# LIGHT

## *Generation of highest peak intensities of ultrashort MeV proton bunches and going towards applications*

D. Jahn, D. Schumacher, C. Brabetz, J. Ding, S. Weih, A. Blazevic, V. Bagnoud, F. Kroll, F.-E. Brack, T. Cowan, U. Schramm, M. Roth

**EAAC 2017**
Biodola, Elba
24th - 30th September 2017

LIGHT
Laser Ion Generation, Handling and Transport

HELMHOLTZ GEMEINSCHAFT GSI

# The LIGHT collaboration

TECHNISCHE UNIVERSITÄT DARMSTADT

LIGHT

Laser Ion Generation, Handling and Transport

TECHNISCHE UNIVERSITÄT DARMSTADT

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

TECHNISCHE UNIVERSITÄT DRESDEN

GSI PP PHELIX Accelerator

HI Jena Helmholtz-Institut Jena

HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

*S. Busold et al., Shaping laser accelerated ions for future applications – The LIGHT collaboration, NIM-A **740**, 94-98 (2014)

# The LIGHT collaboration

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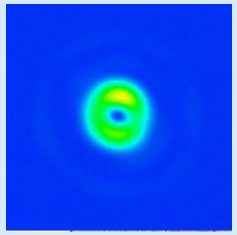
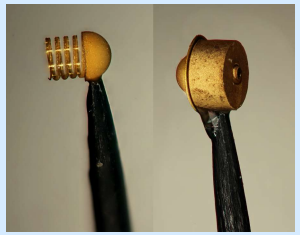
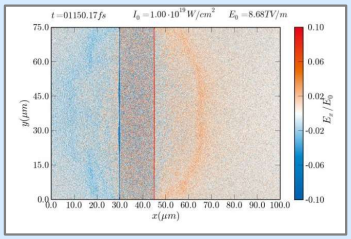
Laser Ion Generation, Handling and Transport



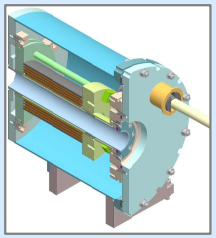
laser shaping



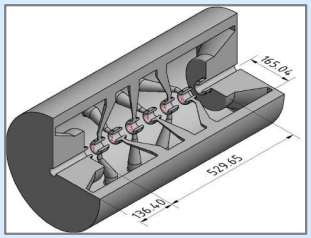
target shaping



simulation



transport




post acceleration

# The LIGHT beamline

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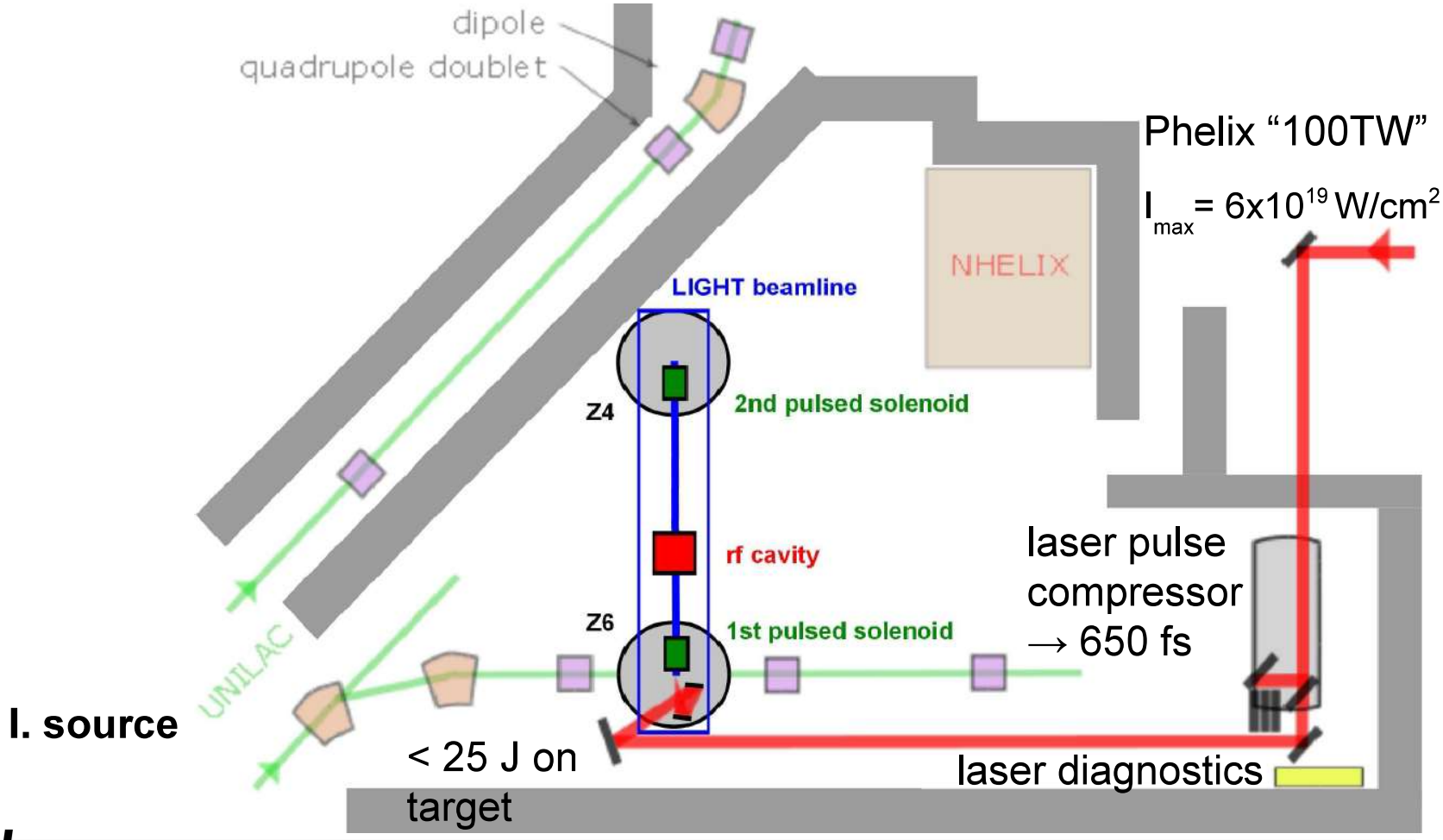

