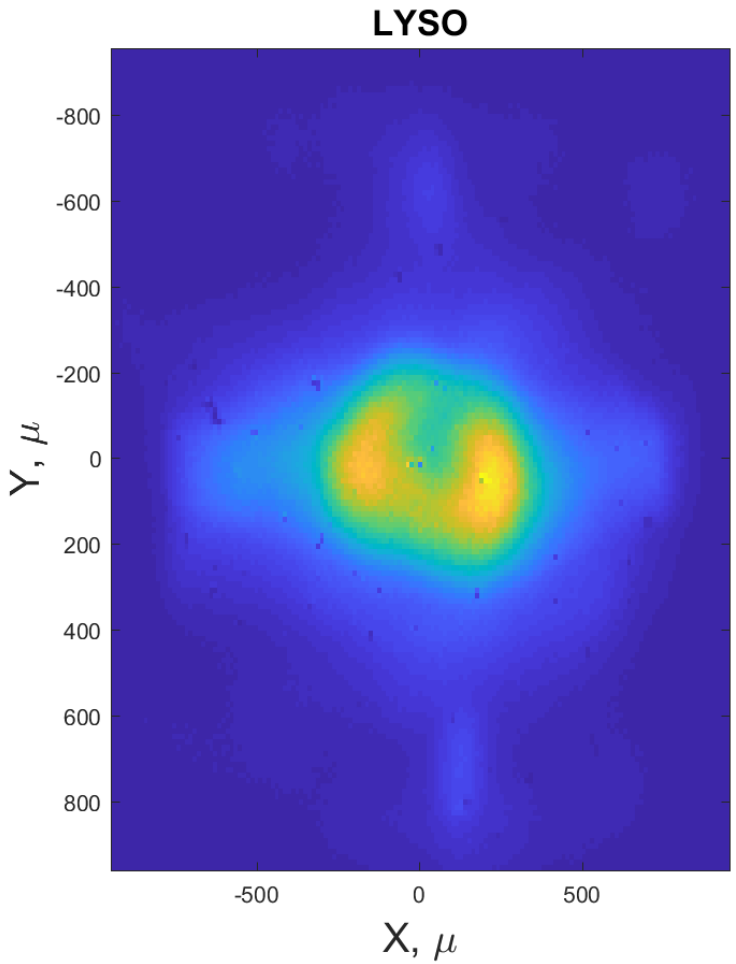
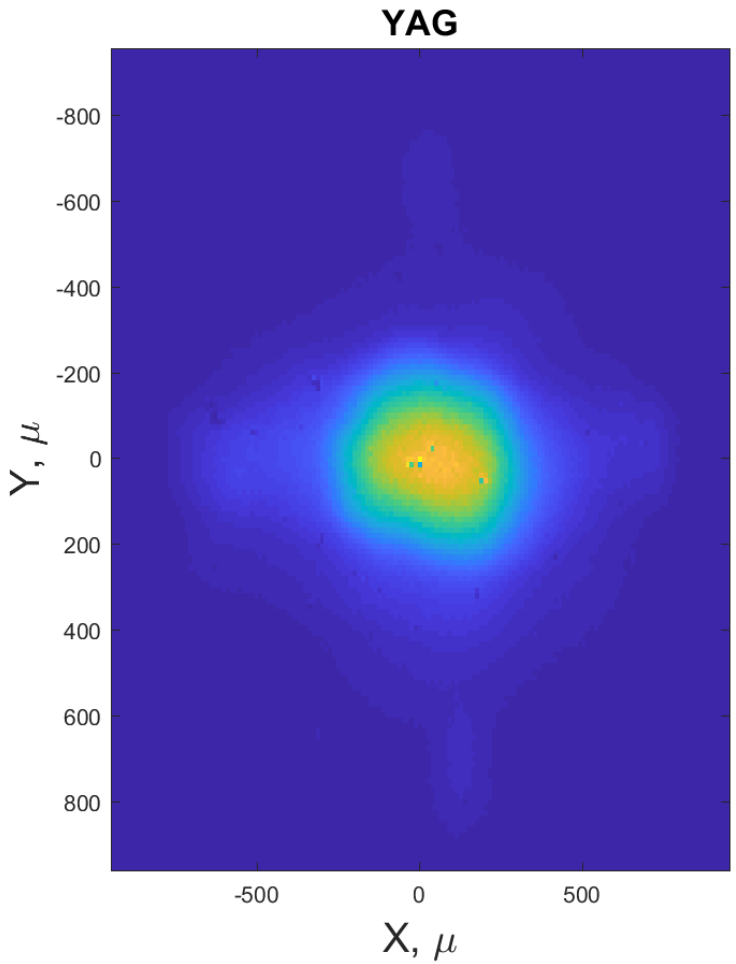
Studies of Scintillators Nonproportionality

