

# WG4: experimental summary

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MPI@LHC November 24th 2023



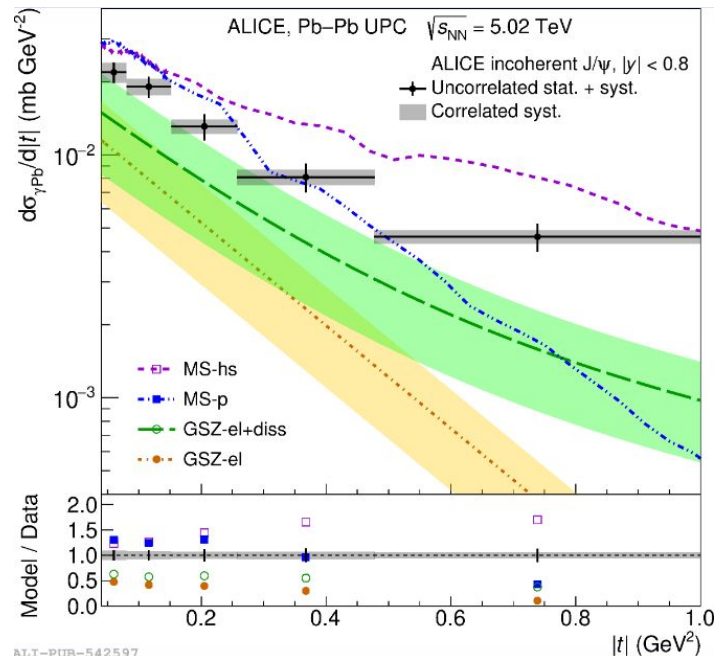
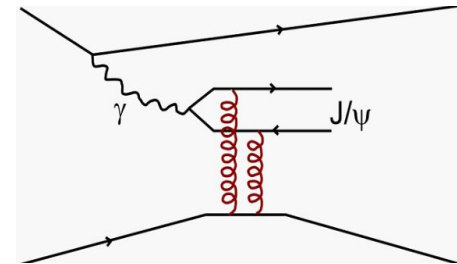
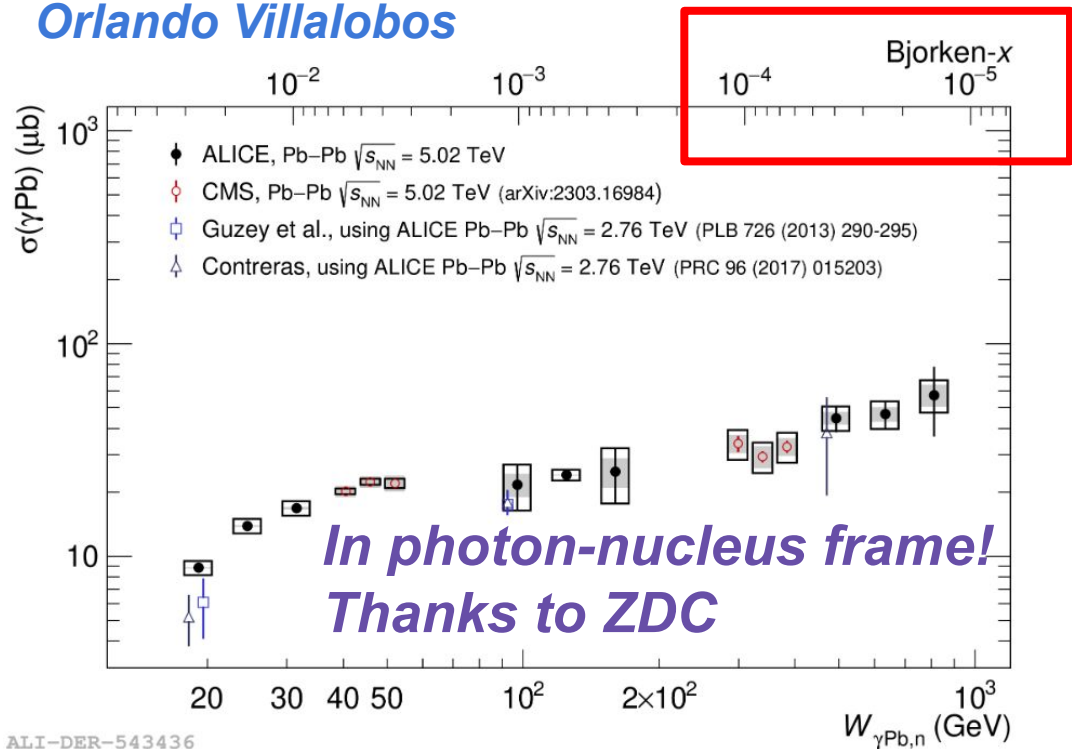
SAPIENZA  
UNIVERSITÀ DI ROMA



