

FBCT experience at Desy

Presenter:

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At CERN Workshop:

**„Improving the accuracy of the BCT
measurements in the LHC“**

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About this presentation:

- ⌘ This presentation consists mainly of information from our BCT expert Reinhard Neumann and shows developments of our former BCT expert Willi Radloff.
- ⌘ I just present their results.

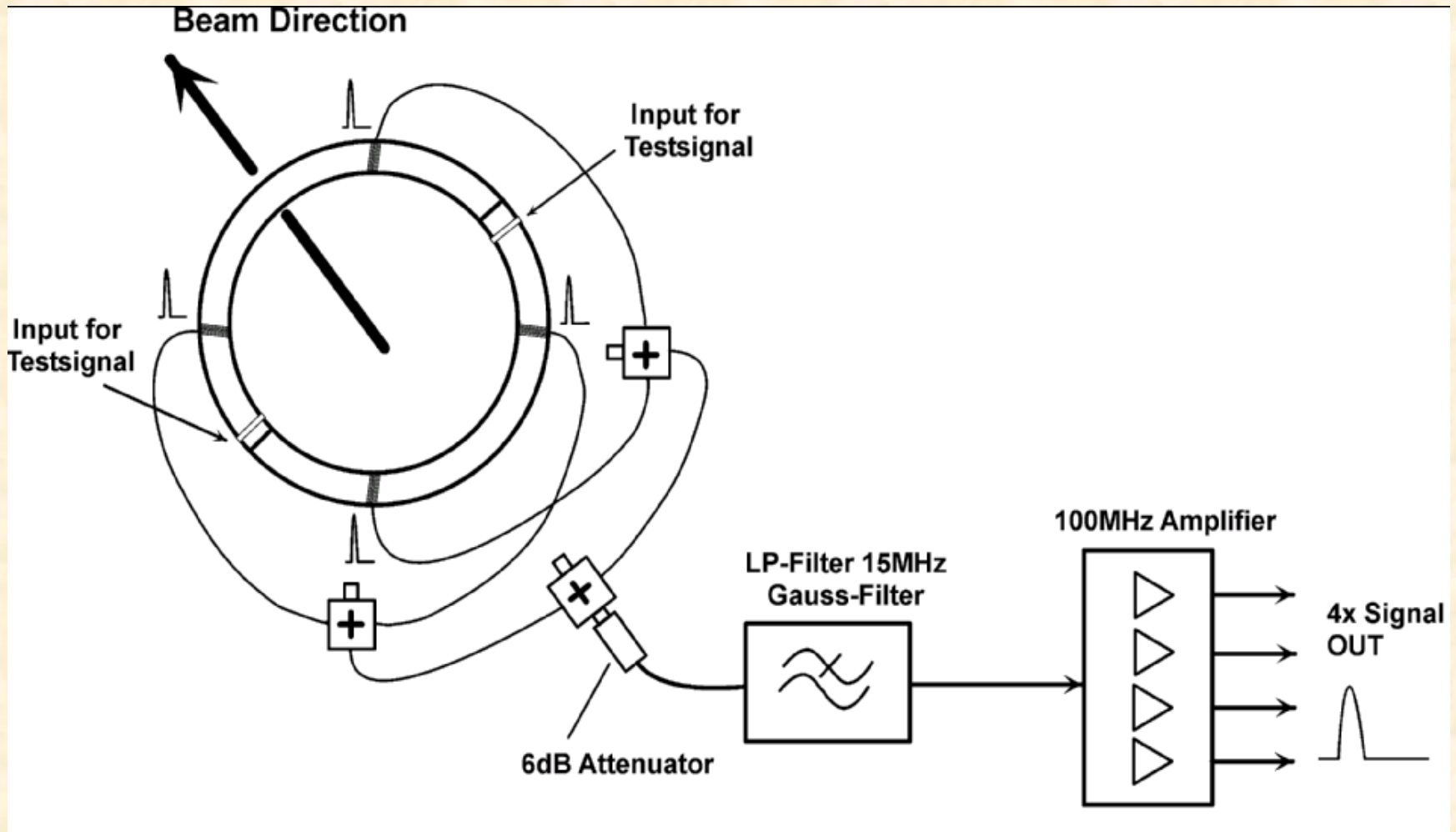
FBCTs used at DESY

- ⌘ Bergoz FBCTs e.g. for Petra accelerator for high bandwidth
- ⌘ Inhouse development (by W.Radloff) e.g. for FLASH and XFEL accelerator for low beam position dependence.

