Investigation of Scintillation Screens for High Energetic Heavy Ion Beams at GSI

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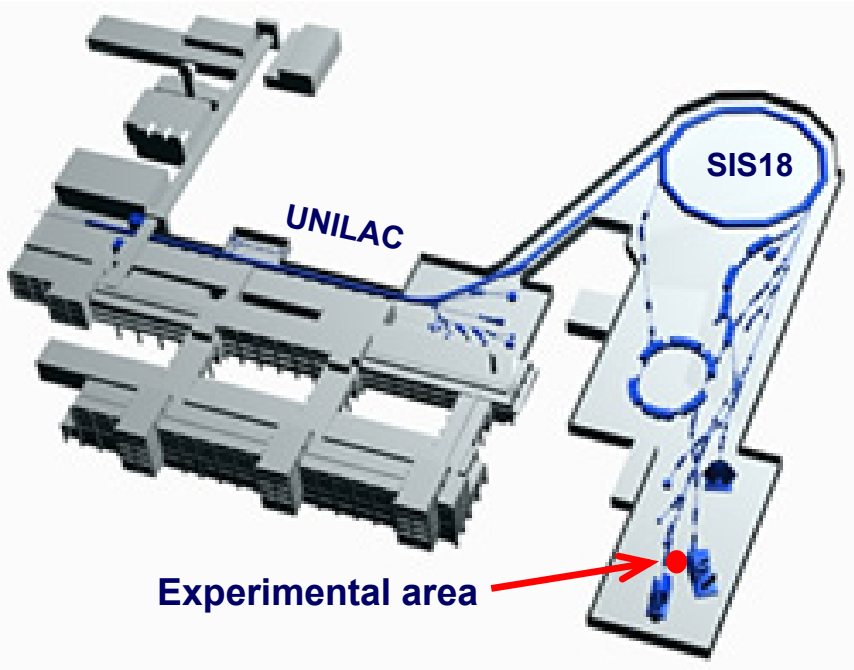
Plan of talk

- Motivation
- Experimental setup
- Results
- Conclusion

Motivation and Beam parameters



SIS 18 features

- 200 MeV/u < E < 3 GeV/u

(56 % < β < 98 %)

- All ion species
- Up to 10^{11} particles per pulse

Behaviour of screens @ high energies

Profile reproduction, light output, Radiation hardness

To be investigated for FAIR

Experiments

- U @ 269 MeV/u
- 10^4 to 10^9 particles per pulse
- 1 m upstream of a Beam dump
- Current measurement-IC & SEM

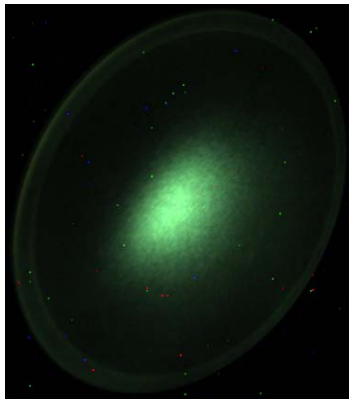
Investigated Scintillators

Type	Material	Producers
Single crystal	*CsI:Tl* *YAG:Ce*	Saint Gobain Crystal
Phosphor screen	*P43 (Gd_2O_2S:Tb)*	Proxitronic
Glass	*Quartz (Herasil 102)* *Quartz:Ce (M382)*	Heraeus Quarzglas
Ceramics	*Al_2O_3:Cr, Al_2O_3* *ZrO_2:Mg (Z507)* *ZrO_2:Y (Z700)*	BCE Special Ceramics

To compare imaging property of different materials

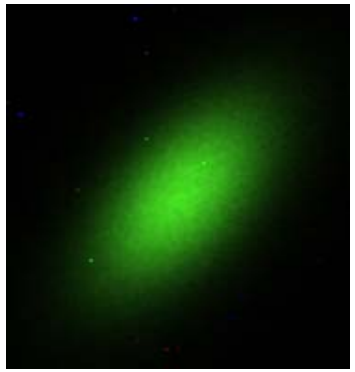
Scintillating effect of different screens

