

Low Energy, Low Intensity Limits of Scintillators*

Janusz Harasimowicz

* J. Harasimowicz, L. Cosentino, P. Finocchiaro, A. Pappalardo, and C. P. Welsch,
**Scintillating Screens Sensitivity and Resolution Studies for Low Energy, Low
Intensity Beam Diagnostics**, Rev. Sci. Instrum. 81, 09xxxx (2010)

Content

- Results** {
- ① Motivation
 - ② The Project
 - ③ Beam Profiles
 - ④ Resolution
 - ⑤ Beam Current
 - ⑥ Sensitivity
 - ⑦ Outlook

Motivation



Diagnostic Challenges

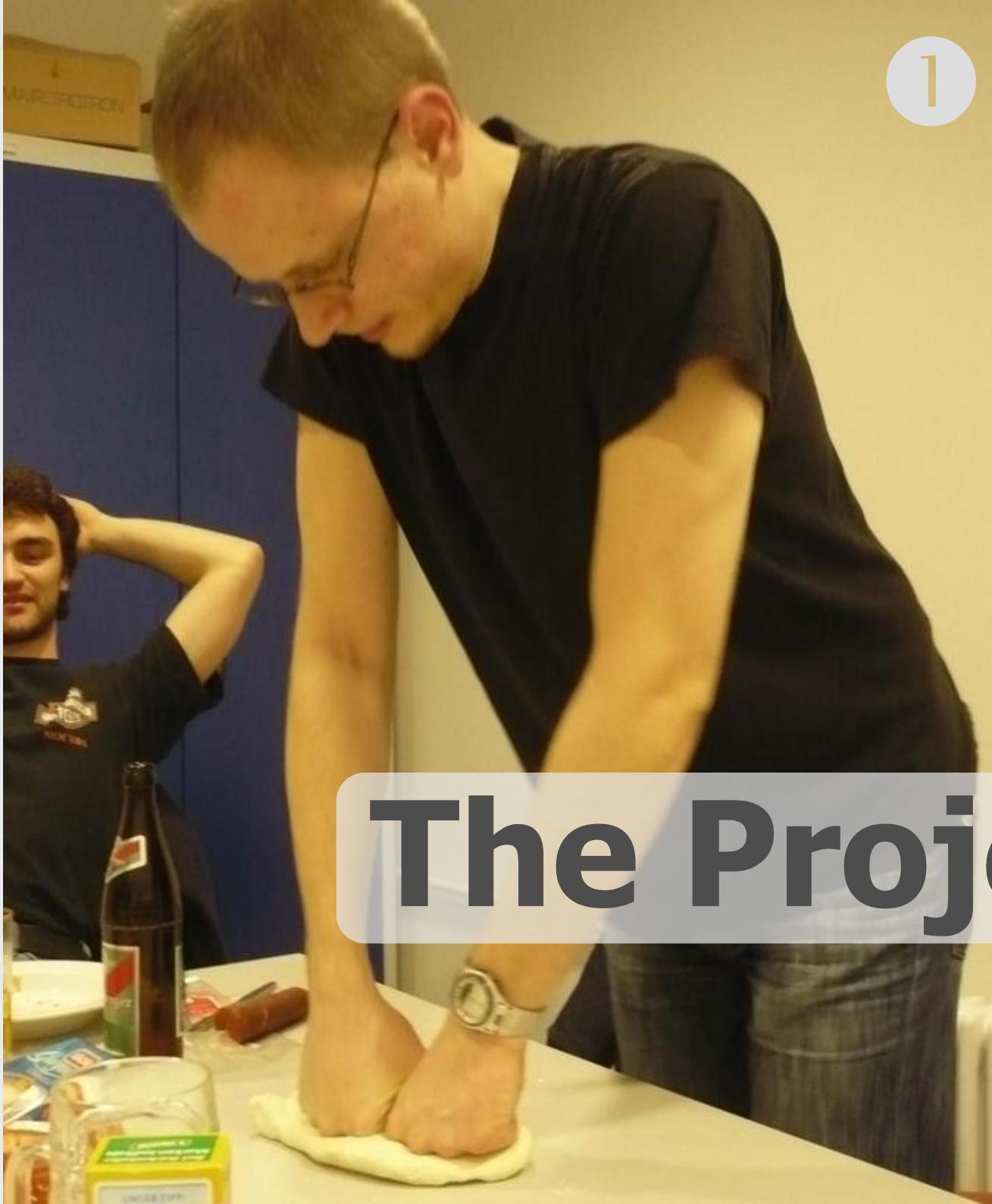
- **Low energy beams:** $<500 \text{ keV}$
- **Low intensity beams:** $<10^7 \text{ pps}$

Beam Profile Monitoring

- **Scrapers** (time consuming)
 - **Gas. detectors** (too destructive)
 - **SEE monitors** (££, complex)
 - **Gas-jet curtain** (£££, complex, huge)
 - **Scintillators** (not sensitive)?