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de Alcalá

# Coherent & incoherent diffraction in PbPb

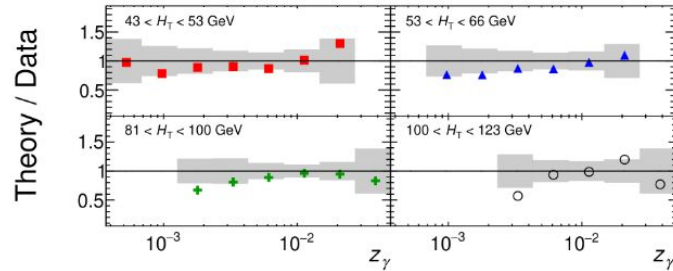
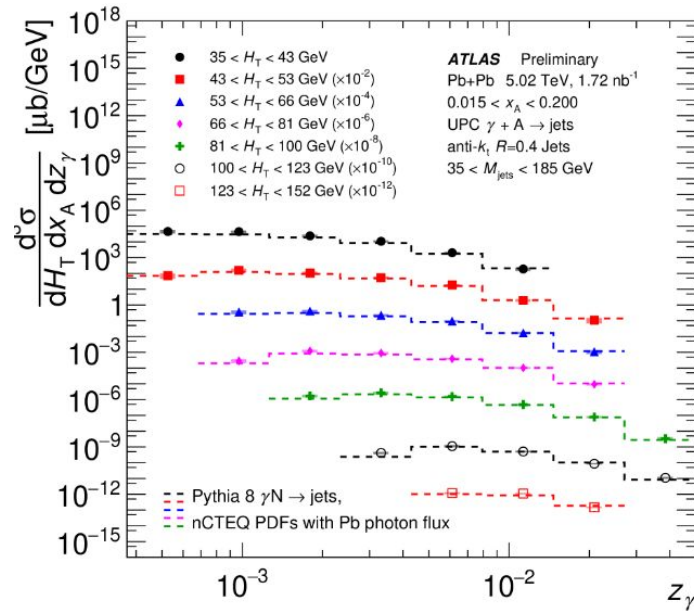
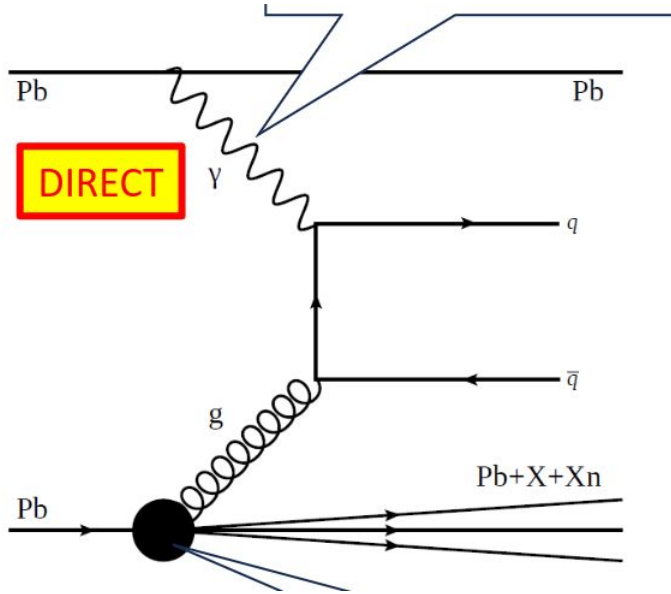
Orlando Villalobos



CMS&ALICE overcoming two-way ambiguity in PbPb!  
Crucial to disentangle small- $x$  evolution

Sensitive to subnucleonic fluctuations  
("hotspots") expected from saturation models

