h1

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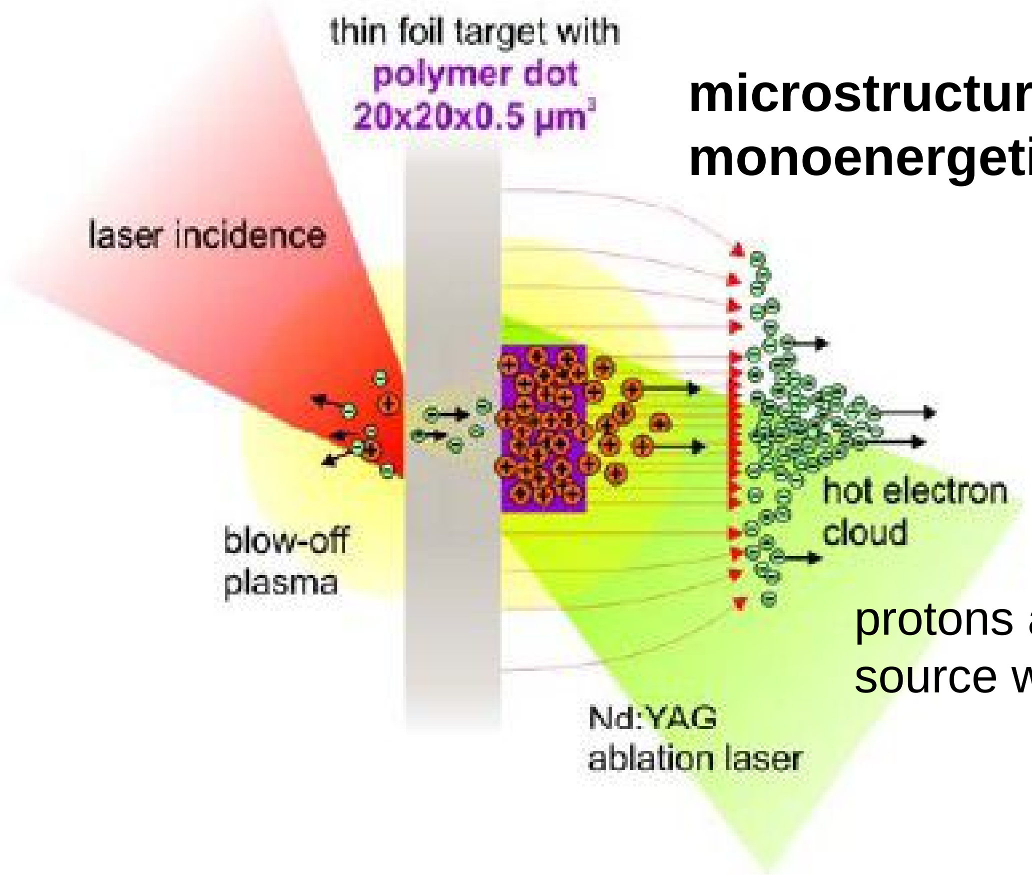
Folie 1

h1 herzer; 22.09.2008

TNSA



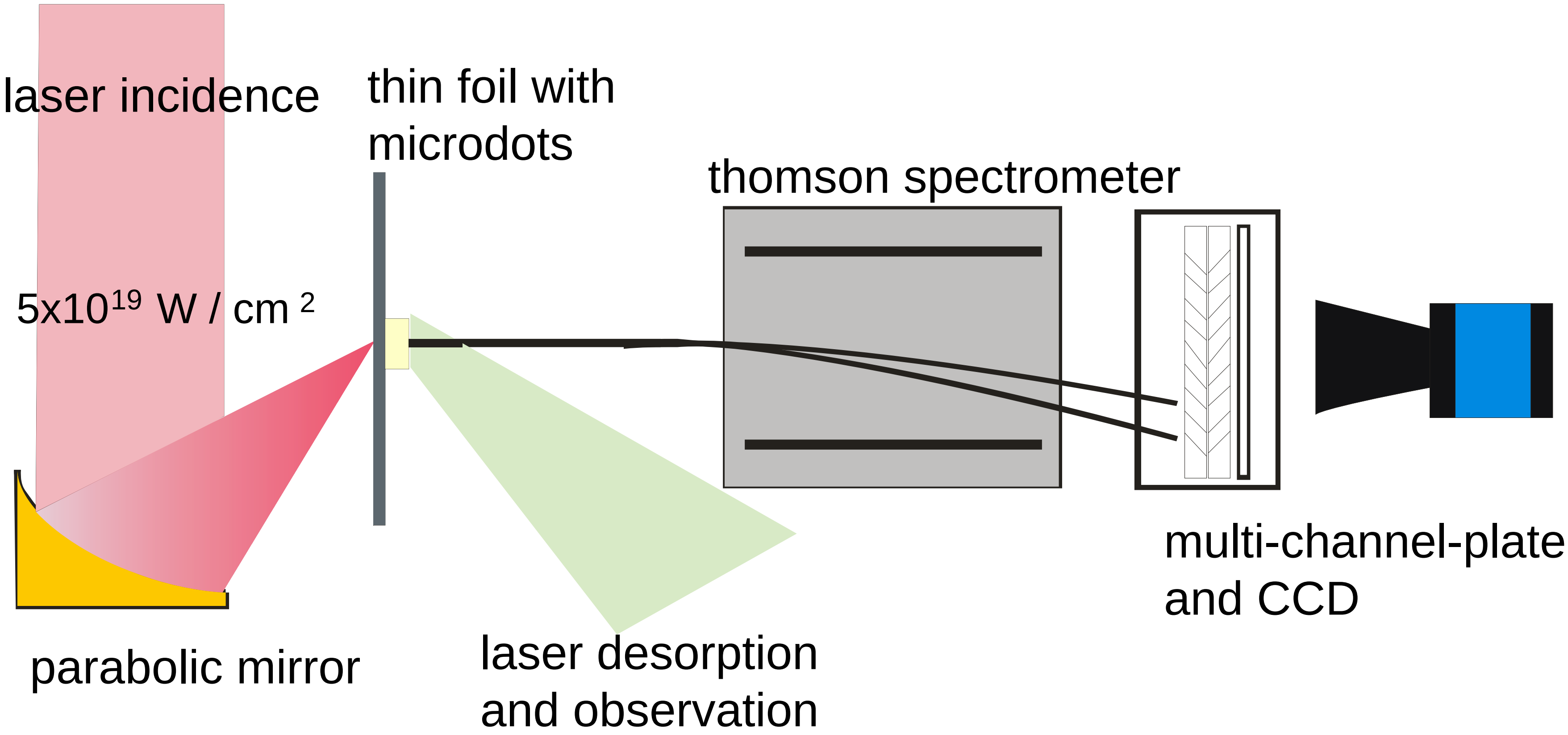
microstructured targets for producing monoenergetic proton beams

