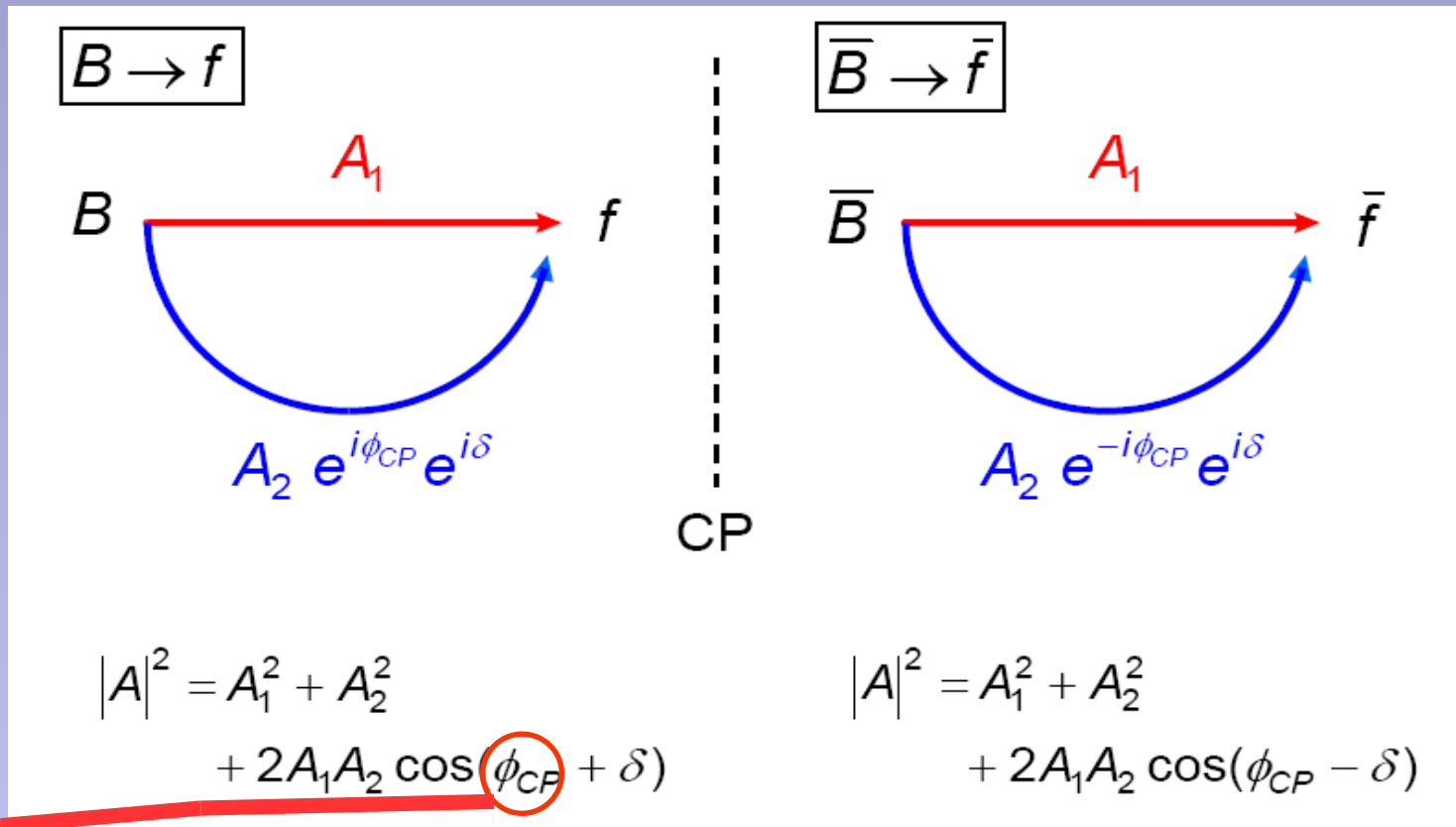
Time measurement



Whats next?

