

Stimulated Recovery of Radiation Damage for the PANDA EMC

TILL KUSKE, VALERA DORMENEV, RAINER NOVOTNY, RENE SCHUBERT
AND FOR THE PANDA COLLABORATION

II. PHYSIKALISCHES INSTITUT / JLU GIEßEN

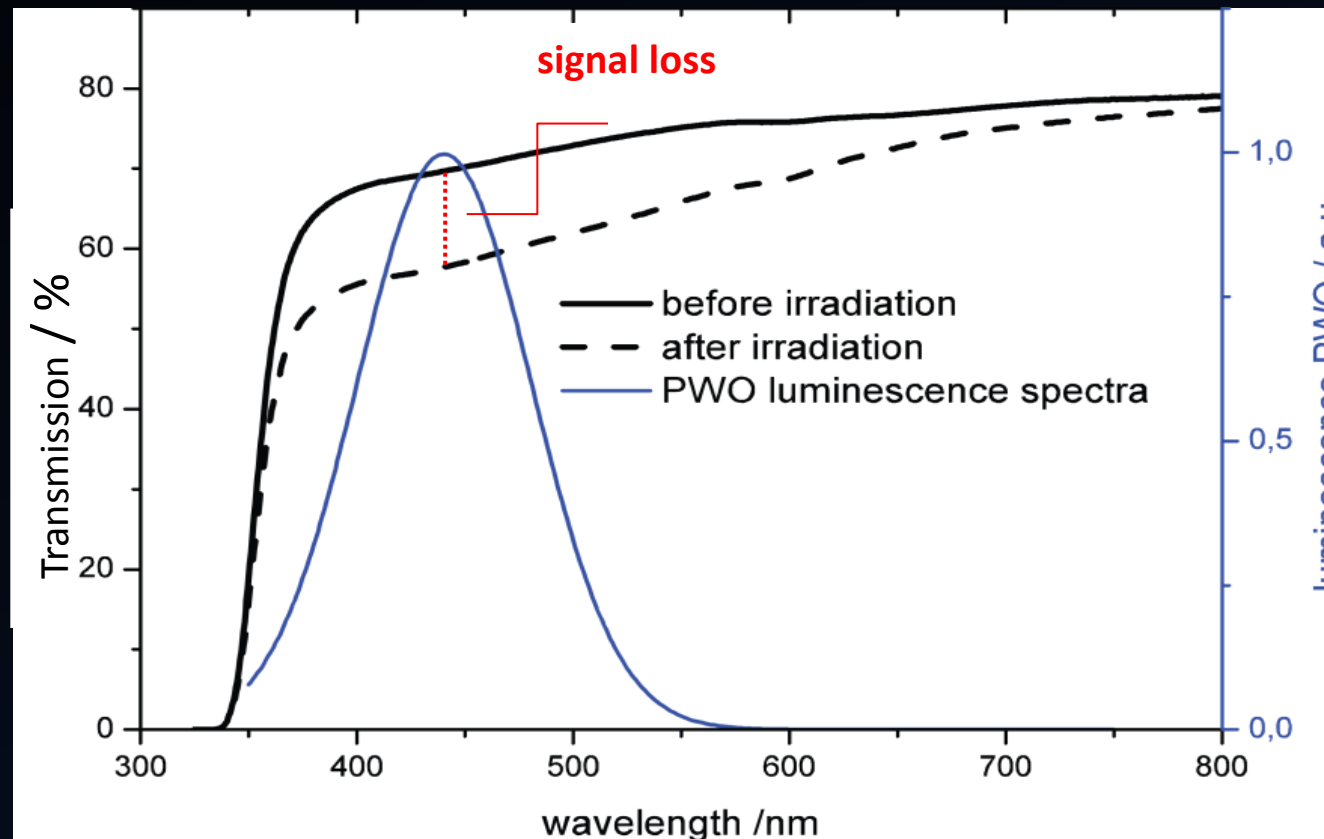
PANDA COLLABORATION MEETING GOA 2013

Overview

- Impact of Radiation Damage on PbWO_4
- Hadron induced radiation damage
 - new data for low energy protons
 - recovery of proton induced damage
- Stimulated recovery for the PANDA EMC
 - recovery dependencies
 - Laser diode light sources
- Conclusion

