Investigation of CSR-spectra at BC3

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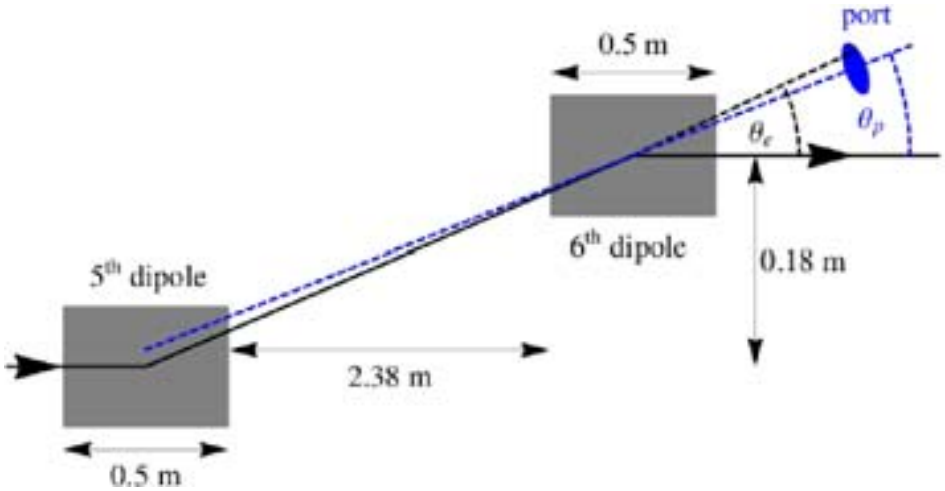
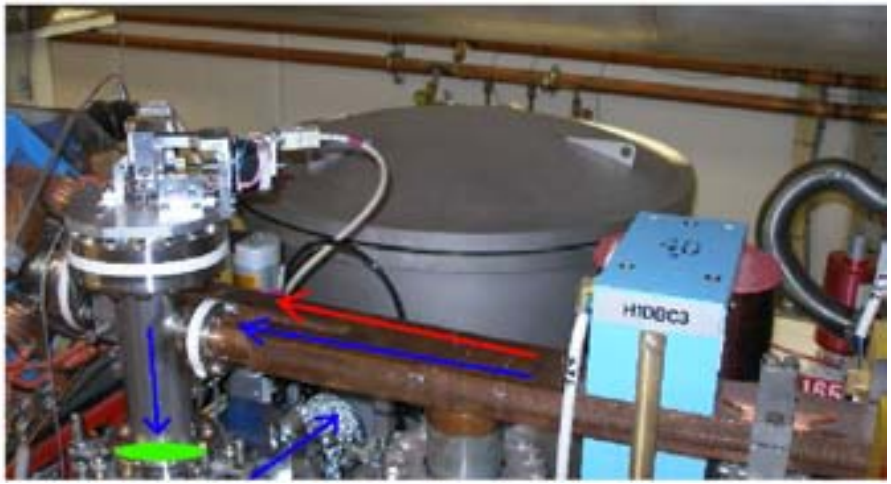
Outline

Synchrotron radiation port

SR-port at BC3

- located after the last dipole (height: $8\mathrm{mm}$, width: $26\mathrm{mm}$)
- equipped with a diamond window
- two remote-controlled focussing mirrors



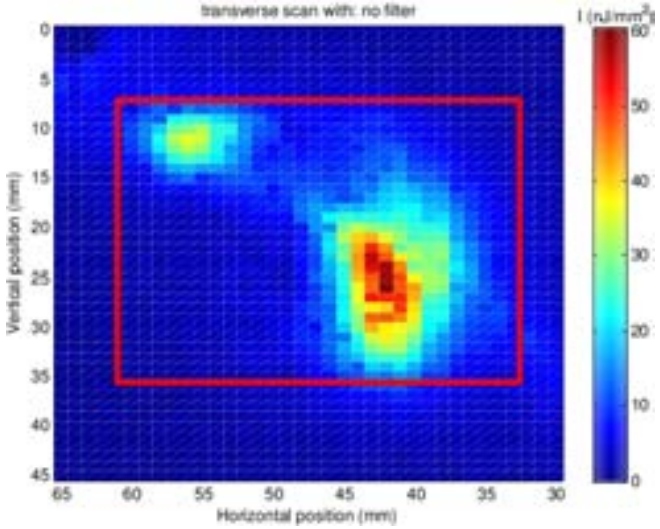


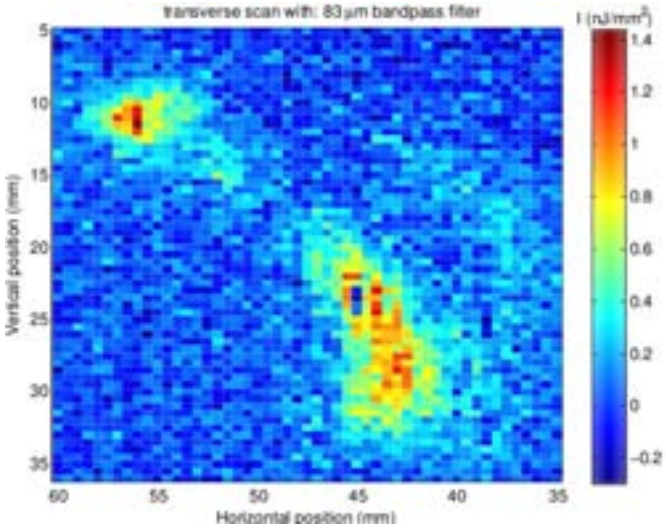
- port angle: $\Theta_p = 3.2^\circ$
- bending angle: $2.1^\circ < \Theta_e < 5.4^\circ$ (nominal: $\Theta_e = 3.8^\circ$)
- interferences are expected (edge radiation)

Old setup

Transverse scanning device

- first detection of CSR at BC3
- transverse intensity distributions
- first spectral informations





- two maxima (effects of edge radiation?)
- rather low intensity (compared with CTR)

New setup

New vacuum tank

- much more space (diameter: 750 mm, heigth: 477 mm)
- designed for a 4-stage single-shot spectrometer