Al_2O_3

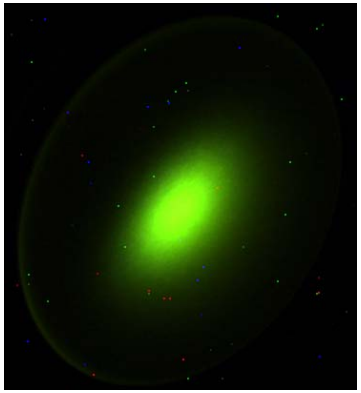


CsI:Tl

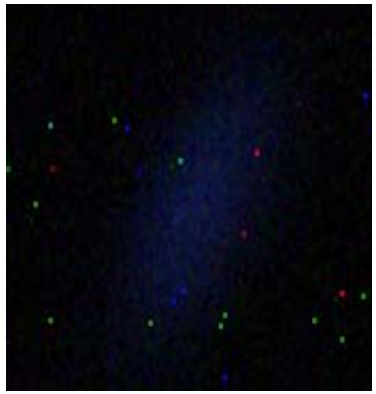
Chromox



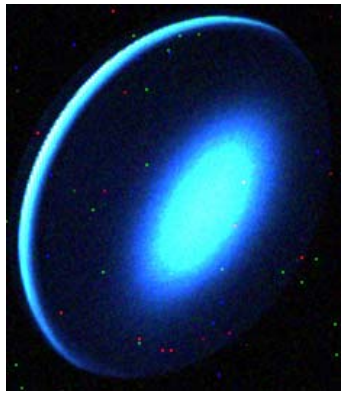
P43



YAG:Ce



Herasil



Quartz:Ce

Z507

Camera: AVT Marlin F033C , picture @ different current

Optical setup

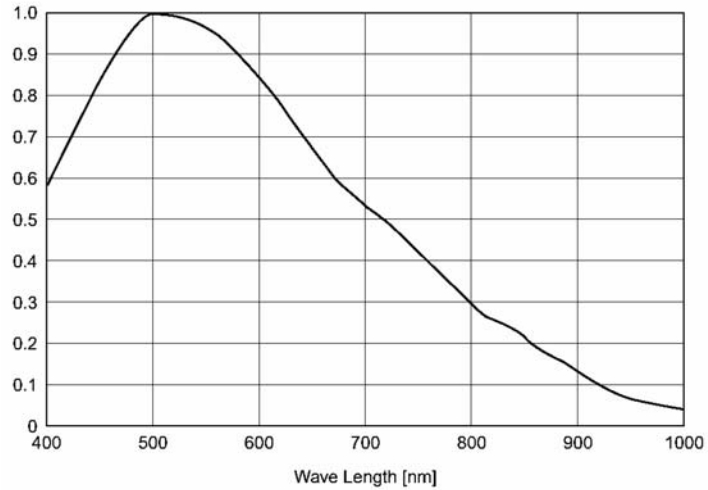
Camera: AVT Marlin

- without IR cut filter
- VGA resolution
- Firewire interface
- Trigger mode
- Variable exposure time
- Variable gain settings
- Data acquisation-BeamView

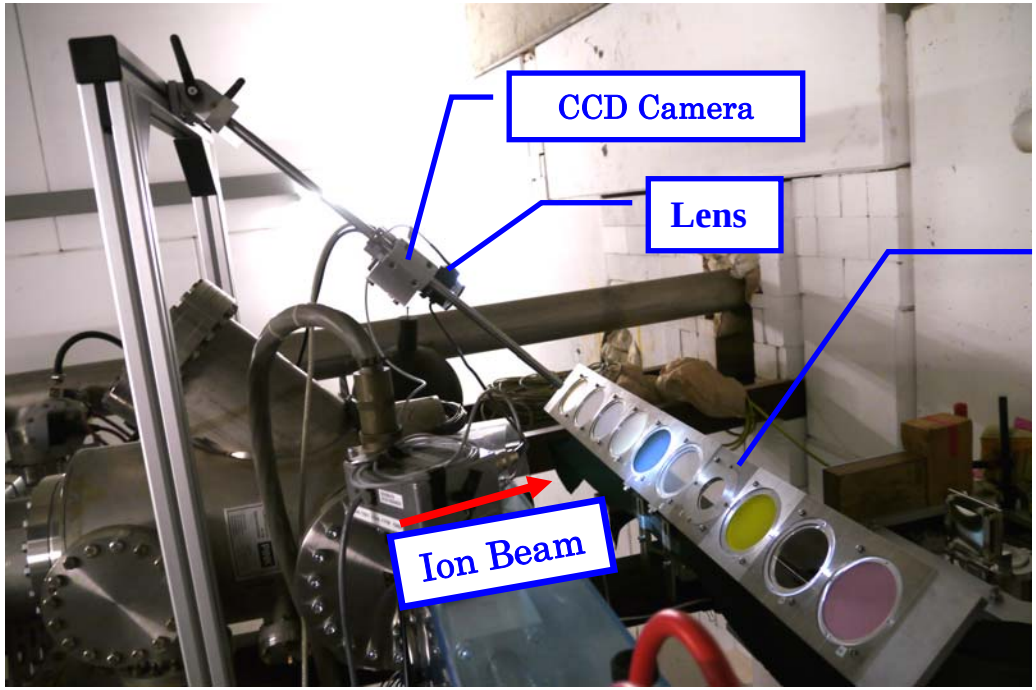
Lens system: Pentax lens

- 16mm focal length
- Remote controlled iris
- Dynamic range of 4 orders of magnitude

