

The Outer Tracker Detector at LHCb

13th Pisa Meeting on Advanced Detectors May 2015

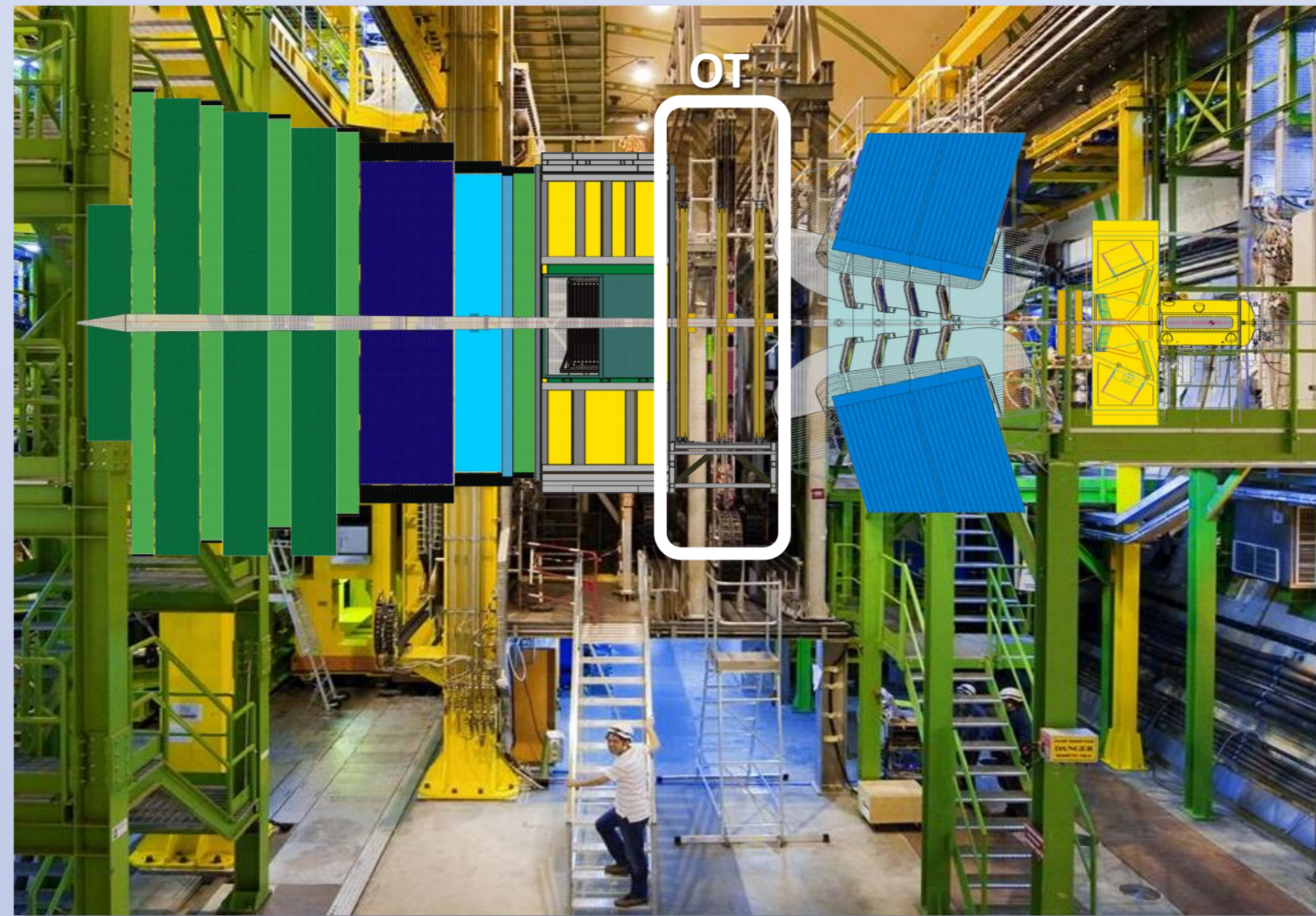
Mark Tobin, Niels Tuning
on behalf of the Outer Tracker Group