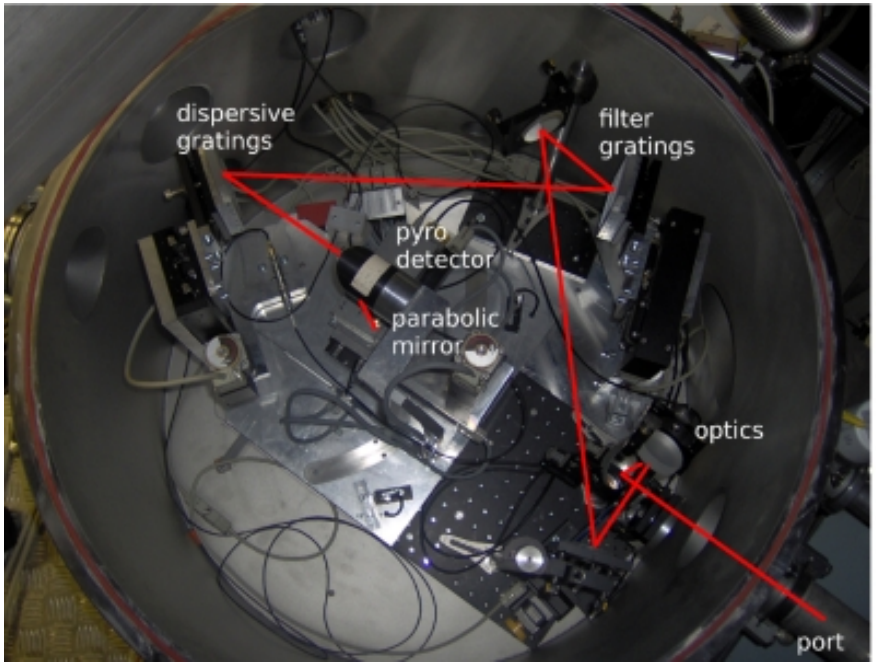
First spectral measurements

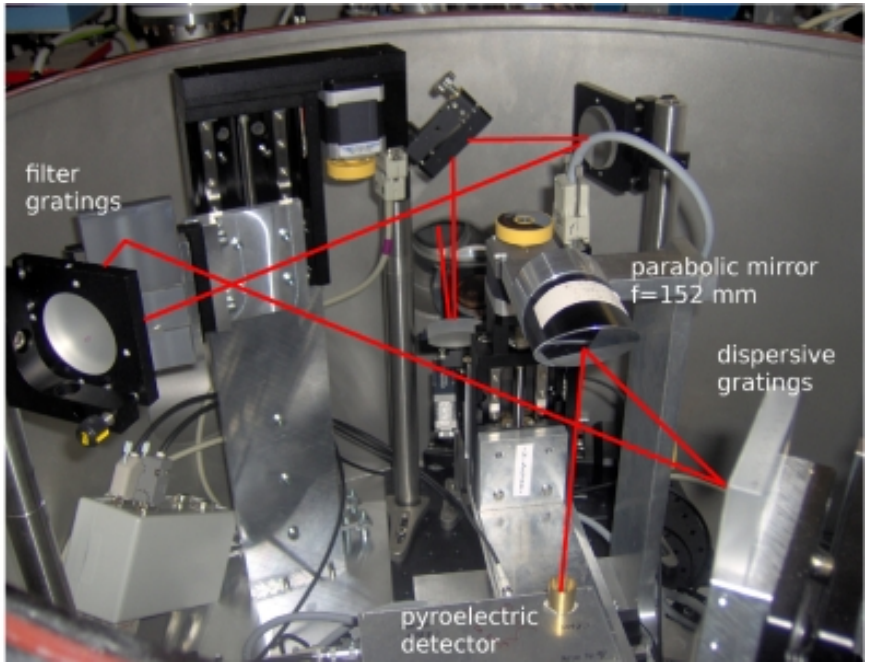
- rotating mirror spectrometer (no single-shot)

Rotating mirror spectrometer

Spectrometer

- filter and dispersive gratings
- pyroelectric detector
- rotating focussing mirror
- some optics

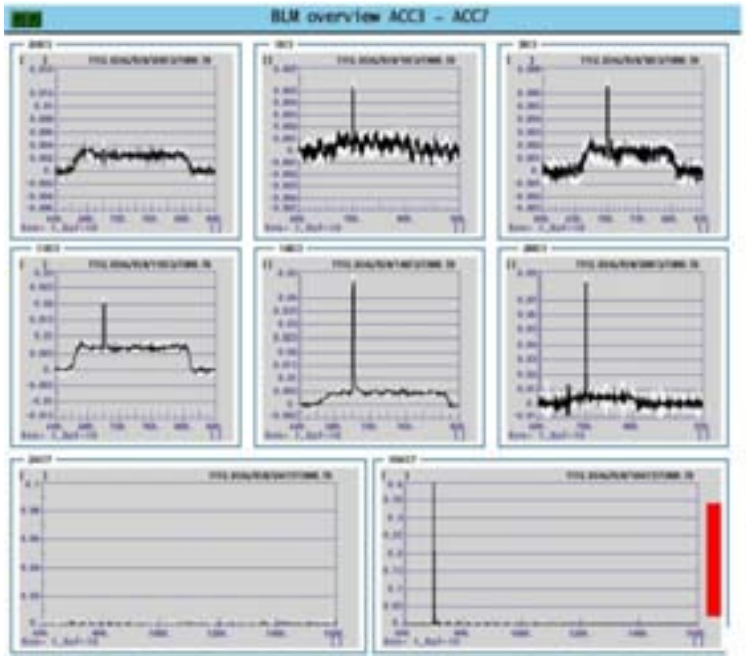


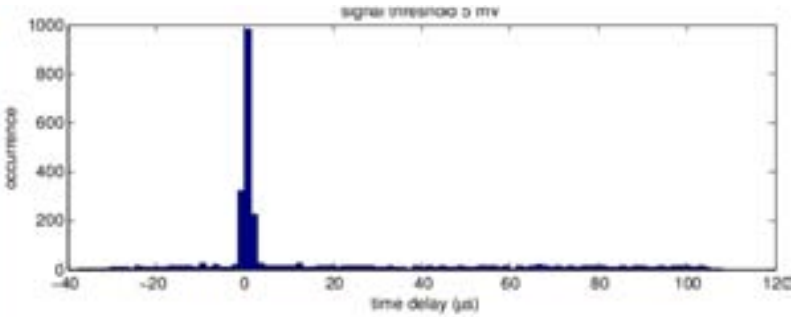


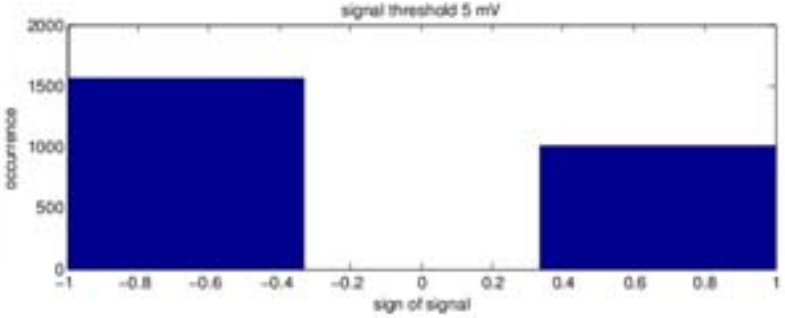
Electromagnetic shower

Artificial signals

- same shape as the signals due to CSR
- occurrence of both polarities (negativ and positiv)
- same time-profile as the beam loss monitors (BLM)