Impact of Radiation Damage on PbWO₄

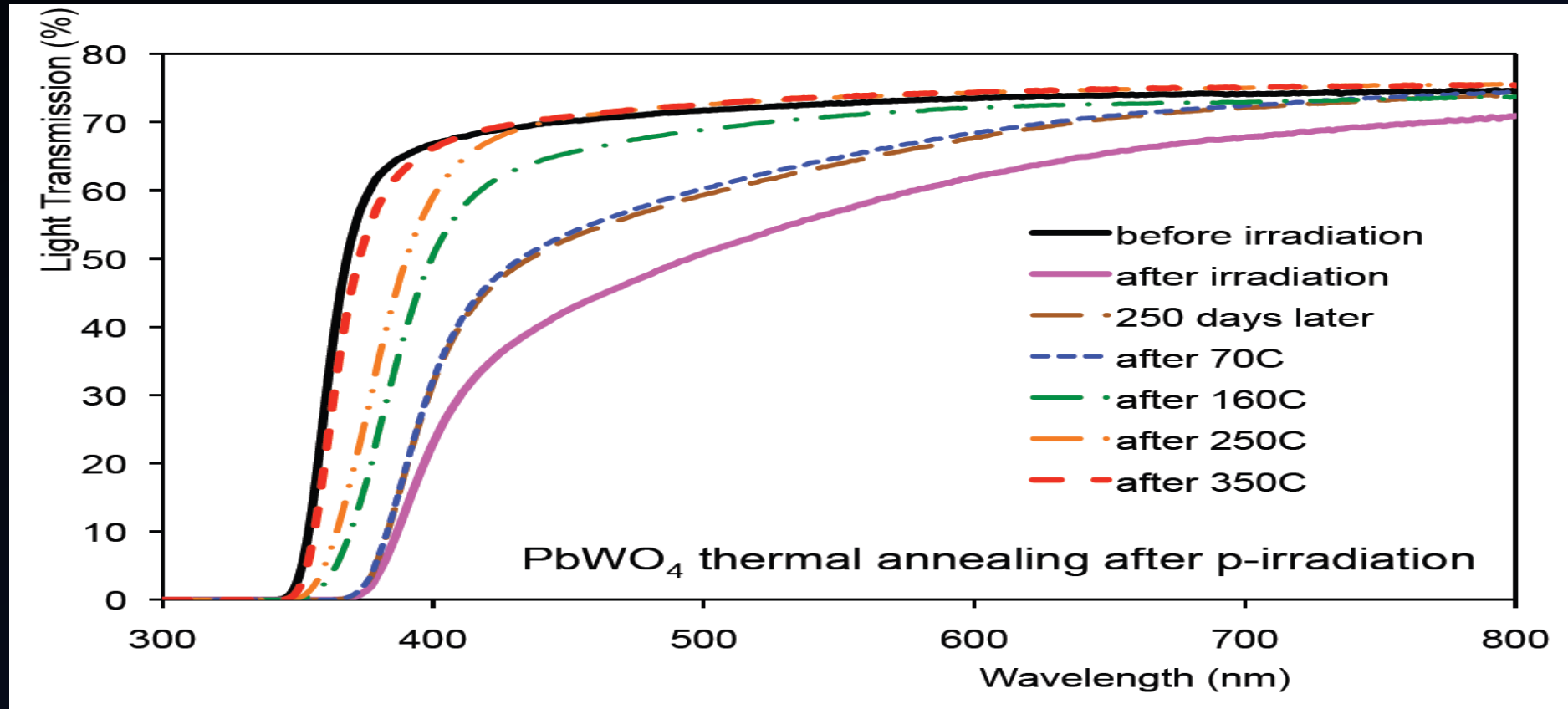
- color center population due to gamma irradiation
- loss of optical transmittance
- selfabsorption of scintillation light