protons are radially confined to a dot source within the central field region

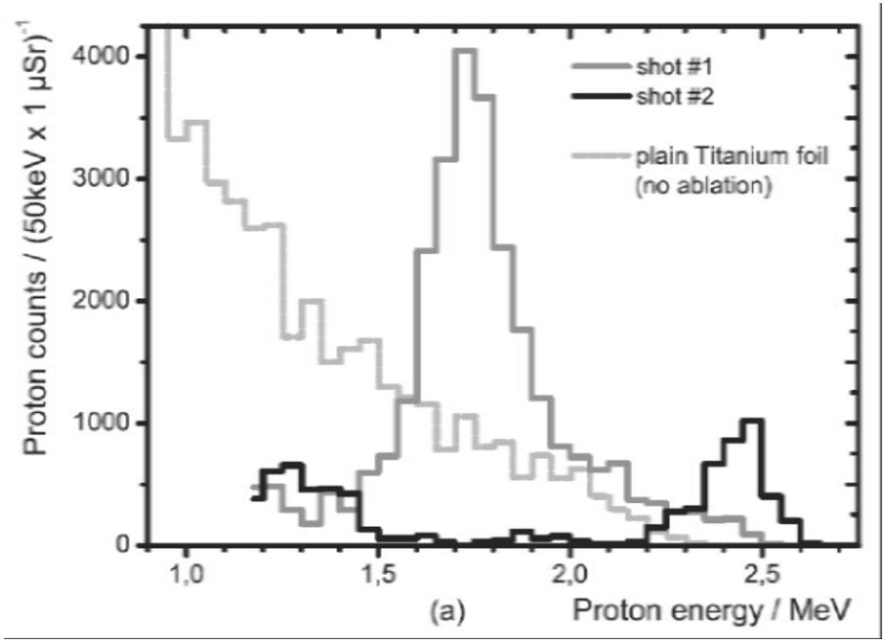
[1] Esirkepov TZ *et al* 2002 Proposed double layer target for the generation of high-quality laser-accelerated ion beams *Phys.Rev.Lett.* **89** 175003

setup at JETI

JETI: 10TW titanium:sapphire laser system in Jena
1.3J, 80fs, 10Hz repetition rate



Monoenergetic protons



- proton beams with 1.2 – 2.2 MeV central energy

-10 percent energy spread

-more than 10^9 protons per laser shot

[2] Schwoerer *et al* 2006 Laser-plasma acceleration of quasi-monoenergetic protons from Microstructured targets *Nature* **439** 445-8

[3] Pfotenhauer et al 2008 Spectral shaping of laser generated proton beams *New Journal of Physics* **10** 033034

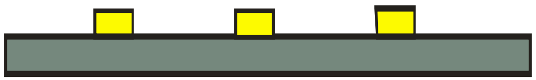
Methods of target fabrication

Structuring via laser ablation:

- mask projection technique (excimer laser)

- direct writing (short pulse laser)

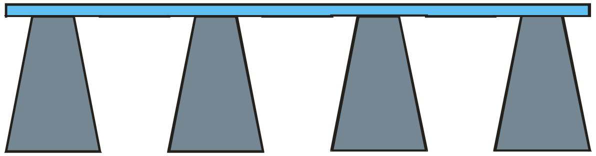
Several microns thick titanium foil



spin-coated PMMA layer, dispensable polymer ablated by laser

Structuring via photolithography:

