Telescope geometry optimisation

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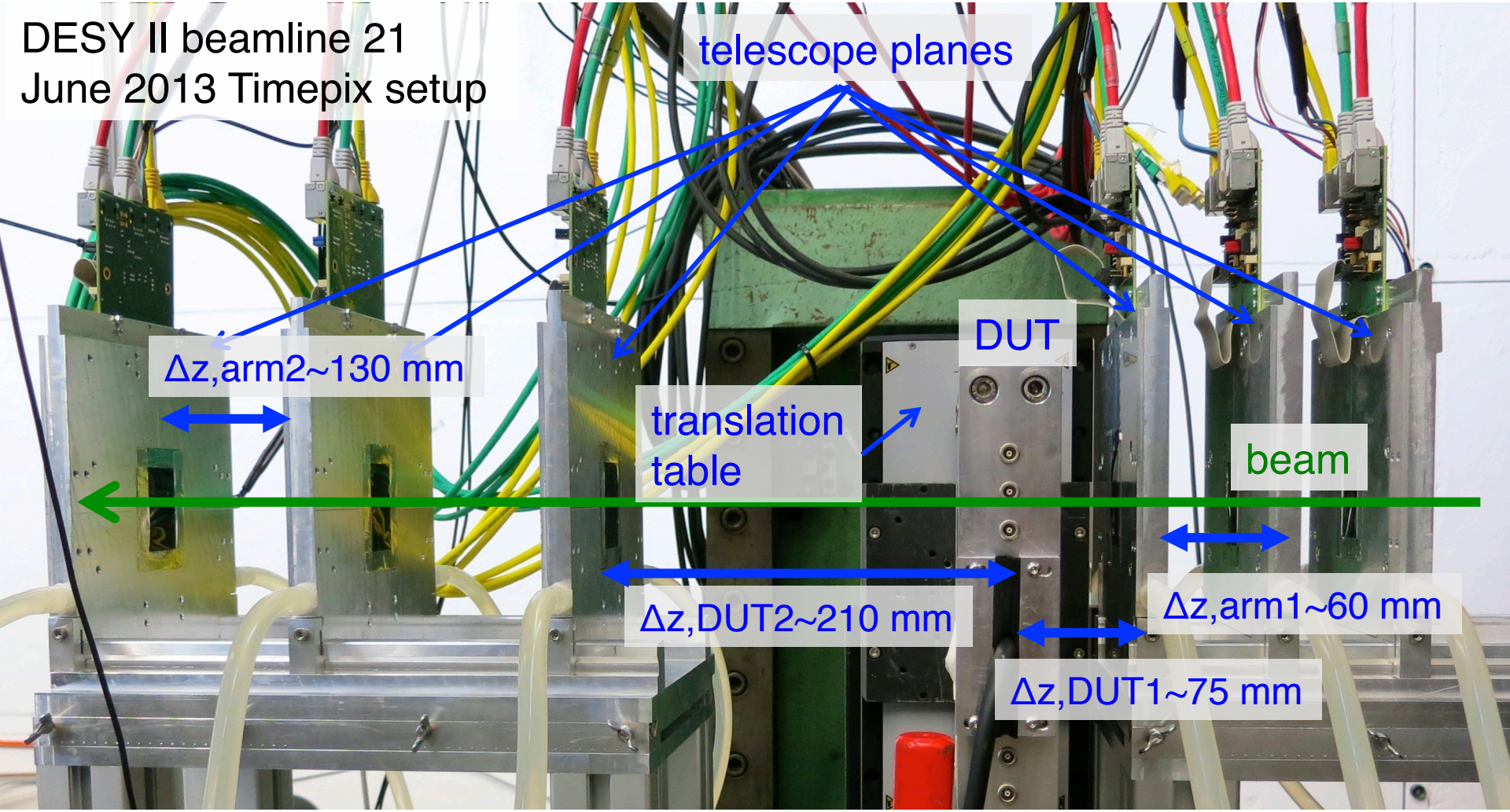
Example: sub-optimal telescope setup

