

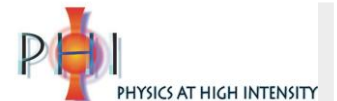
Diagnostics of Laser-Accelerated Proton (Ion) Beams on UHI100

V. Floquet, T. Ceccotti, A. Levy, S. Dobosz-Dufrenoy, P. Monot, E. Attinault and Ph. Martin

CEA/SPAM/PHI

Saclay, FRANCE

Instrumentation for 09-10/08/2010
Diagnostics and Control of
Laser-Accelerated Proton
(Ion) Beams
Workshop, Abingdon (UK)



Diagnostics of Laser-Accelerated Proton (Ion) Beams on UHI100

- UHI 100
 - Facility
 - Thomson Parabola
 - MCP Calibration
- High fluence effect detection
 - Absorbing material
 - NaCl
 - RadioChromic Film HD 810
 - Scintillating material
 - CdWO₄

Diagnostics of Laser-Accelerated Proton (Ion) Beams on UHI100

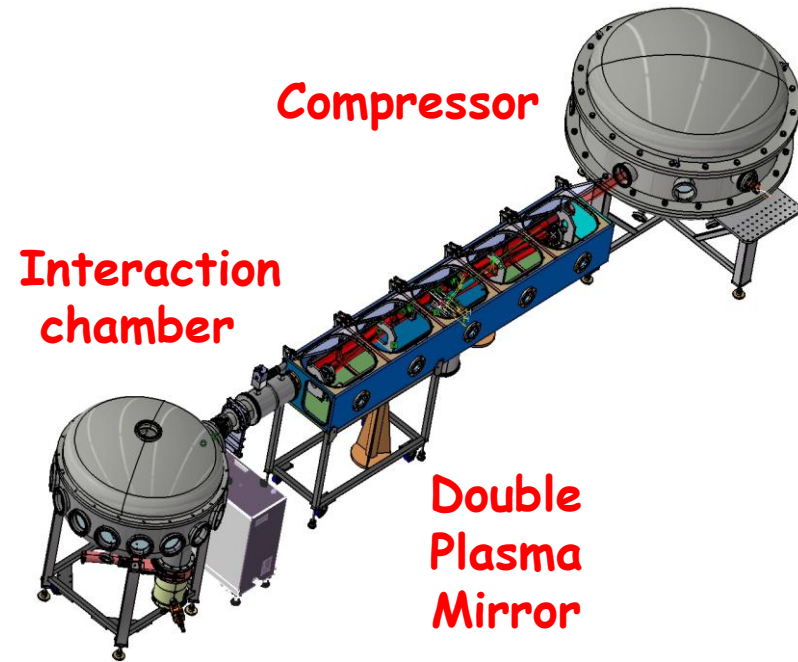
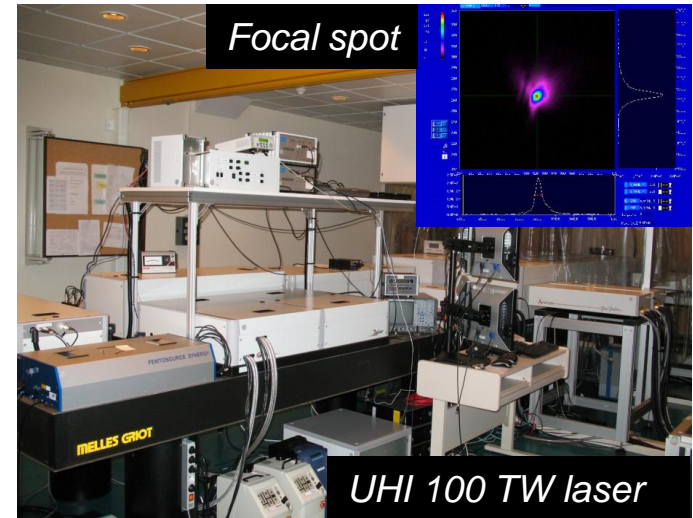
- UHI 100
 - Facility
 - Thomson Parabola
 - MCP Calibration
- High fluence effect detection
 - Absorbing material
 - NaCl
 - RadioChromic Film HD 810
 - Scintillating material
 - CdWO₄

