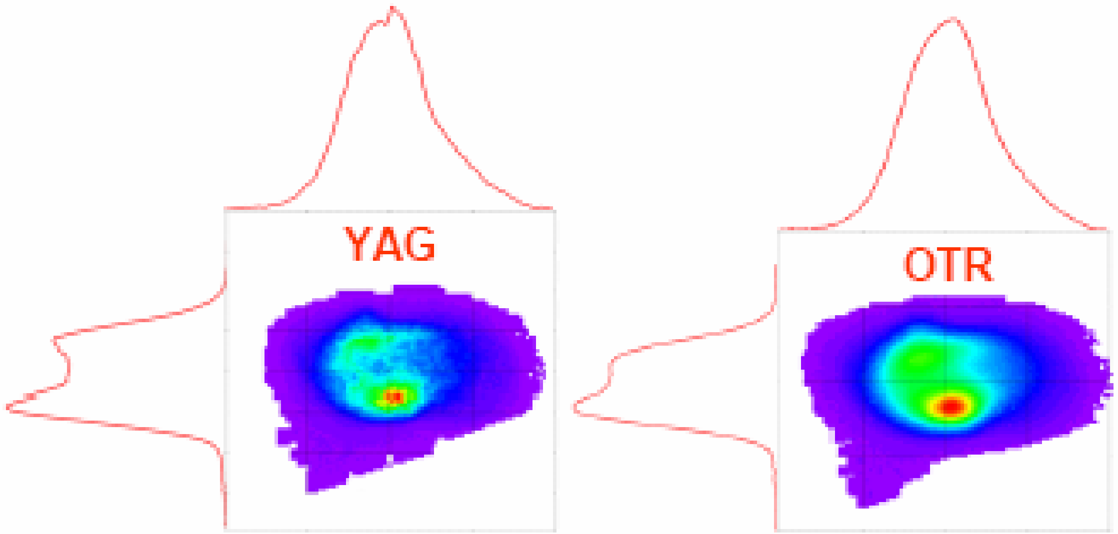
A very rough summary of an interesting and exiting workshop.

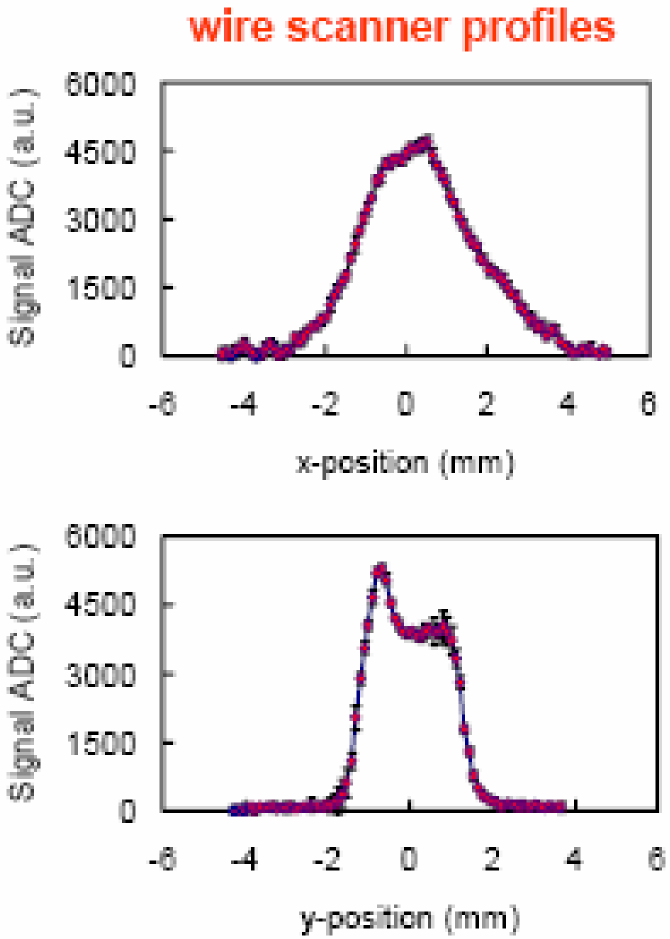
The following slides should force a discussion!!!

Can we trust the image?

So far, OTR is the reference as long as there is no COTR!

YAG and OTR screens: intensity distribution & projection profiles

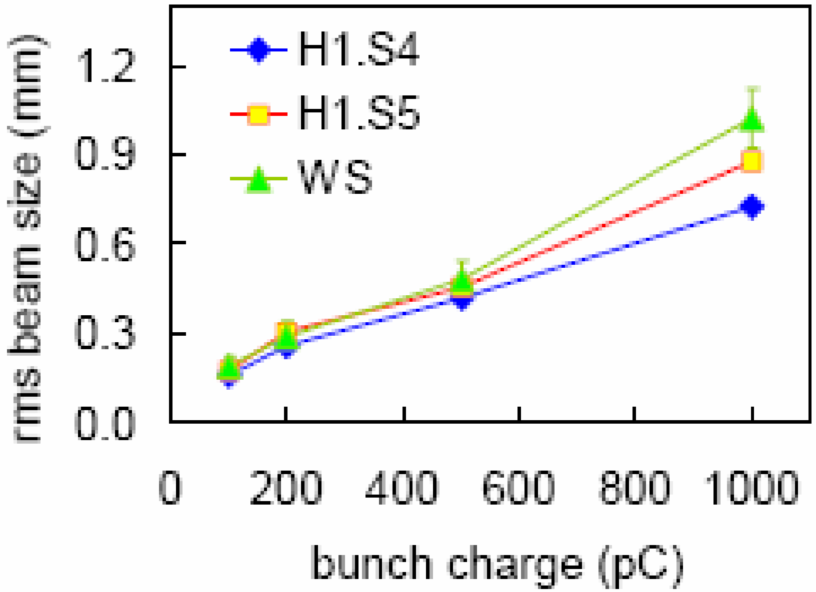


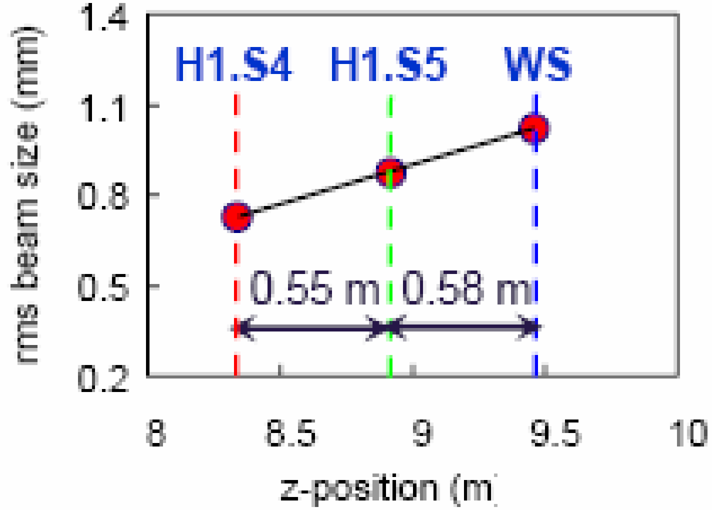


YAG screen shows more detail structure of the beam image & profile (OTR: smoothing image and profiles)

- **Fixed parameters:**
  - Momentum ~24.5 MeV/c
  - Bunch charge: 1 nC
  - Focusing
  - Camera gain: 1 dB
- **Vary parameters:**
  - No. of bunches per train
    - YAG: 1 bunch
    - OTR: 24 bunches

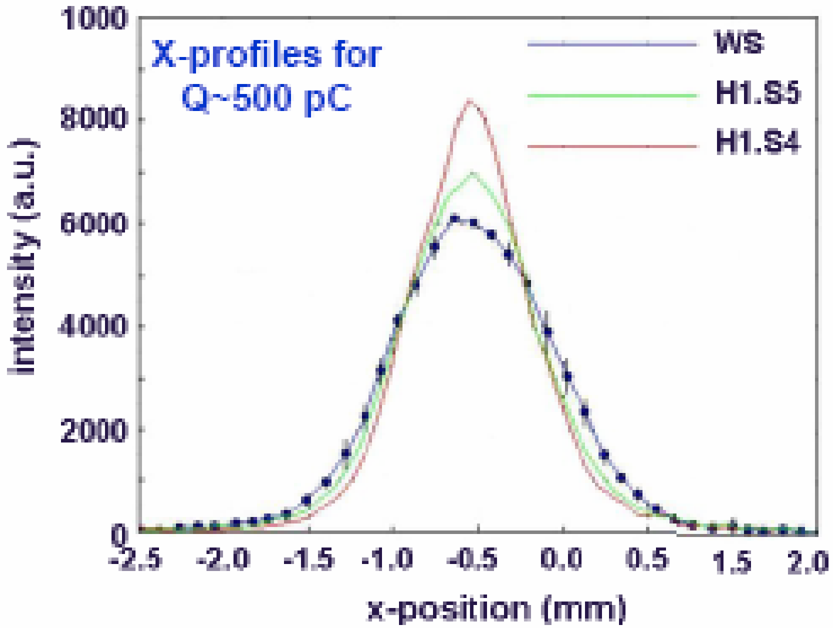
YAG screen and wire scanner (WS): beam size & profile