5 micron thick nickel foil with polymer dots fabricated by contact printing lithography

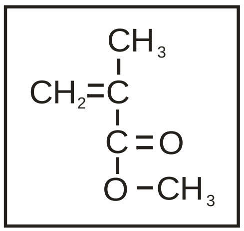


80 nano-meters chrome membrane on silicon wafer with channels for laser incidence produced by etching

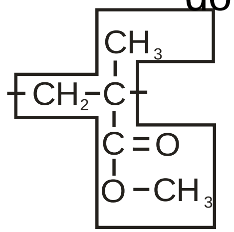
PMMA as proton source

Polymethacrylat (PMMA) applied on 5µm titan foil by spincoating

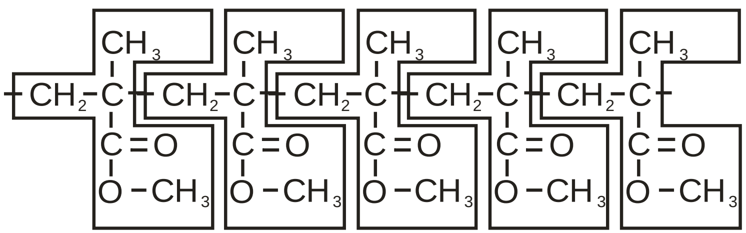
