First observations of short wavelength coherent synchrotron radiation (CSR) at BC3

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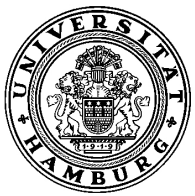


Coherent radiation delivers much information about bunch profile

spectral energy density

- $\frac{d}{d\omega}U = C \cdot N^2 \cdot |F_{long}(\omega)|^2 \cdot T(\omega, source)$

longitudinal form factor

- $F_{long}(\omega) = \int_{-\infty}^{\infty} \rho_{norm}(t) \cdot exp(-i\omega t) \cdot dt$

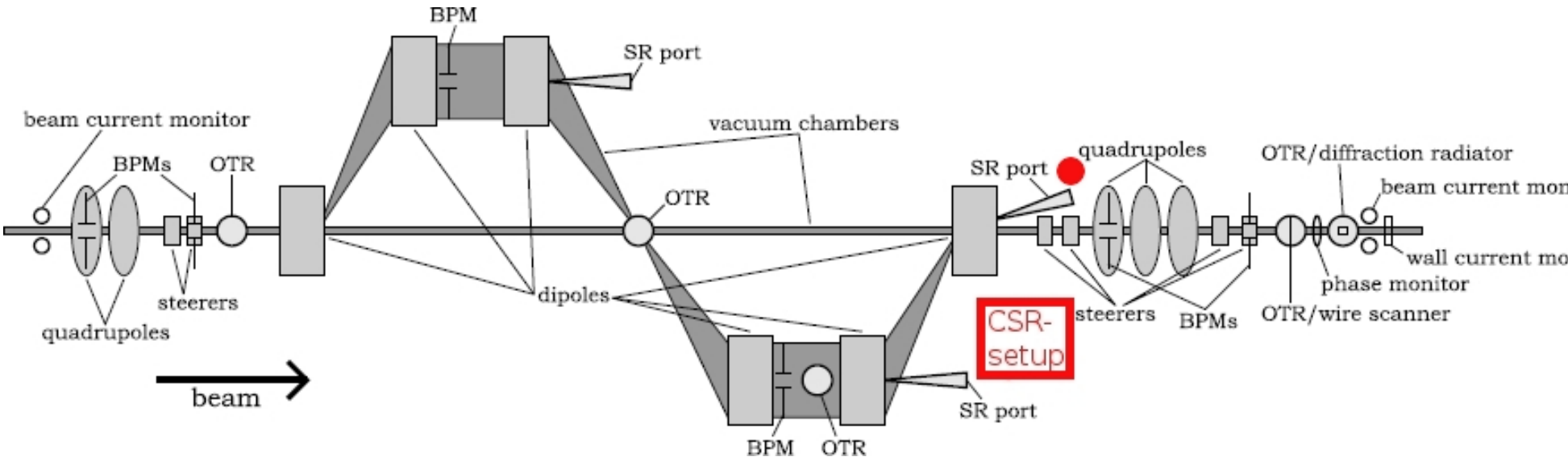
main advantages of CSR for diagnostics

- parasitic and non-destructive measurements (compare CTR)
- no suppression of short wavelength like diffraction radiation (CDR)
- full spectral information (diamond window)

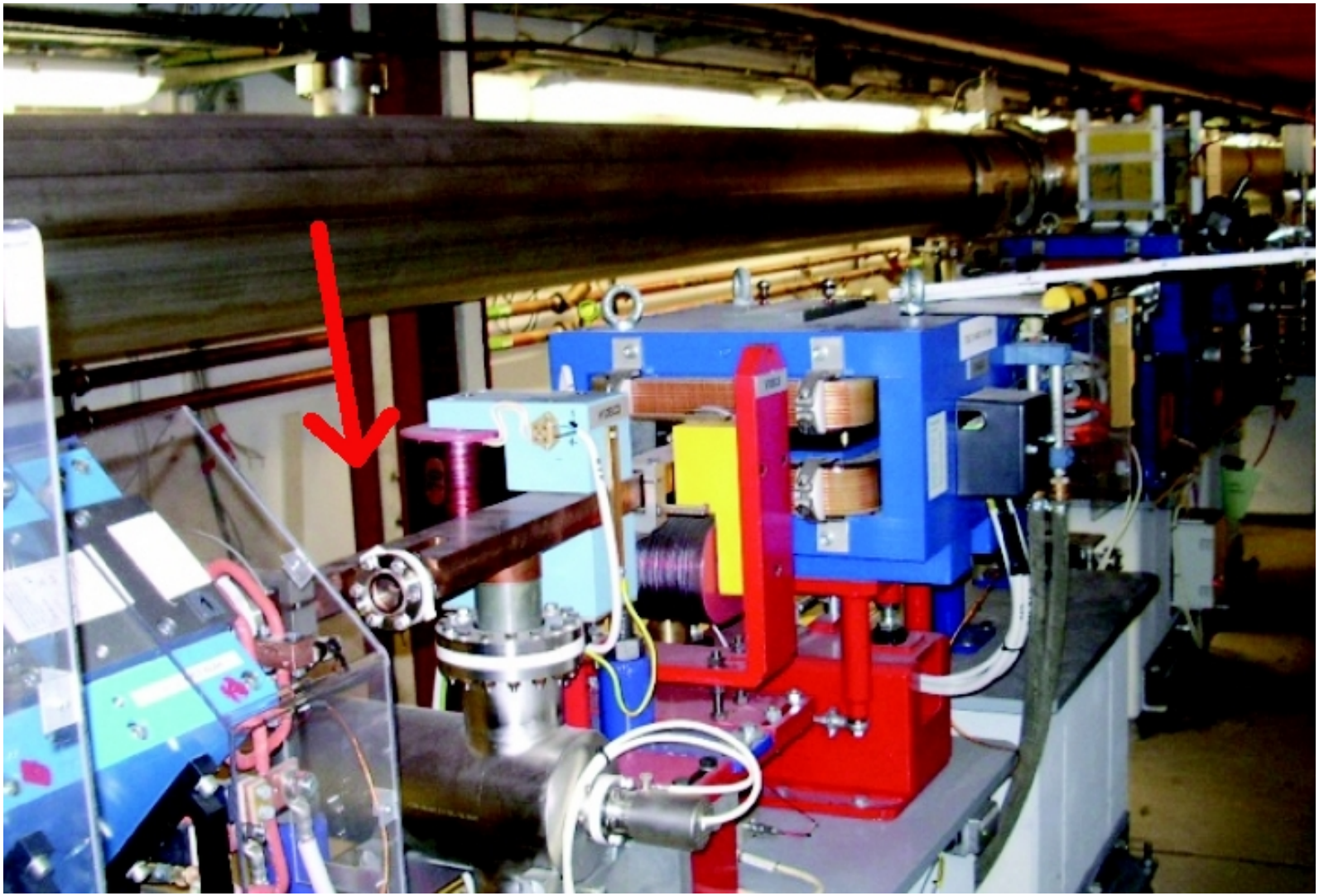
one of the most important parameter for driving a SASE-FEL is the current density ⇒ bunch compression

places of bunch compression are interesting for diagnostics with CSR

- the dipoles produce synchrotron radiation anyhow
- get information directly after compressing process