Artem Novokshonov

Nonproportionality problem

- The screen material taken for the European XFEL was LYSO
- Already during the commissioning the beam profiles were odd

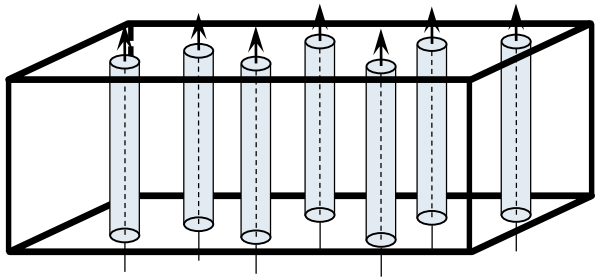


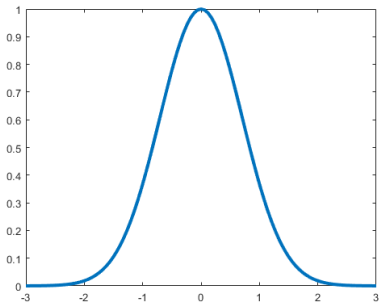


Nonproportionality problem

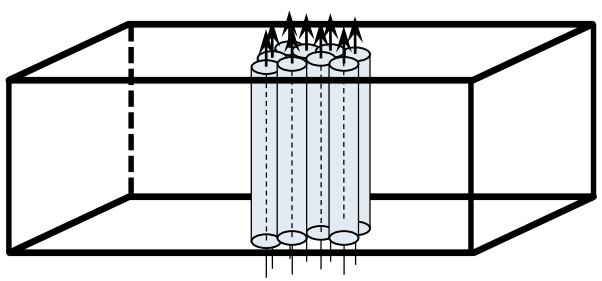
- The problem is well-known in High Energy Physics – ***Light Output on Deposited Energy dependence isn't linear***.
- The effect depends on the **Scintillator Material** and the **Deposited Energy Density.**
- In case of XFEL **the Energy deposited inside a scintillator is relatively *low* and *constant*.**
- However **the Electrons Density is high.**