$$\Delta k = \ln \left(\frac{T_{before}}{T_{after}} \right) \times \frac{1}{d}$$

Hadron induced radiation damage

- Protons with 24 GeV/c
- Fluence $\phi_p = (1,59 \pm 0,13) * 10^{12} cm^{-2}$

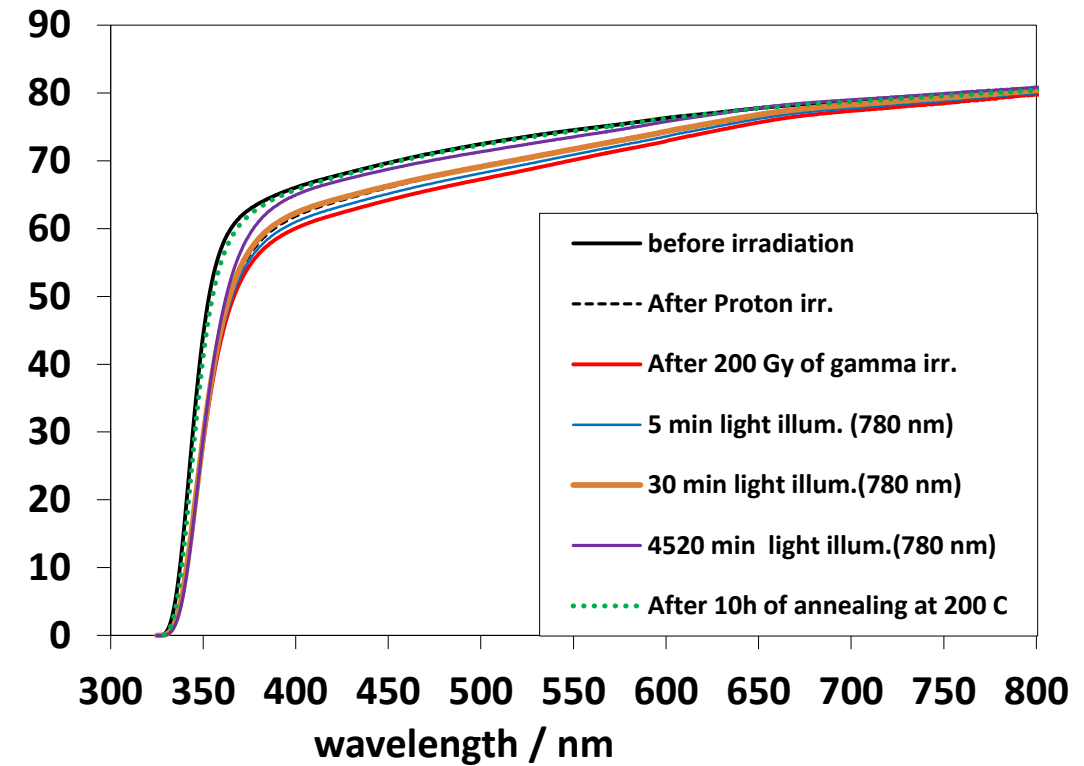
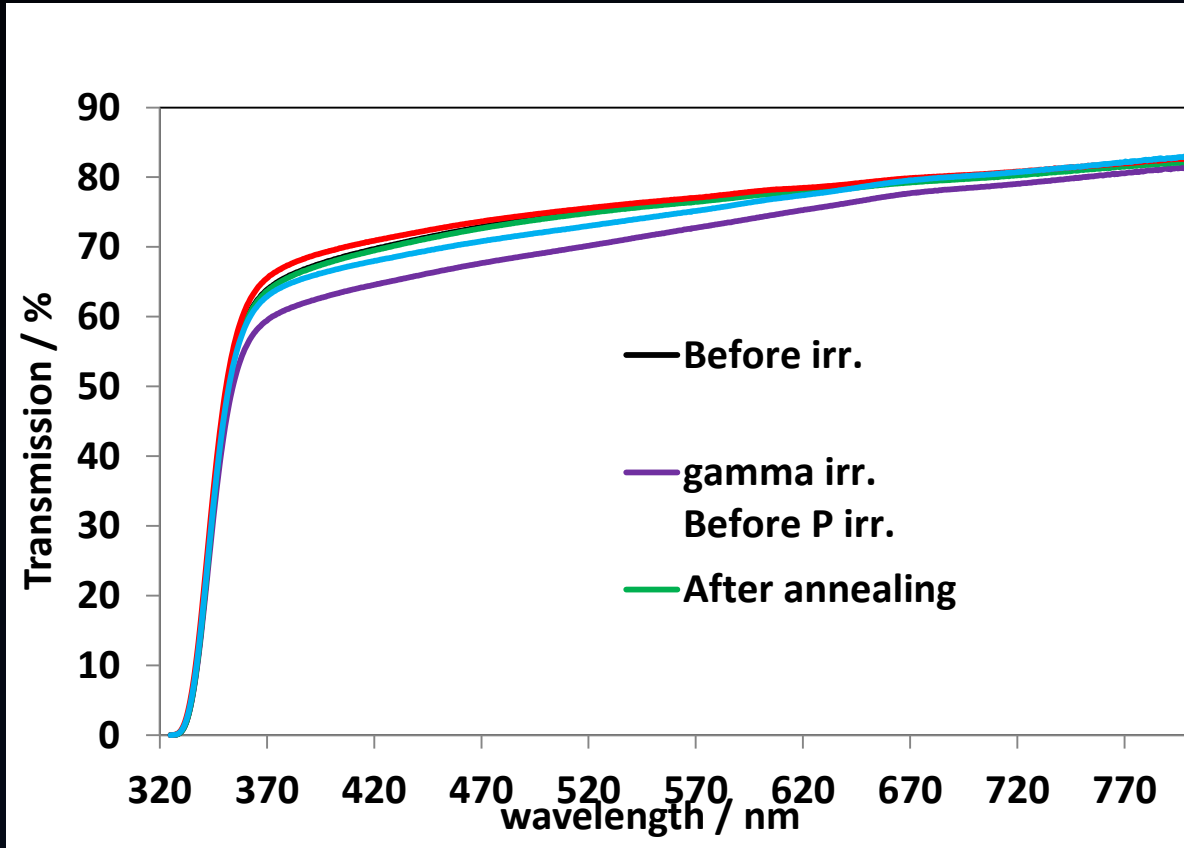


[G.Dissertori et al /ETH Zürich /2012]