# I. Source:
# Target Normal Sheath Acceleration (TNSA)

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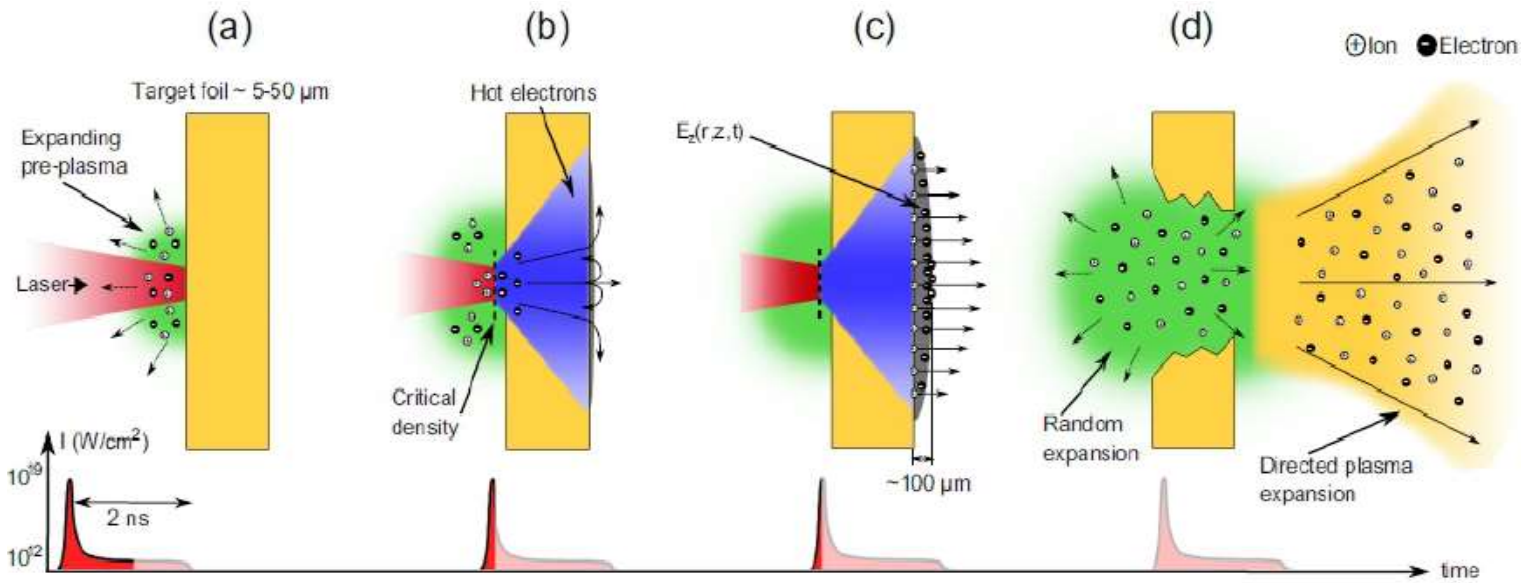


F. Nürnberg, PhD thesis TU Darmstadt (2010)

- **intense ion source**: $10^{11}$ – $10^{13}$ protons in ~ 1 ps
- **low emittance**: < 0.01 mm mrad transversal, $10^{-4}$ eV s longitudinal*
- **huge accelerating field gradients**: MV/µm

* *T. Cowan, Ultralow Emittance, Multi-MeV Proton Beams from a Laser-Virtual Cathode Plasma Accelerator,* PRL 92:204801 (2004)

# I. Source:
# Target Normal Sheath Acceleration (TNSA)

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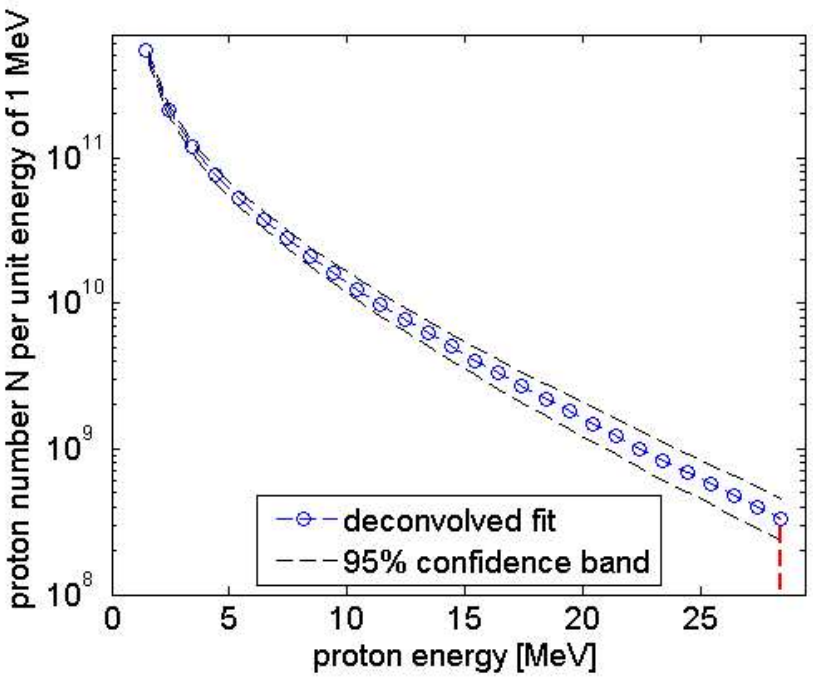