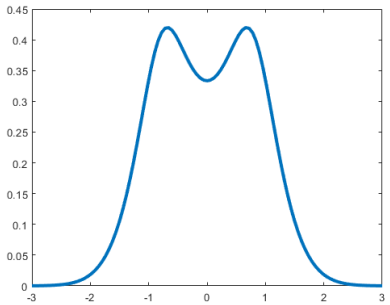
Low charge density

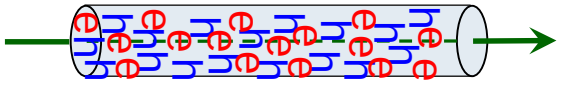


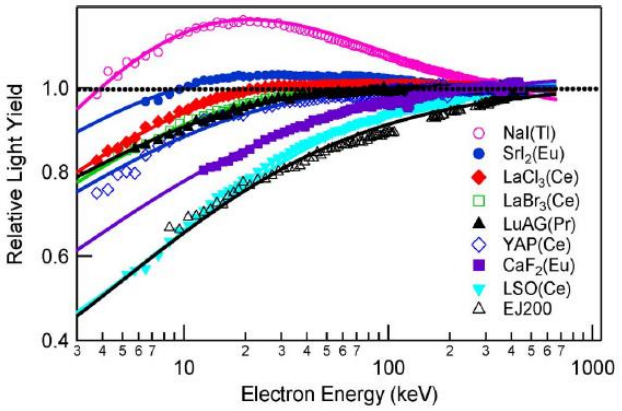


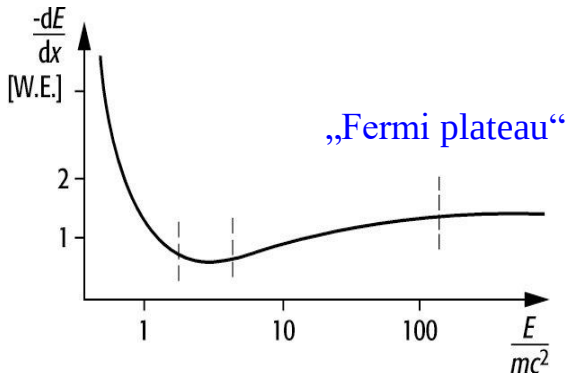
High charge density





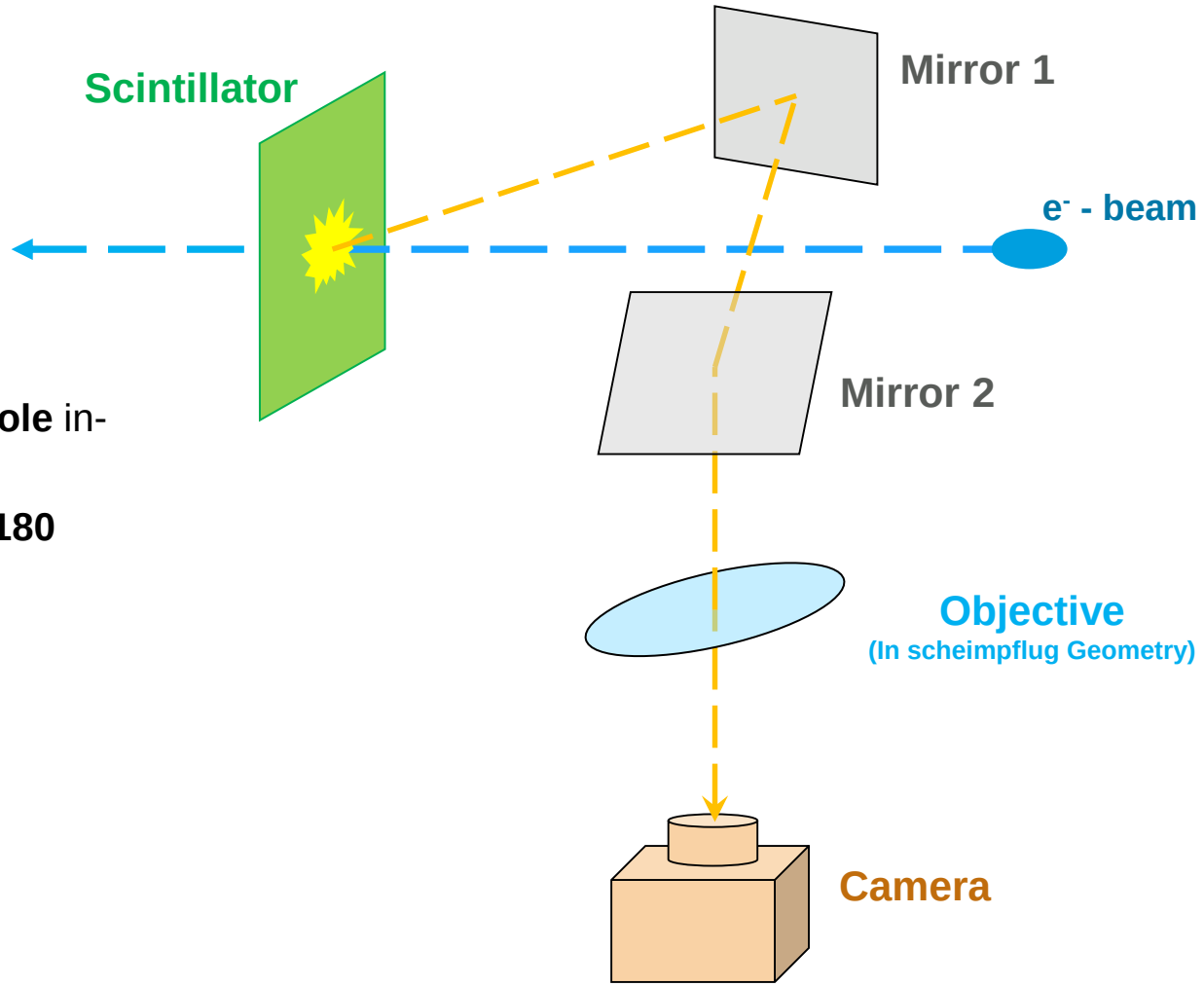






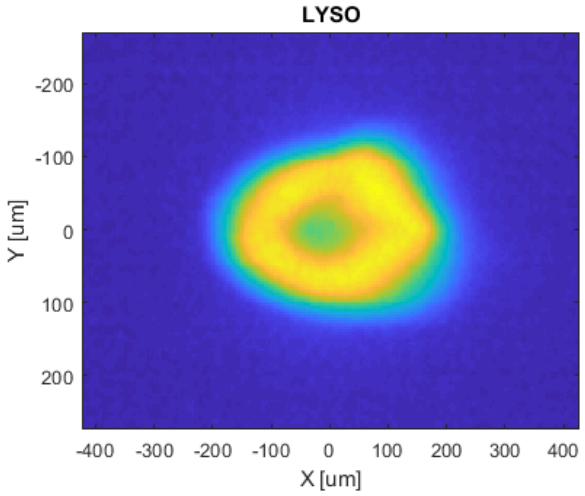
PITZ measurement setup

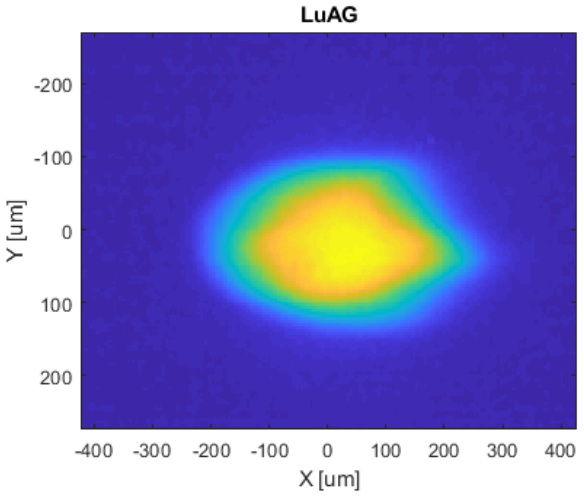
- The measurements have been carried out at the **High1.Scr5** station
- The were 5 different scintillator materials:
  1. *LYSO ($Lu_2 Y_2 SiO_5$:Ce)*
  2. *YAG ($Y_3 Al_5 O_{12}$:Ce)*
  3. *YAP ($Y Al O_3$:Ce)*
  4. *LuAG ($Lu_3 Al_5 O_{12}$:Ce)*
  5. *GAGG ($Gd_3 Al_2 Ga_3 O_{12}$:Ce)*
- The charge density was varied either by one of the **Quadrupole** in-front of the screen or by the **Charge**
- The Objective - **Schneider Kreuznach Makro Symmar 5.6/180**
- The Camera - **Allied Vision Prosilica GT GC1350**