Spectral sensitivity of CCD



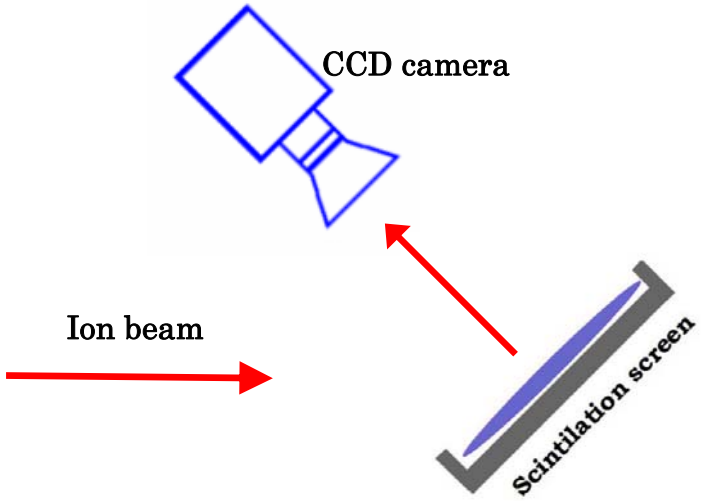
Experimental Setup at HTP



Target ladder→110 *11.5 cm

Sample size→5 to 8 cm diameter

Target ladder mounted on linear drive moved by a stepper motor

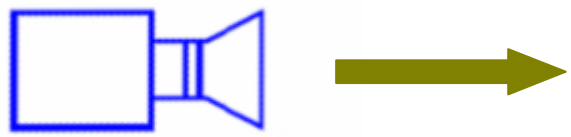


Energy loss per ion in scintillators

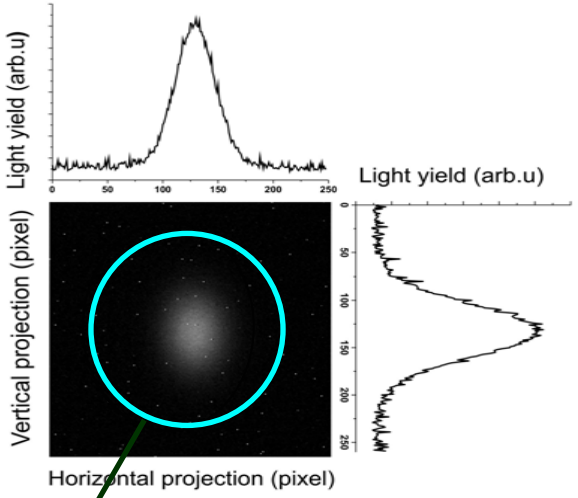
Minimum: 28 MeV/u (6.7 GeV)

Maximum: 54 MeV/u (13 GeV)

Data evaluation



CCD camera



Region of intrest

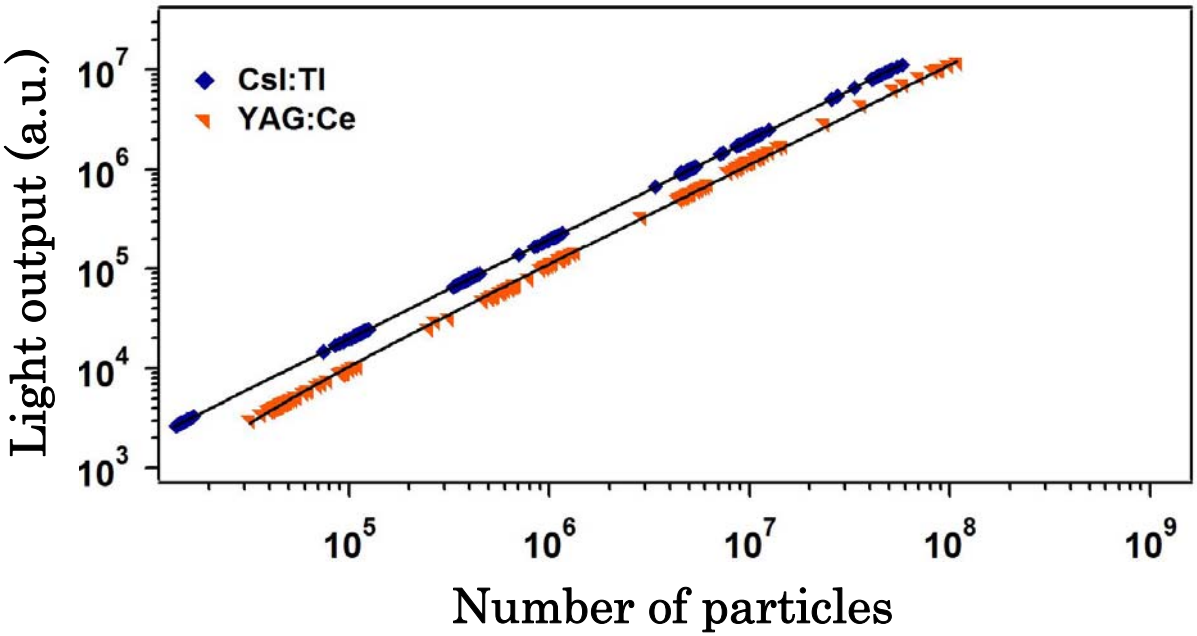
- Projection
- Light output
- Beamwidth
- Higher statistical moments