# Photonuclear jets!

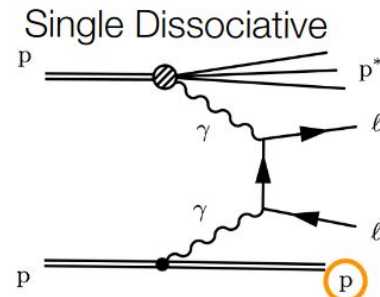
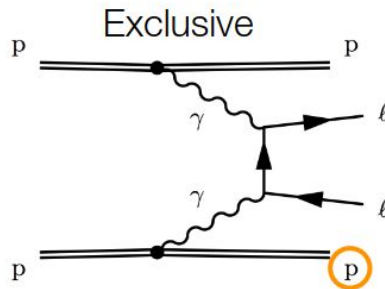
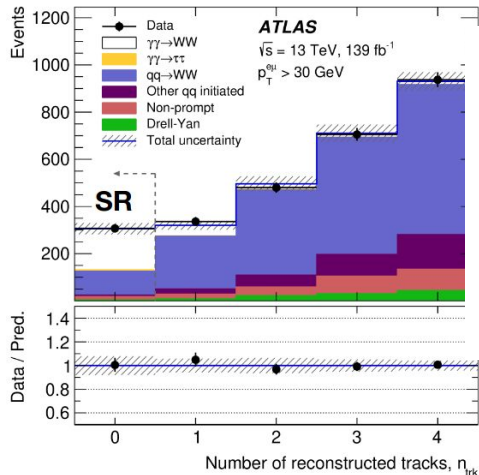
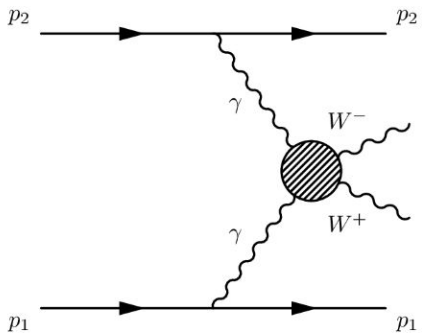


Orlando Villalobos

EIC-like physics already at the LHC, complementary kinematics!  
 ( $x \sim 10^{-3}$ ,  $Q \sim 20 \text{ GeV}$ ,  $A \sim 208$ )

