Experience with DCCTs at DESY

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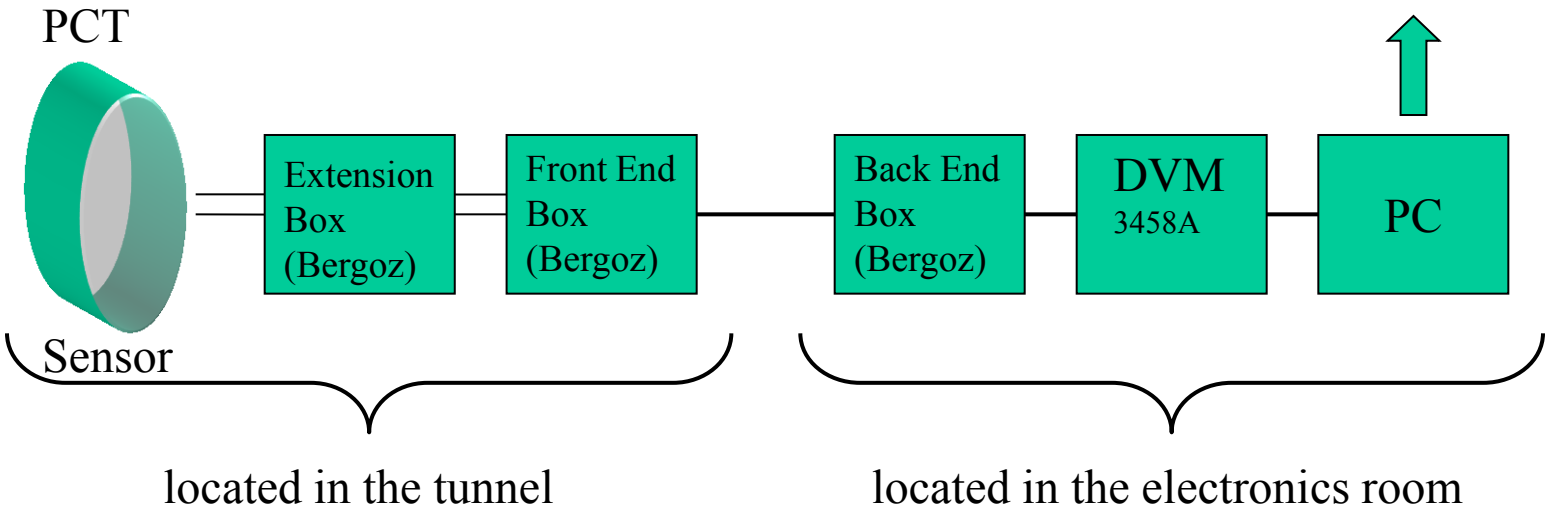
All DC current measurements at DESY are done by PCTs (DCCTs) from Bergoz. They are installed in all circular accelerators at DESY and they provide the main current values of the machines.

The following table shows the ranges and resolutions of the DCCTs, specified by BERGOZ for an integration time of 1 second.

In case of PETRAIII, we use **two** refurbished PCT's from BERGOZ, manufactured at the **same time** with the **same technical data**.

accelerator	range	resolution
HERA-e	up to 200mA, 20mA/V	< 5μA
HERA-p	up to 200mA, 20mA/V	< ± 0.5μA
PETRAIII	up to 200mA, 20mA/V	< ± 2μA
DORIS	up to 400mA, 40mA/V	< 2μA

In every accelerator the same signal path is used:

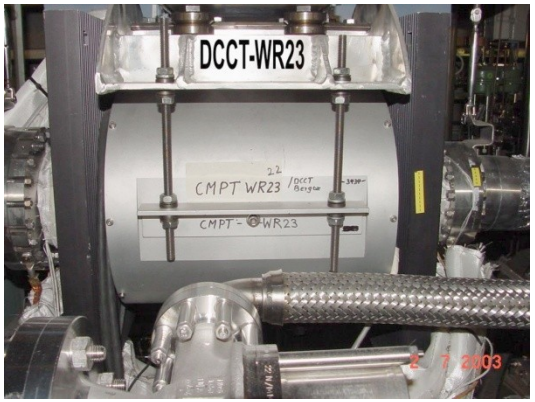


The Bergoz PCT equipment provides a DC voltage between 0 and 10 V.

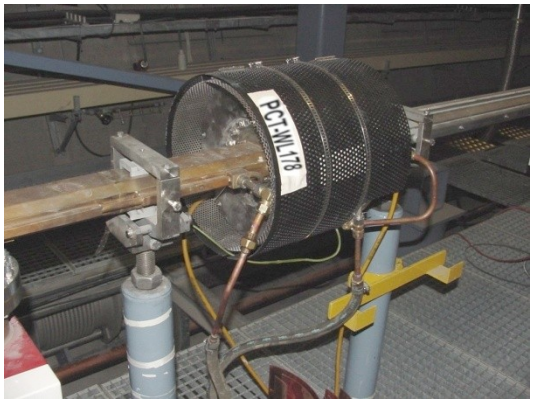
Agilent DVMs (8 ½ digits) digitize the values and sends them via a GPIB interface to a PC.

The PC provides the current and lifetime data over the DESY intranet.