UHI 100 - Facility

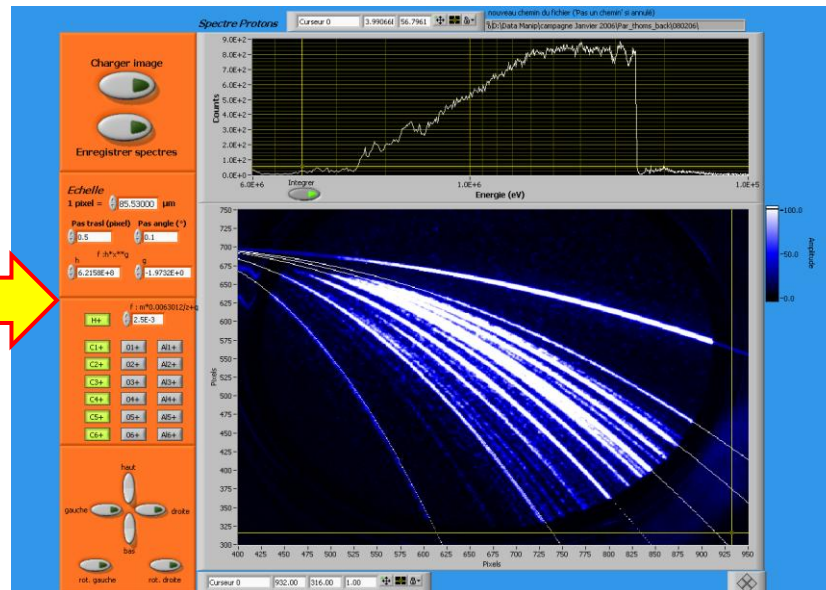
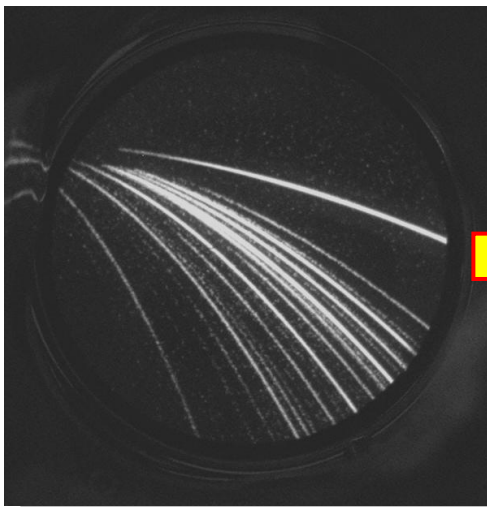
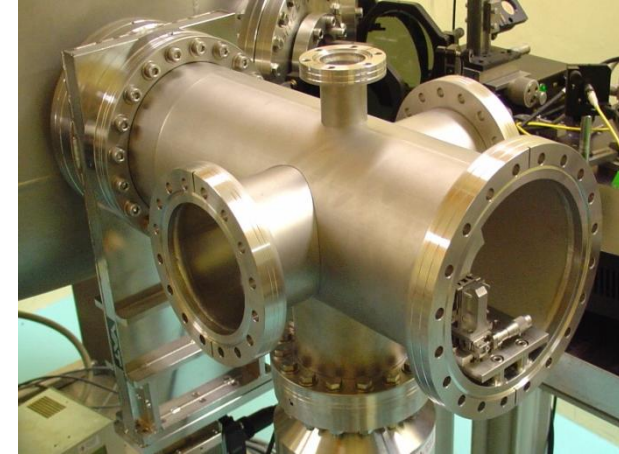
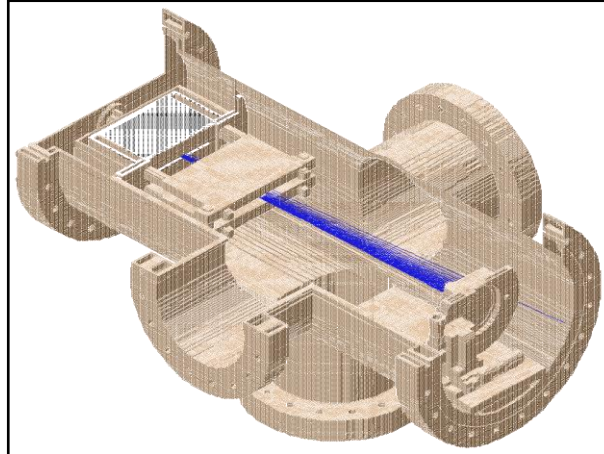
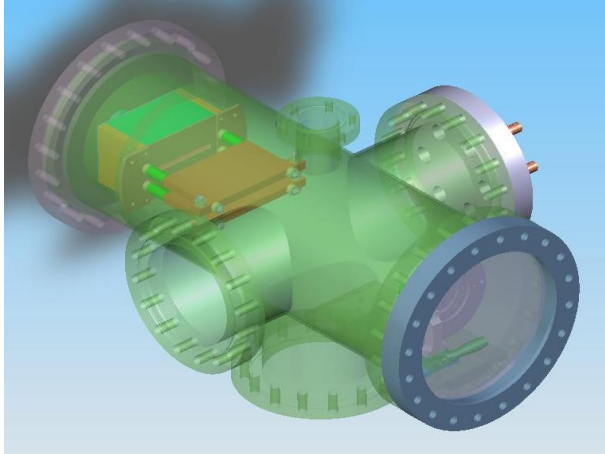
- 2.2 J
 - 25 fs
 - $I_{\text{laser}} \approx 8 \cdot 10^{19} \text{ W/cm}^2$
 - Contrast ratio $\approx 10^{12}$ (?) – DPM
 - Deformable mirror (September 2010)
- Expected max proton energy $\geq 10 \text{ MeV}$

