

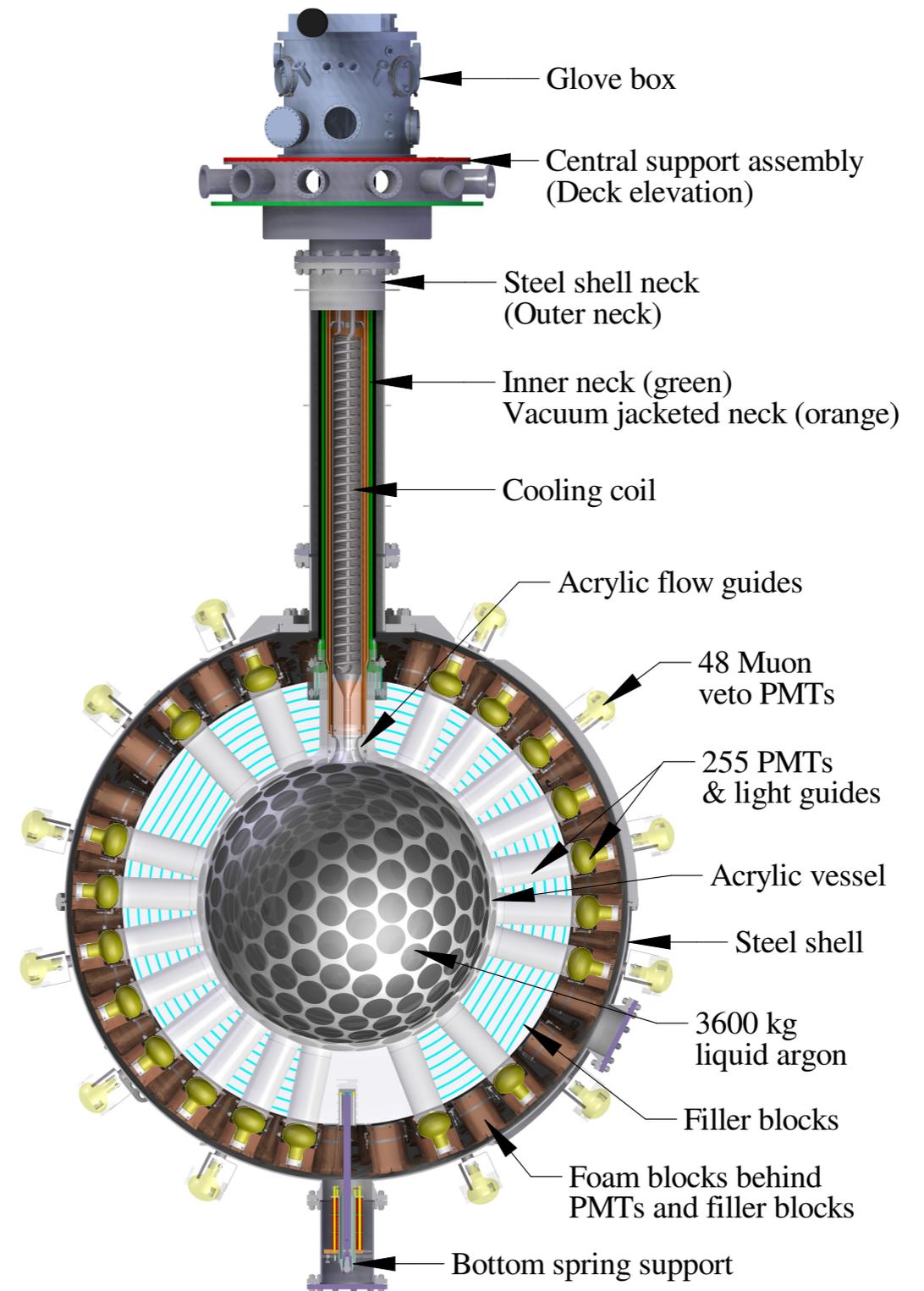
Early studies of detector optical calibrations for DEAP-3600

Berta Beltran, UofA, for the DEAP collaboration
