MedAustron (22nd March 2018) beam test analysis

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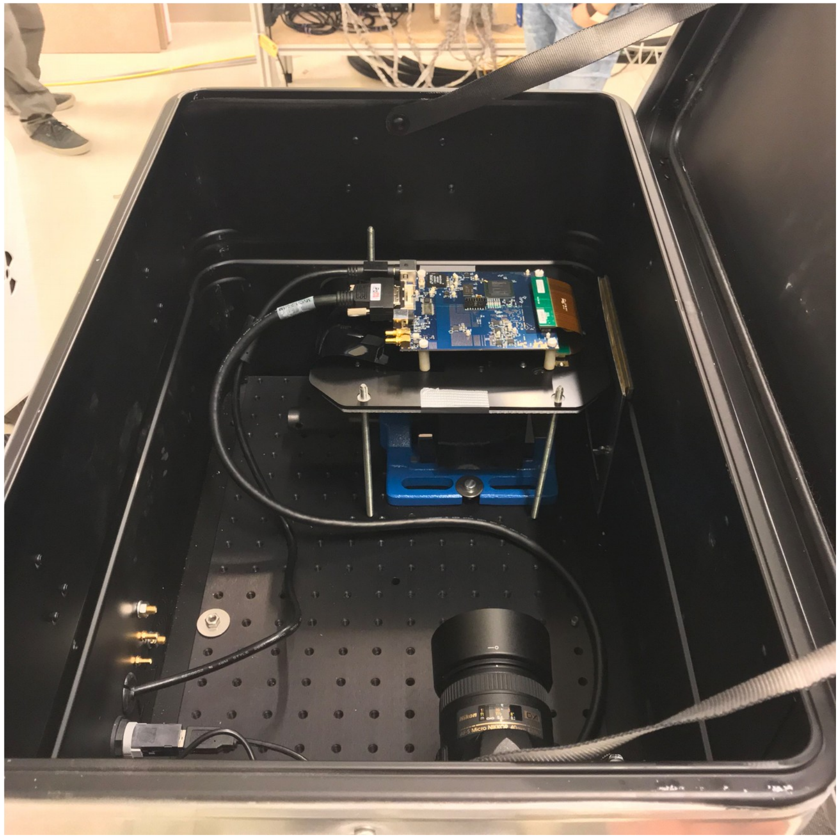
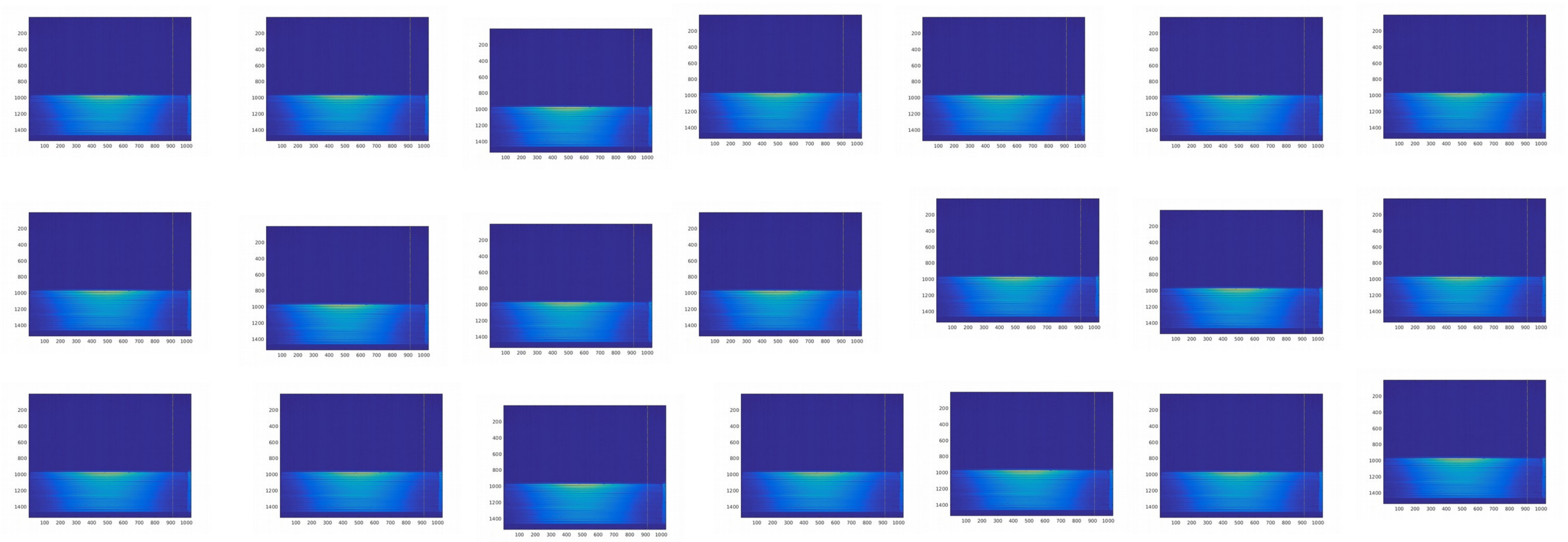
Setup

- Beam test of range calorimeter prototype
- Scintillator stack + ISDI sensor + DSLR camera
- Performed tests: scan over intensities, energies and beam positions