Detection

Applications



UHI 100 - Thomson Parabola



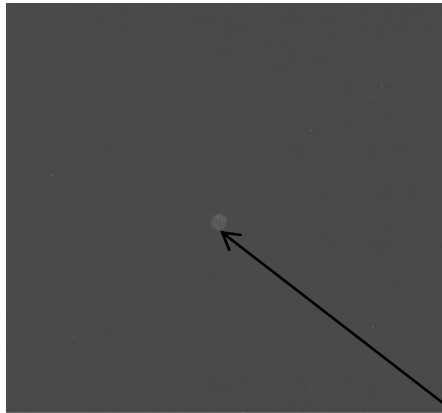
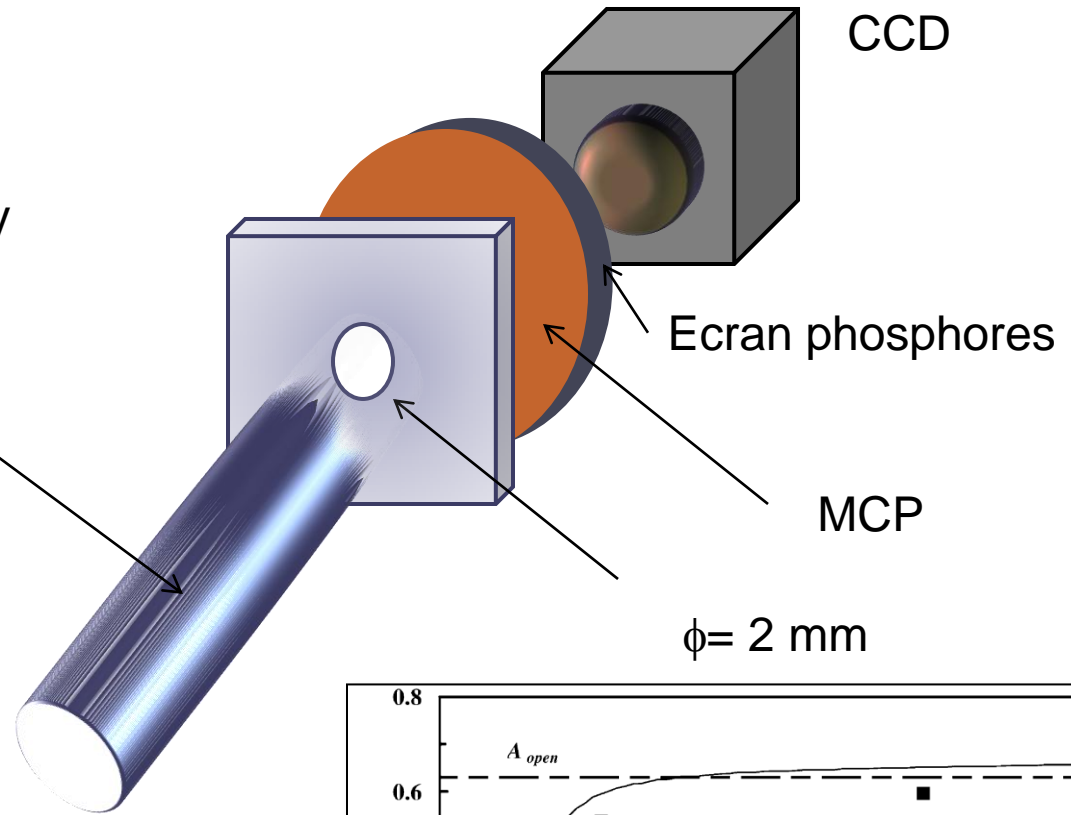
- Magnet ~ 2850 G
- Electric field ~ 4000 V
- Spatial res. ~ 100 μm
- Range ~ 500 KeV ÷ 15 MeV
- $E/\Delta E \sim 60$ @ 1 MeV
- MCP + phosphors screen + CCD

