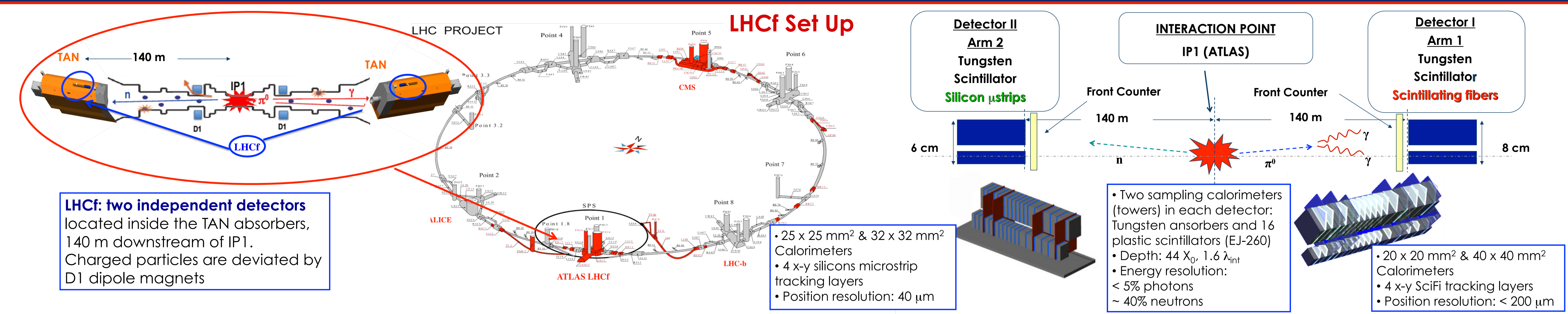


First evidence of LPM effect in LHCf, an LHC experiment

Marina Del Prete
on behalf of the LHCf collaboration
4th International Conference on New Frontiers in Physics, 23-30 August 2015, Crete Greece



L(andau) P(omeranchuk) M(igdal)