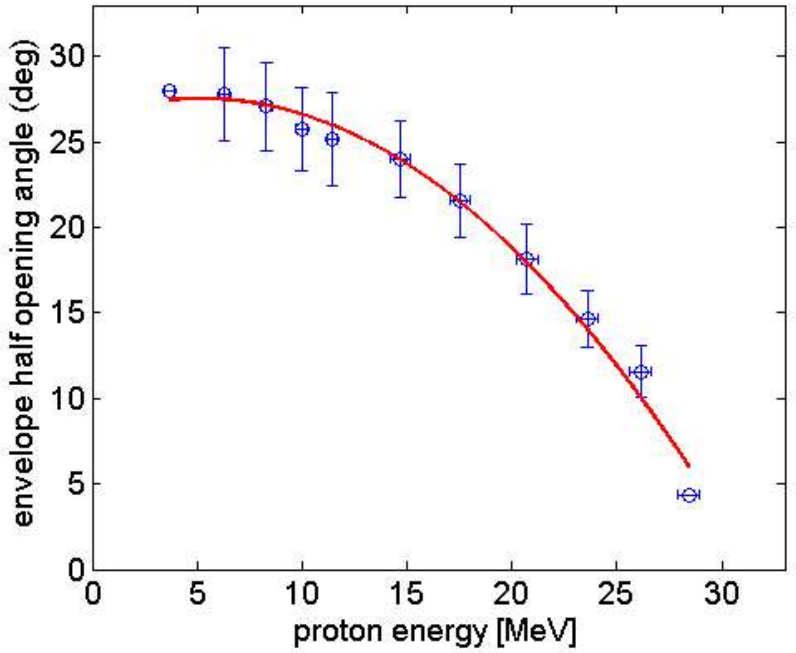


- **divergence**: ≤30deg (half angle)
- **continuous exponential spectrum**
- **disturbed environment** (electrons, γ, EMP background)

# The LIGHT beamline

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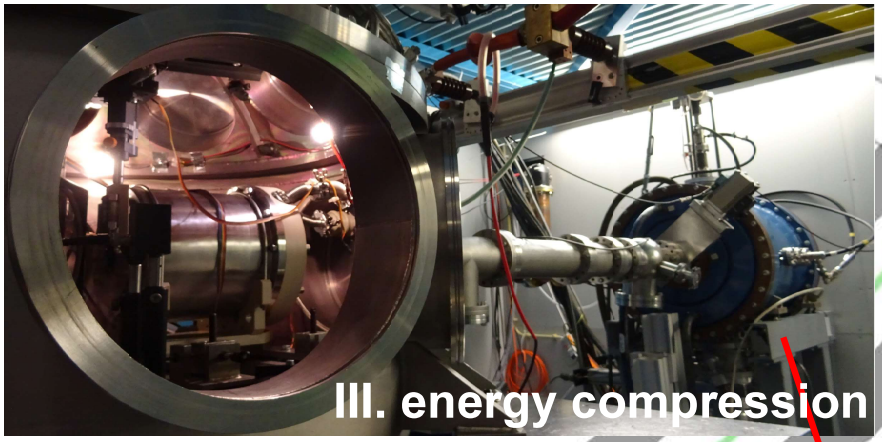