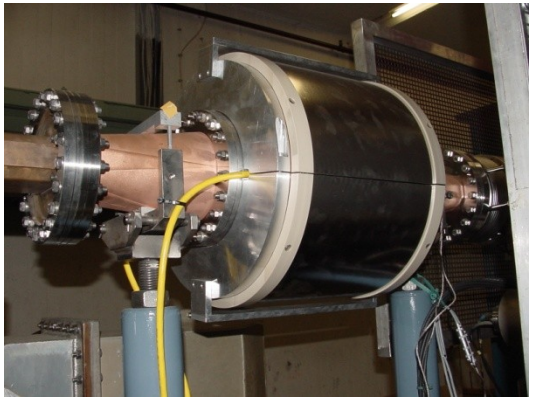
All DCCTs are mounted with an extra magnetic shielding, some with active cooling. This slide shows some examples



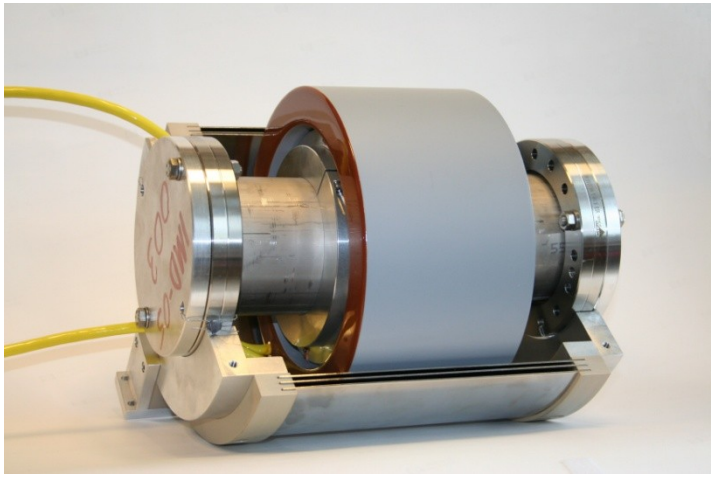
HERA p: complicated with heat sinks



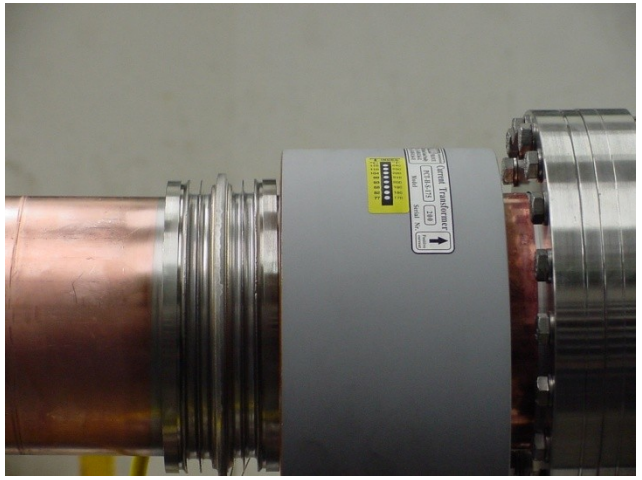
HERA e: simpler with water-cooling



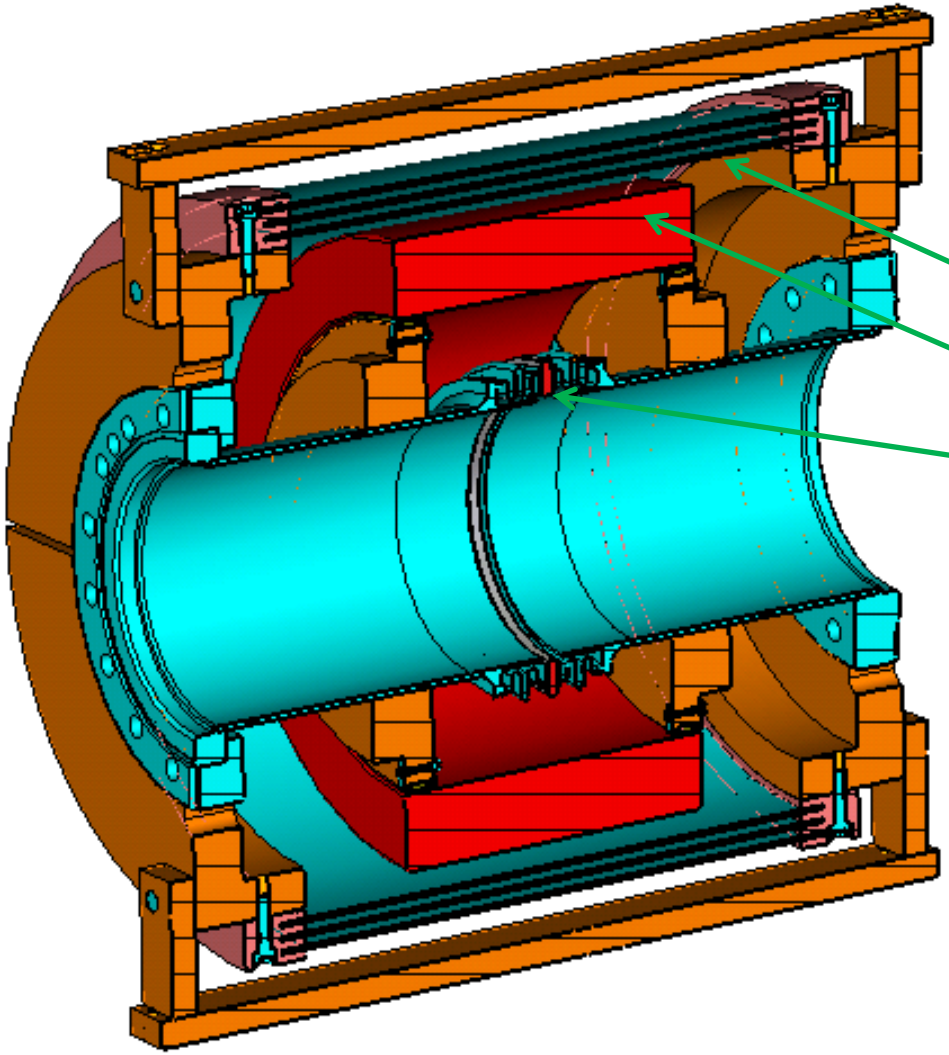
DORIS: better magnetic shielding, no cooling