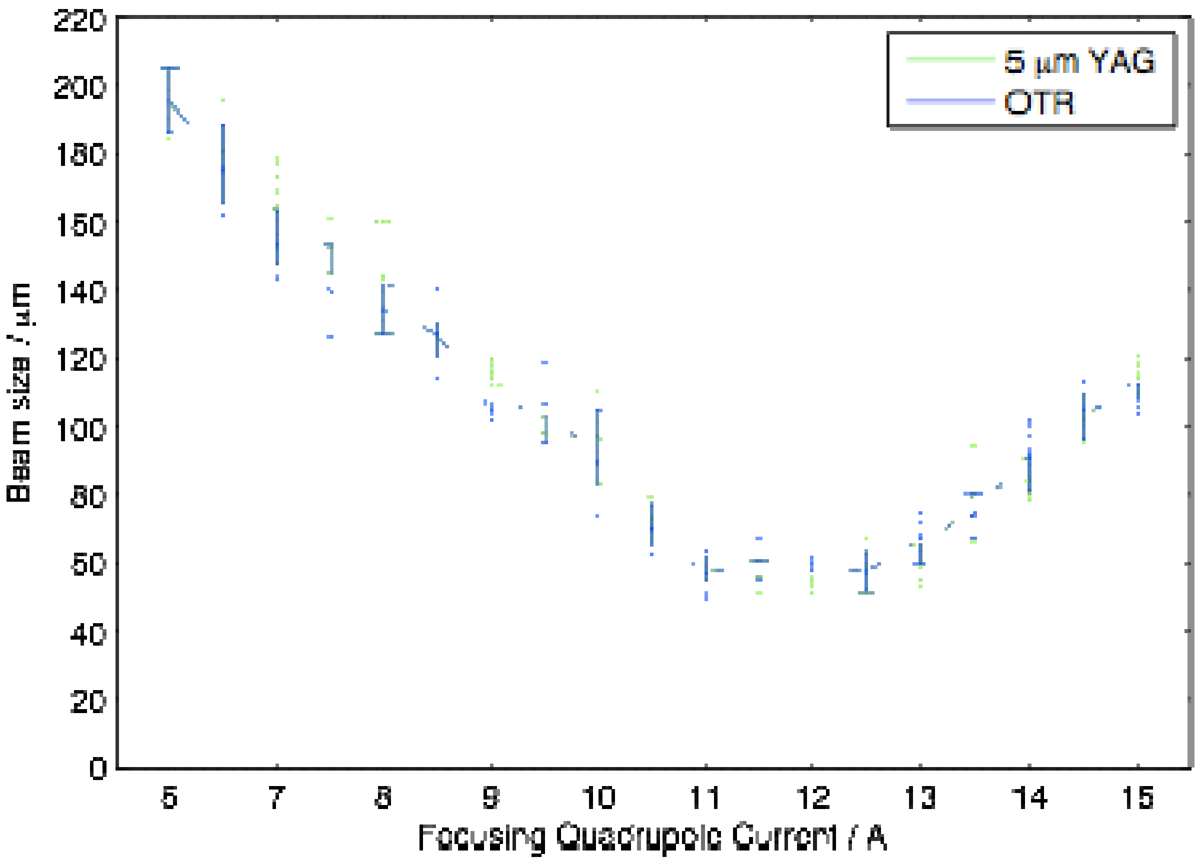
rms beam size: $\sigma_{xy} = \sqrt{\sigma_x \sigma_y}$

- **Fixed parameters:**
  - Momentum ~24.5 MeV/c
  - 1 bunch per train
  - Focusing (fixed main solenoid current)
  - Camera gain: 2 dB for H1.S4, 7 dB for H1.S5
- **Vary parameters:**
  - Bunch charge ~ 0.1, 0.2, 0.4, 0.6, 0.8, 1 nC



Measurement at 130 MeV

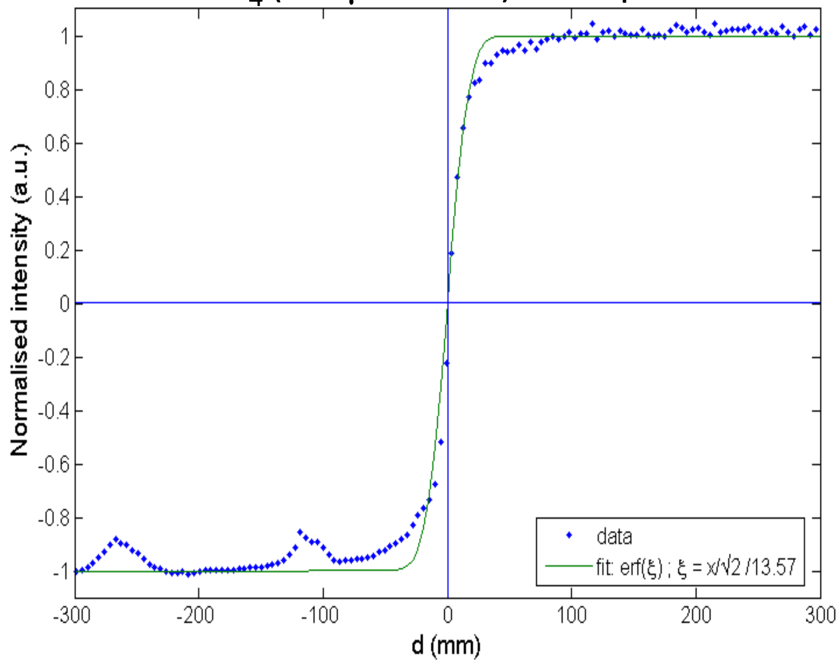
- Comparison to beam size measurement with optical transition radiation shows good agreement down to 60 µm rms
- Gauss fit to beam size; error bars represent statistical variation in 5 images each
- **200 pC electron beam**



Screen Resolution Results

- Nominal electron beam (K=1%)
- constant current
- camera mag = 1
- pixel size 4.65 μm

$CdWO_4$ (500μm thick): 13.5 μm

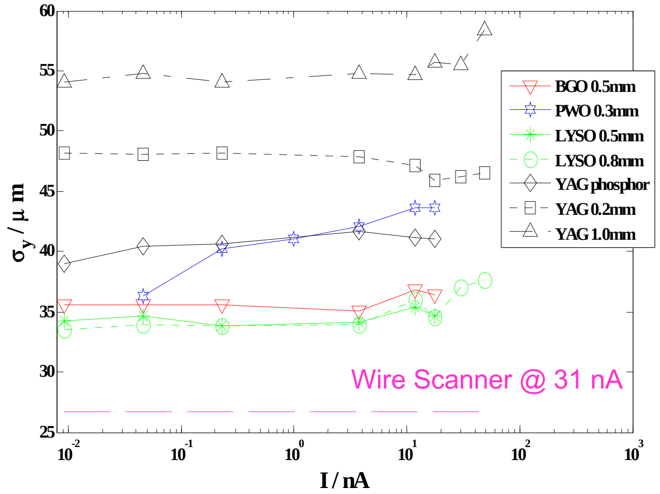


PSF width for several screens

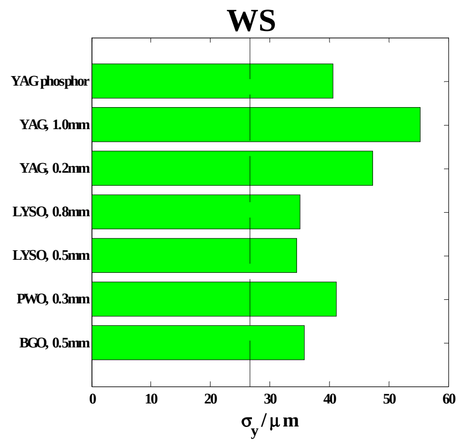
	Thickness (μm)				
	500	**400**	**200**	**100**	**5**
CdWO4	13.5	10	8	7	-
LuAG	-	10	8	-	-
P43	-	-	-	-	6

