

Fast diamond membrane detector for the measurement of intense ion bunches

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Target Normal Sheath Acceleration (TNSA)



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 92,20 (2004)



Laser Ion Generation, Handling and Transport



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proton acceleration by the GSI Phelix Laser

beam shaping via conventional accelerator technology





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The LIGHT project





S. Busold, PhD thesis TU Darmstadt (2014)

HELMHOLTZ

GEMEINSCHAF1

LIGHT beamline





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LIGHT beamline: cavity

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LIGHT beamline: cavity





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prototype detector



prototype with 13 μm pcCVD

characterization with laser irradiation FWHM: 323 ps ± 40 ps









prototype detector



prototype with 13 μm pcCVD

measurement of proton bunch length: FWHM: 462 ps ± 40 ps*



*S.Busold et al., Towards highest peak intensities for ultrashort MeV-range ion bunches, Scientific Reports 5, 12459 (2015)







design of the membrane detector



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design of the membrane detector





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response function



- laser irradiation
 - λ = 1053 nm
 - τ = 350 fs
 - E = 1 10 mJ
- detector response FWHM: 110 ps ± 40 ps







TECHNISCHE experiment setup UNIVERSITÄT DARMSTADT diamond detector bunch propagation 30 V power supply 8 GHz oscilloscope SMA cables E HELMHOLTZ 4.12.2015 | 4th Adamas Workshop at GSI | Diana Jahn **GEMEINSCHAFT** Laser Ion Generation, Handling and Transport

proton bunch measurement



- optimization of cavity parameters
- shortest measured ion bunch:
 - FWHM: 235 ps ± 40 ps



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proton bunch measurement



- optimization of cavity parameters
- shortest measured pulse:
 - FWHM: 235 ps ± 40 ps

deconvolution:

FWHM: 209 ps ± 18 ps





summary



realization of scCVD membrane detector with an upgraded design thinness: 5 - 7 μm diameter: 0.5 mm

• characterization under laser irradiation (τ = 350 fs, λ = 1053 nm)

 \rightarrow response time of 110 ps ± 40 ps at FWHM

successful application within the LIGHT project

 \rightarrow measurement of proton bunches with 235 ps ± 18 ps at FWHM







Thank you for your attention!

The experimental team

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with the help of

M. Träger and M. Kis

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



