PAUL SCHERRER INSTITUT

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Progress of profile measurement refurbishment activities at HIPA

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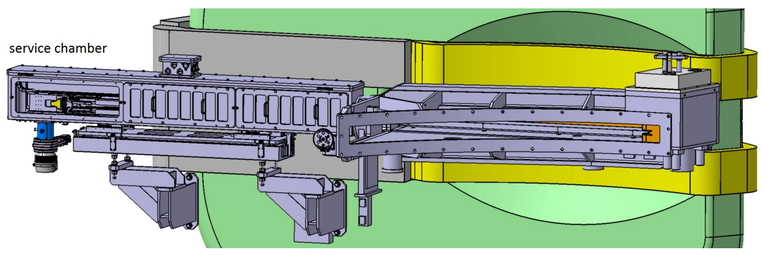
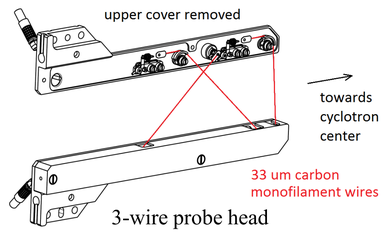
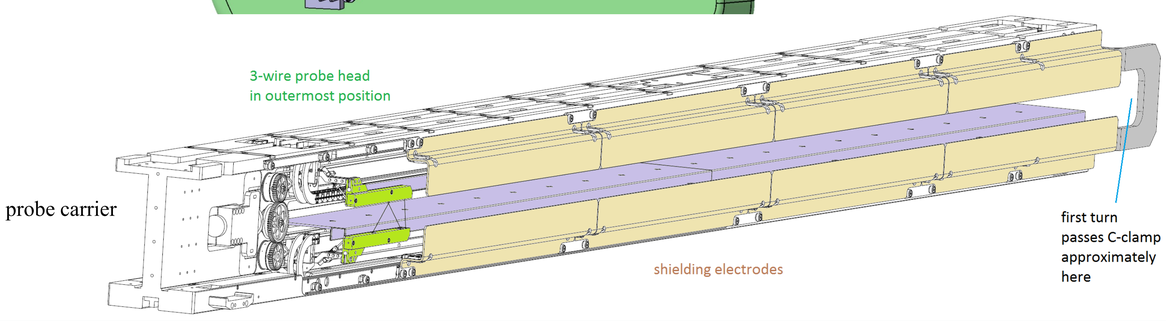
At PSI's High Intensity Proton Accelerator facility some 180 profile monitors and 10 radial probes are in use to measure transverse beam profiles in beam lines and cyclotrons at energies of 0.87 to 590 MeV. Mechanical malfunctions and increased noise in some devices, a lack of spare parts and the obsolescence of most of the driver and read-out electronics as well as extended requirements to the measurement, necessitate the development of improved versions of the electronics and of several monitors. We give an update on the status of three projects in this regard: A long radial probe in the Ring Cyclotron, a profile monitor and BPM at 590 MeV in high radiation environment and new loss monitor electronics, which should also serve as a basis for the profile monitor readout.

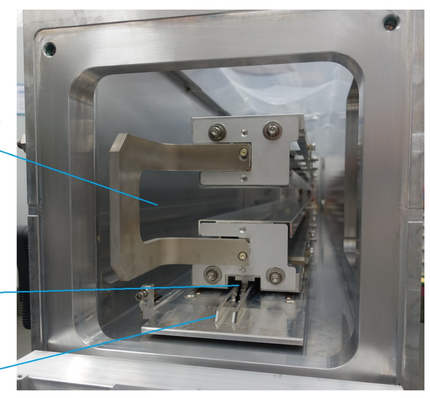
Radial Probe in Ring Cyclotron

- We report on progress with respect to http://accelconf.web.cern.ch/cyclotrons2019/papers/mop024.pdf
- Basic variant with 3-wire probe head and shielding electrodes in preparation.
- Biased shielding electrodes hopefully prevent disturbances by plasma clouds.
- Service vacuum chamber/support/pump is ready.
- Mechanism to move the probe carrier into the cyclotron is ready.
- 3-wire probe head under fabrication.
- Feedthroughs and wiring nearly defined.
- Wiring and lab testing of the assembly pending.
- Evtl. installation in Ring Cyclotron in next, exceptionally short shutdown in February.