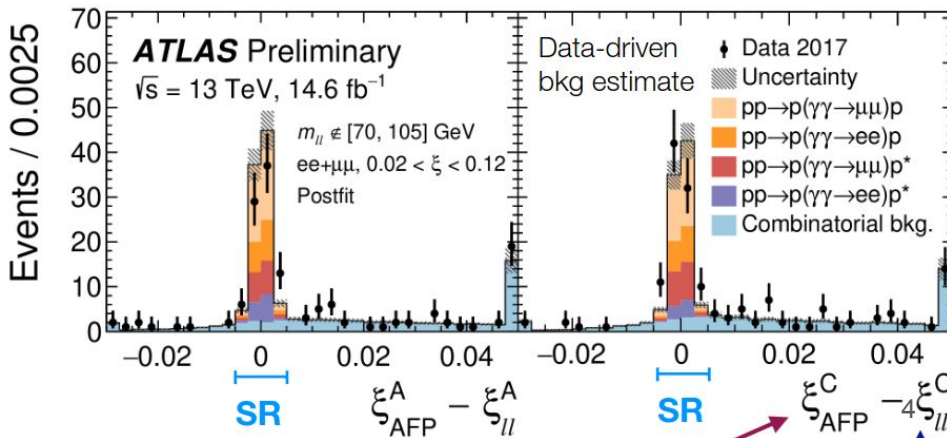
# Photon-photon collisions beyond LEP

Lydia Beresford

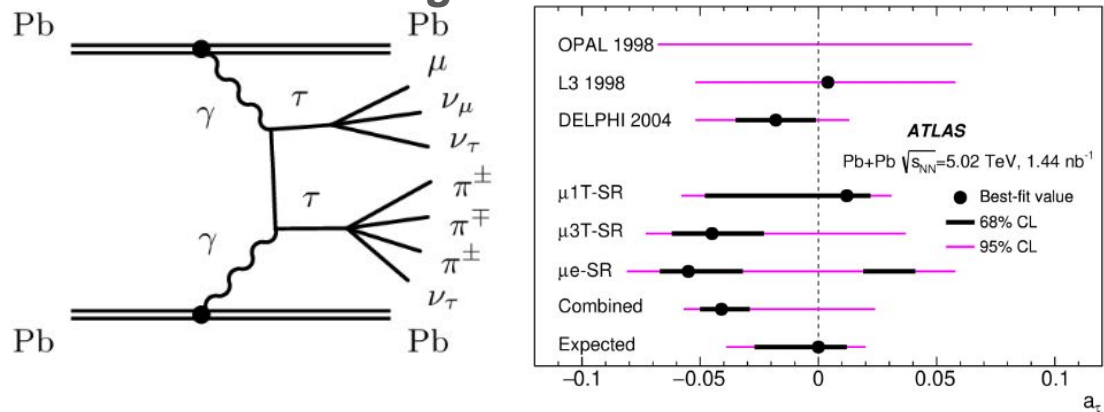


## EW scale photon-photon physics w/ proton tagging

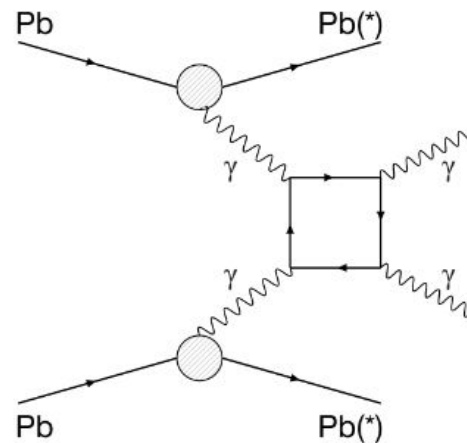
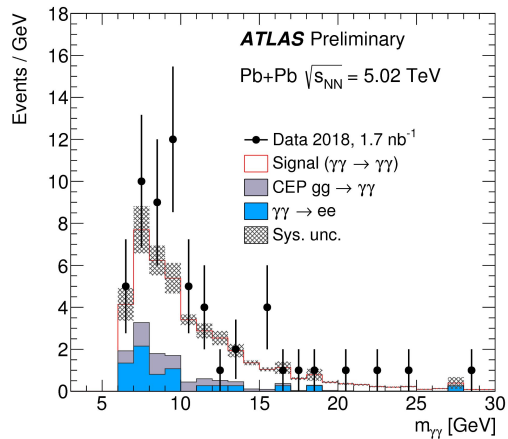
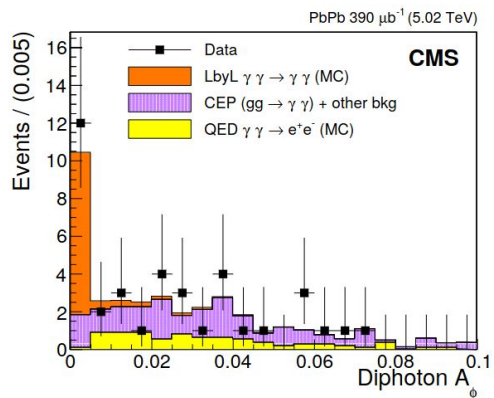
Stress testing EW symmetry breaking ( $\gamma W^+ W^-$  and  $yy W^+ W^-$  couplings)



### Tau g-2

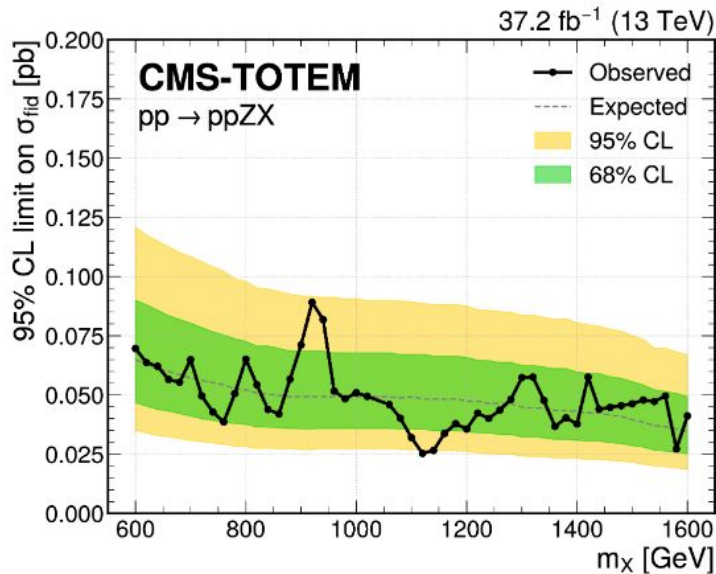
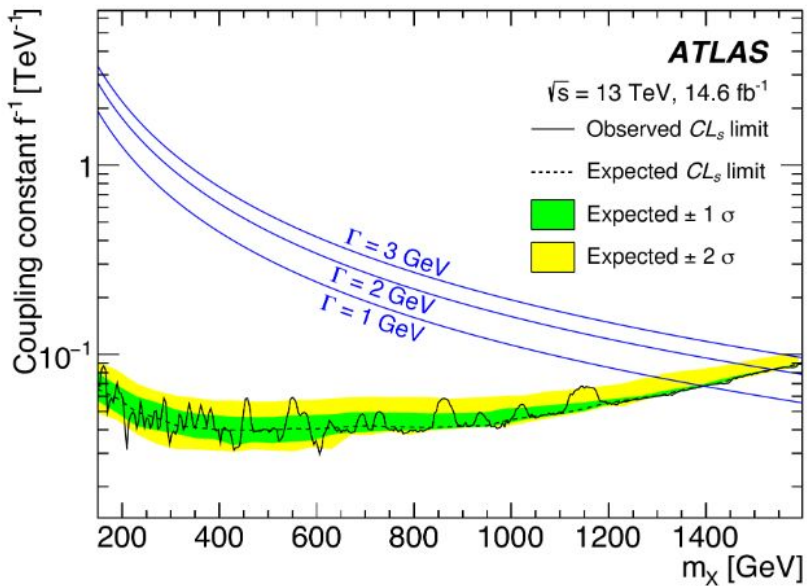
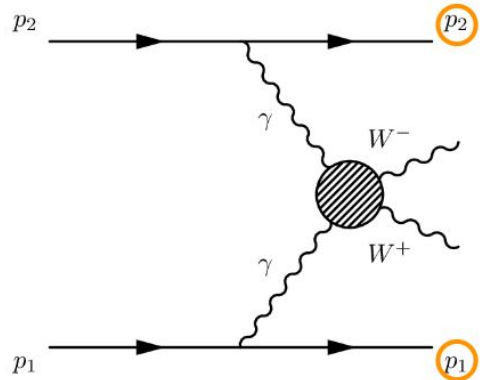
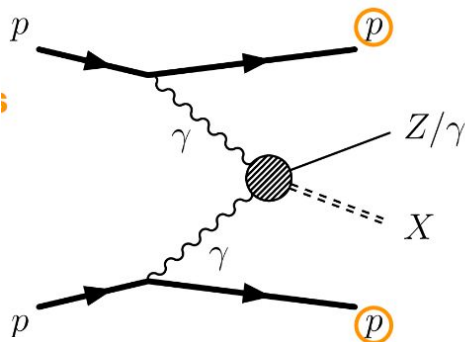
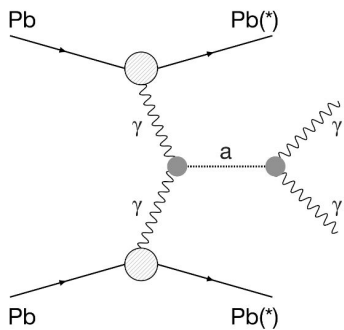


