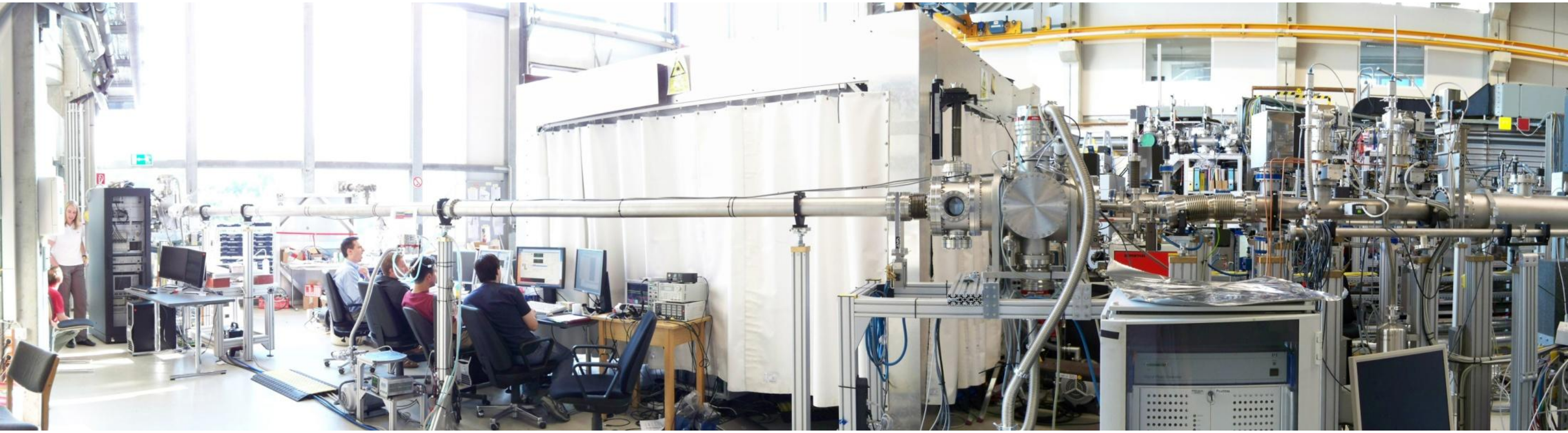

Commissioning of THz beamline at FLASH: beam properties

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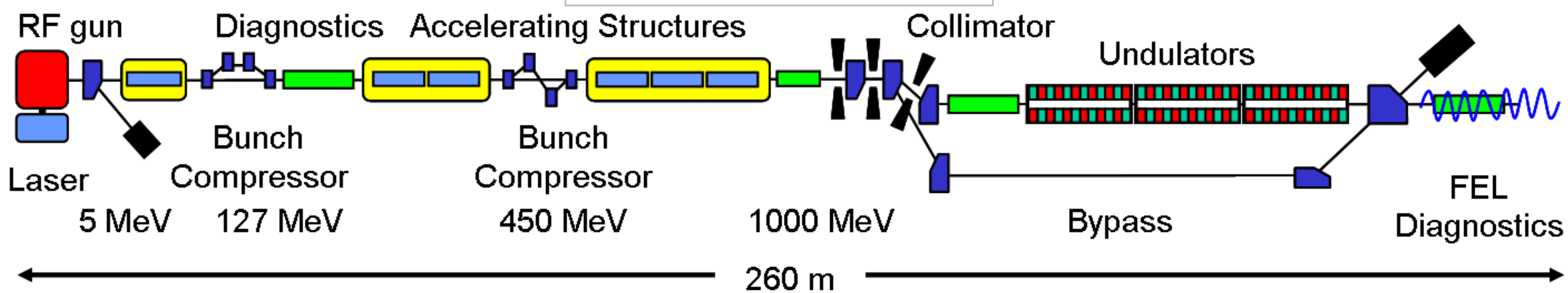
THz beamline at FLASH (I)

- FEL vs conventional laser: completely different physics behind.