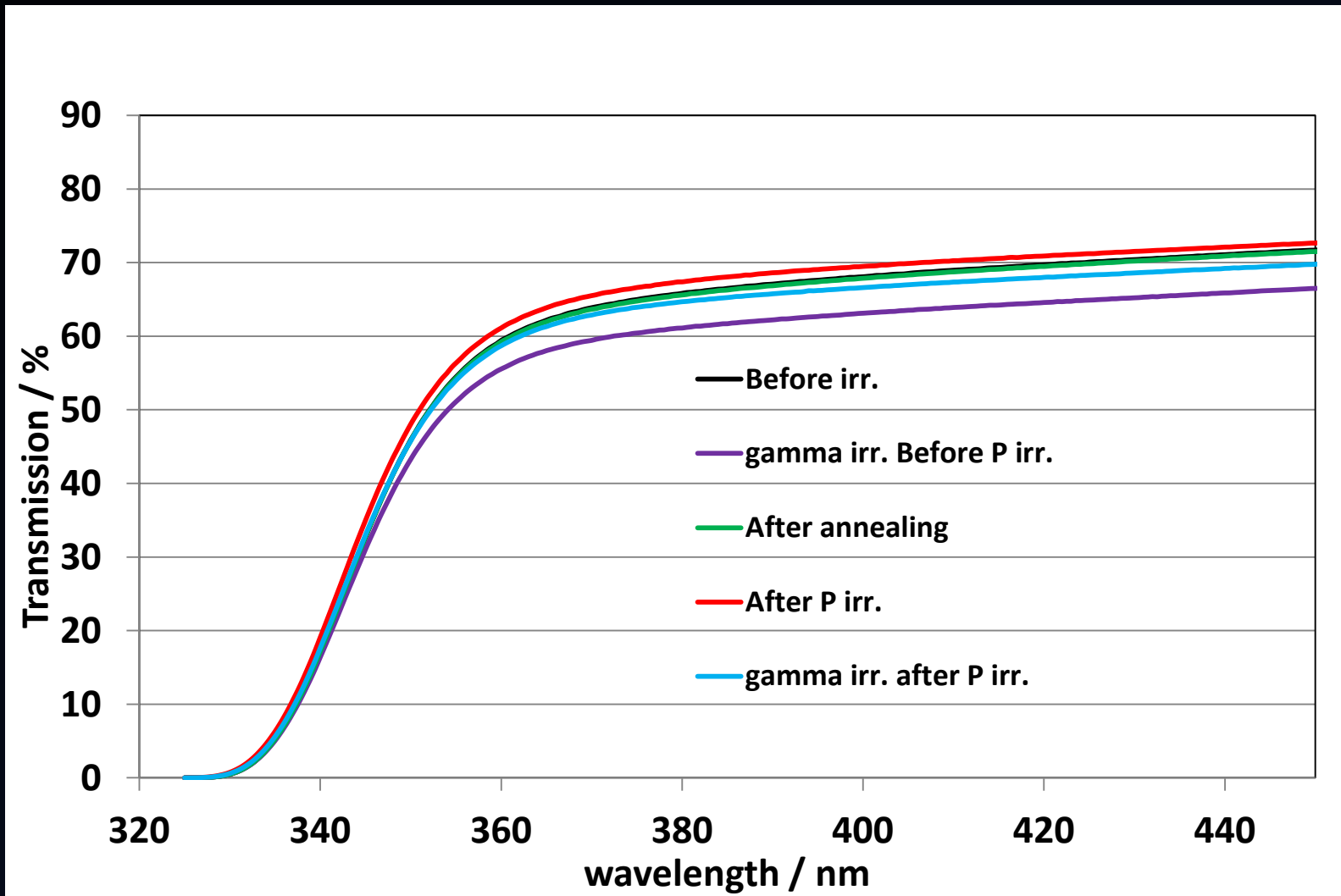
Hadron induced radiation damage

Protons with 90 MeV
 Fluence $\phi_p = 10^{12} \text{ cm}^{-2}$

Protons with 150 MeV
 Fluence $\phi_p = (1,8 \pm 0,10) * 10^{13} \text{ cm}^{-2}$