Results

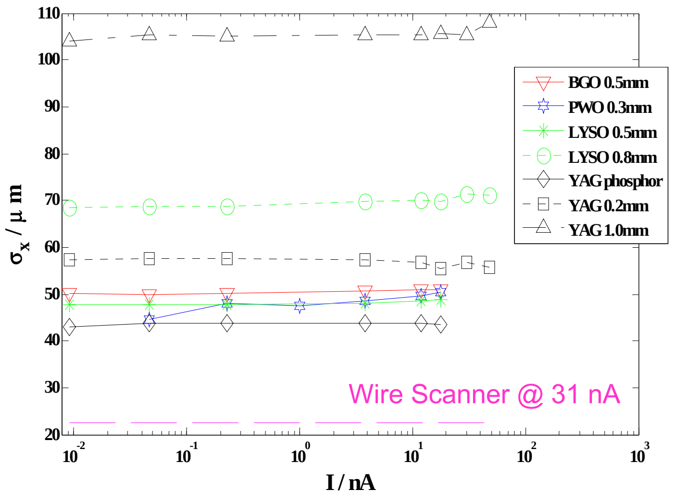
- vertical beam size

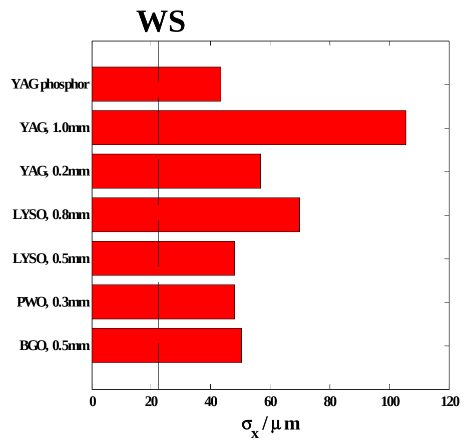


- mean values



- horizontal beam size

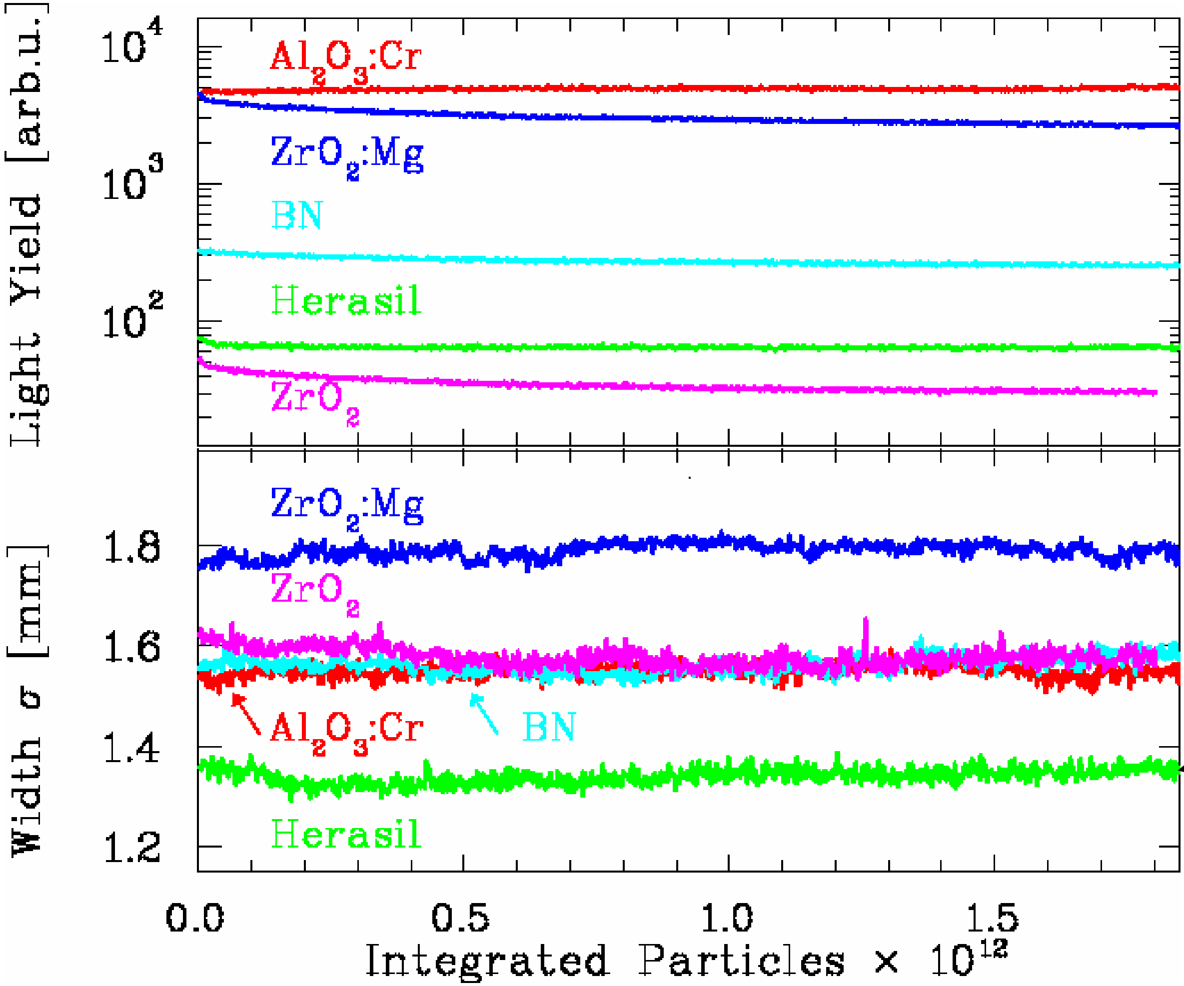




⟹ dependency on observation geometry

Light yield and profile width @ low intensity

Beam parameters: $^{40}Ar^{10+}$, 11.4MeV/u, **2*10^9** Ions/Pulse in 100µs, ~30µA, 2.4Hz, 1000 beam pulses



Results:

- **reproducible behavior**
- **different light yield and width reading**
- **light yield does not correlate with beam width**
- different beam shape (from higher stat. moments)

Difference of 14% in profile width is not negligible for quantitative evaluation

Average temperature: ~47°C (backside of ZrO_2:Mg)

What is the useful operating range of an Al_2O_3 Screen?

4.8 MeV/u

$4.3*10^{10}$ ppp

5ms

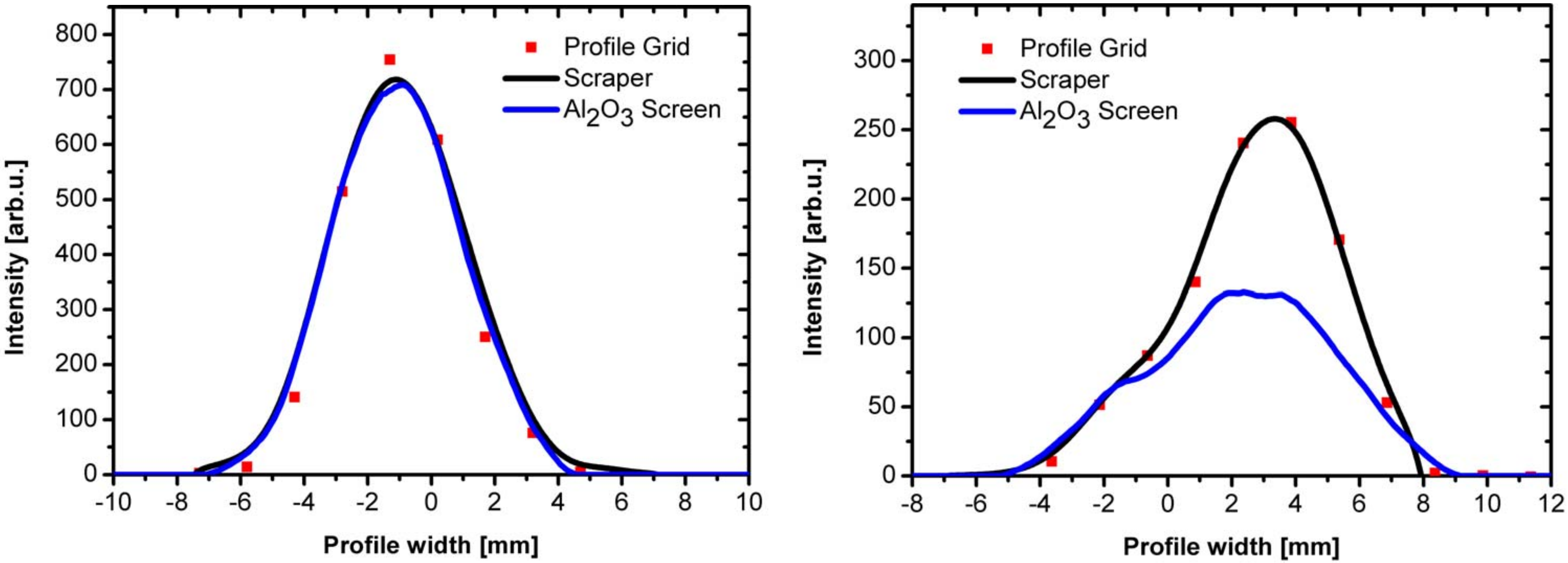
← Same pulse energy →

(~similar flux [ions/(cm² s)])

11.4 MeV/u

$1.8*10^{10}$ ppp

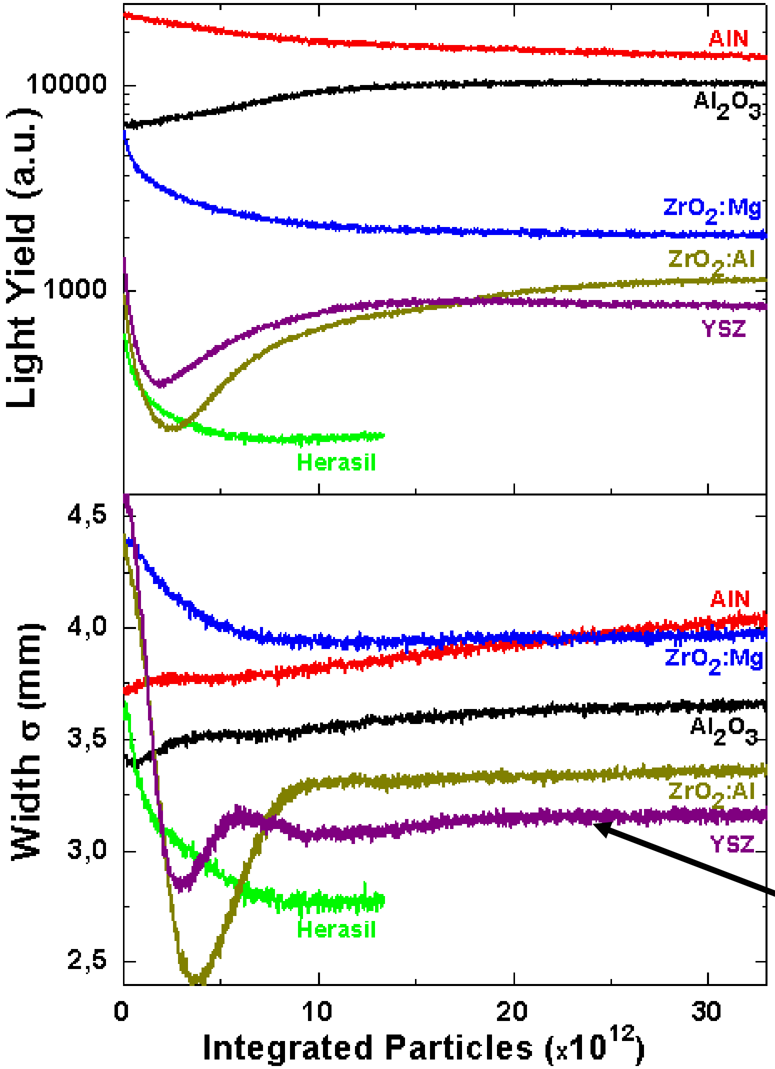
1,2 ms



Result: **Light yield is the same for both energies. For the 11.4 MeV/u case, the imaged beam profile does not math to both reference methods.**