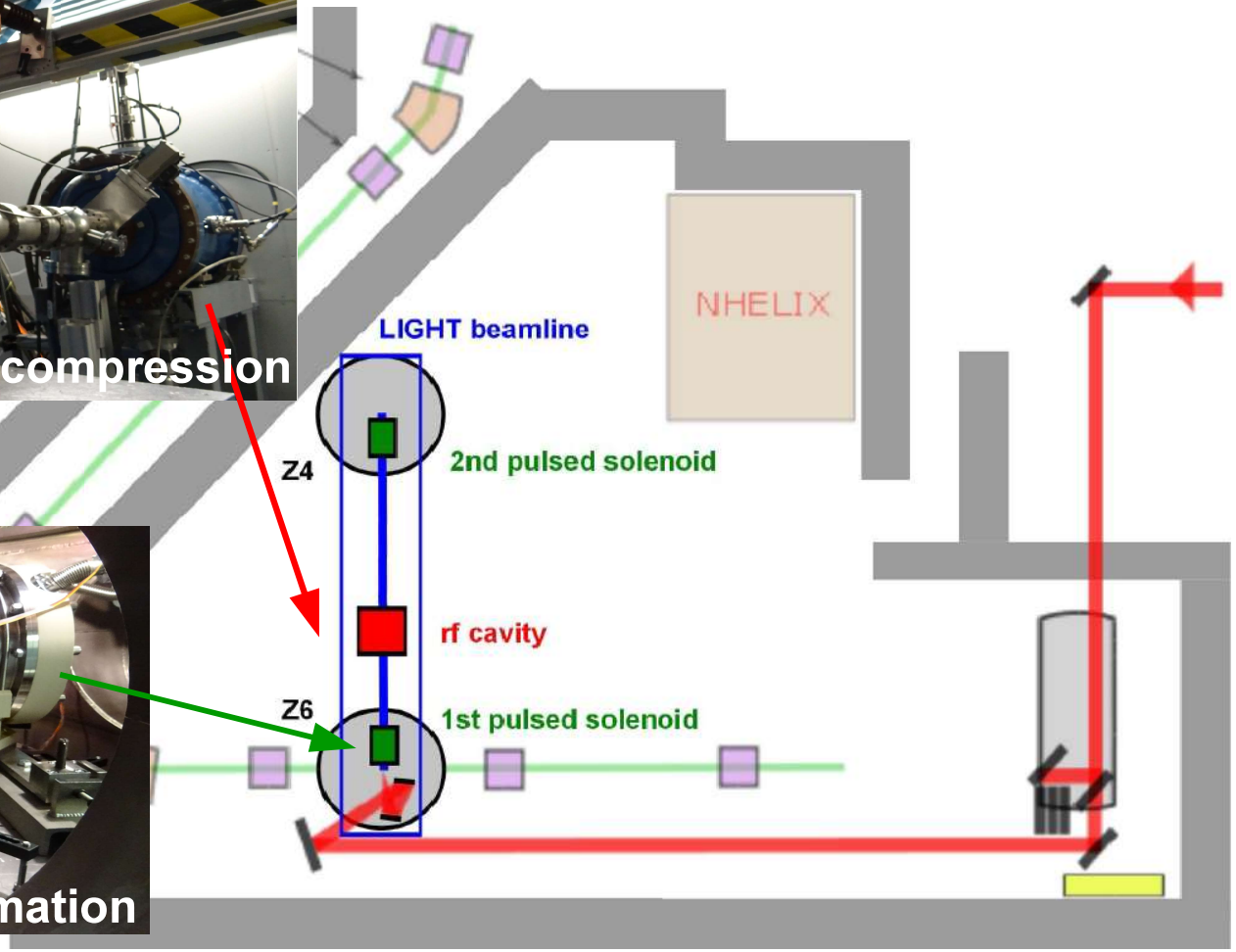

# II. Beam collimation and III. phase rotation

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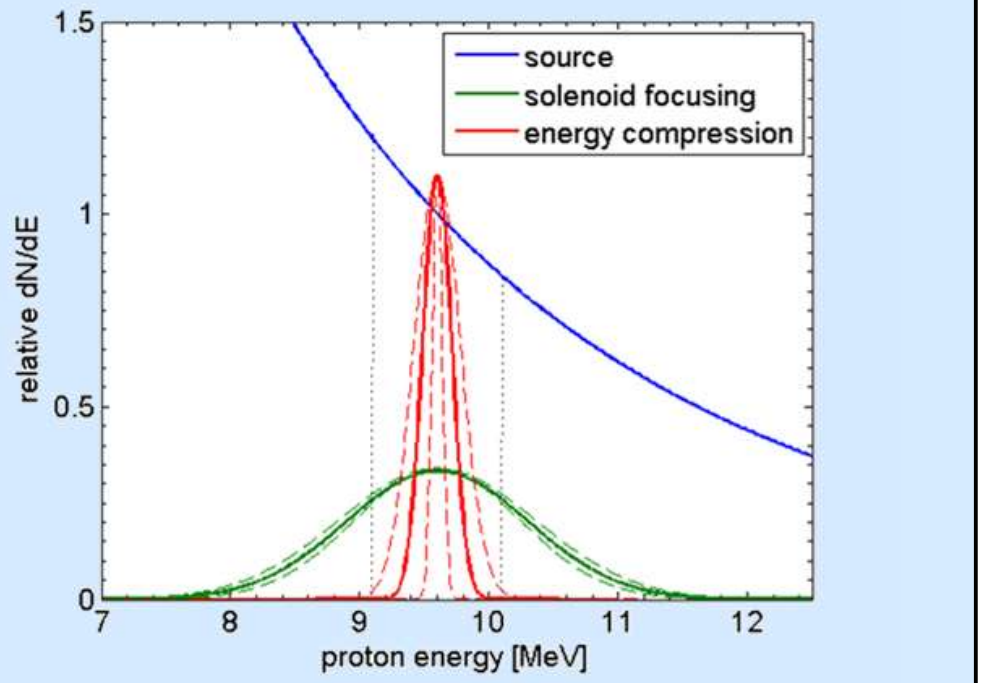