CAP, 16 June 2015



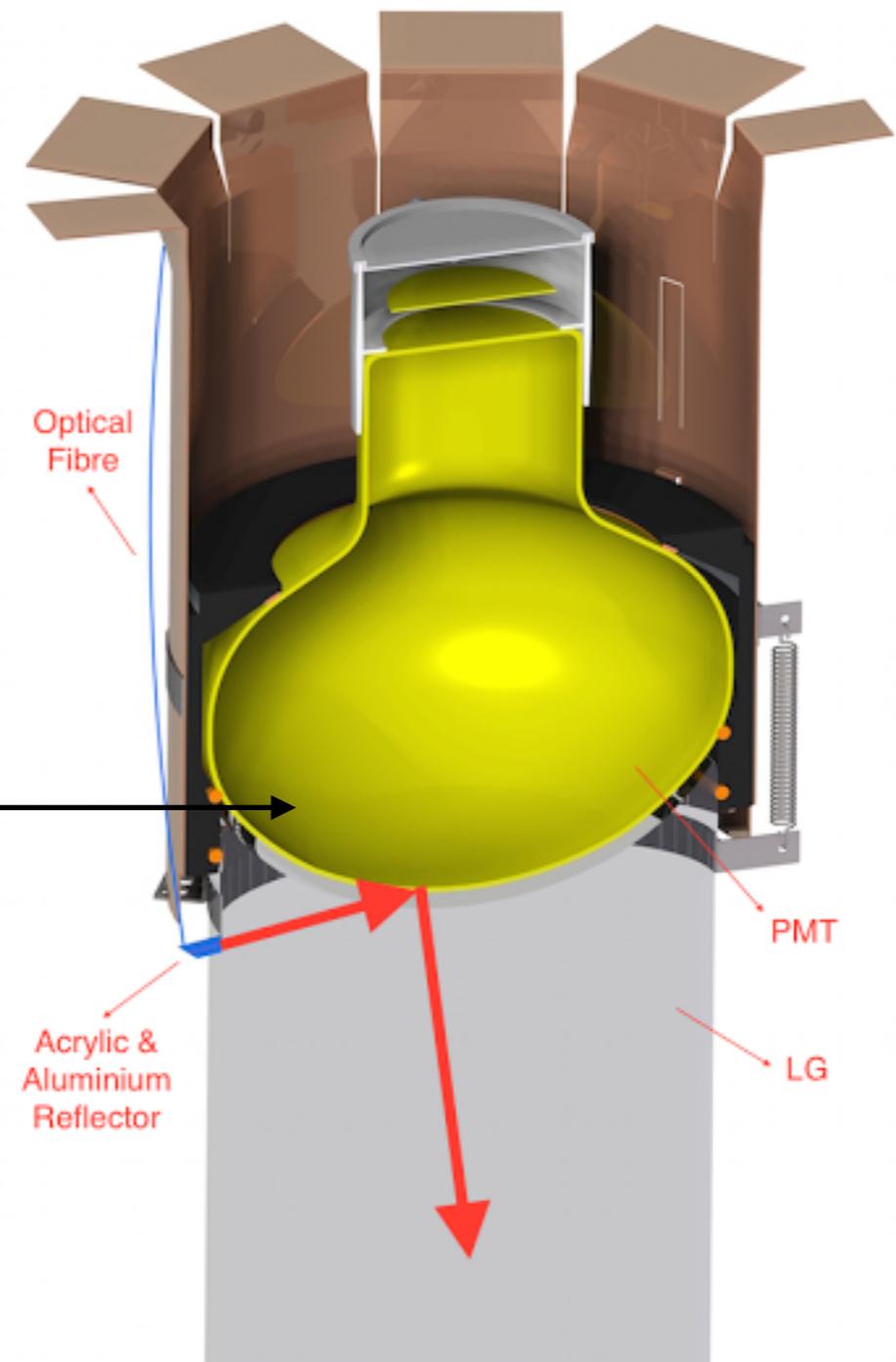
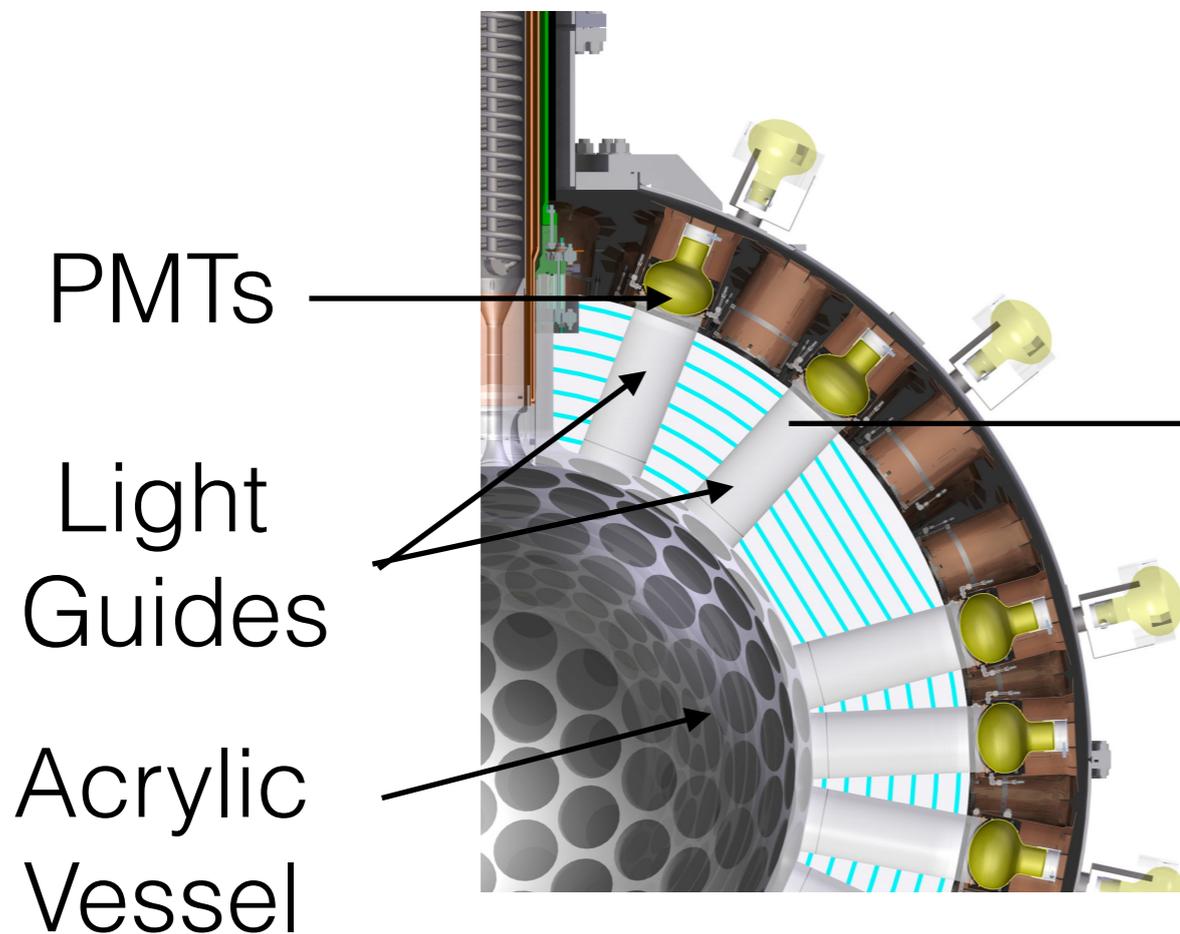
DEAP-3600