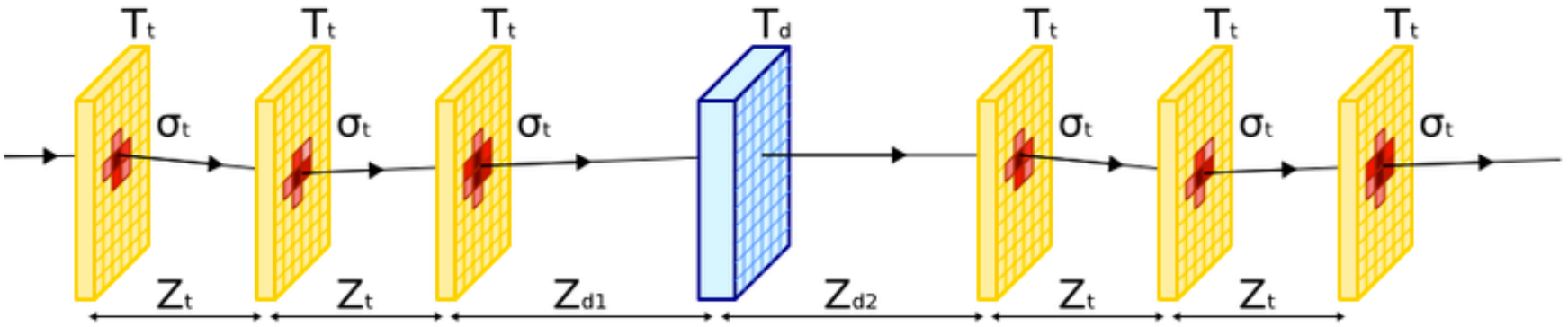


- Almost arbitrary plane spacing, DUT placement constrained by translation table
- What is the prediction resolution at the DUT? How can we optimise the geometry?

Telescope resolution estimates

•Measured residuals in DUT are convolution of telescope and DUT resolutions:

$\sigma_{meas}^2 = \sigma_{pred,DUT}^2 + \sigma_{DUT}^2$



•Track-segments fit taking into account hits in telescope planes + multiple scattering:

→ global analytical chi2 minimisation, based on EUDET-Report-2007-01
(similar to EUTelTestFitter in EUTelescope)
contributions to chi2 from single-point resolution ($\sigma_i=\sigma_t$) and scattering $\Delta\Theta_i$

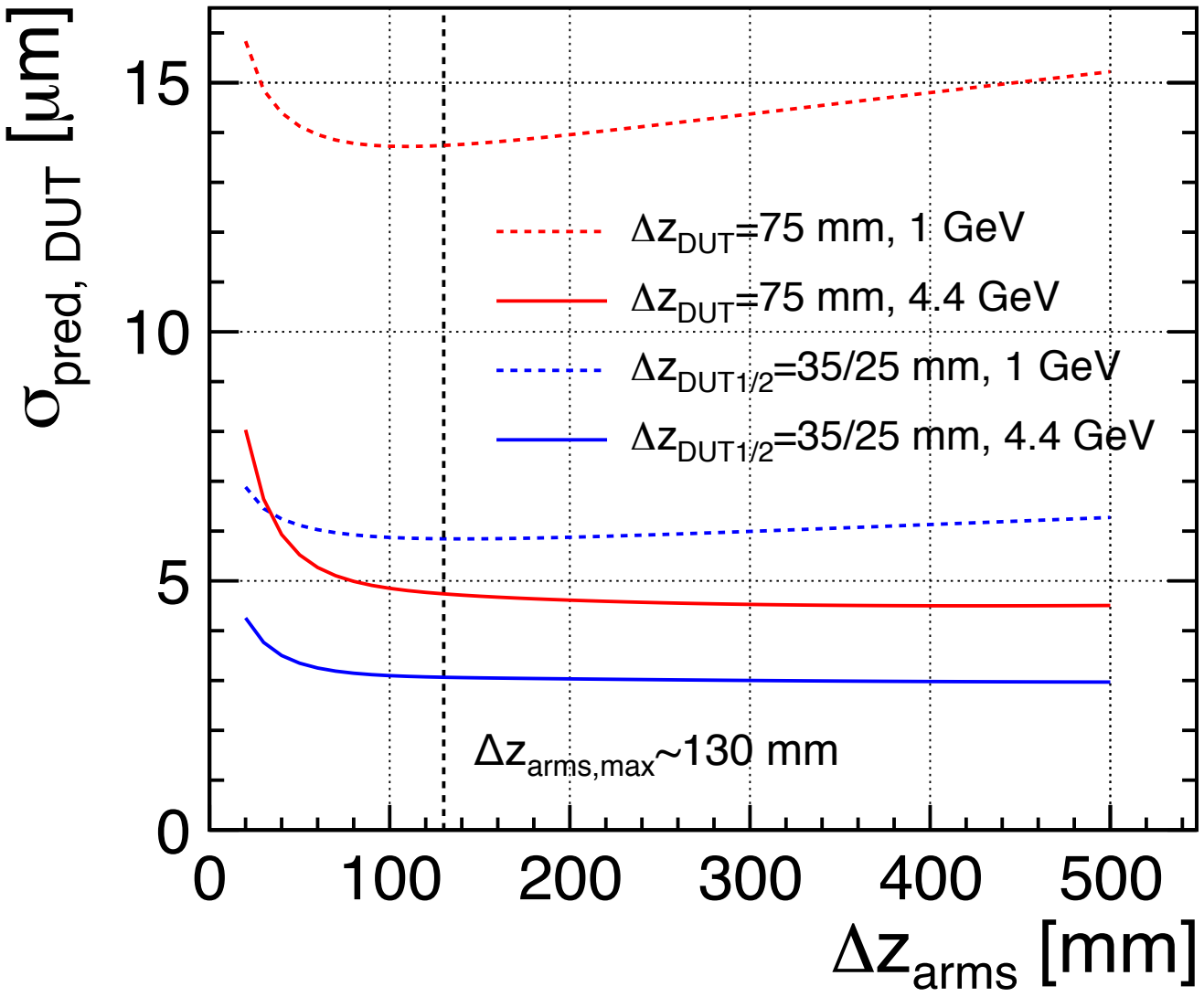
$$\Delta\chi_i^2 = \left(\frac{y_i - p_i}{\sigma_i}\right)^2\Bigg|_{i\neq i_{DUT}} + \left(\frac{\Theta_i - \Theta_{i-1}}{\Delta\Theta_i}\right)^2\Bigg|_{i\neq 1,N}$$