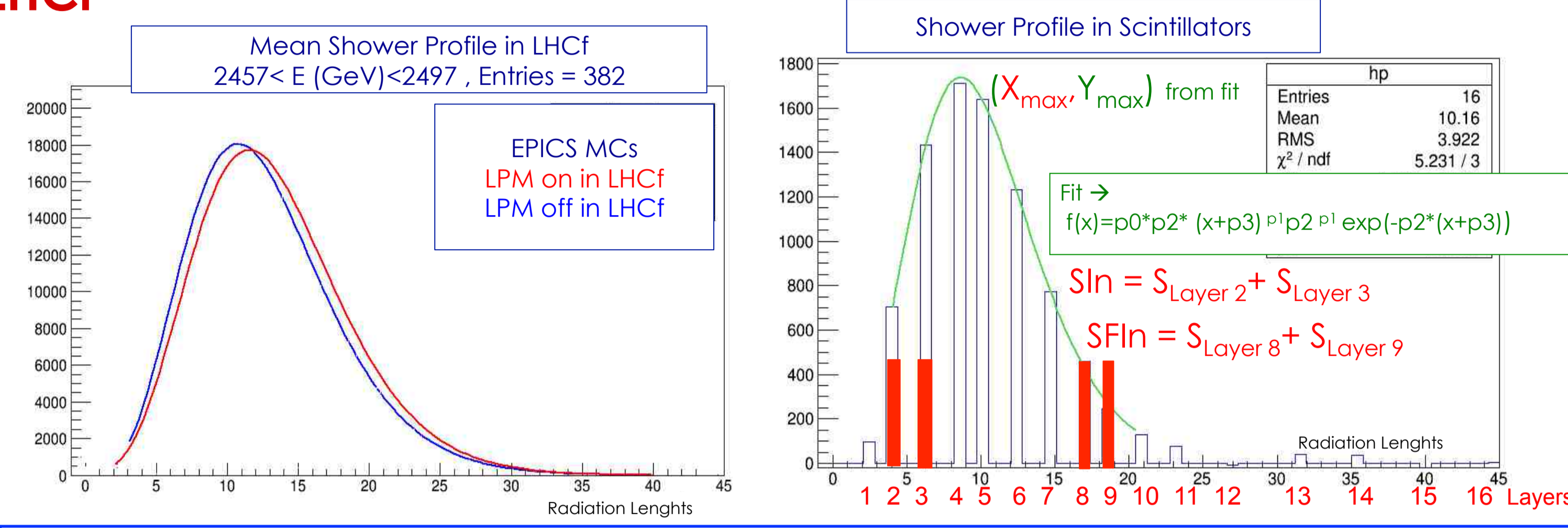
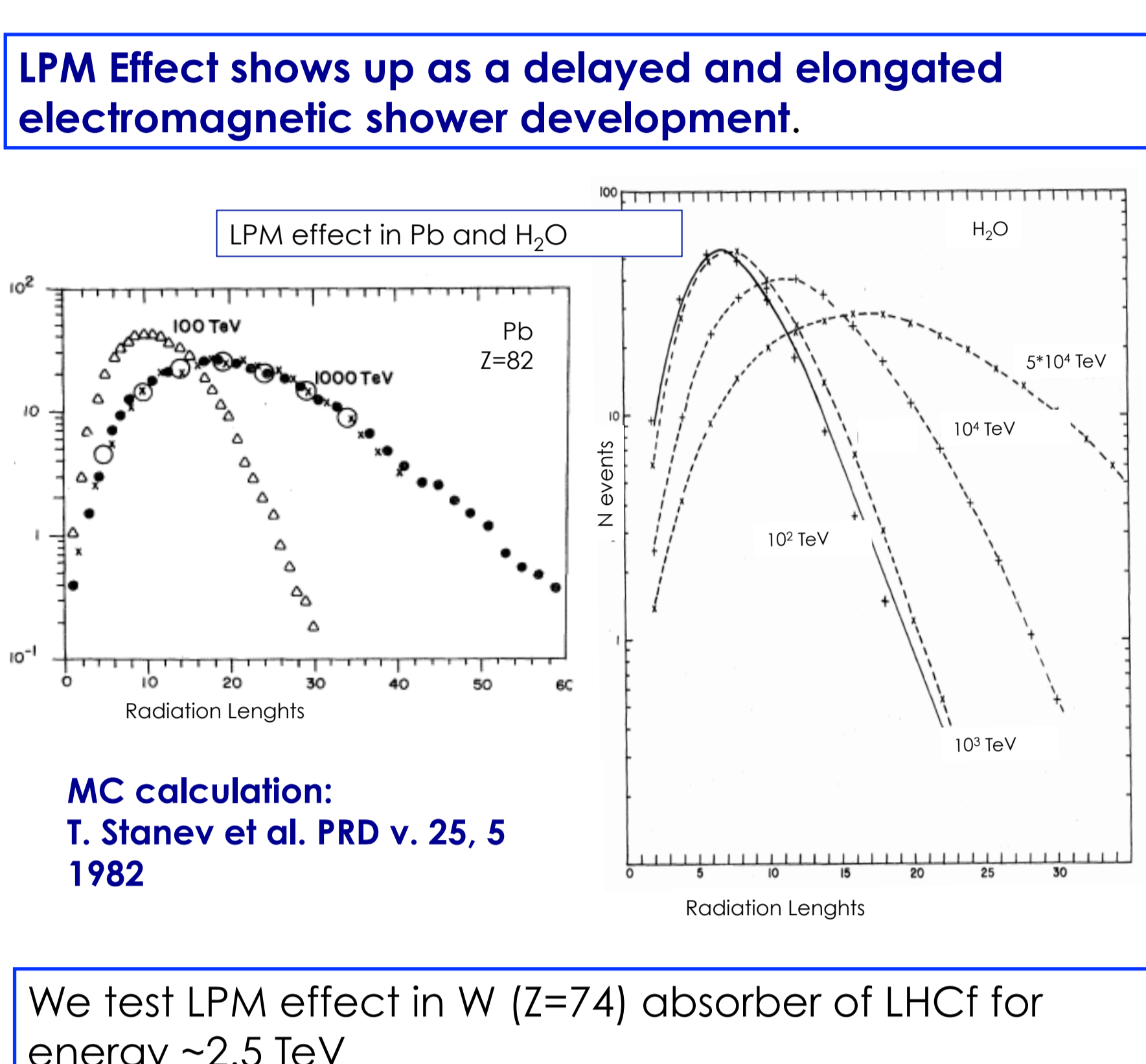