- ▶ Single phase scintillation dark matter detector
- ▶ 85 cm radius acrylic vessel
- ▶ 3600 kg of LAr as detector medium
- ▶ 255 pmts will detect scintillation light
- ▶ LED data with Nitrogen gas inside the detector has been collected.



LED Optical calibration sources

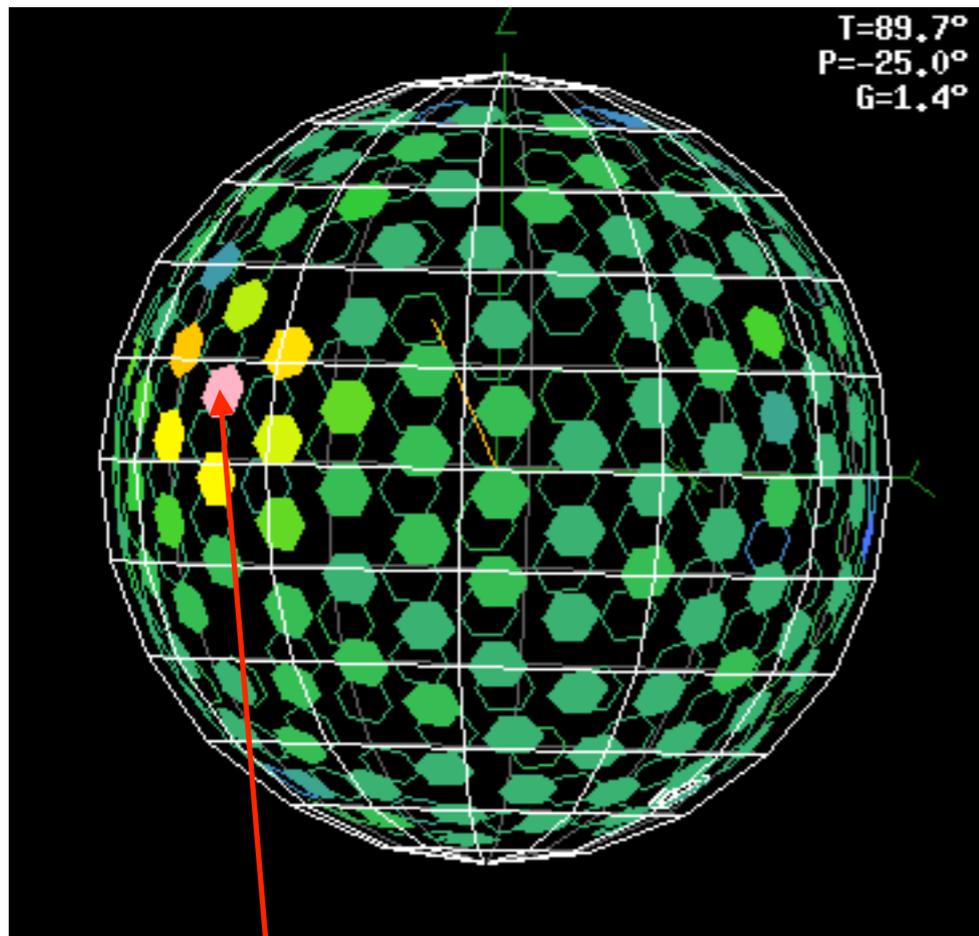
20 LED sources mounted in PMTs around the detector



First LED data

- ▶ We have collected good quality LED optical calibration data during March, April and May 2015.
- ▶ The PMTs are working properly within expected dark rate levels and behaviour.
- ▶ The DAQ has proven to be stable over time and to perform according to specifications.