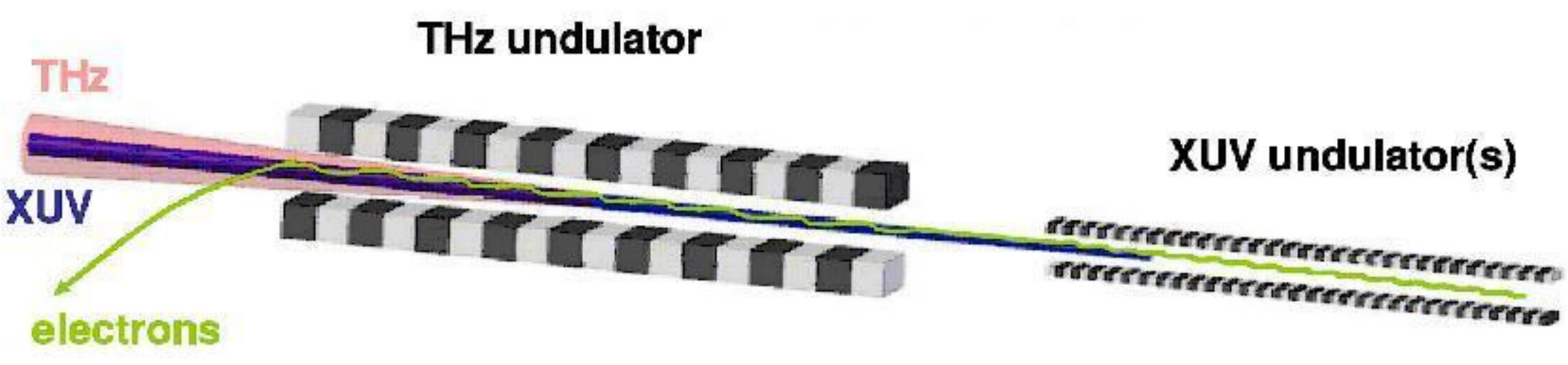
- So how do we characterize the propagation of FEL light?

FLASH tunnel devices



THz beamline at FLASH (II)

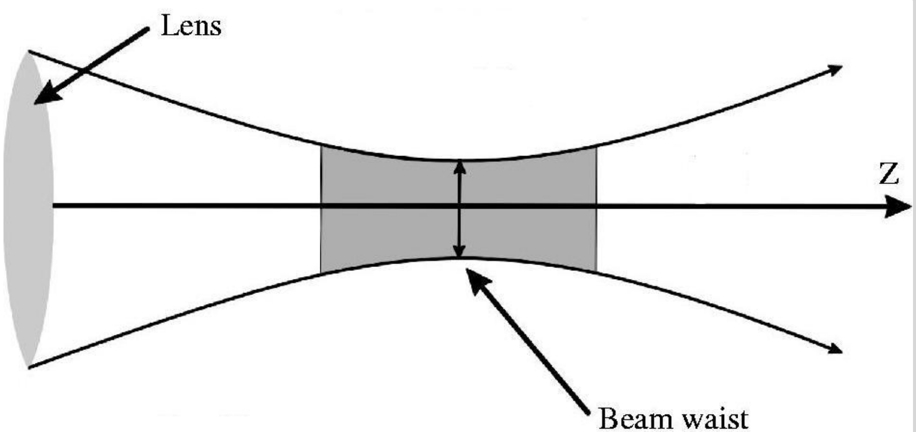
- Spectral range 10 – 200 μm (30 to 1.5 THz).
- fs to 6ps pulse duration with pulse energies ~ 10 μJ.
- Synchronized to FLASH-XUV pulse.



