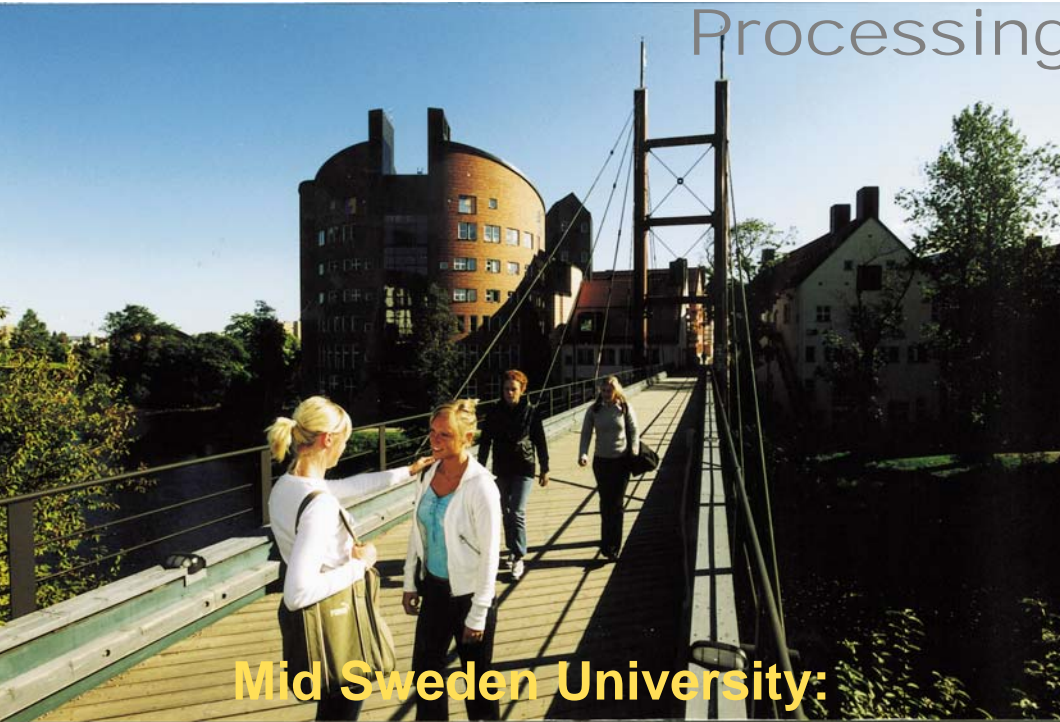


# Characterisation of the charge sharing in pixellated Si detectors with Single Photon Processing Readout



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# Disposition

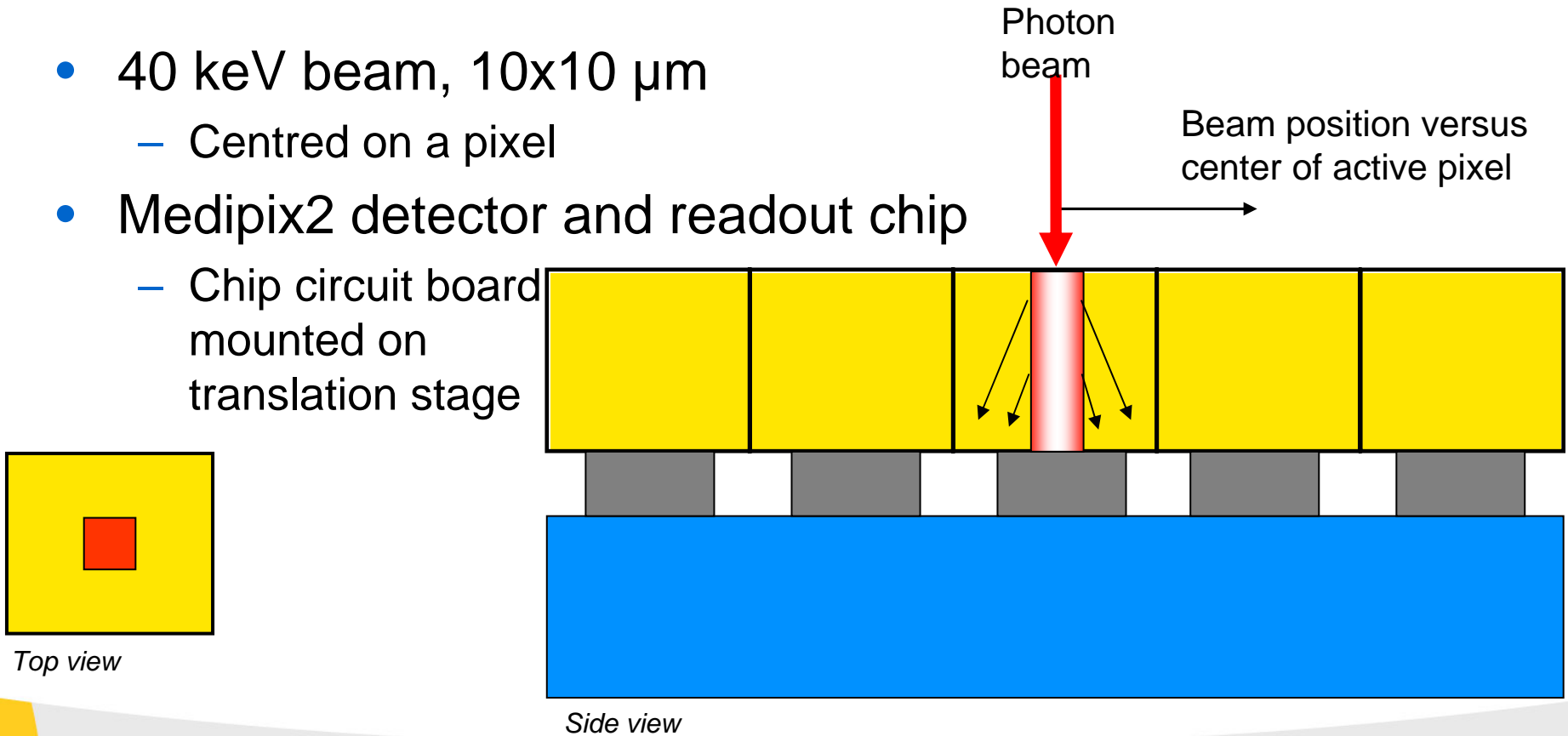
- **Measurements**
  - Narrow beam centred on one pixel
  - Scanning the beam over the pixel
- **Simulations**
  - Physical conditions for the measurements
  - Comparison between measurements and theory
  - Study of beam size, profile and measurement accuracy
- **Conclusions**