Background picture before each pulse

Different algorithm for data evaluation→similar trend is observed

Results: light output

CsI:Tl and YAG:Ce shows the highest light output



Parameters:
U@ 269 MeV/u
10^4 to 10^9 ppp
300 ms pulse length

Results: light output

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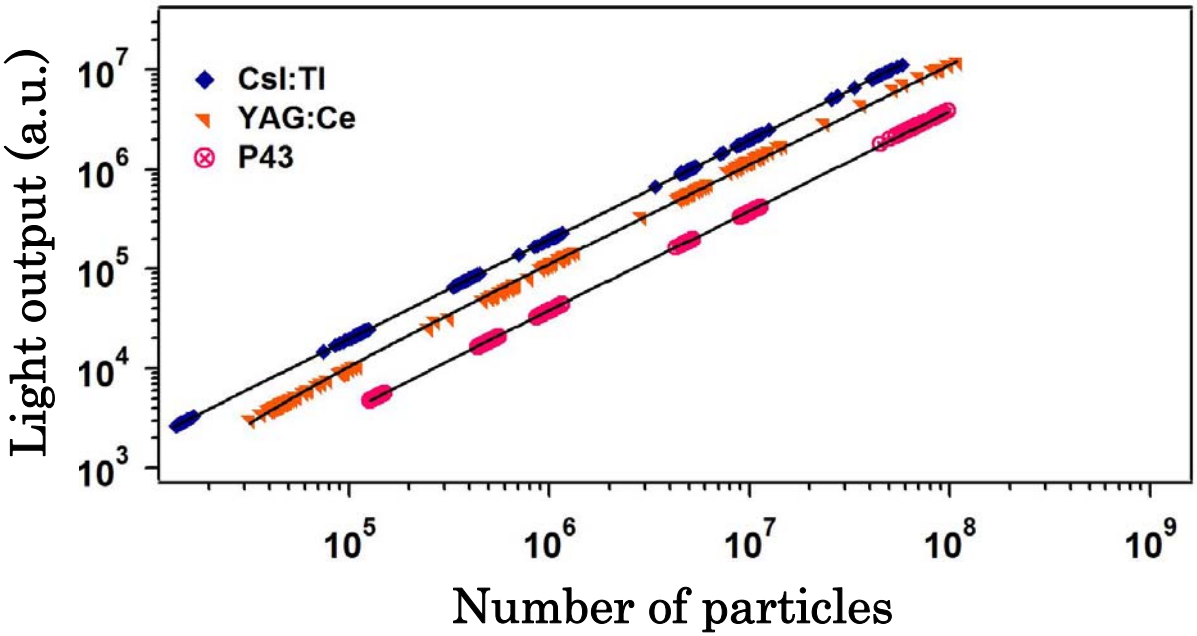
Phosphour screen took the 3rd place