Monomer

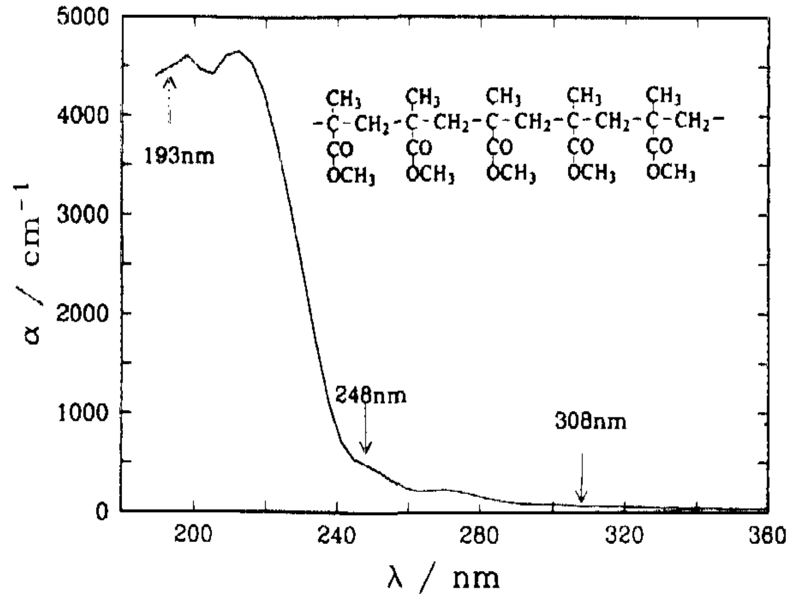


Polymerization by breaking the double bond



Polymer chain

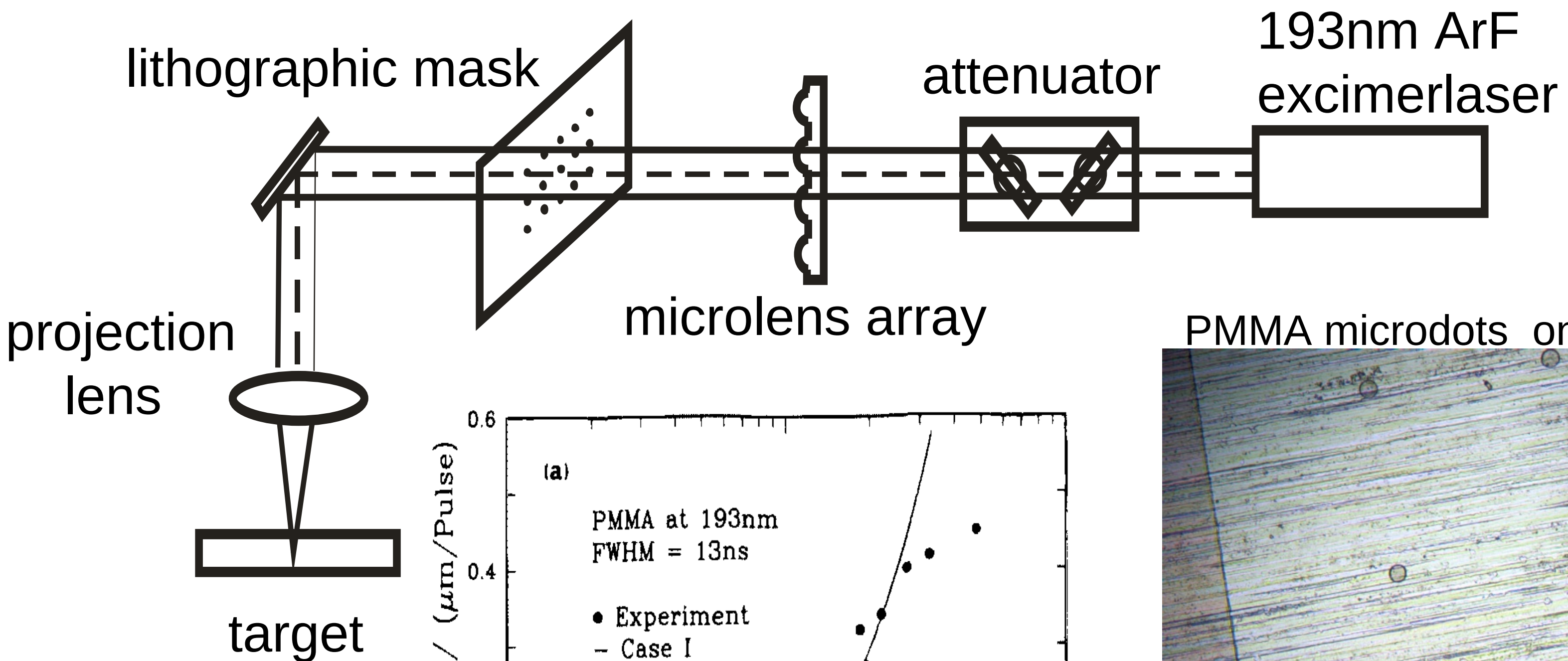


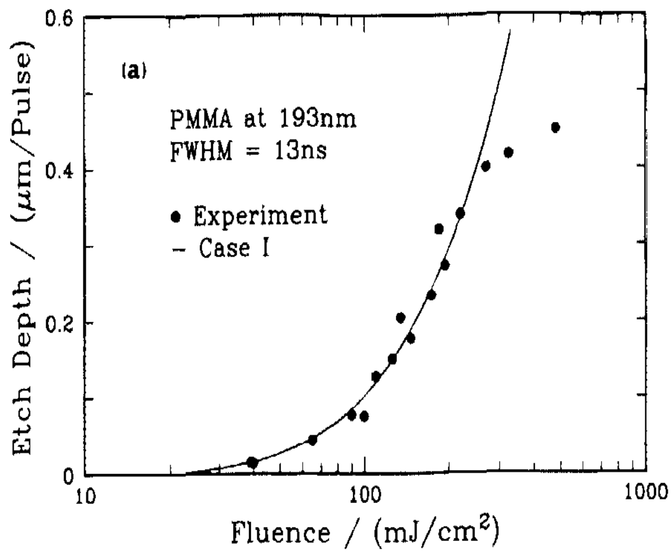


absorption spectrum of PMMA

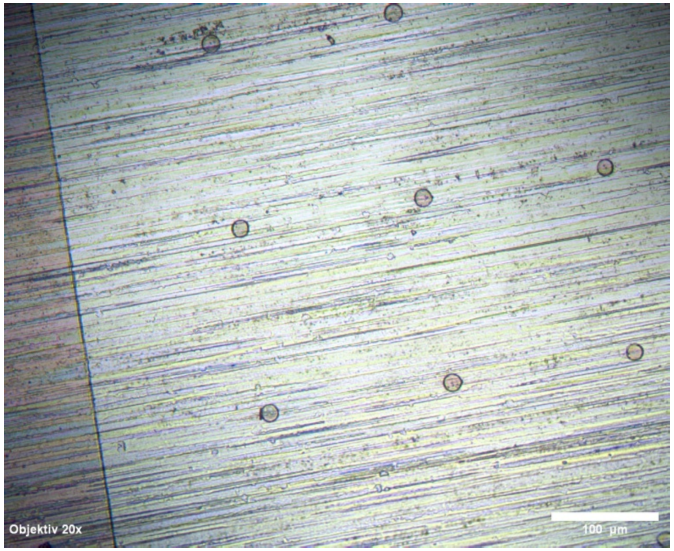
[4] Sutcliffe *et al* 1986 Dynamics of UV laser ablation of organic polymer surfaces *J.Appl.Phys.* **60** (9)