PETRA: like DORIS, better shield, but no cooling



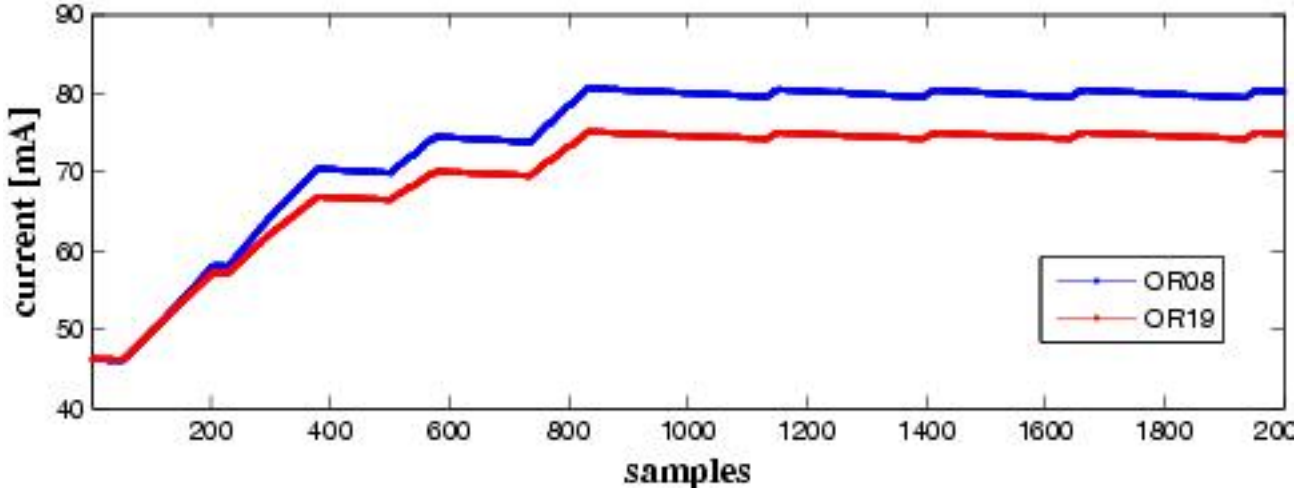
Actual DCCT setup with extra magnetic shielding for better lifetime measurement



Two models with this design were mounted in PETRA, 11m apart. They have the same technical data, were bought at the same time. Bergoz PCT Sensor head #24 and #25.

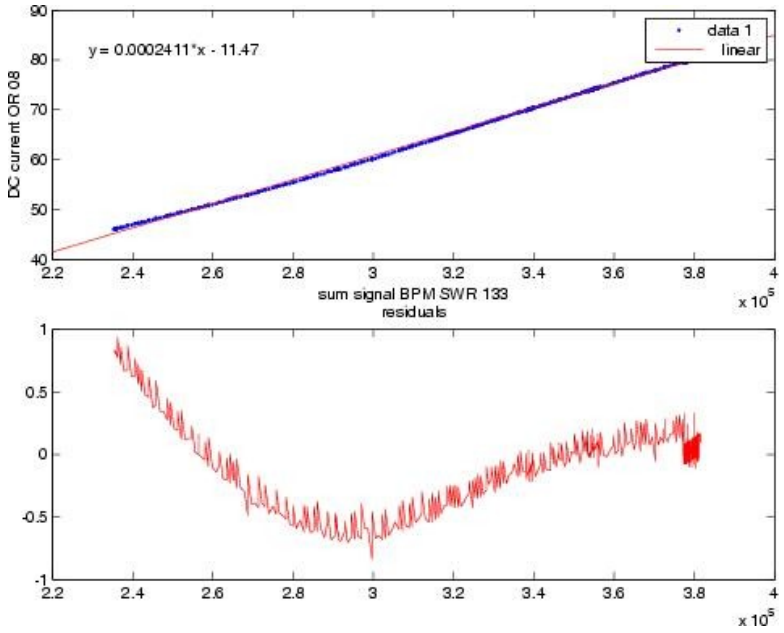
Example PETRA OR08 and OR19

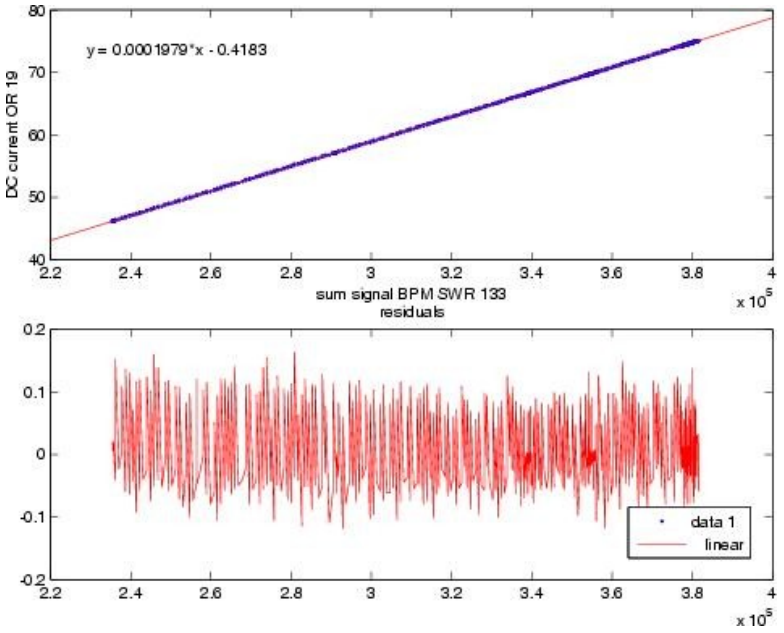
Here is an example from August 2010, when PETRA was running in „Top-Up“ mode with 40 or 60 bunches.