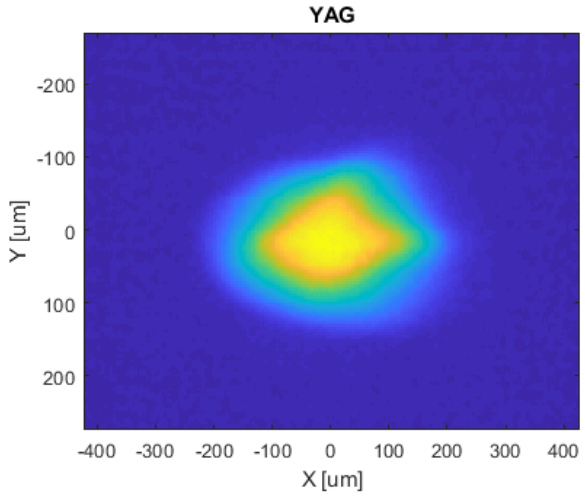


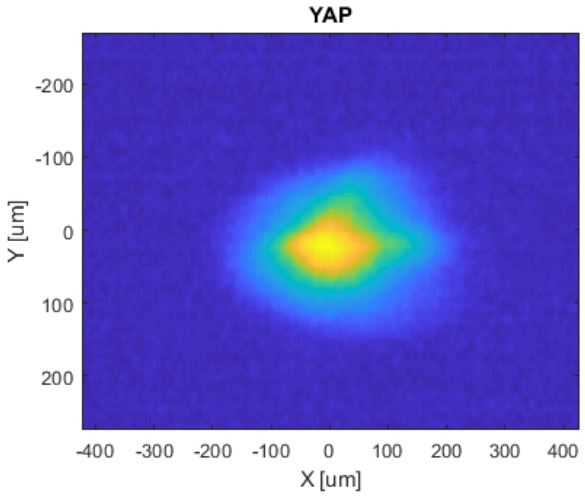
The Scintillators Comparison

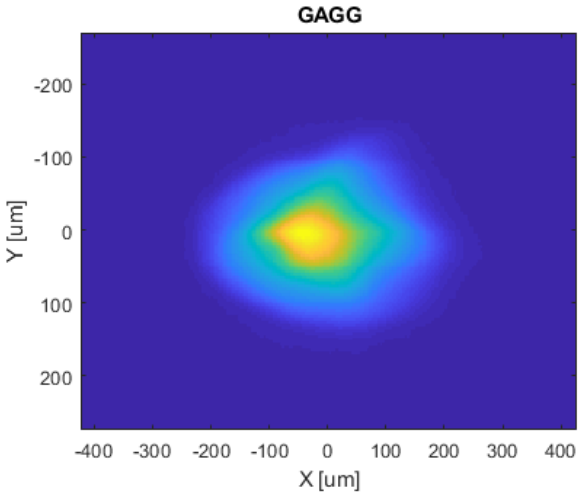
- Electron energy = 20 MeV.
- Charge is 2.2 nC
- The images are averaged per 10 shots.
- Exposure Time = 10 us, Gain = 0.
- 3 ND filters were used filter = 1/120 Transmittance