# Experimental setup

- Silicon detector assembly
  - 300  $\mu\text{m}$  and 700  $\mu\text{m}$  thick silicon detectors bonded to a MEDIPIX2 readout chip. Bias voltage is 100 V and 250 V.
  - The assembly is mounted on an X,Y translation stage
  - Readout controlled with MUROS2 and MEDISOFT4
- Beam conditions
  - Monoenergetic beam at 40 keV
  - Collimated with slits to 10 x 10  $\mu\text{m}$  (extrapolated)
  - Intensity: around 65000 photons/second
- Low threshold scans with Medisoft (automatically)
  - Achieving cumulative spectra
  - Exposure time varied to get reasonable number of counts

# Experimental setup

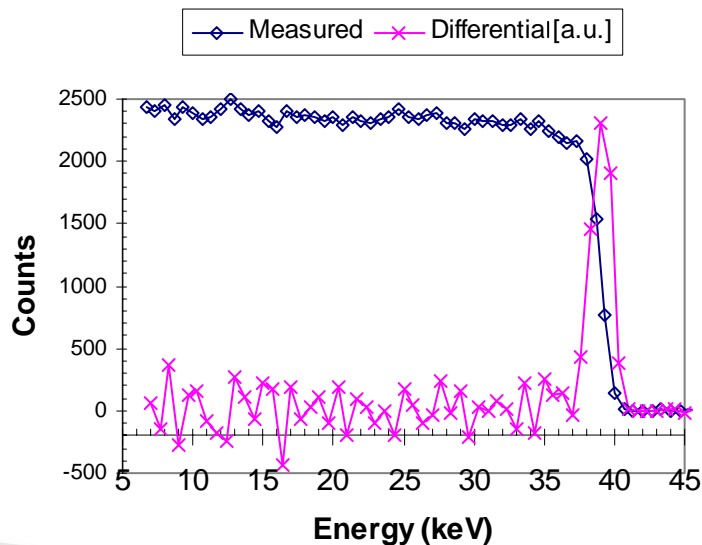
- 40 keV beam,  $10 \times 10 \mu\text{m}$ 
  - Centred on a pixel
- Medipix2 detector and readout chip
  - Chip circuit board mounted on translation stage



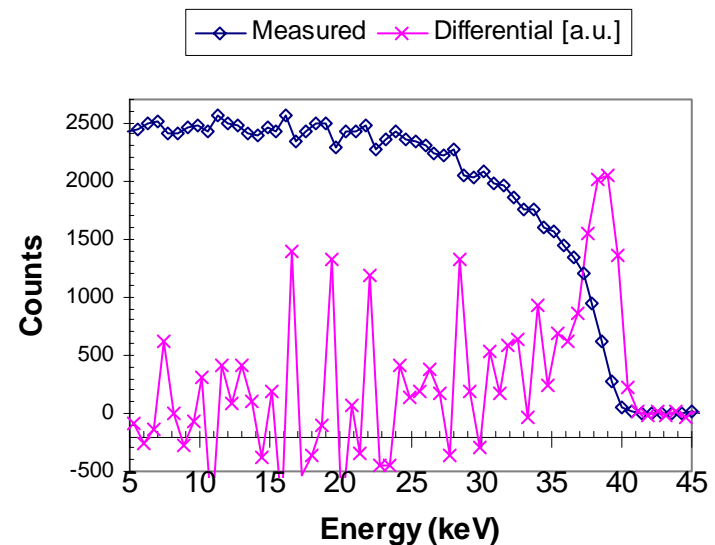
# Measured cumulative spectra

- Narrow 40 keV beam centred on one pixel for 300  $\mu\text{m}$  and 700  $\mu\text{m}$  thick silicon detectors