FBCTs with reduced beam position dependence

- ⌘ The monitors are equipped with 4 symmetric coils to minimize beam position dependence.
- ⌘ In the original design, each coil has 10 turns.
- ⌘ In the actual design for FLASH, each coil has 1 turn and an RF transformer ($w_1/w_2 = 1/10$), resulting in increased bandwidth (in the order of 100 MHz) for optimized design, but decreased amplitude.
- ⌘ The currents of the 4 coils are added up by a summing network combined with an impedance matching transformer (improved version under development).
- ⌘ Unconfirmed tests showed an amplitude change of $\pm 0.3\%$ for position changes of ± 6 mm – this could be further improved by trimming.

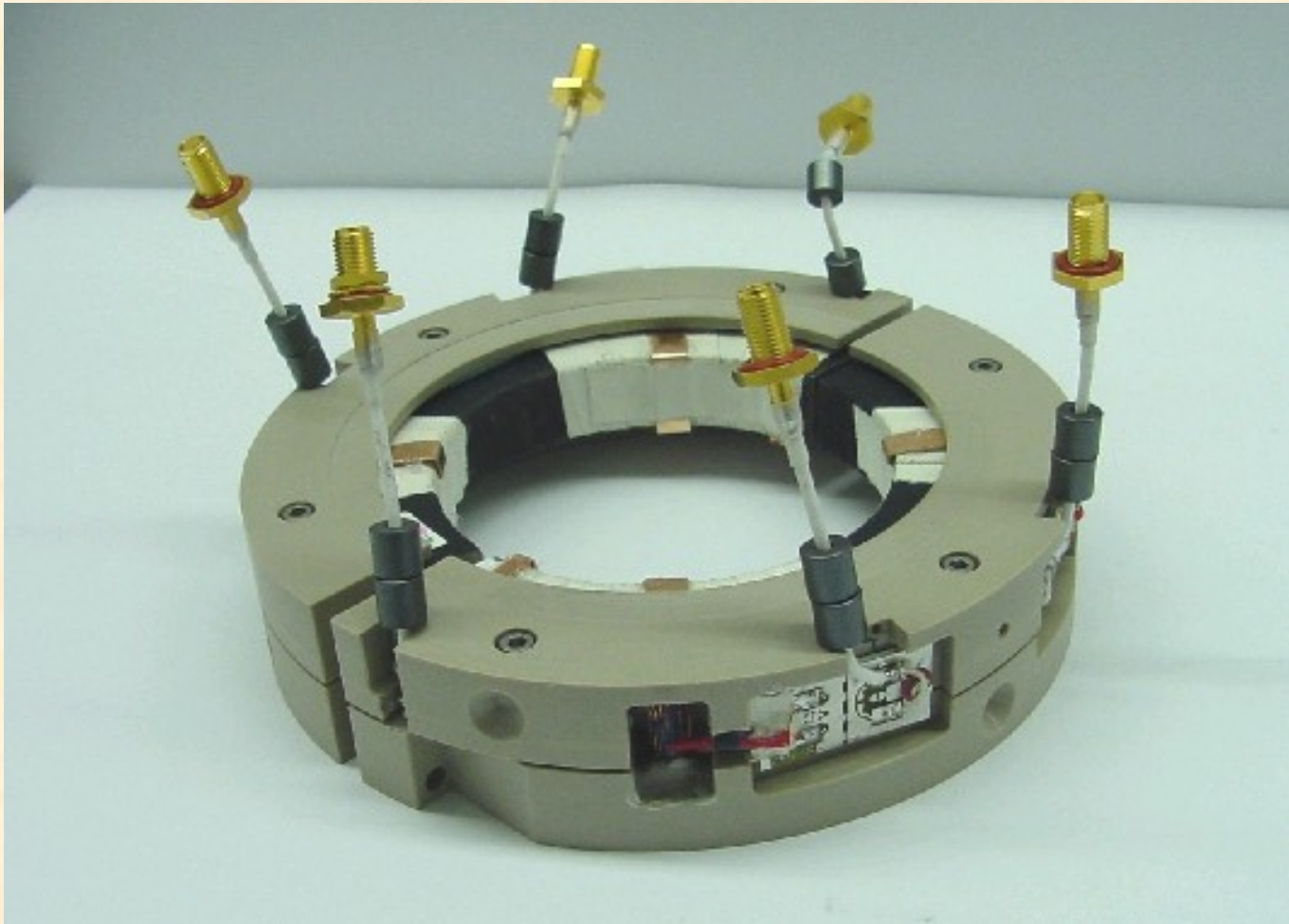
Pickup and Electronics



Halfcore in PEEK-Carrier

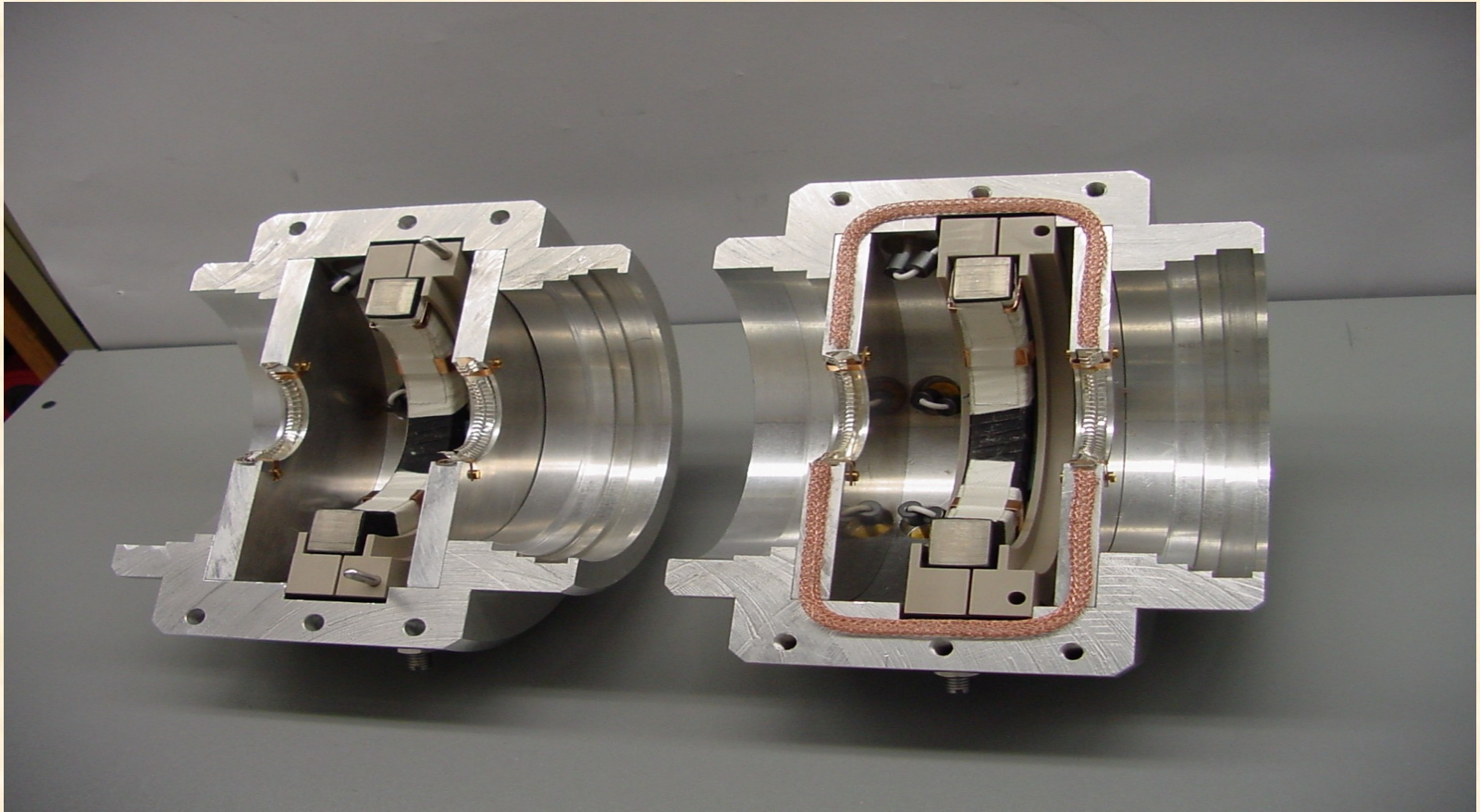


Both Halfcores



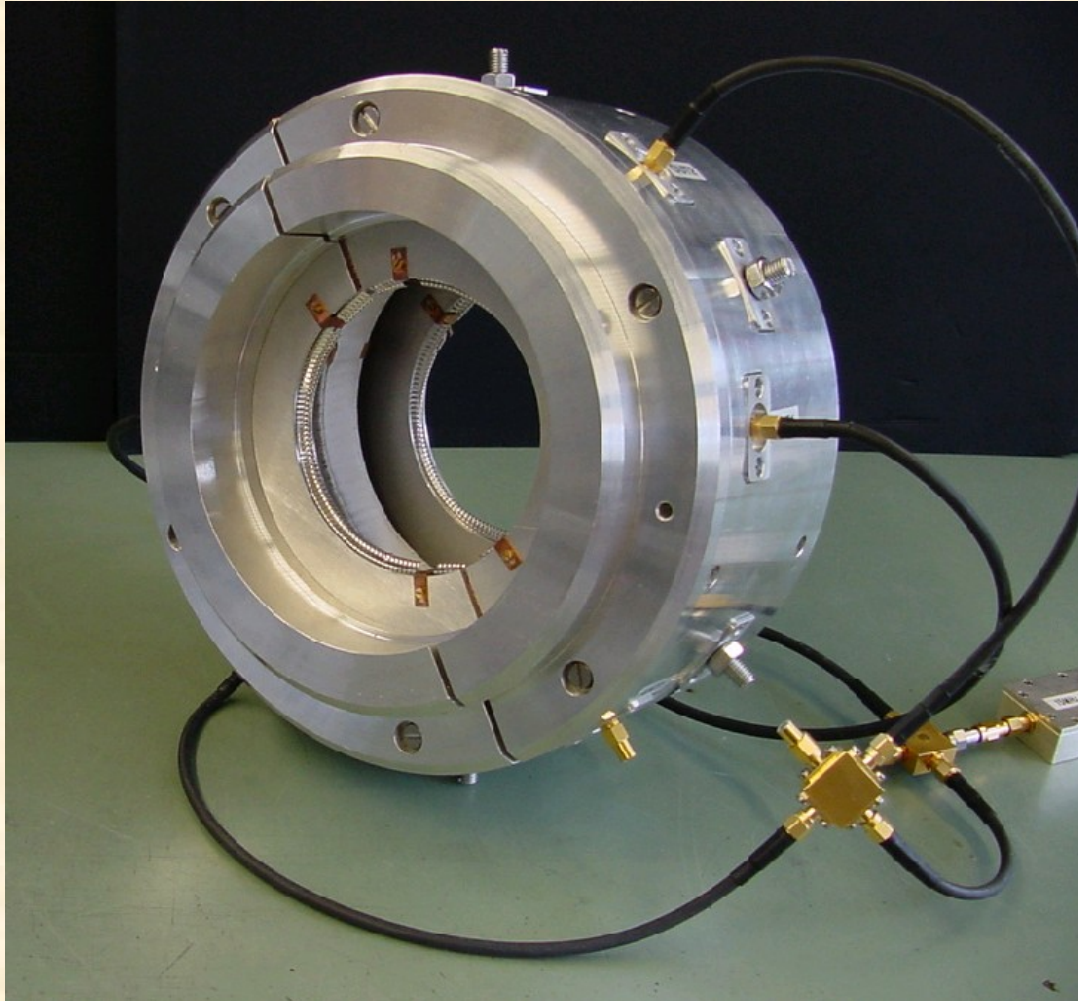
Fully equipped beam transformer halfcores