Light yield and profile width @ higher intensity

Beam parameters: Ar^{10+}, 11.4 MeV/u, **3.3*10^{10}** Ions/Pulse in 0.2ms, 260µA, 1.7Hz, 1000 Pulse



Difference of 30% in profile width is not negligible for quantitative evaluation

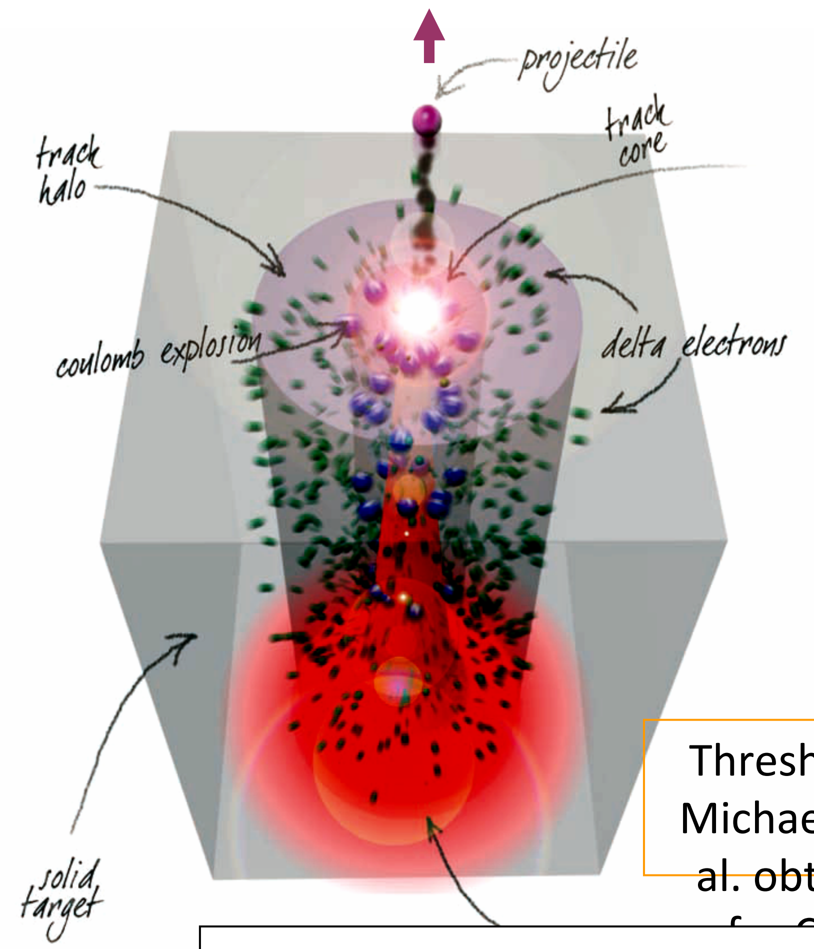
~10 times higher beam current

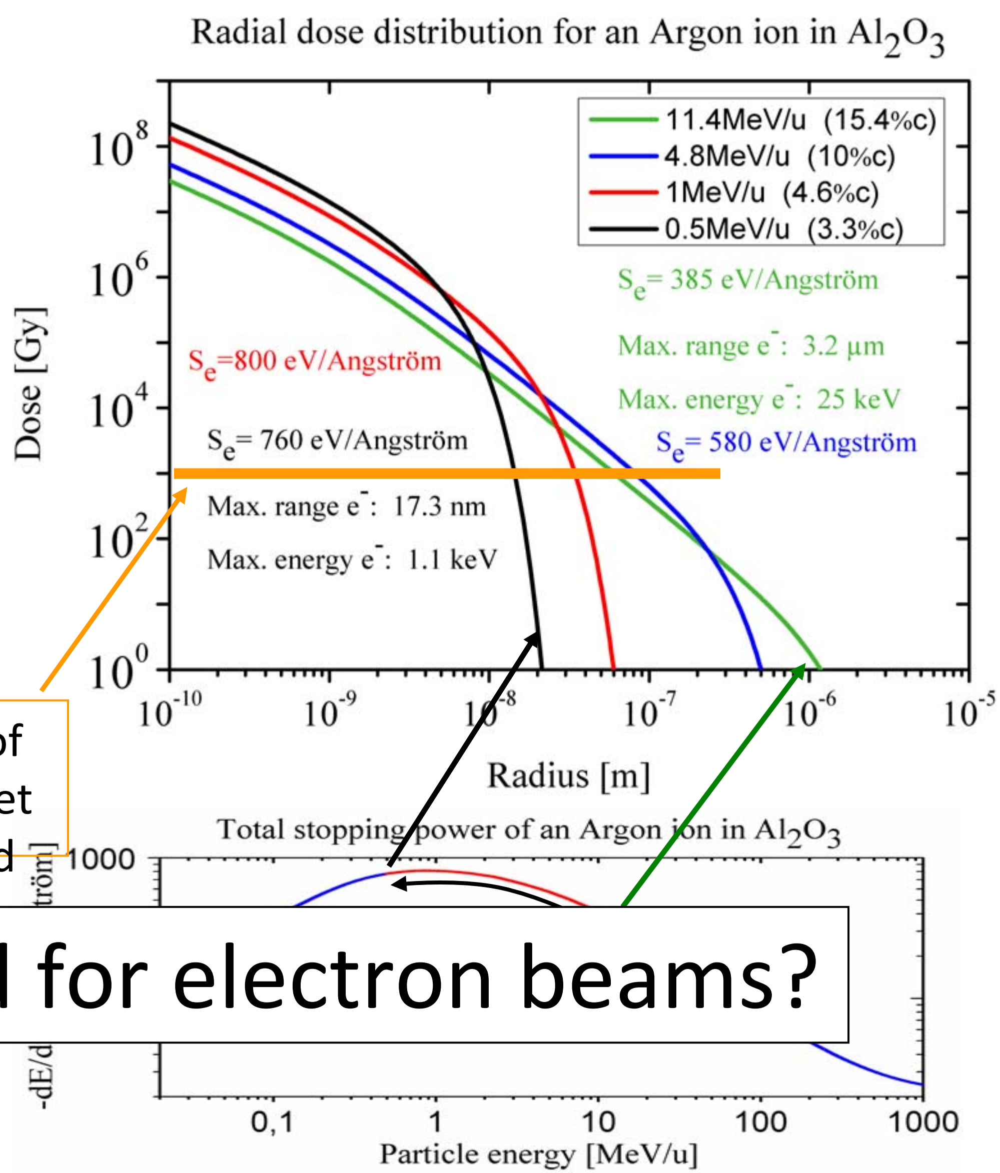
Results:

- **light yield and profile width depend on material**
- **different dynamical behavior**
- **possible reasons: material modification and temperature dependency**
- **for the zircon oxides the behavior is clearly temperature dominated**

Average temperature: ~200°C
(backside of Al_2O_3)

The radial dose distribution of an ion track





Threshold of Michaelian et al. obtained

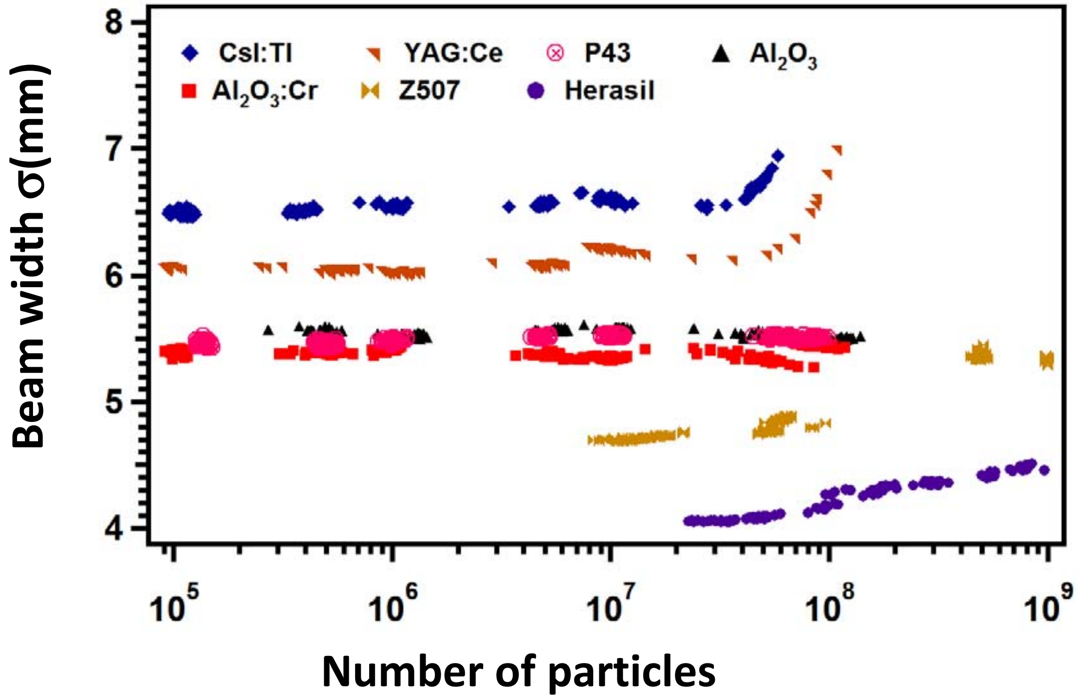
Courtesy

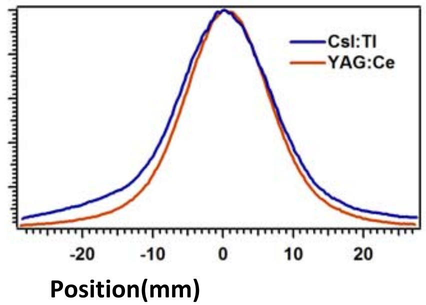
Concept also valid for electron beams?