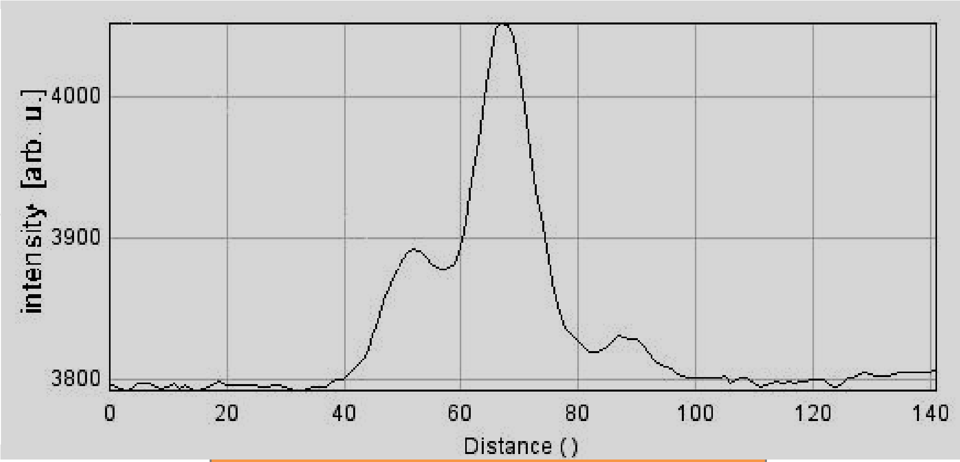
Theory behind the story (I)

- The basic problem: defining beam width.

- Second-moment based σ as the beam width: why?



Gaussian beam propagation



Nongaussian intensity profile

Theory behind the story (II)

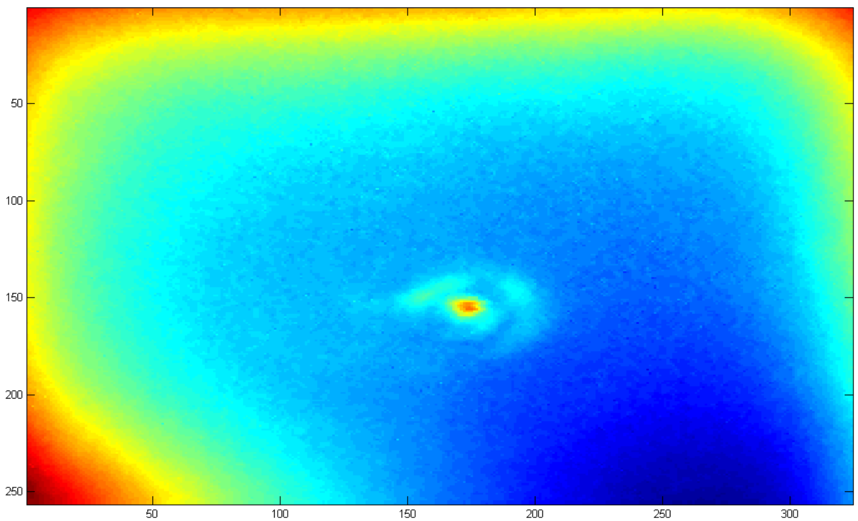
$$\sigma_x^2 = \frac{\int_{-\infty}^{\infty} (x - x_0)^2 I(x,y)\,dxdy}{\int_{-\infty}^{\infty} I(x,y)\,dxdy}$$ → Second-moment definition

- It leads us to a quadratic propagation rule for any laser beam → M^2 method!

$$W_x^2 = W_{0x}^2 + M_x^4 \left(\frac{\lambda}{\pi W_{0x}} \right)^2 (z - z_{0x})^2$$ → $W_x = 2\sigma_x$
M^2 = propagation factor!