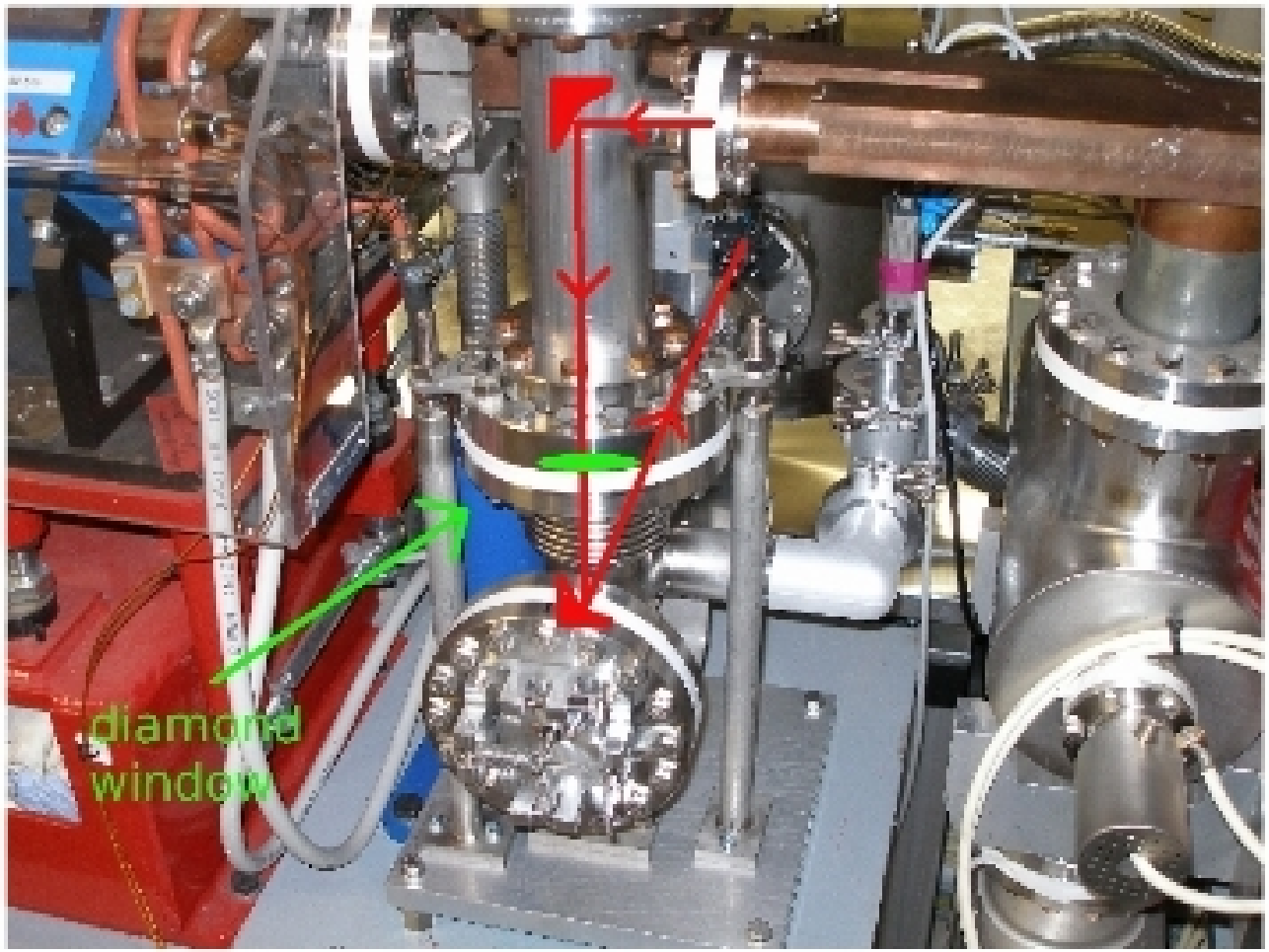


the place is after the last dipole (D14BC3) of BC3 at 82 m

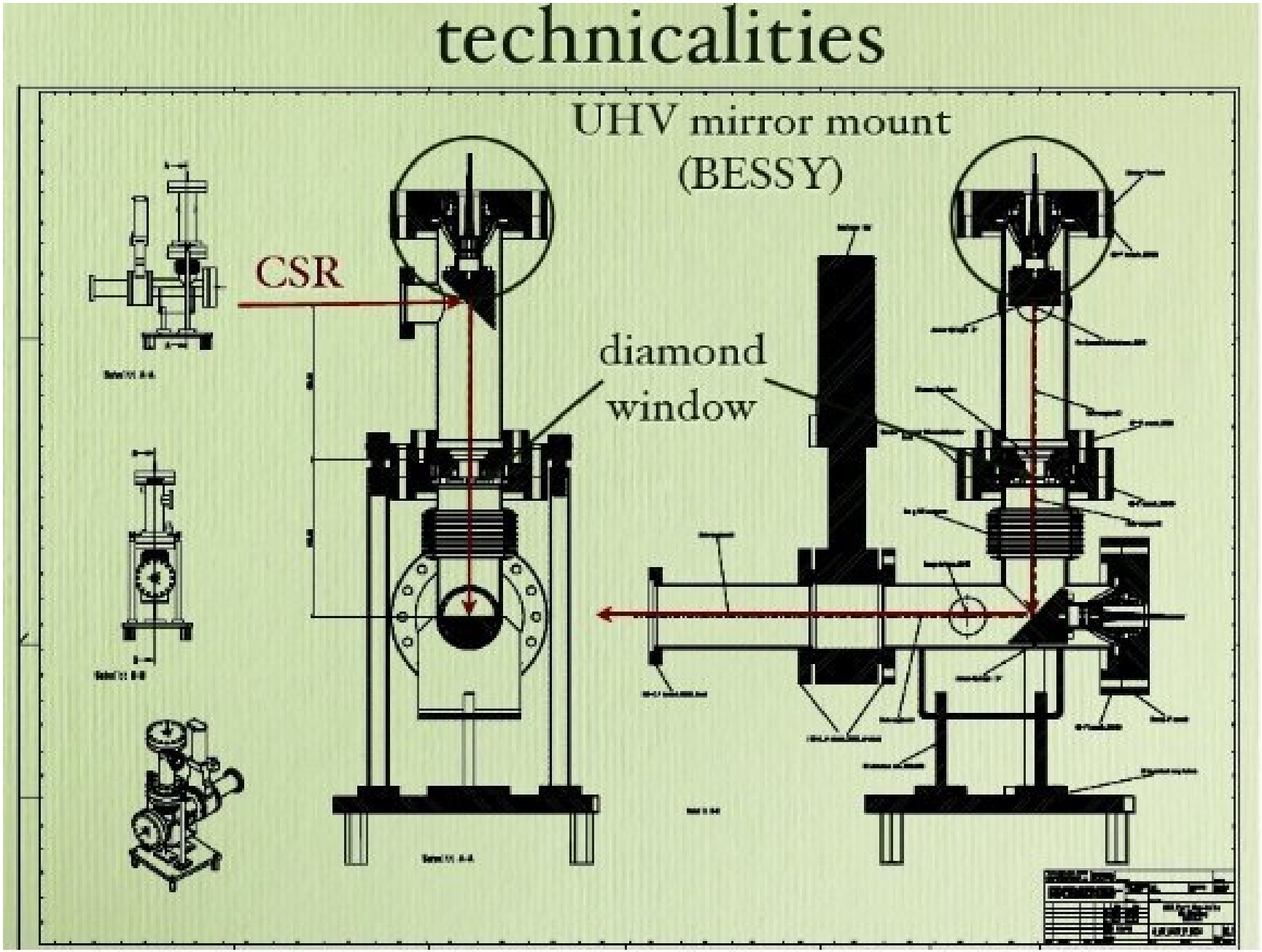


mirror mechanics

- includes a diamond window
- 2 focusing parabolic mirrors (currently not motorized)