→ multiple scattering $\Delta\Theta_i$ according to PDG2011 + correction for air btw. planes

→ use ROOT script for inversion of 13x13 matrix (once for a given setup)

→ gives estimate of telescope prediction resolution at DUT ($\sigma_{pred,\ DUT}$)

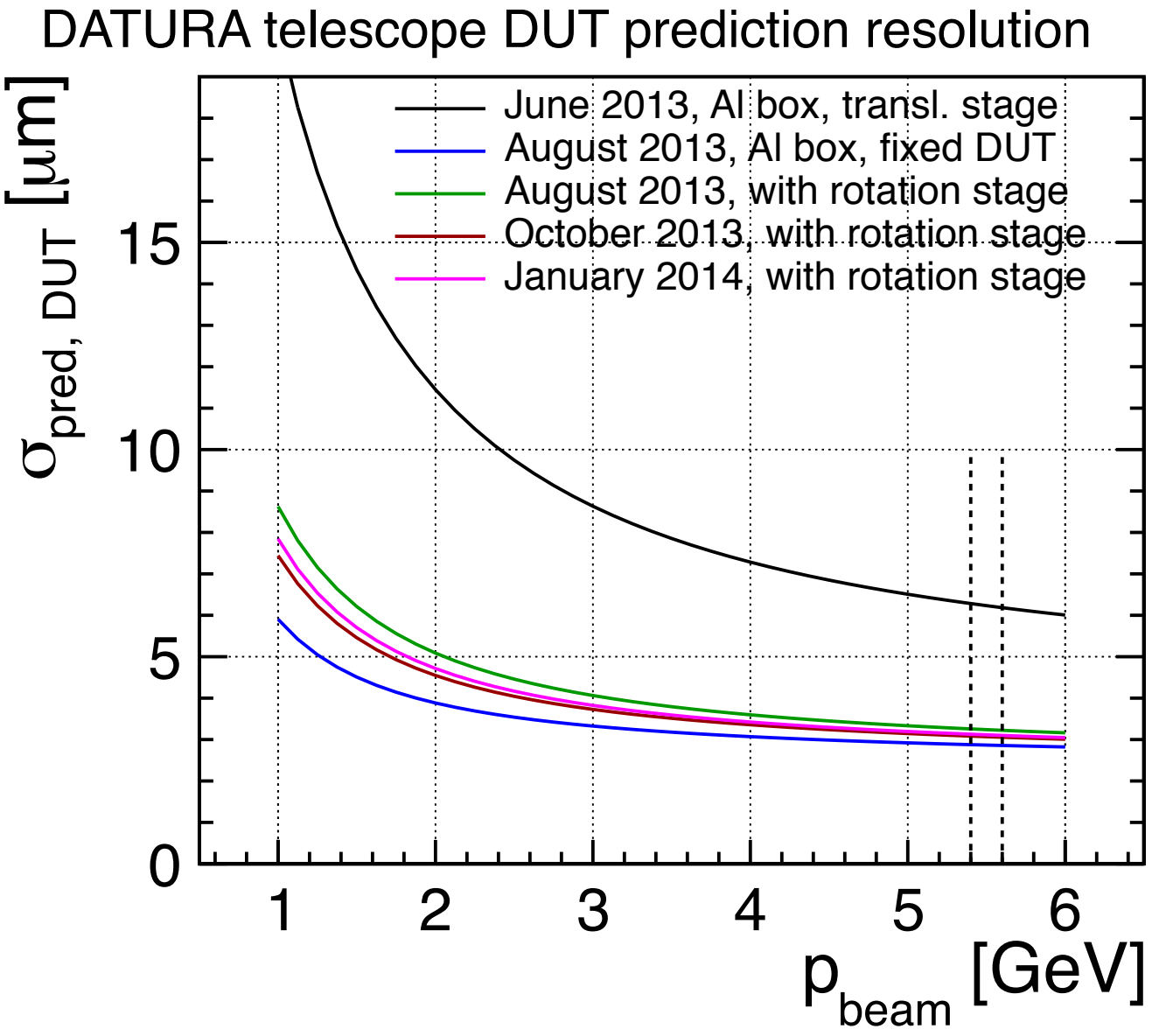
Spacing between telescope layers



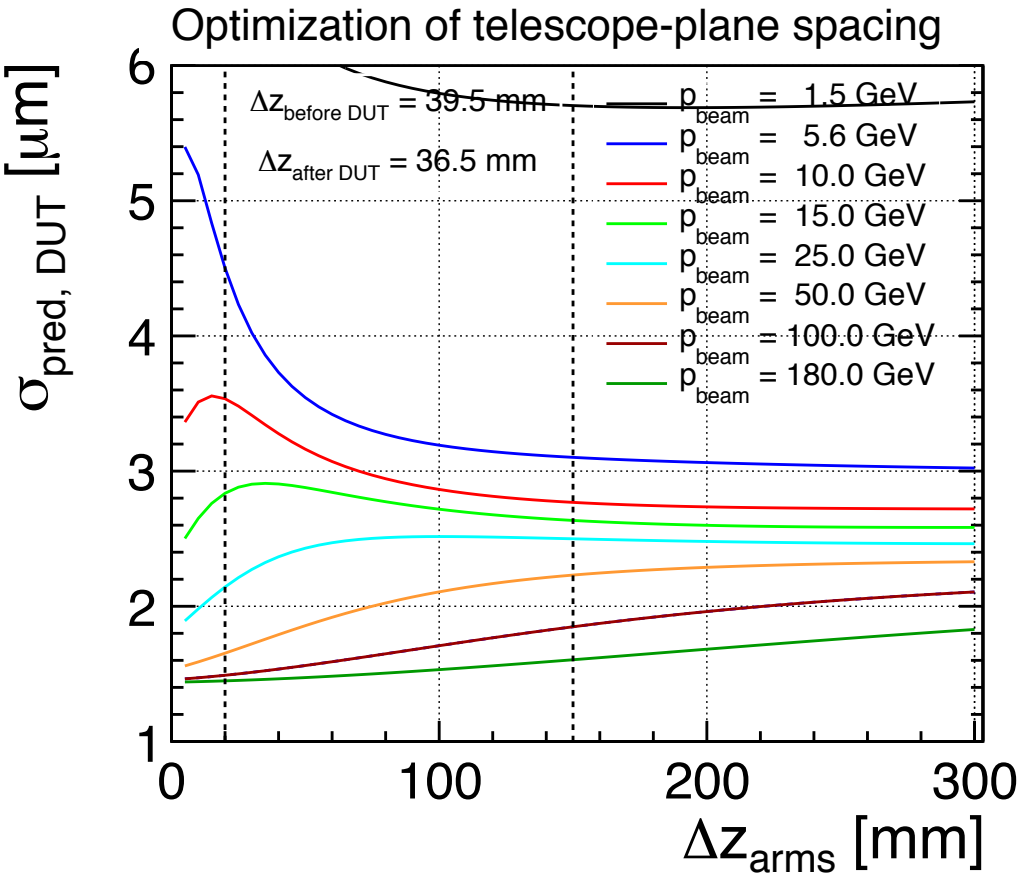
DUT should be placed as close as possible to innermost telescope layers (Δz_{DUT} small)