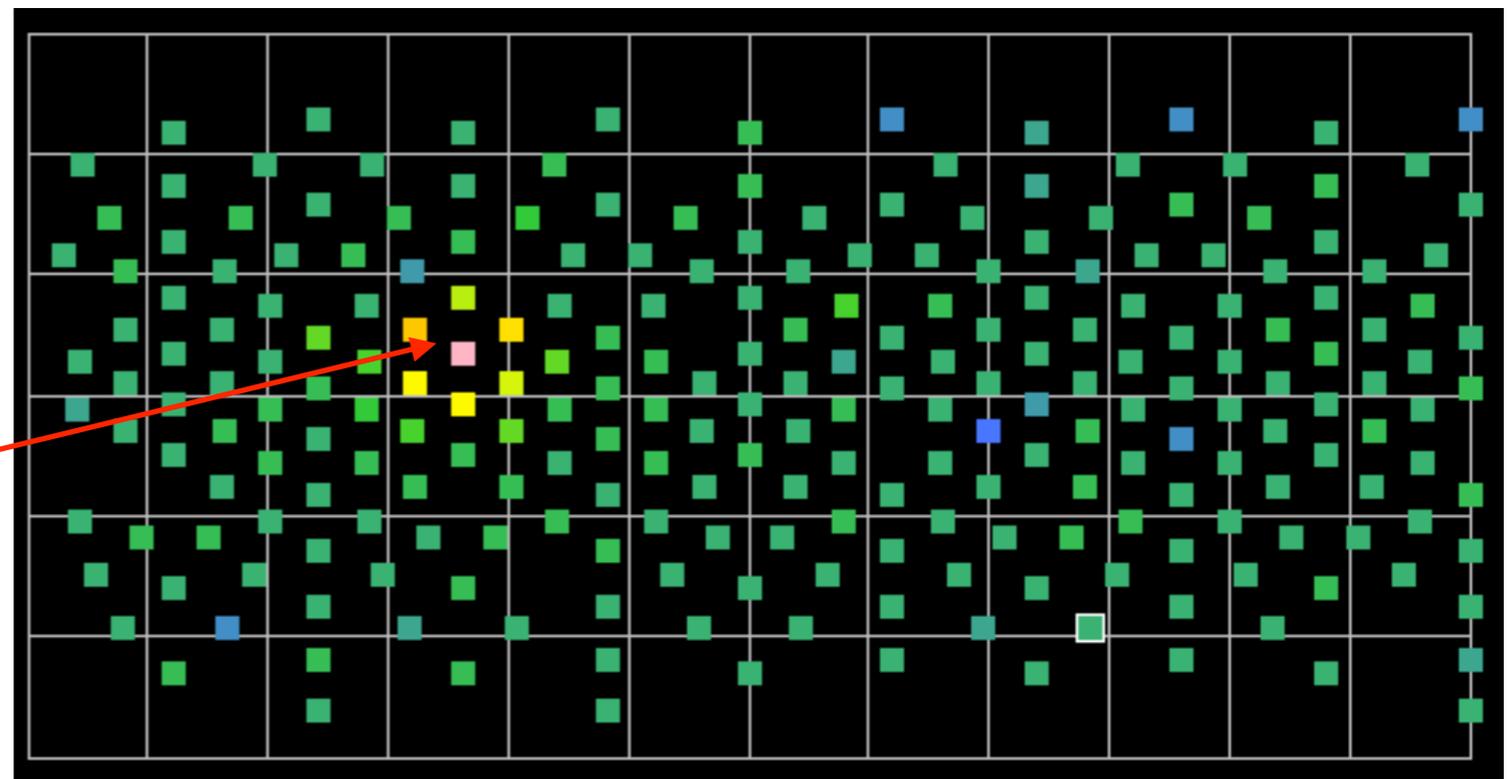
LED data



PMT hits for one LED run
Color scale represents
charge collected in a PMT

LED PMT

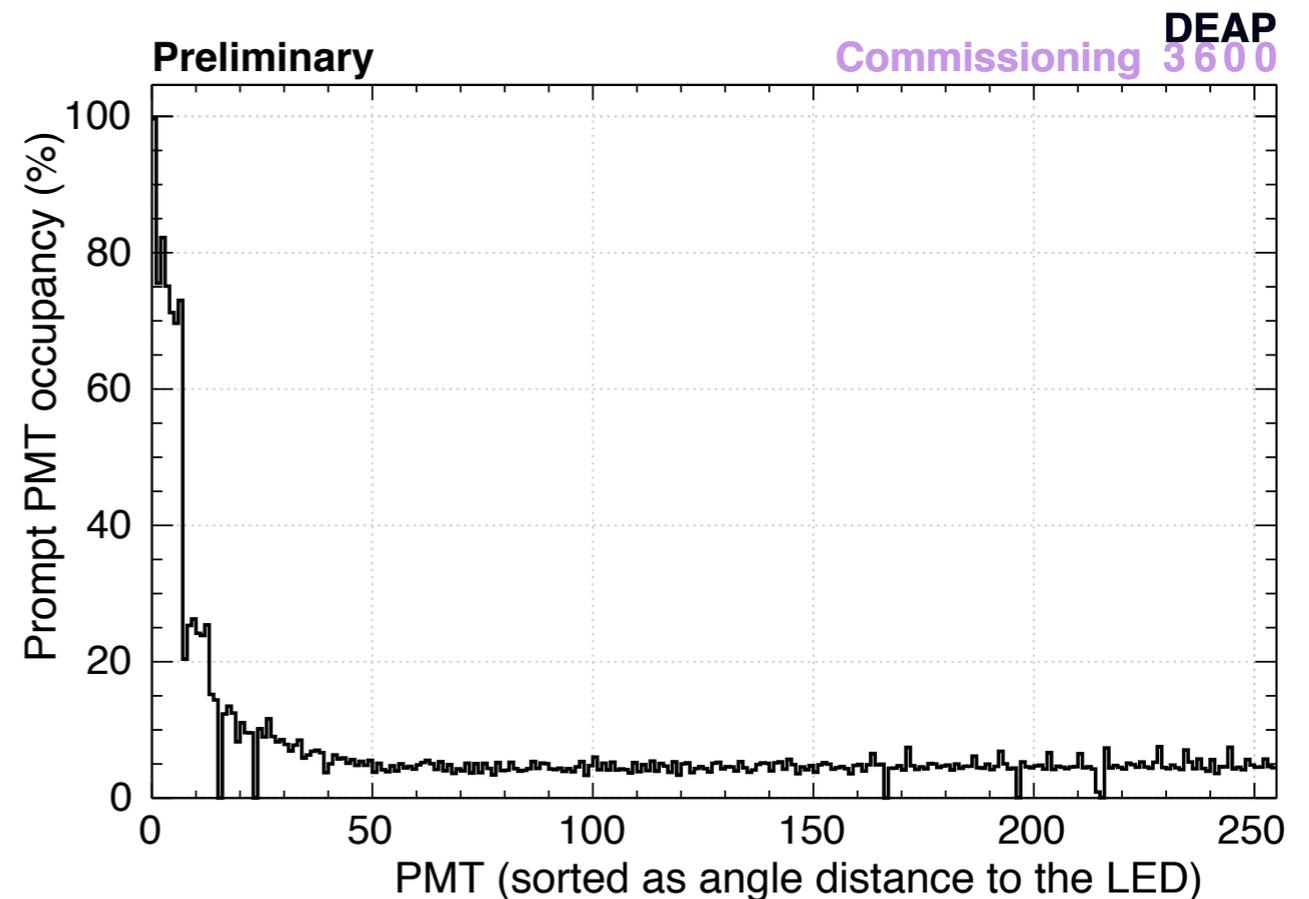
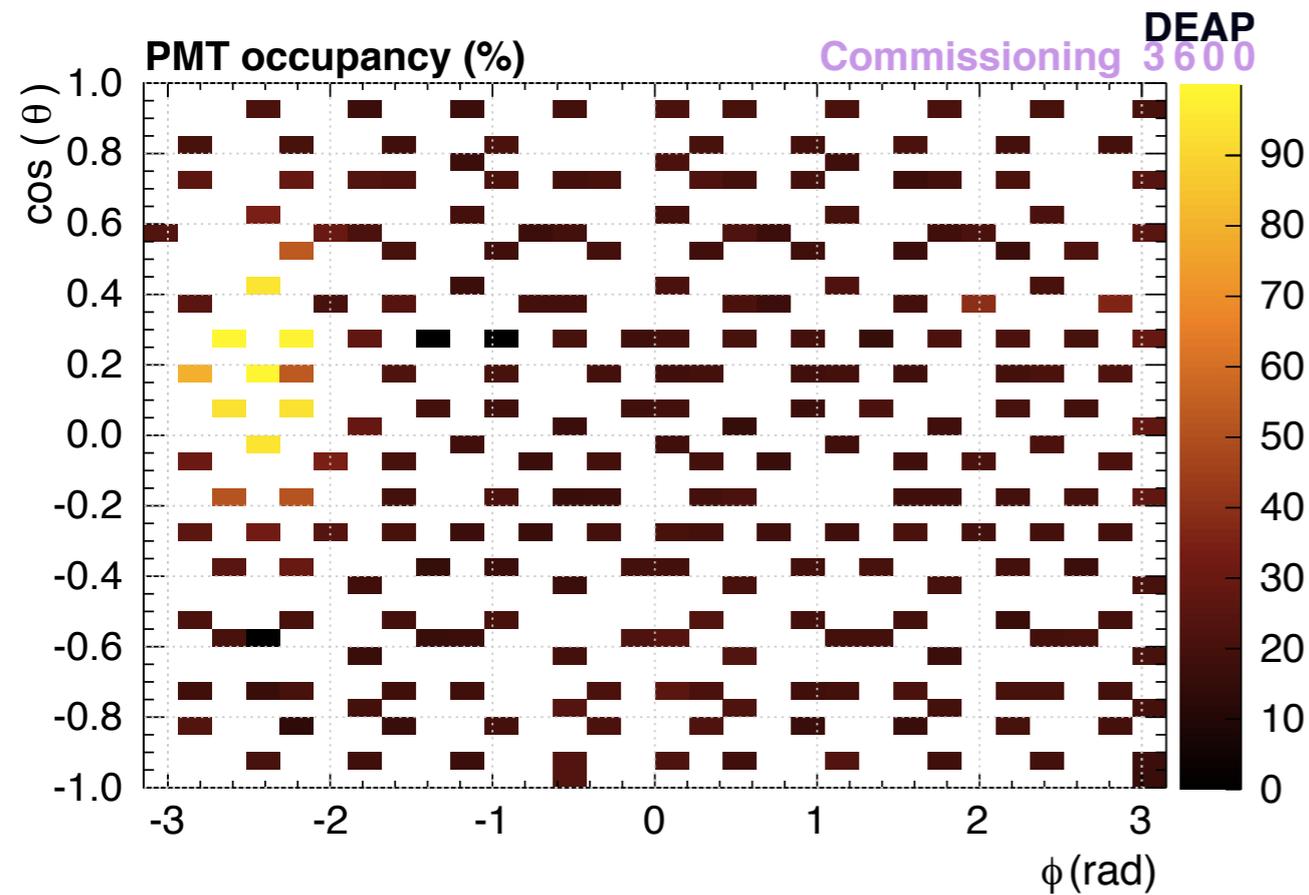
Theta