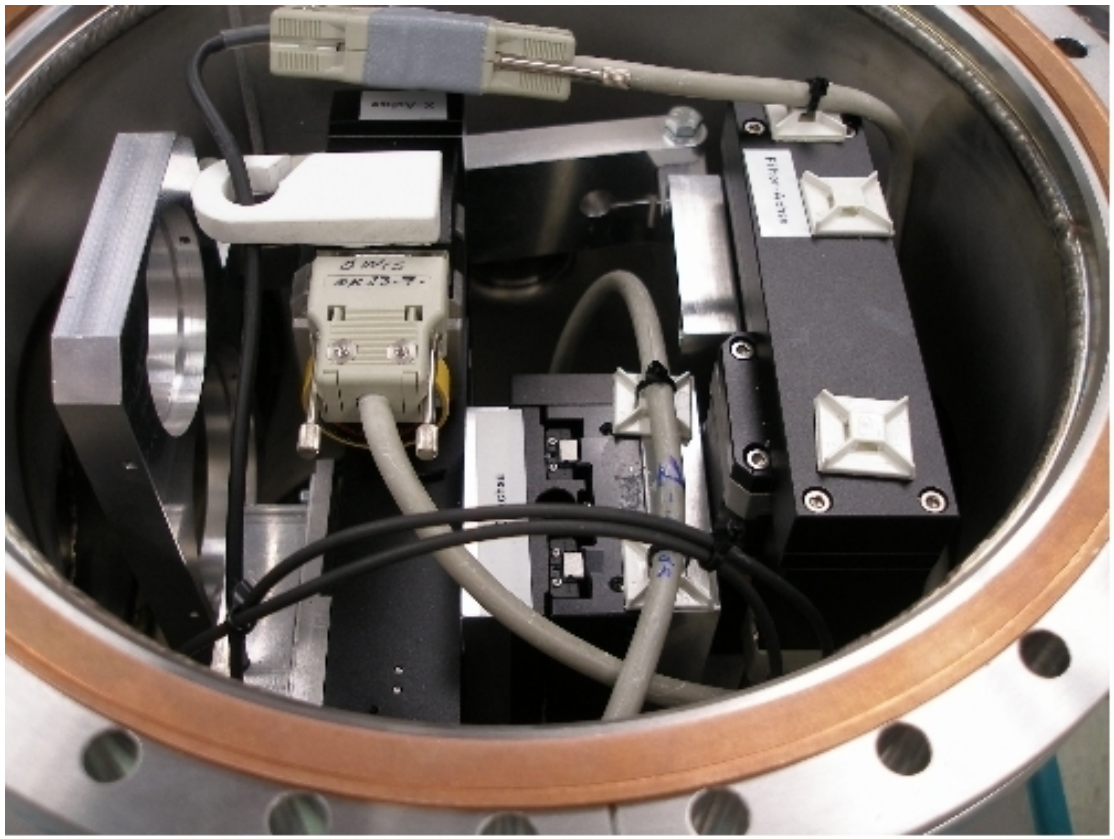


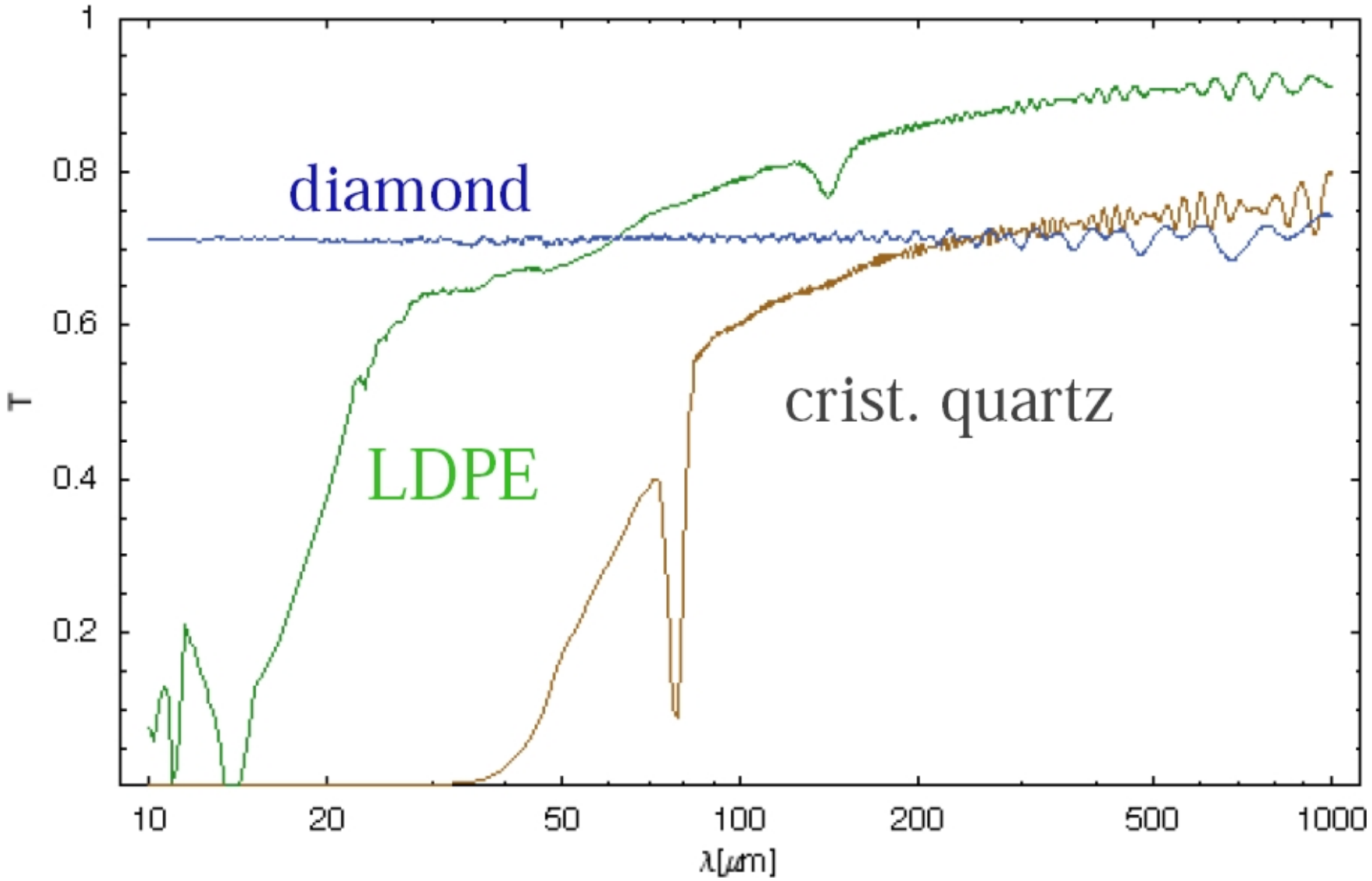
technicalities



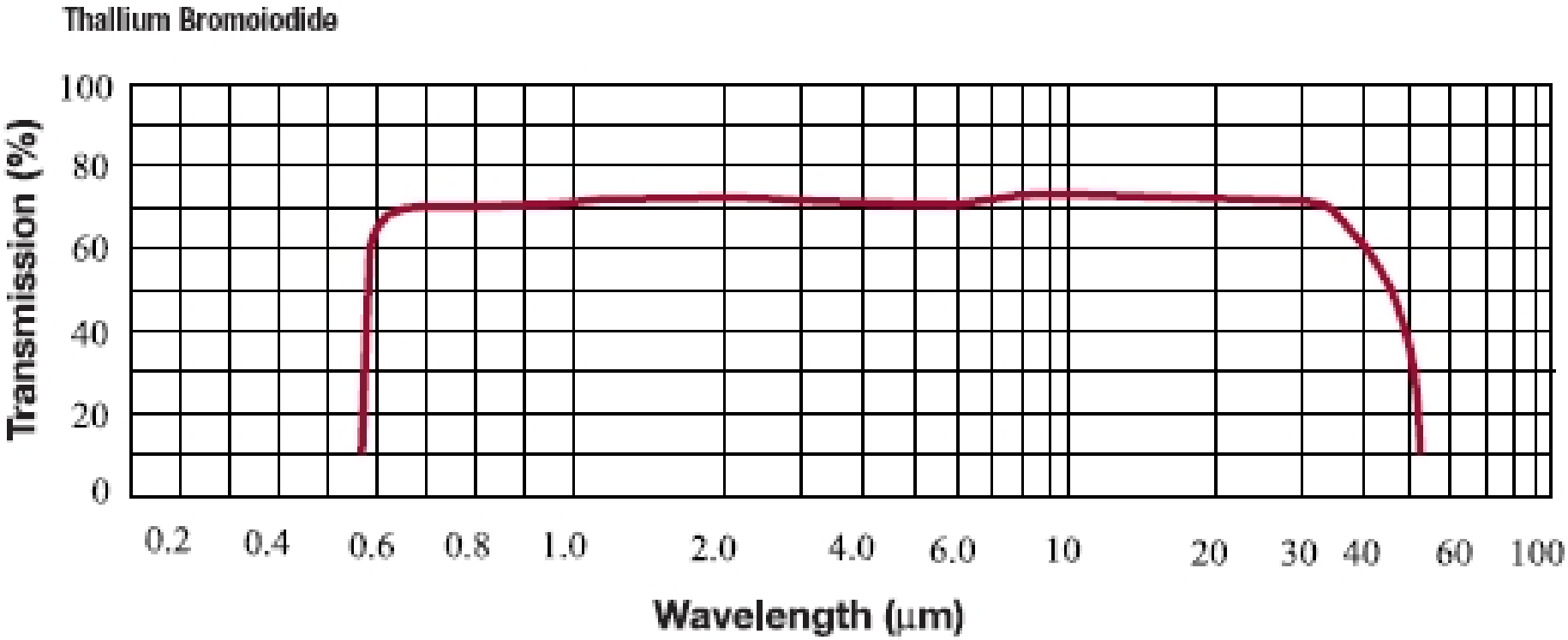
vacuum chamber

- pyro detector
- mounting for 2 filter
- 2 motors for horizontal and vertical motion
- 1 motor to move filter