Optimal spacing between telescope layers (Δz_{arms}) is compromise between multiple scattering (better for smaller spacing) and lever arm (better for larger spacing)

Optimised telescope resolution



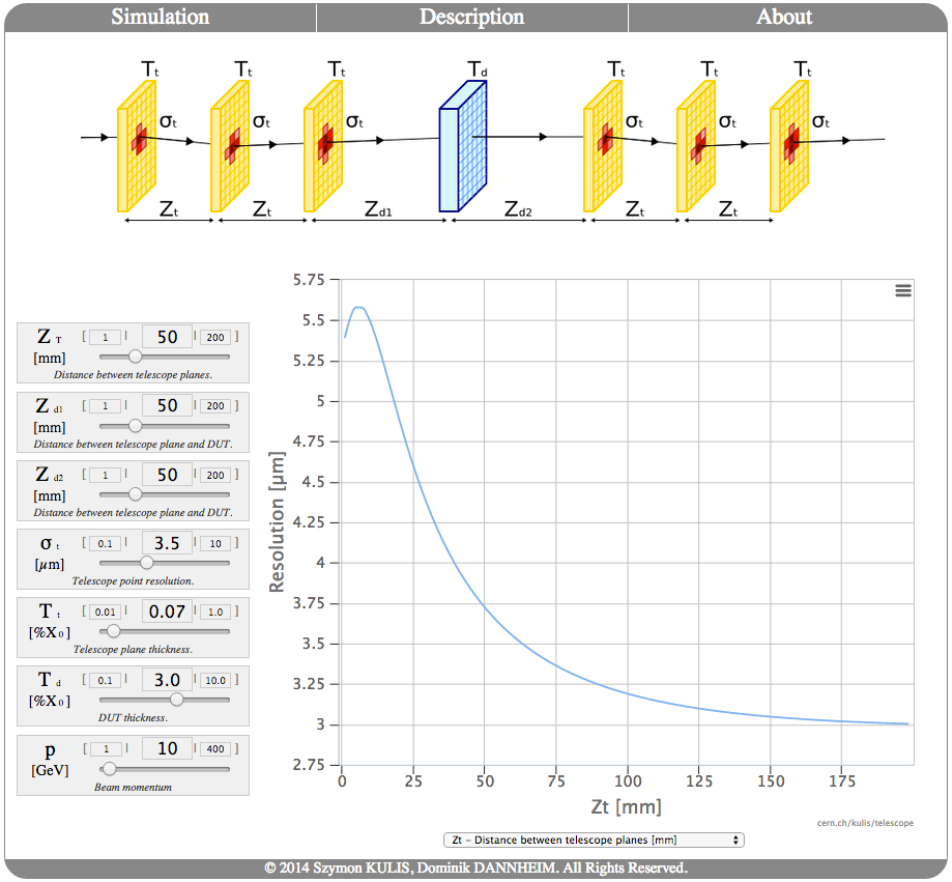
Optimal spacing depends on p_{beam}



- Optimal spacing between telescope planes to minimise resolution
  - at DESY, CERN-PS: largest possible spacing
  - at CERN-SPS: shortest possible spacing

Web tool

- JavaScript web tool to calculate prediction resolution as function of geometry, material, p_{beam}
- Calculations based on same code as results on previous slides
- Allows for easy and fast optimisation of geometry and extraction of telescope prediction resolution for a given parameter set
- Tested for several platforms and browsers
- User feedback very welcome!



http://cern.ch/kulis/telescope

Summary / Outlook

- Developed code to extract telescope prediction resolution based on global chi2-minimisation method (EUDET-Report-2007-01)
- Used for optimisation of telescope spacing for various test beam campaigns

→ Significant improvement of telescope performance

- Web tool available

- To do:
  - Further validation with unbiased residuals for the telescope planes (comparison with data and with Geant4 simulations)
  - Take into account feedback from users of the web tool
  - Document method and results in a note