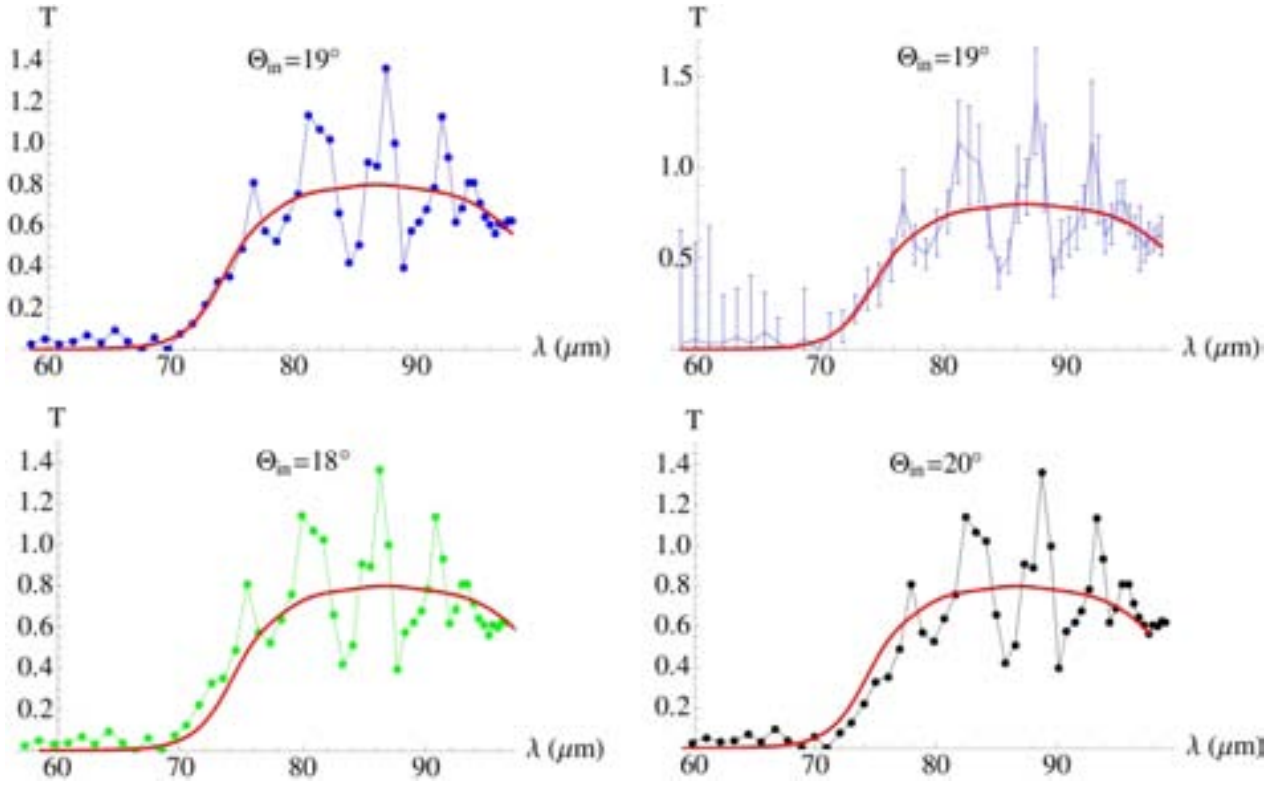






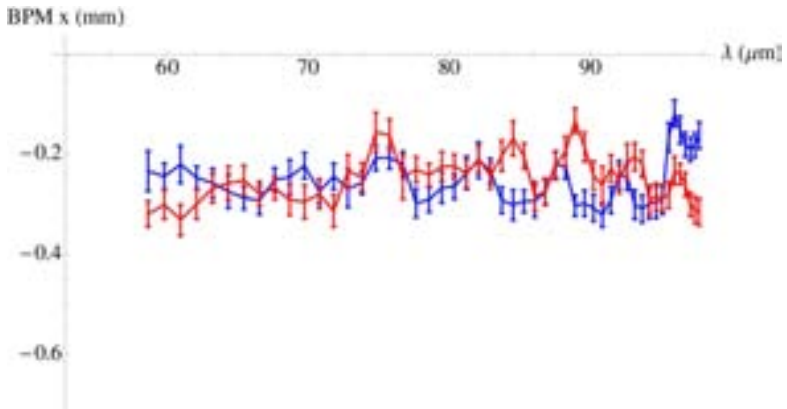
Shielding with lead from both sides helps. (upstream and downstream!)