The LHCb Outer Tracker group
R. Arink¹, S. Bachmann², Y. Bagaturia², H. Band¹, Th. Bauer³, A. Berkien¹, Ch. Färber², A. Bian², J. Blouw², L. Celesia², V. Cocco², M. Deckenhoff², Z. Deng², F. Dettori¹, D. van Eijk¹, R. Ekelhof², E. Gersabeck², L. Grillo², W.D. Hulsbergen¹, T.M. Karbach^{2,4}, R. Koopman¹, A. Kozlinskiy¹, Ch. Langenbruch², V. Lavrentyev¹, Ch. Lüth², M. Merk¹, J. Merkel³, M. Meissner², J. Michalowski², P. Morawski², A. Nawrot², M. Nefes², A. Pellegrino¹, G. Polok², O. van Petten¹, J. Bövelmann², F. Schimmel¹, H. Schayyenbour², R. Schwemmer^{2,4}, P. Seyfert², N. Serra¹, T. Shijk¹, B. Spaan², J. Spiel¹, B. Storažić¹, M. Szczekowski², S. Swiatkowski², S. Tolk¹, N. Tuning¹, U. Uwer², D. Wiedner², M. Wittek², M. Zeng¹, A. Zwart¹.

¹Nikhef, Amsterdam, The Netherlands
²Physikalisches Institut, Heidelberg, Germany
³Technische Universität Dortmund, Germany
⁴CERN, Geneva, Switzerland
⁵H. Niewodniczanski Institute of Nuclear Physics, Cracow, Poland
⁶A. Soltan Institute for Nuclear Studies, Warsaw, Poland
⁷Tsinghua University, Beijing, China



Aerial view of the Large Hadron Collider



The LHCb detector with a sketch of the subdetectors

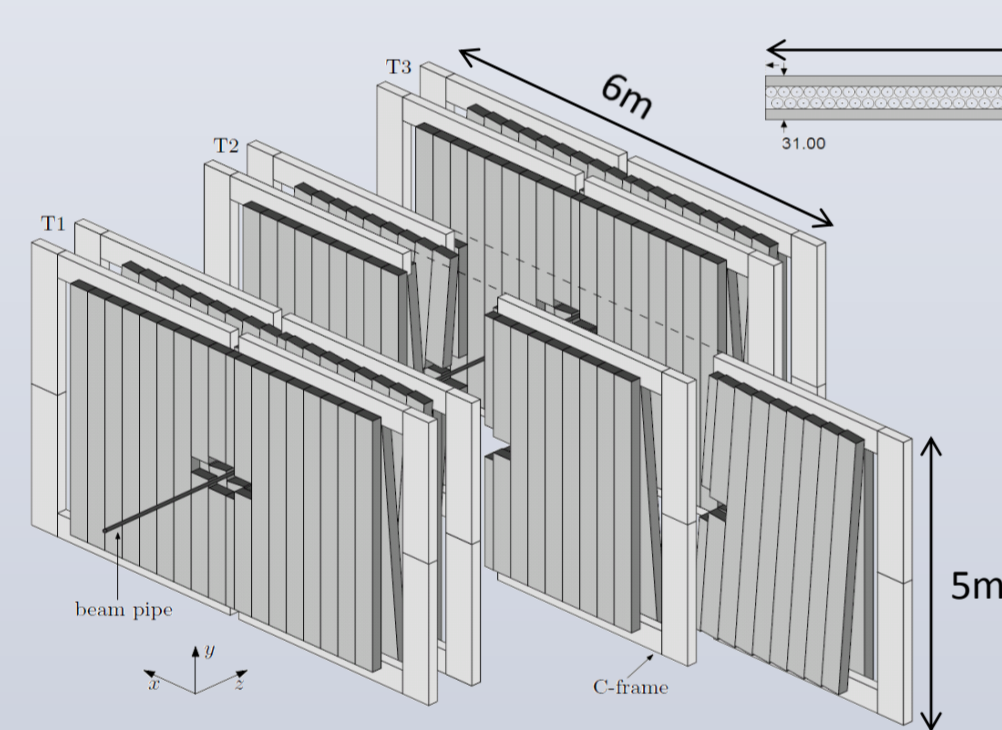
The Outer Tracker detector seen from inside the magnet