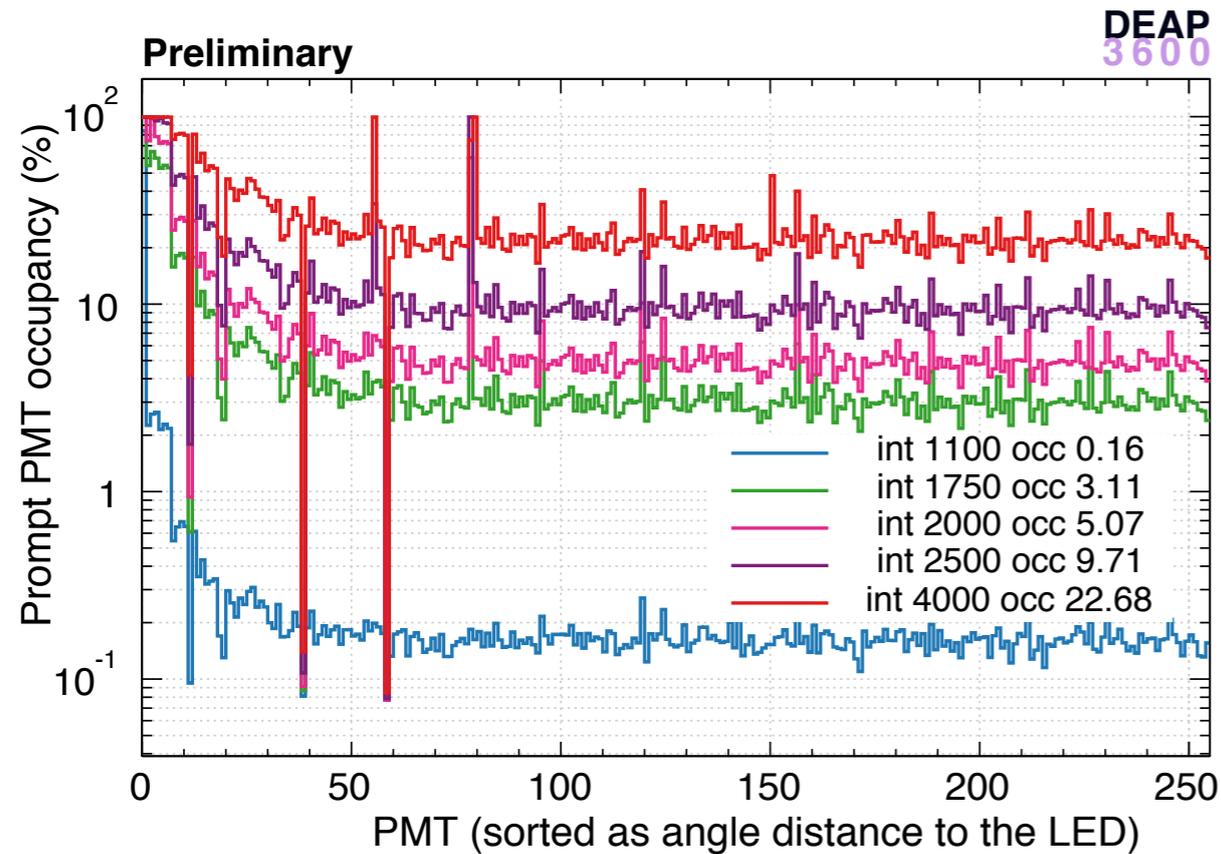
Phi

LED Data analysis

Occupancy (%) = number of hits in a pmt / total number of LED events

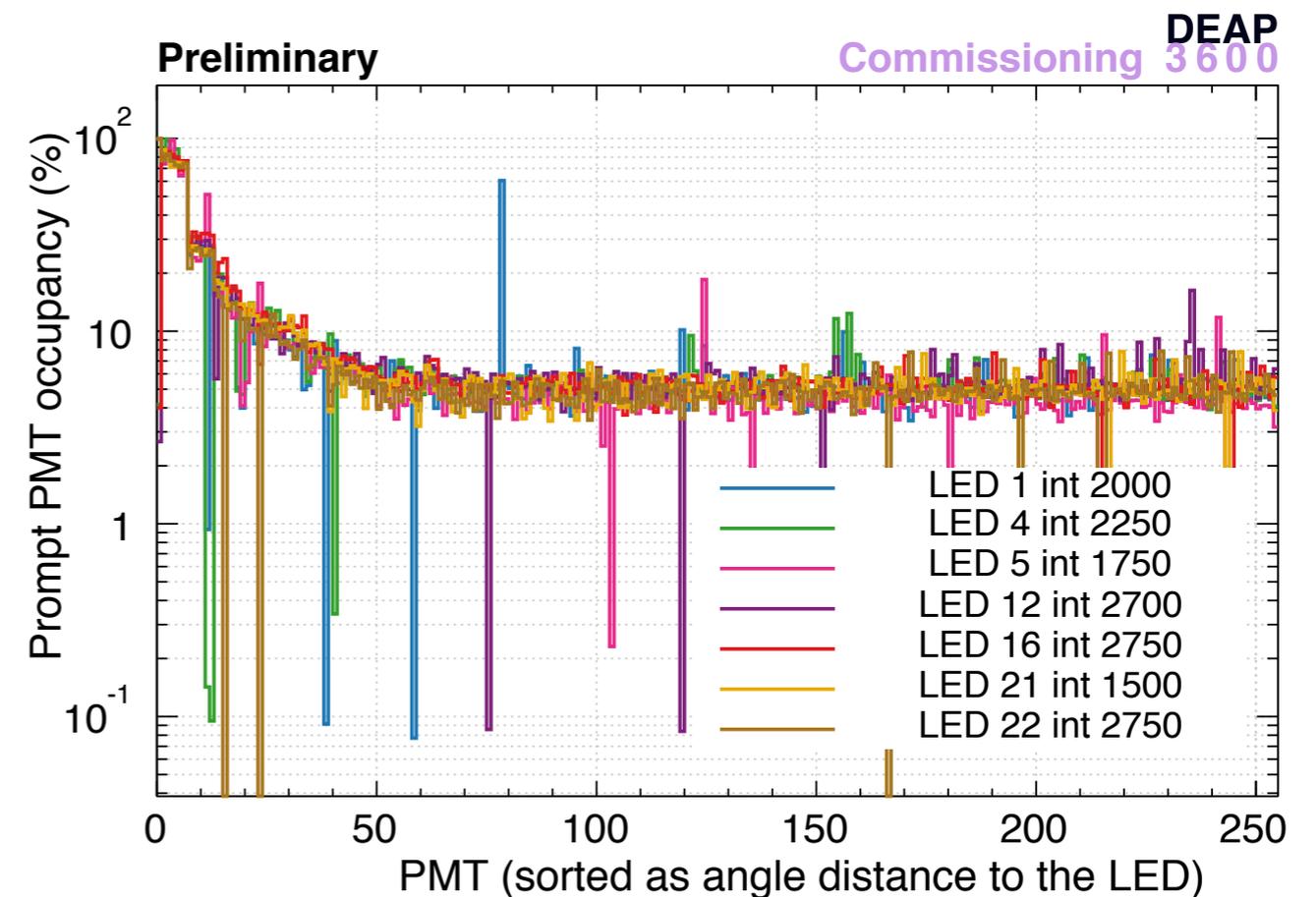


LED Data analysis



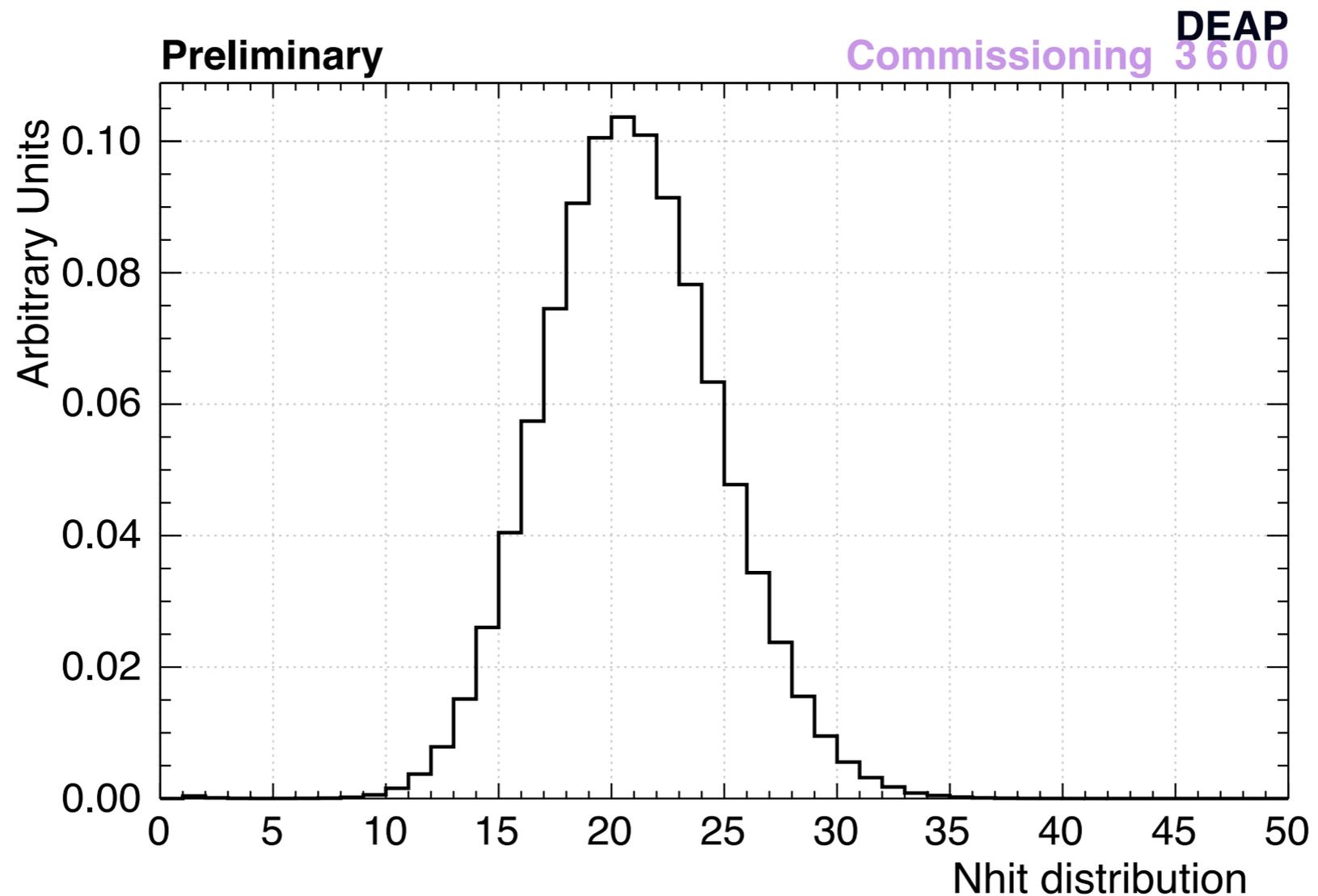
- ▶ Occupancy, same LED source at different intensities