Split Pickup Electrode



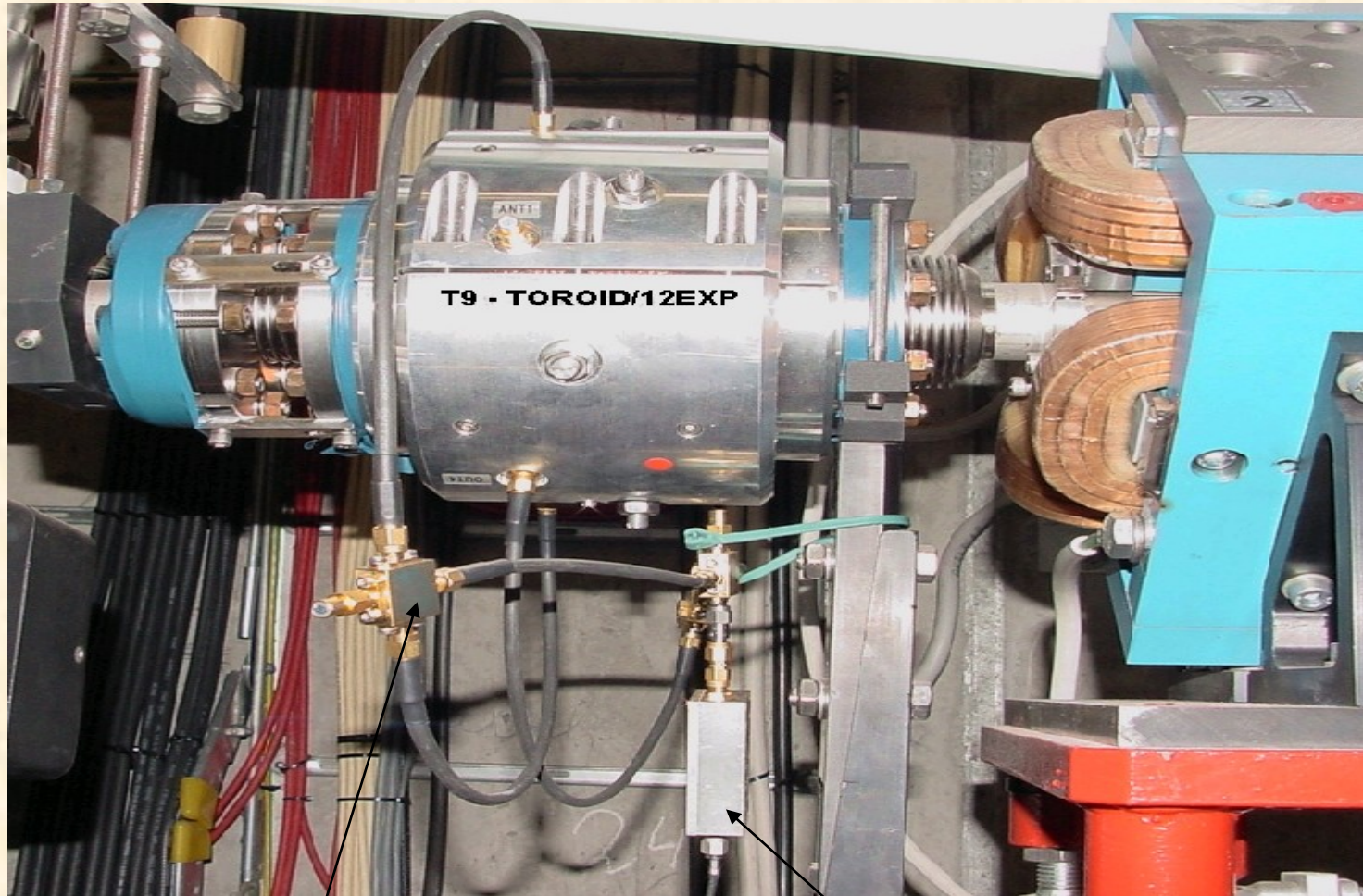
Transformer halfcores embedded in shielding halfcovers

Toroid *TTF2*- Dump



Complete, with cables, combiner and filter

Toroid in *TTF2 Linac*



Combiner

LP-Filter

Precision of BCTs at DESY

Info from Reinhard Neumann:

⌘ Up to now, a precision of $\approx 1\%$ (reproducibility, not absolute accuracy) of full range was achieved, this was enough for the Desy accelerators, so no further development was done to improve the precision.