### Scattering of light-by-light by ATLAS/CMS



# New channels with photon-photon collisions

Lydia Beresford





# Forward energy spectra at the LHC

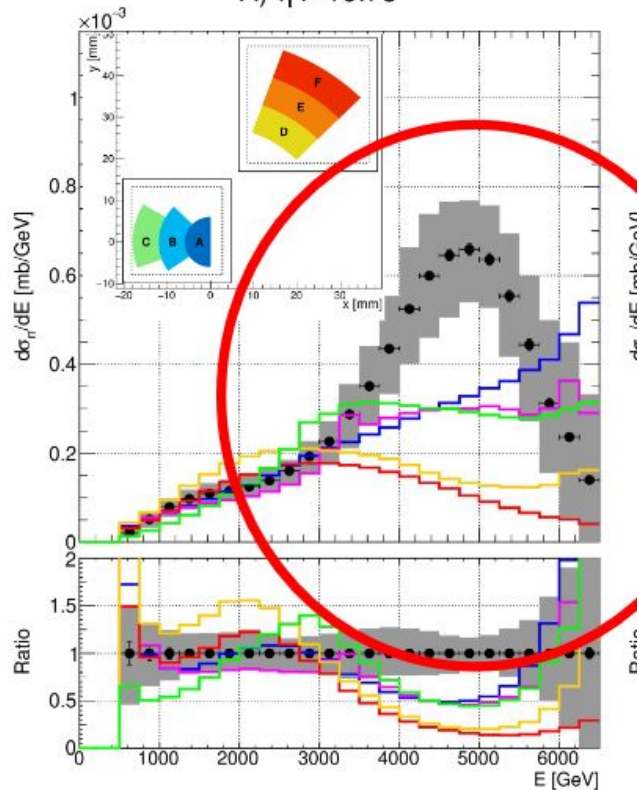
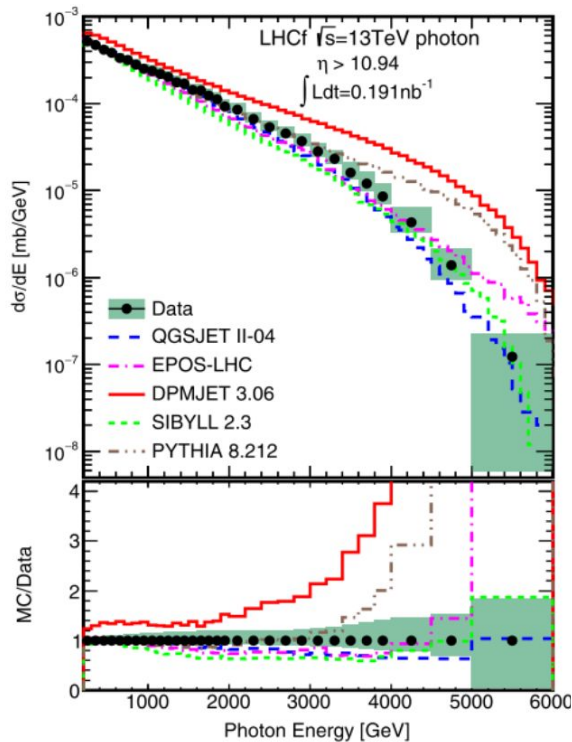
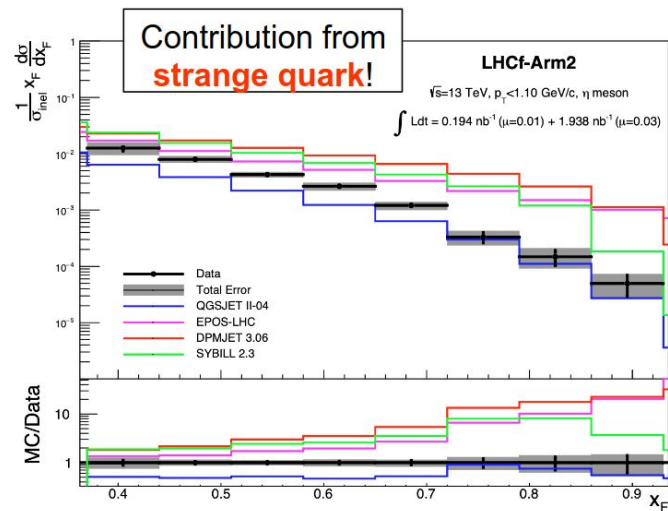
Oscar Adriani