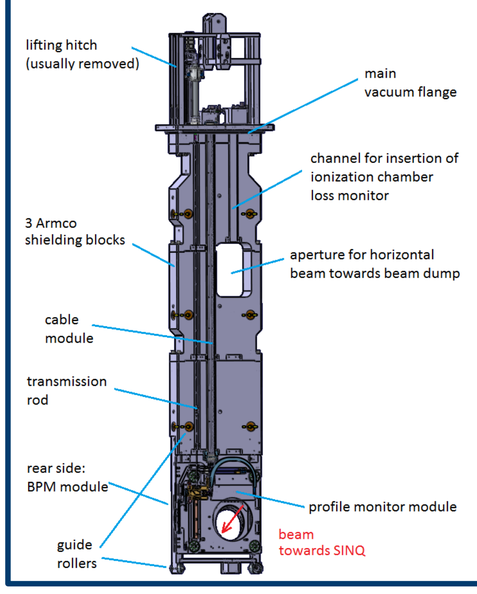


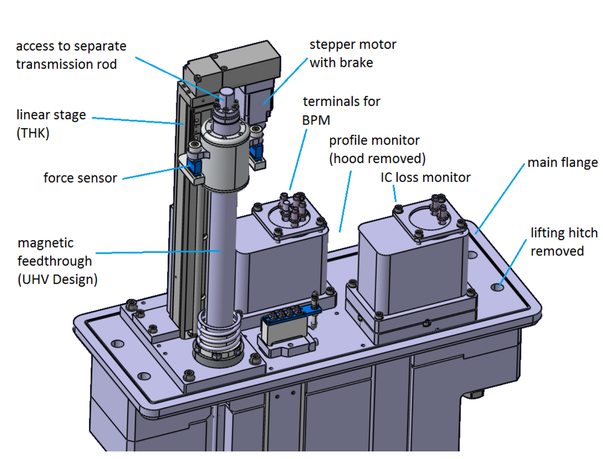


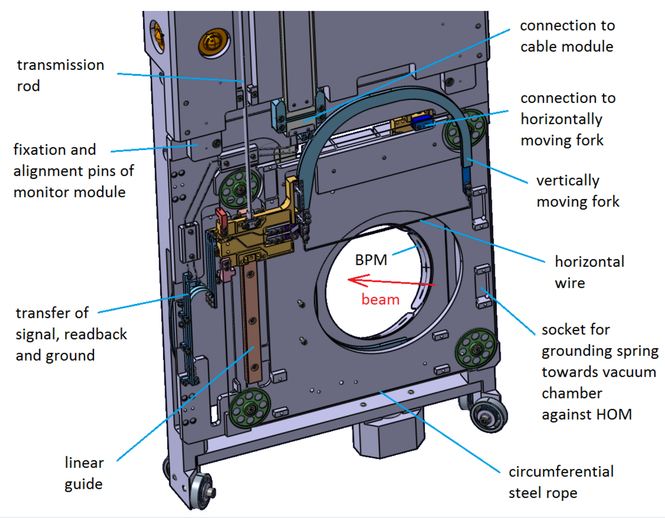
Probe carrier in parking position in the service chamber (in the lab, shields removed, seen from cyclotron side).