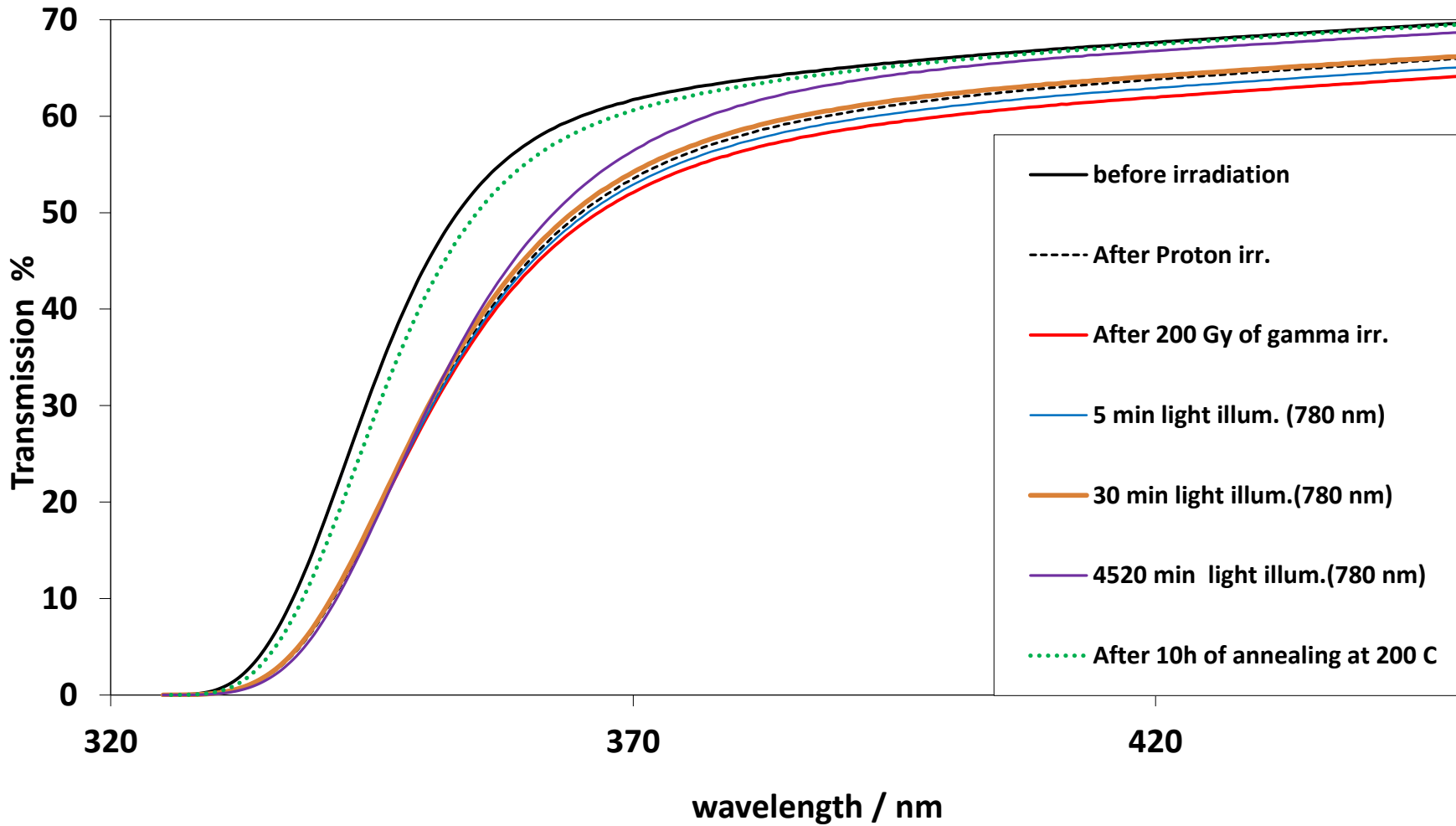


Hadron induced radiation damage



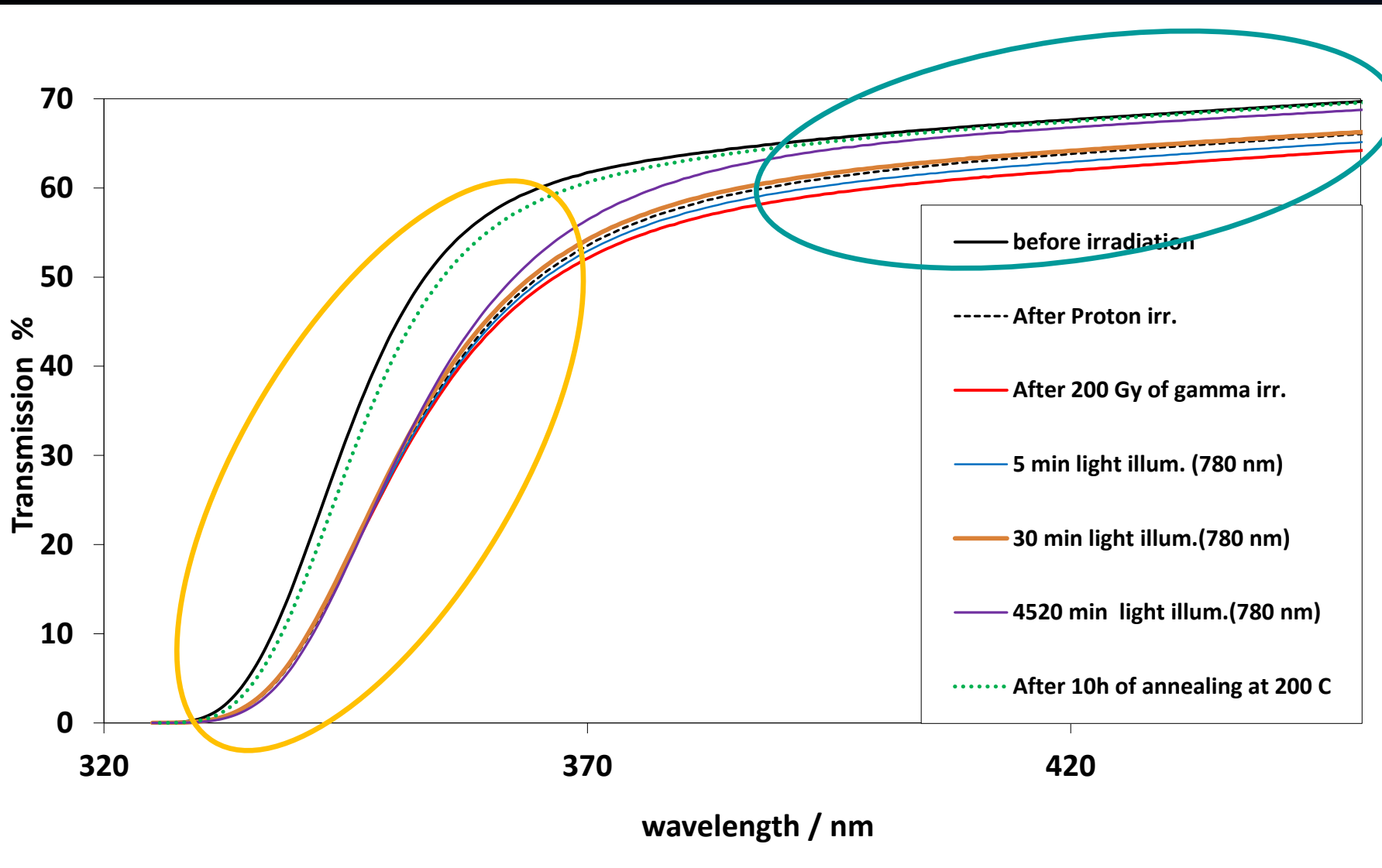
- γ before P irr. = 10800 Gy
- total fluence = 10^{12} p/cm²
- γ after P irr. = 150 Gy