The Question

**What are the limitations of
scintillators applied to keV proton
beam profile monitoring?**



The Project

People Involved



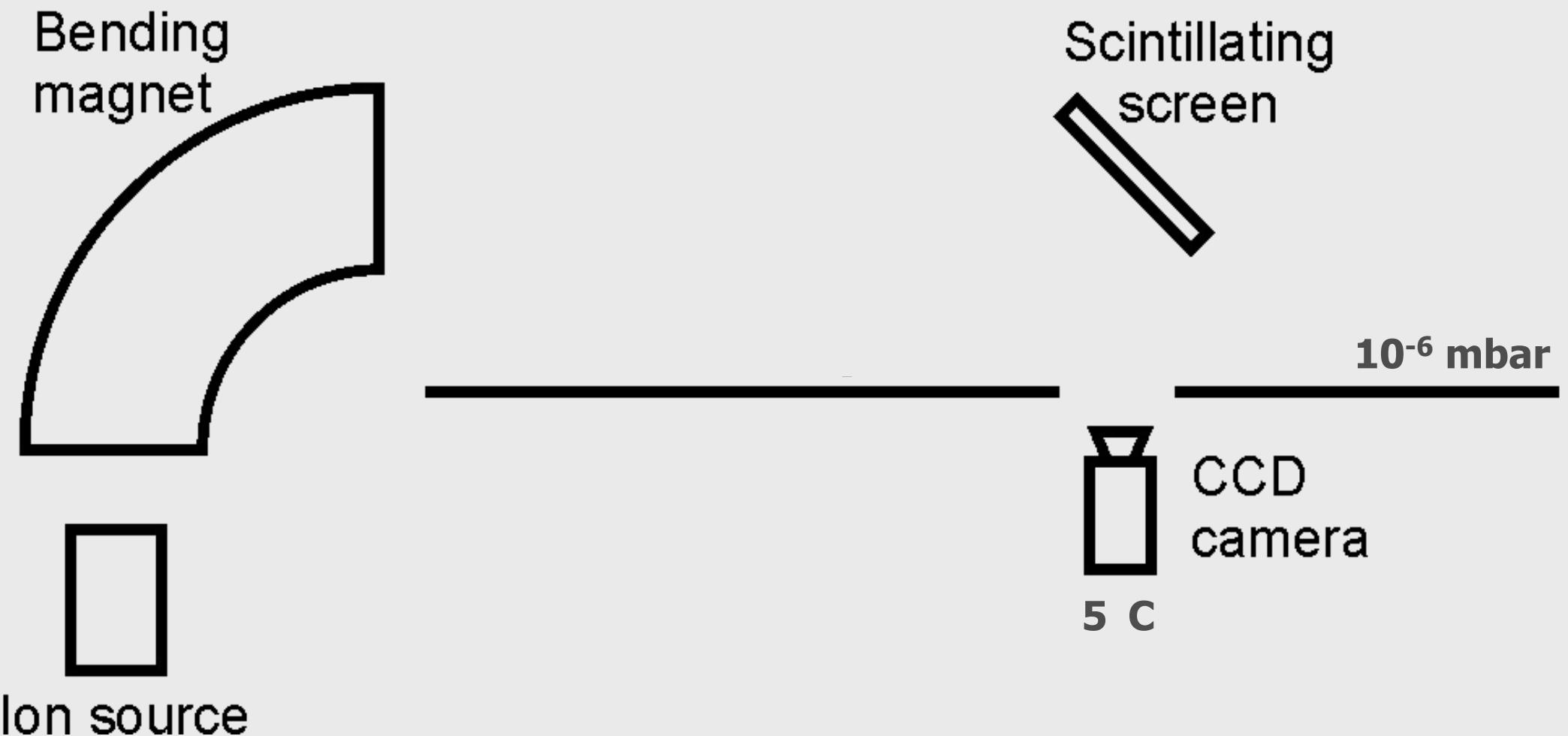
**Paolo
Finocchiaro**
INFN-LNS

**Luigi
Cosentino**
INFN-LNS

**Carsten P.
Welsch**

**Alfio
Pappalardo**
INFN-LNS
(not in the pic.)

Setup @ INFN-LNS



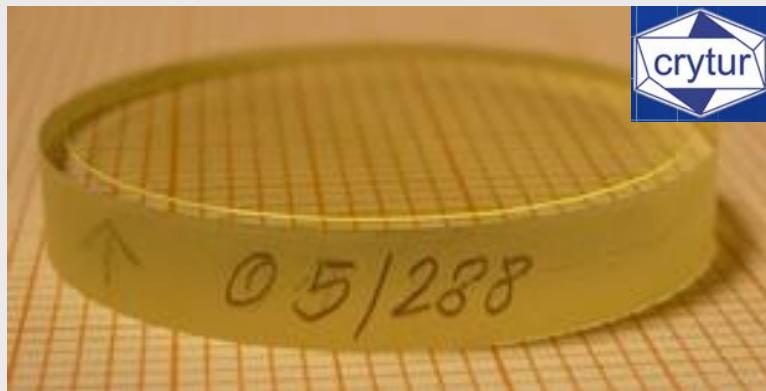
Particle Beams

- **Particles:** protons
- **Energy:** 200 keV & 50 keV
- **Intensity:** down to few pA
(plus attenuators)