UHI 100 - MCP calibration

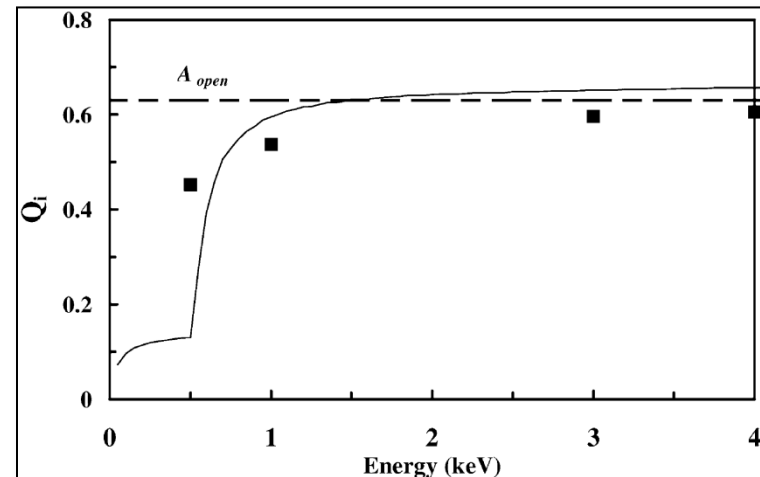
TANDEM accelerator (IPN, Orsay)

Proton energies: 5 to 20 MeV

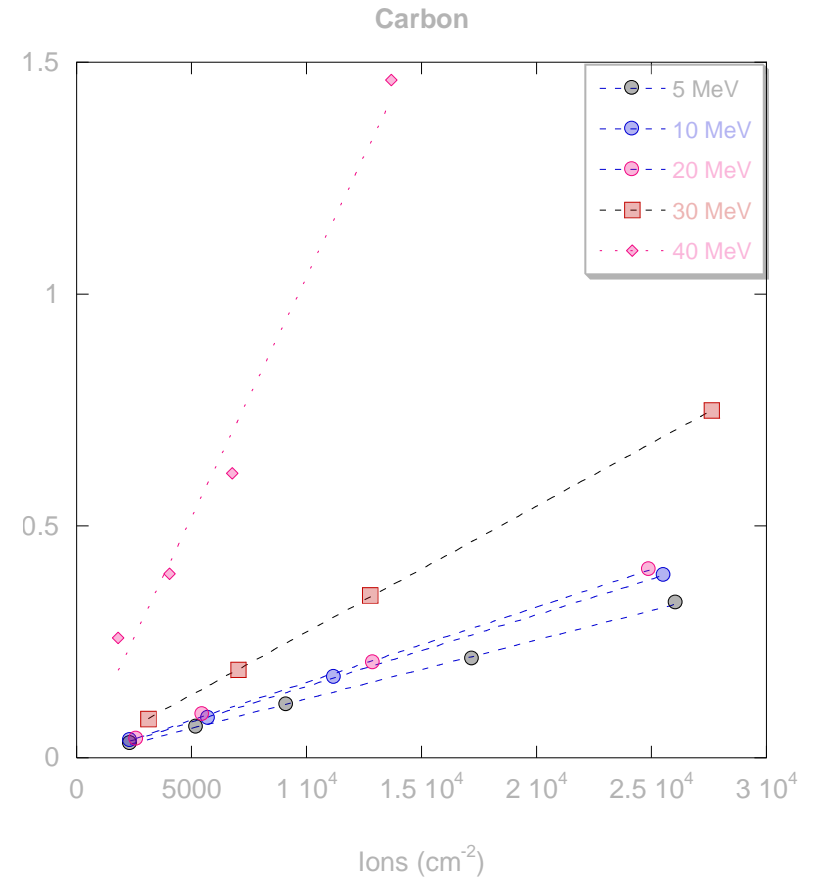
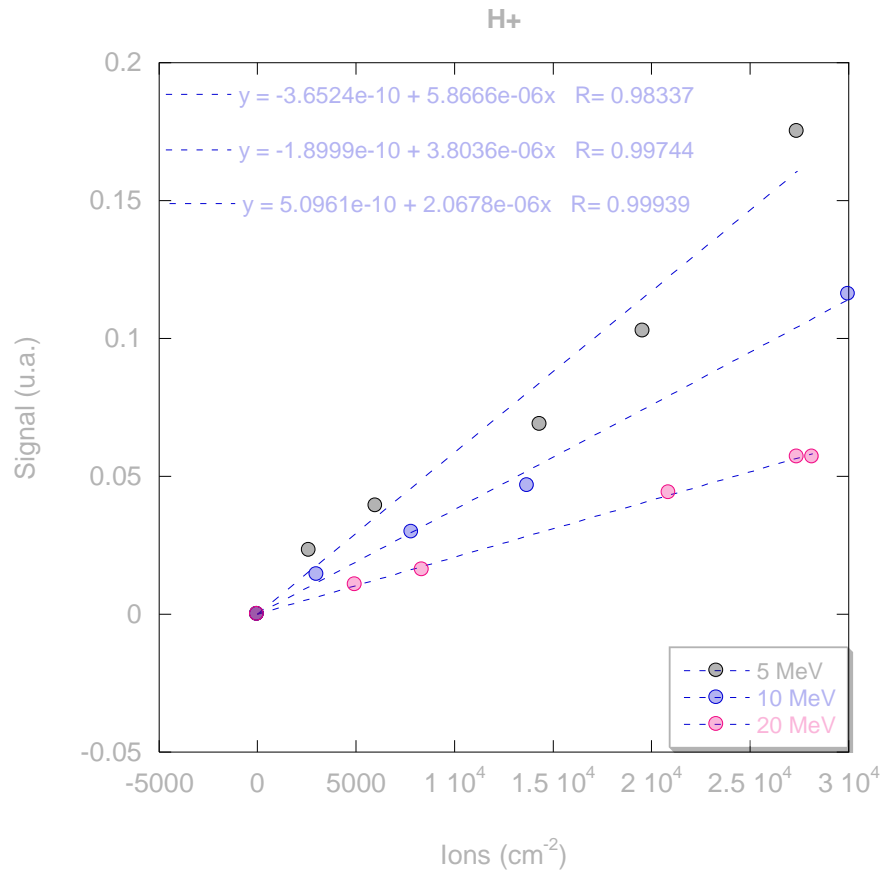
Carbon ions energies : 5 to 40 MeV