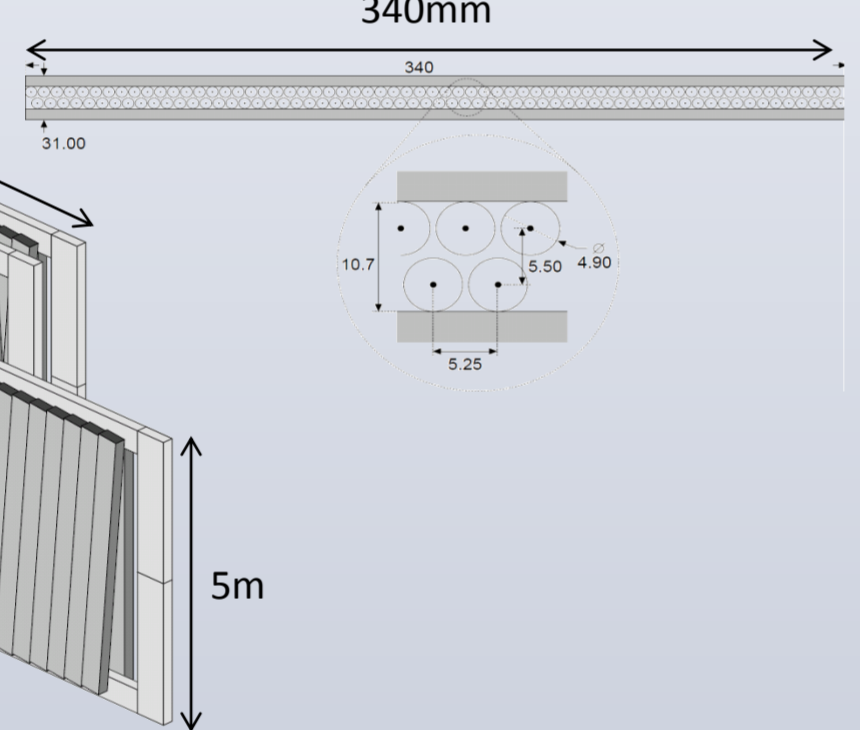
The Outer Tracker Detector

The Outer Tracker Detector is a “gaseous straw tube detector”, consisting of 53760 straw tubes filled with Ar/CO₂/O₂. A charged particle ionizes the gas, and the electrons drift to the wire (at 1550V). The arrival time of the resulting pulse is detected by the readout electronics.

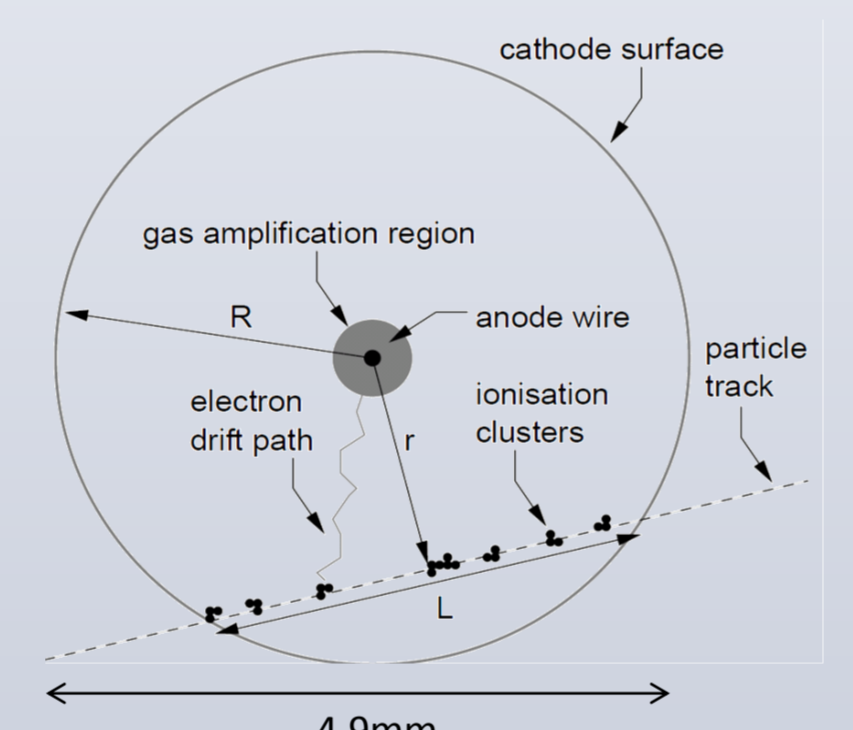
Detector geometry, with 12 module layers:



Module cross section with 2x64 straws:

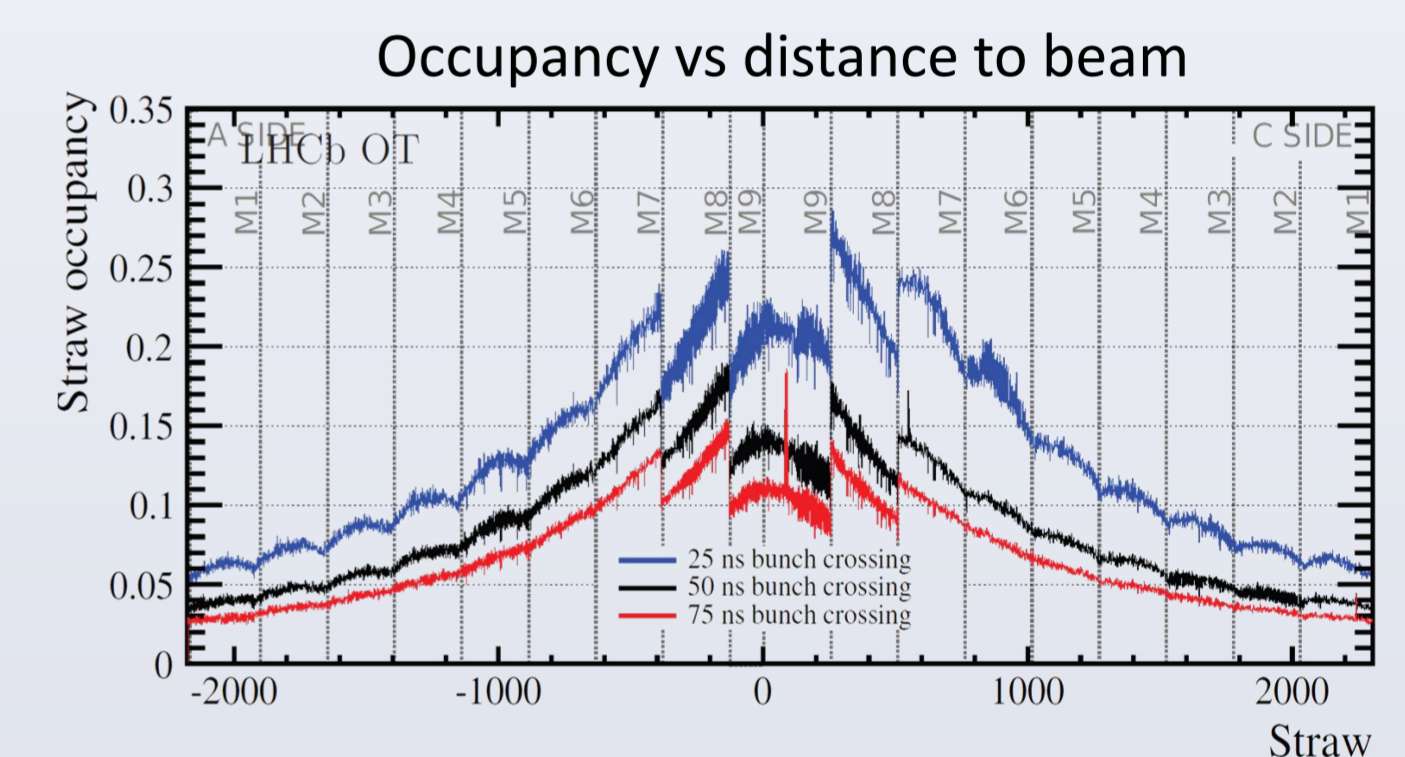