- energy compression of ion bunch
- beam transport to 3 m

ΔE/E0 = (2.7 ± 1.7) %

# LIGHT beamline

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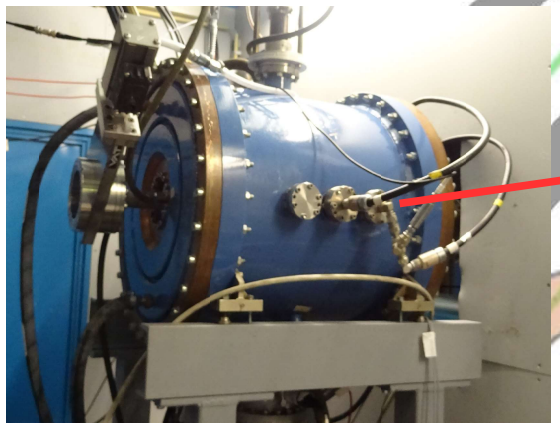
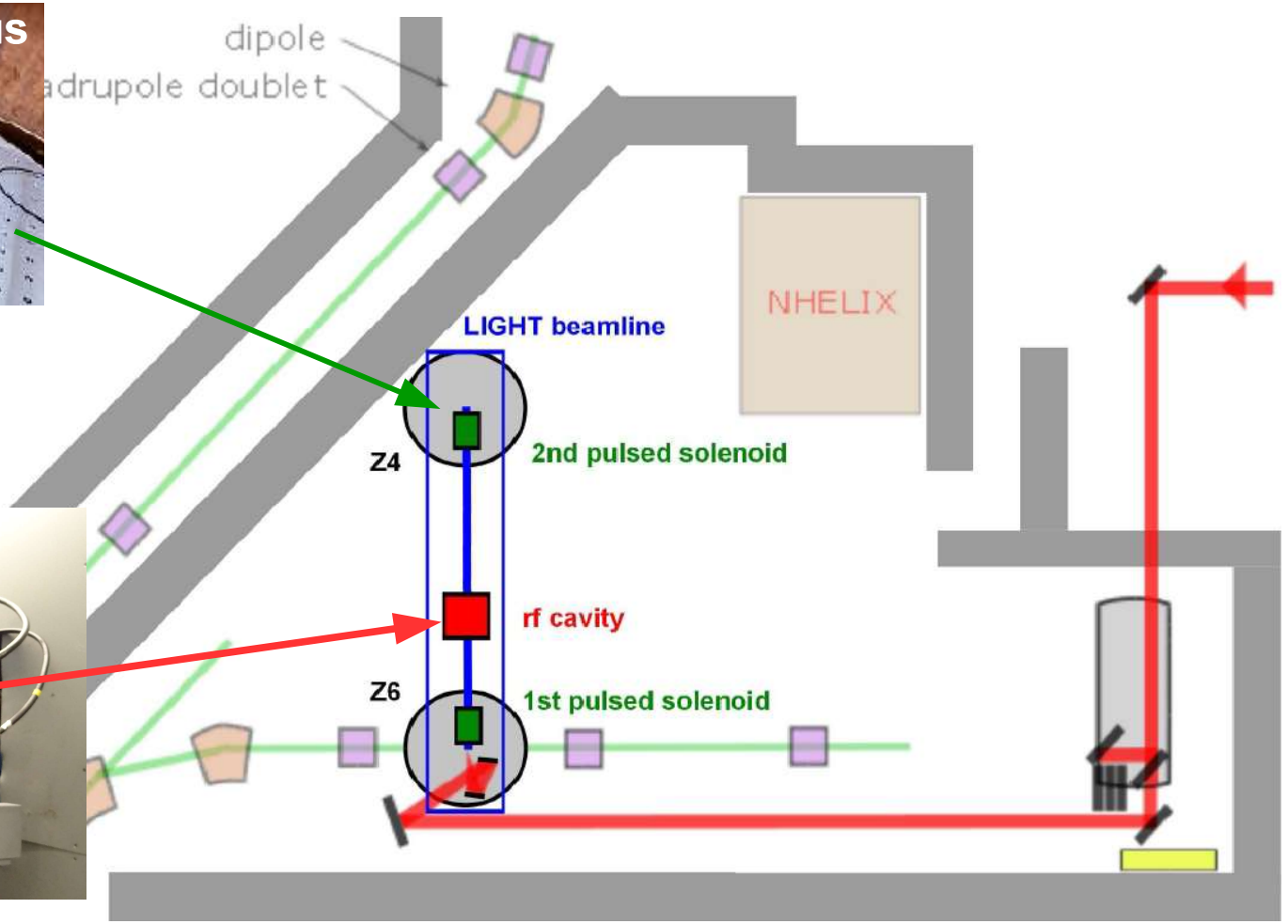
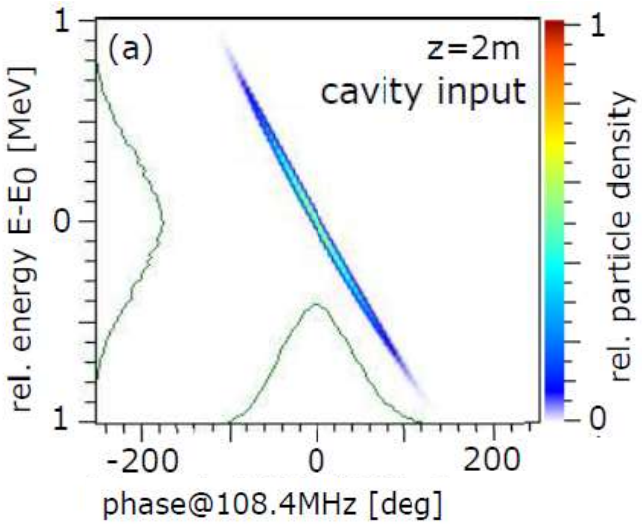
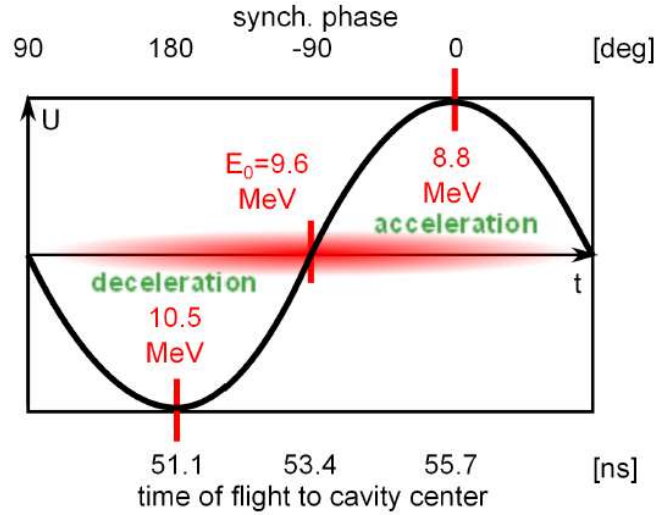