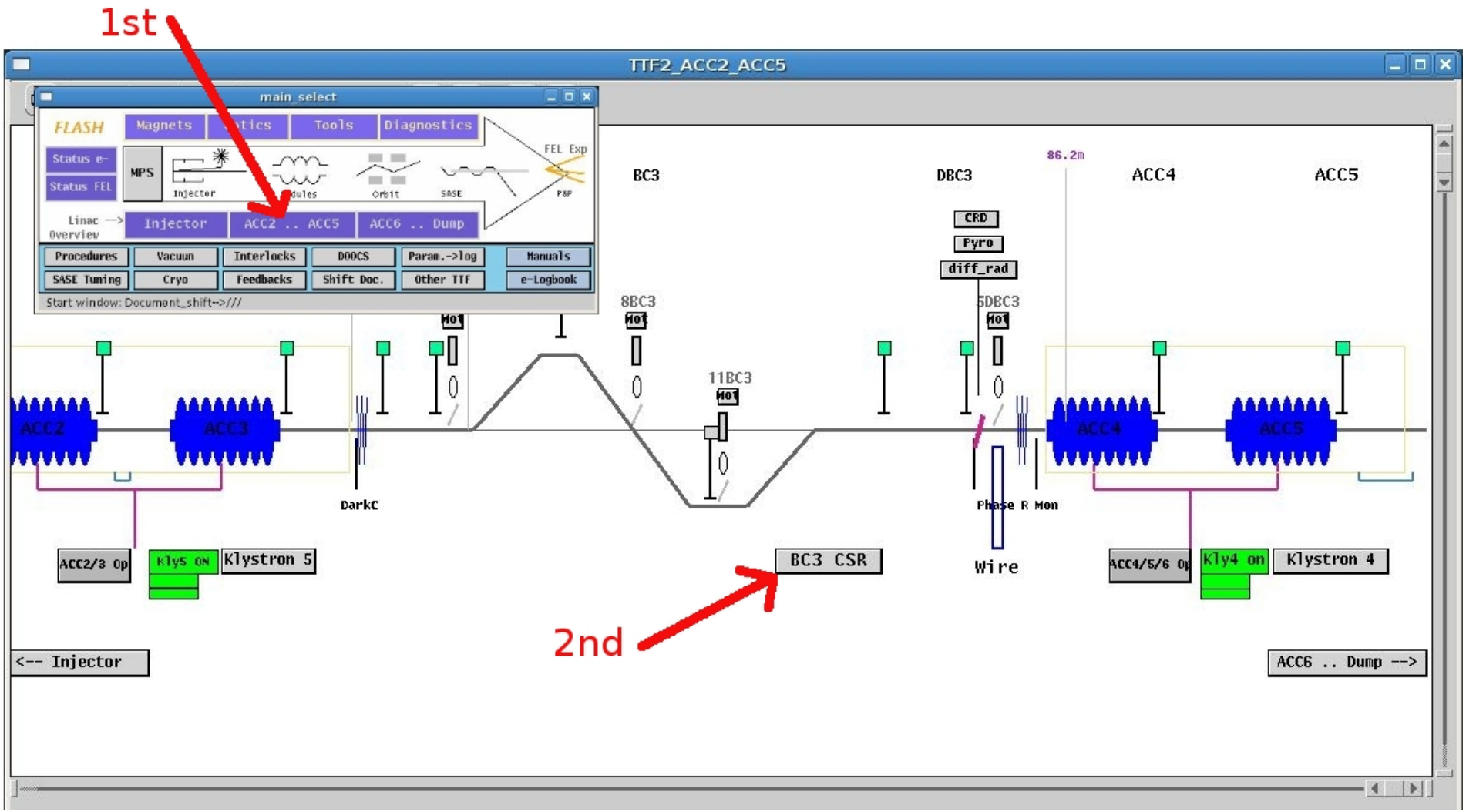
diamond has an uniform transmission curve down to short wavelength



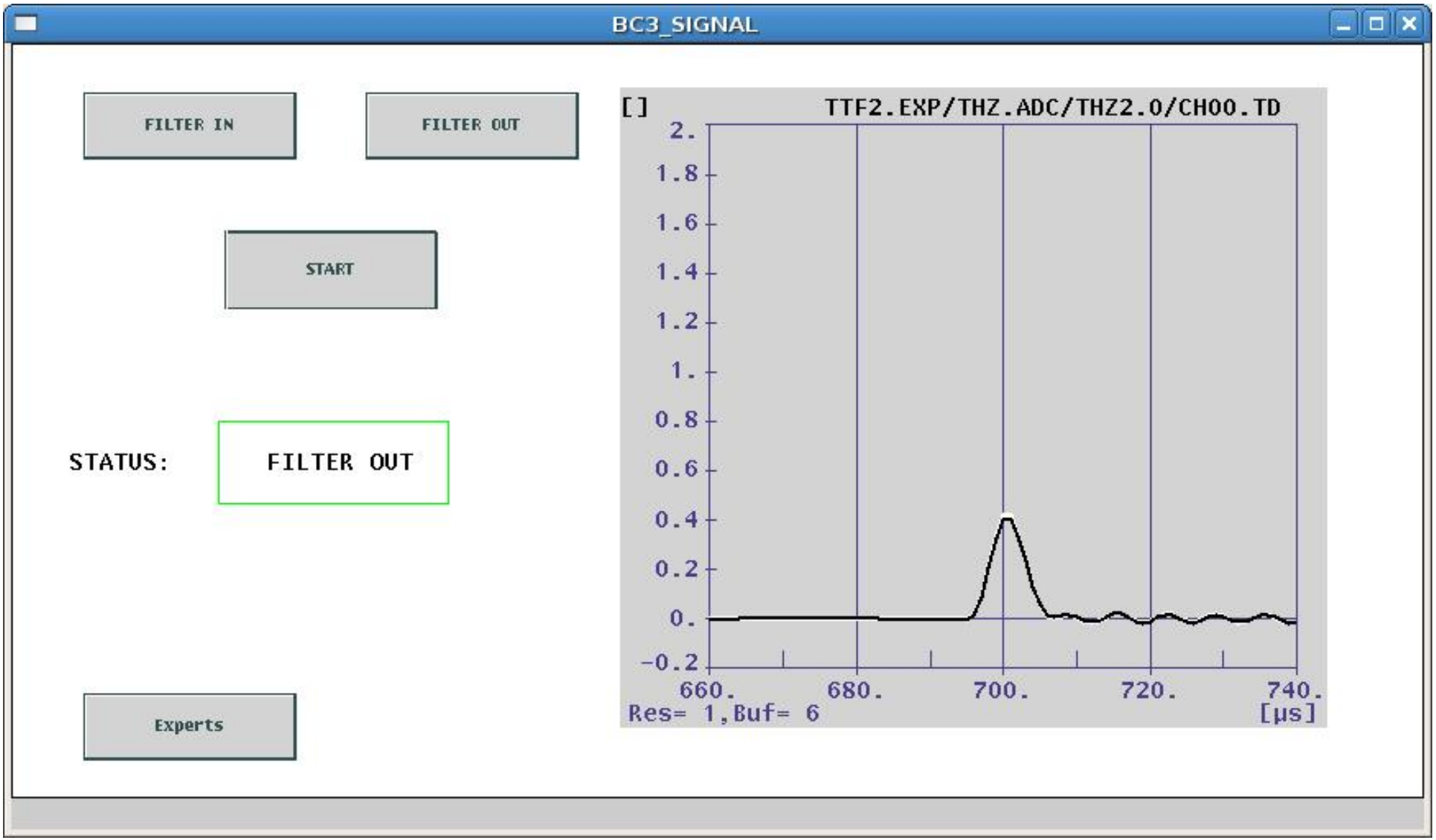
properties of KRS-5

- high-pass filter
- approx. flat curve from 35 μm down to 700 nm

the panels in DOOCS



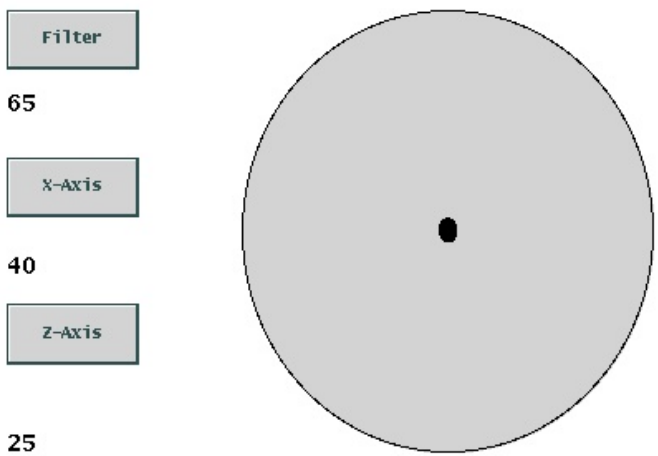
- BC3-CSR crate with 9 MHz ADC

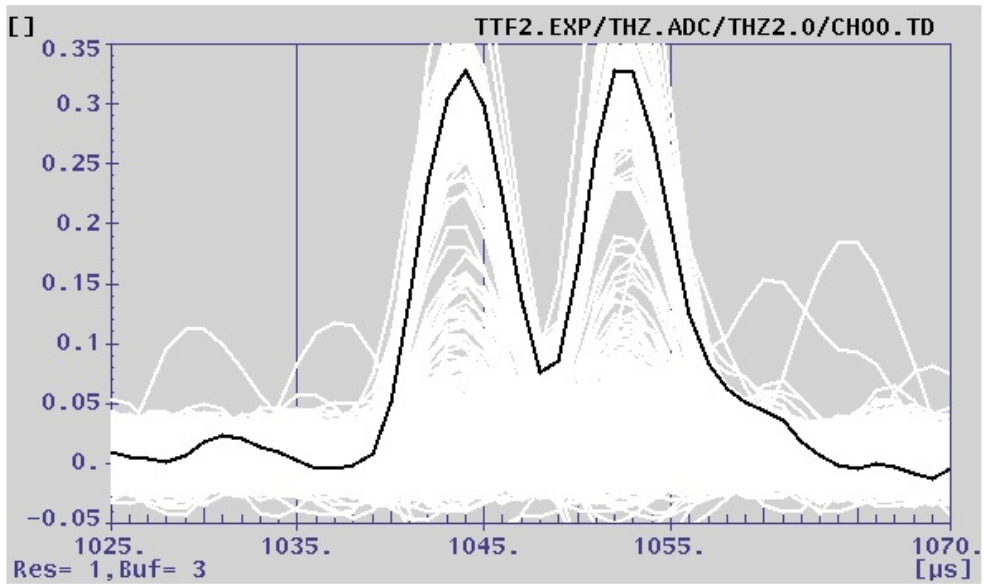


main goals for the BC3-CSR port

- characterize coherent synchrotron radiation (transverse profile, intensity, ...)
- correlation with other coherent radiation ports and SASE-signal
- THz-spectroscopy