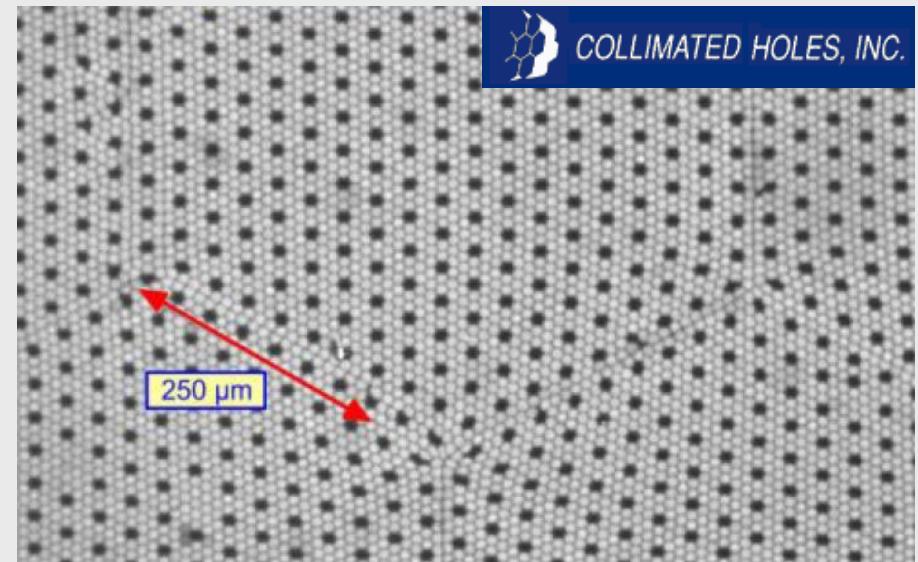
Scintillators



**1 mm thick Thallium-doped
Caesium Iodide (CsI:Tl)**

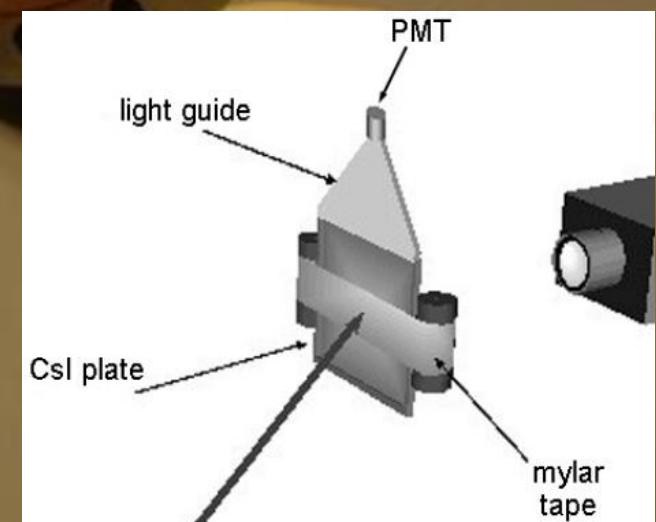
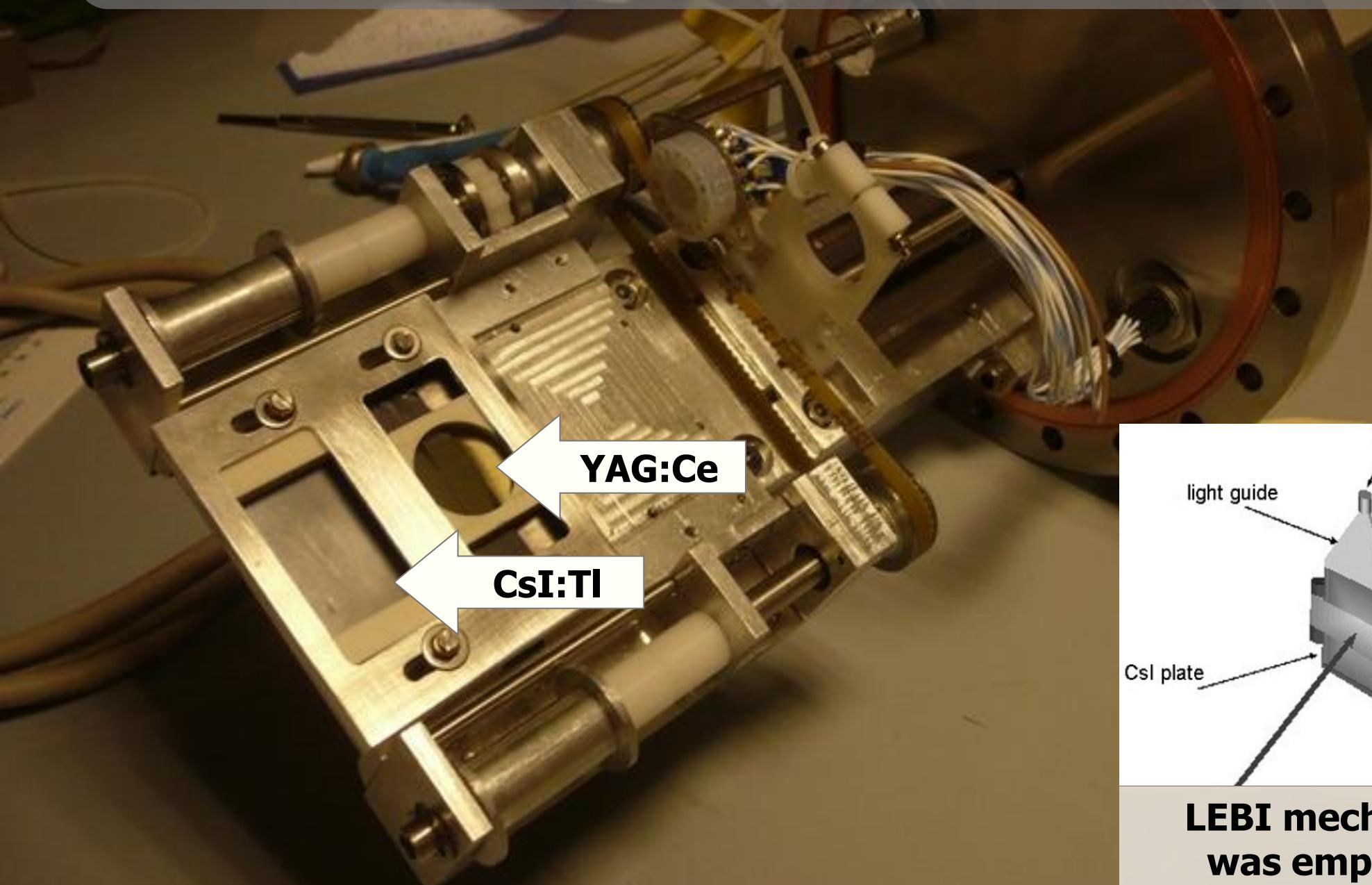