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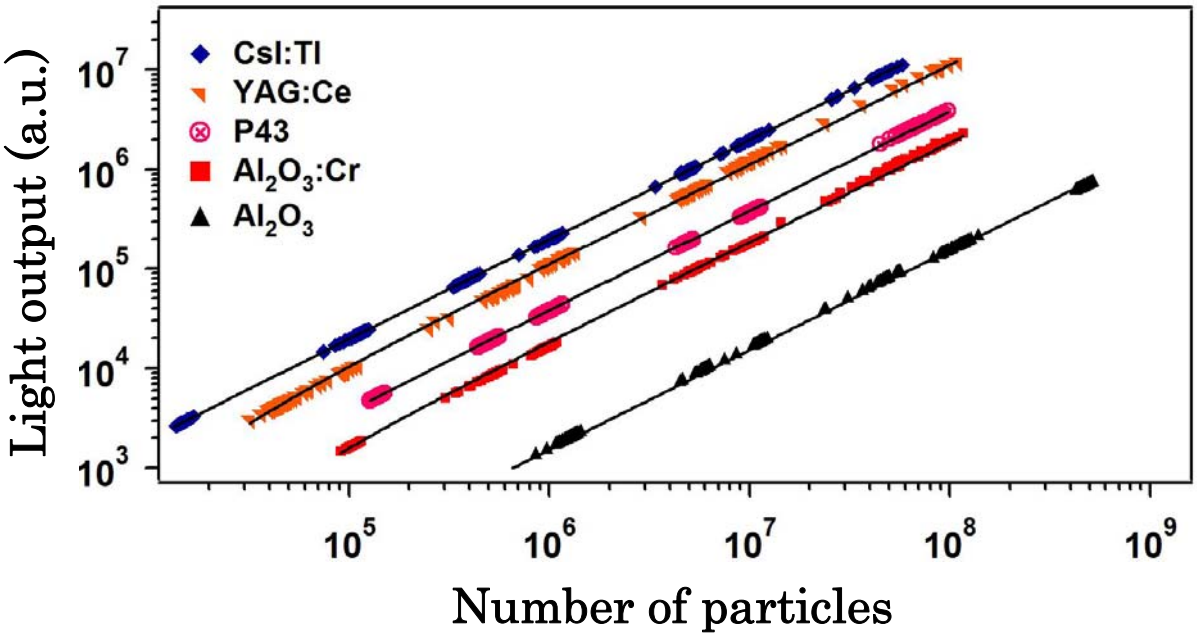
Al_2O_3 : Cr shows one order of magnitude more light than Al_2O_3



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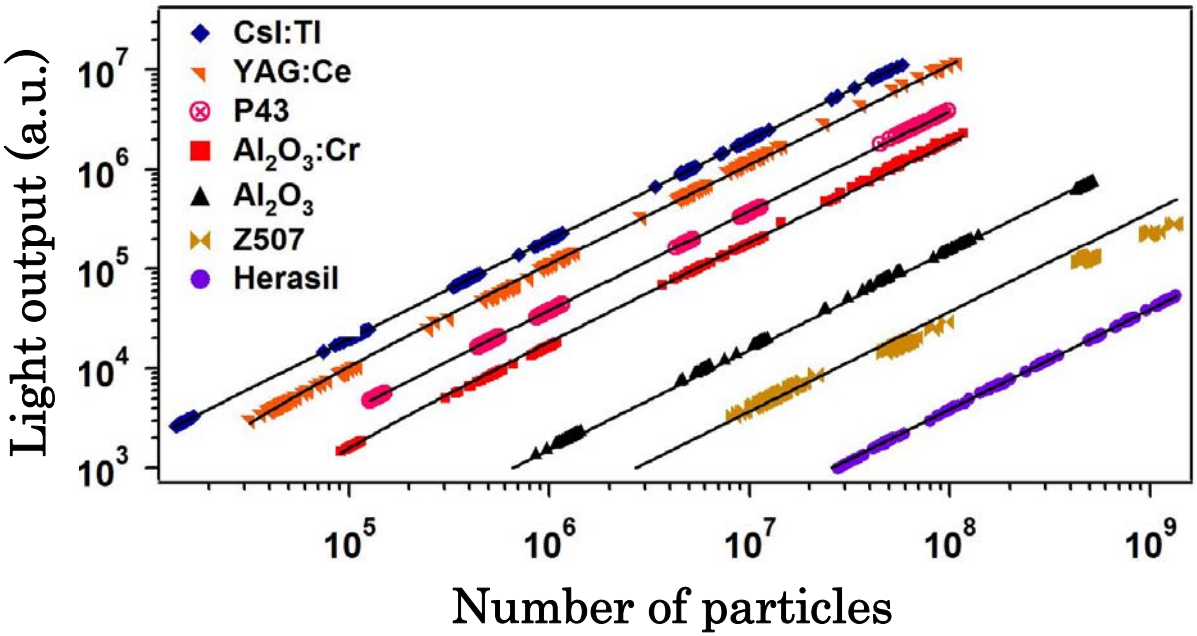
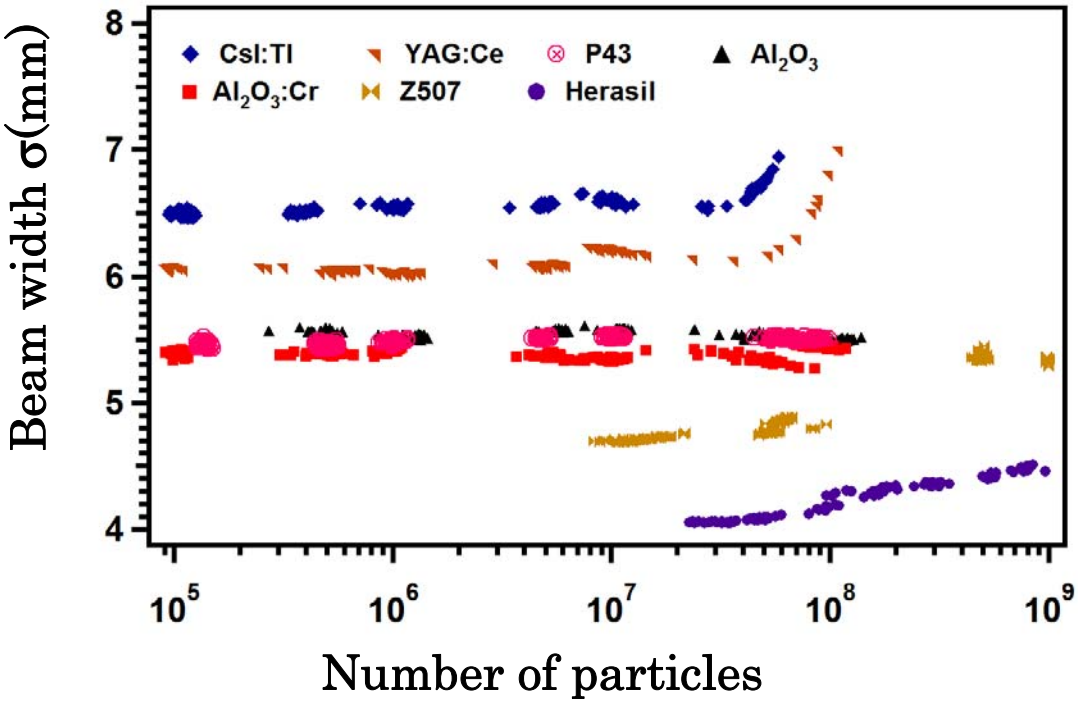
Herasil gives the lowest light output