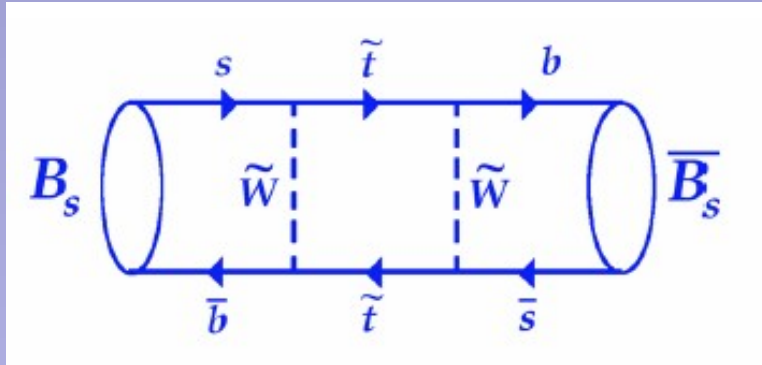
- * install electronics ✓
- * discover new physics

CP asymmetries

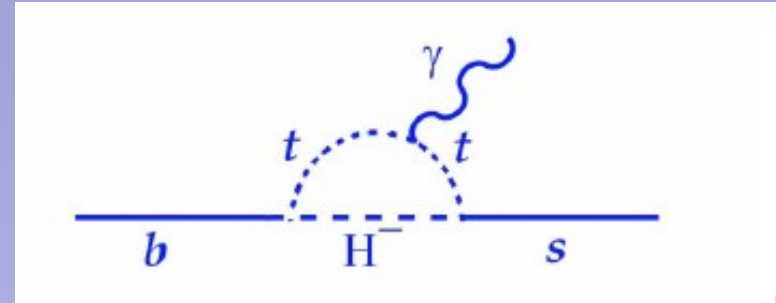


Measurement of ϕ_{CP} is a very sensitive probe to Physics Beyond the Standard Model

New physics at LHCb



Box diagram

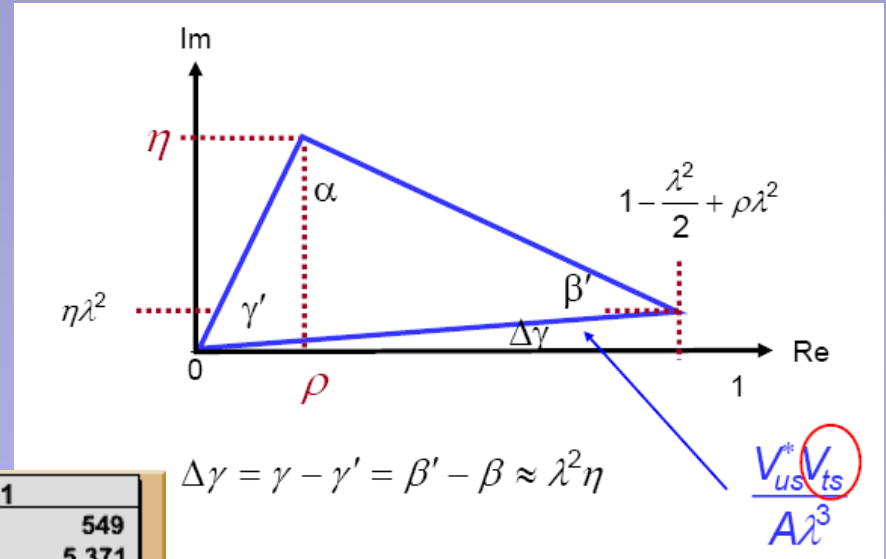
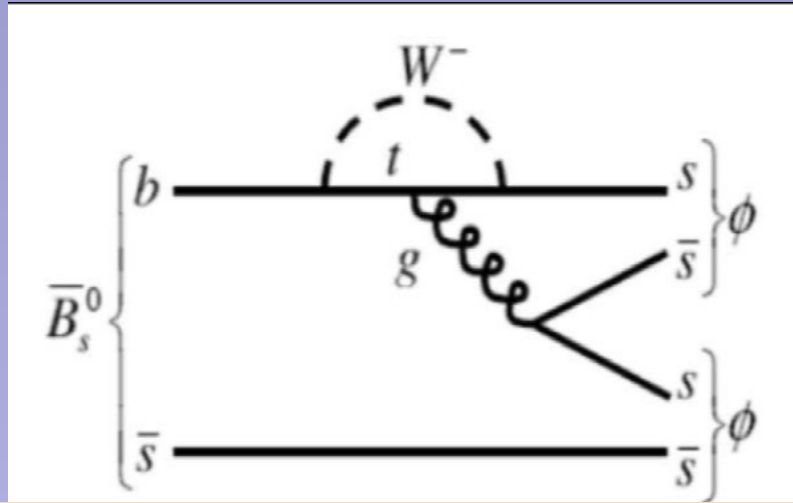