Centred 40 keV beam on 300  $\mu\text{m}$  Si



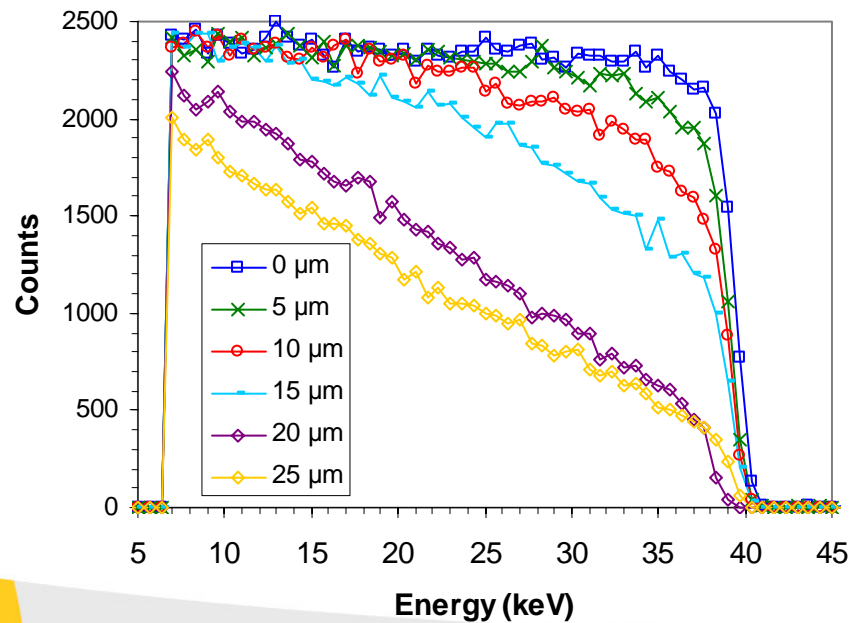
Centred 40 keV beam on 700  $\mu\text{m}$  Si