Parameters:
U@ 269 MeV/u
10^4 to 10^9 ppp
300 ms pulse length

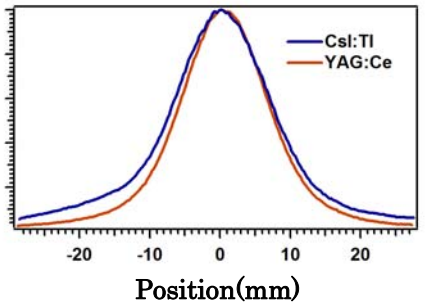
Similar trend in another Beam time

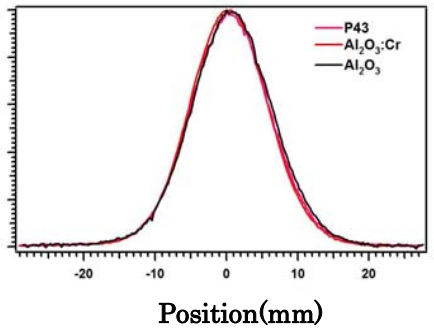
Results: Profile Reproduction

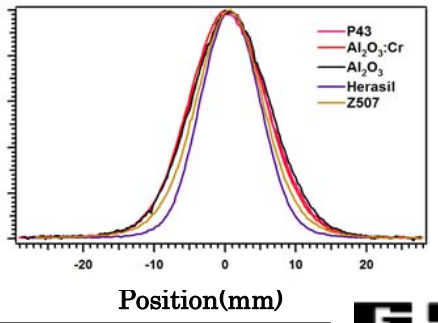


σ of a Gaussian fit

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

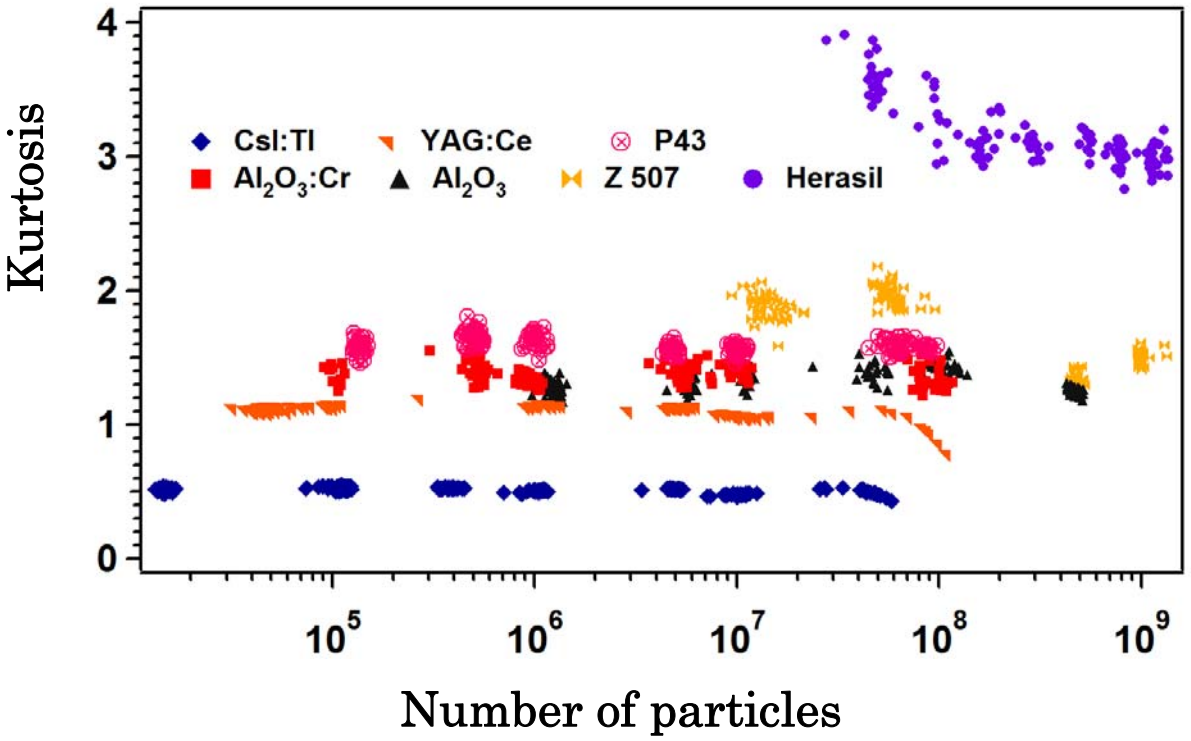