A.E. Siegman, Stanford University: How to (Maybe) Measure Laser Beam Quality, 1997

Experimental data (I)



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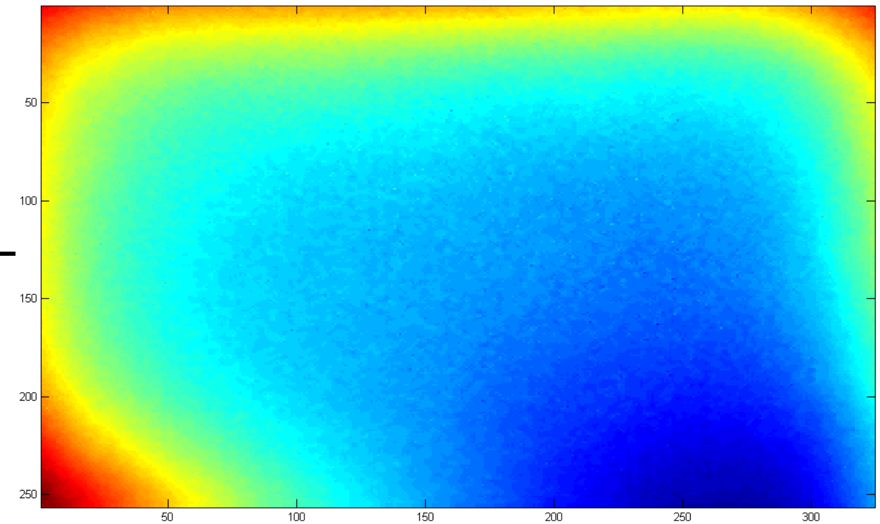

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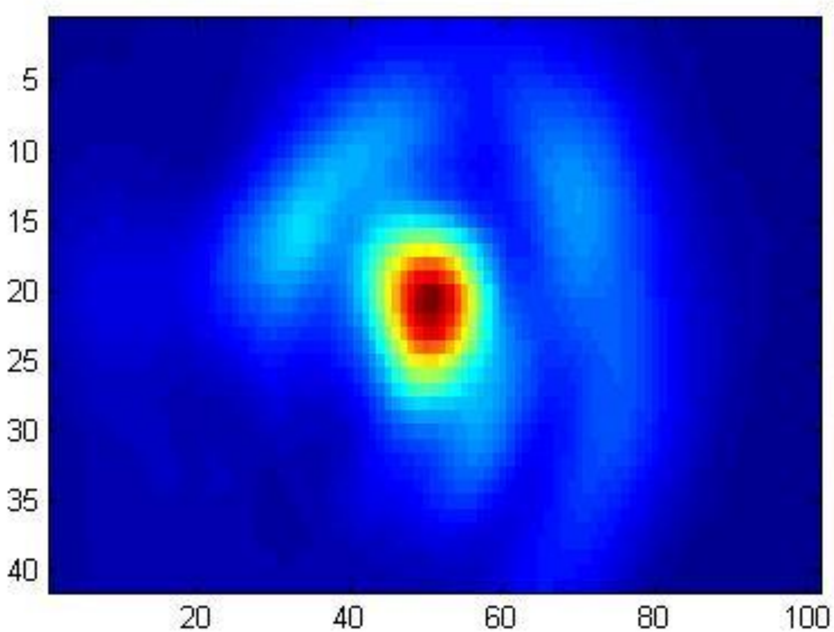
CCD camera pictures along z axis, around beam waist