- ▶ Different LED sources at similar occupancies. Detector optically homogeneous



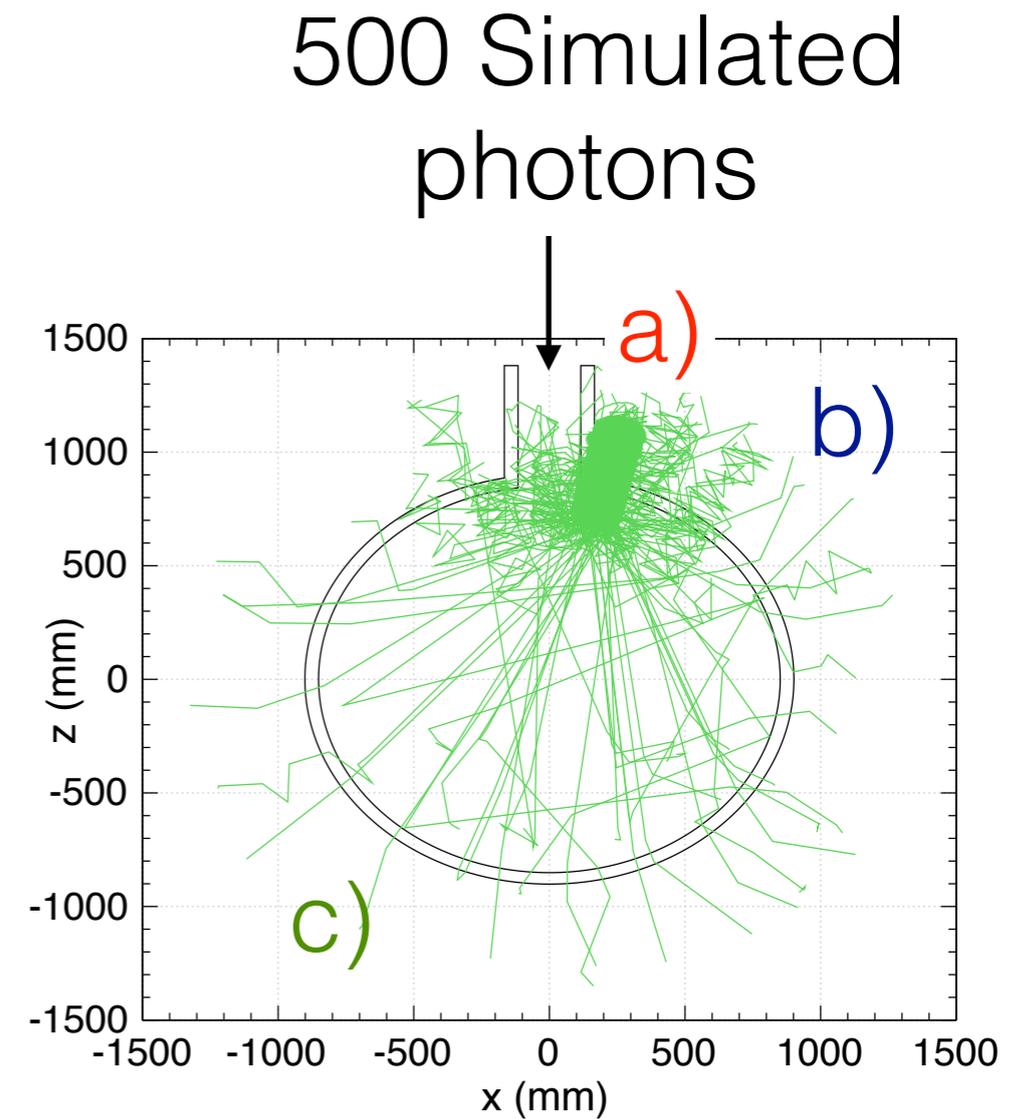
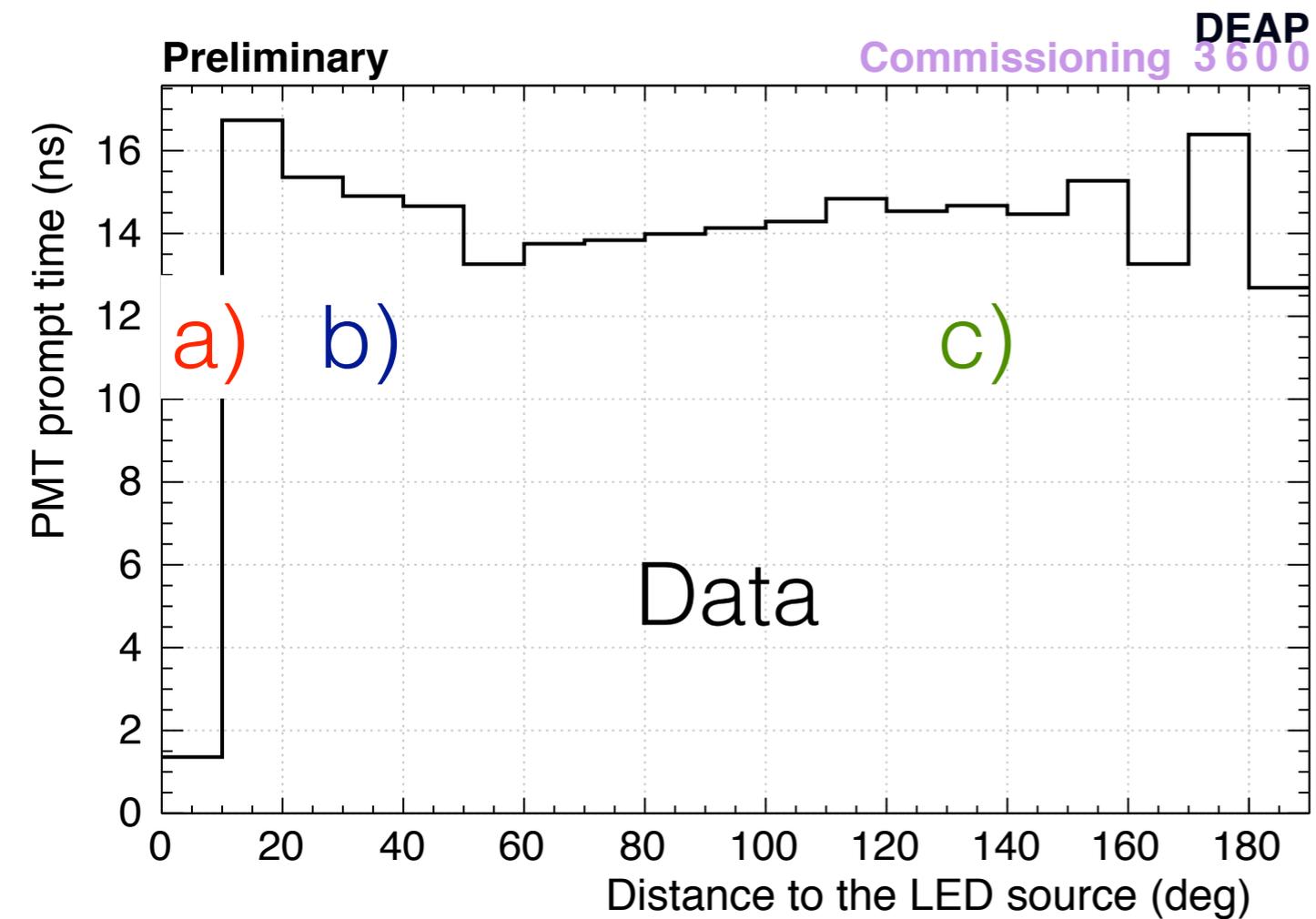
LED Data analysis