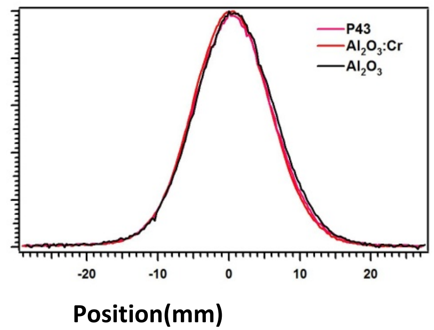
The camera can see all energies (depth) weighted with a Lambert-Beer absorption

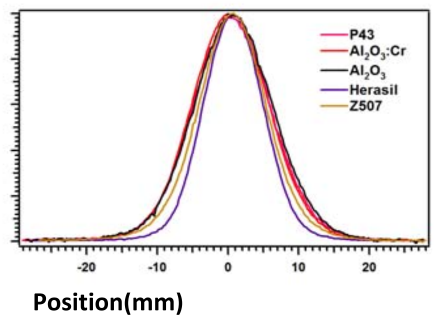
Results: Profile Reproduction

300MeV/u



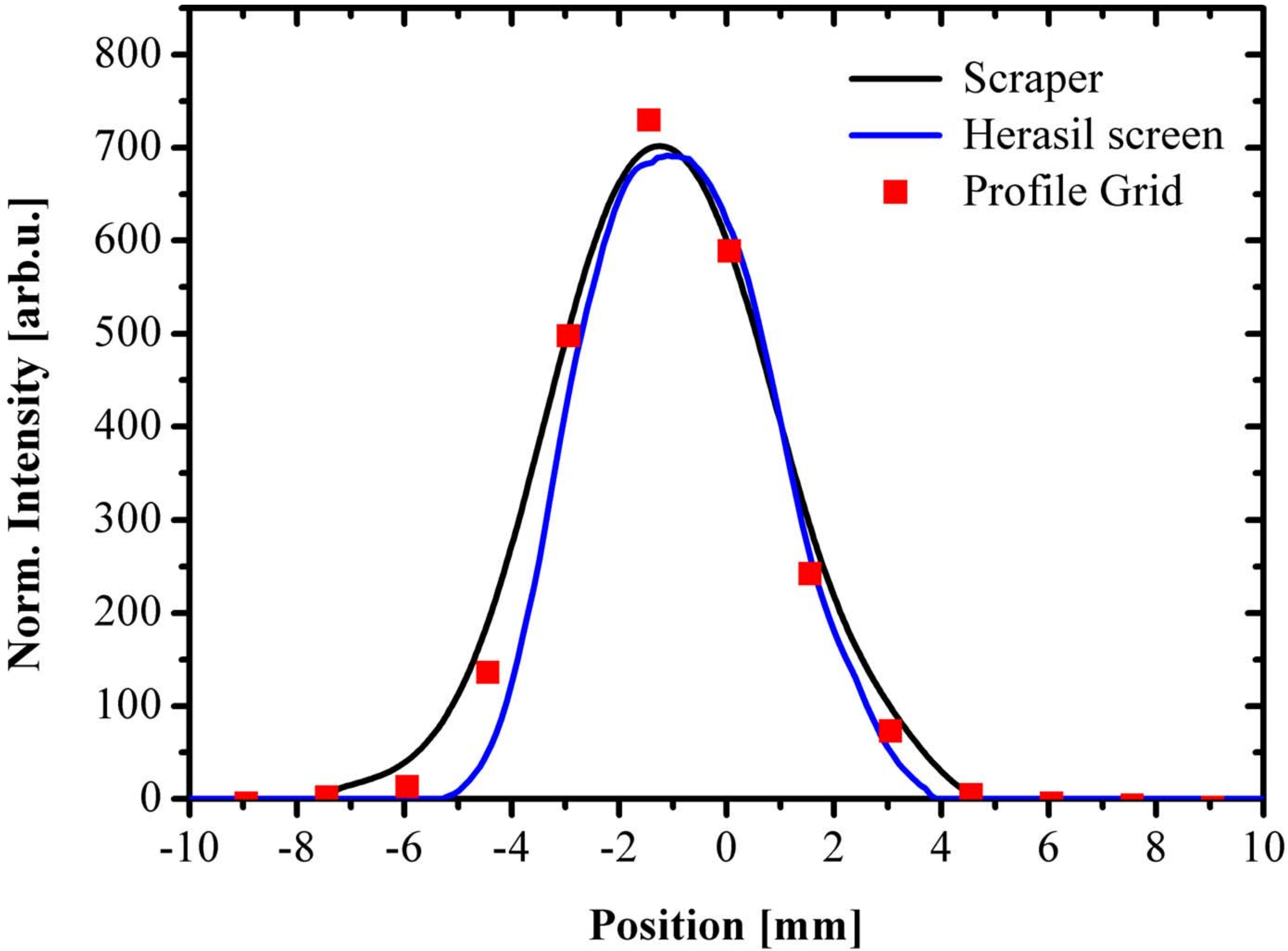






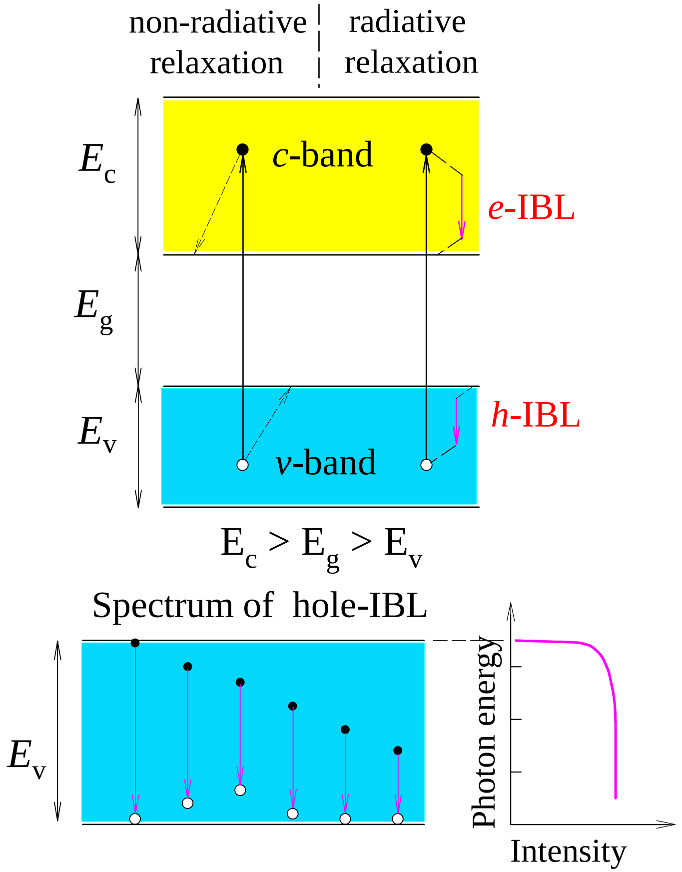
σ of a Gaussian fit

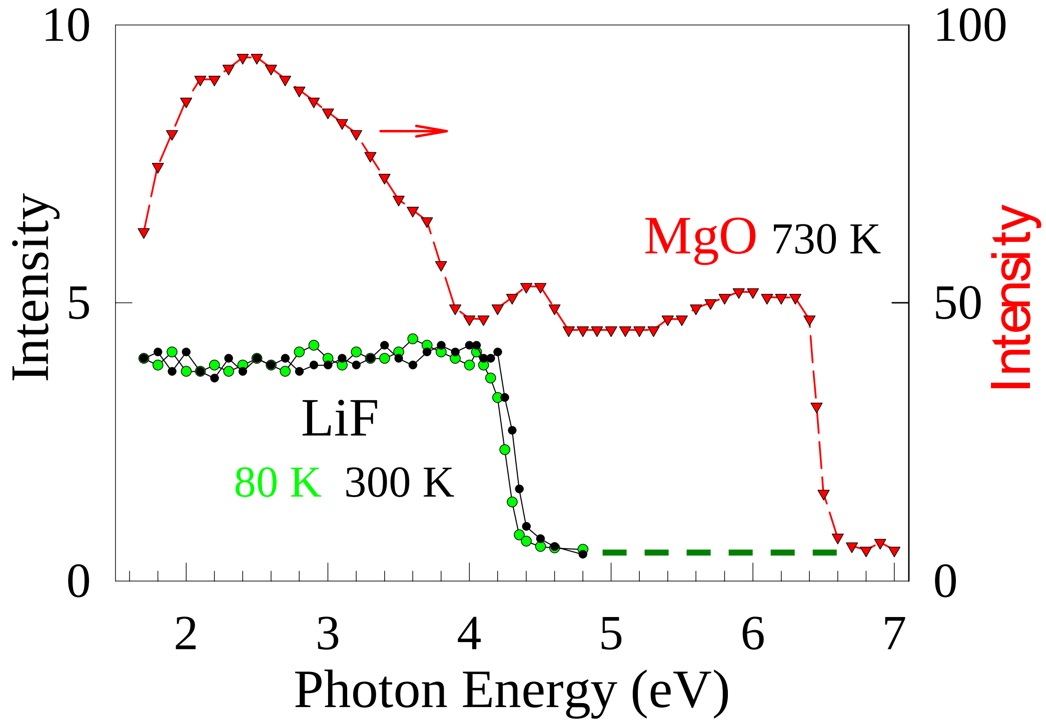
CsI:Tl and YAG:Ce shows broad profile P43, Al_2O_3:Cr, Al_2O_3→similar profile
Herasil→small profile→small width



Scraper
Herasil screen
Profile Grid
Norm. Intensity [arb.u.]
Position [mm]
0
100