$\phi \text{ (ions/cm}^2) \propto \text{signal/Surface}$



UHI 100 - MCP calibration

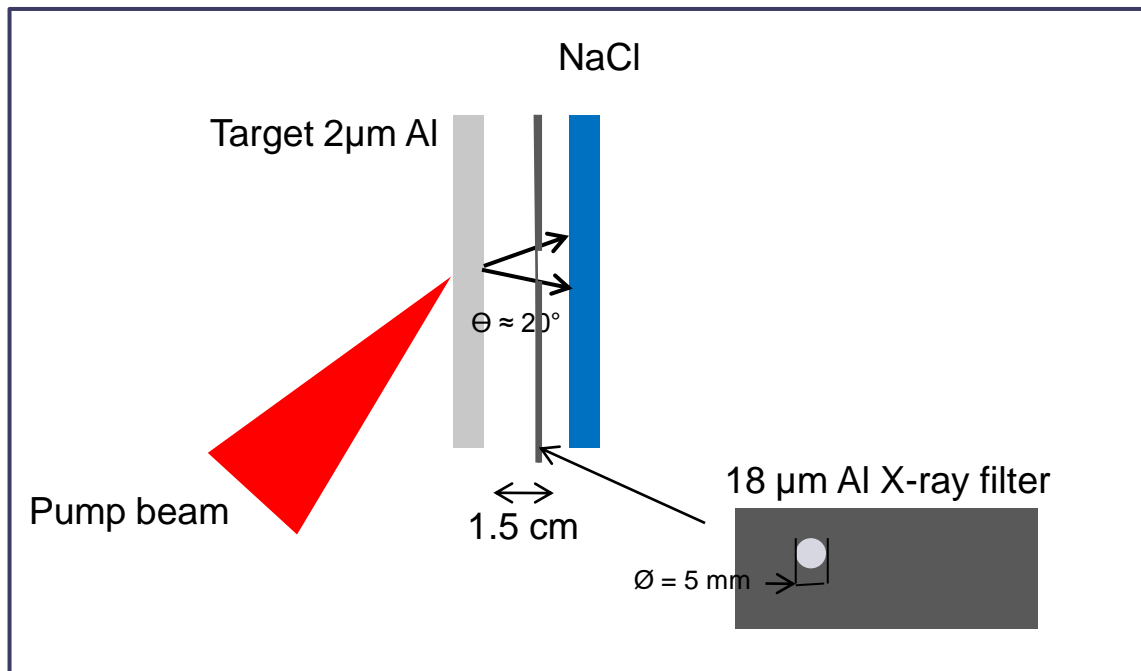


* Signal = valeur moyenne par pixel

Diagnostics of Laser-Accelerated Proton (Ion) Beams on UHI100

- UHI 100
 - Facility
 - Thomson Parabola
 - MCP Calibration
- High fluence effect detection
 - Absorbing material
 - NaCl
 - RadioChromic Film HD 810