laser microstructuring 1



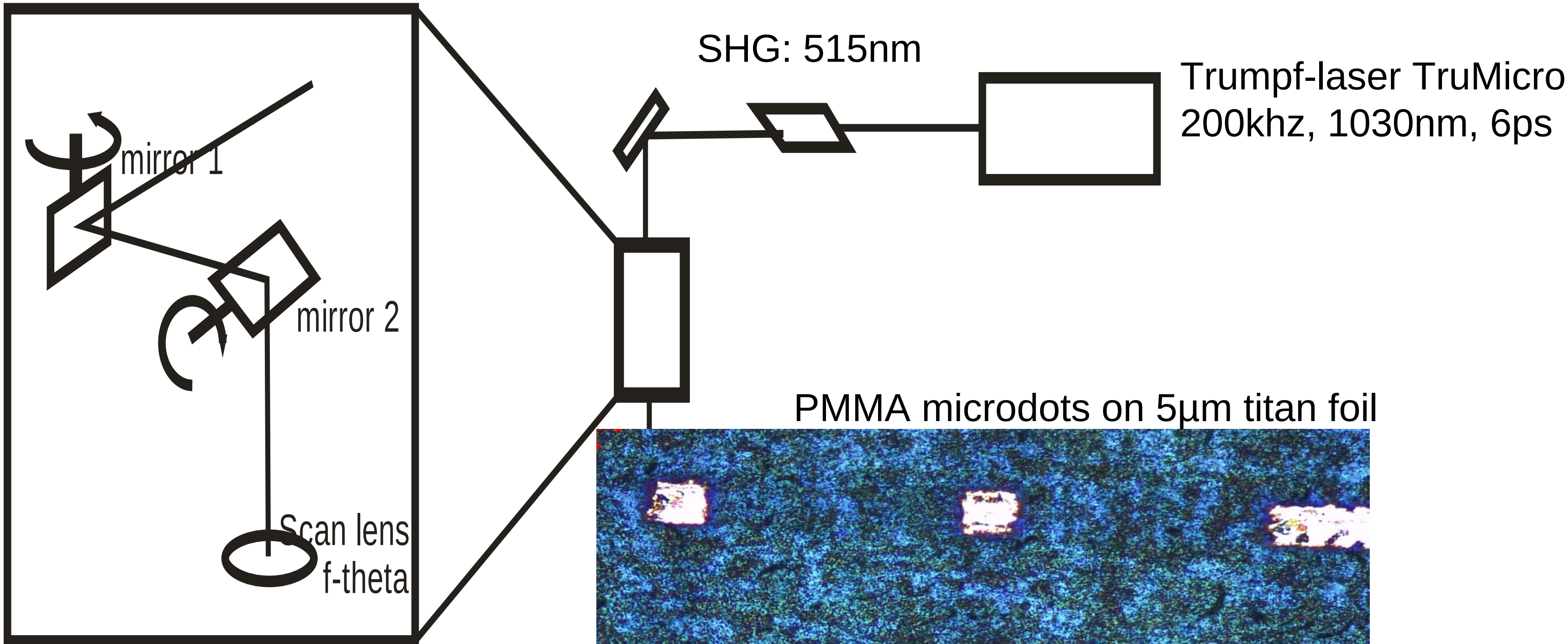


PMMA microdots on titanium foil



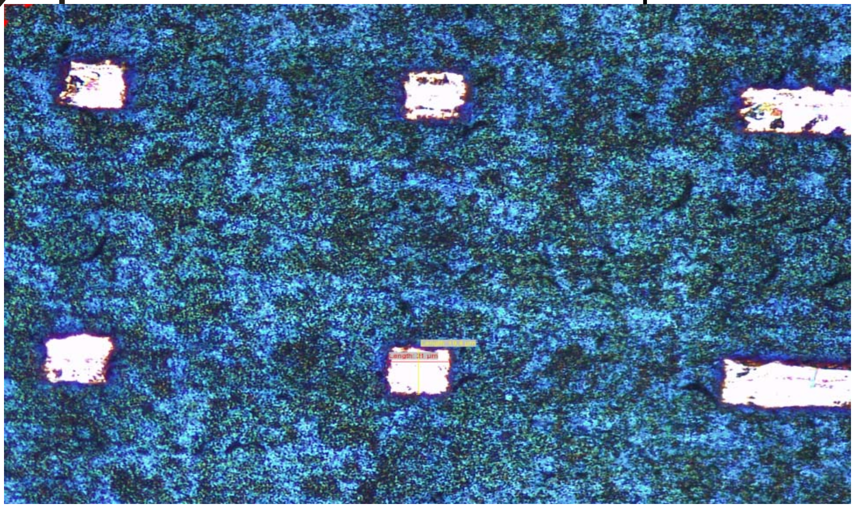
laser microstructurig 2

Microstructuring through direct focusing:



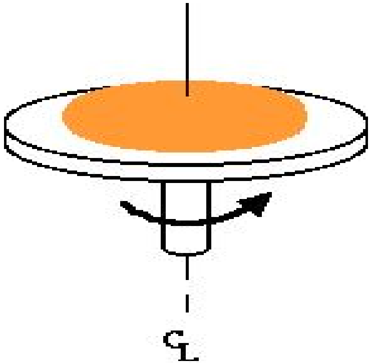
Scanner

PMMA microdots on 5µm titan foil



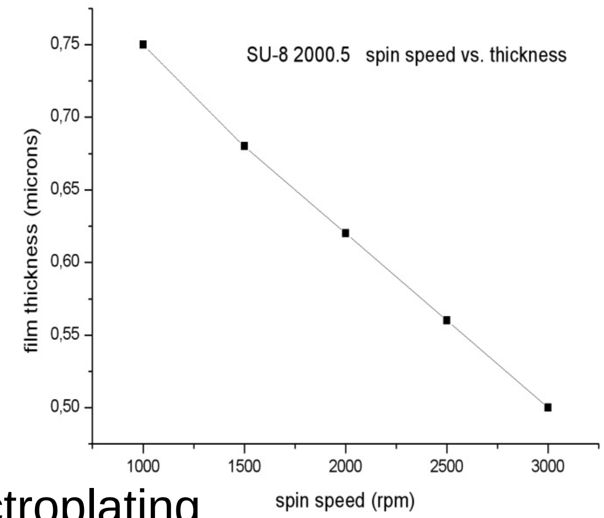
Photolithography

SU-8 (negative photoresist) as proton source applied on 5µm nickel by spincoating