200
300
400
500
600
700
800
-10
-8
-6
-4
-2
0
2
4
6
8
10

Intraband luminescence (IBL)

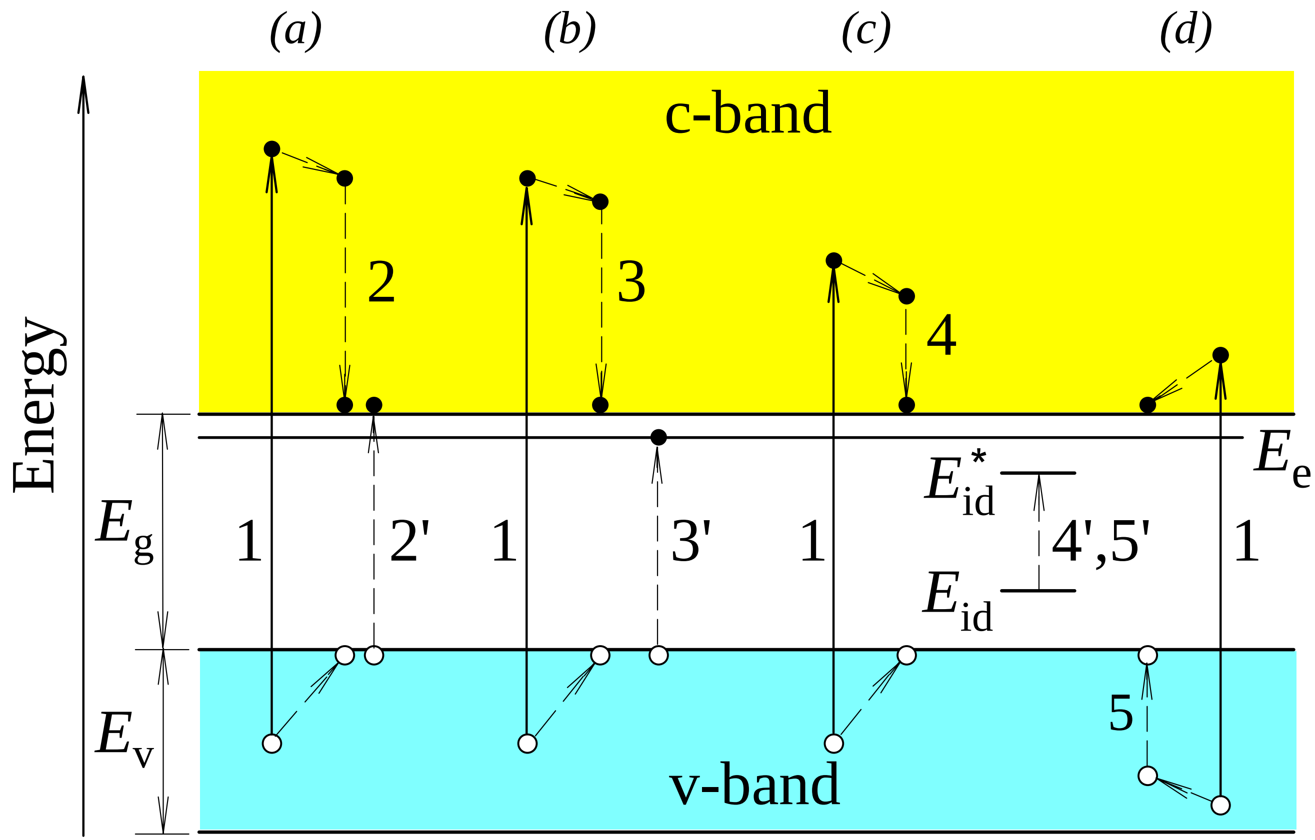




Spectra of fast (τ< 2 ns) intraband (IBL) luminescence under irradiation by single nanosecond 300-keV electron pulses of the Kovalchuk-Mesyats-type generator

*A. Lushchik, Ch. Lushchik, M. Kirm, V. Nagirnyi, F. Savikhin, E. Vasil'chenko, Nucl. Instr. and Meth. B **250** 330 (2006)*

Multiplication of electronic excitations (MEE)



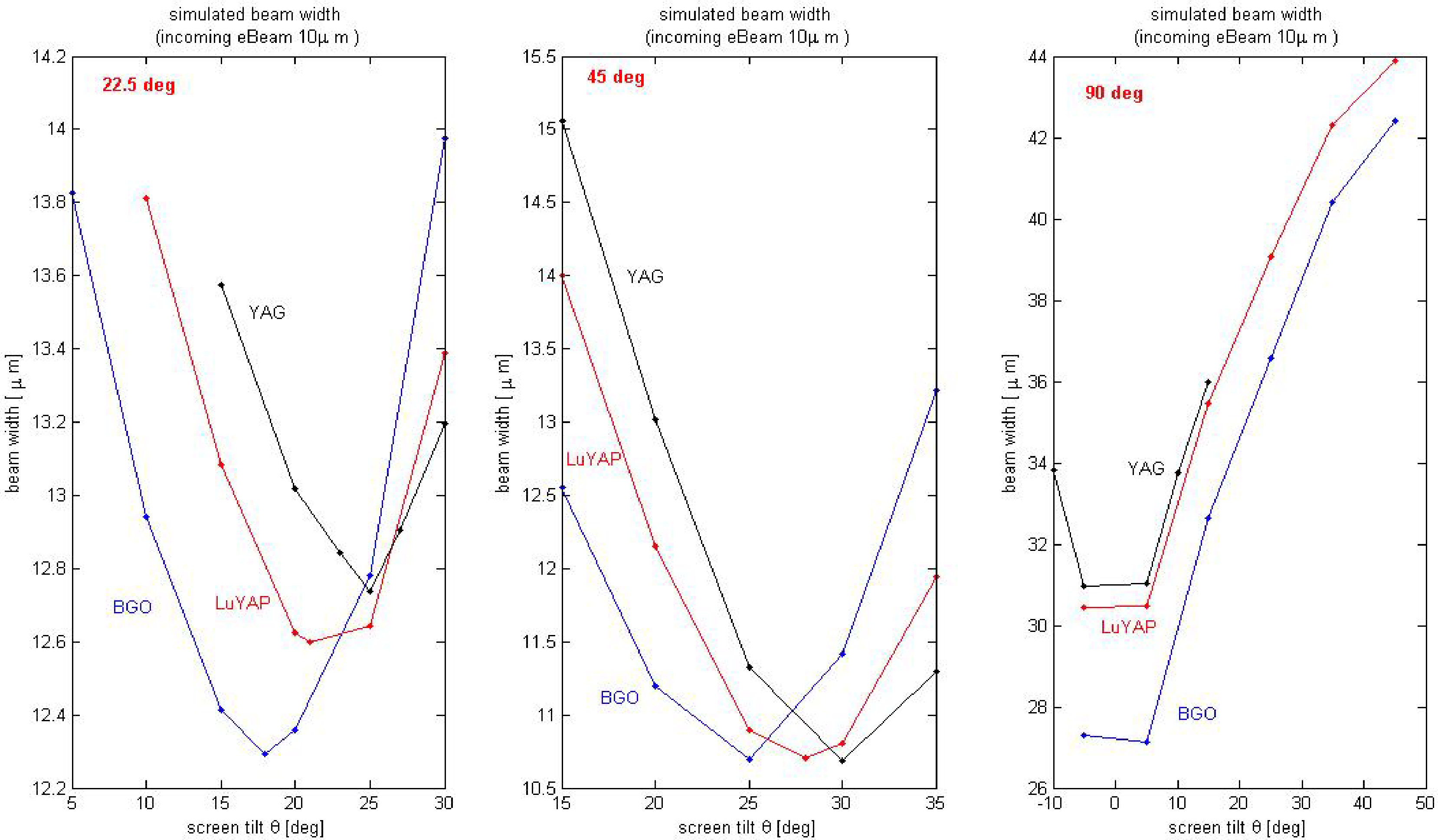
<u>Three mechanisms of MEE in dielectrics:</u>