**0.05 mm thick Cerium-doped YAG crystal
(YAG:Ce) deposited onto a 4 mm thick glass base**



**2 mm thick Terbium-doped
glass Scintillating Fibre Optic
Plate (SFOP) consisting of 10
μm diameter fibres**

Setup



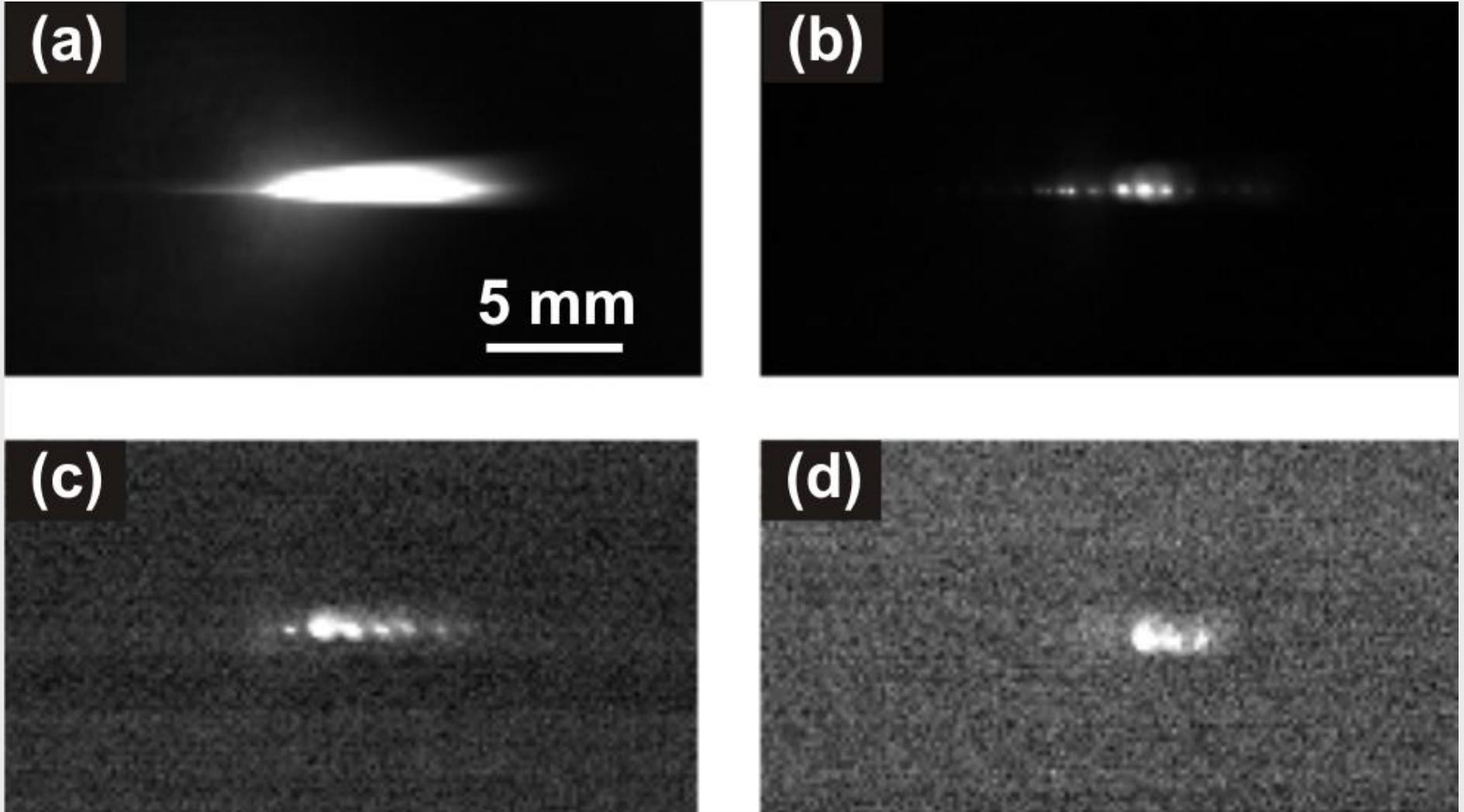
**LEBI mechanism
was employed**

Results

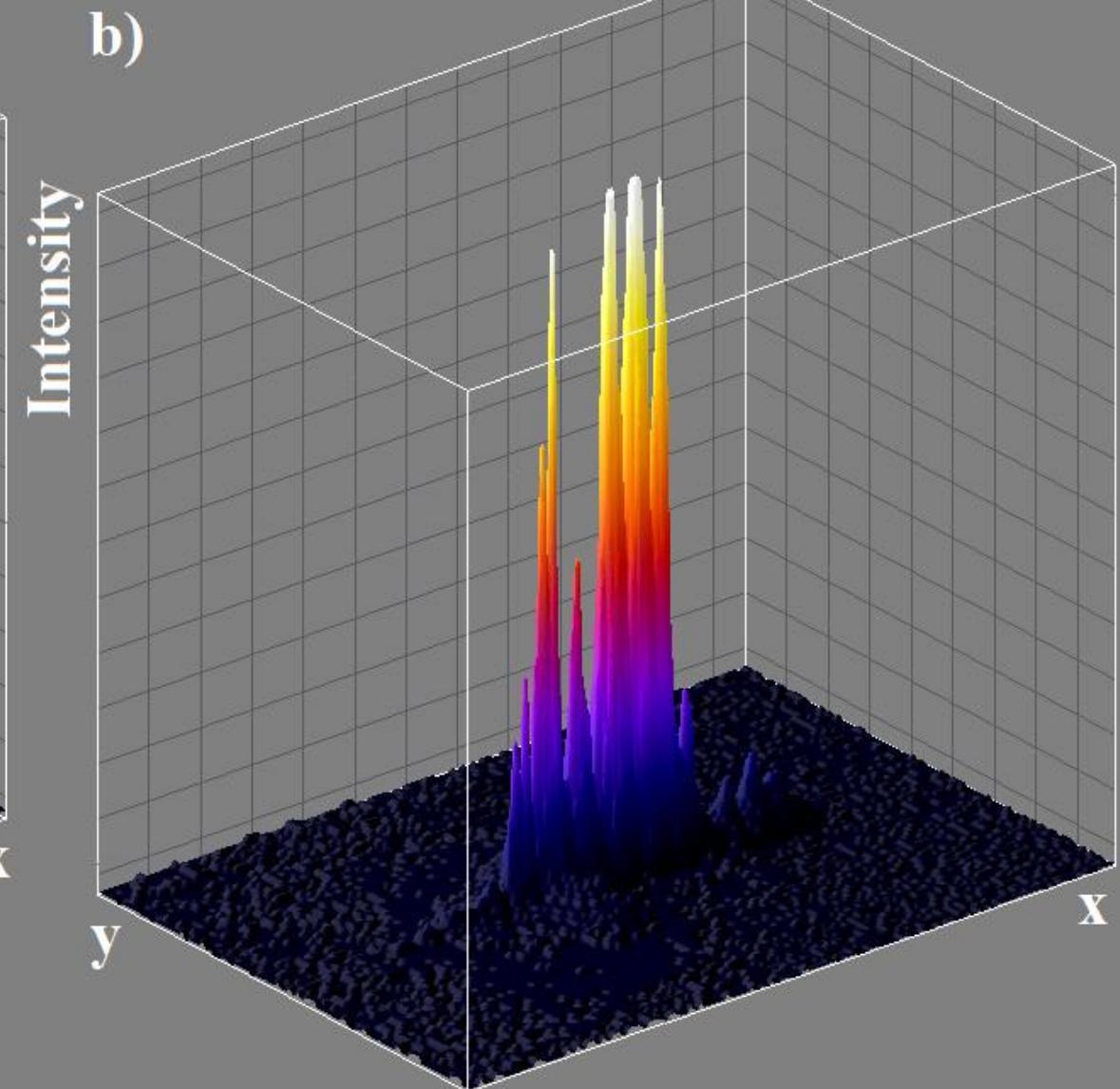
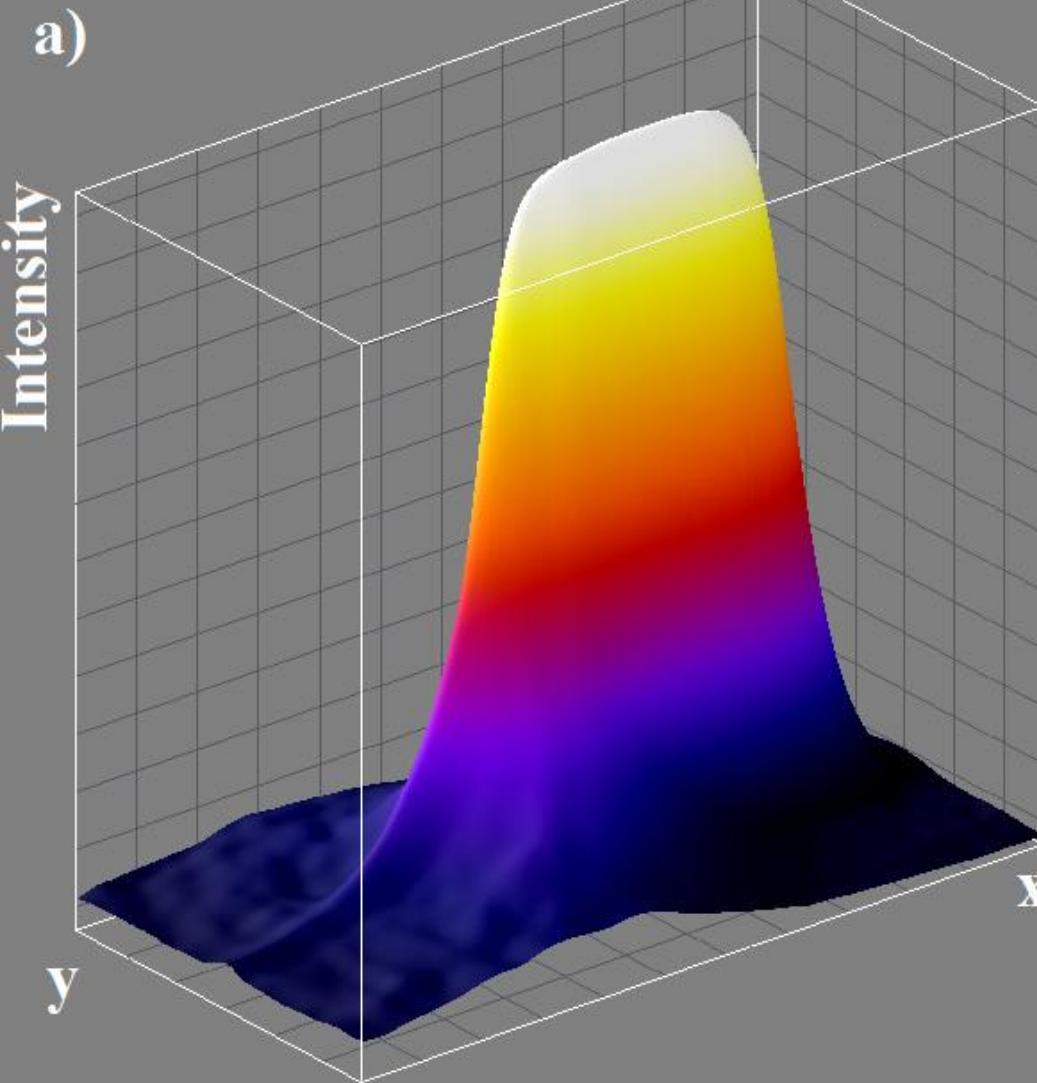