During injection (after beam loss), an increasing difference of the measured values for currents higher than 55mA was observed.

A colleague compared the current values of the DCCT‘s OR08 and OR19 with the sum signal output of a BPM [the Libera BPM SWR 133].

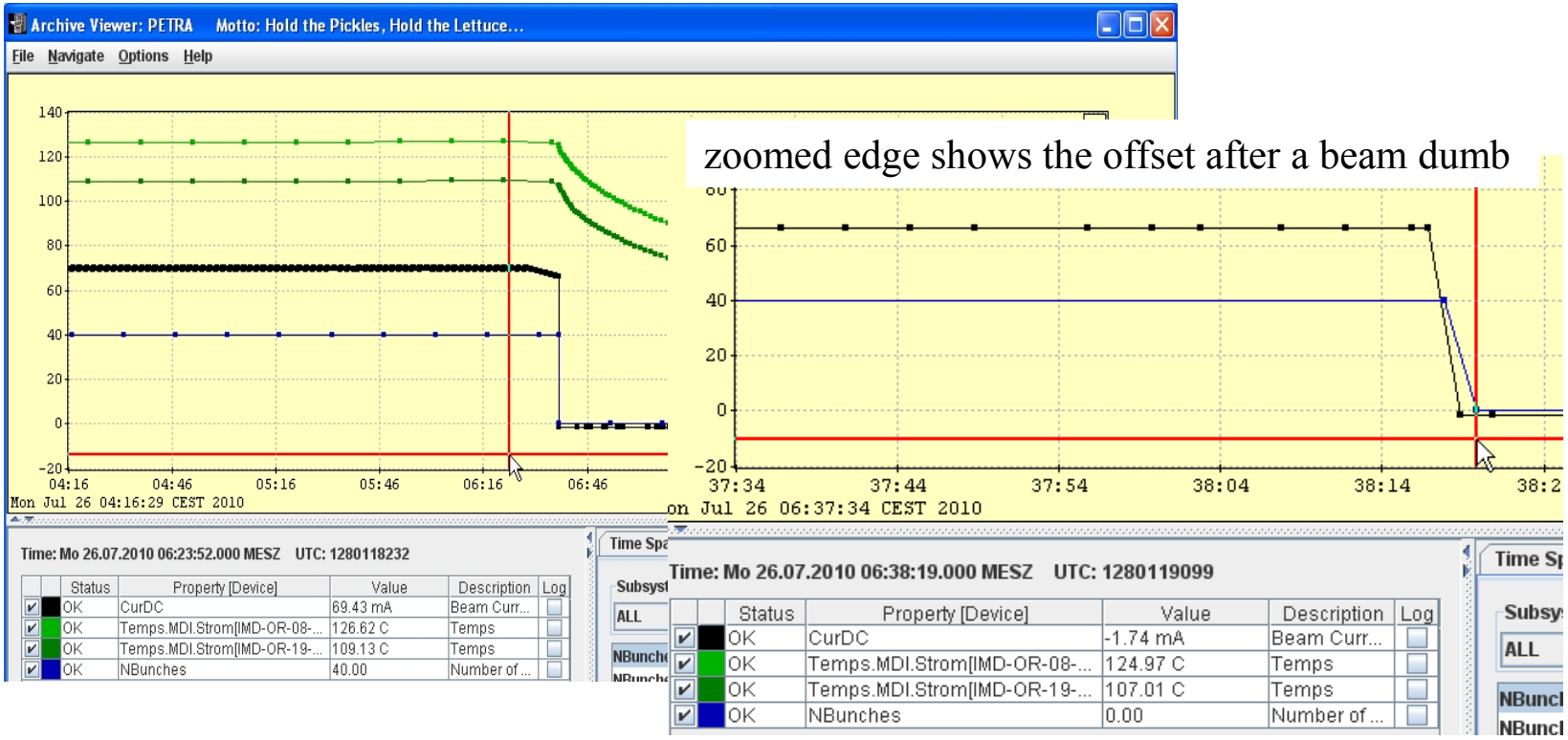




The OR19 values are better correlated to the sum signal output values, so we use the OR19 as the main DCCT for the PETRA current display.