spin-coater

covering the nickel layer with 500nm SU-8 by spin-coating technique



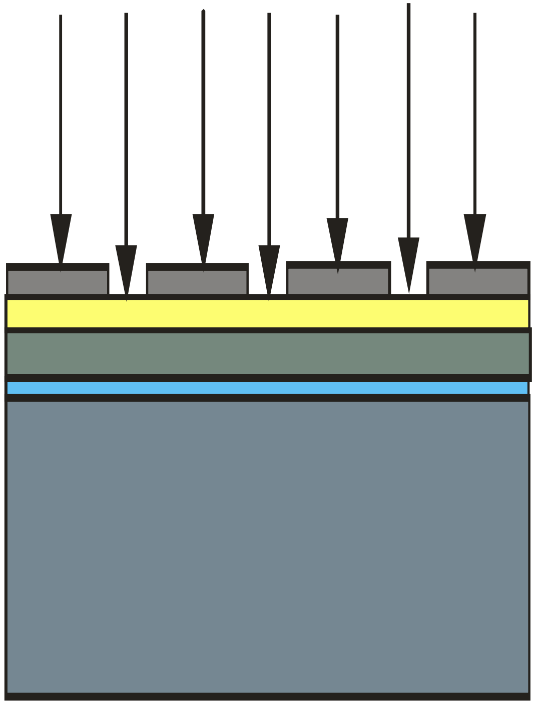
5 microns nickel by electroplating

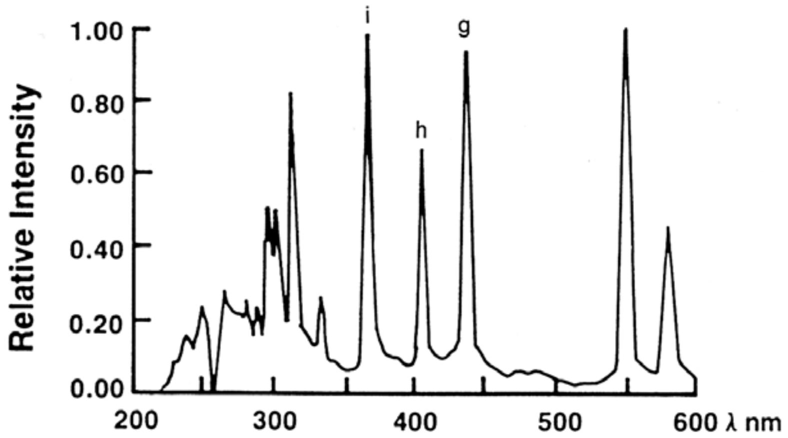
4“ quartz mask blank carried with a thin chrome layer by sputtering technique

Photolithography 2

contact printing:

exposure parts of the polymer-layer with a conventional uv source: 350…405nm



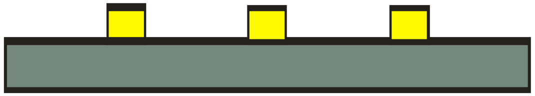


spectral distribution of a mercury discharge

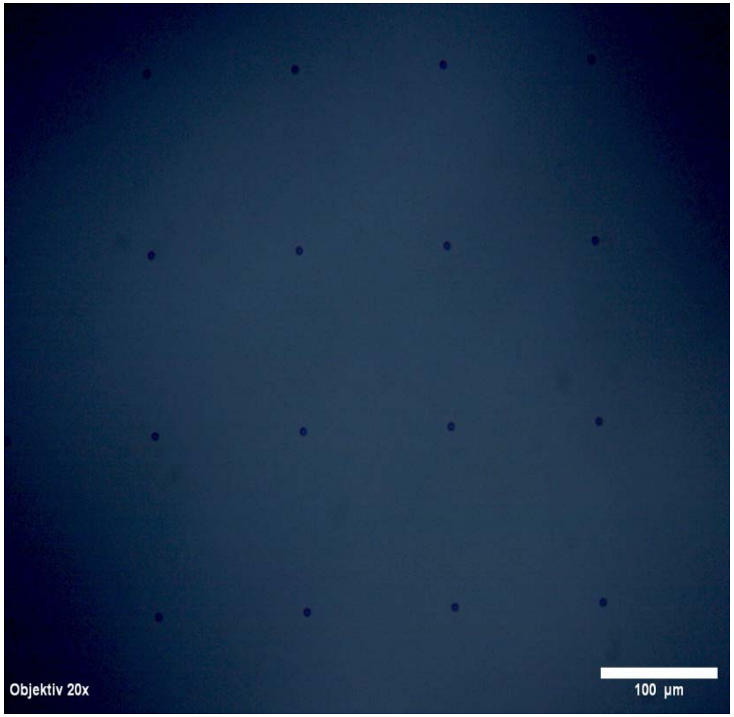
Photolithography 3

photomask

SU-8 microdots on 5µm nickel foil



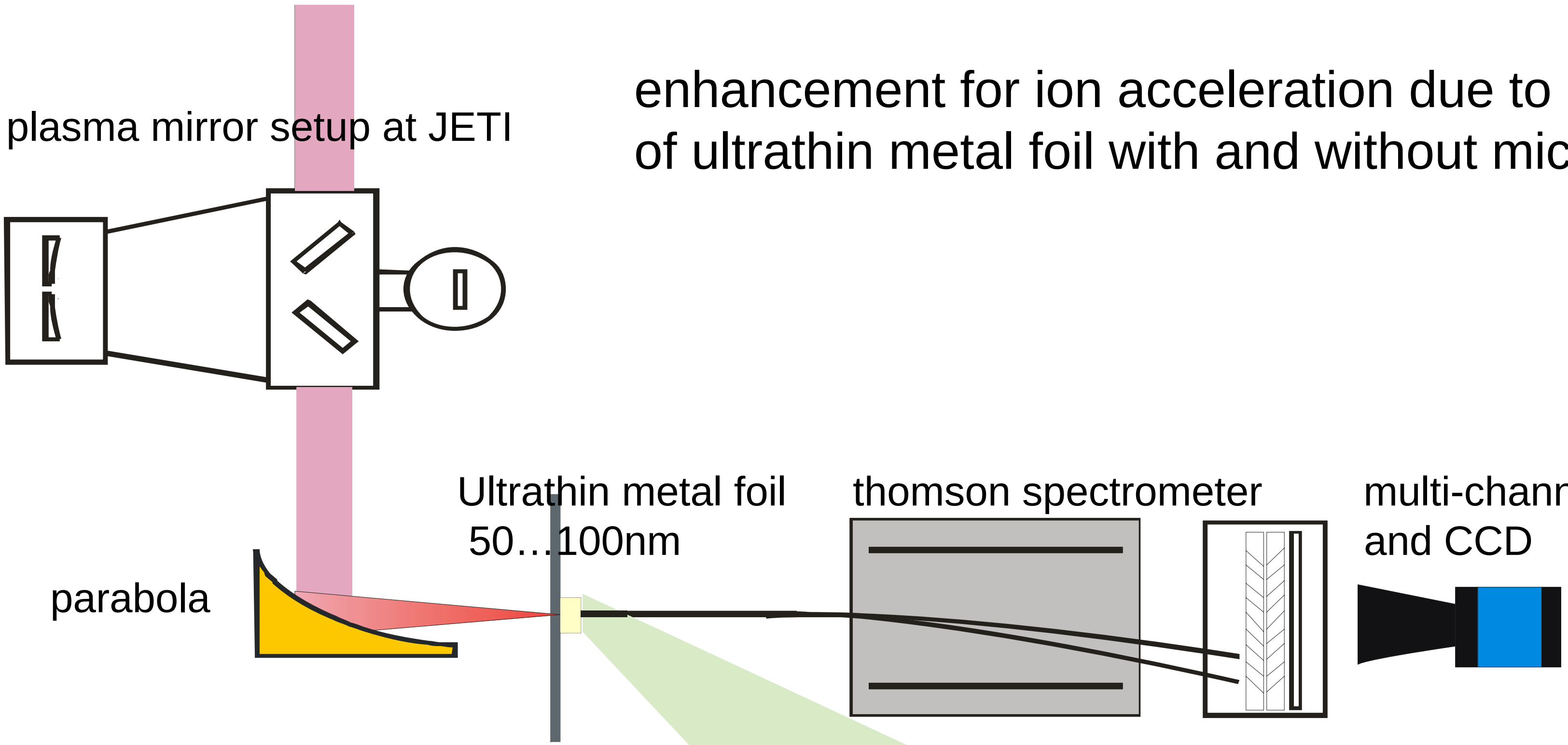
quartz plate (reusable)



micrograph of microdots on foil

High contrast laser pulse

enhancement for ion acceleration due to usability of ultrathin metal foil with and without microdots



[5] Antici *et al* 2007 Energetic protons generated by ultrahigh contrast laser pulses interacting with Ultrathin targets *Physics of Plasmas* **14** (030701)

[6] Neely *et al* 2006 Enhanced proton beams from ultrathin targets driven by high contrast laser pulses *Appl.Phys.Lett*. **89** 021502