Beam Profiles

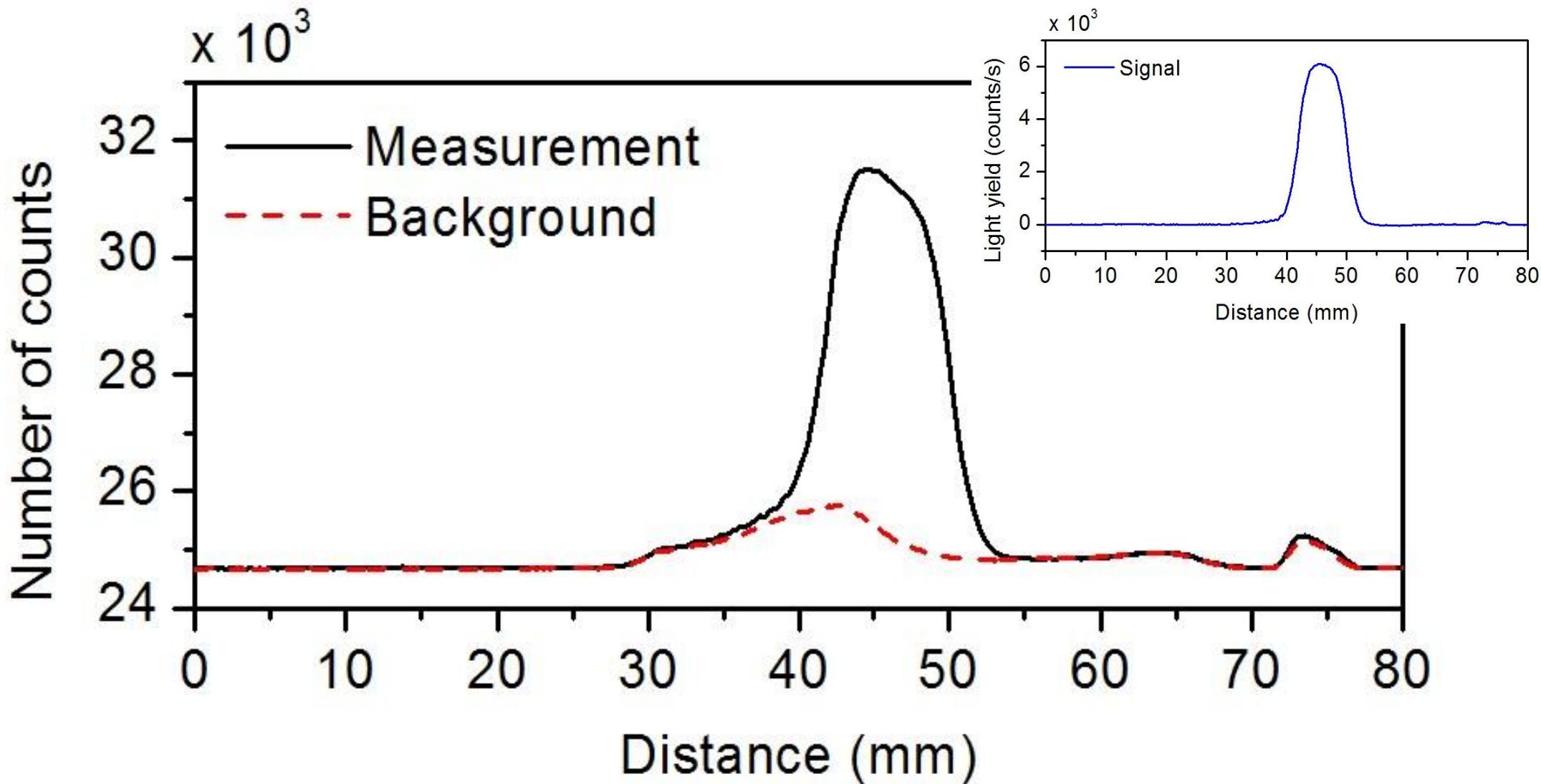
Beam Images



Beam Images



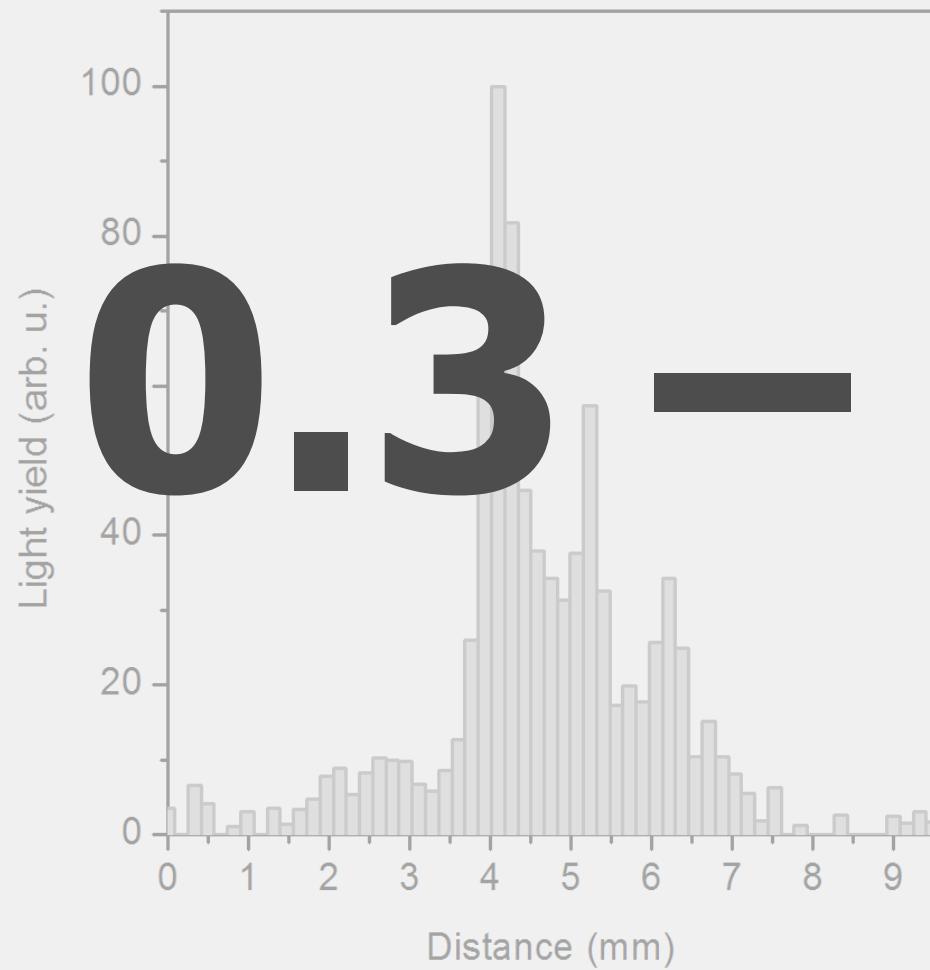
Background Subtraction