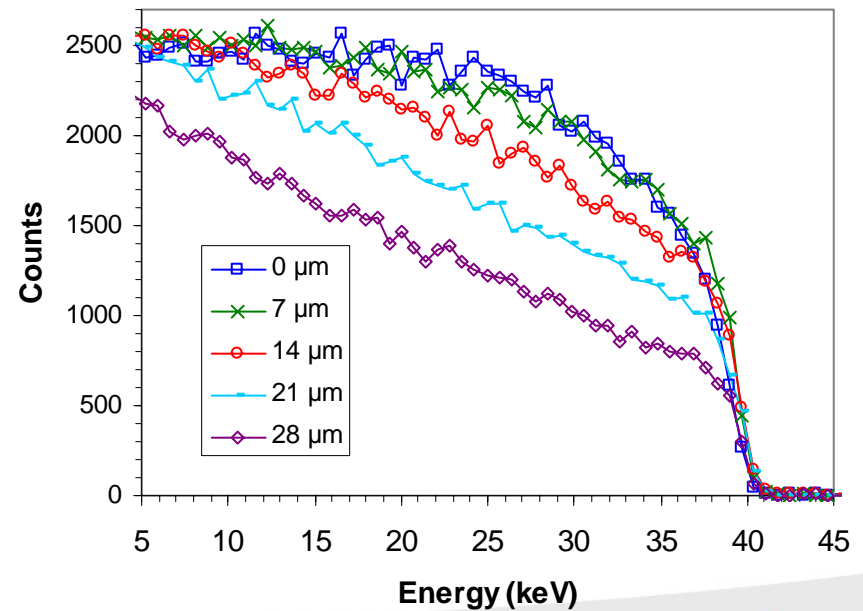
# Scanning the beam over the pixel

- Position of narrow beam relative the centre of the pixel

Scanning the beam over the pixel - 300  $\mu\text{m}$  Si

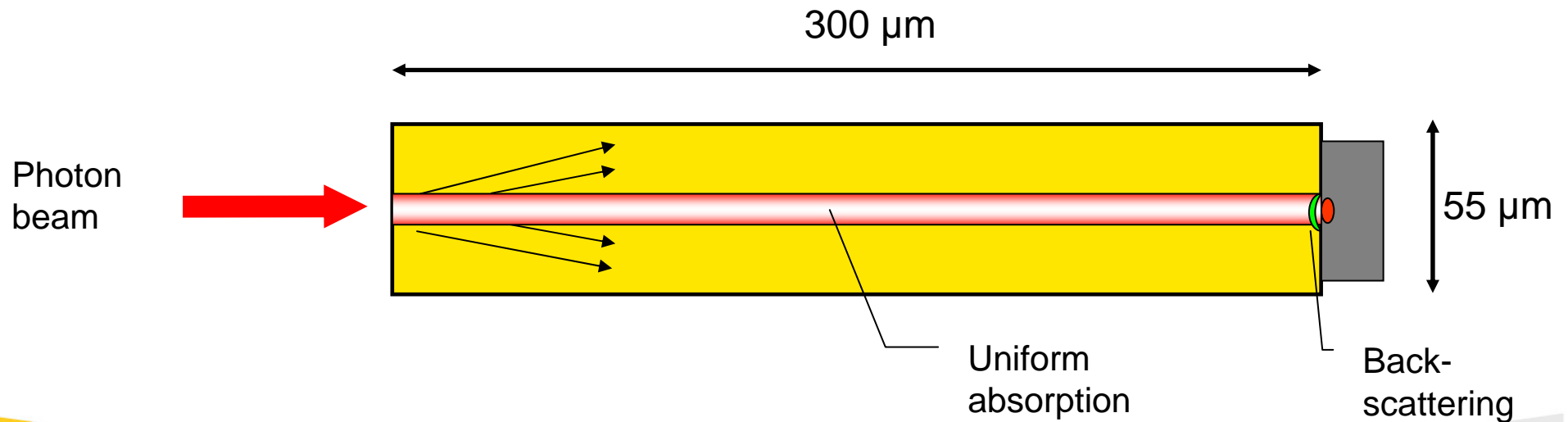


Scanning the beam over the pixel - 700  $\mu\text{m}$  Si



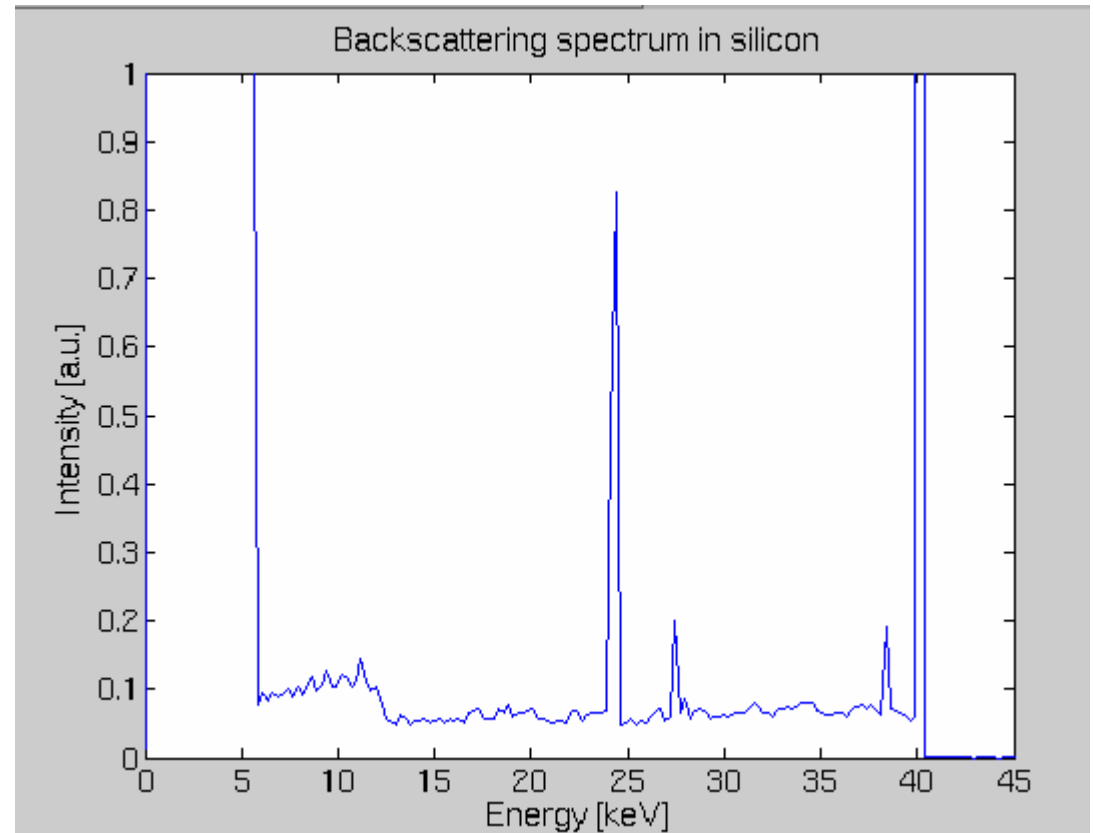
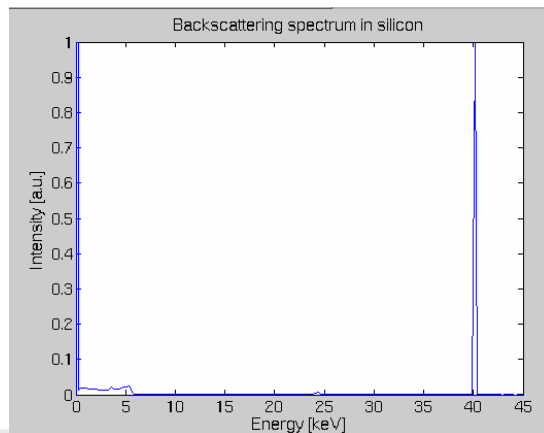
# Simulation

- MCNP for simulation of photon absorption
- In house code for Monte Carlo charge transport simulation