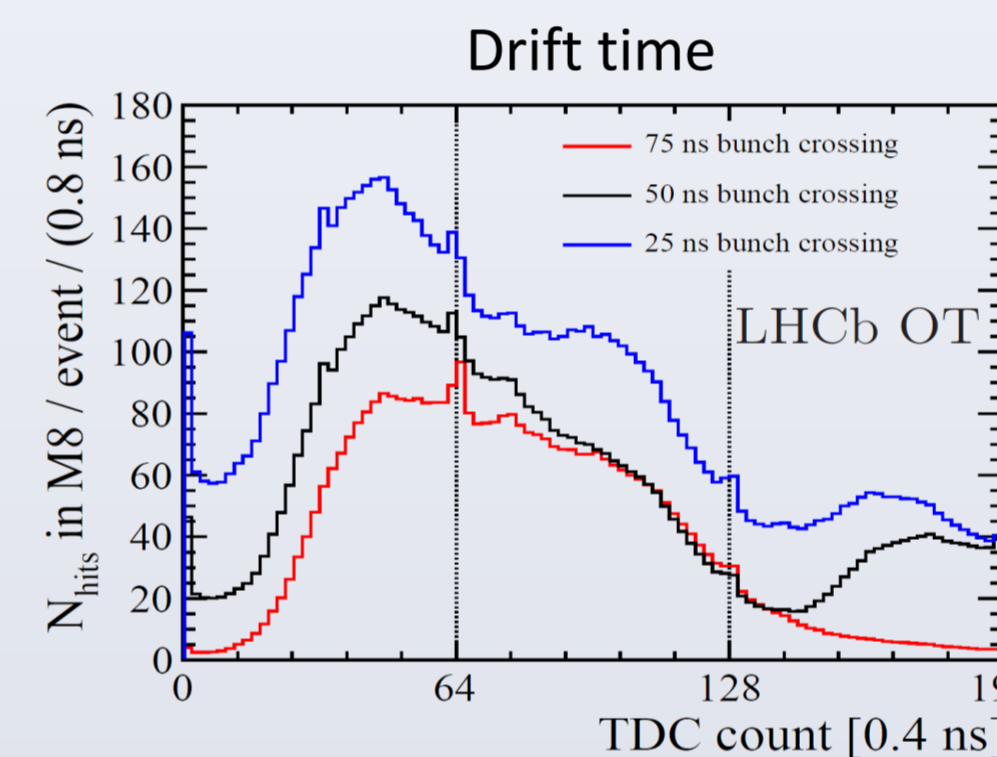


Charged particle traversing the straw, ionizes the gas:



Expectations for 2015-2018

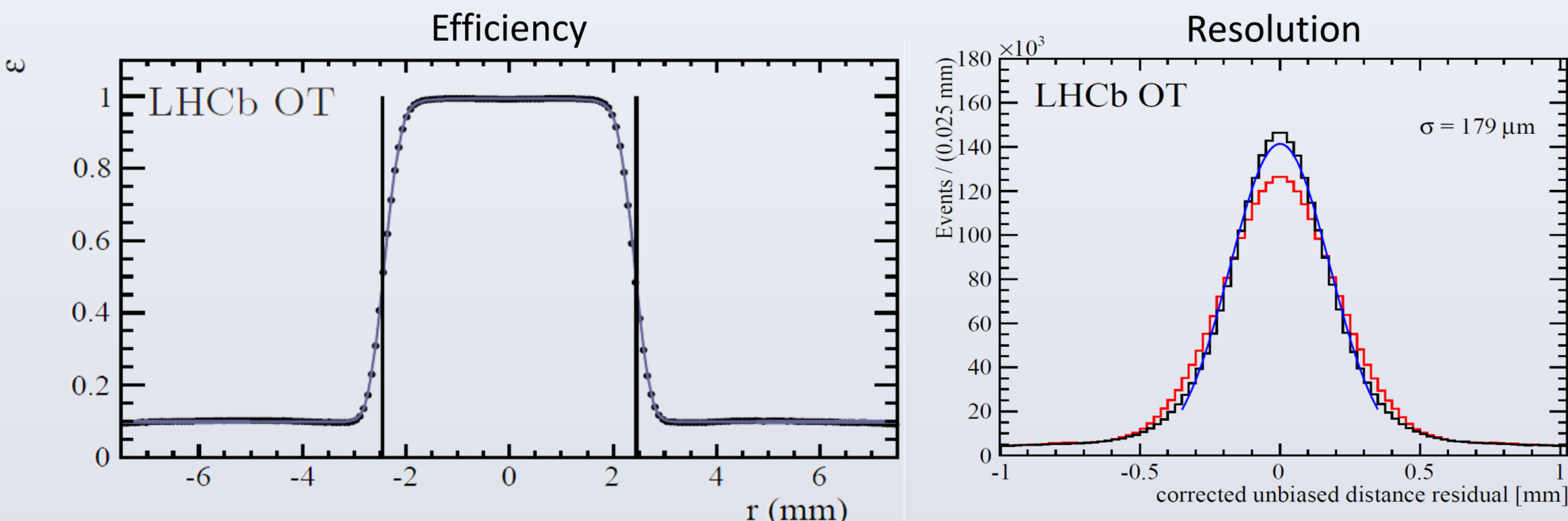
The LHC operates now at the highest beam energy of 6.5 TeV, colliding bunches every 25 ns. The spill-over from neighbouring bunch crossings is seen in the Outer Tracker drift time distribution, and increases the straw occupancy.



The Outer Tracker detector is constructed with a glue that contains the plastifier di-isopropyl-naphthalene [4,5]. Due to irradiation, this can form an insulating layer on the wire, reducing the pulse height. In the period 2010-2012, the average pulse height has not decreased [1,3].