83 μm bandpass filter

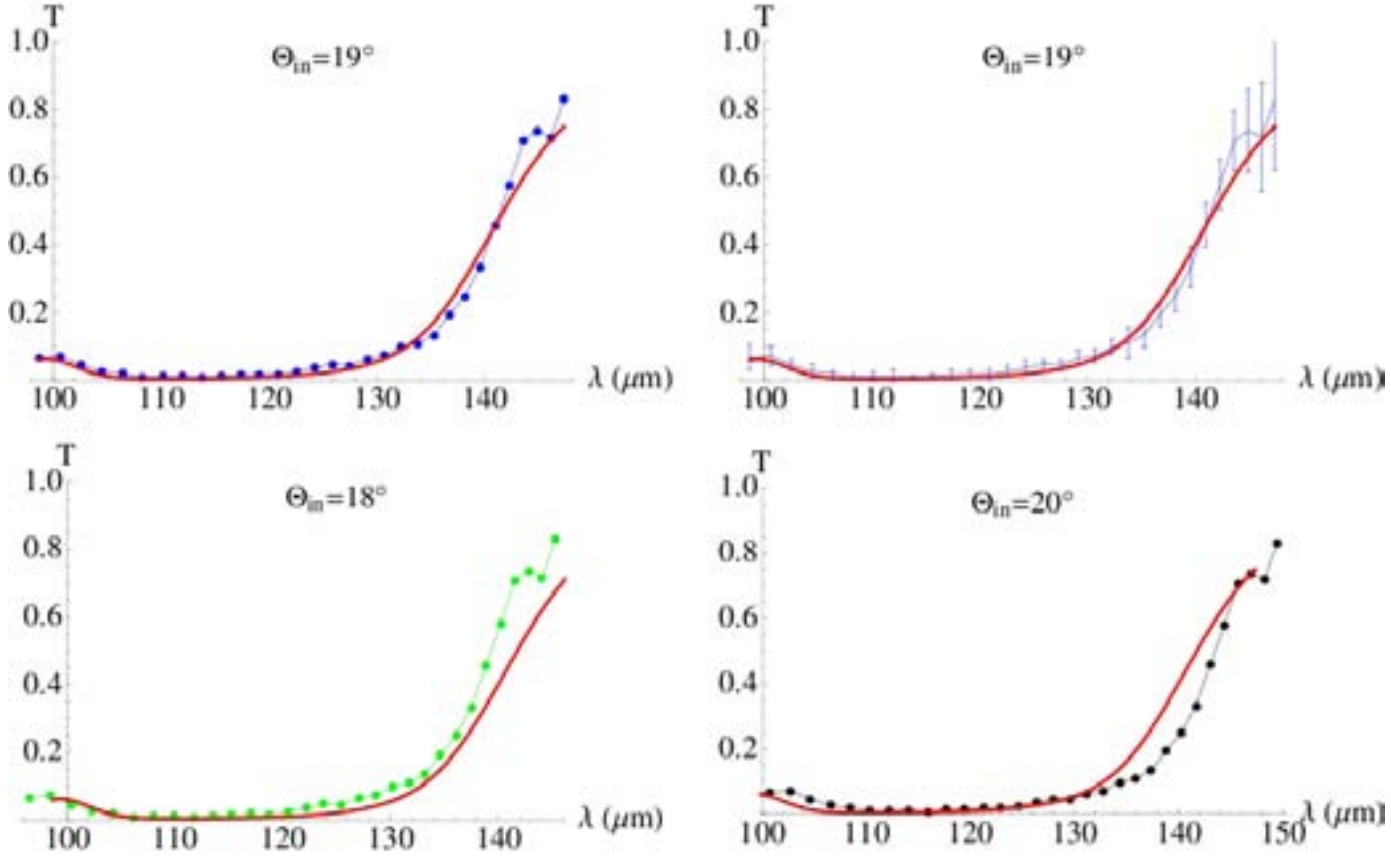


Wavelength calibration

- design incoming angle of $\Theta = 19°$
- orbit dependencies appeared



155 μm bandpass filter



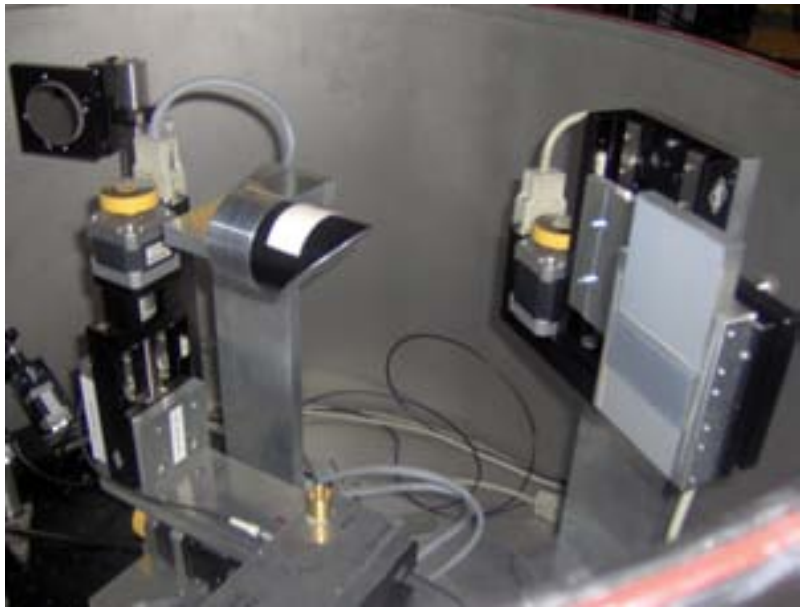
Wavelength calibration

Good alignment for the design incoming angle of $\Theta = 19°$.

Spectrometer settings

Grating sets

- 6 grating sets (G90, G50, G30, G20, G13.3, G7.9)
- wavelengths from 160 μm down to 9 μm



Grating exchange

The spectrometer was used with two grating sets
$\Rightarrow$ temporary access (ZZ)