# Backscattering

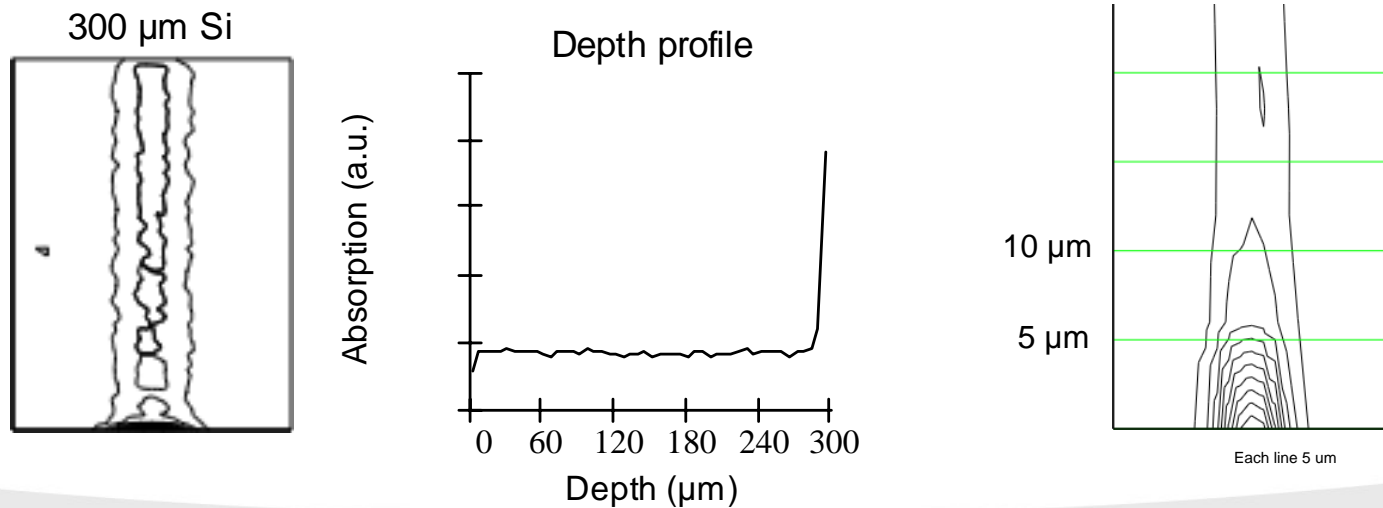
- Spectrum from MCNP
  - Backscattered photons from the bump-bonding distributed between 5 and 40 keV





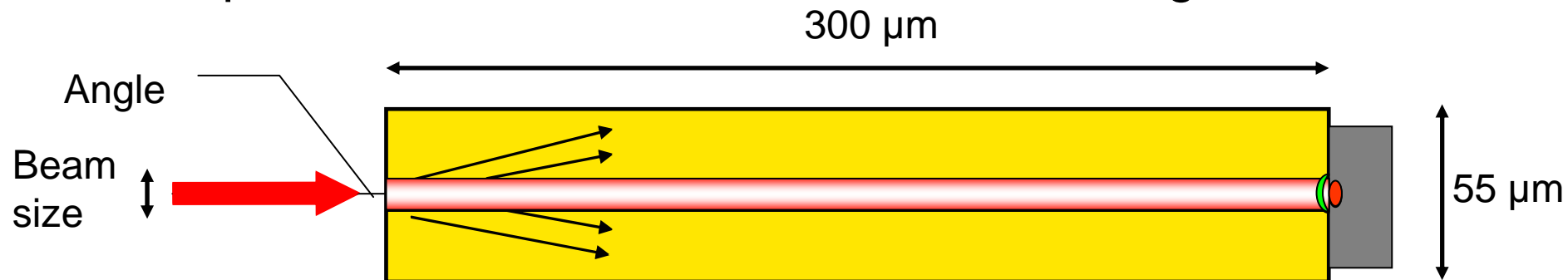
# Deposition of backscattering

- Absorption profiles
  - The backscattered photons are absorbed close to the bump bond



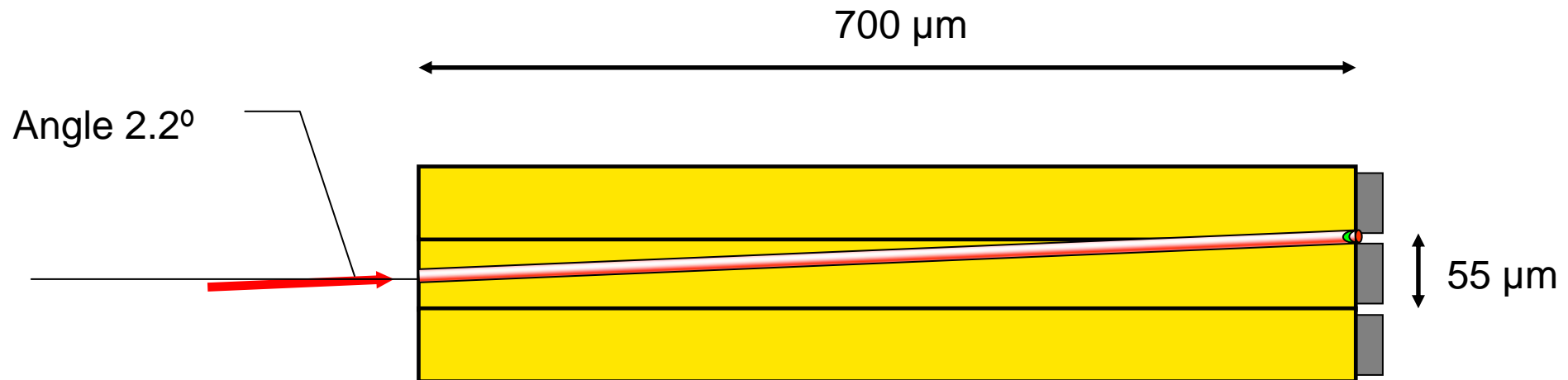
# Simulation conditions

- Input to charge transport simulation (GEMS):
  - Photon spectrum
  - Distribution of positions for photon absorption
  - Readout noise 80 e
- Varied parameters are beam size and beam angle