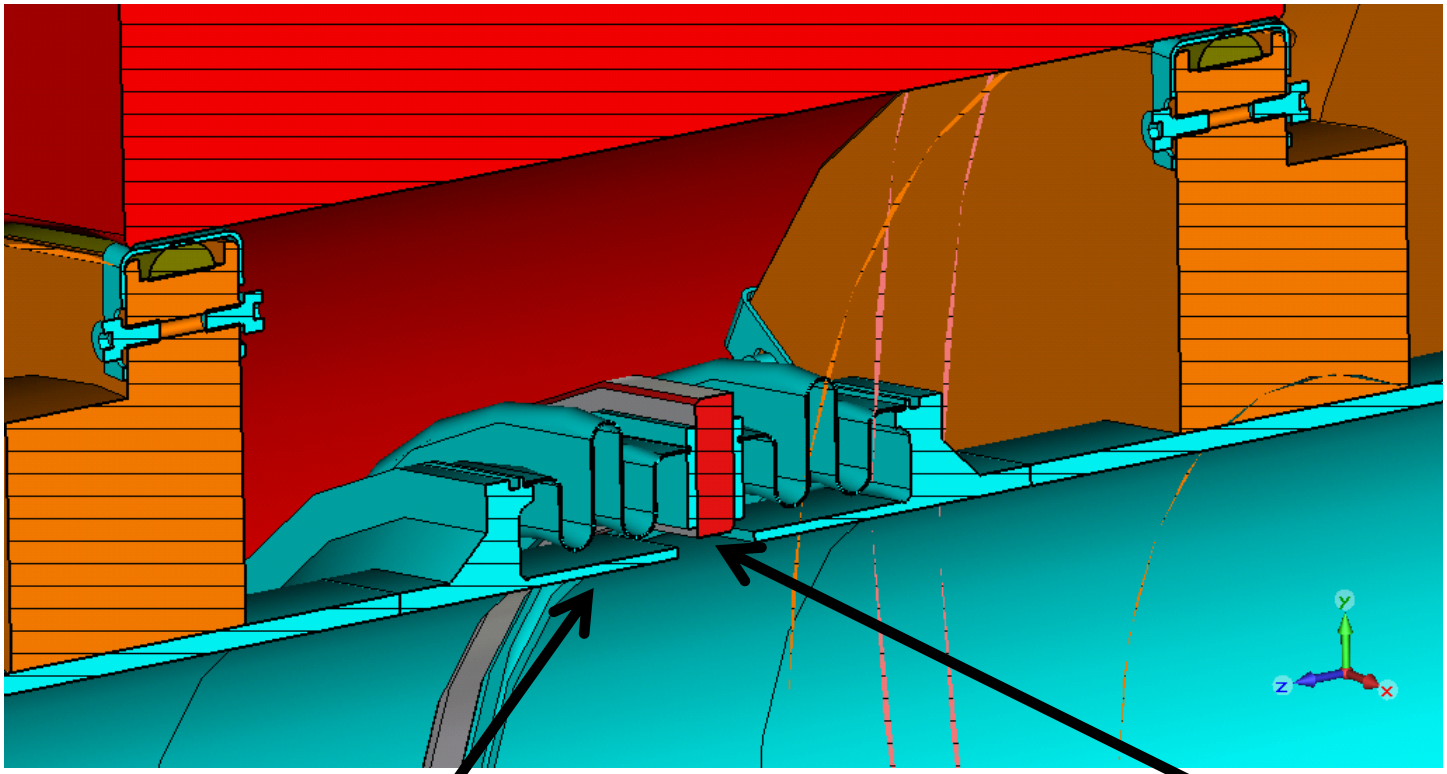
The monitor temperatures in DORIS and PETRA are much too high, particularly in the case of PETRA run with 40 bunches.
Gap-temperatures of 130 degrees have been measured!

The dcct‘s may become damaged if toroid temperatures of 90 degrees are reached.
The offset in the measurement can be 1 mA and more.



When the monitor cools down, the offset decreases to -0.7mA

My colleage Dirk Lipka did energy loss (e.g. wakefields) simulations of particles in PETRA traversing the DCCT‘s, to find the reason for the high temperatures.



The bellow is shielded, which results in a resonator

Metal coated ceramic

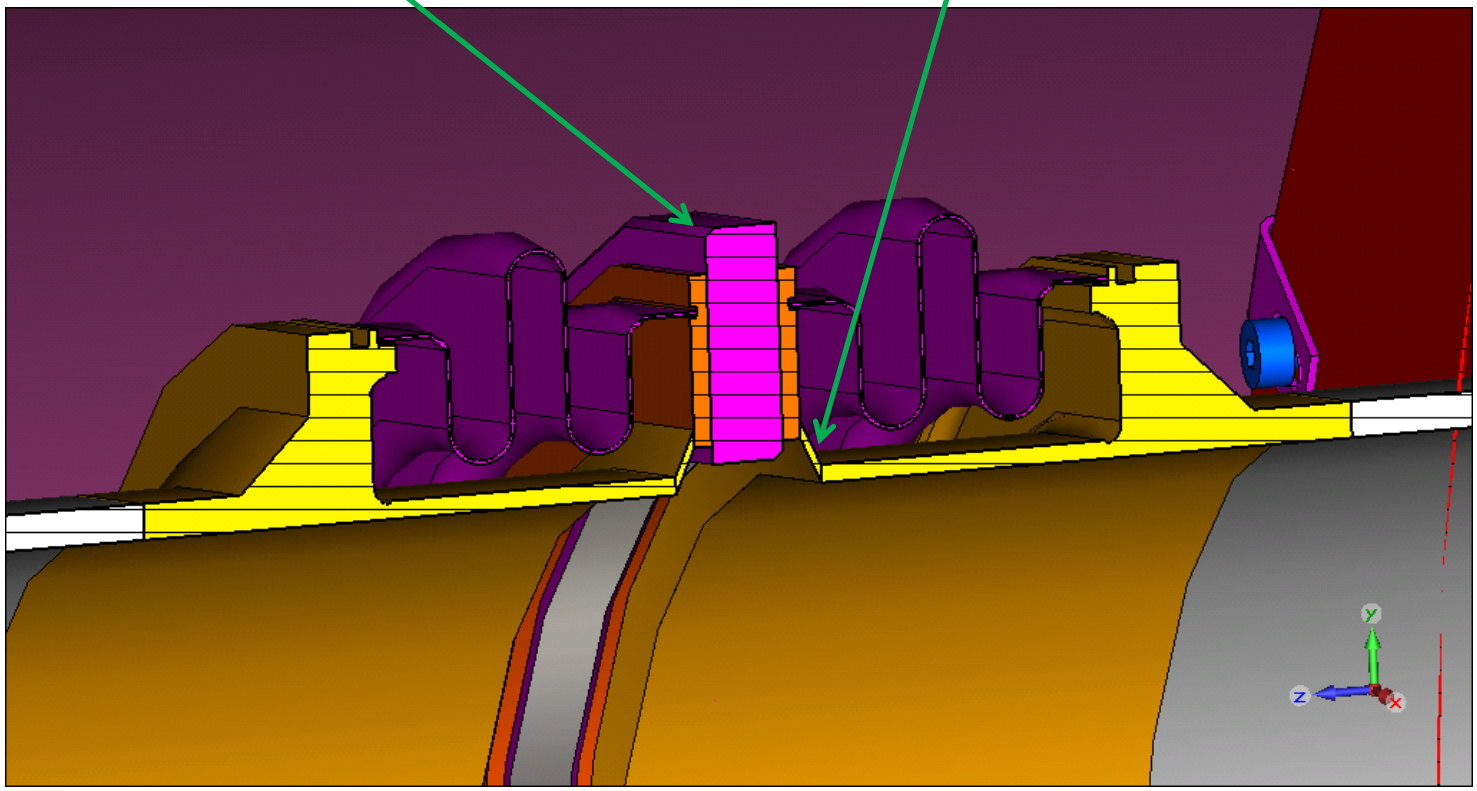
When a charged particle moves through the DCCT, energy is deposited in the gap area