$\eta$

$\gamma$

neutrons

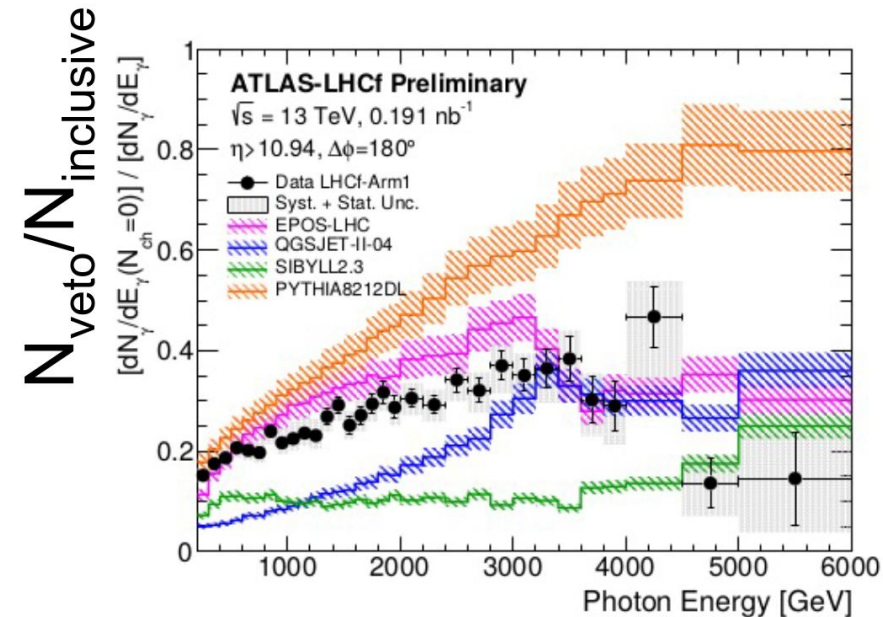
A)  $\eta > 10.75$



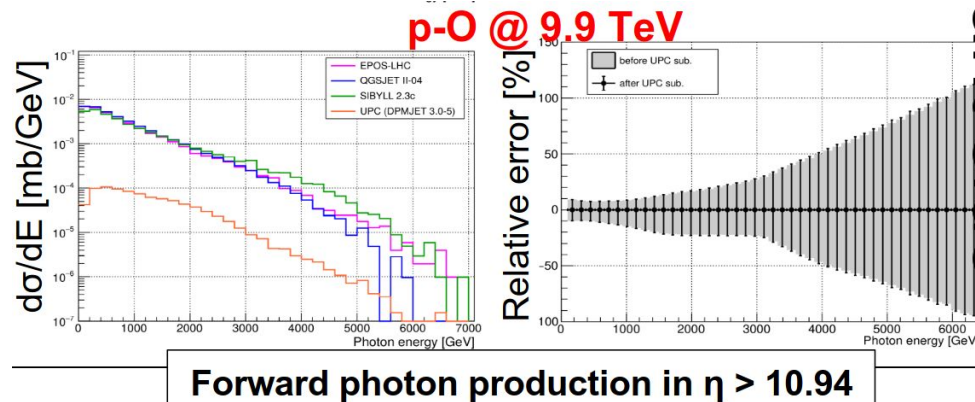
*Huge spread between cosmic ray MC generators predictions*