first signal on 13th September (11:53pm) in the night shift

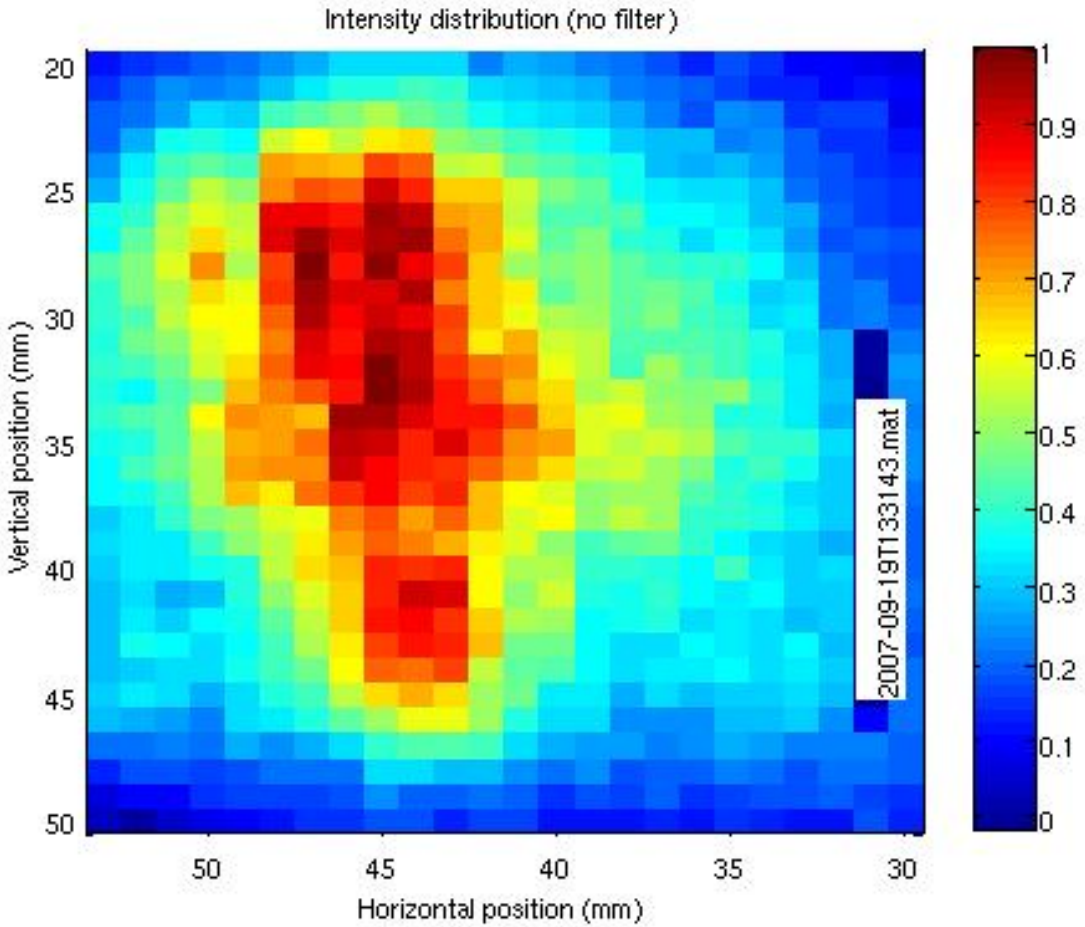




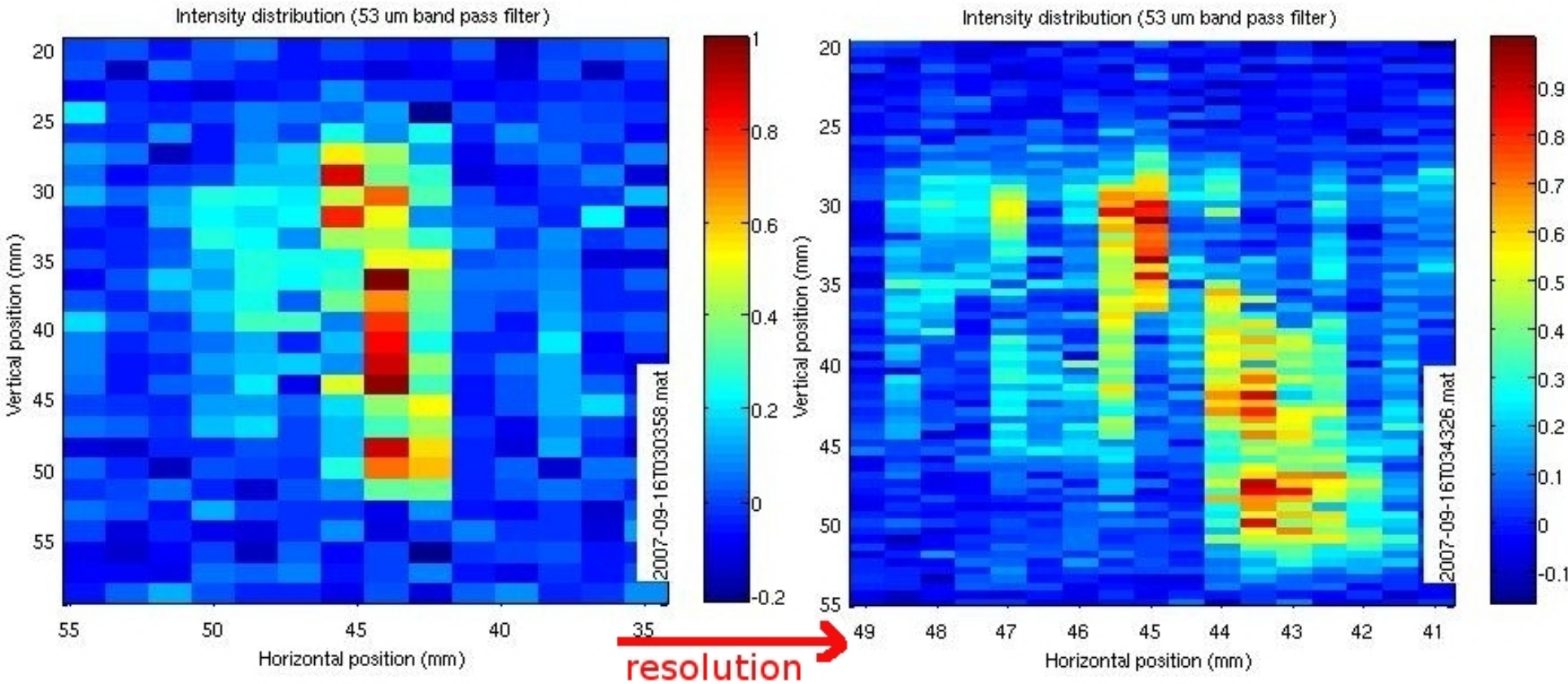
conditions for all following measurements (FEL-studies)

no SASE, good compression after BC2 (9DBC2.1 pyro)