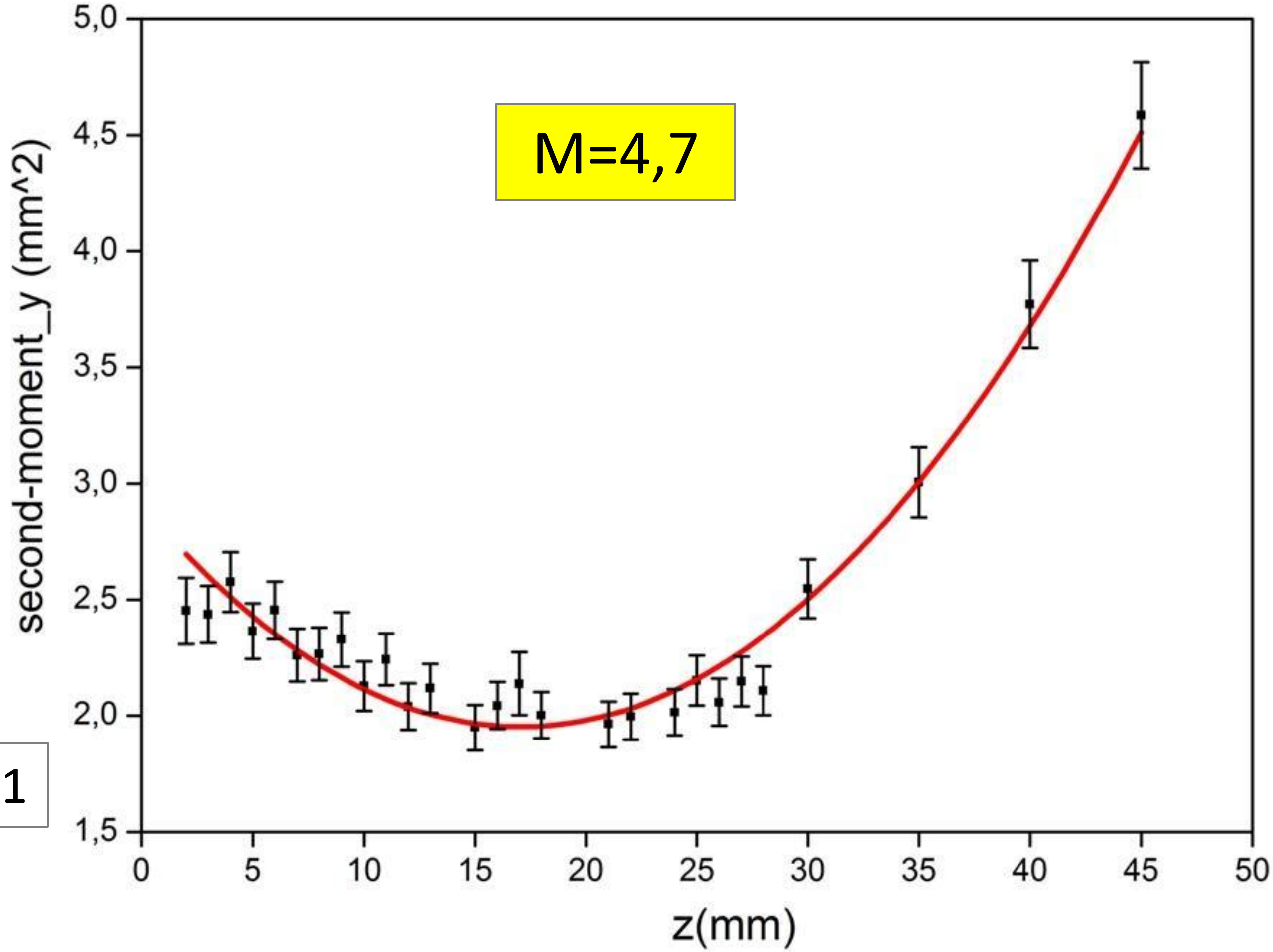
Experimental data (II)

- MATLAB program extracts the background .
This is how our beam looks like!