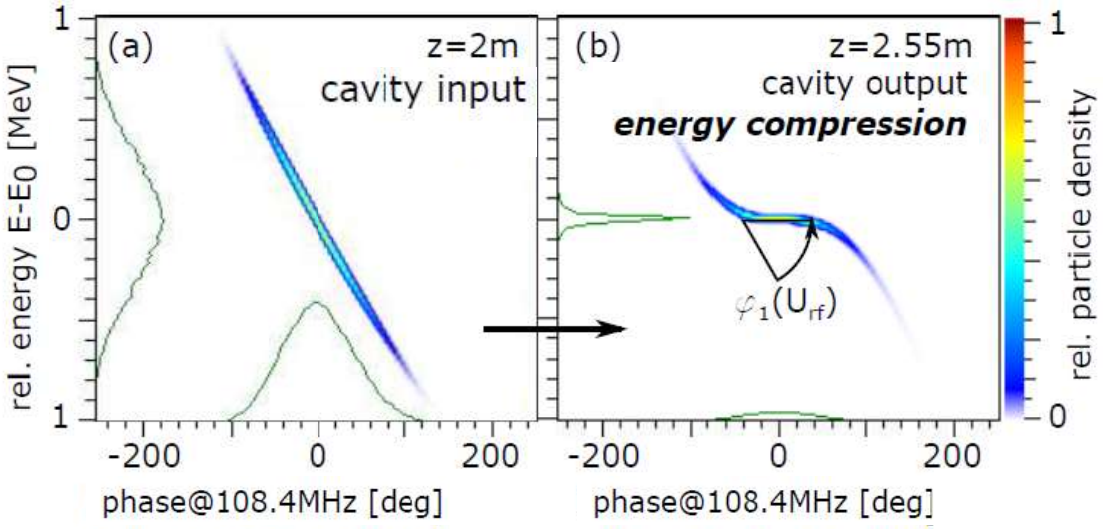
# LIGHT simulations

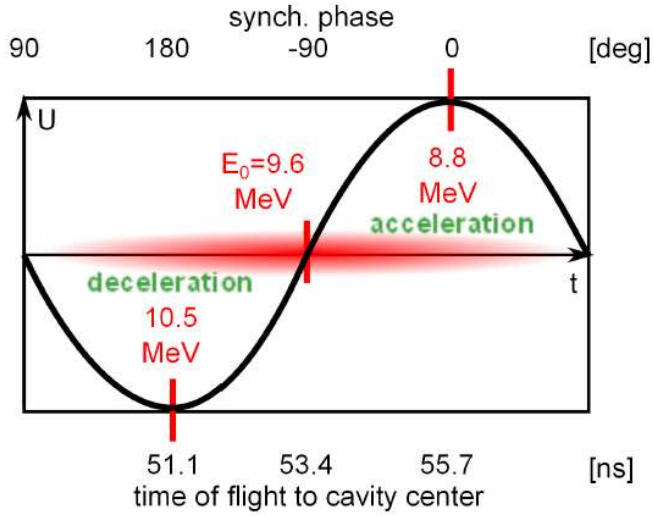



injection phase $\Phi_s$ = - 90°

# LIGHT simulations

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# LIGHT simulations

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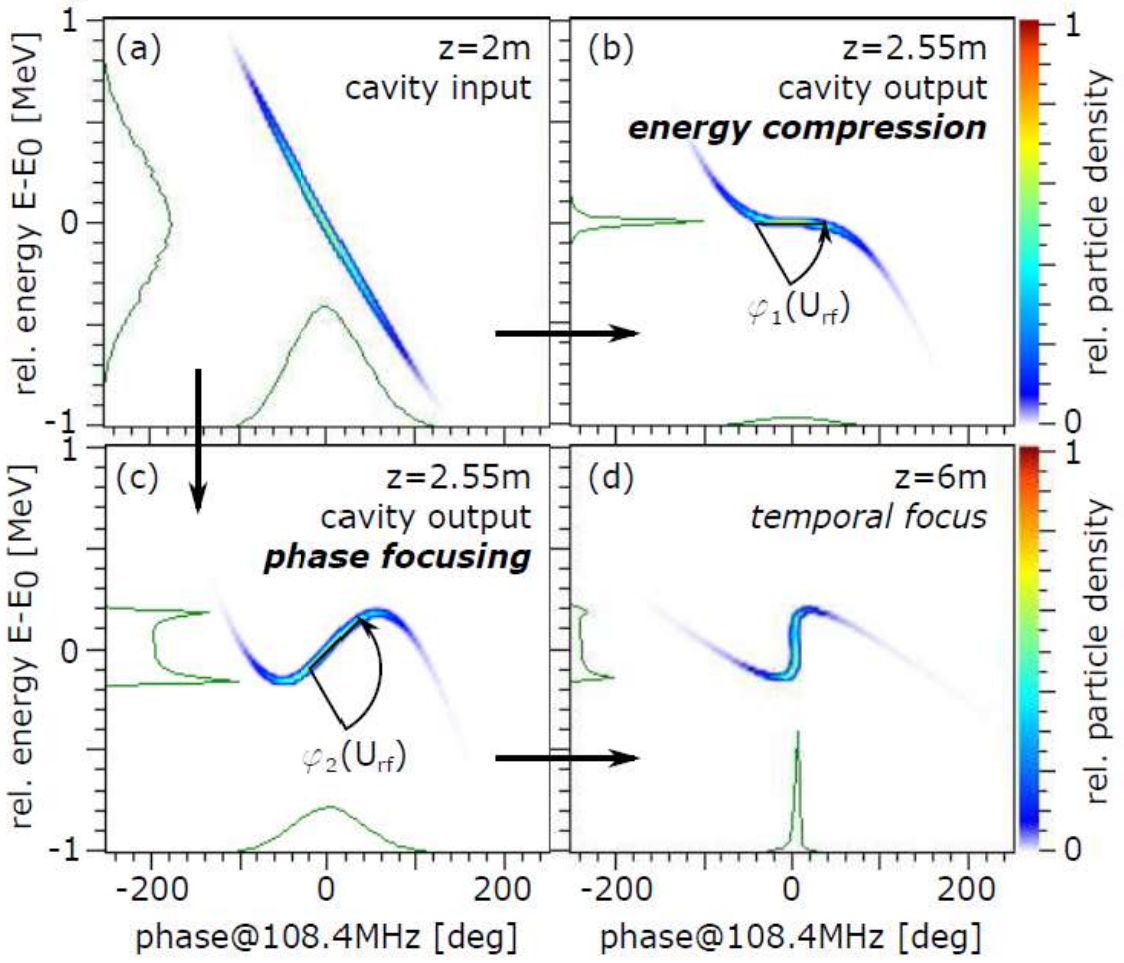