(*a*) electron-hole, (*b*) excitonic and

(*c, d*) solid-state analogue of the Franck-Hertz effect in gases. QY >1

Solutions

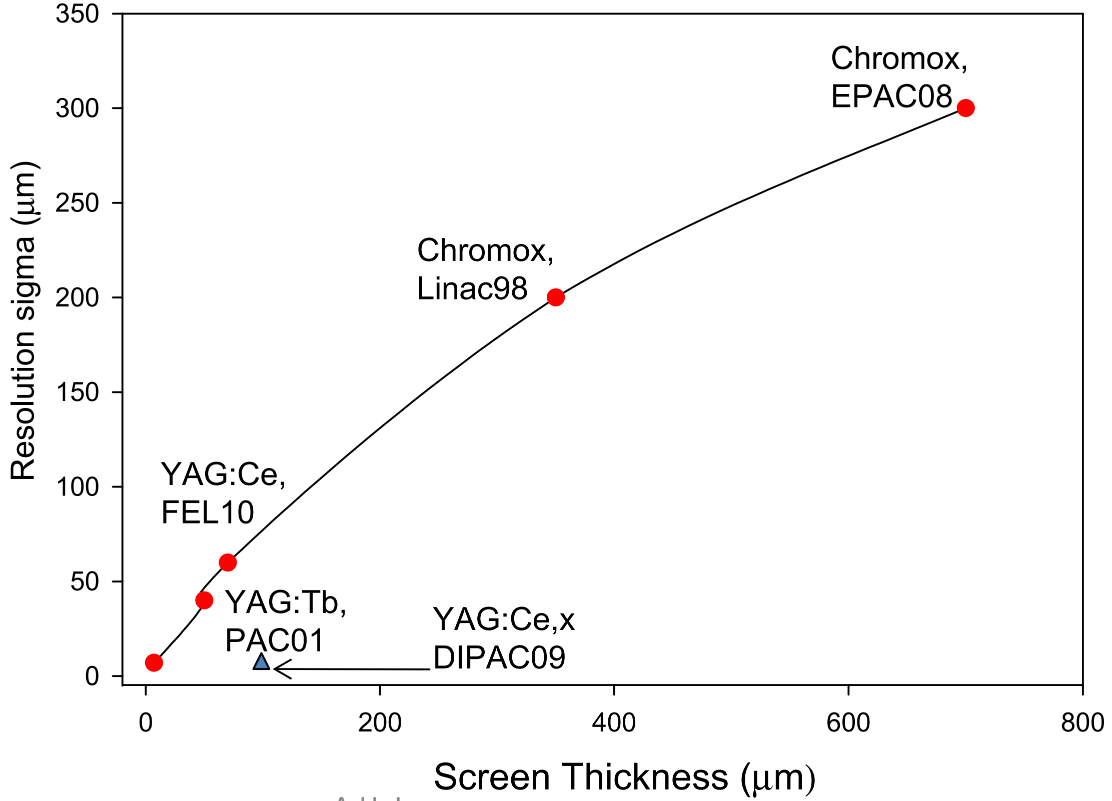
Some proposals



- The best resolution is achieved in BGO crystal with the biggest refractive index among the 3 materials.
- larger refractive index seems to have better resolution (but weak influence)

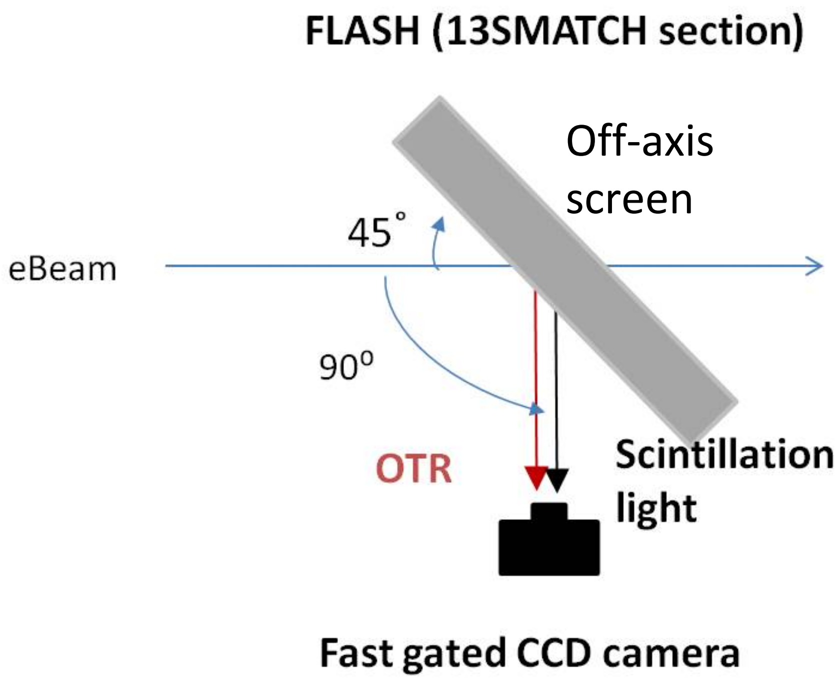
Collated Powder-Screen Data

- Evaluation of reports on beam imaging show trend after invoking Eq. 1 for determining resolution term.
- Collect additional data reports at this workshop.

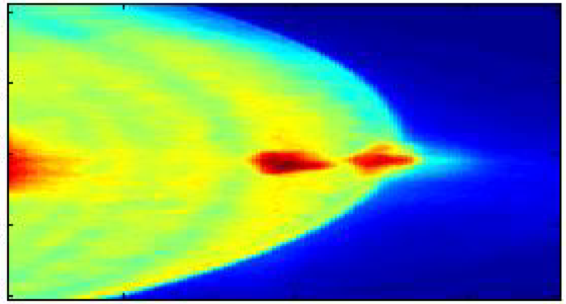


Motivation

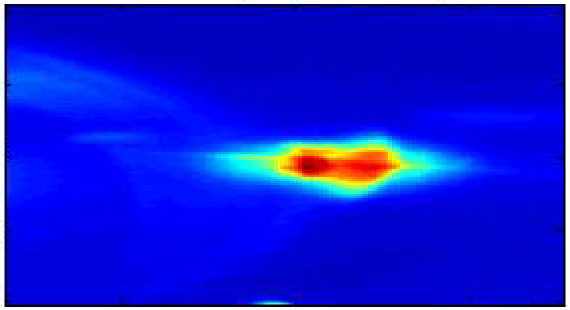
- Scintillation screen + gated camera



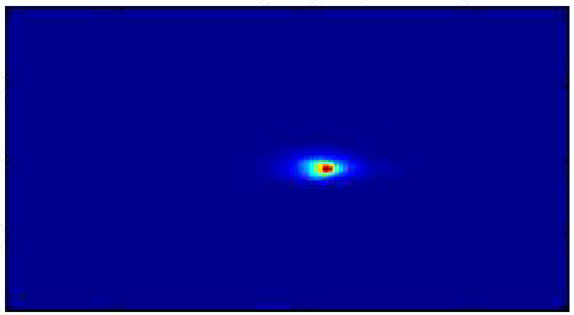
Camera image: FLASH, 13SMATCH section, 9.Jan.2011