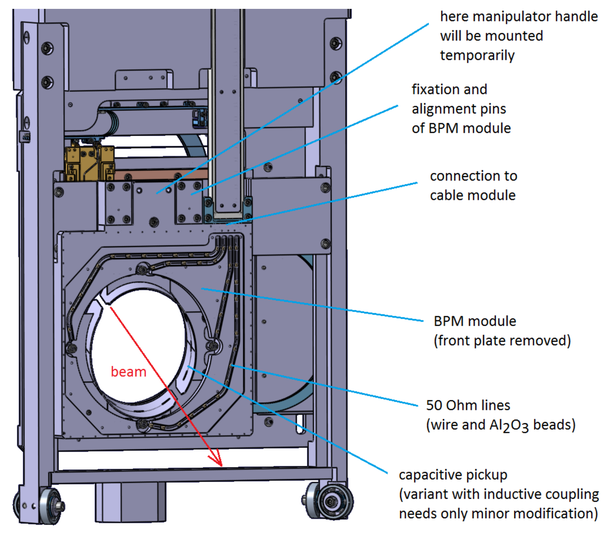
Profile monitor and BPM in SINQ line

- We report on progress with respect to http://accelconf.web.cern.ch/ibic2019/papers/tupp035.pdf
- Strict modularity preserved in detailed design.
- Drive concept changed to magnetic linear feedthrough.
- Force transferred to profile monitor mechanism is measured. Should allow online diagnosis of health of mechanism at the highly activated lower end of the plug.
- Procurement of components just starts.
- If production and assembly run smoothly, we may install the monitor in the coming shutdown to replace the defect plug.
- Also a variant of the monitor plug without shielding blocks should be installed in a test chamber in the horizontal line towards UCN.
- There, radiation levels are much lower, and individual parts can be modified with hands-on access after testing.
- Especially the BPM, in a variant for horizontal beam, will be tested in order to evaluate the strength of HOM and measures for their limitation.
- The situation should be comparable due to grounding springs between modules and towards the vacuum chamber located close to the BPM. Foregoing simulations are pending. Hence, manufacturing and installation of the BPM module will take place later.



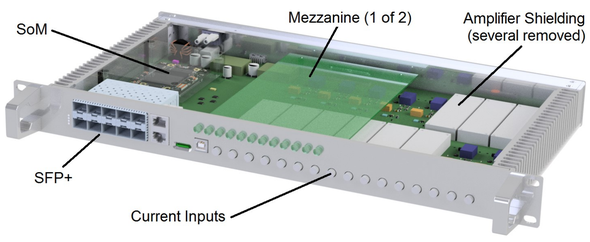






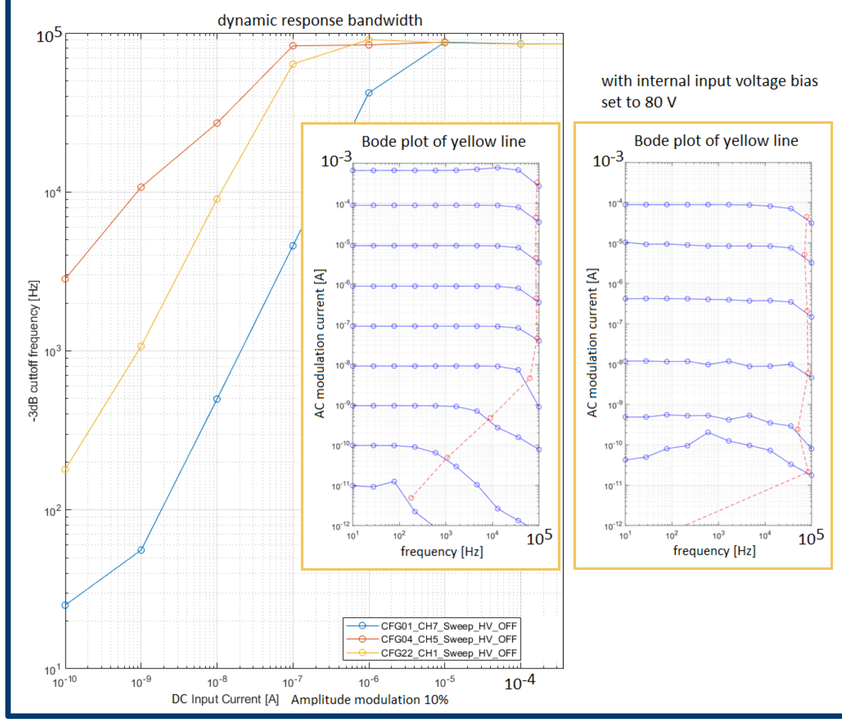
Loss monitor electronics

- We report on progress with respect to http://accelconf.web.cern.ch/ibic2019/papers/mopp024.pdf