Hadron induced radiation damage



total fluence = 10^{13} cm^{-2}
 γ After P irr. = 200 GY

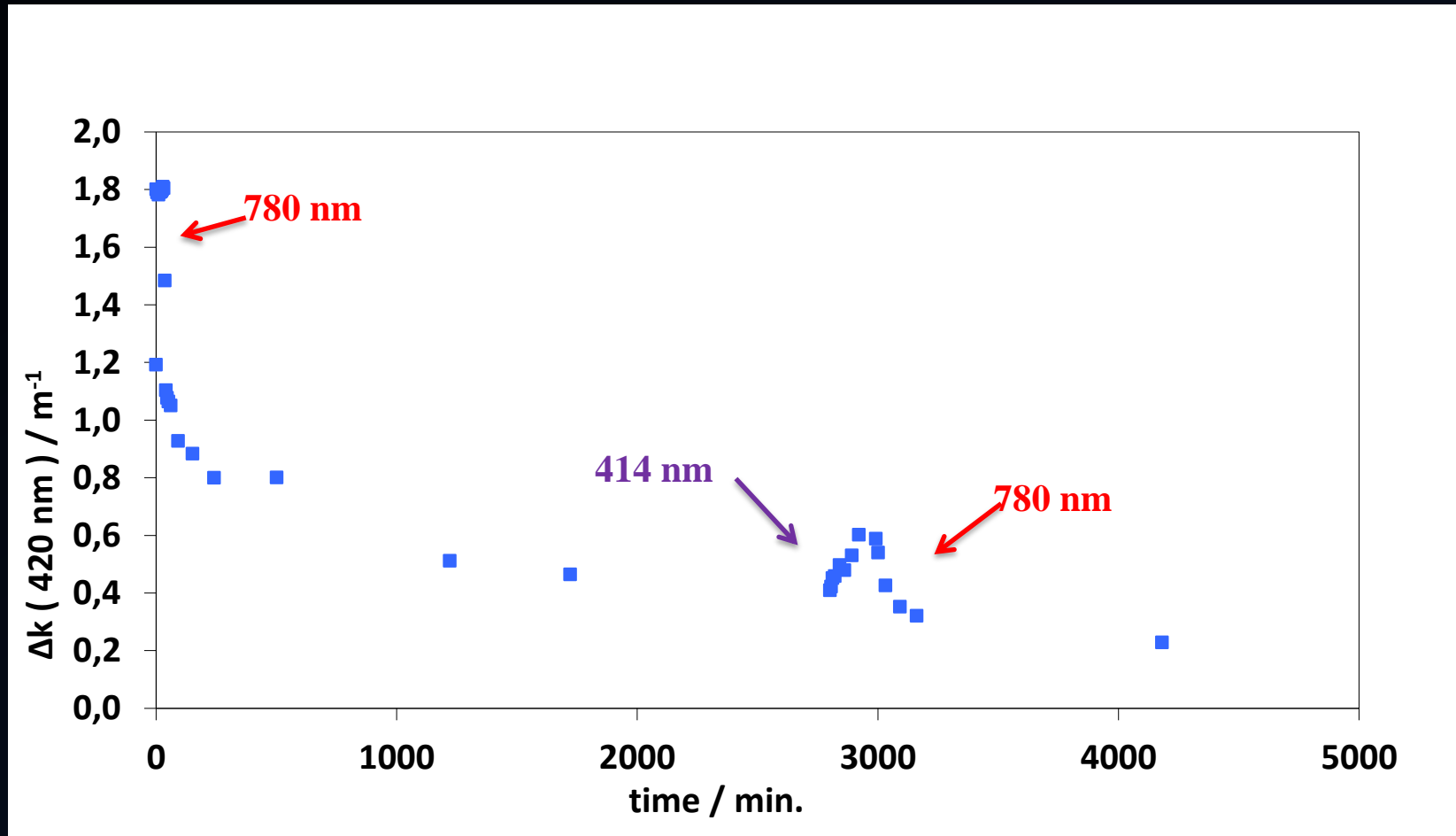