Al coated Si OTR screen,
COTR light,
Coherent SR

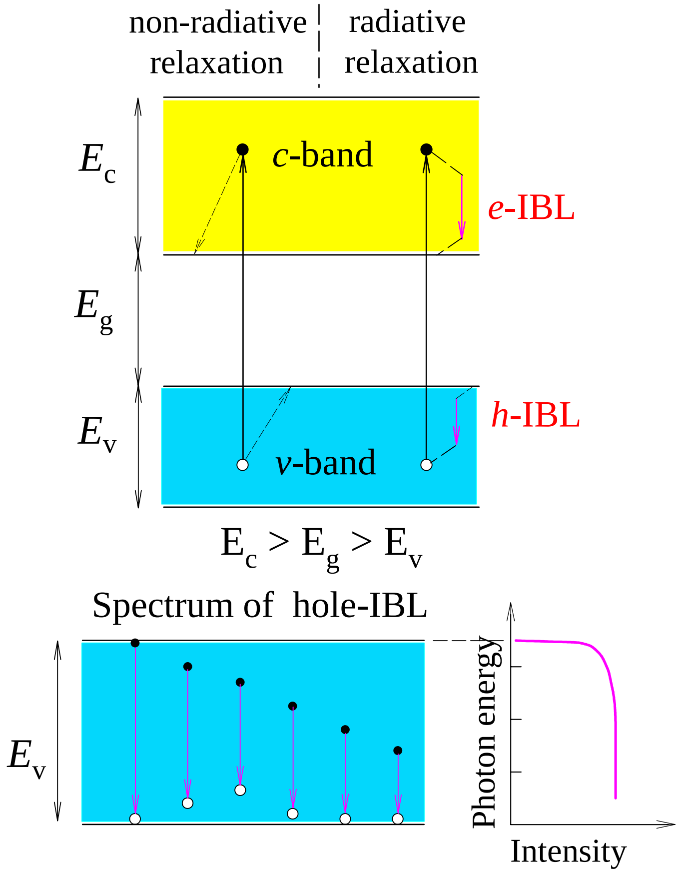


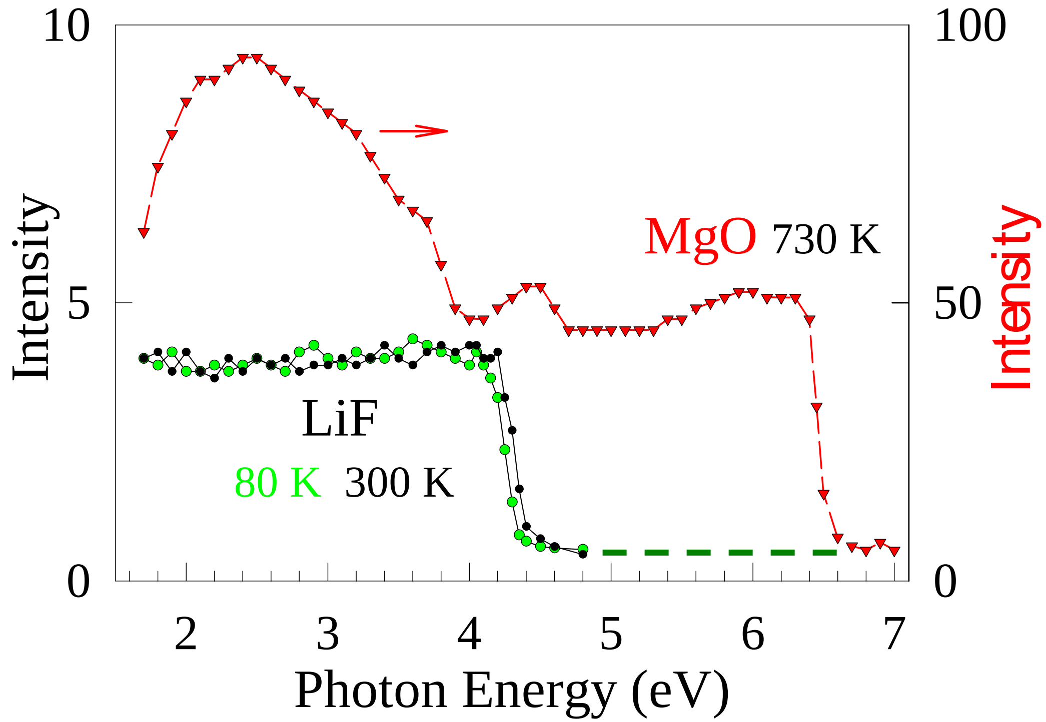
LuAG screen,
COTR & scintillation light



LuAG screen
+100ns delay
Only scintillation light

Intraband luminescence (IBL)





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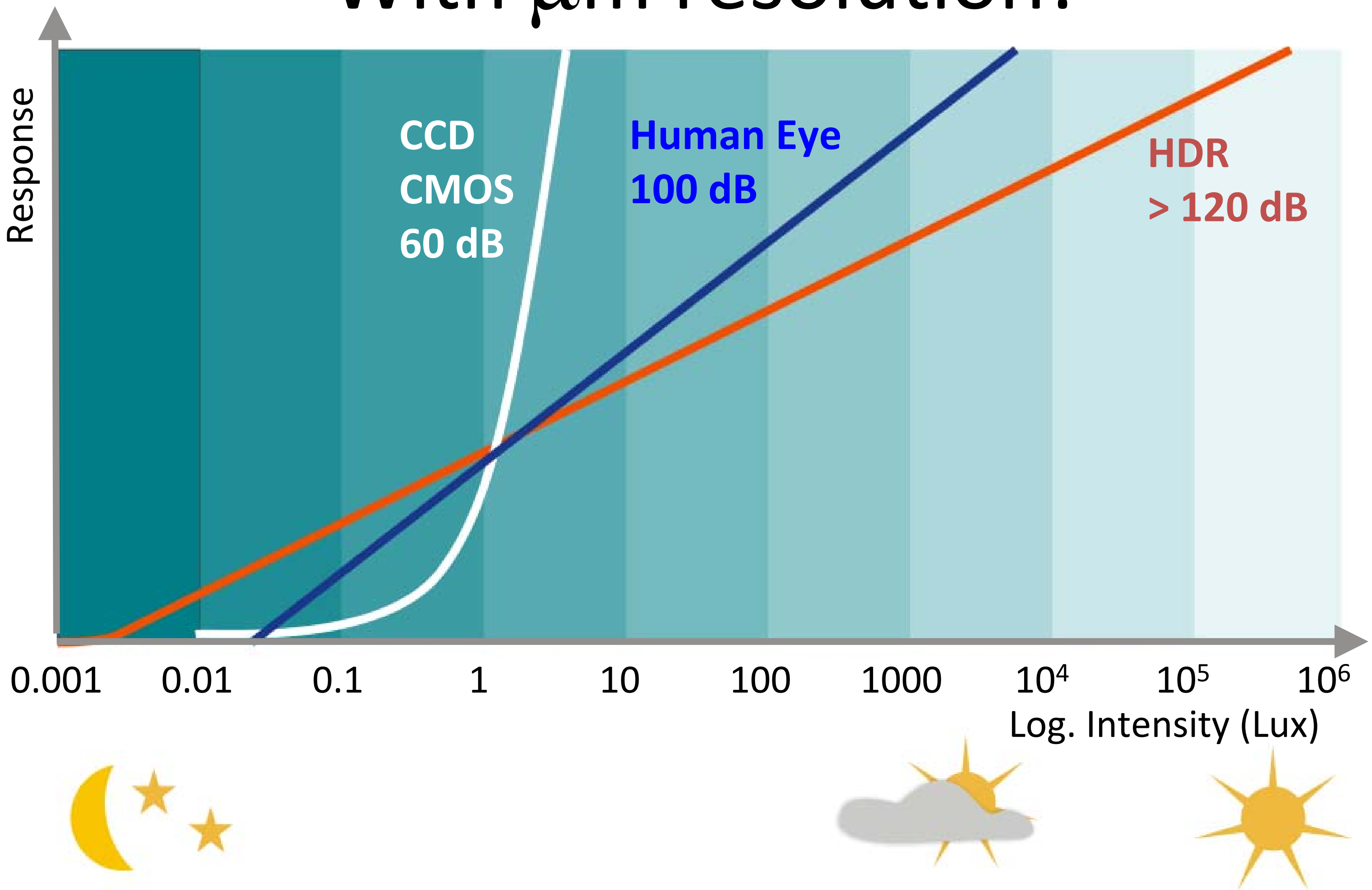
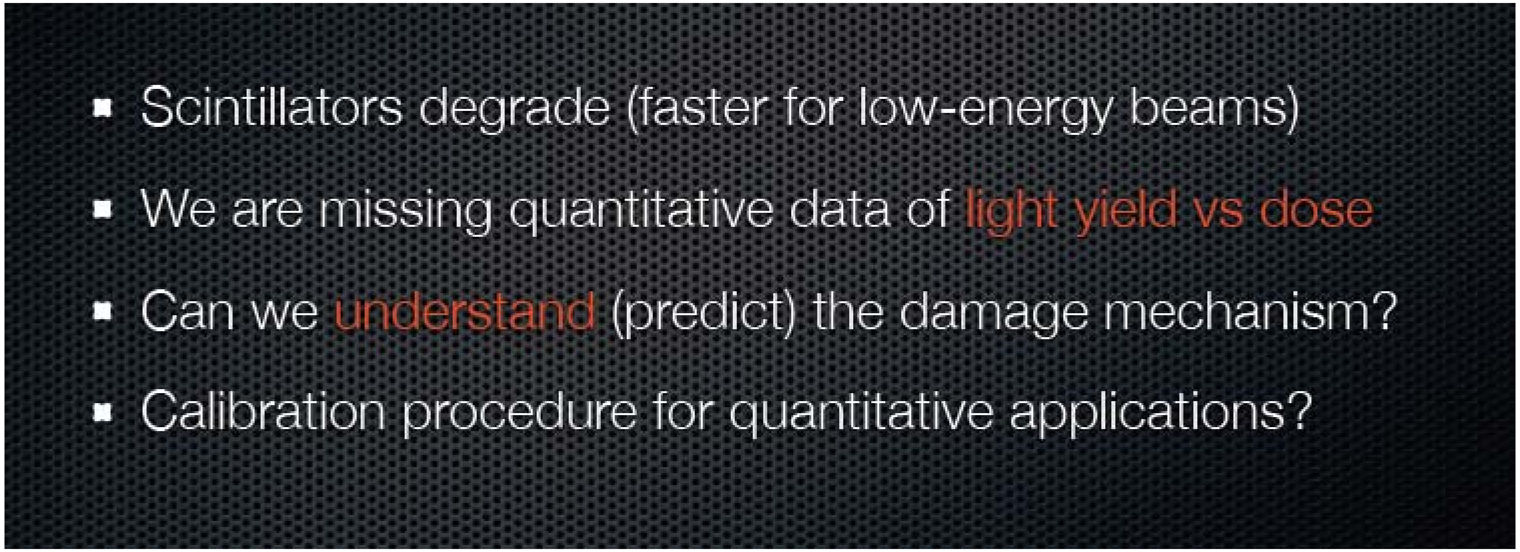
Use of OTR for highly charged Ion beams possible?

We need High Dynamic Range!
With µm resolution!



- And screen material with no degradation (radiation damage) and saturation.



Further Topics

- Common set of parameters for comparison.
- Camera shielding/rad hard devices
- Light yield/efficiency/uniformity of various materials (sorry for not treating in the summary)

<u>Have a save trip home!</u>