Nhit = number of PMTs that fired in an event



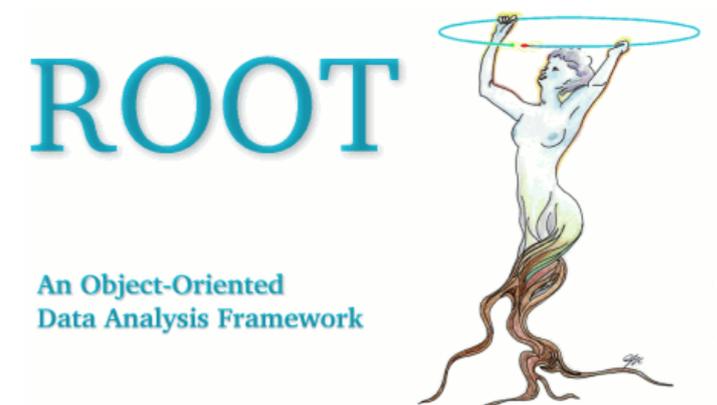
LED Data analysis

Events average time distribution



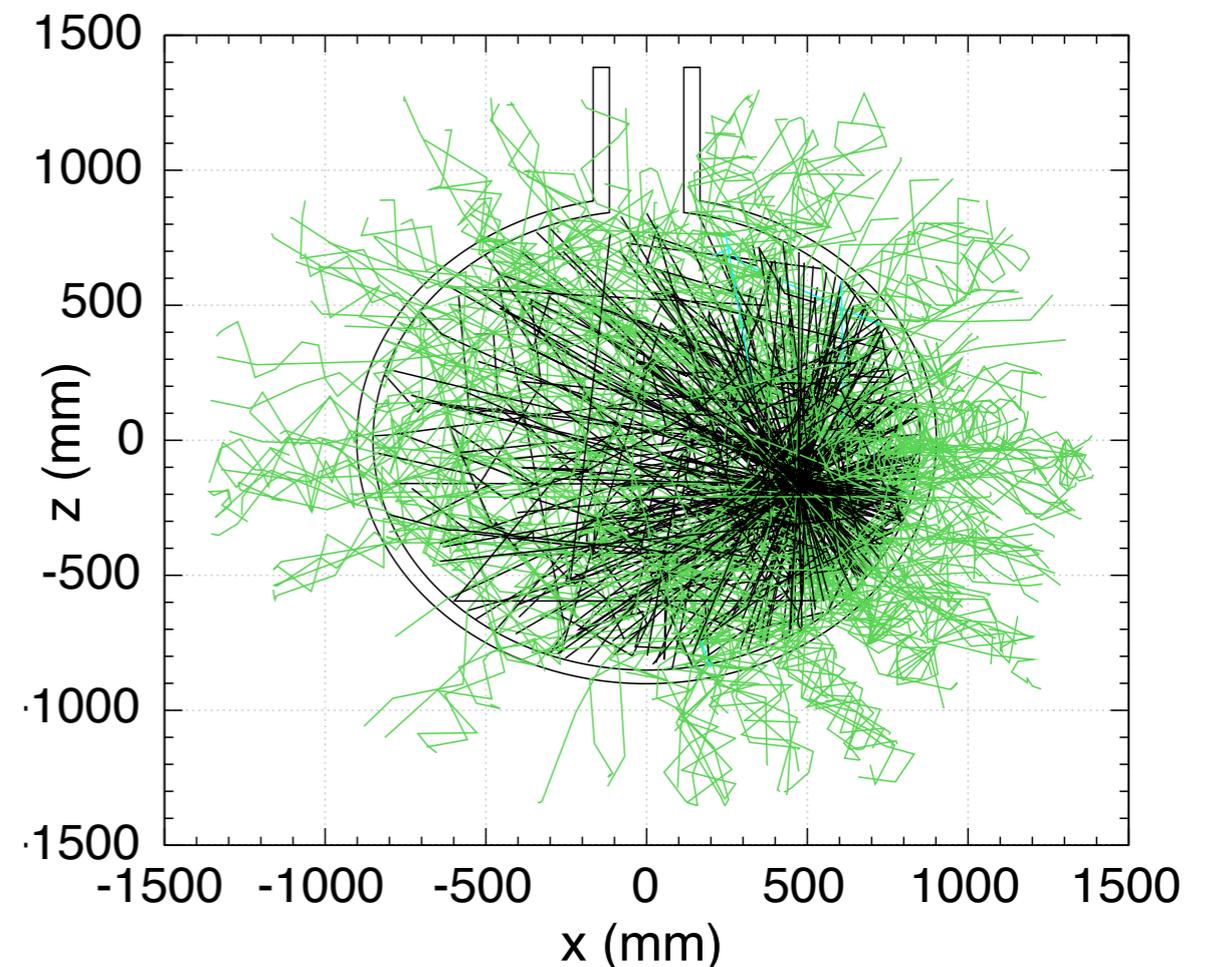
DEAP-3600 MC and data analysis package (RAT)

- ▶ Reproducing different physics process relevant for DEAP-3600:
 - ▶ Custom detector geometry and material optical properties list.
 - ▶ Use well defined GEANT4 engine to propagate particles and photons.
 - ▶ Use of the NEST engine to simulate noble liquid scintillation process.
 - ▶ Custom data analysis processors supported by the ROOT framework.

The logo for Geant 4, featuring the text "Geant 4" in a stylized, orange-brown font with a slight shadow effect, set against a light green rectangular background.

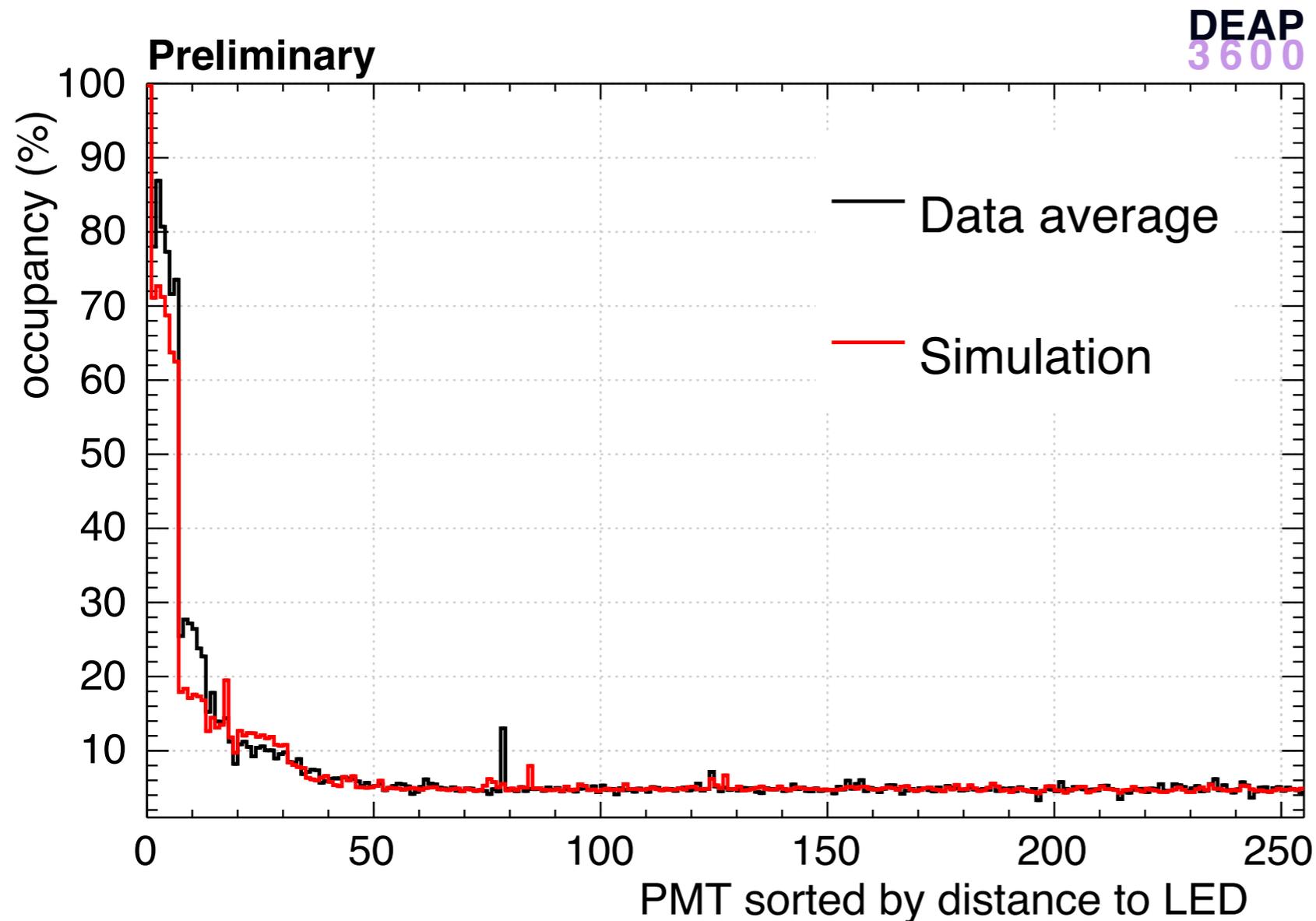
DEAP-3600 Optical properties in RAT

- ▶ Need good knowledge of the optical properties of the materials involved:
 - ▶ Refractive index, absorption and scattering lengths
 - ▶ Optical transmission between boundaries.
- ▶ Some come from the literature, some have been measured by the DEAP-3600 collaboration.