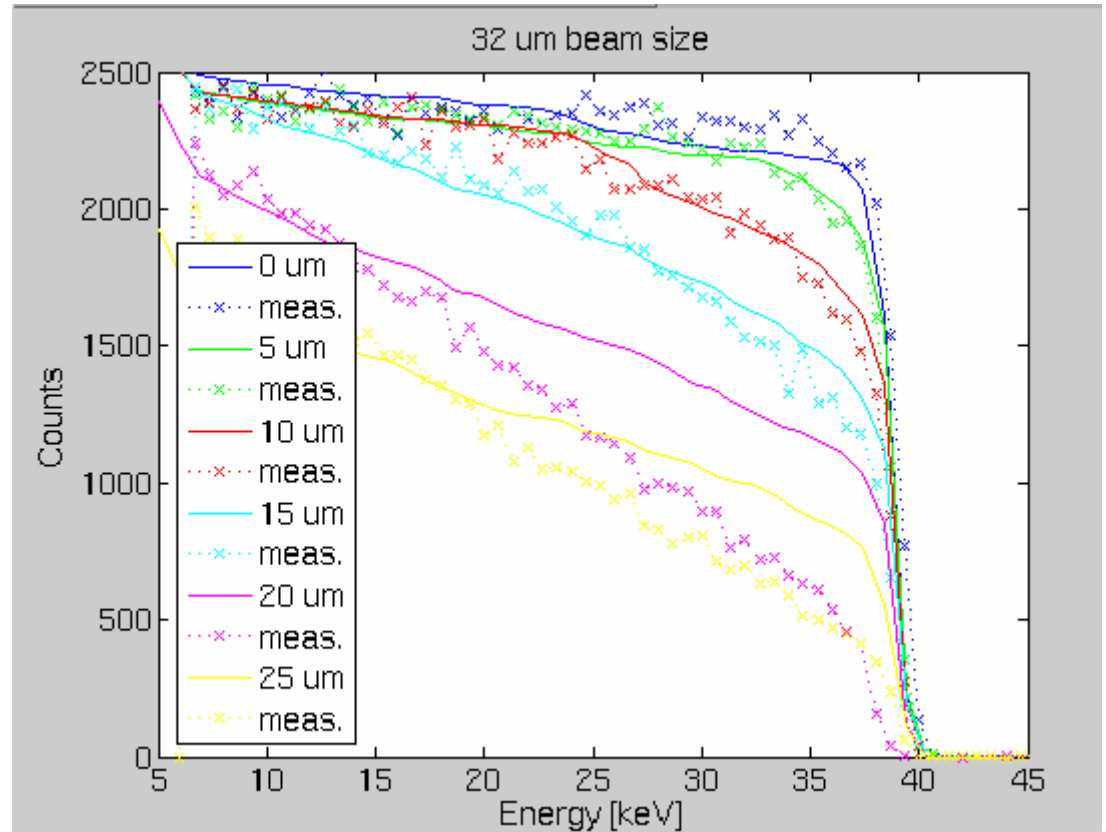
# Beam alignment

- Vertical alignment is very important for thick detectors
  - Example: 700  $\mu\text{m}$  thick detector with  $2.2^\circ$  misalignment



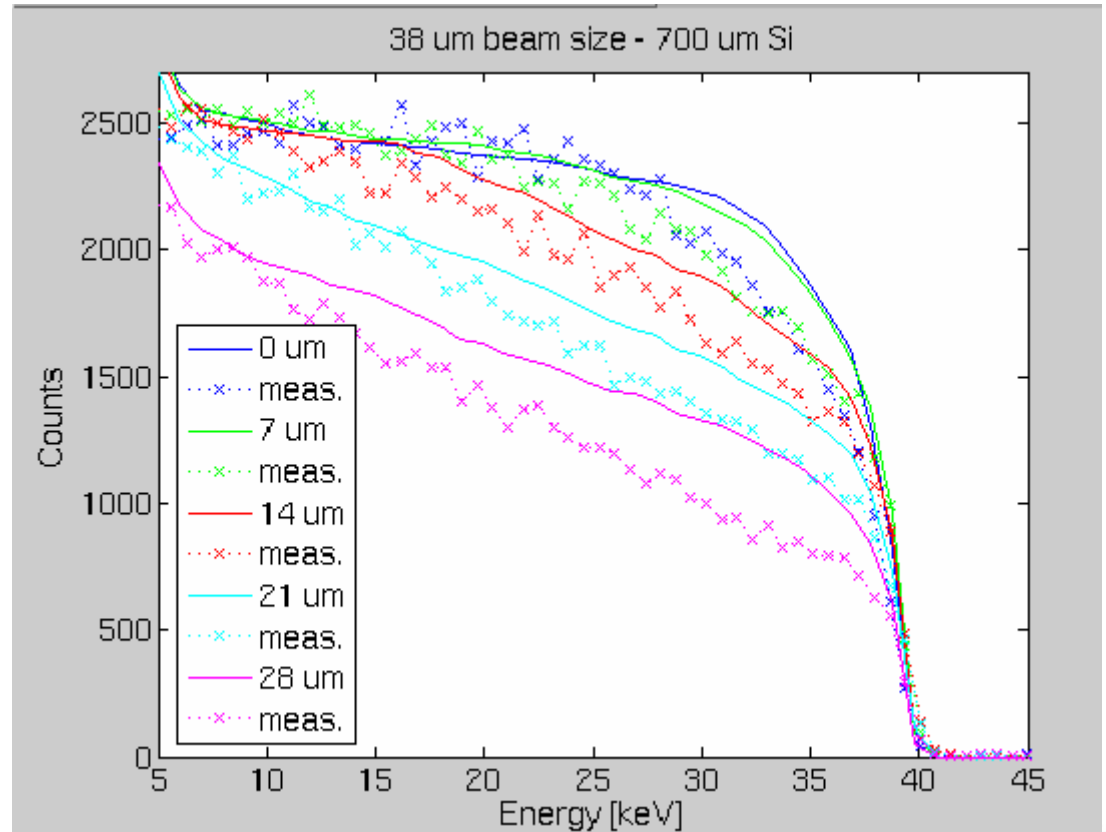
# Simulation result – 300 $\mu\text{m}$ Si