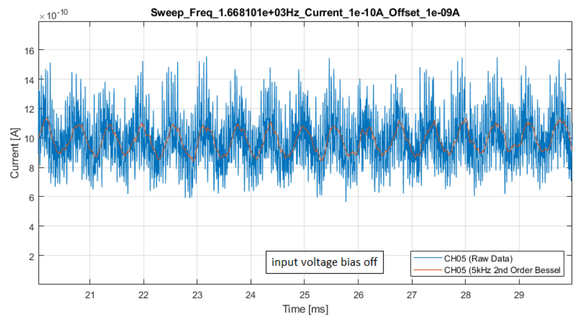


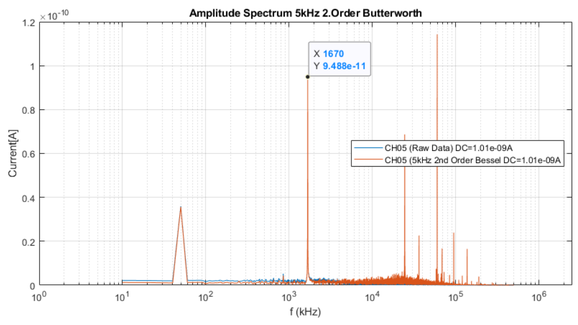
Logarithmic amplifier and internal shielding

- ADL5304 from Analog Devices.
- At currents above 10 nA bandwidth is limited by the ADC anti-aliasing filter (50 kHz).
- Bandwidth decreases at low input currents.
- This is shown below for three circuit configurations (input filter and amplifier circuit).
- Without input voltage bias, average DC current is correctly represented within bandwidth.
- With the bias on, this is the case only above a DC current of ~30 µA.

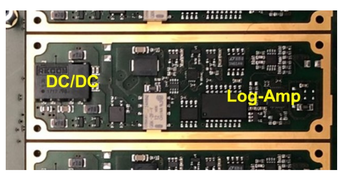


- With lower currents, the sensitivity to noise increases. A plot of a 10% current modulation (below) is showing strong noise at a DC current of 1 nA.
- The amplitude spectrum was analysed (below). Beside 50 Hz noise, there are several high-frequency spurs. To isolate the power supply of the log-amplifier, a Recom R1D-1205-R DC/DC converter is used in the prototype. This circuit is switching typically at 60 kHz. The spectrum is showing that most noise stems from this DC/DC converter, as there is major peak in the spectrum at 60 kHz.

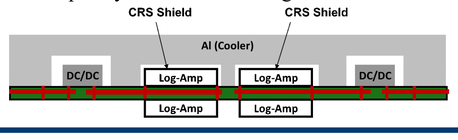




- Actual layout (below) provides no shielding between the DC/DC circuit and the log-amplifier. Both are under the same shielding cover.
- Switching noise couples strongly into the log-amplifier circuit.

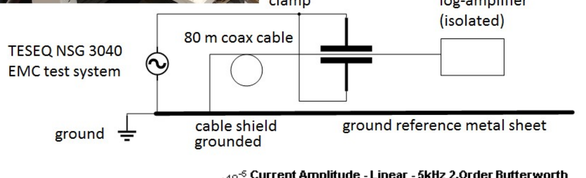


- Improved layout (proposal below) needs better shielding and separation of DC/DC and log-amplifier.
- Increased switching frequency also shifts the noise above the cut-off frequency of the anti-aliasing filter.

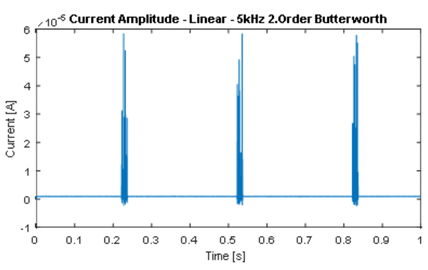


EMC

- Electromagnetic compatibility is required to guarantee that the log-amplifier not goes into latch-up due to unexpected noise.
- Fast transient bursts up to 500 V were applied to the signal cable utilizing a capacitive coupling clamp (below).
- Test criterion is IEC61000-4-4 type B: Measurement distorted, but the channel must recover to normal operation after the burst.



- Output signal from ADC is showing how the bursts influences the measured current strongly (right).
- No latch-up occurs, circuit recovers after the bursts.



Cooling

- Not all components well cooled in initial design (but still inside allowed temperature range).
- To improve cooling (and to reduce the number of mechanical parts), a massive milled aluminium cooler (below) is proposed to replace the cover plate of the module.
- All components with high power losses will connect thermally directly to this cooler.
- SFP+ modules will use integrated thermal pads (Thermal Bridge Technology, TE).
- Other components with high power consumption, as System-on-Module and 24 V DC/DC converter, will also use thermal pads.