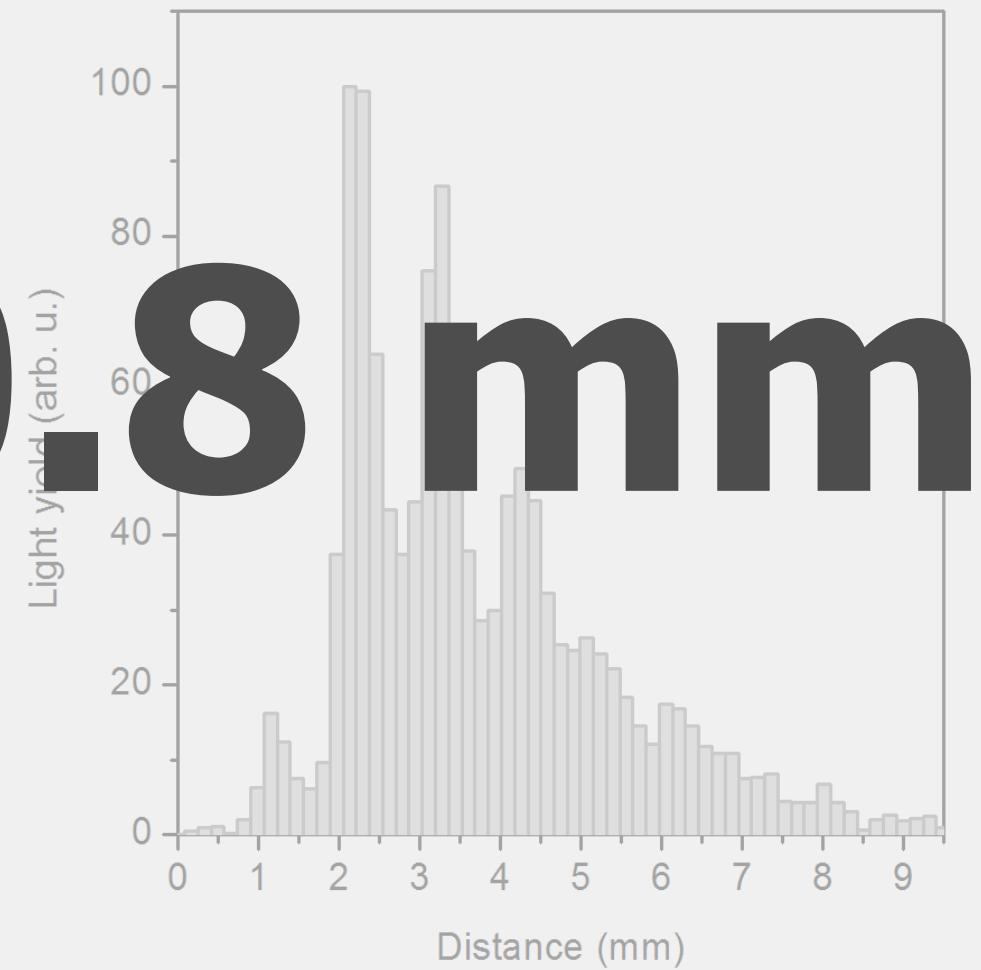
Resolution

Observed FWHM

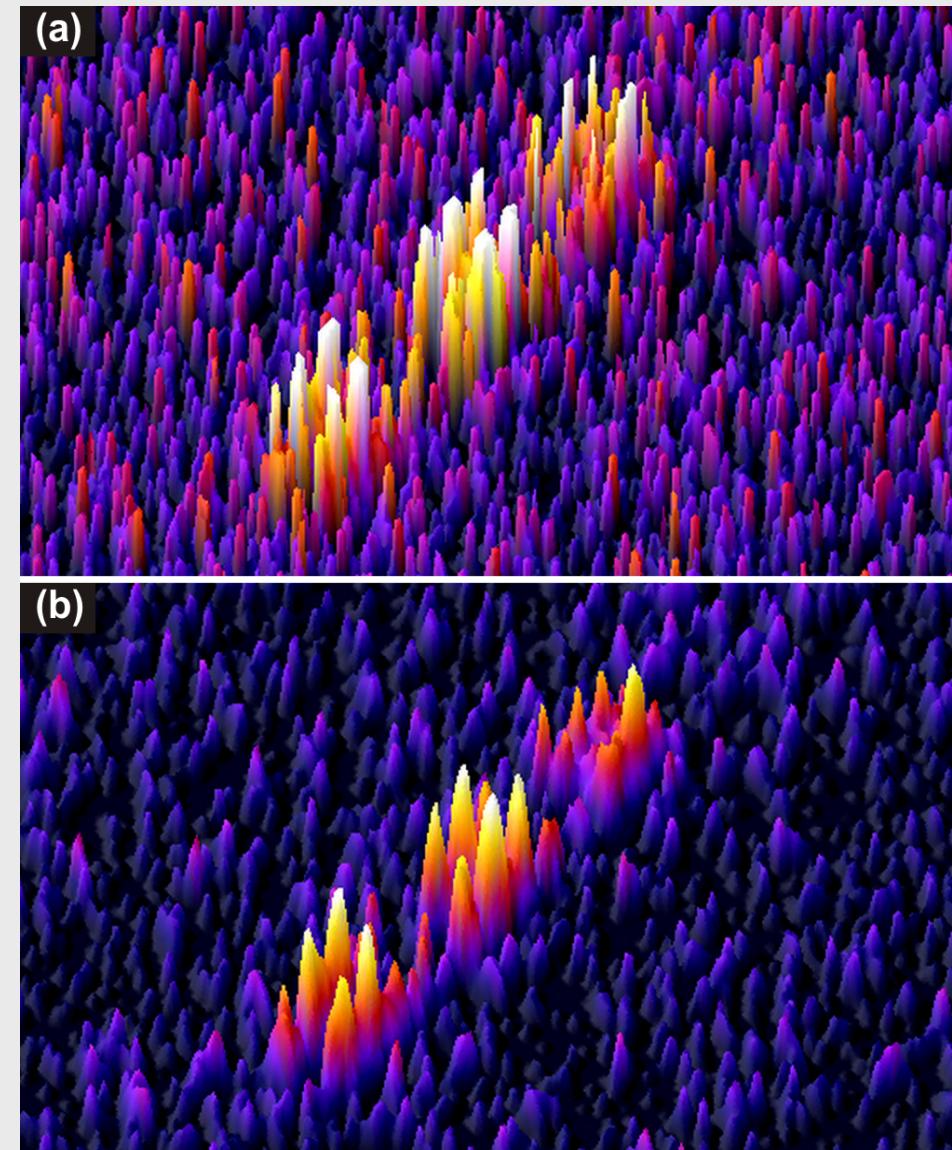
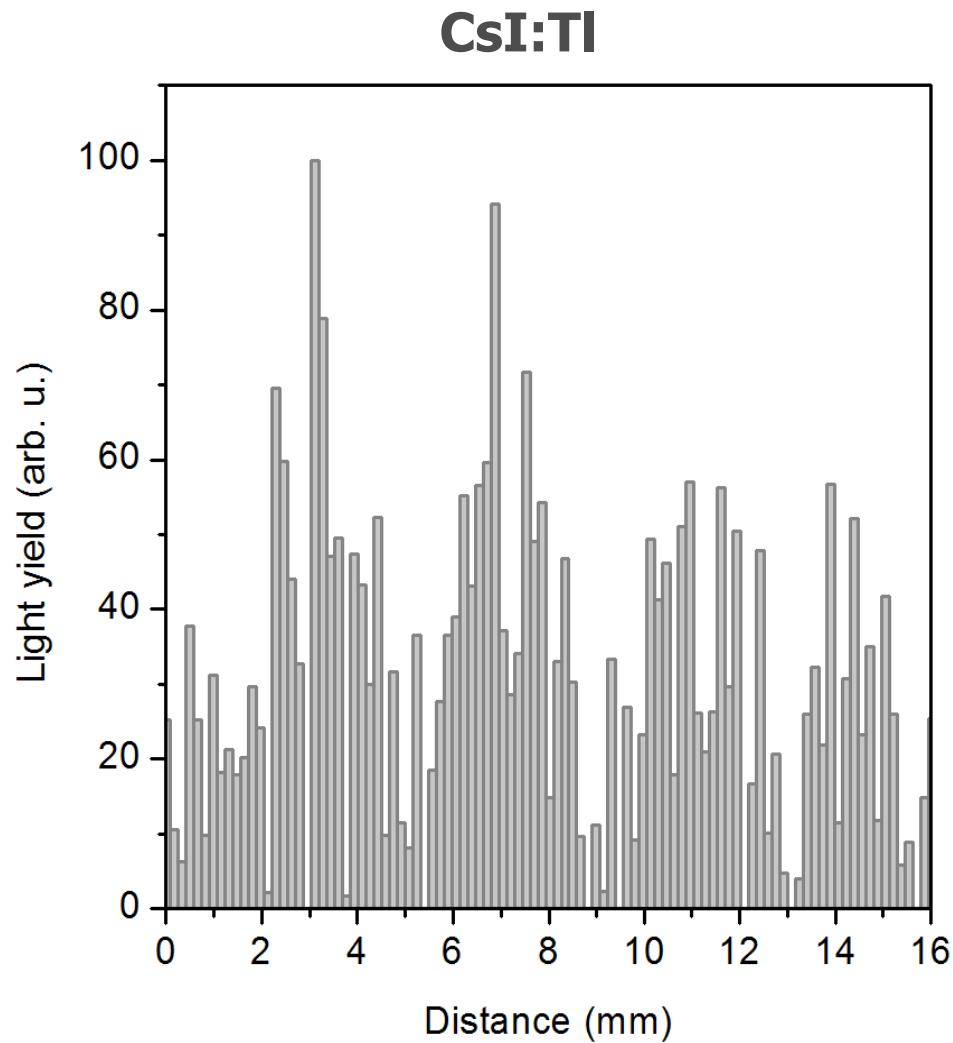
CsI:Tl