Hadron induced radiation damage



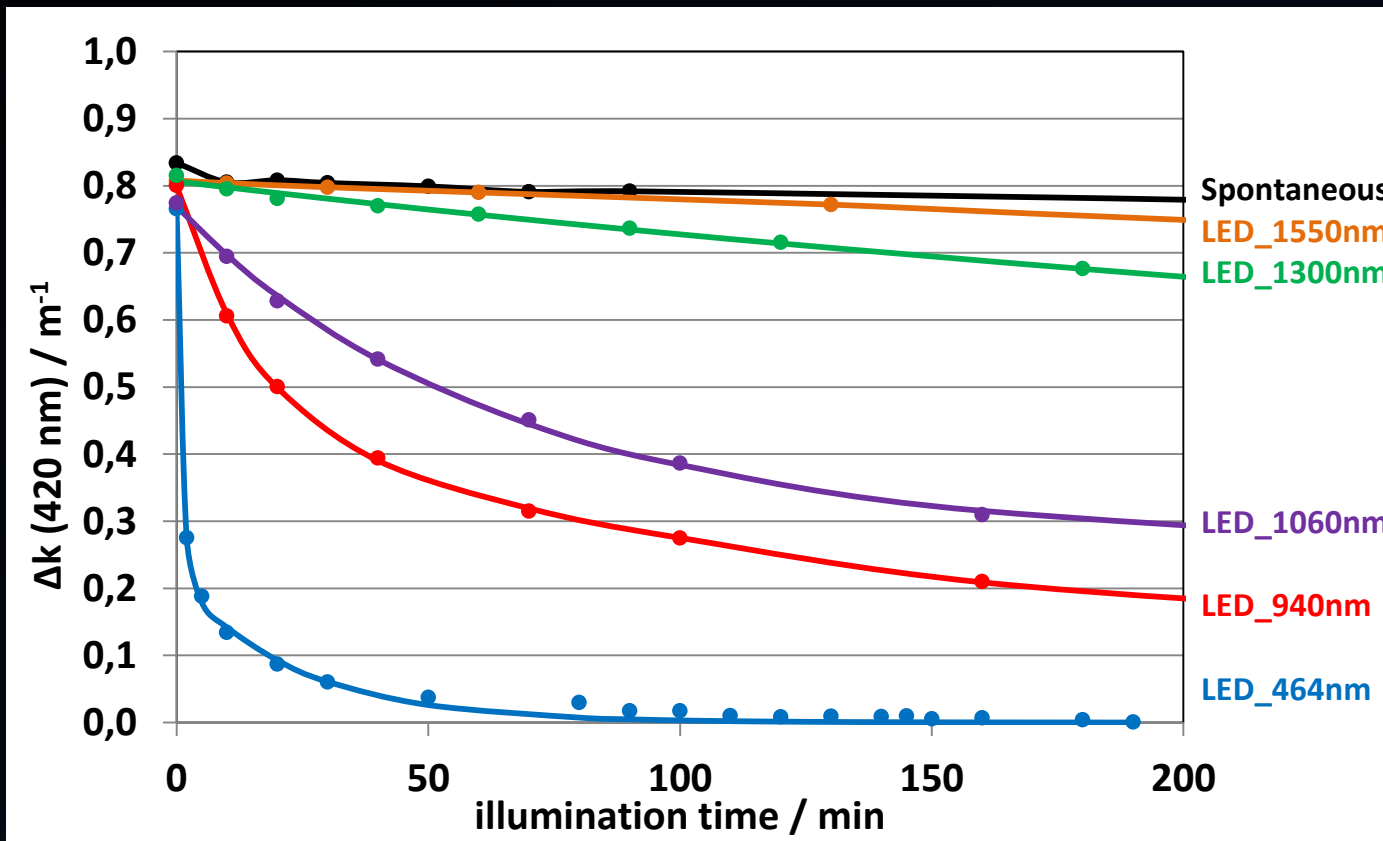
total fluence = 10^{13} cm^{-2}
 γ After P irr. = 200 GY