Measurement settings

Settings: $\Phi_{ACC2/3} = 0^\circ$

$Q(\mathrm{nC})$: \ $\Phi_{ACC1}(^\circ)$:	-6	-9
0.5	-	x
0.8	x	x

Beam conditions

- 20 bunches per train
- orbit approx. constant in BC3

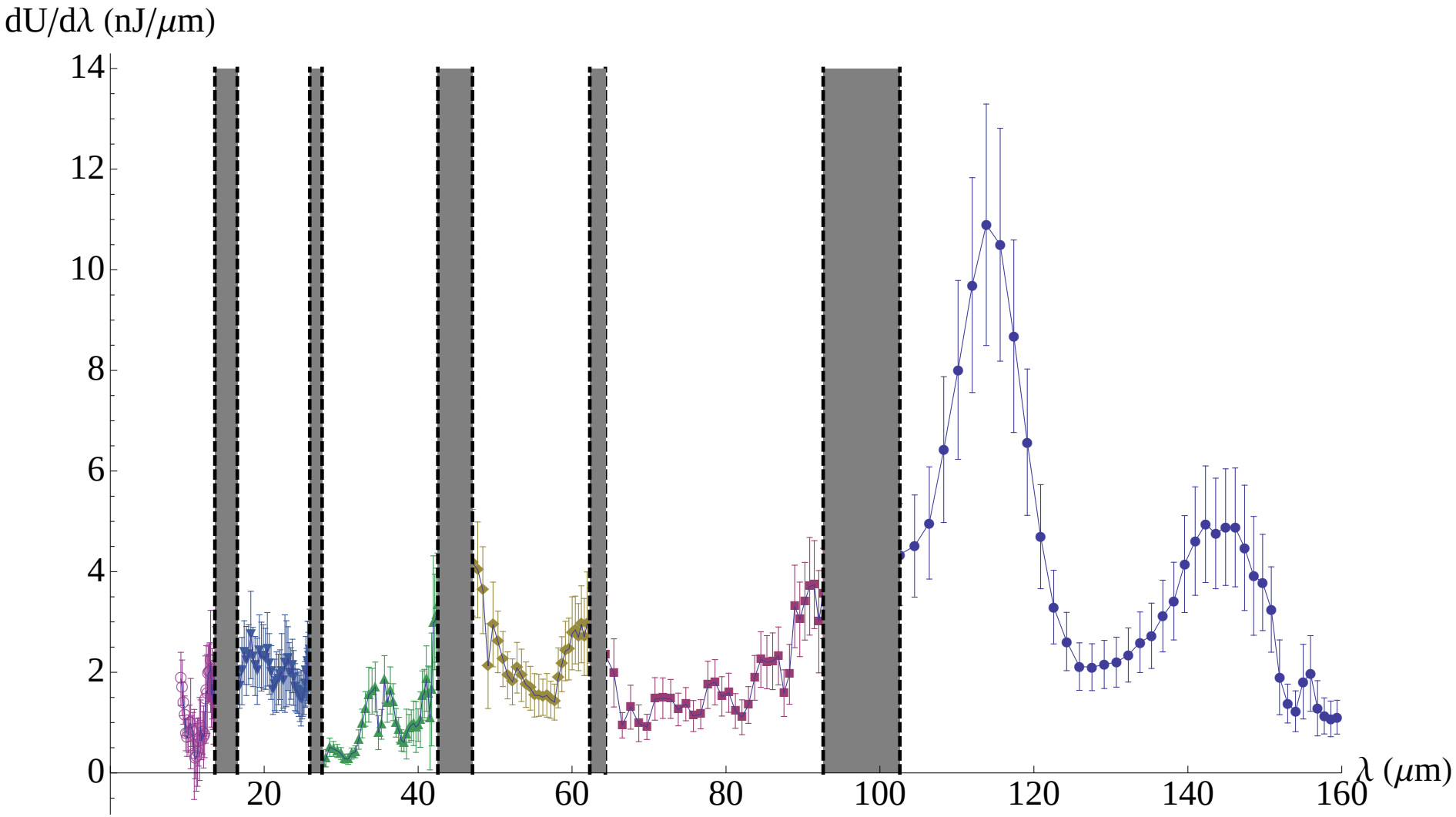
Measurements

- summed over the whole train
- averaged over 50 bunch trains (shots)

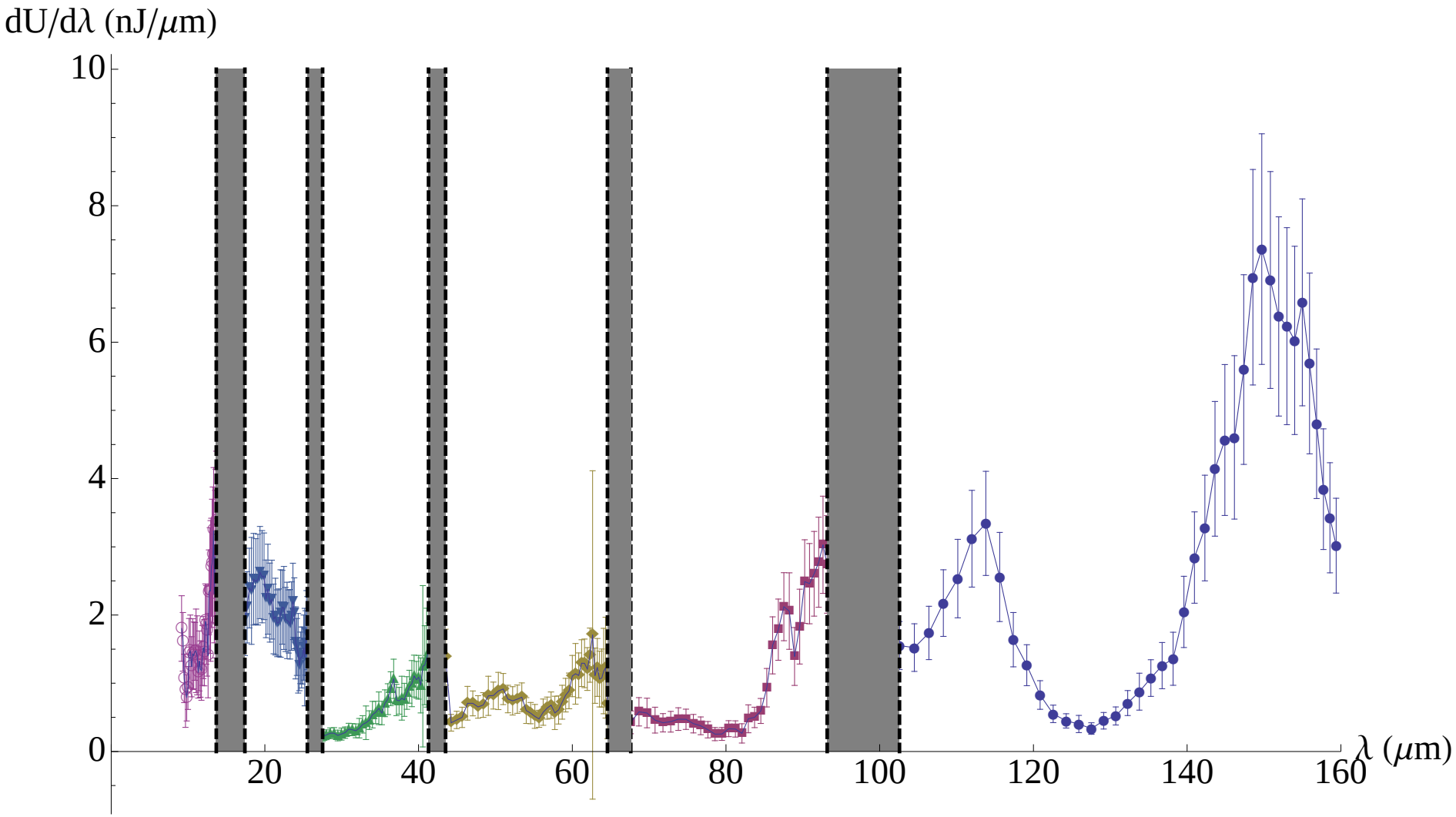
Results

The spectra were counted back for one bunch.