transverse intensity distribution without any filter

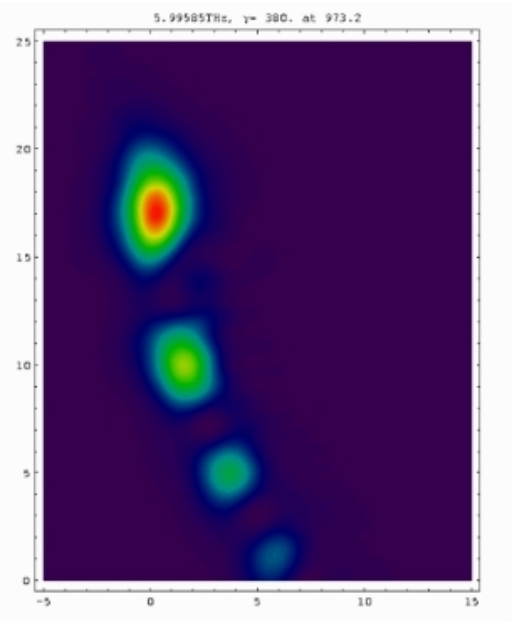


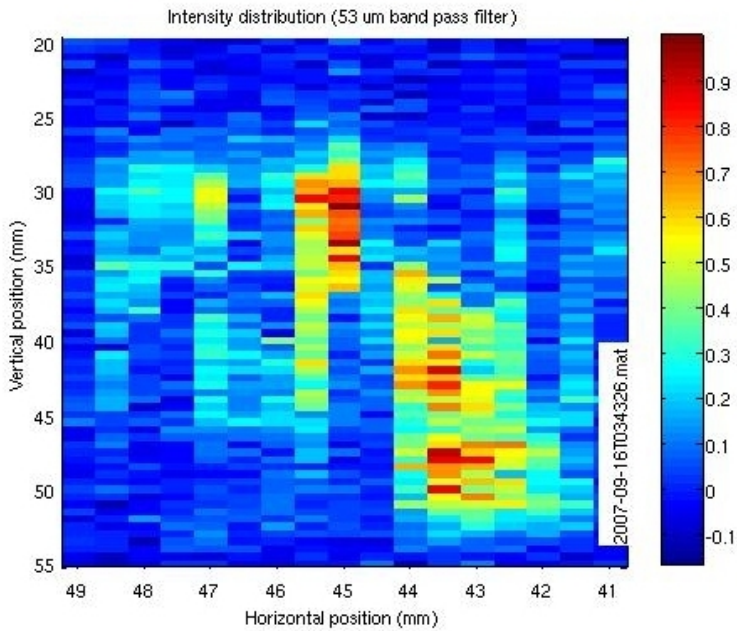
transverse intensity distributions with 53 μm band pass filter



comparison with simulation

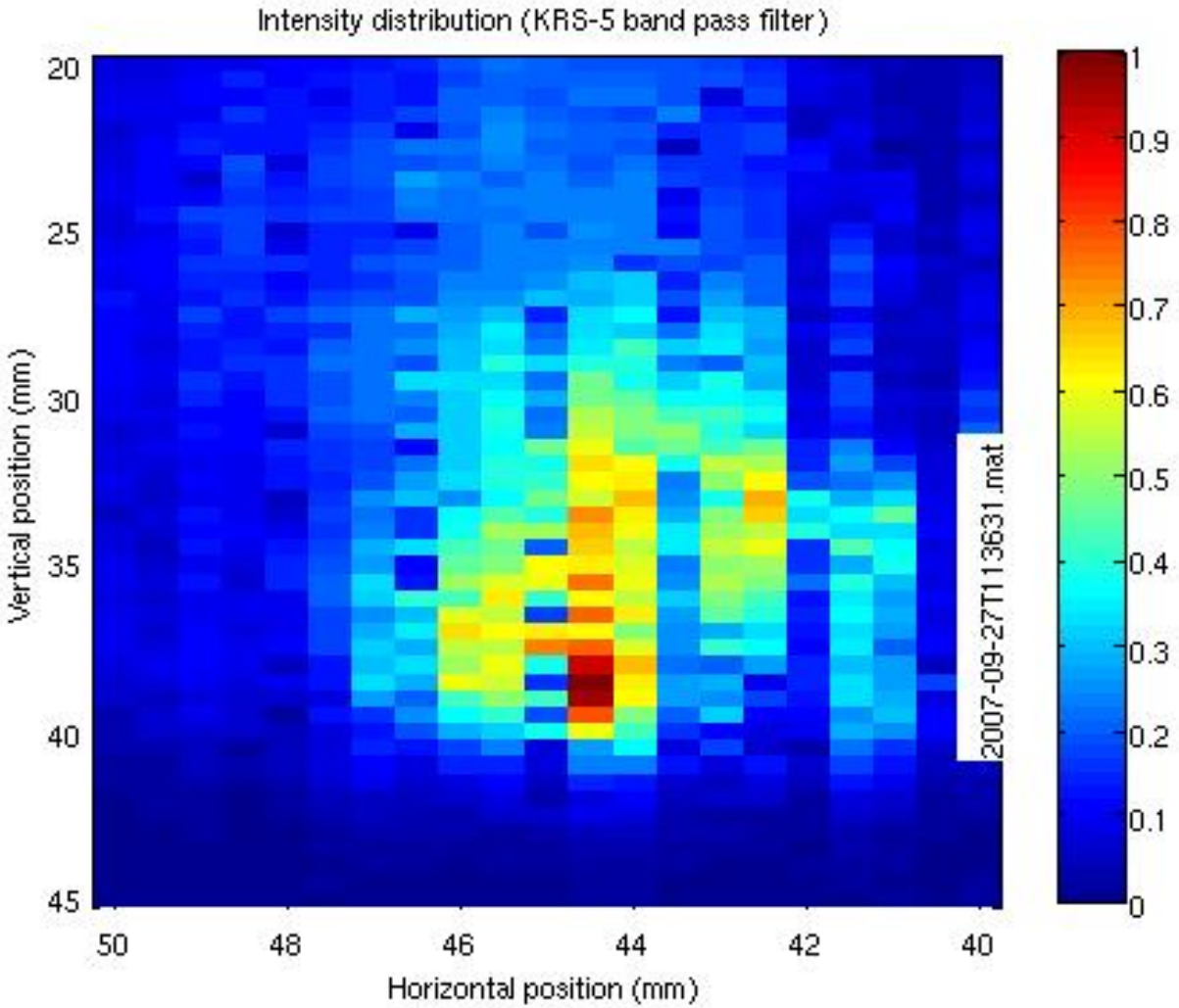
- synchrotron radiation with SynchroSim by O.Grimm (tracking algorithm with mirror charges)
- optical propagation with THzTransport by B.Schmidt (fourier optics)





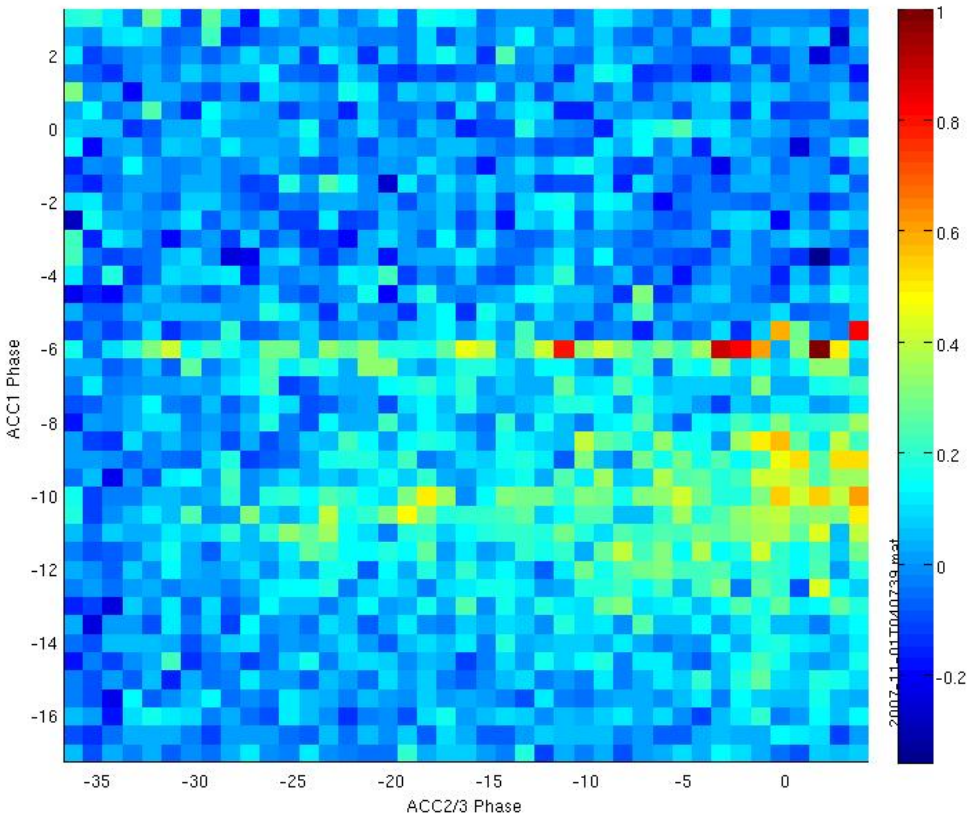
there is some agreement in pattern and size