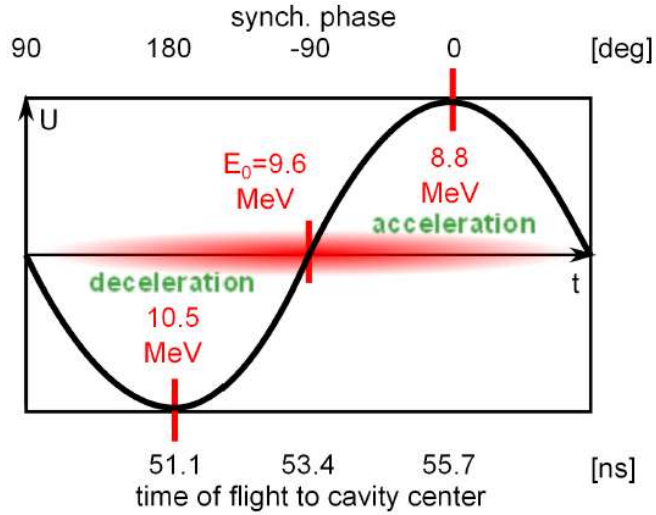


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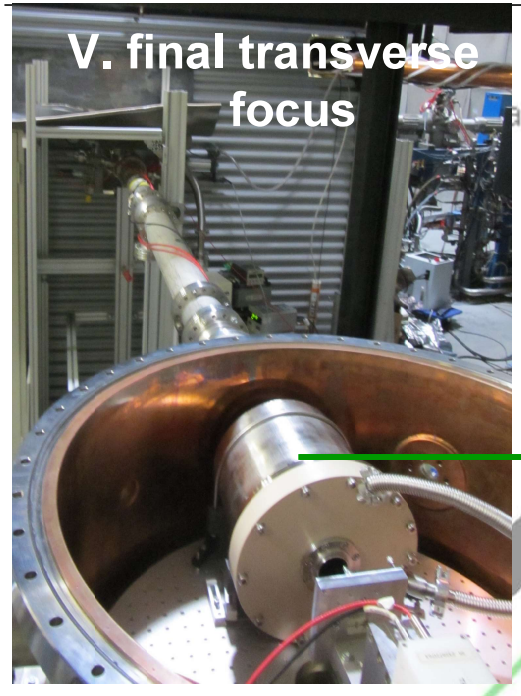