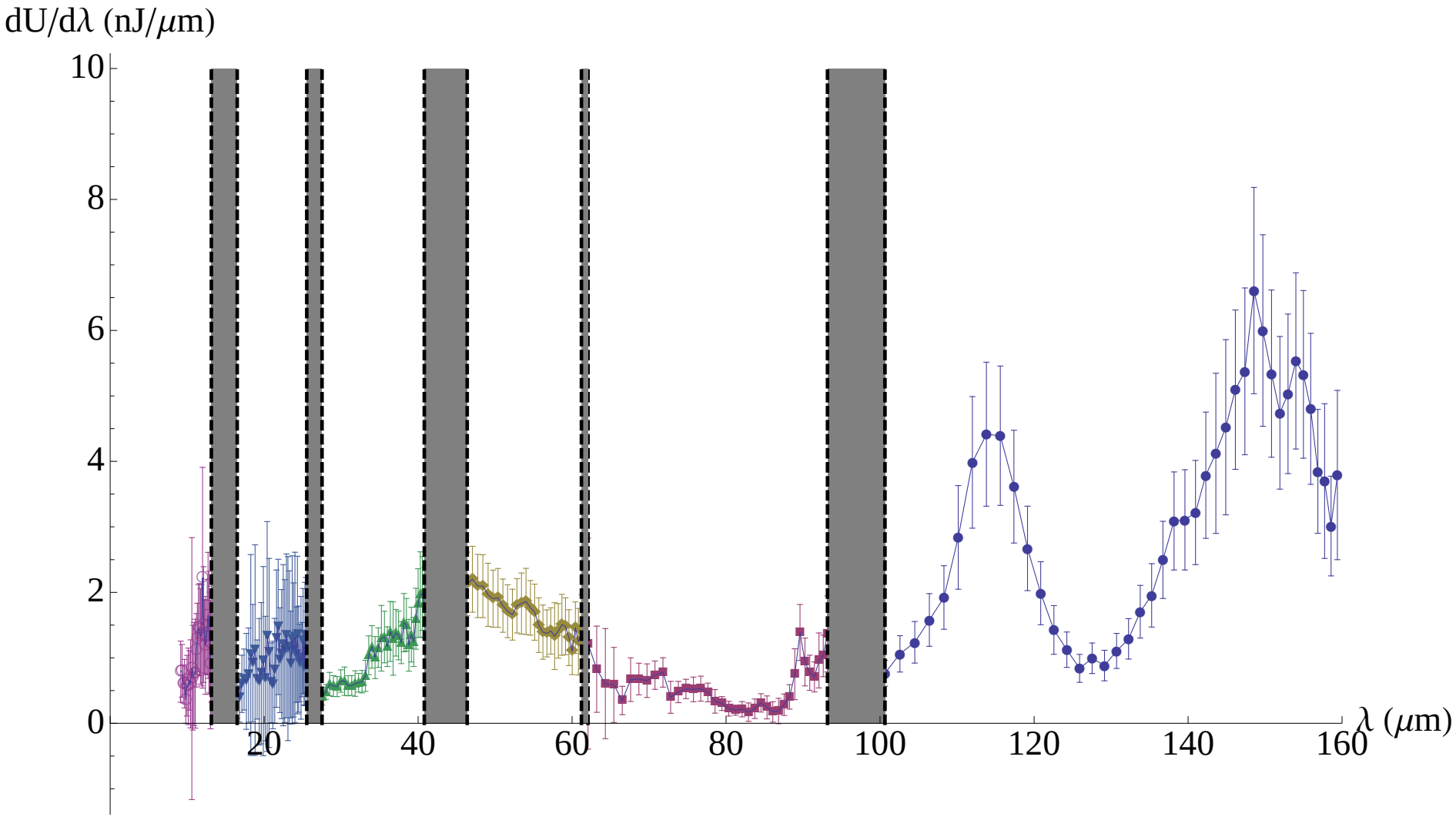
$\Phi_{ACC1} = -9^\circ$ and $Q = 0.8\,\mathrm{nC}$



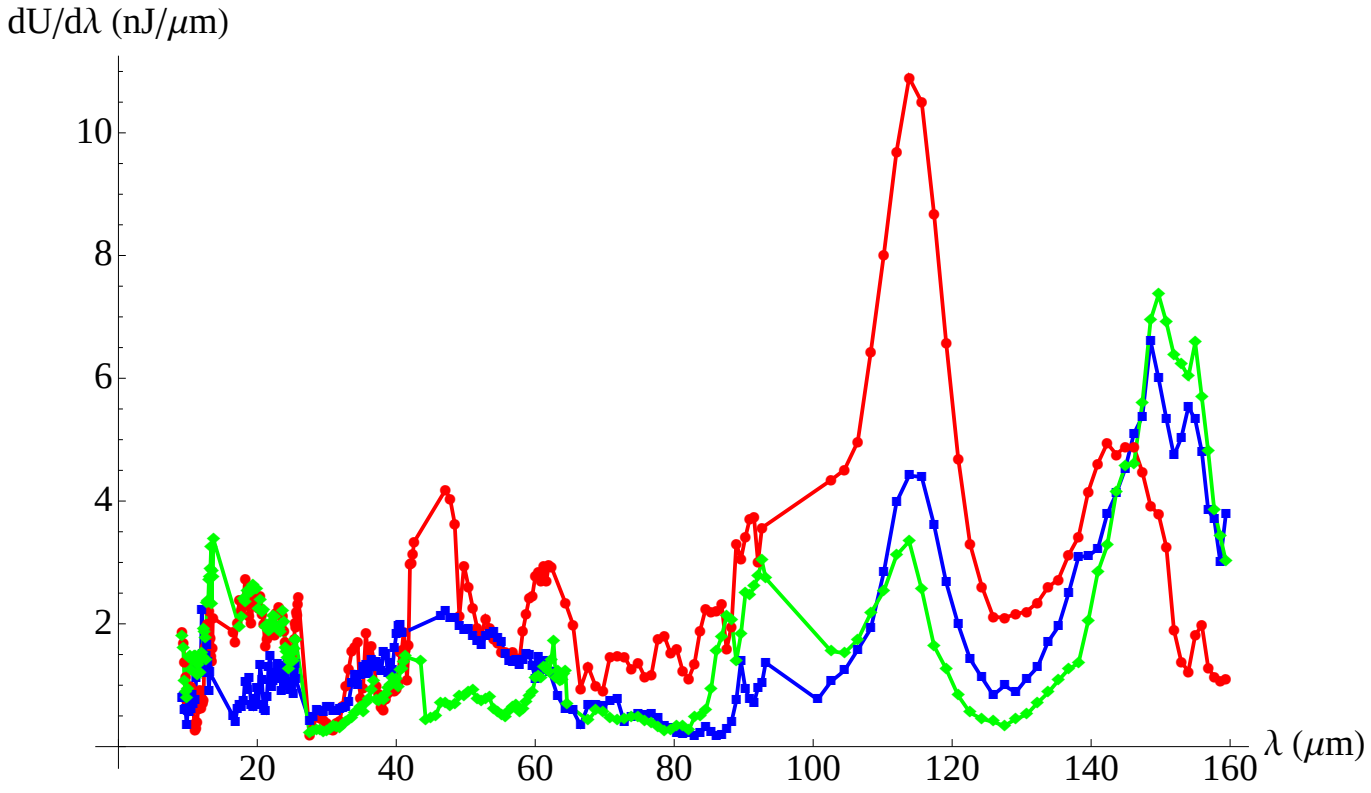
$\Phi_{ACC1} = -9^\circ$ and $Q = 0.5\,\mathrm{nC}$