SFOP



Complex Structures



Beam Current

Absolute Measurements

- Faraday cups (not sensitive)
- Attenuation factors (spatial resonances)
- Light calibration (uncertainty)

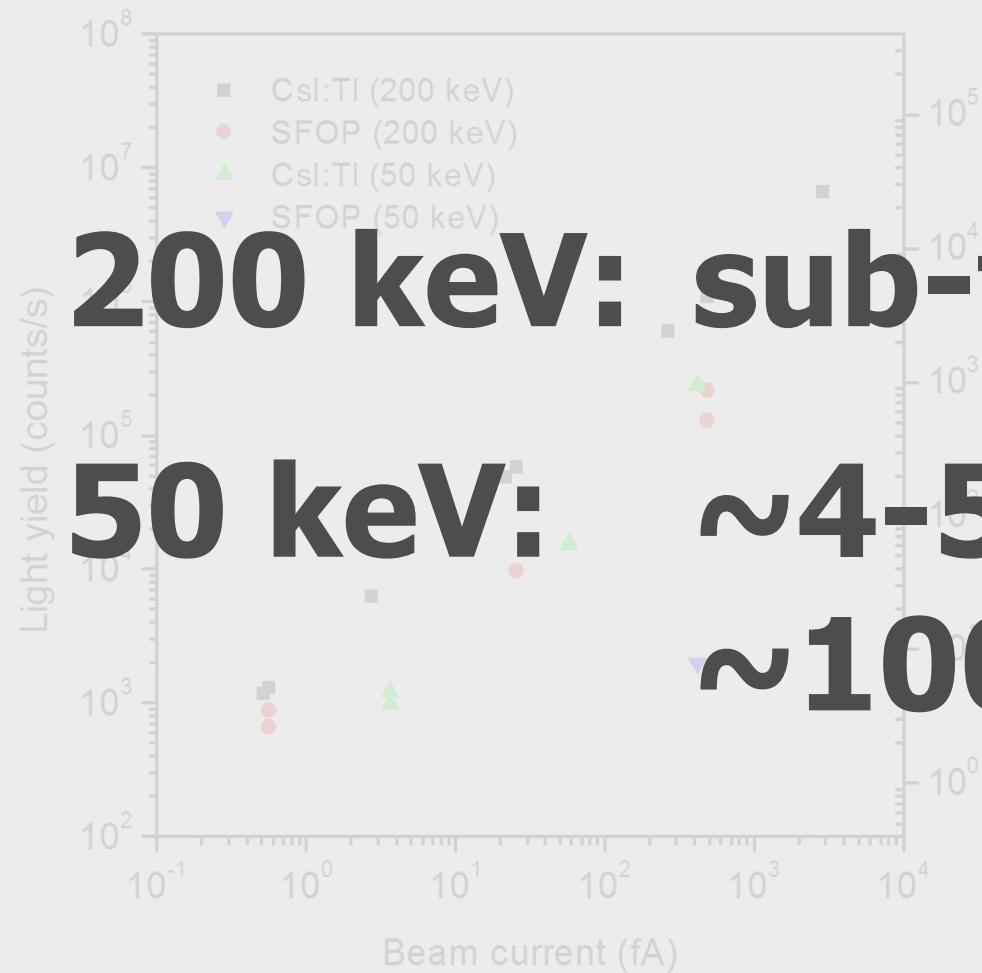
Light Yield Calibration*

- CsI:Tl calibrated with ^{241}Am
- Results rescaled to keV protons
- ... and to SFOP
- Systematic indetermination of one order of magnitude assumed

* A. Pappalardo, L. Cosentino, and P. Finocchiaro, **An Imaging Technique for Detection and Absolute Calibration of Scintillation Light**, Rev. Sci. Instrum. 81, 033308 (2010)