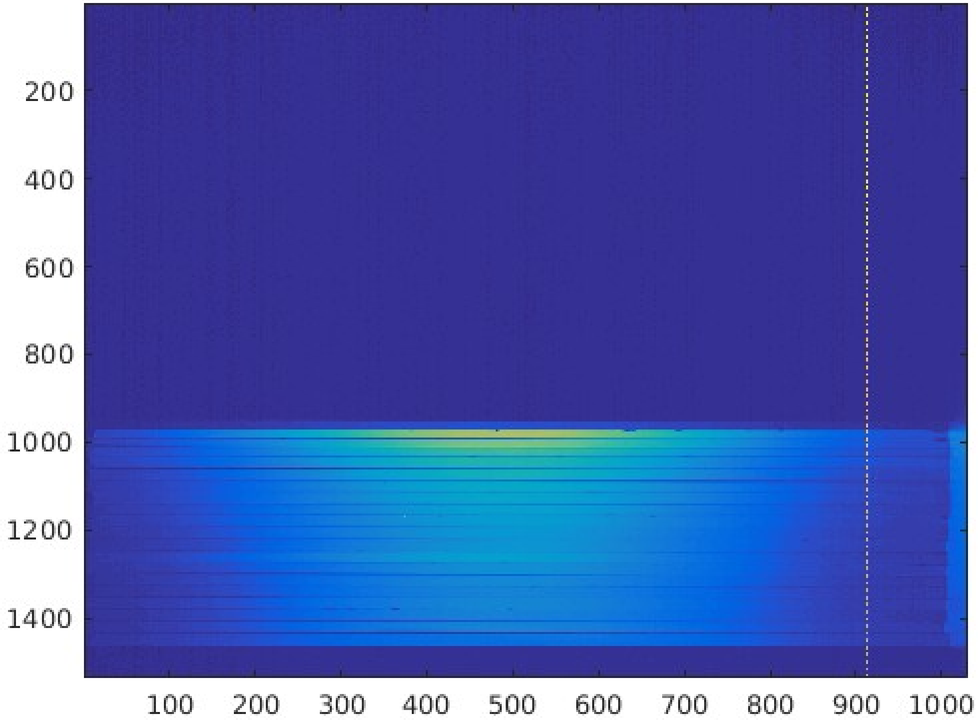
Analysis procedure

- Start with set of 21 raw .tif images in one run



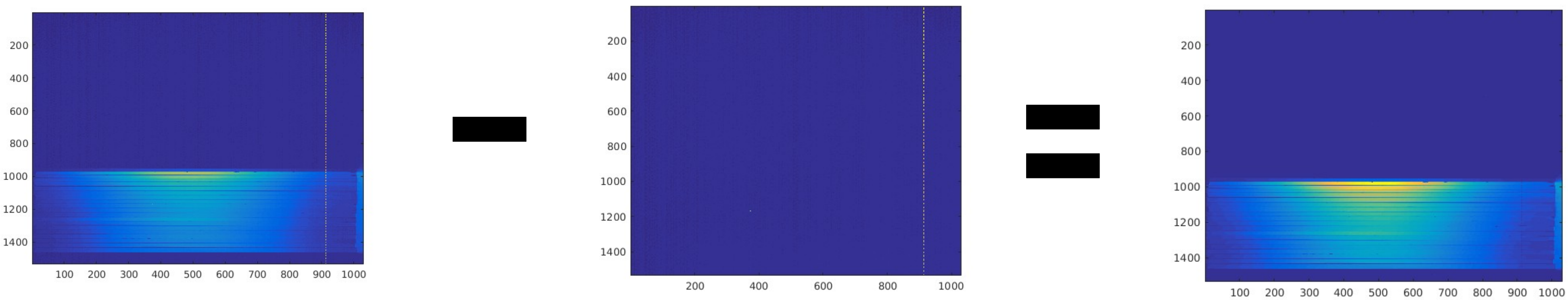
Analysis procedure

- Merge them into one .tif image



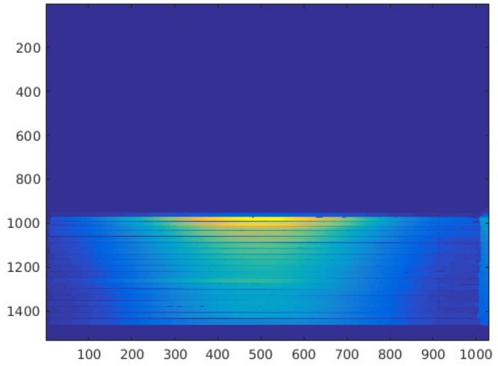
Analysis procedure

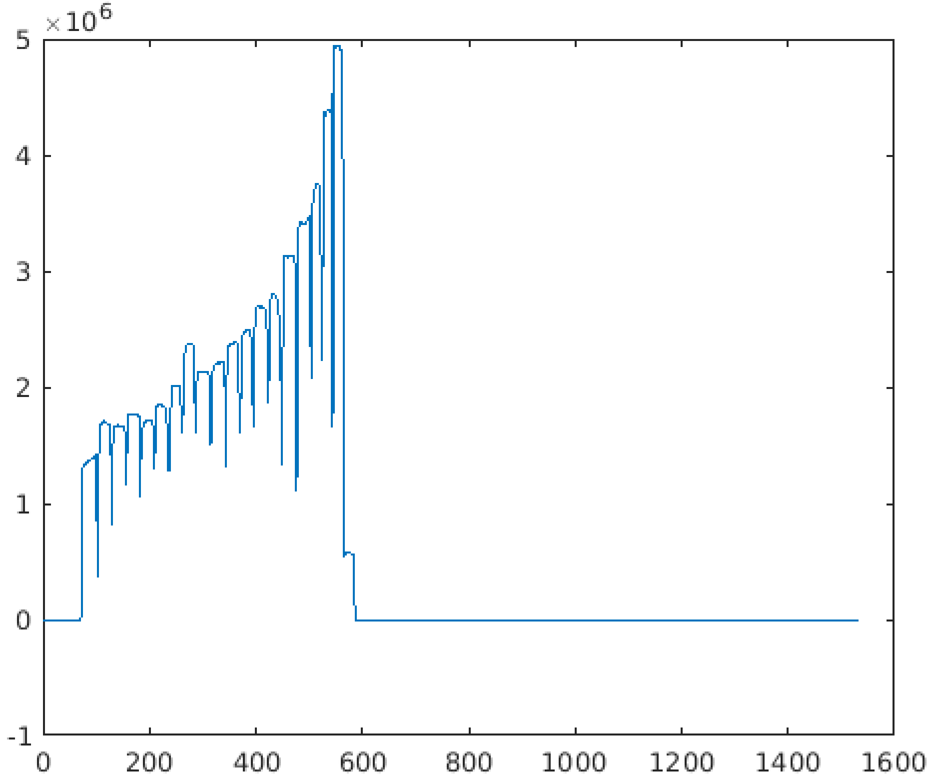
- Subtract the background (Run0003: no beam)



Analysis procedure

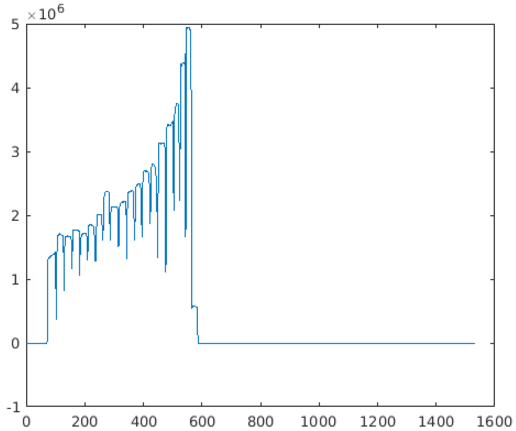
- Project image on beam axis





Analysis procedure

- Divide by calibration run (Run0021: high energy beam straight through the scintillator stack)



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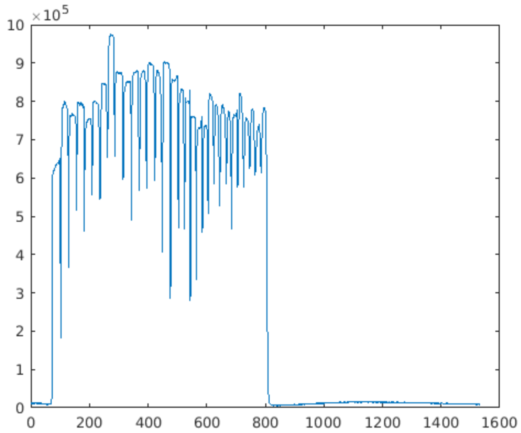