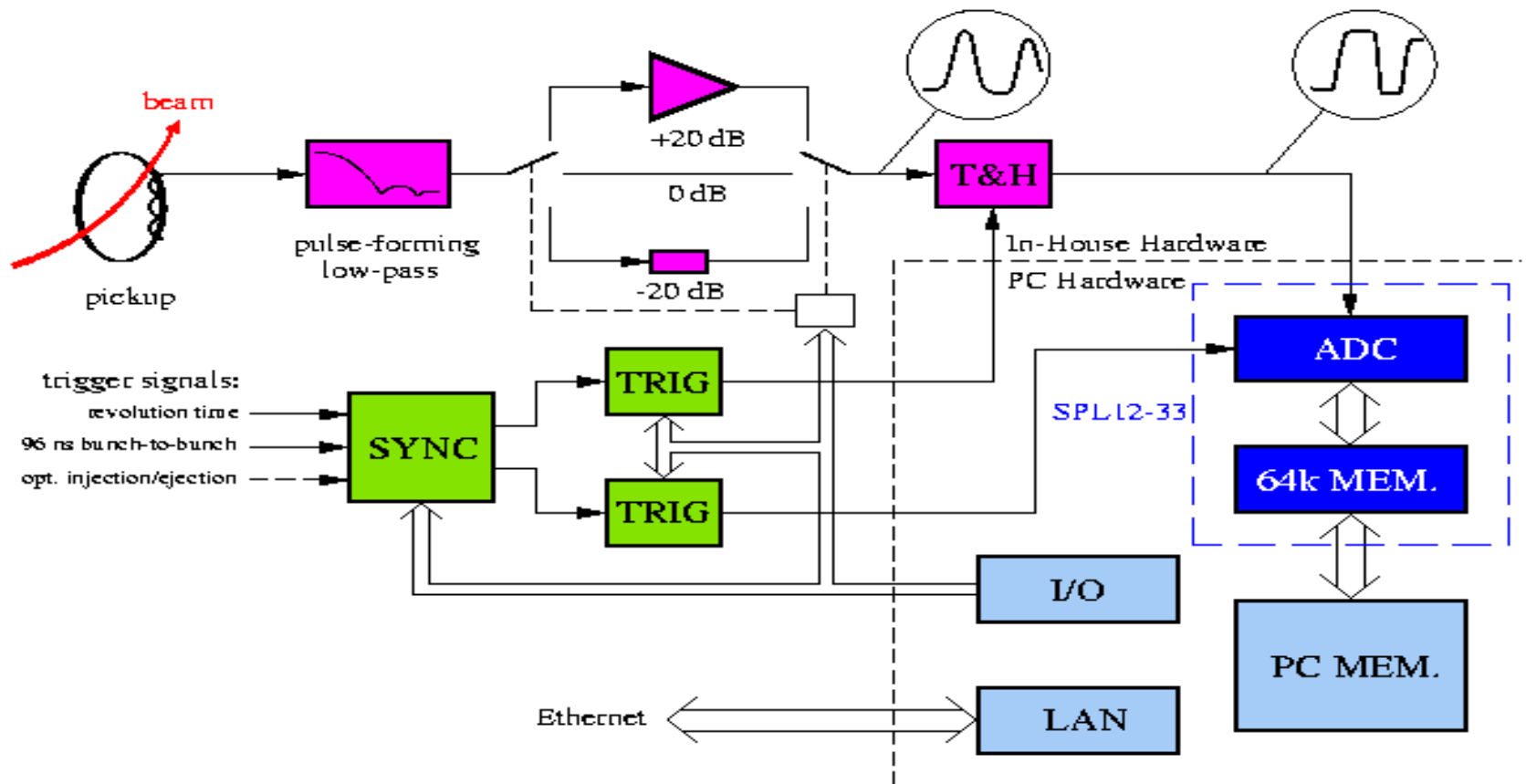
What can affect precision and resolution of a BCT?

- ⌘ Calibration method
- ⌘ Amplitude stability of signal processing chain
- ⌘ Temperature dependence
- ⌘ Beam position dependence
- ⌘ Baseline suppression: Take zero reference from bunch gap or before every bunch?
- ⌘ Lowpass filter directly after BCT or processing a high bandwidth signal?
- ⌘ Interference: symmetric or asymmetric data transmission?
- ⌘ Signal processing principle: integrating over a window or sampling a filtered signal?
- ⌘ Noise in the signal processing chain: Amplifier, Integrator (if any), ADC
- ⌘ Digital processing algorithm