$\Phi_{ACC1} = -6^\circ$ and $Q = 0.8\,\mathrm{nC}$



All together



- $\Phi_{ACC1} = -9^\circ$ and $Q = 0.8\,\mathrm{nC}$
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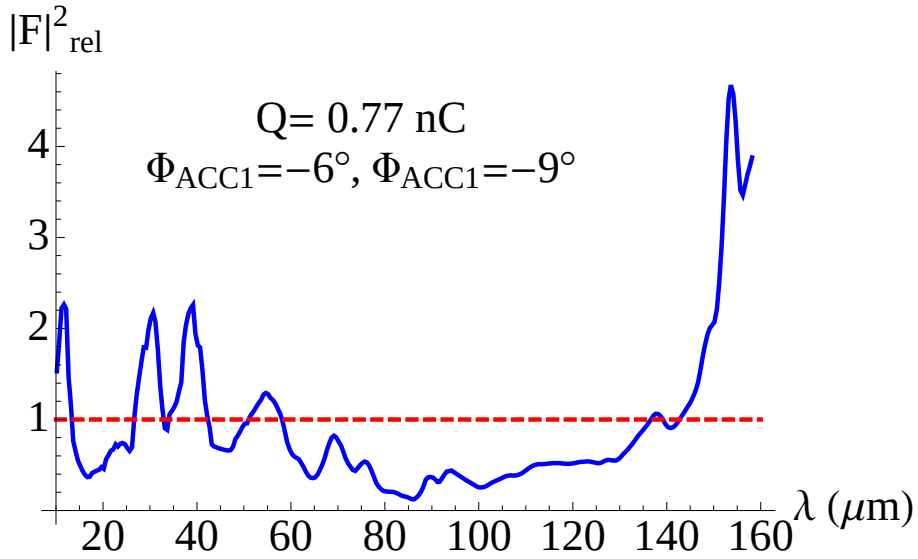
Relative formfactor $|F|^2_{rel}$



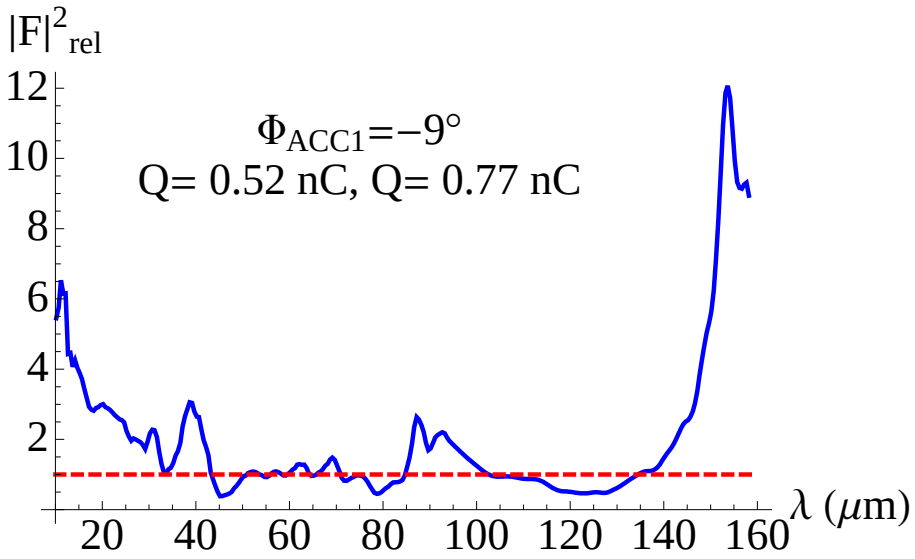
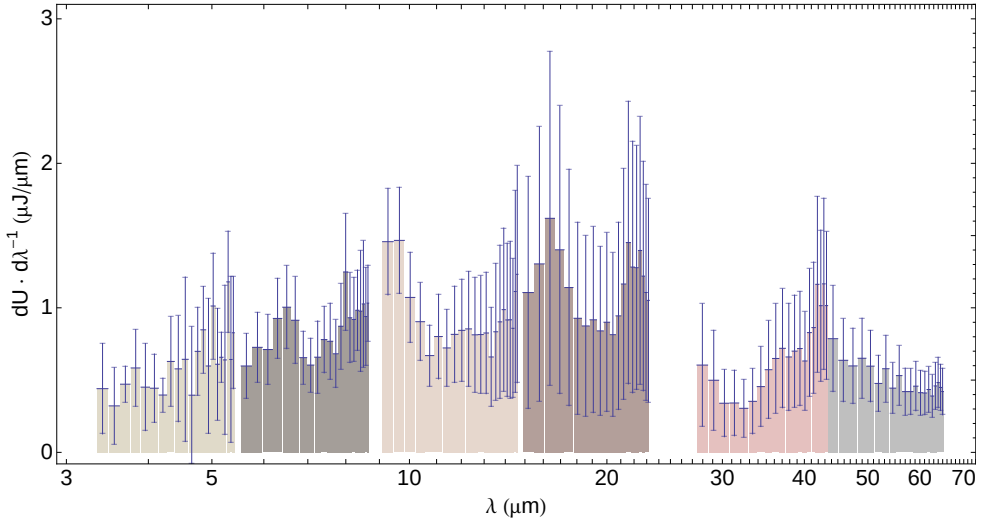