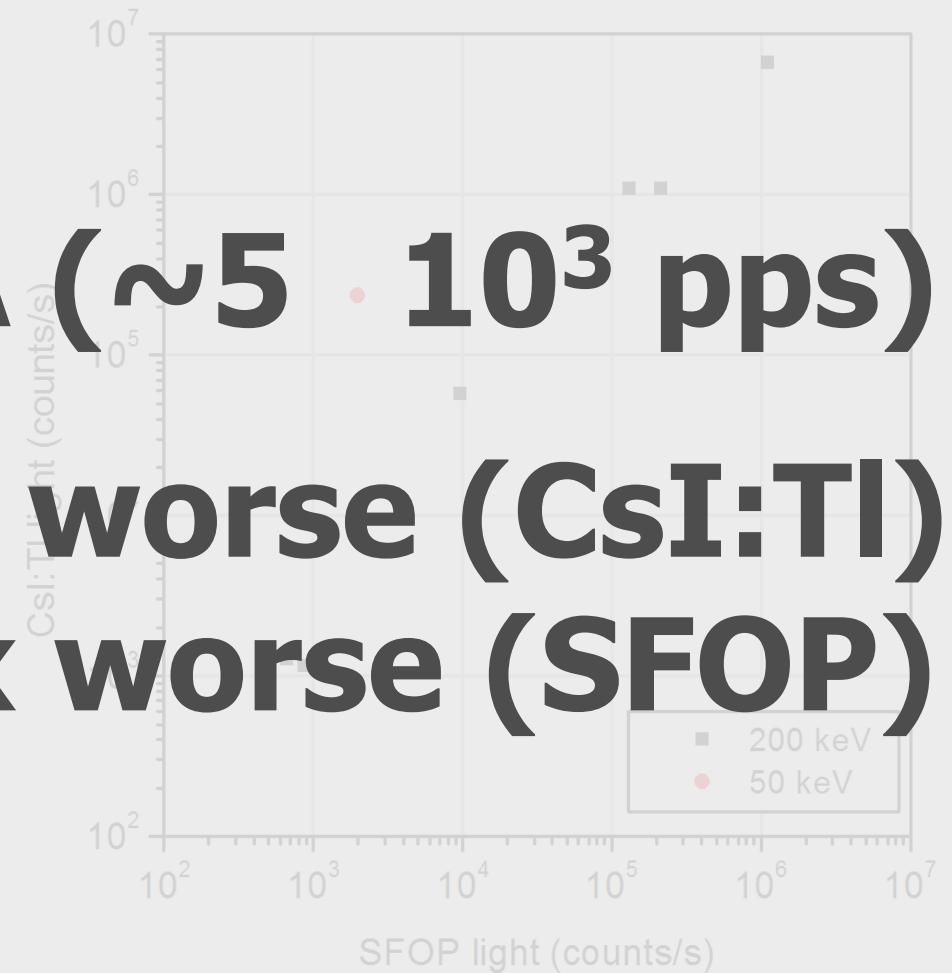
Sensitivity

Sensitivity Limits



200 keV: sub-fA ($\sim 5 \cdot 10^3$ pps)

50 keV: $\sim 4\text{-}5\times$ worse (CsI:TI)
 $\sim 100\times$ worse (SFOP)



Outlook

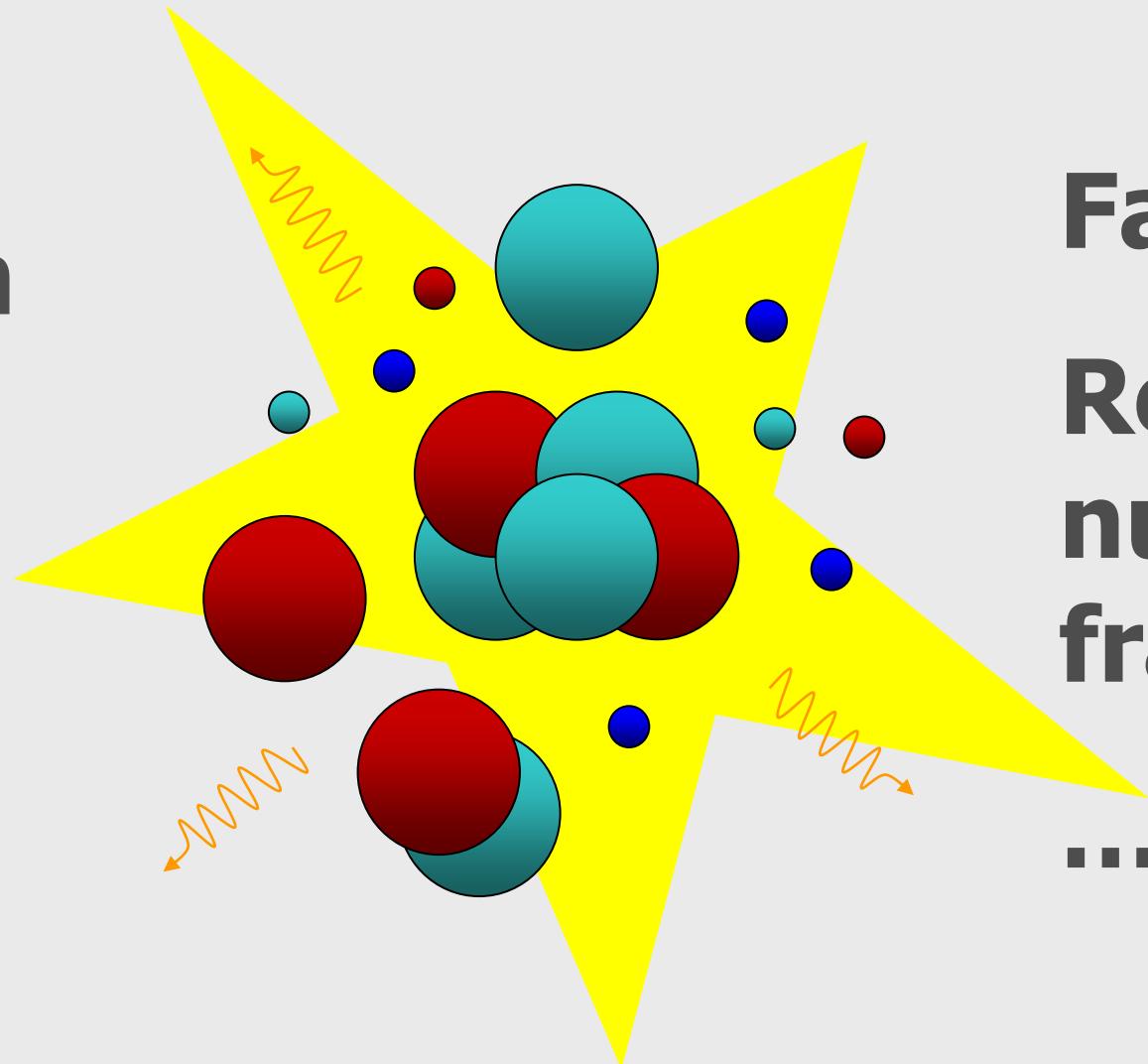
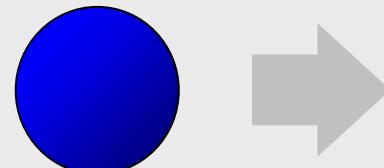
Challenges @ USR*

- **Particles:** anti-p & protons
- **Energy:** 300 keV & 20 keV
- **Intensity:** $5 \cdot 10^5 - 10^6$ pps
(extraction)

* C. P. Welsch, M. Grieser, J. Ullrich, and A. Wolf, **An Ultra-low-energy Storage Ring at FLAIR**, Nucl. Instrum. Methods Phys. Res. A 546, 405 (2005)

Annihilation

Antiproton



Fast pions
Recoiling
nuclear
fragments

...

A photograph of a man with glasses and a dark shirt examining a human skull. He is holding it by the jaw. In the background, there are large windows showing a cityscape. A white speech bubble contains the text.

Questions?

SKELETON