transverse intensity distributions with KRS-5 high pass filter



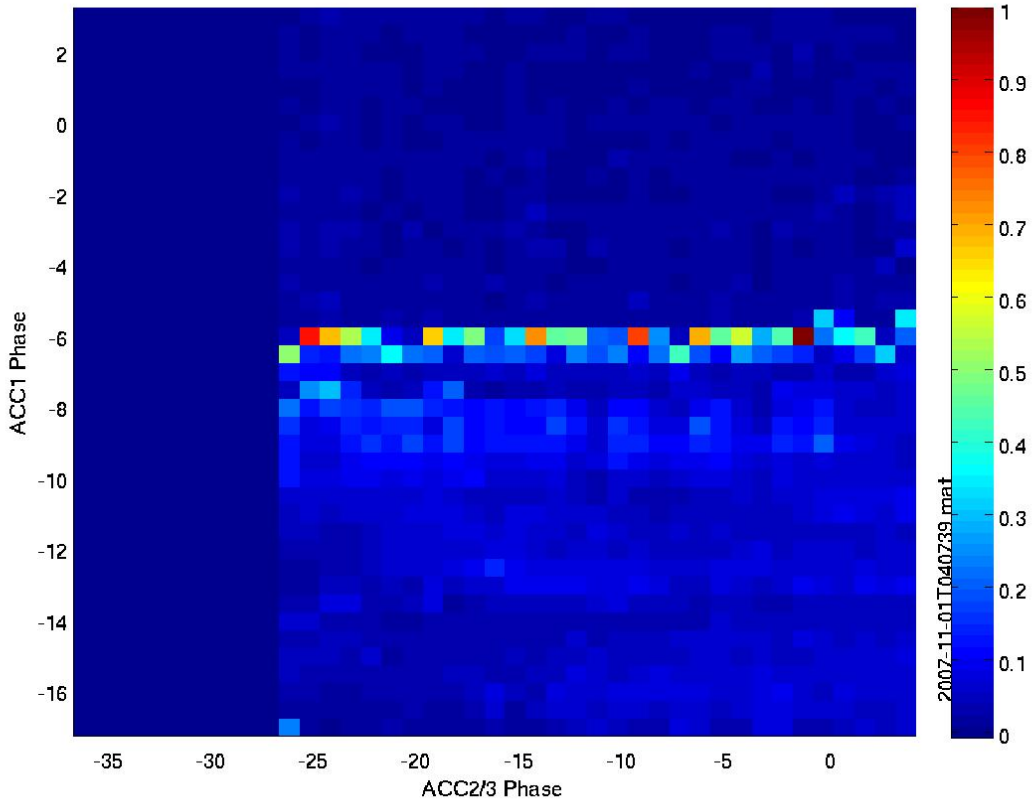
2 dimensional phase scan with KRS-5 filter

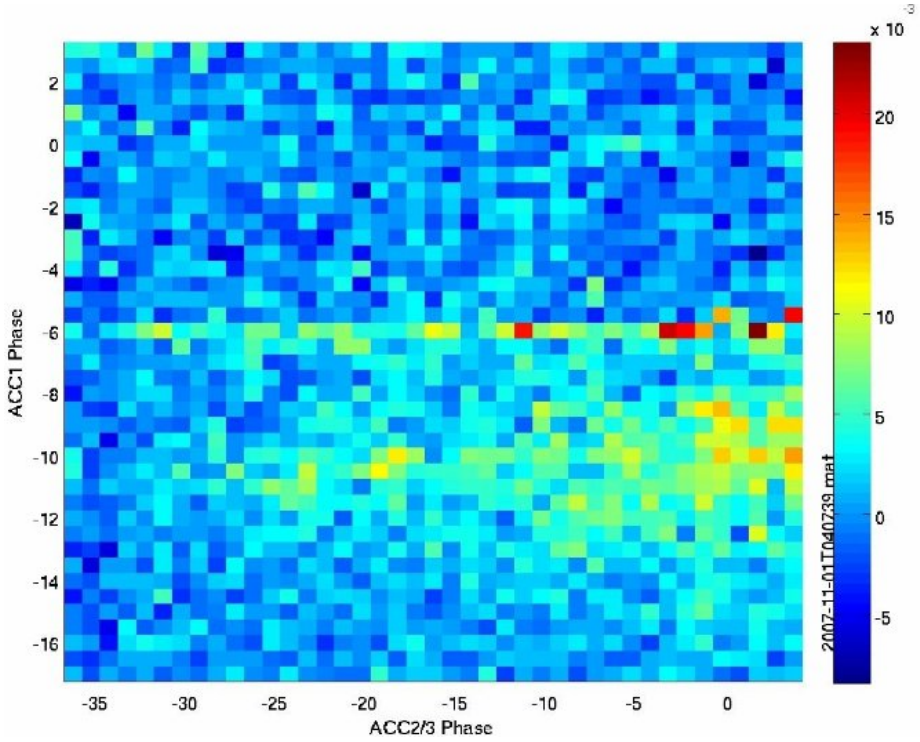
- signals from pyro at BC3 port (CSR@82m)
- average over 10 shots (one bunch per bunchtrain)
- stepsize 0.5° for ACC1 and 1.0° for ACC23

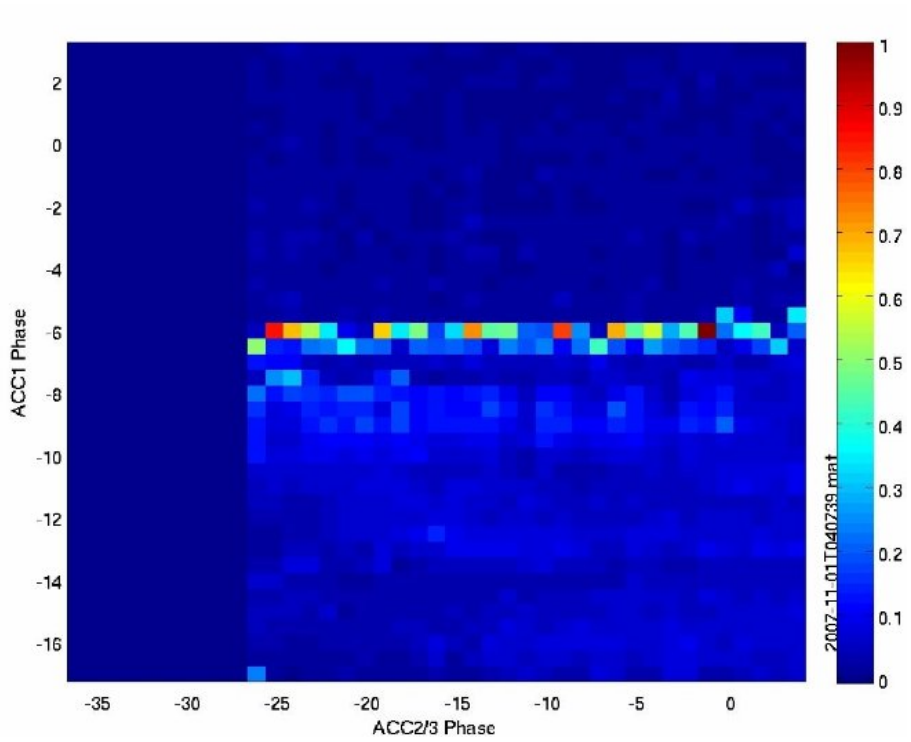


2 dimensional phase scan with KRS-5 filter

- signals from pyro at THz-Beamline port (CTR@140m)
- average over 10 shots (one bunch per bunchtrain)
- stepsize 0.5° for ACC1 and 1.0° for ACC23