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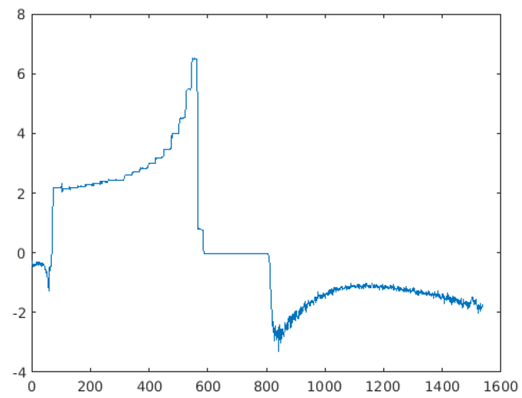
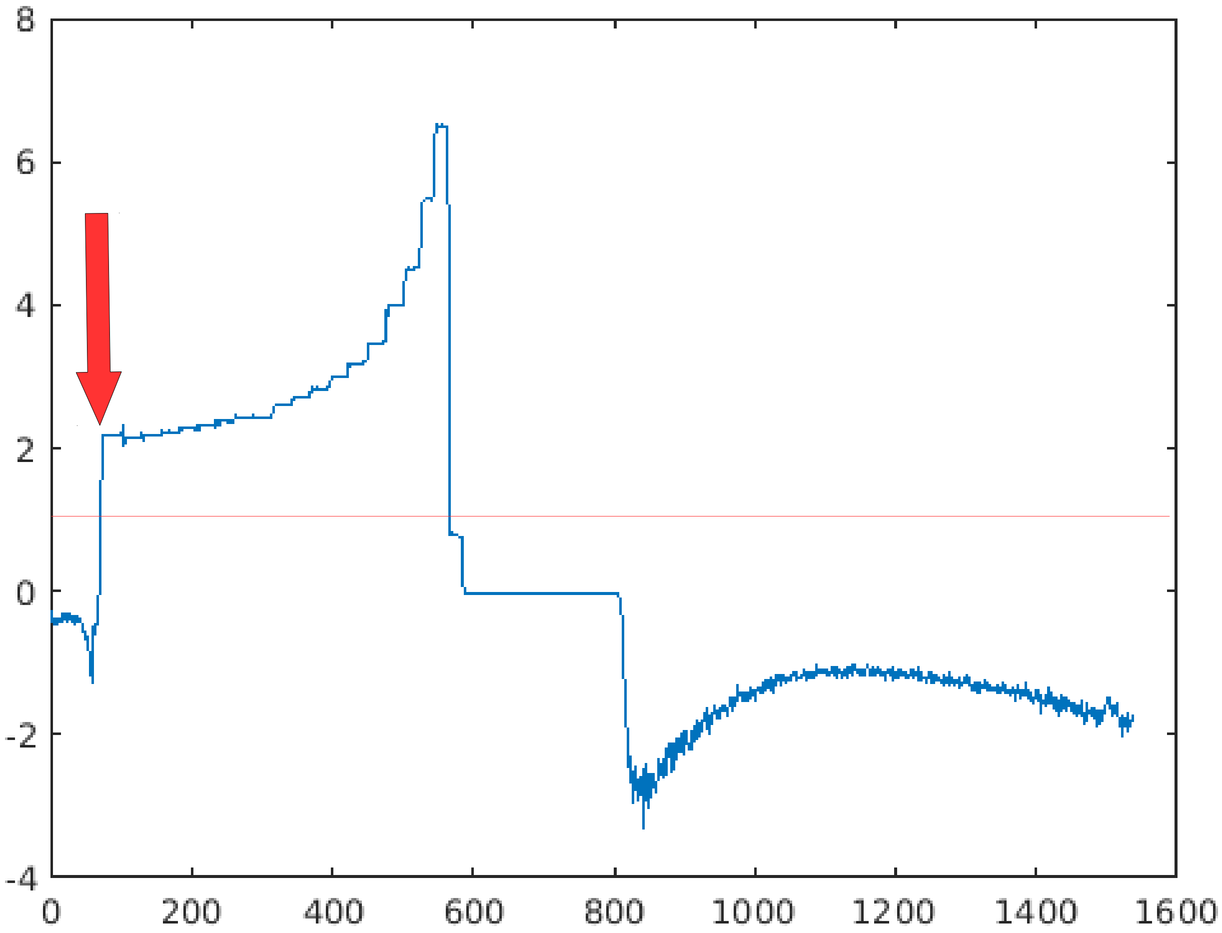


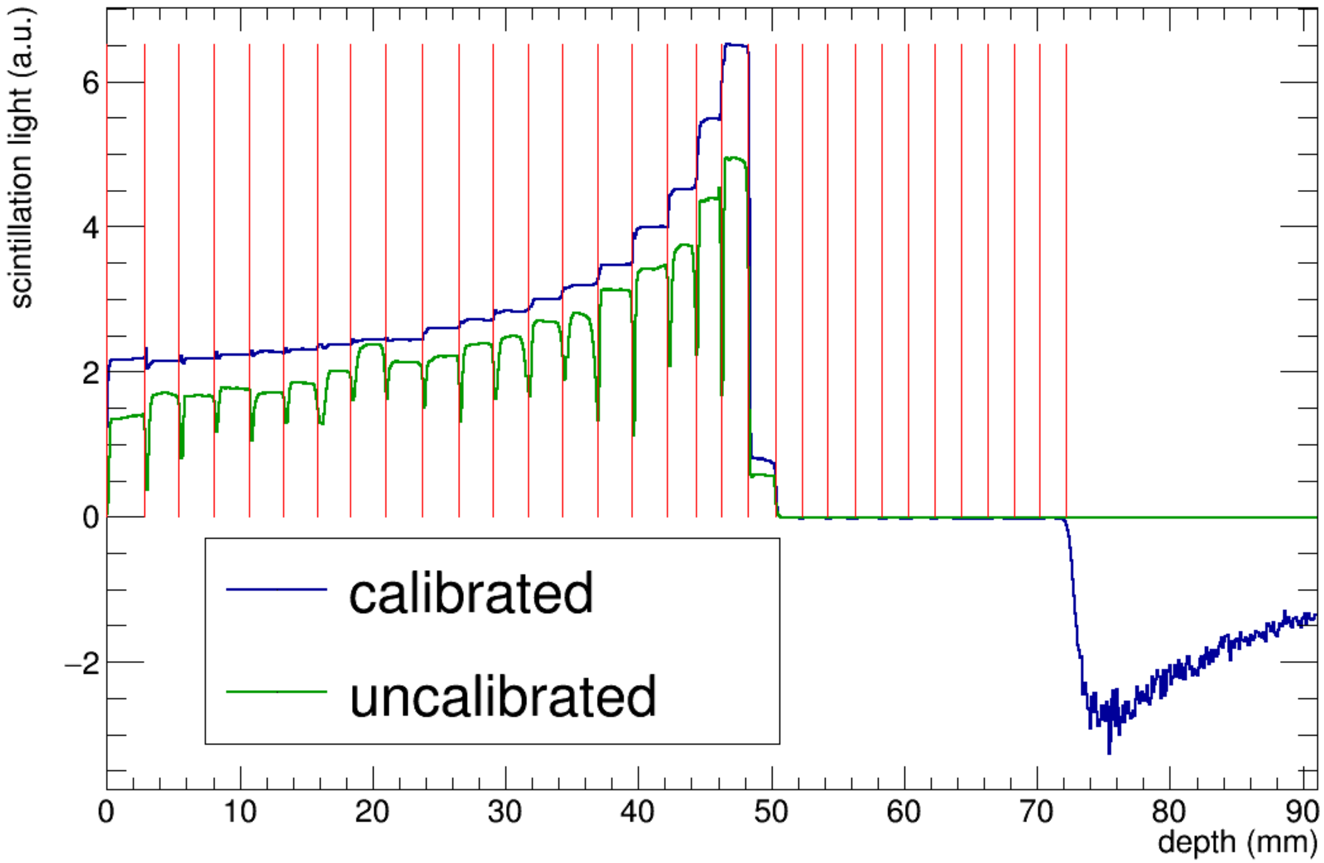
Analysis procedure

- Choose depth at which the first sheet reaches half of its centre value as start depth (x = 0 mm)