# Forward energy spectra at the LHC

Oscar Adriani



Stay tuned for LHCf+ATLAS data for central-forward correlations

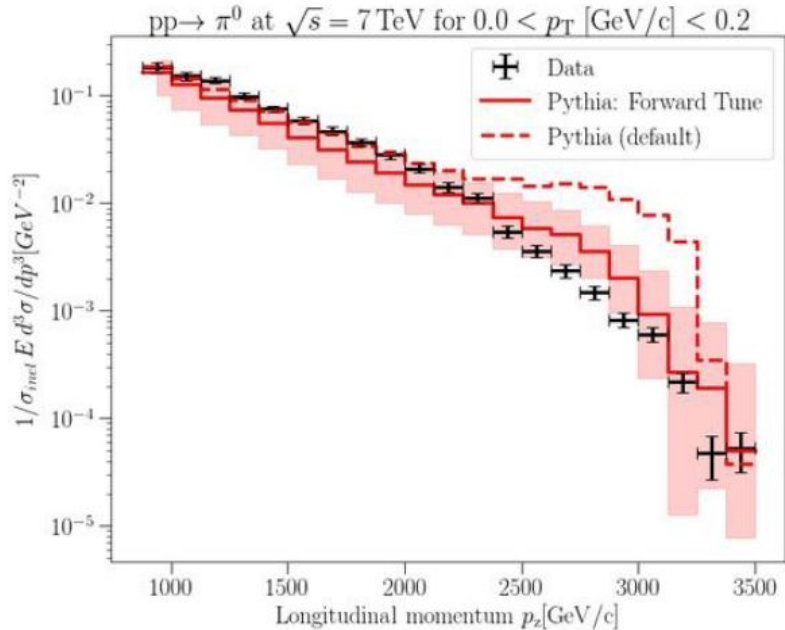


Forward photon production in  $\eta > 10.94$

+ pO (and OO) data in 2024!  
(less UPC contamination than pPb)



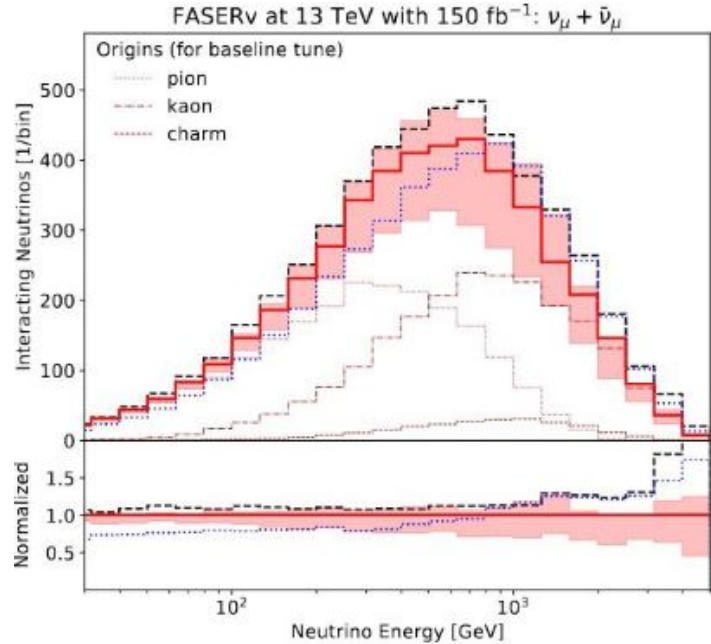
# Forward tune to LHCf data



Forward tune to LHCf data, decoupled from central rapidities! Potential baseline tune for general purpose LHC applications?