penguin diagram

Look for deviations from the standard model in absolute rates and phase dependent CP asymmetries

→ Complementary approach to the direct search at Atlas / CMS

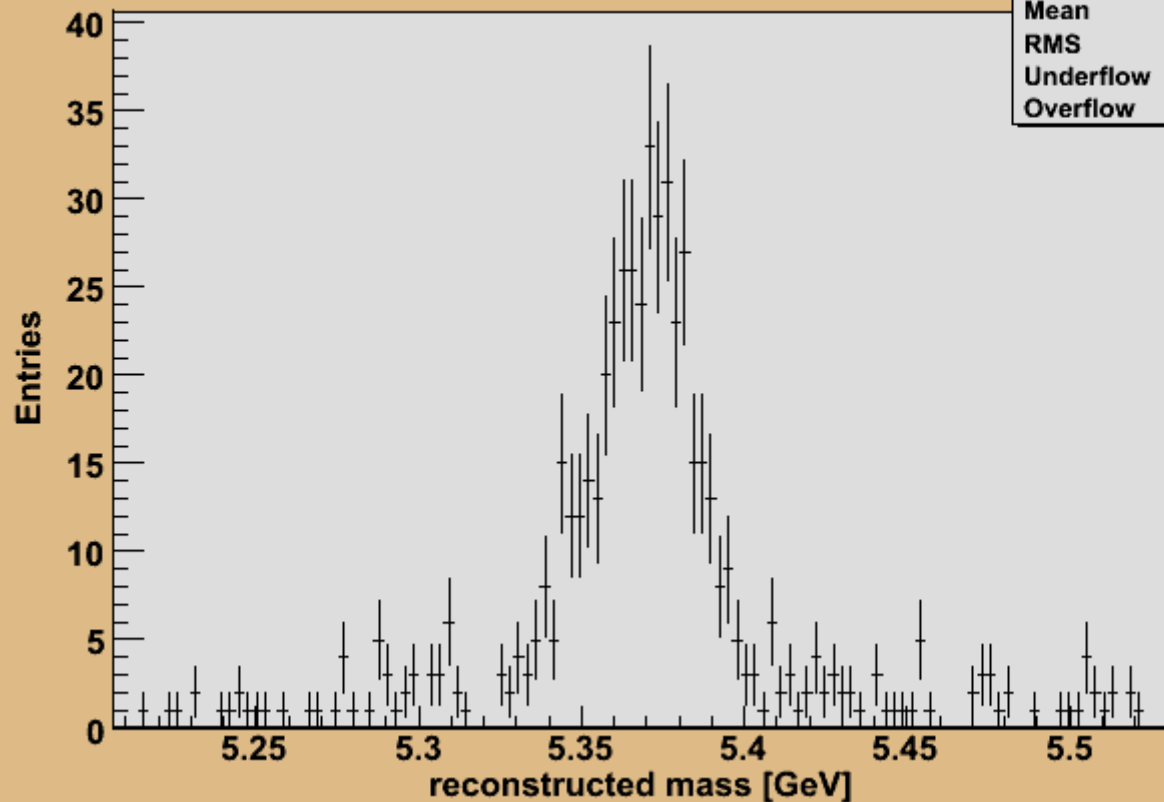
$$B_s \rightarrow \phi\phi$$



→ CP-asymmetry = 0 within the standard model

→ Measurement extremely sensitive to new physics

B_s0 mass



Summary

- The Outer Tracker is installed
- The electronic is currently put on the remaining C-Frames
- So far all tests indicate full operation capability