- Simulation (lines) less position sensitive than measurements (x)
- Increased beam size gives better agreement



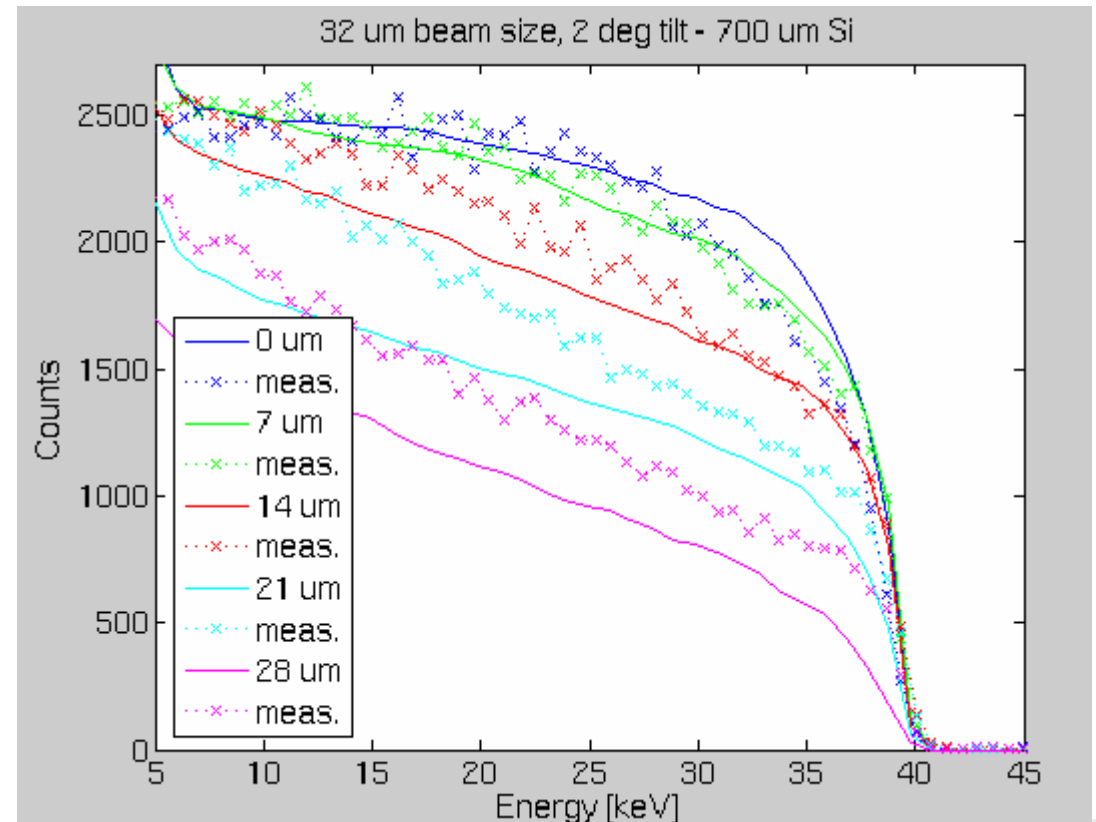
# Simulation result – 700 $\mu\text{m}$ Si

- Thicker detector
  - Needs wider beam for agreement
  - Might indicate a tilted beam