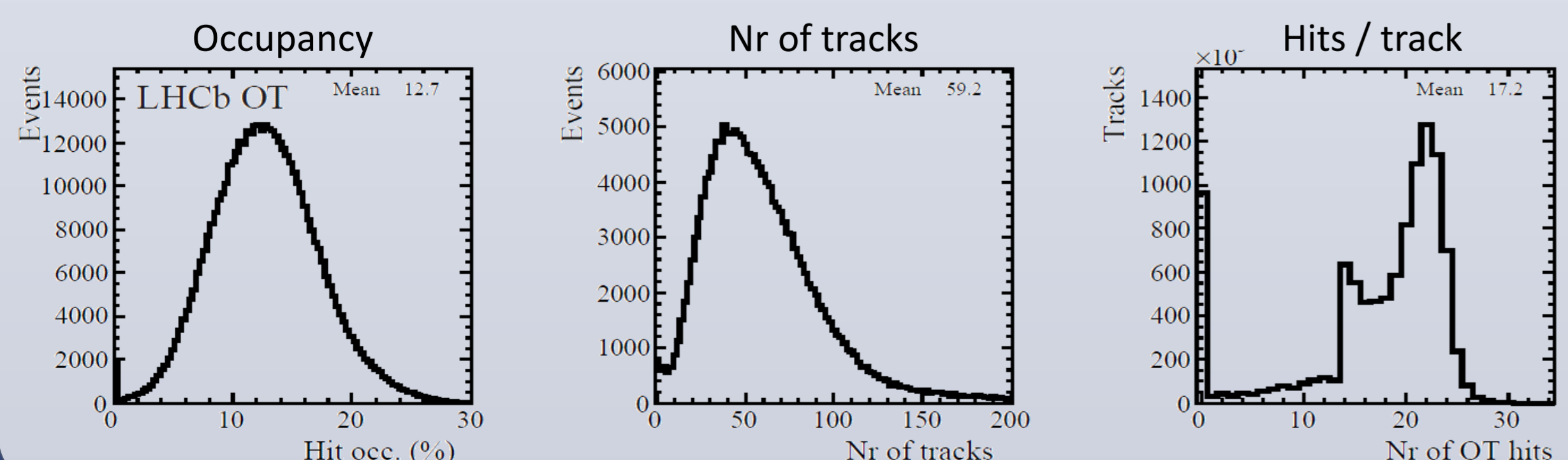
Detector Performance in 2009-2013

If the charged particle traverses the straw within 1.25mm of the wire, the hit is detected in 99.3% of the cases. The position of the hit is determined with a precision better than 200µm [1].

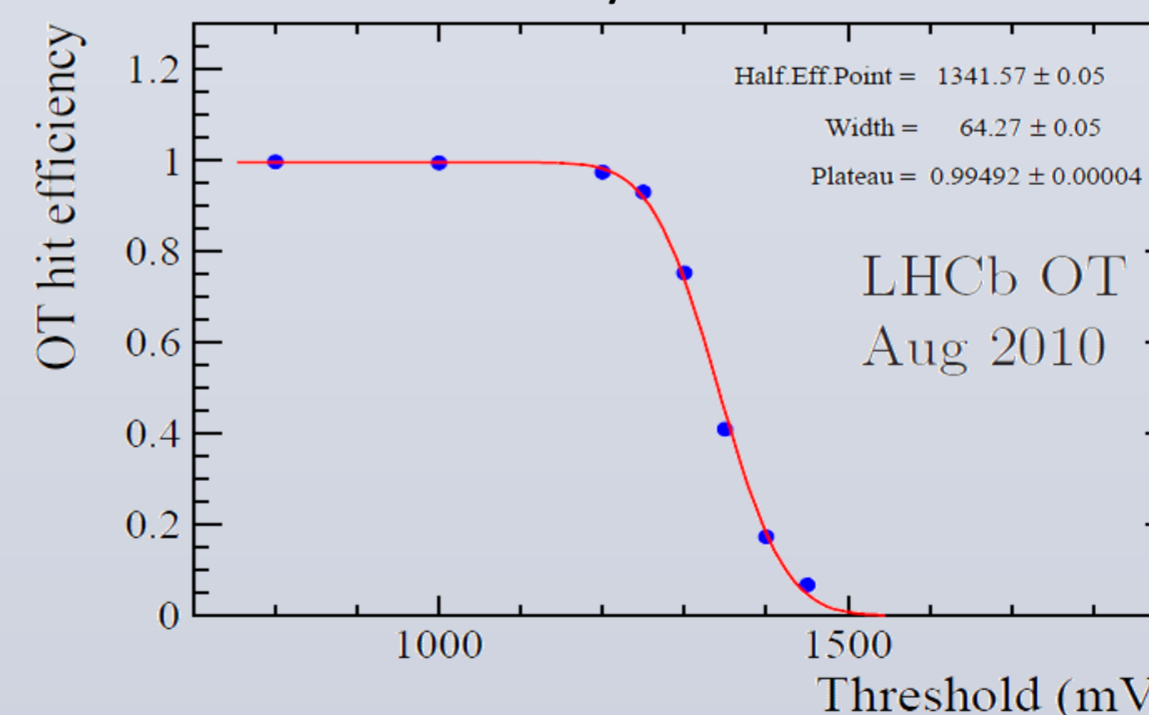


The LHCb detector operated at an instantaneous luminosity of $4 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$, which corresponds to 1.2 overlapping interactions at 50 ns bunch spacing.