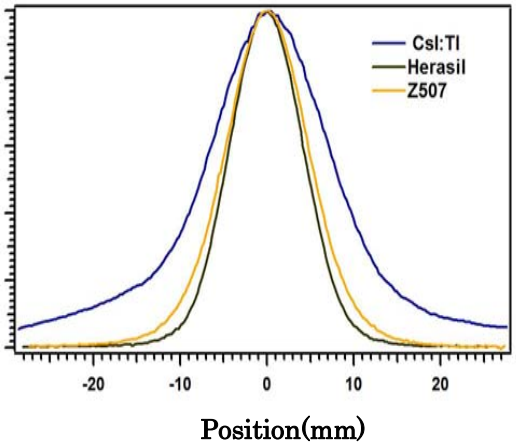


Kurtosis

Peakedness of the distribution



$$K = \sum_{j=1}^{N} \frac{w_j \left(\frac{x_j - \overline{X}}{\sigma} \right)^4}{W} - 3$$

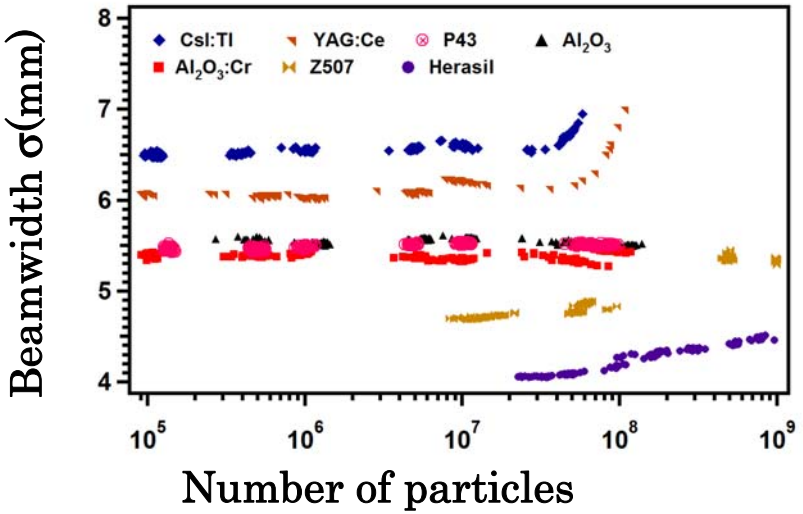


Lower the kurtosis→platykurtic distribution

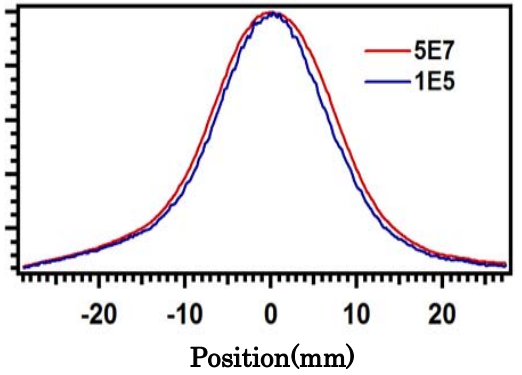
Herasil shows high values→leptokurtic distribution