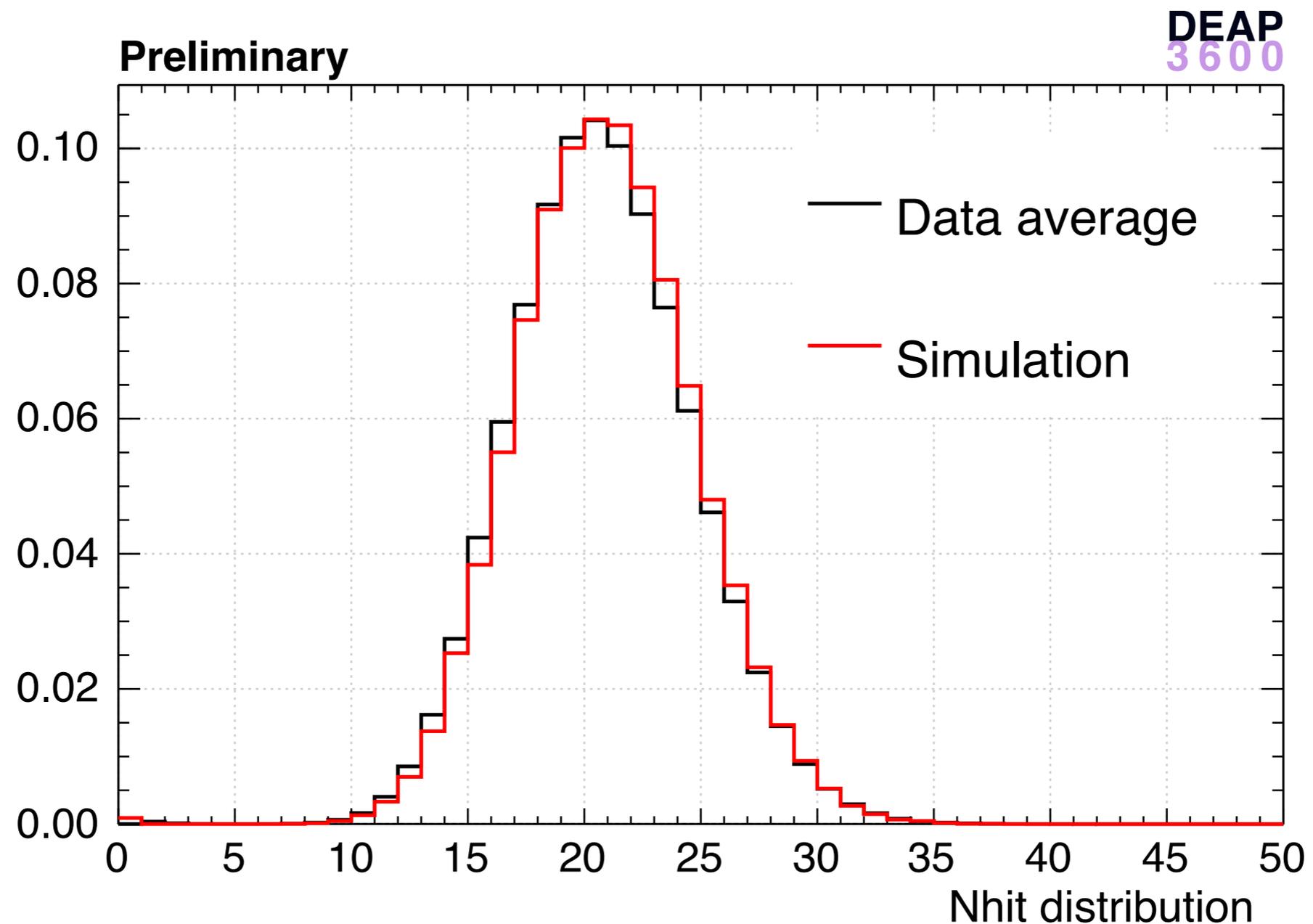
*A 100 GeV Wimp event simulation
(**black**) scintillation photons
(**green**) TPB shifted photons*

Comparing LED data with out of the box simulations

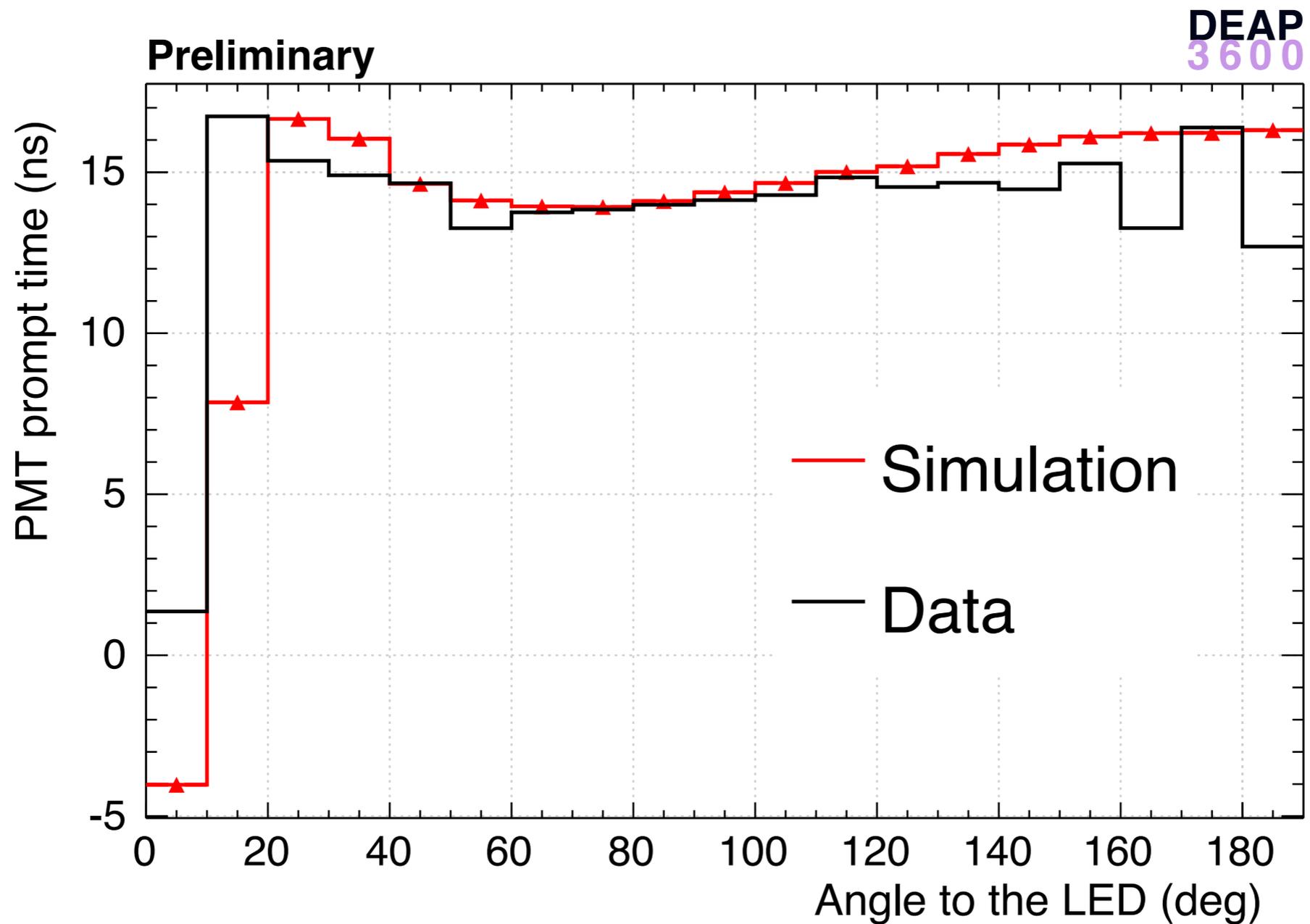


- ▶ Qualitatively the out of the box simulation reproduces the main features of the data.

Comparing LED data with out of the box simulations



Comparing LED data with out of the box simulations



Summary

- ▶ The DEAP-3600 has collected good quality LED optical calibration data.
- ▶ A full Monte Carlo simulation of DEAP-3600 has been developed.
- ▶ LED data the detector is being used to test the optical parameters of the simulation.

Acknowledgements

- ▶ Thanks to CFI, NSERC, the provinces of Alberta and Ontario and SNO Lab for funding and support.