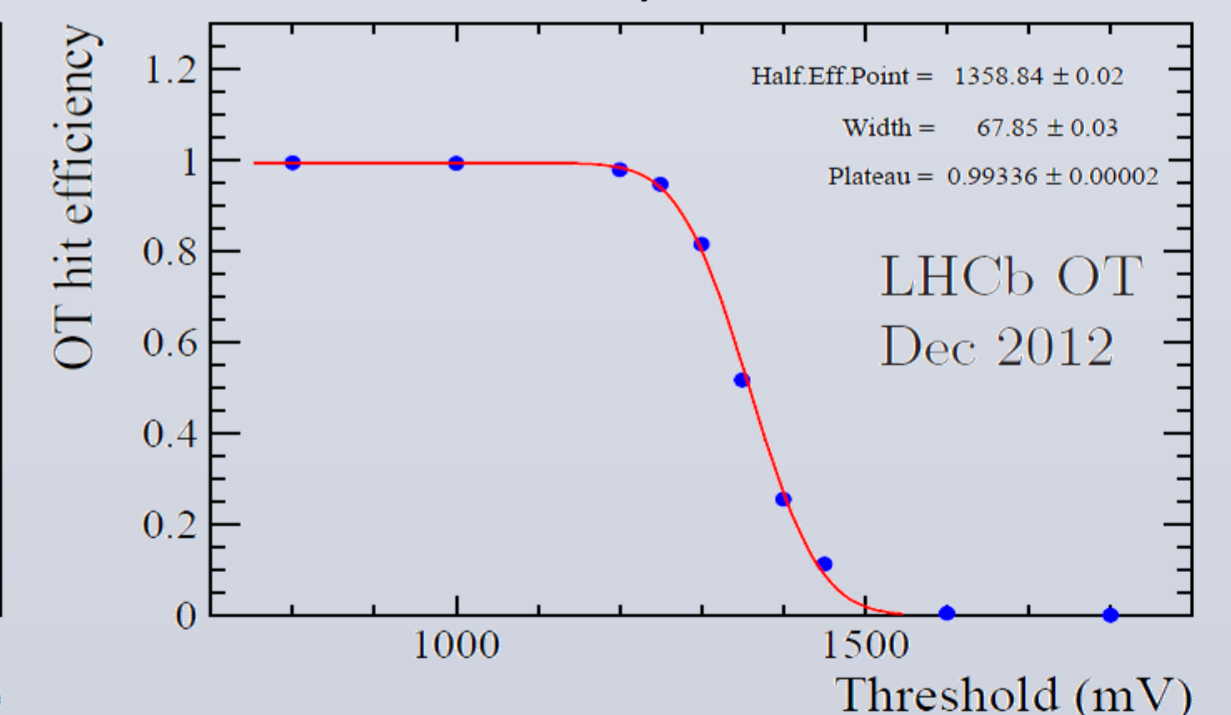
Typically 60 long tracks are reconstructed per event, with on average 13% of all straws being hit. A long track typically contains 22 OT hits [2].



Efficiency vs threshold



Efficiency vs threshold



References

- [1] R. Arink et al., [OT group], “Performance of the LHCb Outer Tracker”, JINST 9 (2014) P01002 [arXiv:1311.3893 [physics.ins-det]]
- [2] N. Tuning, “Detailed performance of the Outer Tracker at LHCb”, JINST 9 (2014) C01040
- [3] D. van Eijk et al., [OT group], “Radiation hardness of the LHCb Outer Tracker”, Nucl. Instrum. Meth. A685, 62-69, 2012
- [4] N. Tuning et al., [OT group], “Ageing in the LHCb Outer Tracker: Aromatic hydrocarbons and wire cleaning”, Nucl. Instrum. Meth. A656, 45 (2011)
- [5] S. Bachmann et al., [OT group], “Ageing in the LHCb Outer Tracker: Phenomenon, culprit and effect of oxygen”, Nucl. Instrum. Meth. A617, 202 (2010)