 - Scintillating material
 - CdWO₄

High fluence effect detection - Absorbing material: NaCl



More than 10 shoots
>10⁹ Protons

Sample Analysis
afterward



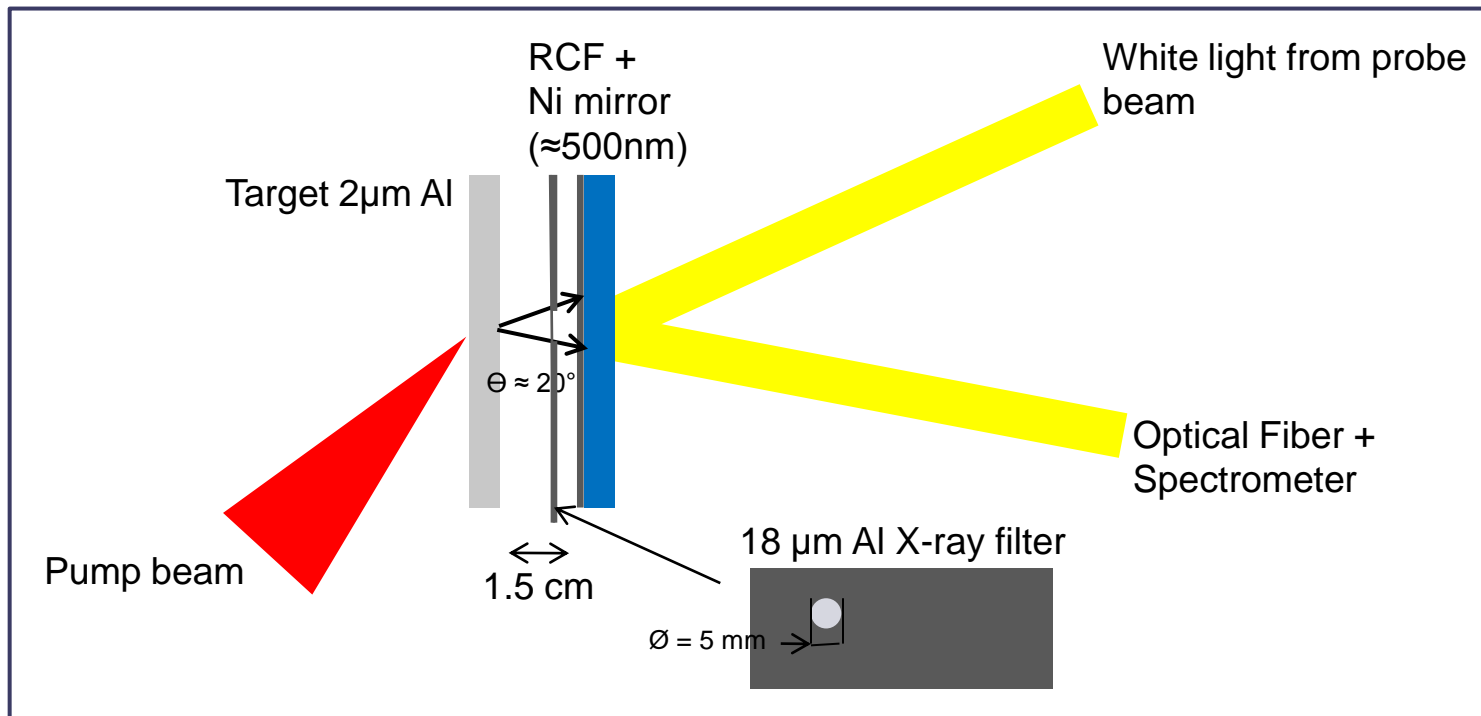
**No darkening of the
material**



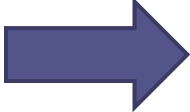
**pump/probe
installation useless**

Slight darkening starts at about 360 Gy... (tested with a ¹³⁷Cs photon source)