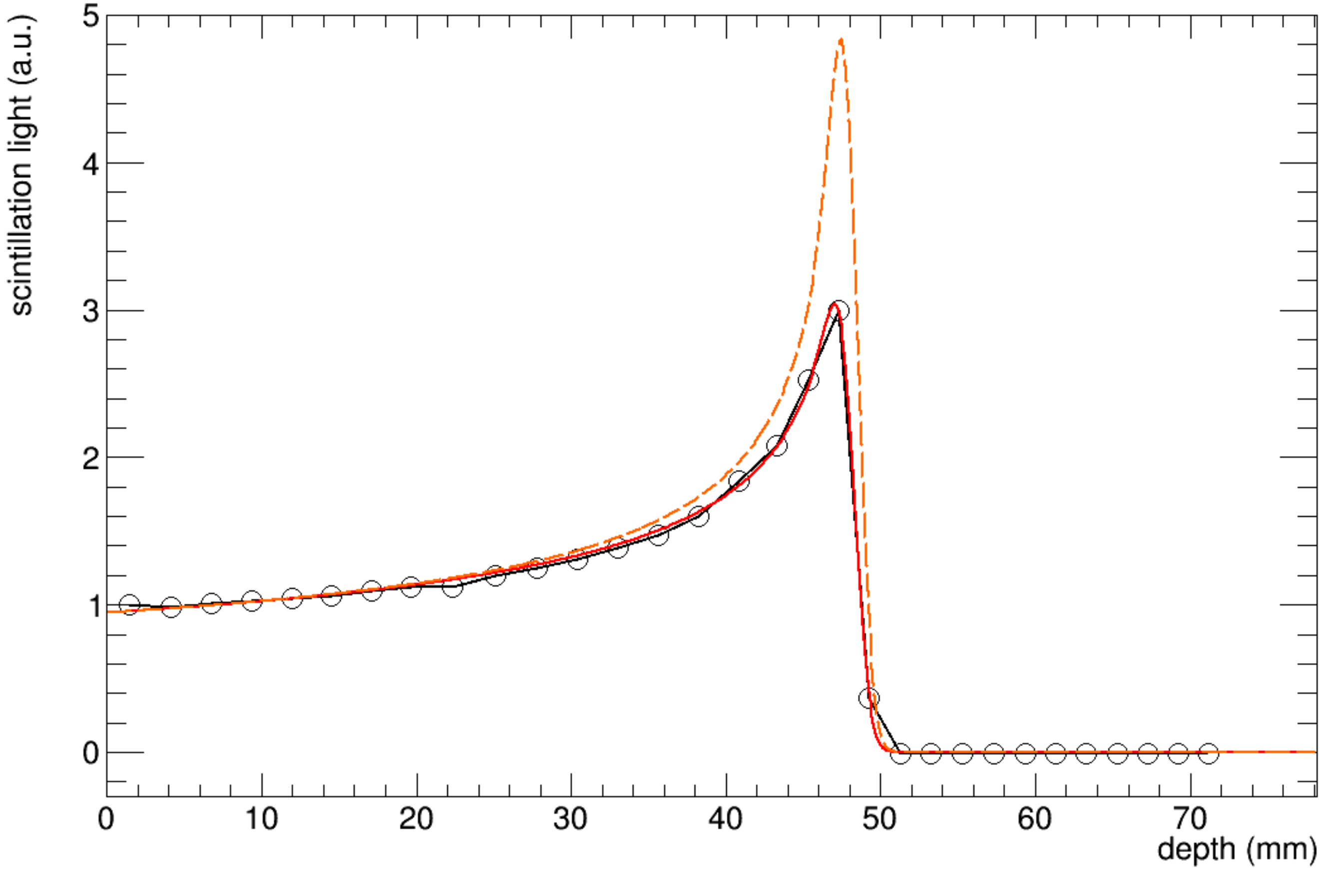
Analysis procedure

- Choose pixel size such that the measured sheet edges overlap with visible sheet edges (best match: pixel size = 98 um; offcial = 100 um)



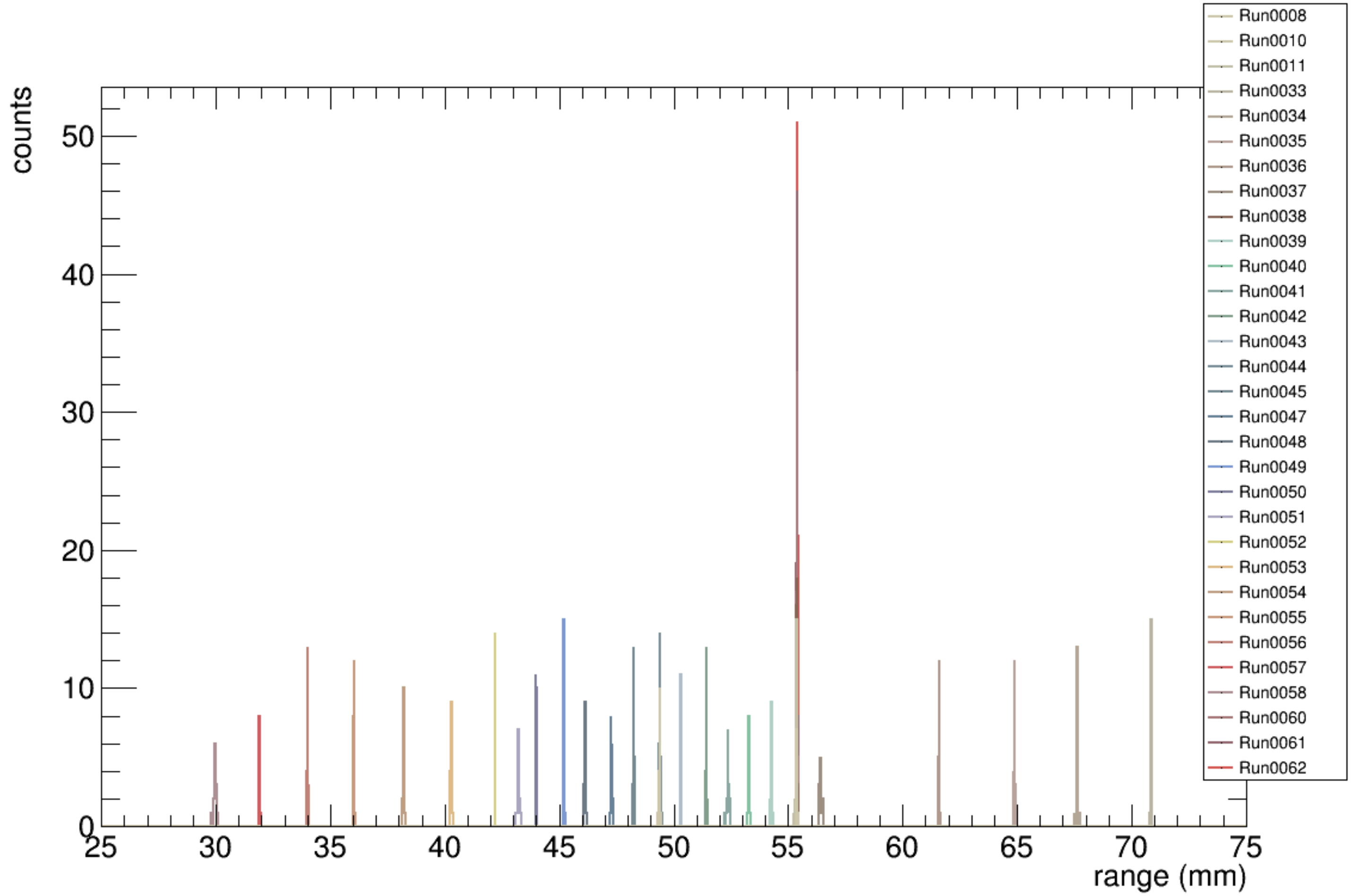
Analysis procedure

- Average value in centre of each sheet (0.5mm away from sheet edges) and fit quenched Bragg curve + draw reconstructed Bragg curve