The result of his simulations:
A smaller gap and shielding of the resonator reduces the temperature

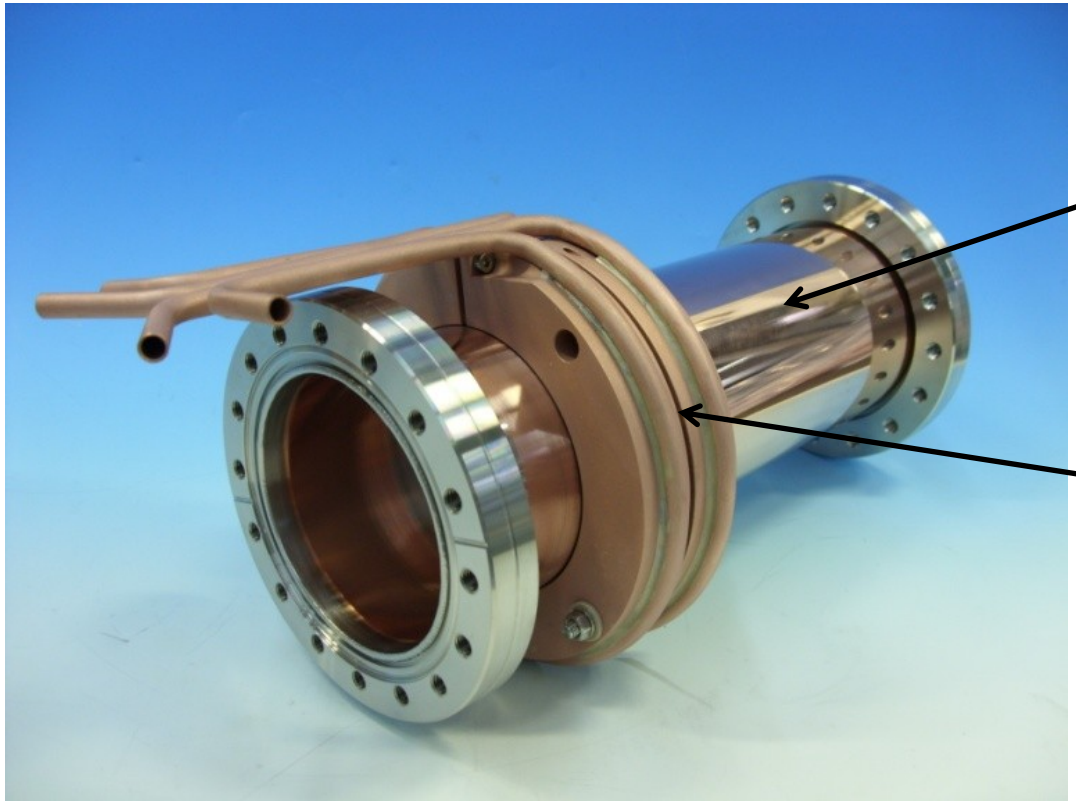
Our solution for PETRA look like this and its realization is in progress

Gap of the coated ceramics

Resonator shielding



The new DORIS design with additional water cooling rings around the ceramic gap. Unfortunately, there hasn‘t been time for its installation until now.