Landau, Pomeranchuk and Migdal observed that at high energies and large densities the Bremsstrahlung and Pair Production do not follow the B-H formula. These low p_T processes had a long formation zone comprising several scattering centers which negatively interfered in the final cross section. **LPM effect becomes important:**

- at large Z of absorbers
- at large photon energy K_γ
- at small emission angle θ

$K_{\gamma} > E_{LPM}$
 $E_{LPM} = m^2 c^3 \alpha X_0 / 4\pi \hbar \sim 0.35 \text{ TeV (for } Z=74)$ [2]

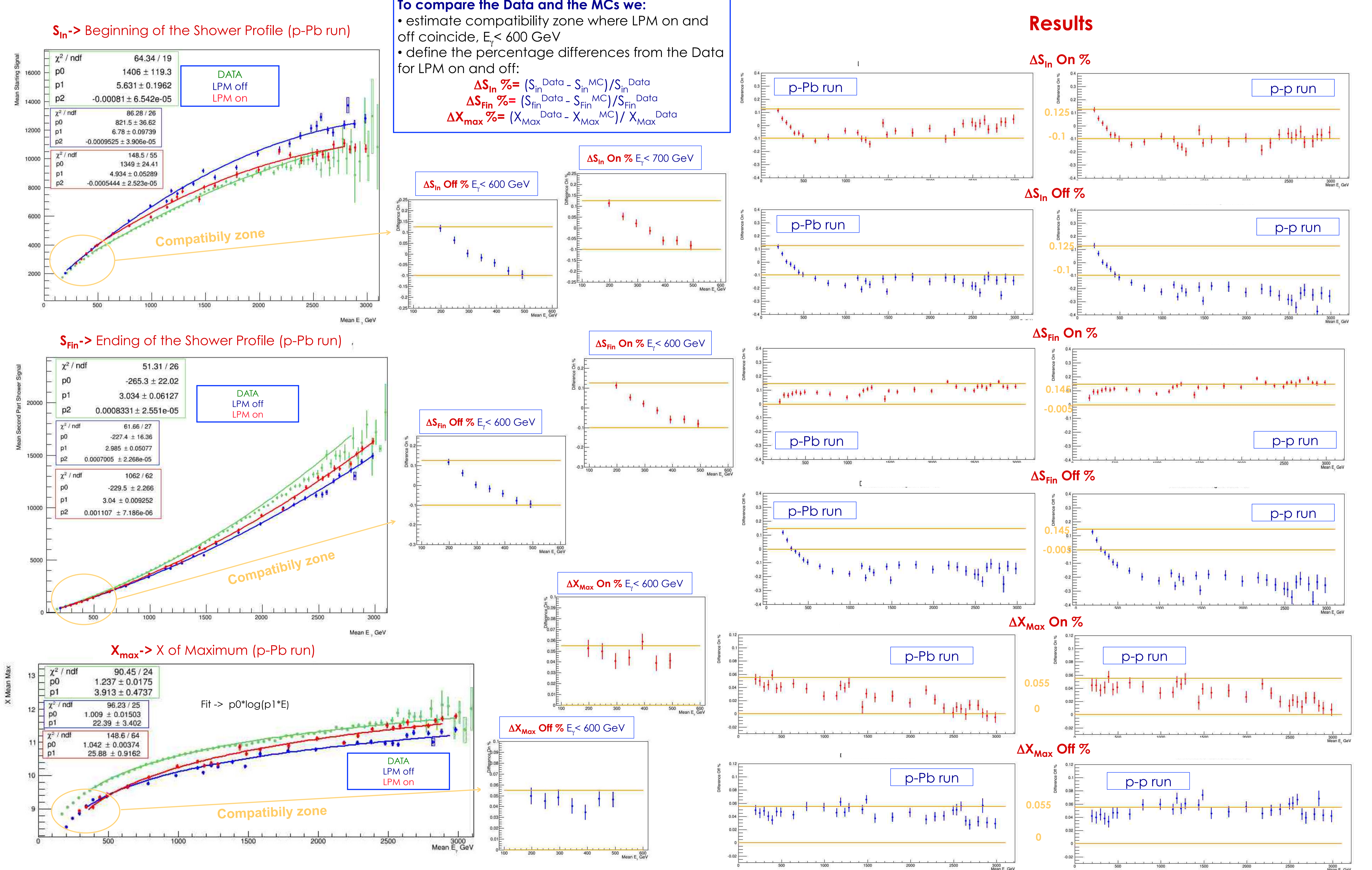
LPM Effect and LHCf



LHCf has the optimal set up to detect LPM in Pair Production process directly by measuring the shape of longitudinal profile of the shower and its delay. The steps are:

- 1) compare EPICS simulations with and without LPM effect to LHCf experiment data
- 2) parametrize the shower shape using the scintillators signal in the layers of ARM2:
 $S_{in} \rightarrow$ will be smaller for LPM on than for LPM off because of delay
 $S_{Fin} \rightarrow$ will be larger for LPM on than for LPM off because of delay
- 3) full shape shower analysis using the Gamma Function \rightarrow maximum position
 $X_{Max} \rightarrow$ LPM on will be larger than for LPM off because of delay

DATA USED: photons in p-Pb interactions at $\sqrt{s}=5.02$ TeV in the 2013 and in p-p at 7 TeV in the 2010.