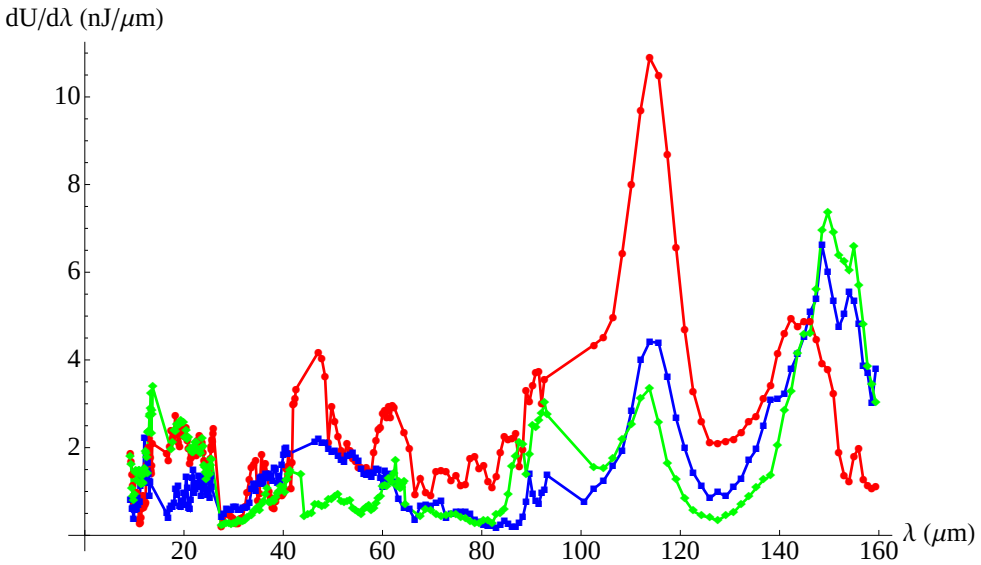
Figure: Left: F_1 with $\Phi_{ACC1} = -6°$ and F_2 with $\Phi_{ACC1} = -9°$, Right: F_1 with $Q = 0.52\,\mathrm{nC}$ and F_2 with $Q = 0.77\,\mathrm{nC}$

Ratio of form factors

$$|F|^2_{rel}(\lambda) = \left(\frac{Q_2}{Q_1}\right)^2 (dU_1/dU_2) = \frac{|F_1(\lambda)|^2}{|F_2(\lambda)|^2}$$

Intensity comparisons





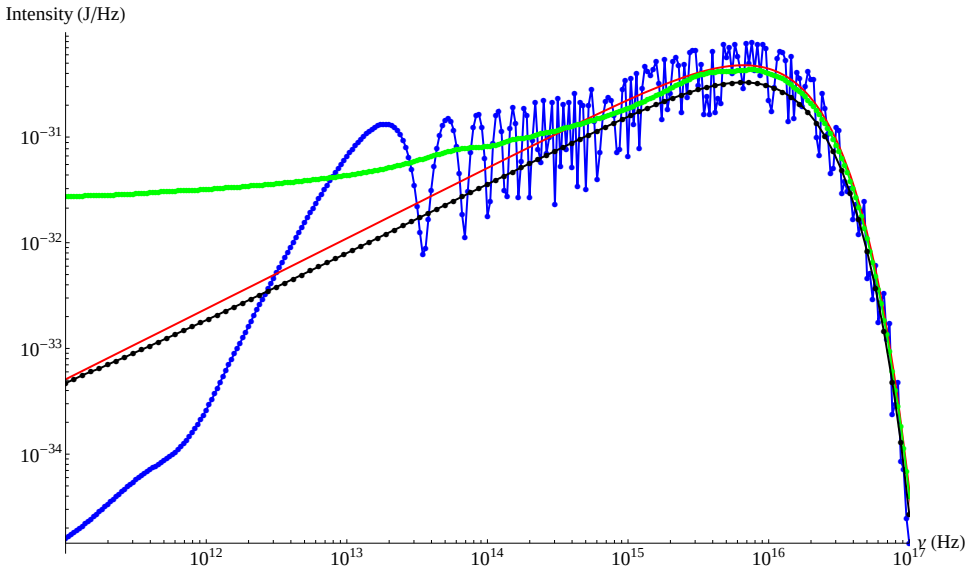
CTR spectrum

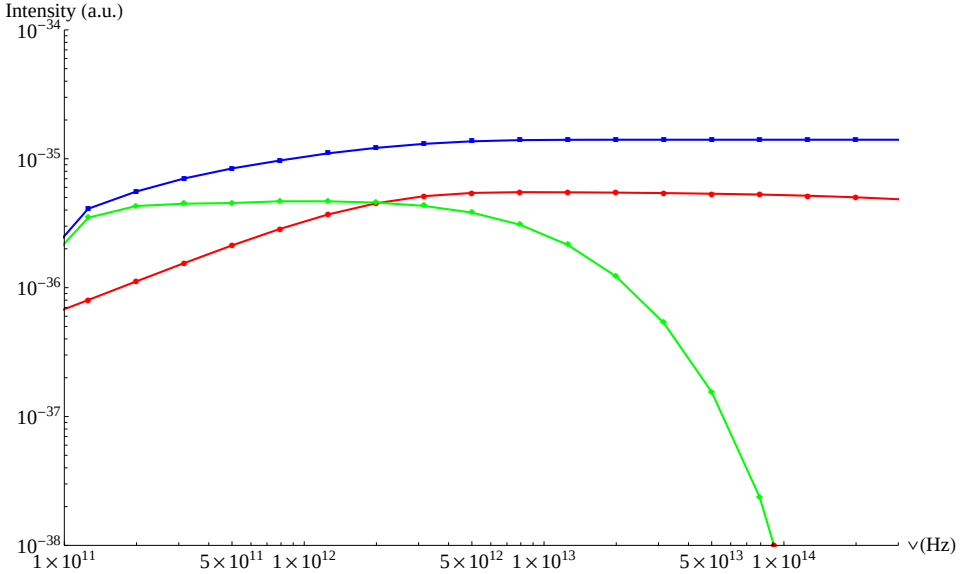
- $E = 700\,\mathrm{MeV}$
- $Q = 0.75\,\mathrm{nC}$
- FEL-mode

CSR spectra

- $E \approx 450\,\mathrm{MeV}$
- $Q = \{0.5, 0.8\}\,\mathrm{nC}$
- $\Phi_{ACC1} = \{-6, -9\}^\circ$
- $\Phi_{ACC2/3} = 0^\circ$

Simulations (single electron)





SR spectrum (BC3 conditions)

- analytical (red)
- long single dipole (black)
- last dipole of BC3 (green)
- last two dipoles of BC3 (blue)

SR, TR and DR (FLASH)

- SR (red)
- TR (blue)
- DR (green)

Source for Feedback-systems (XFEL)

Requirements

- (almost) non-destructive measurements
- good signal-to-noise ratio (S/N) for single bunch
- effective input information (wavelength selected/integrated)

CTR

- good signal-to-noise ratio
- broad spectral range
- fully destructive

CSR

- poor signal-to-noise ratio
- broad spectral range
- fully non-destructive

CDR

- moderate signal-to-noise ratio
- suppression of short wavelengths
- (almost) non-destructive

Summary and conclusions

Results

- spectra in the wavelength range from 160 $\mu\mathrm{m}$ down to 9 $\mu\mathrm{m}$
- spectra of CSR for three different machine settings
- rather low intensity observed (poor S/N)

Conclusions

- single-shot measurements will be difficult
- CSR is maybe not the best candidate for feedback-systems

End

Thanks for your attention!