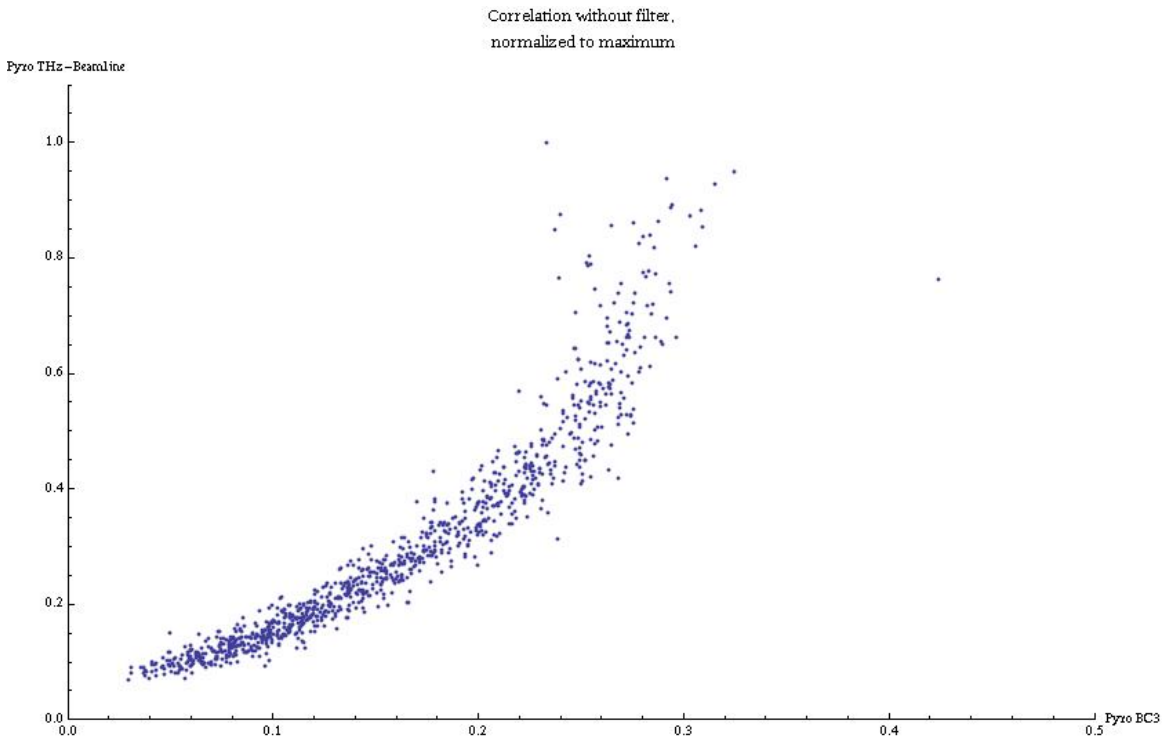




- sharp maxima at ACC1-phase $\approx$ -6° off-crest
- maxima at ACC1-phase $\approx$ -10.0° off-crest only for CSR
- no orbit-feedback
- some losses after BC3

correlation of CSR@82m and CTR@140m

- measurement without any filter
- 1000 shots (one bunch per bunchtrain)
- approx. fixed phases: ACC1 = -5.5°, ACC23 = 1.0°



- strong correlation with nonlinear dependence

results

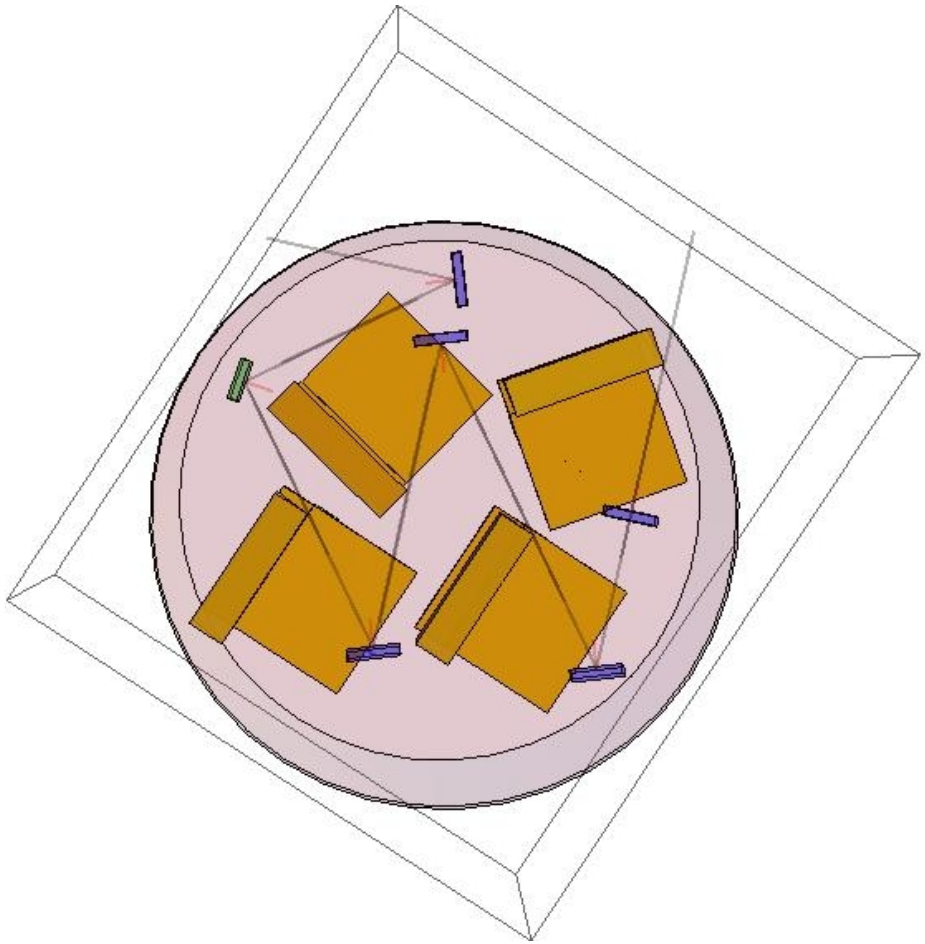
- commissioning of BC3-CSR setup successful
- first measurements were done
- in first order, the BC3-CSR setup ist suitable for THz-diagnostics

next steps

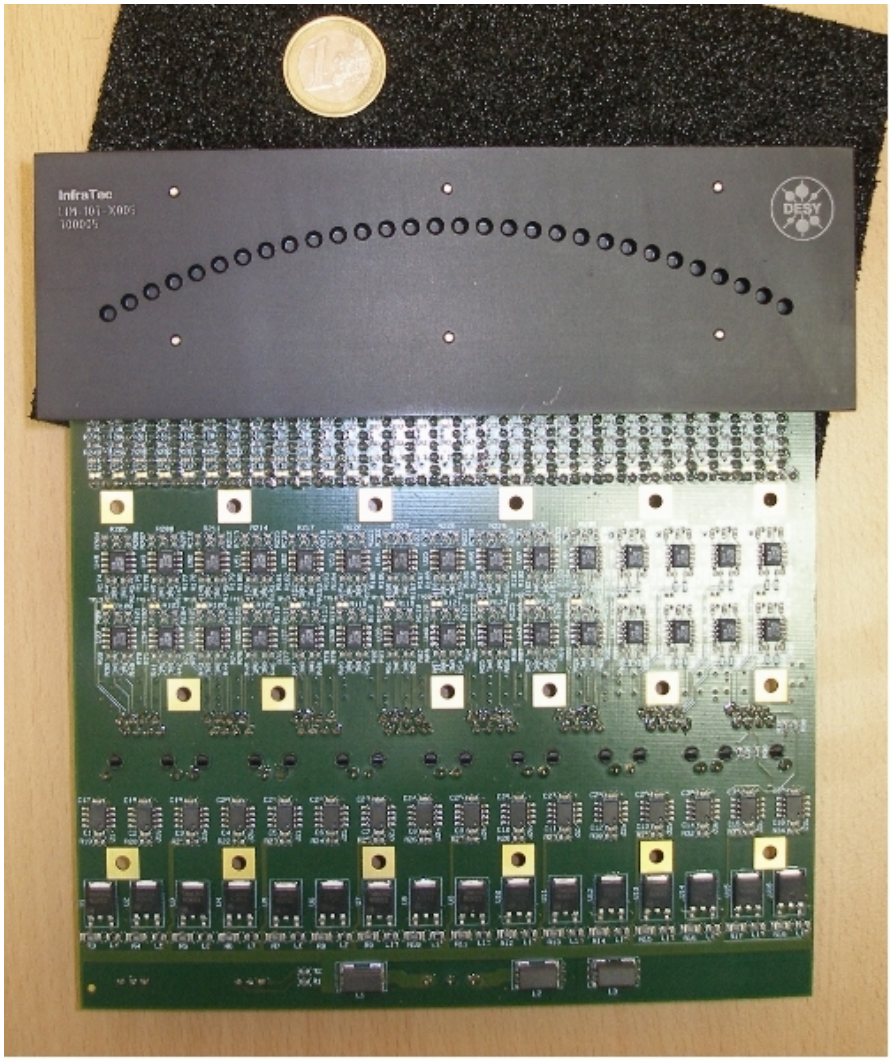
- installing an outcoupling mirror-motorization (ready in mid of january)
- installing a 4 stage broadband spectrometer (ready before spring)

spectrometer

- 4 stages: 3 refractive blazed gratings and 1 transmission grating
- covering wavelength from 10 μm to 200 μm in single shot
- each of the 4 line-detectors has 30 pyro channels



- line-detector with 30 pyro channels
- electronic board



Thanks for your attention!

thanks for fruitful discussions

- Stephan Wesch
- Bernhard Schmidt
- Hossein Delsim-Hashemi
- Oliver Grimm
- Arik Willner