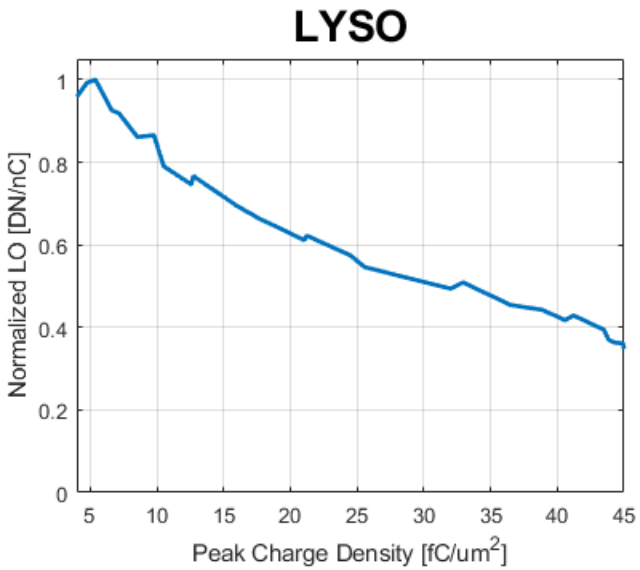


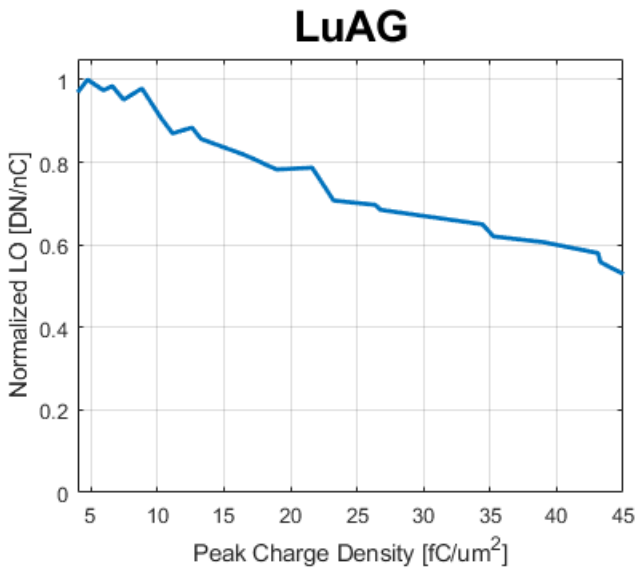


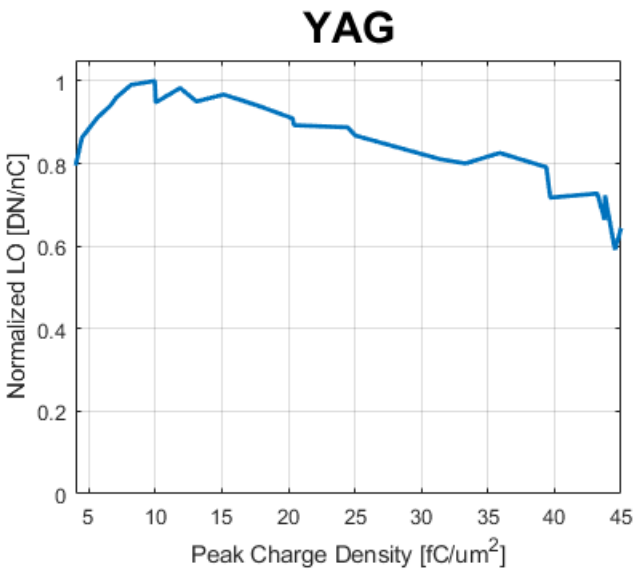


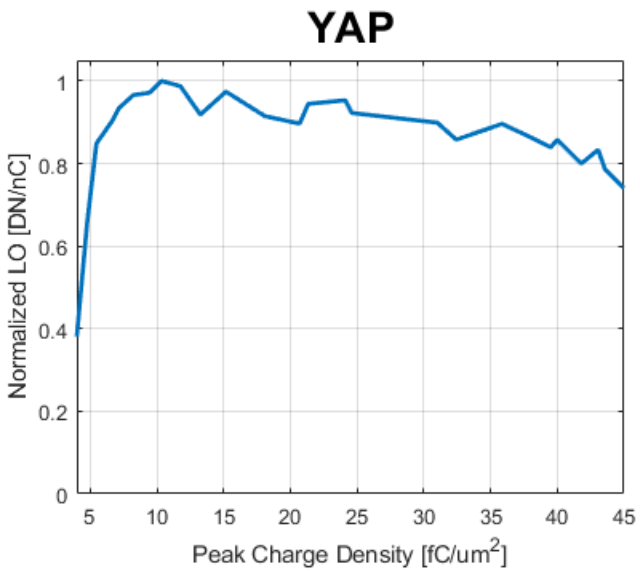
Light Output on Charge Density

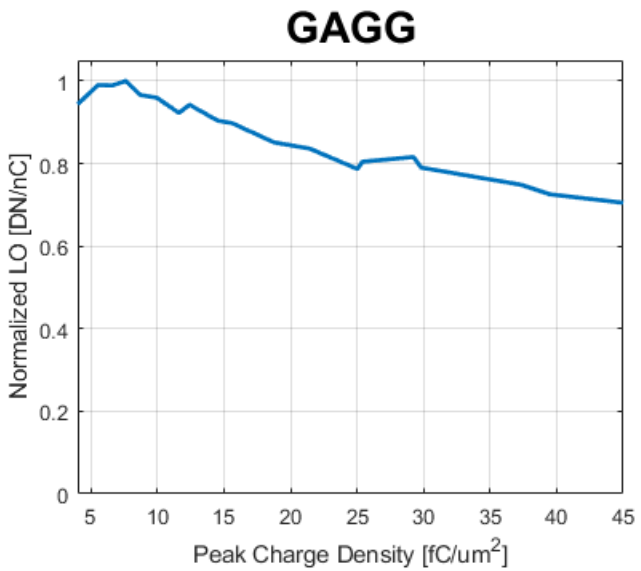
- Here is the comparison of the Light Output per nC
- All the scintillators reveal the intensity drop
- However LYSO has the largest drop ~ 60 %
- *One cannot take GAGG as reference to derive the Birks factor of the other materials…*











Conclusion

1. In the measurement *LYSO* clearly has shown the “smoke-ring” structure.

2. The second candidate to reveal the structure is *LuAG.*

3. The GAGG material is so far seems to be the best candidate to be used in beam diagnostics.