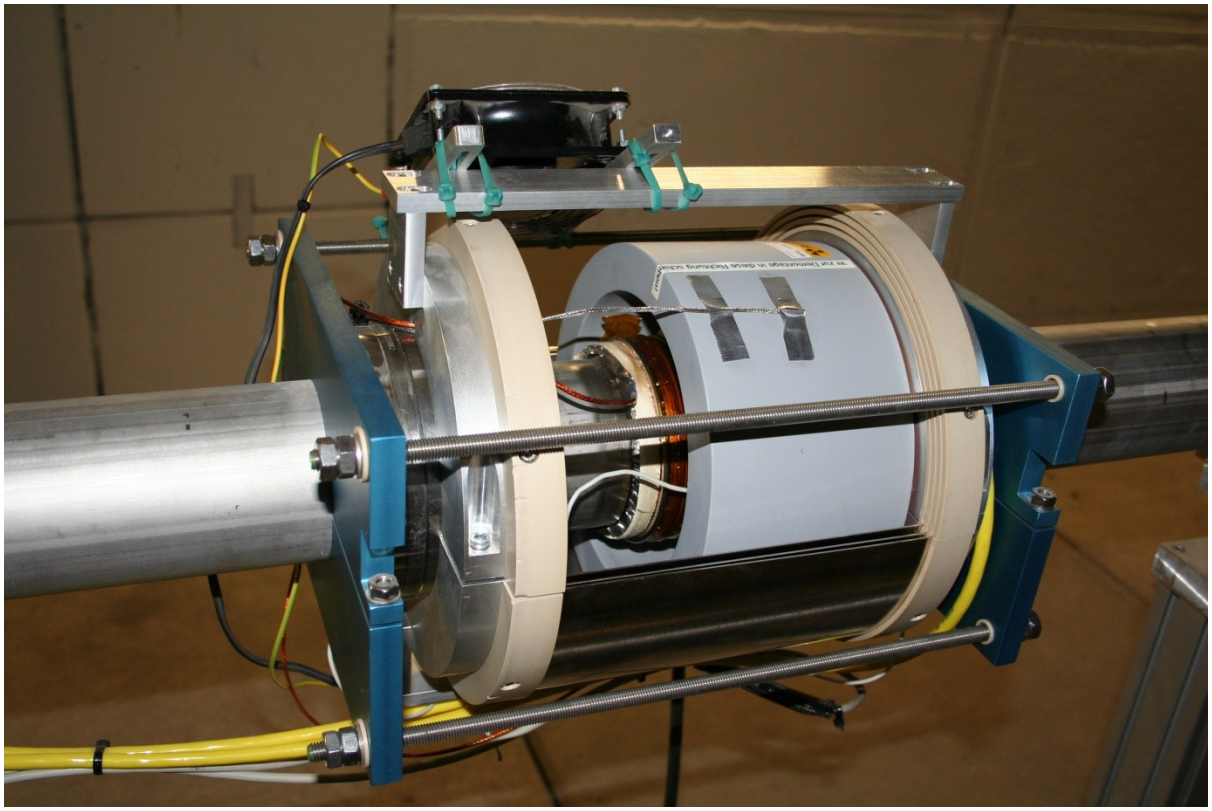


The sensor-head will be mounted on the tube beside the cooling disks.

Isolating slit between the cooling disks

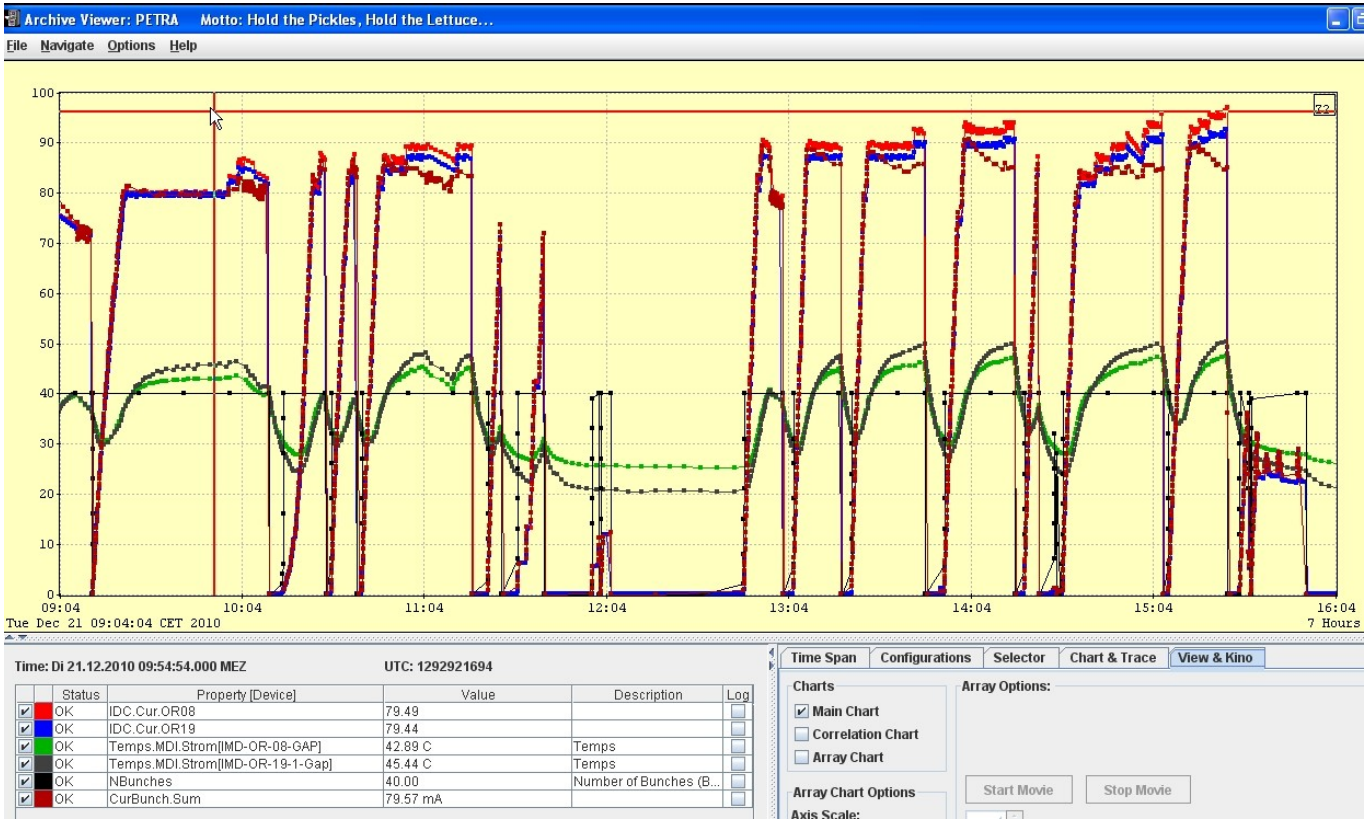
Nearly the same construction [with cooling disks, resonator shielding and a metal coated ceramic gap] will be installed in PETRA, but the construction is still not finished! I can’t show a nice picture, only a sketch on A2-format.