Data analysis. Results (I)

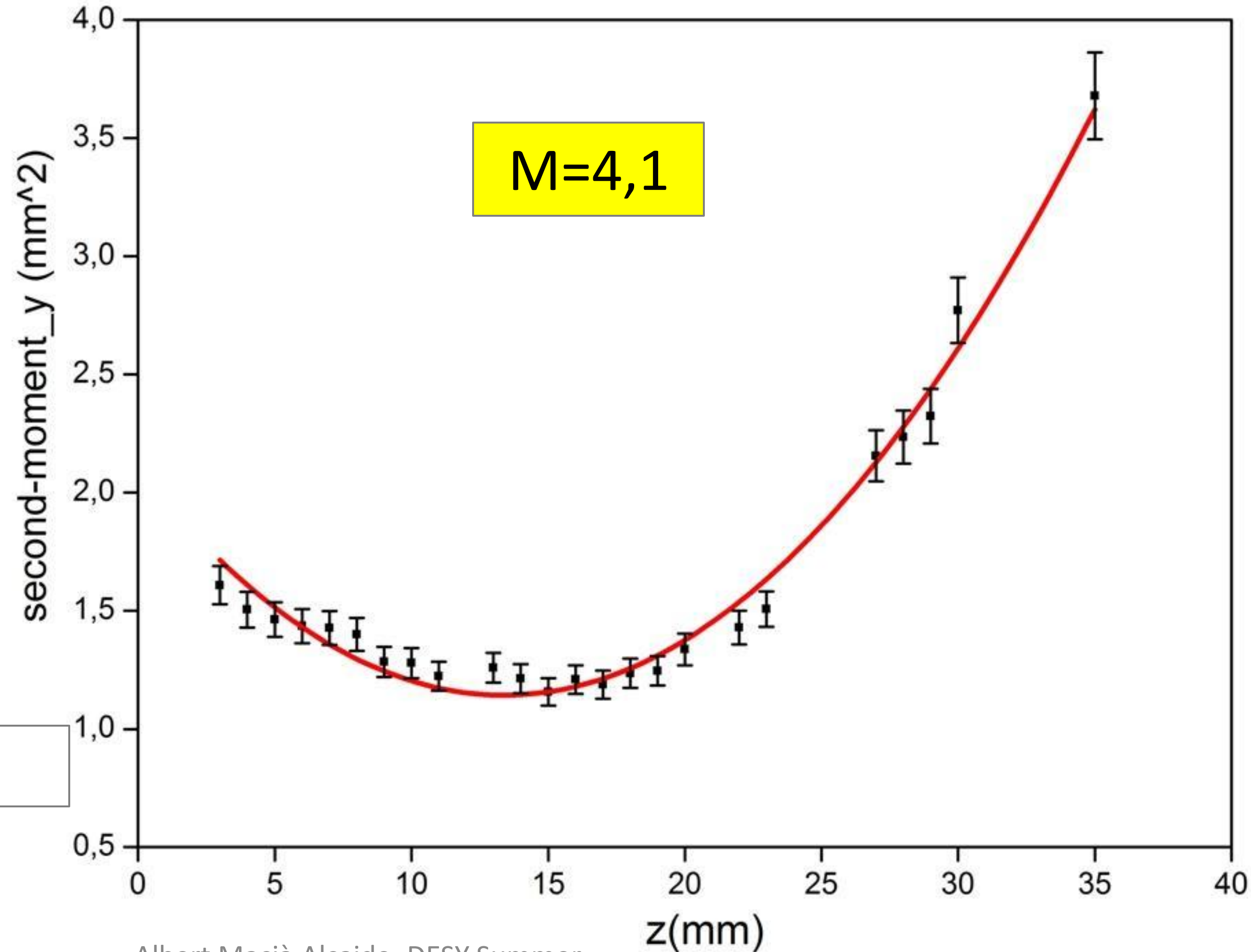
λ=47 µm



Ideal gaussian beam: M=1

Data analysis. Results (II)

λ= 52 µm



TiSa at FLASH: M=3

Conclusions

1- Final result: $\boxed{M = 4{,}4 \pm 0{,}3}$

2- FEL light propagates like conventional laser light!!

3- M factor is wavelength almost-independent!

Acknowledgments

- Thanks to my supervisors for the help. Specially Nikola for all the hours of discussion and explanations.

- Thanks to Carlos for the front page picture.

And thanks to all of you for coming!!