[7] Ch. Rödel, Friedrich Schiller Universität Jena, Diploma thesis

ultrathin chrome membrane

4“ Silicon-Wafer, thickness 525microns

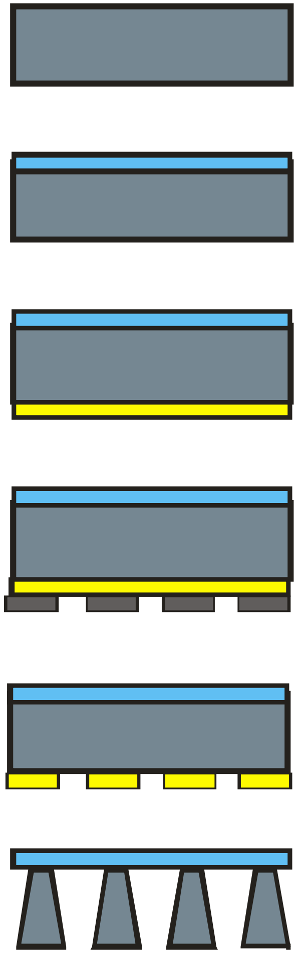
80 nanometers Chrome to wafer backside by sputtering technique

positve photoresist is spincoated to wafer frontside

exposure the resist by intense pattern of light

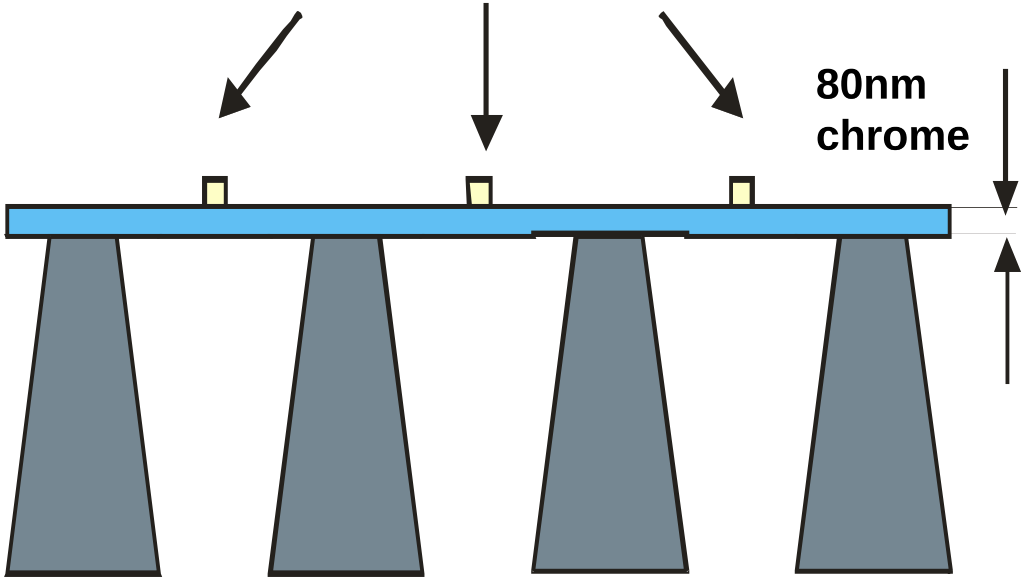
unwanted parts of the resist are removed by developer

wet etching process and strip the photo resist

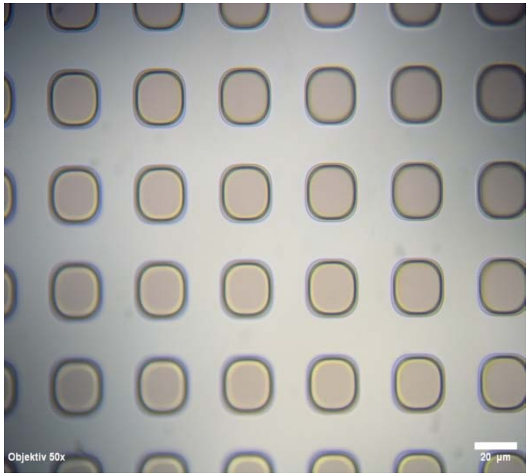


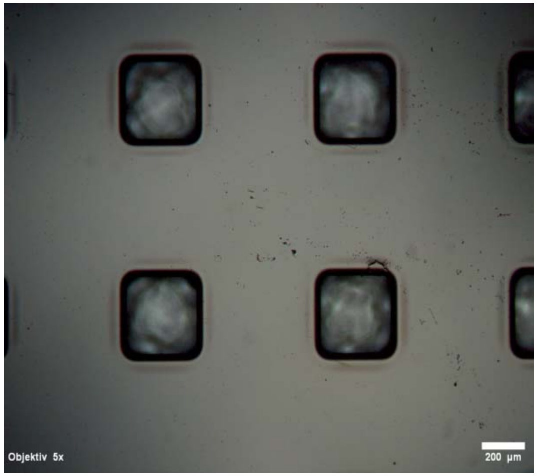
ultrathin chrome membrane

applying microdots at the ultrathin chrome layer at backside of wafer is possible too



channels for the laser pulse incidence fabricated by a wet etching process





Acknowledgements

Institute of Optics and Quantumelectronics:

J.Polz, O.Jäckel, H.P. Schlenvoigt, J. Heymann, W.Ziegler, Ch.Rödel, M.Heyer, F.Ronneberger, B.Beleites, M.Kaluza and G.Paulus

Institute of Applied Physics

S.Döring, F.Brückner, B.Kley, W.Gräf and S.Nolte