Also in PETRA we haven‘t had the possibility to test this newest design with the cooling rings until now.
But since for the end of December 2010 high current runs were planned, we prevented the overheating of our DCCT‘s with this provisional cooling solution:



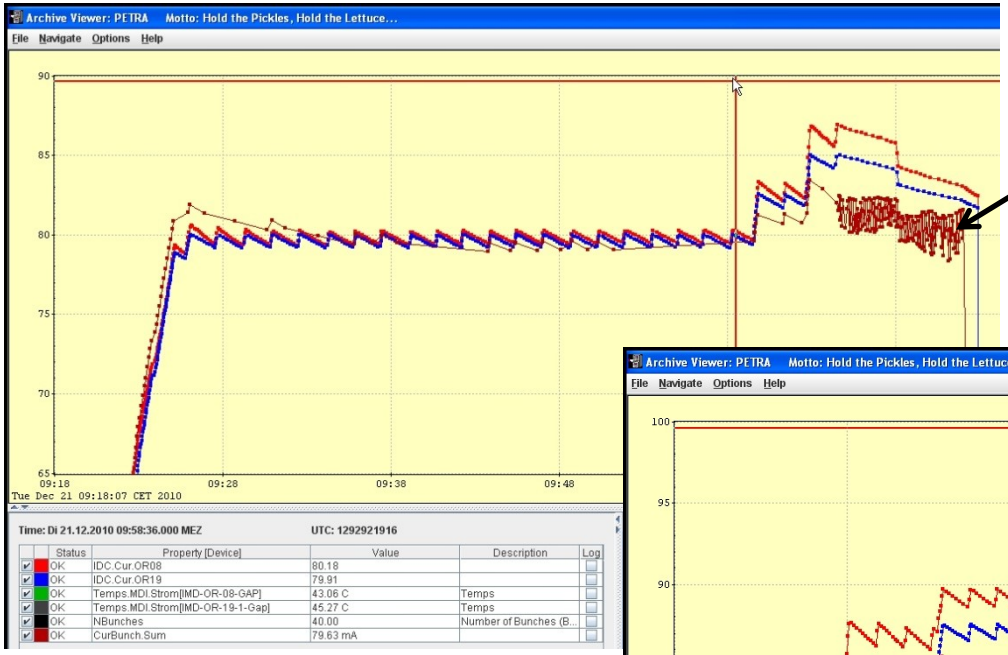
The cooling works fine, but we had to remove the magnetic shield

This reduced the temperatures; the max. wasn‘t higher than 50 degrees.
But with 40 bunches we **still** have differences between the two DCCTs!

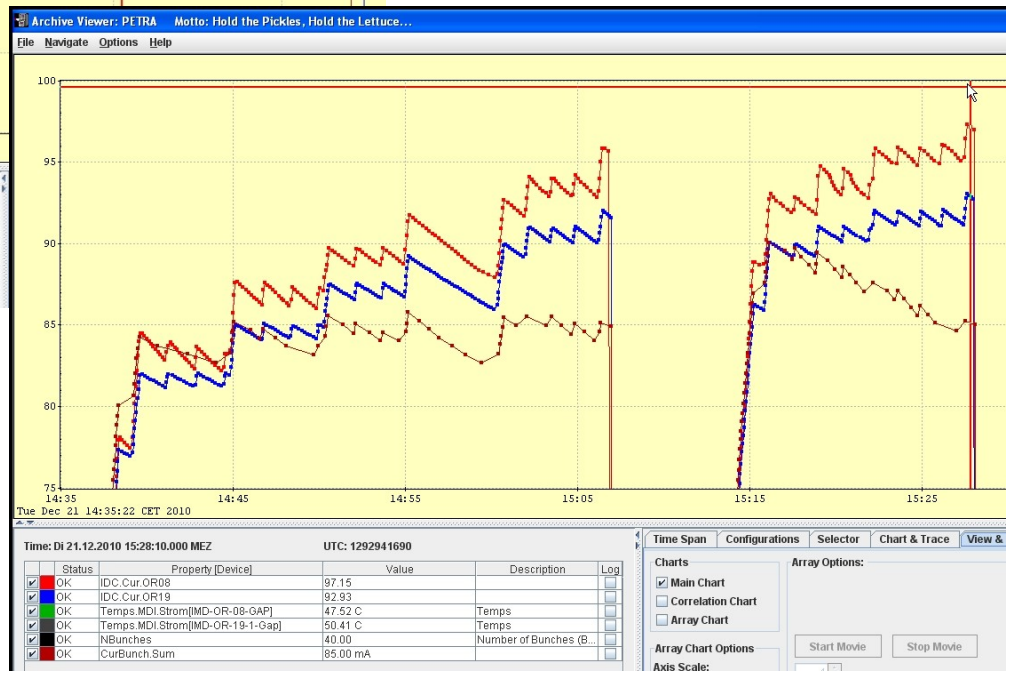


At currents higher than 50mA, there is **still** an increasing difference between the measured current values.

Some zoomed views of the history plot of the last slide show that



The bunch sum measurement is disturbed, we assume it‘s because of longitudinal instabilities



These problems only occur with high bunch currents.

Our question is: What other effects do we need to consider?

We haven‘t understood the cause of these mis-measurements yet.