Broad Beam Width

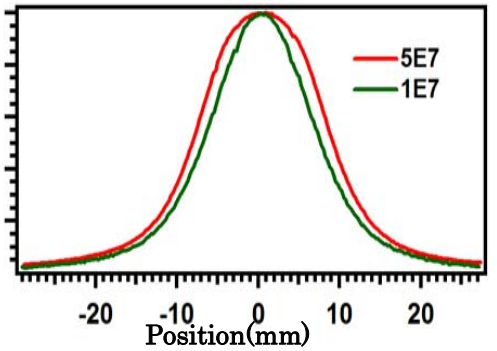
σ *of Gaussian fit*



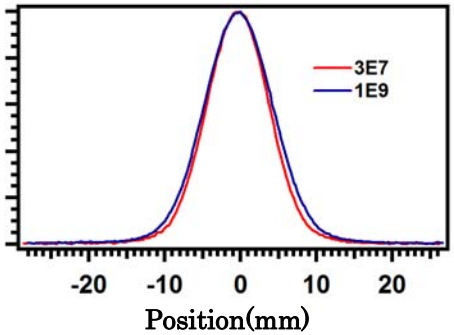
CsI:Tl



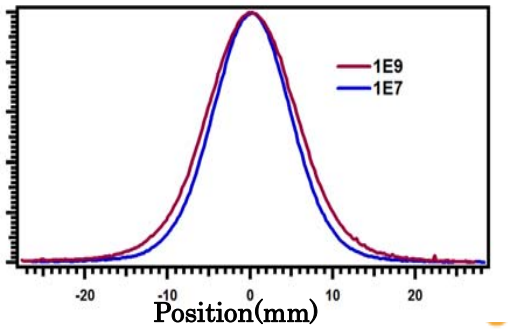
YAG:Ce



Herasil



ZrO_2:Mg

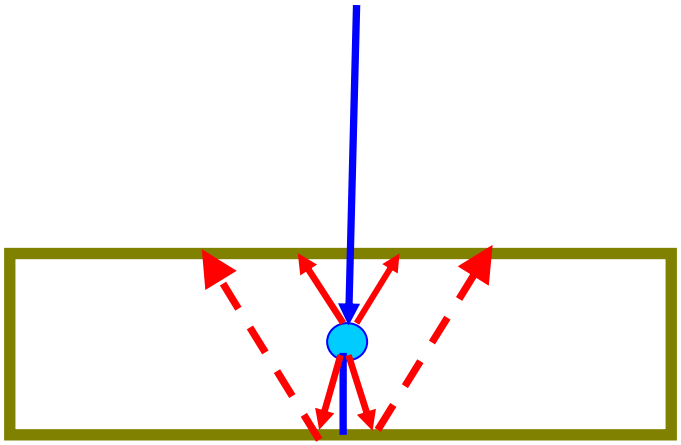


Strange behaviour

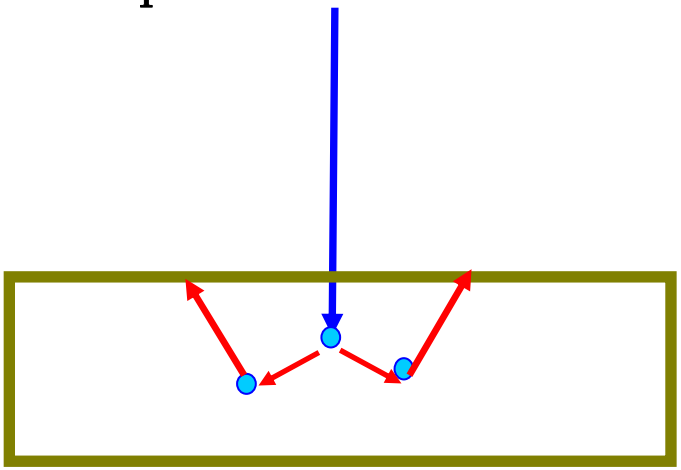
CsI:Tl and YAG:Ce shows relatively broad beam profile

Reason → attributed to

Reflection from backside



Absorption and Re-emission



Herasil being a glass material does not show this effect !

Has to be investigated further

Conclusion

Light output

- CsI:Tl ,YAG:Ce, P43, Al_2O_3:Cr, Al_2O_3, Herasil shows linear light output
- Al_2O_3:Cr shows an order of magnitude more light than Al_2O_3
- Herasil gives the low light yield but linear
- Z507 seems get saturated at higher intensities

Beam width

- CsI:Tl gives the largest while herasil gives smallest beamwidth
- P43, Al_2O_3:Cr, Al_2O_3 gives a comparable result→difference less than 7%
- Broadening of profile @ higher intensities for some samples

Future work

- Various Ion Beams , Different energies
- Spectroscopic investigation
- Investigation of radiation damage in materials

THANK YOU FOR YOUR KIND ATTENTION