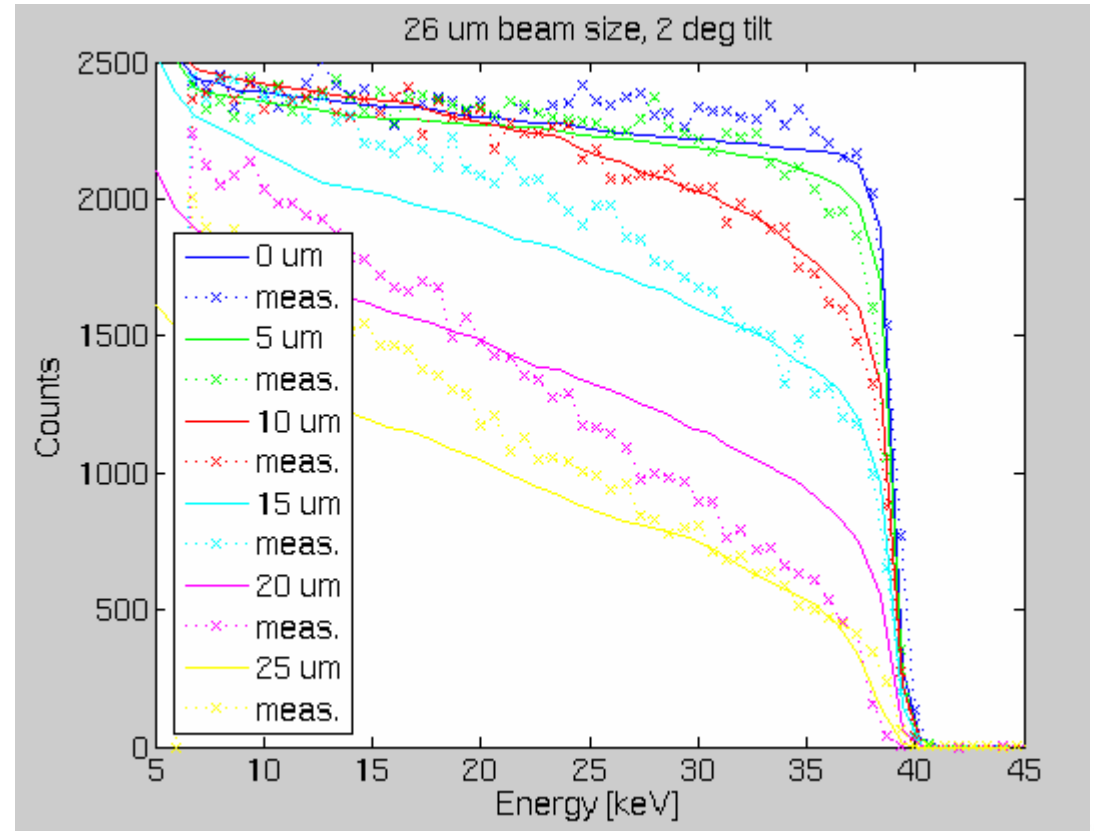
# Result – 2° tilted beam on 700 μm

- Tilted beam simulated
  - Narrower beam size
  - Agreement between simulated and measured spectra improved



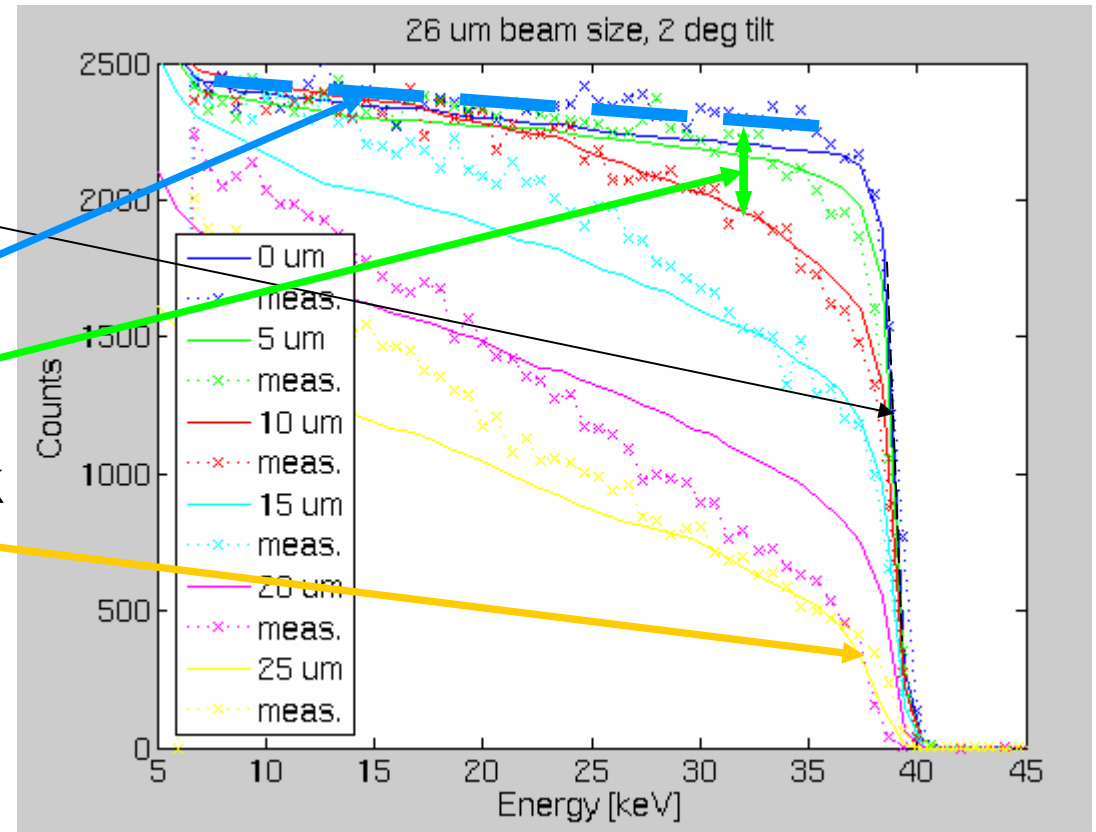
# Result – 2° tilted beam on 300 μm

- Tilted beam for 300 μm
  - Agreement between simulated and measured spectra improved



# What is agreement?

- Source and readout noise
- Low energy counts
- Position sensitivity
- Early bending and peak shift





# Conclusions

- Measurements to achieve position dependent spectra from a narrow monochrome source are done with Medipix2 with 300  $\mu\text{m}$  and 700  $\mu\text{m}$  thick silicon detectors
- Detailed characterization of measurement setup and results are achieved, by comparison between measurements and simulations
- It is shown that tilting of sample can significantly influence the apparent beam size
  - Detector alignment will be a problem for high resolution X-ray imaging systems containing thick detectors