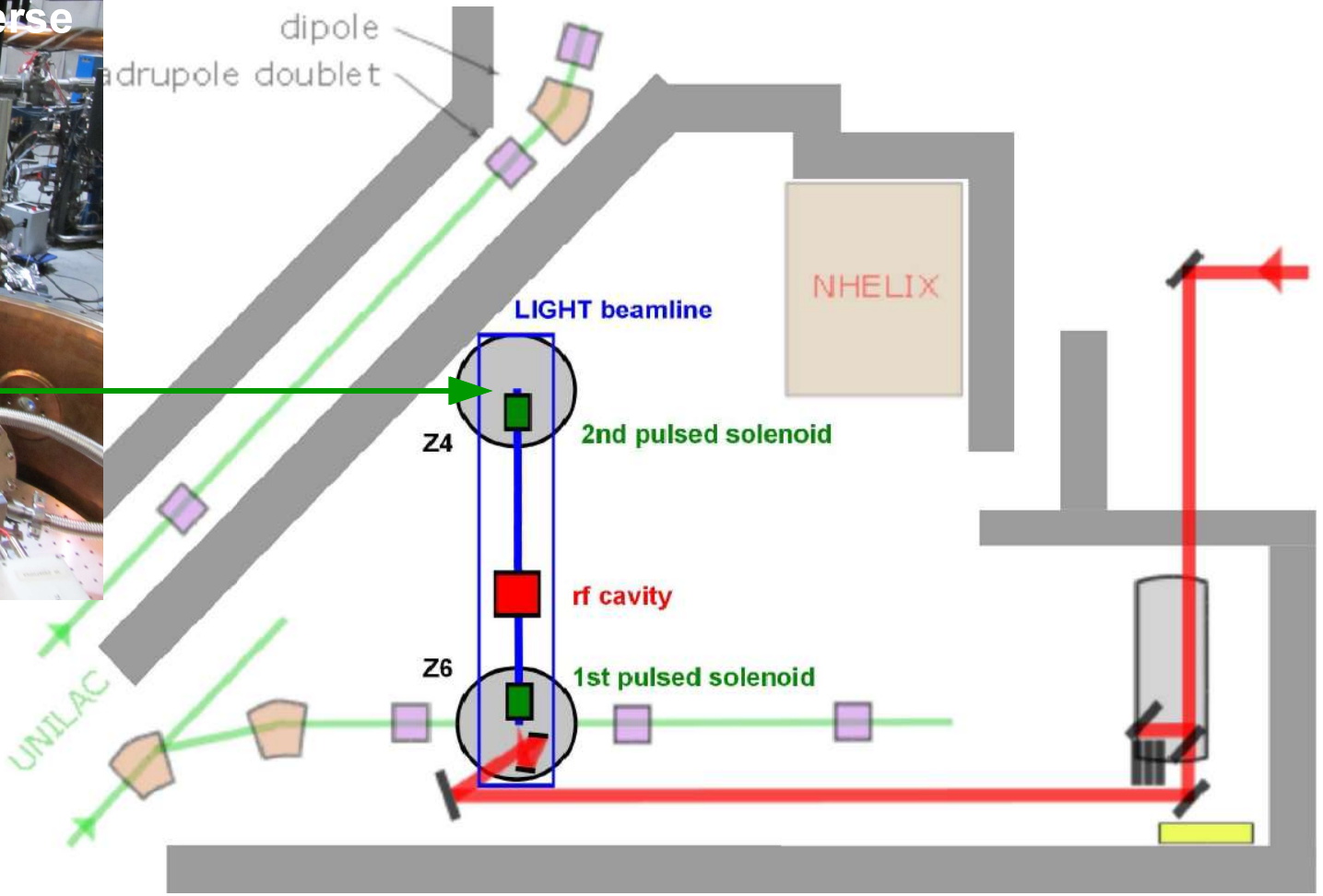

# Towards the future:
## energy loss measurements

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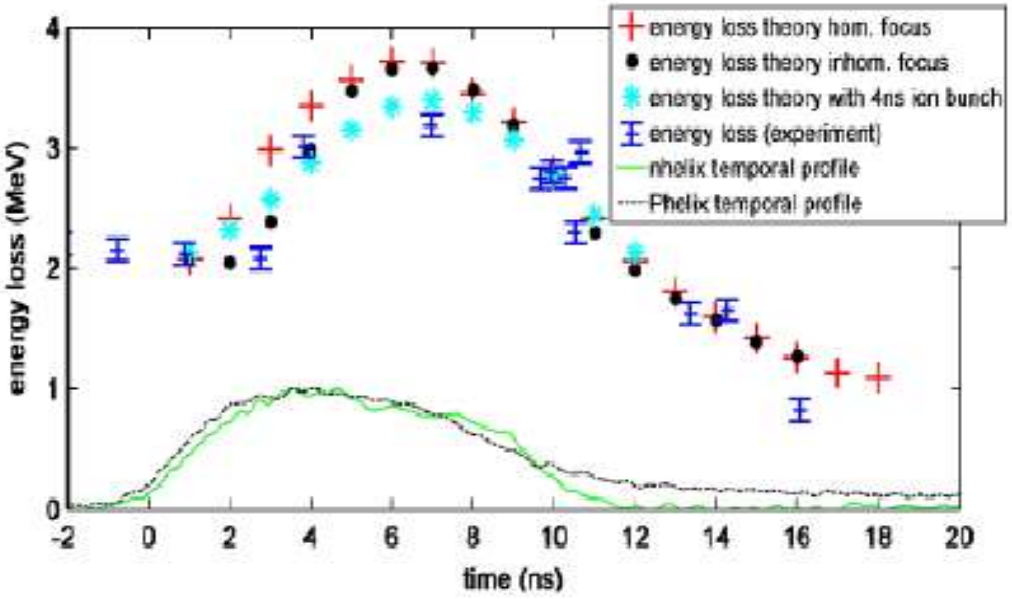
- Energy loss measurement suffer from time-averaging effects
- sub-500-ps ion pulses can enhance the measurement precision and avoid time-averaging effects
- working at maximum stopping power (< 1 MeV/u) is highly desirable




**from A. Frank et al., PRL (2013)**

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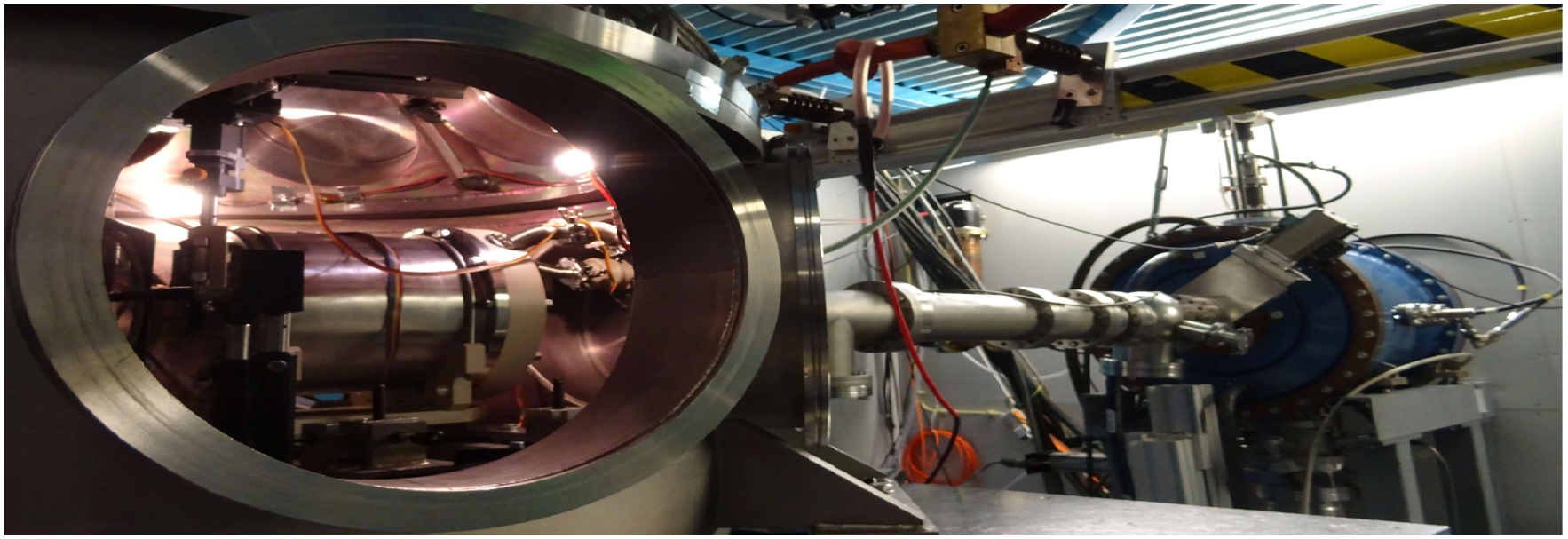

# Thank you for your attention!

The experimental team
D. Jahn, D. Schumacher, C. Brabetz, J. Ding, F. Kroll, F. E. Brack, S. Weih, A. Blazevic, V. Bagnoud and M. Roth

with the help of
PHELIX team, HF group, detector lab and the **LIGHT collaboration**