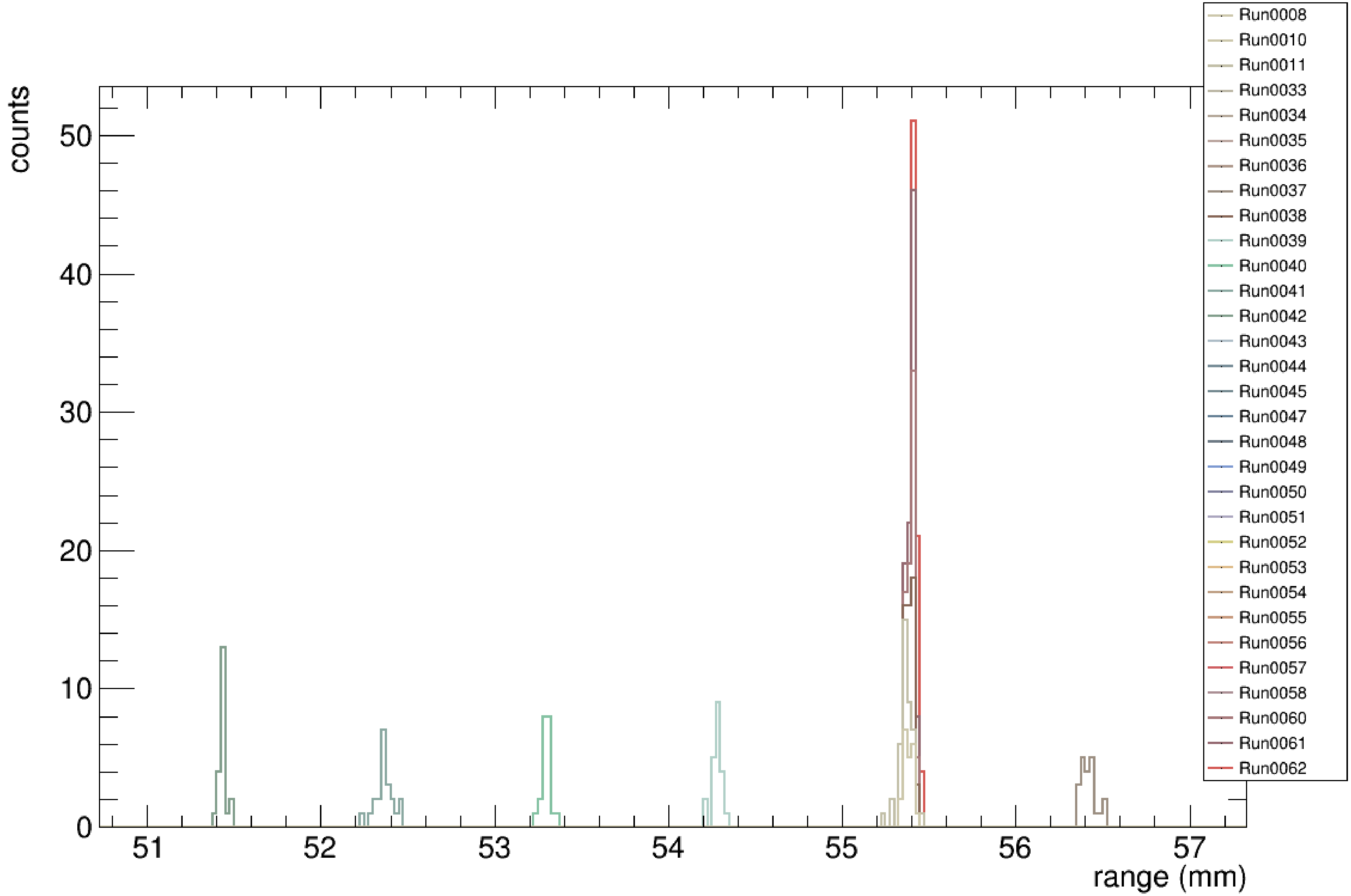


Range reconstruction

- Fit 600 single frames, reconstruct range and plot in histogram
- Well distinct sharp peaks show precision and reproducibility of procedure