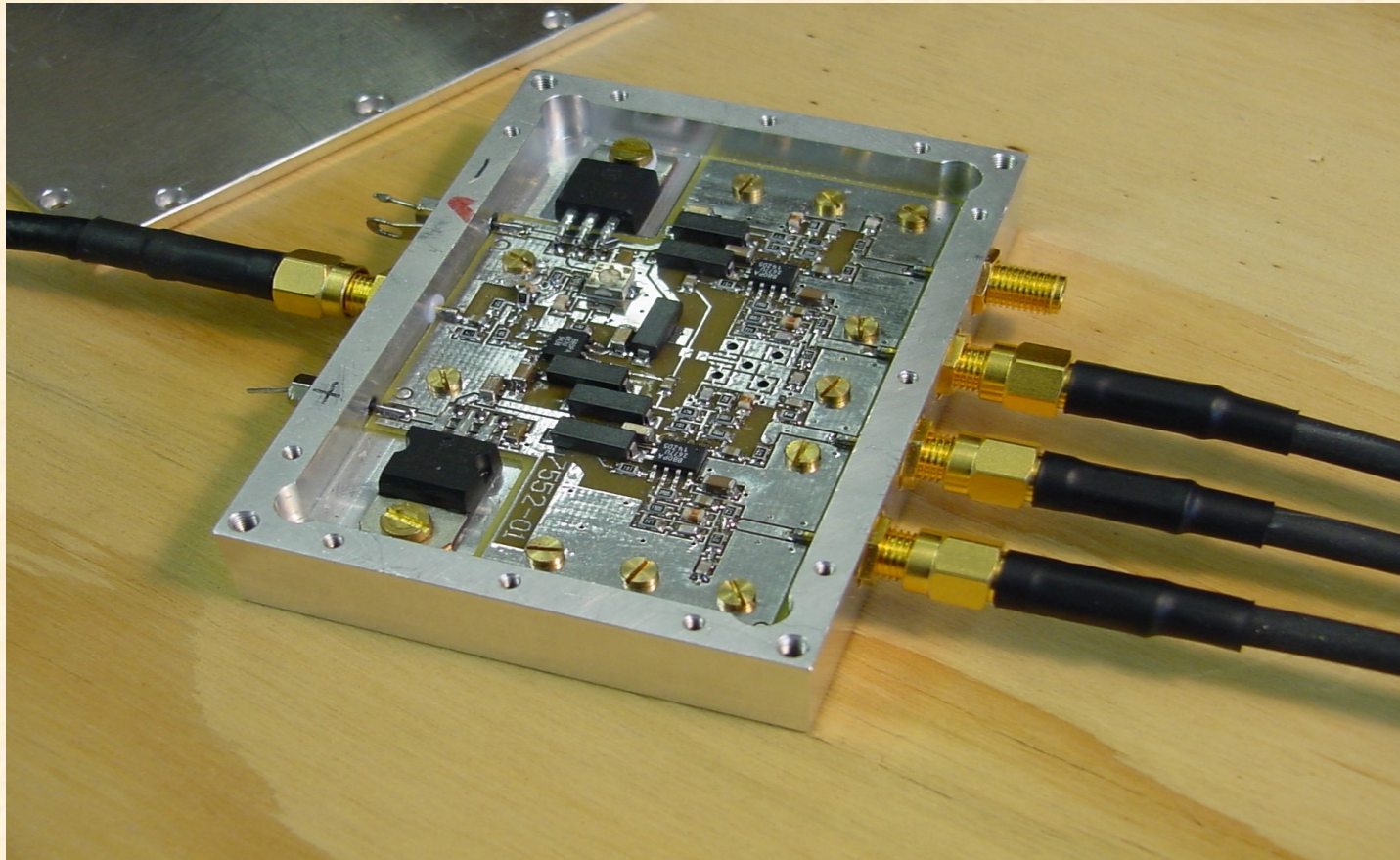
Thank you!

Transparencies beyond the presentation at the workshop

Hardware Schematics of the PC based Bunch Current Monitor



100 MHz Amplifier



Types of BCTs at DESY

Info from Reinhard Neumann:

- ⌘ At Petra (light source, max. planned bunch frequency = 500 MHz):
 - ☒ BCT: Bergoz type (Spec: BW=2GHz, rise time 175 ps) – only one coil
 - ☒ Considerable position dependence observed
 - ☒ Acquisition: Oscilloscope (8 bit resolution)
- ⌘ FLASH accelerator (max. bunch frequency = 9 MHz):
 - ☒ BCT: „Radloff“-Type (selfmade with 4 coils)
 - ☒ Acquisition: VME ADC modules (14 bit, 2 samples per bunch)
- ⌘ Other accelerators and transport lines:
 - ☒ BCT: „Radloff“-Type (selfmade with 4 coils)
 - ☒ Acquisition: PC ADC boards

Impedance matching at BCT coil output

- ⌘ Number of turns on the toroid and Impedance ratio of successive RF transformers determines impedance matching.
- ⌘ What is the source impedance of the coils?
- ⌘ For some termination, we get optimum amplitude, for maximum bandwidth we need a lower termination resistance.
- ⌘ What is the optimum for our case? (Especially important if resolution is limited by noise.)