Hadron induced radiation damage

- Recovery of the radiation induced absorption coefficient



Stimulated recovery



radiation dose = 30 Gy

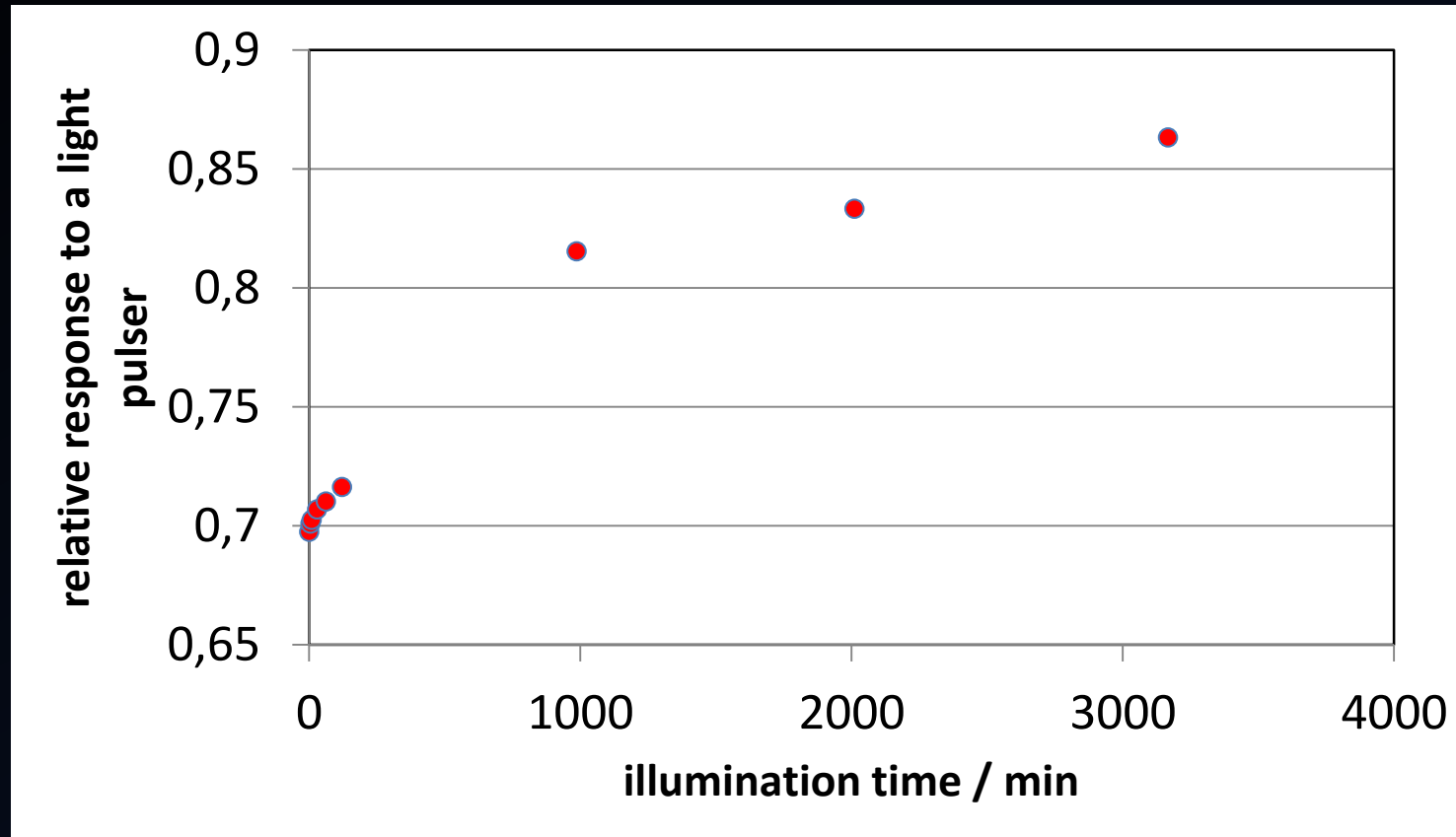
$$\Delta k = \ln \left(\frac{T_{before}}{T_{after}} \right) \times \frac{1}{d}$$

photon flux $\sim 10^{15}$ ph/s

- recovery speed changed drastically by illumination
- recovery speed depends on wavelength of light source

Stimulated recovery at -25°C

- 830nm laserdiodes as light source



radiation dose = 60 Gy

photon flux $\sim 10^{15}$ ph/s

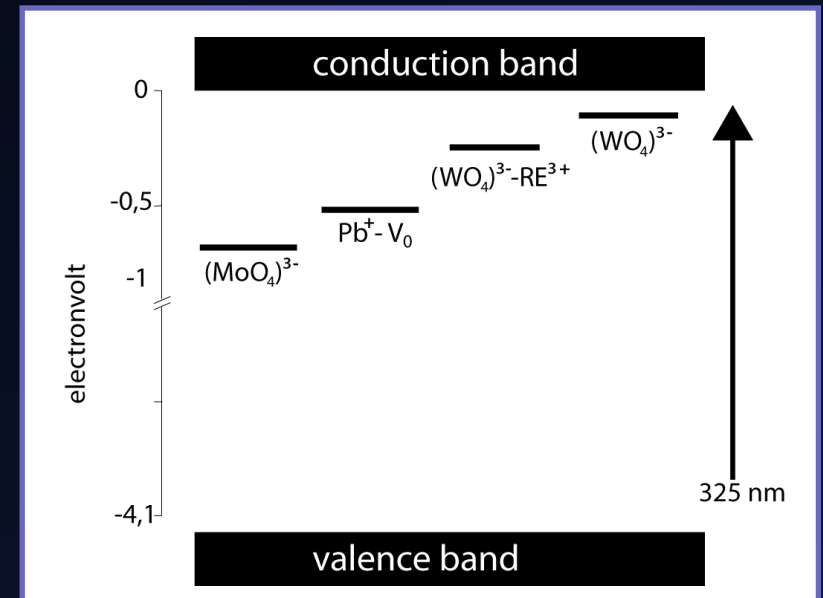
- recovery with 940nm laserdiodes was not observed at -25°C

Stimulated recovery @ the PANDA EMC

- estimated maximum dose rate $2 * 10^{-6}$ Gy/s
- leads to production of $\approx 10^{12}$ populated traps/s

minimum flux for recovery $\approx 10^{13}$ ph/s

$$\text{Doserate } \left[\frac{\mu\text{Gy}}{\text{s}} \right] = C(\lambda, T) * \phi \left[\frac{\text{ph}}{\text{s}} \right]$$



Conclusion

Hadron damage

- Proton damage with 24 GeV/c and 150 MeV are comparable, if the total deposited dose are the same
- Secondary EM damage can be recovered by light illumination, except the shift of fundamental absorption edge
- Shift of absorption edge is not observed with fluence $< 10^{12}$ protons (~ 600 Gy)

Stimulated Recovery @ the PANDA EMC

- online recovery is not applicable for APD readout
- online recovery still possible for VPTs
- offline recovery is viable for the cooled state of the experiment
- light monitoring fibers can be used for recovery scheme
- recovery edge at -25°C somewhere below 940 nm

Thank you

PANDA COLLABORATION MEETING GOA 2013

JUSTUS-LIEBIG-



UNIVERSITÄT
GIESSEN