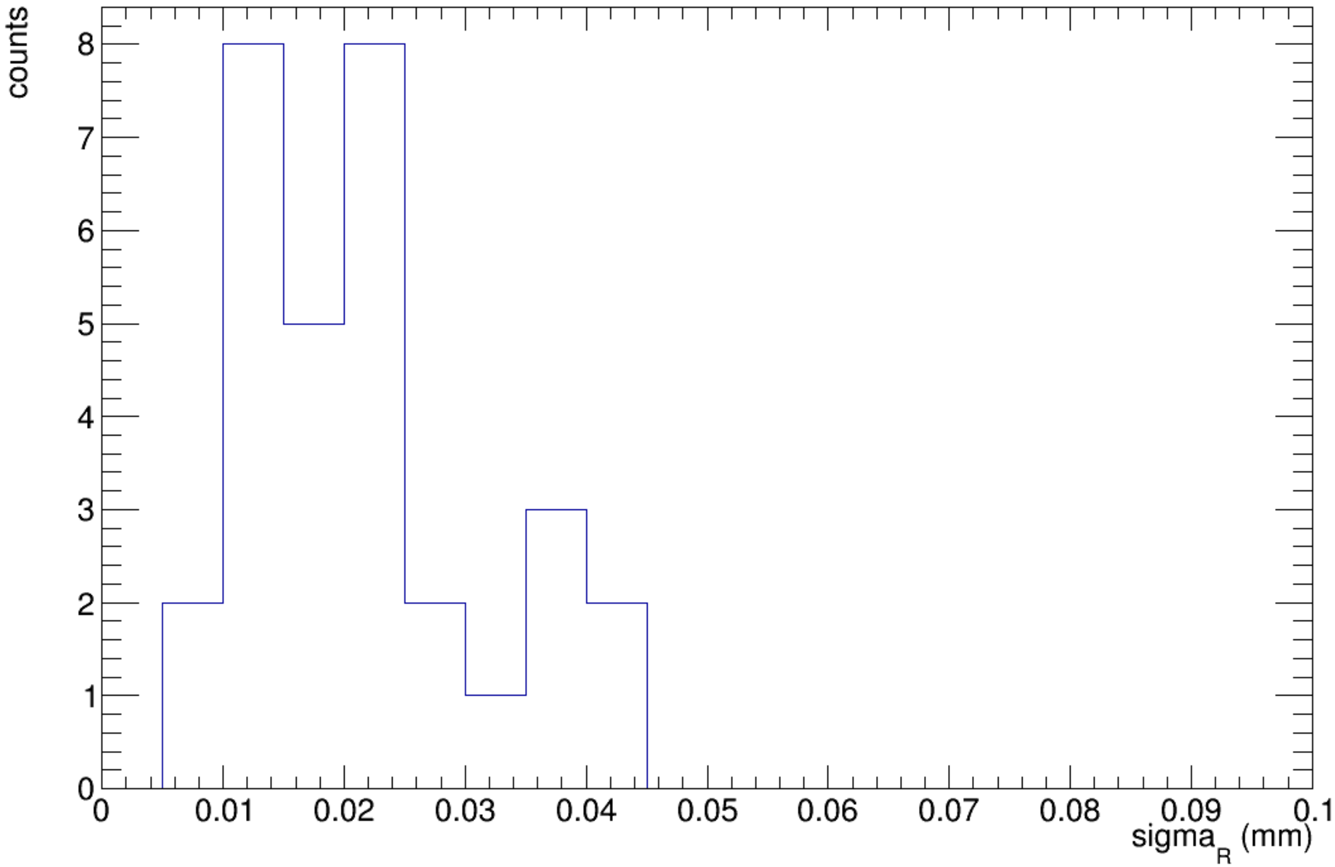


Range reconstruction



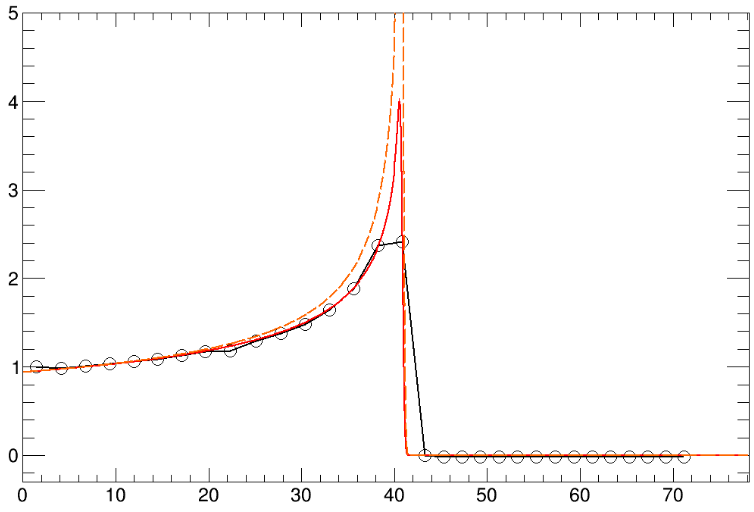
Range reconstruction

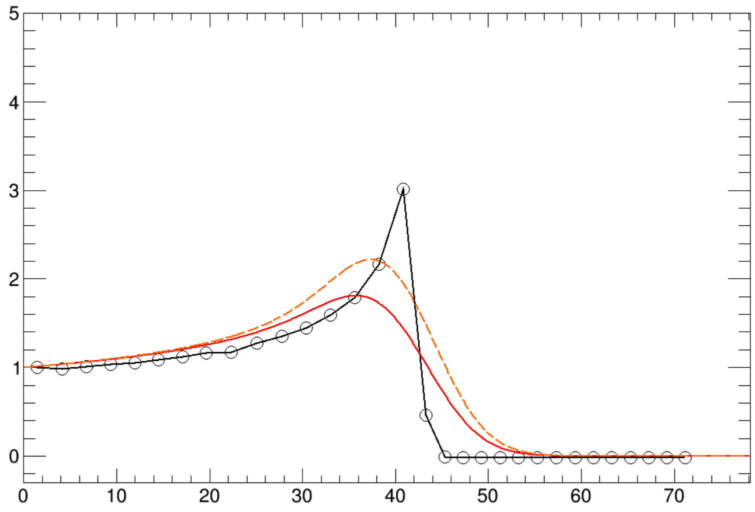
- I calculated the standard deviation for each run (each range)
- The sigma of all Runs are below 0.05 mm !



Range reconstruction

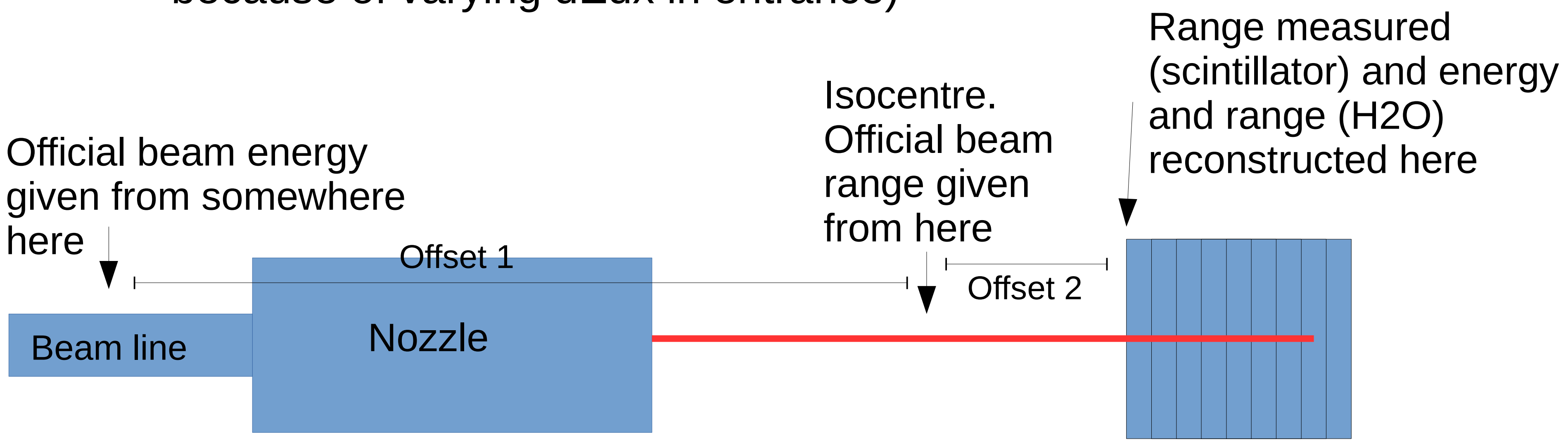
- However, sometimes there are still problems with the fit (estimated occurrence 1/10)
- The width of the quenched Bragg curve can fail to be fitted. Sometimes there seems to be no stable optimisation minimum
- This also affects the range reconstruction
- Problem sometimes gets worse if I restrict the fit parameter to a certain range of values





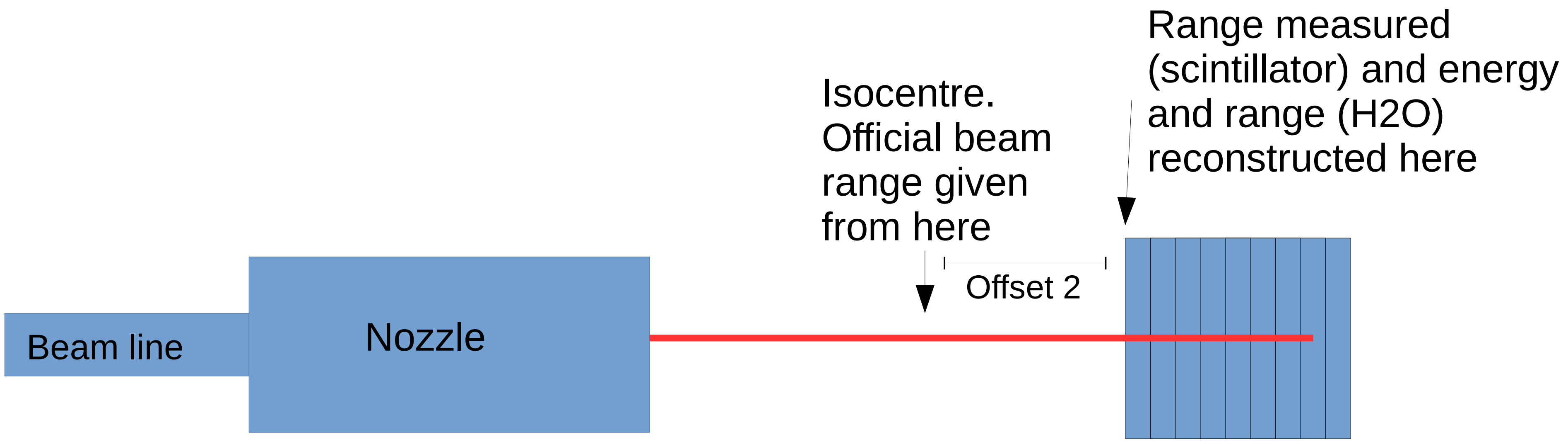
Range reconstruction

- Range is fit parameter, i.e. range is in scintillator (not water)
- How to obtain range in water? → not trivial because there are two unknown offsets
  - Offset 1 between official range measurement of MedAustron and literature range data
  - Offset 2 between official range measurement of MedAustron and our own range measurement (water equivalent thickness not constant because of varying dEdx in entrance)