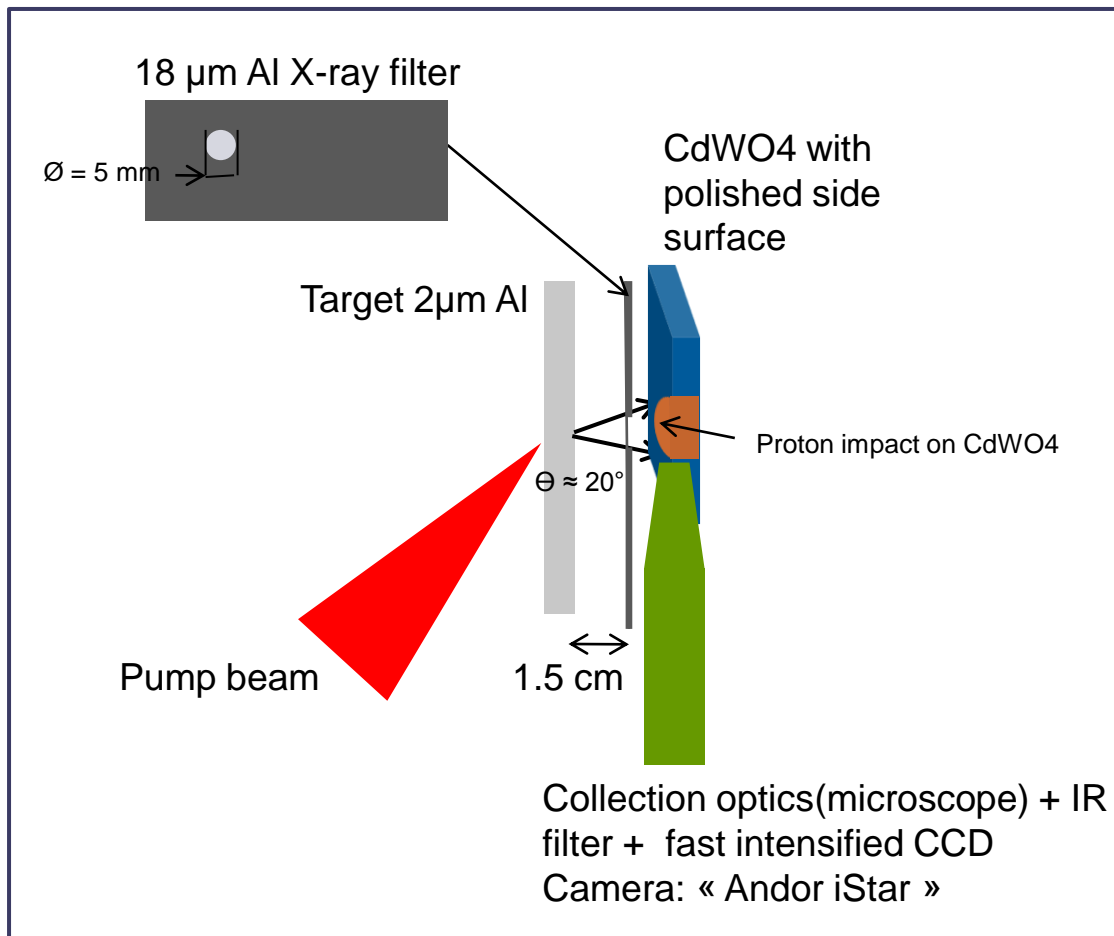
High fluence effect detection – Absorbing material: RCF HD810



High fluence effect detection - Absorbing material: RCF HD810

- Analysing the slow kinetic of polymerisation mechanism!!!
 Need of more than 5 ns delayed probe
- Observing early polymerisation mechanism at different wavelength! ($\lambda = 500\text{nm} ? 600\text{nm} ?$)

High fluence effect detection - Scintillator material: CdWO₄



CdWO₄:

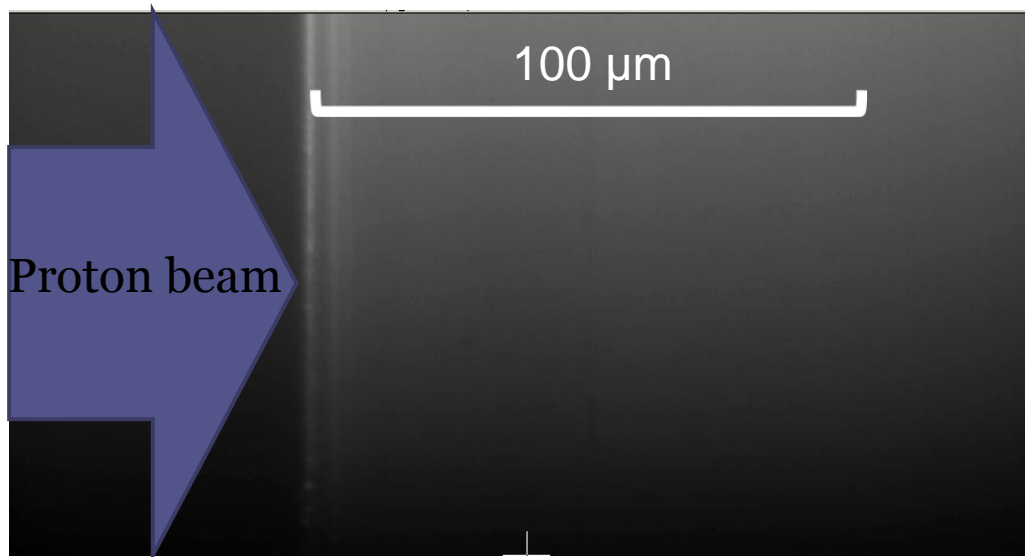
- $\tau = 15 \mu\text{s}$
- $\eta \approx 10$ photons / keV

Collection geometry:

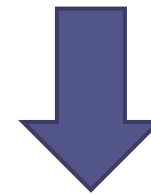
- $S_{\text{image}} = 0.15 \mu\text{m}^2$
- **Microscope opening $\varnothing = 5$ mm $\rightarrow \Omega \approx 0.34$ sr**

Particles of use to image:

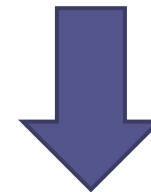
- ≈ 2000 Protons
- $\approx 10^6$ Photons



2D image: white light
reflection



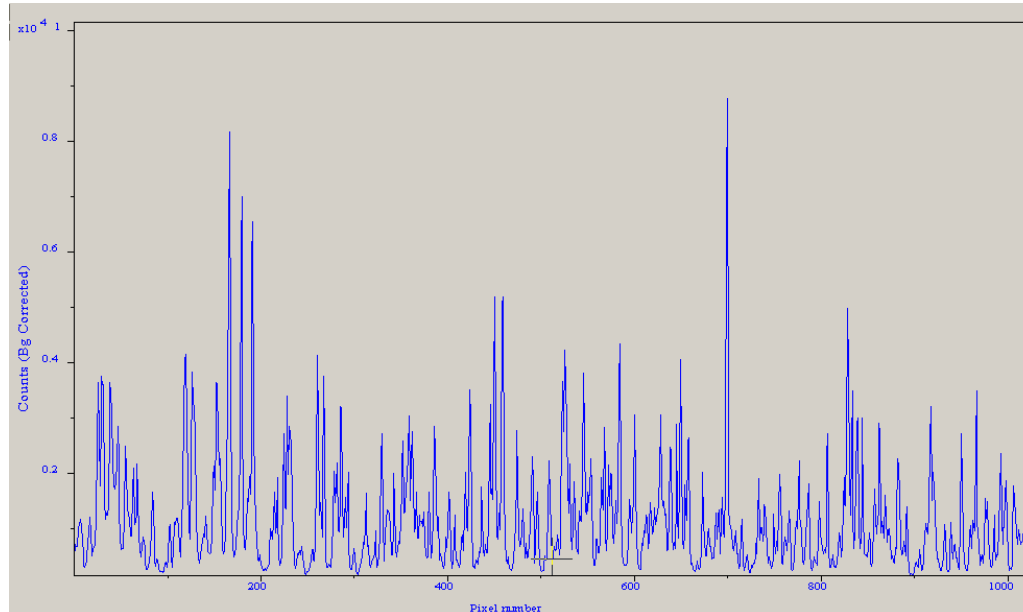
2D luminescence image
-> No signal



Full Vertical Bining

100 μ s after
the laser
shot

(= no laser
signal
integrated)



Integration width tested: few μ s to few ms
Integration window delay tested: -2 μ s to 200 μ s

Thank you for your attention