MC USED: mono-energetic Epics MC \rightarrow tested for LPM effect only for energy up ~400 GeV. Up now there no MC checked for LPM effect at higher energy, where LHCf works. We select an hit area in the Small Tower of ARM2 far away $2X_0$ ($X_0 = 3.5$ mm) from the edge to avoid leakage problems. We study the events with energy $150 \text{ GeV} < E < 3100 \text{ GeV}$ (have stable data and statistically significance). For each events and energy intervals of ± 20 GeV we compute: S_{in} , S_{Fin} and the longitudinal position of maximum X_{Max} . **MCs are not in complete agreement with the Data.** The origin of disagreement is still unknown, probably it is because the absolute magnitude of LPM effect has not been tested at very high energies and could be different from Migdal's one used in Epics and good for $E_{\gamma} < 300$ GeV (SPS tests).



Conclusions

The LPM effect is small at these runs energies ($E_{\gamma} < 3.1$ TeV) yet a first evidence emerges from our analysis. **The statistics S_{in} and S_{Fin} are well described by Epics (LPM on) and show a good evidence of LPM effect.** More elaborated analysis based on fit needs more work, X_{Max} is not in clear agreement with simulations of LPM on and off. **To do:** Other MCs (Geant 4, etc.) are needed for comparison. Data at 13 TeV (2015 runs) will have more statistics in the optimal energies range and will confirm this evidence using also Y_{Max} and the size of shower profile.

References

- 1) O. Adriani et al., Phys.Rev. C89 (2014) 6, 065209
- 2) H. Bethe et W. Heitler, Proc. Royal Society of London, 146 (1934), pp. 83-112
- 3) A. B. Migdal, Phys. Rev., V. 103 (1956) 6, pp.1811-1820.
- 4) T. Stanev et al., Phys. Rev. D, V. 25 (1982) 5, pp. 1291-1304.
- 5) S. Klein, Rev. Mod. Phys., Vol. 71, (1999) 5.
- 6) E. Longo and I. Sestili, NIM 128, (1975) 283.