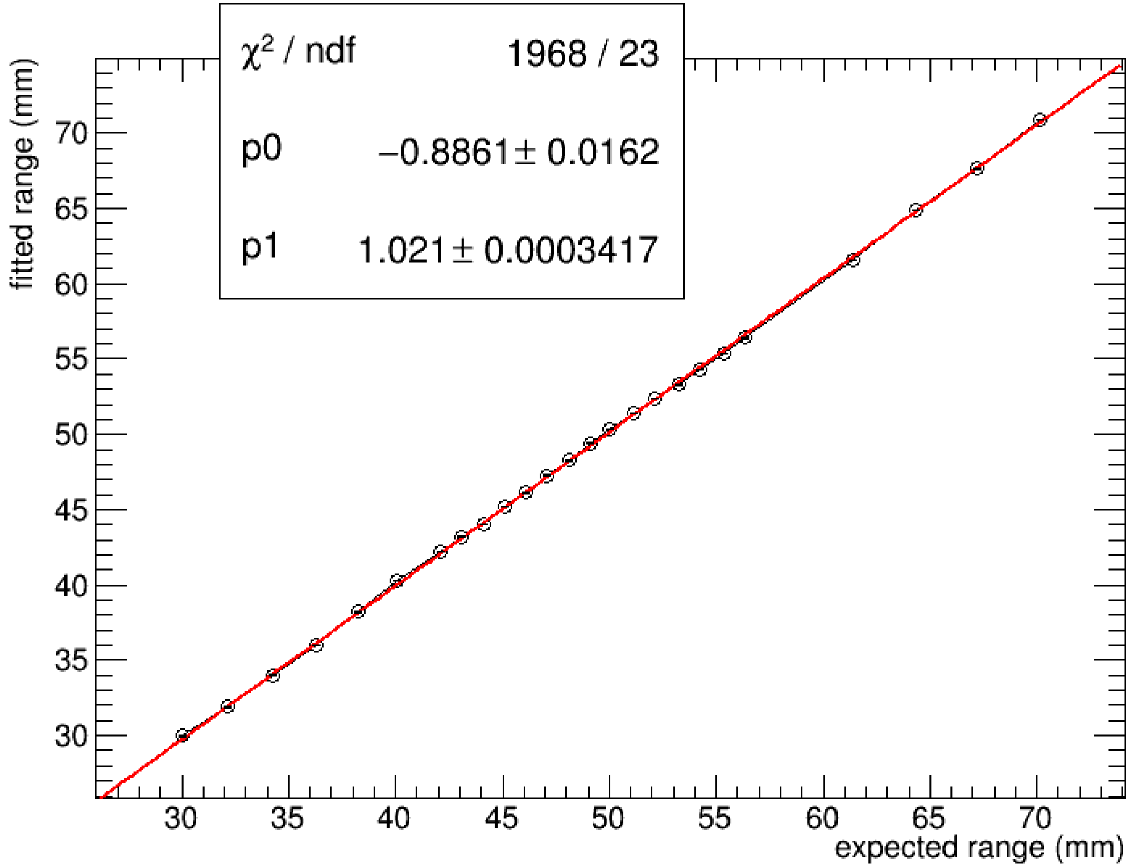
Range reconstruction

- Reconstruct range relative to start of scintillator using simulated curves of R(E) in scintillator and in water
- Simulation might be wrong: Material in simulation is PVT not PS and density might be slightly off as well
- Expected outcome: reconstructed range in water is always slightly lower than the official range. However, this difference decreases with increasing beam energy as dEdx in entrance decreases.



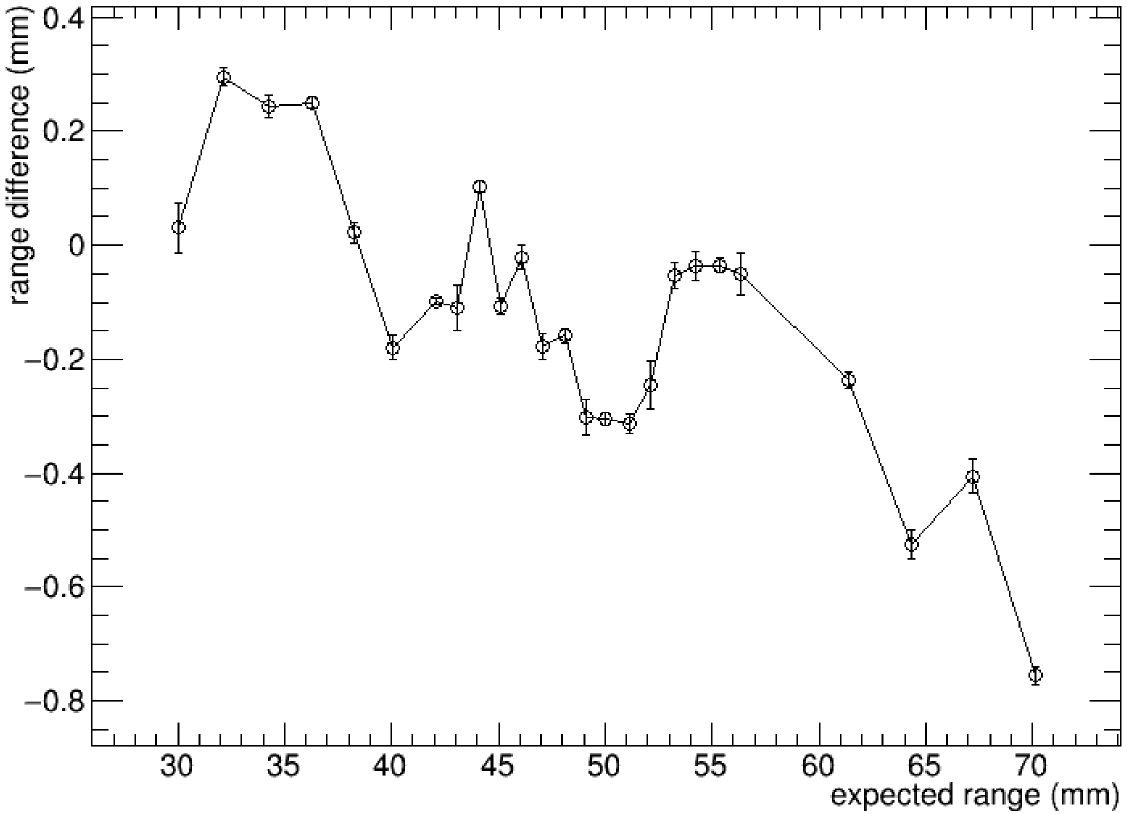
Range reconstruction

- Plot fitted vs expected range
- Slope is close to 1 but >1, indicating the reconstructed range is overestimated at high beam energies
- Offset p0 is subject to strong variation! But if stable it could be interpreted as Offset 2 (water equivalent thickness between isocentre and start of scintillator)

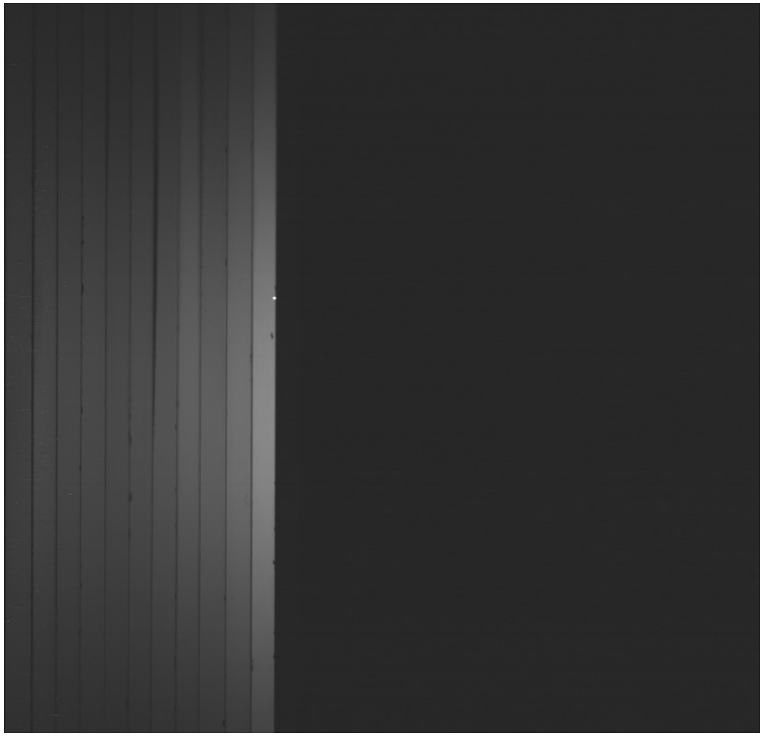


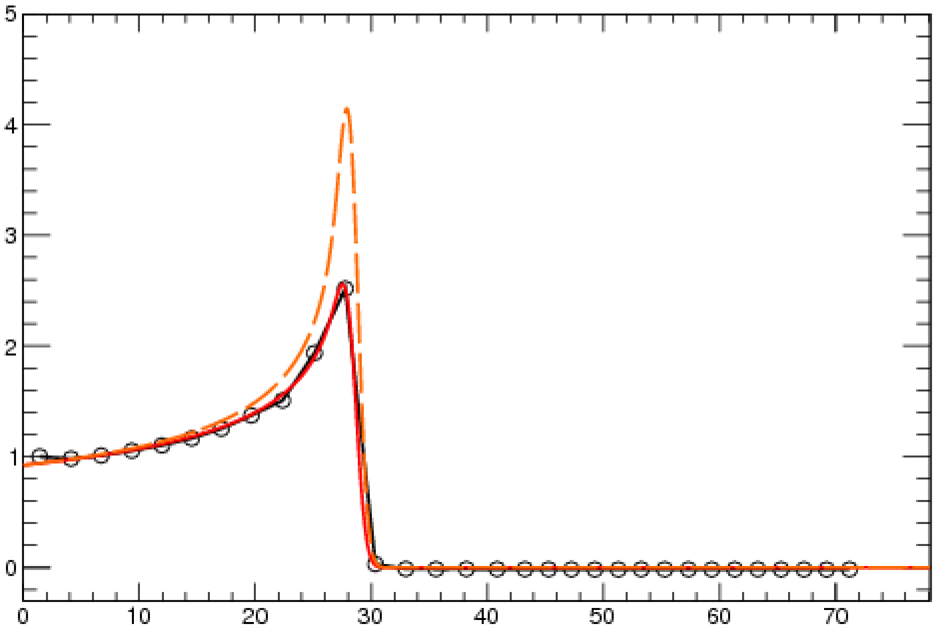
Range reconstruction

- Plot (expected range – reconstructed range) vs expected range, which is equal to offset 2
- It indicates a negative offset 2, which might be unrealistic (verify position of isocentre)
- Expected tendency of decreasing water equivalent thickness of offset 2 is observed



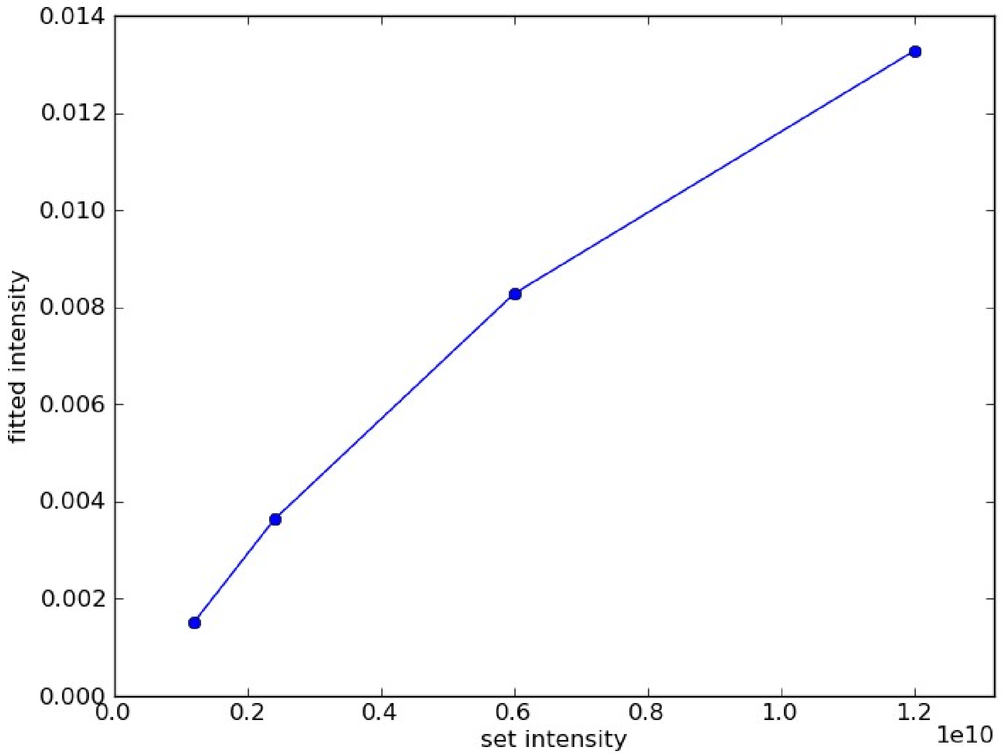
Energy scan





Intensity scan

- Plot fitted intensity vs set intensity
- Unfortunately there are not many data points and the beam is fluctuating a lot within acquisition time!
- Amplitude of fluctuation and fit error under investigation, but so far there is a hint for intensity-induced quenching



Conclusion

- Finish intensity scan analysis
- Quantify offset 2 (distance to isocentre in air + mylar window)
- Come up with a reliable way of reconstructing the range in water
- Make some final pretty plots
- Start Clatterbridge analysis
- Upcoming events:
  - PART talk 4 May
  - PTCOG poster 24 May
  - OMA topical workshop Geneva: poster & talk 4 June
  - ENLIGHT talk 26 June