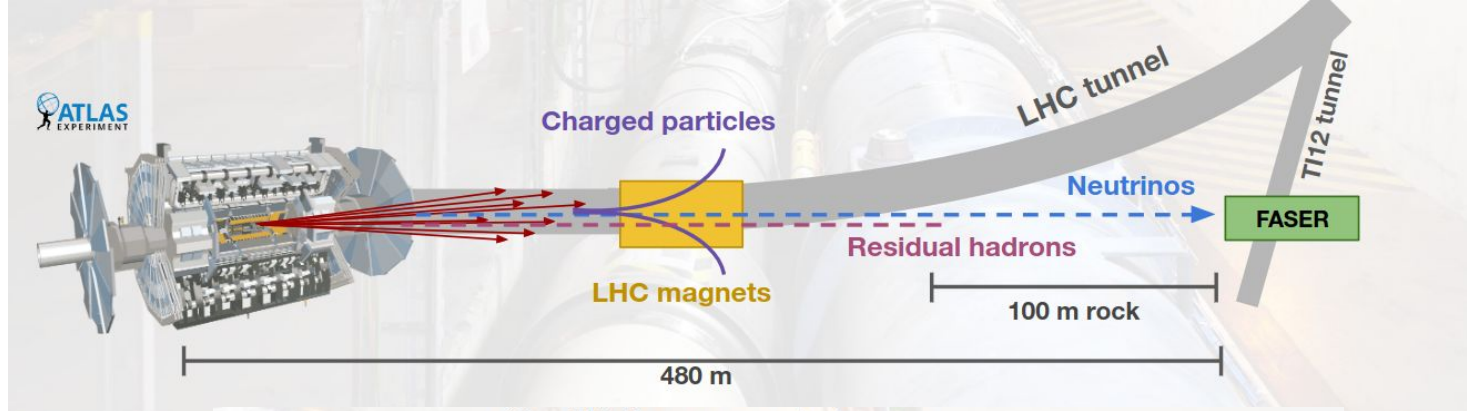
# Max Fieg (from WG1)

## Post-tune

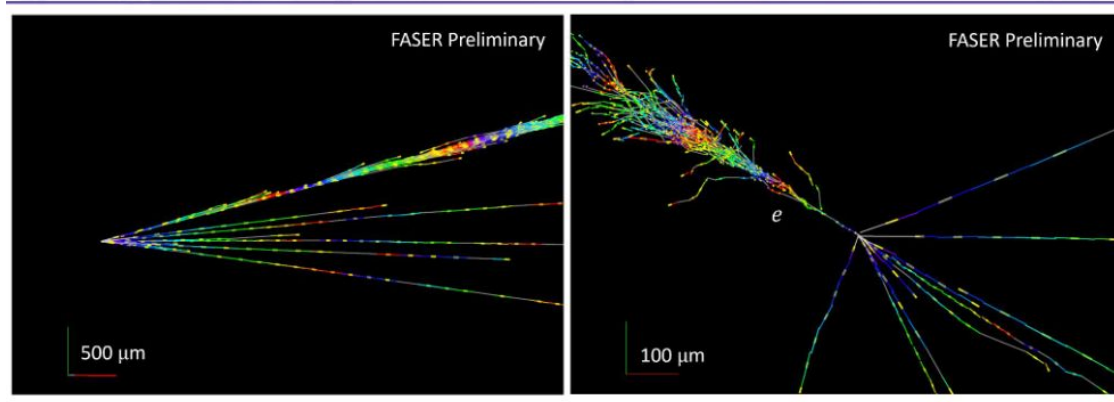


# LHC neutrinos detected by FASER!

Michaela Queitsch-Maitland

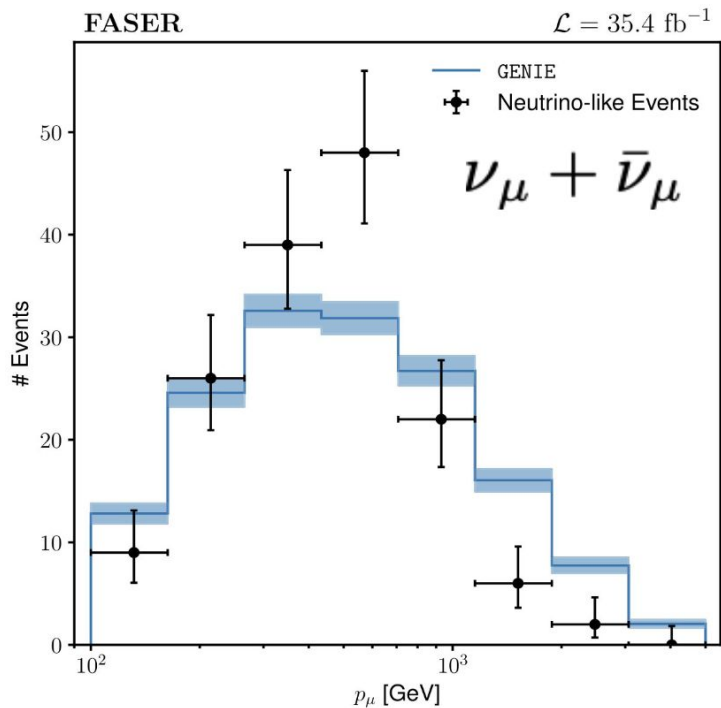


## Collider neutrinos



# Collider neutrinos@FASER

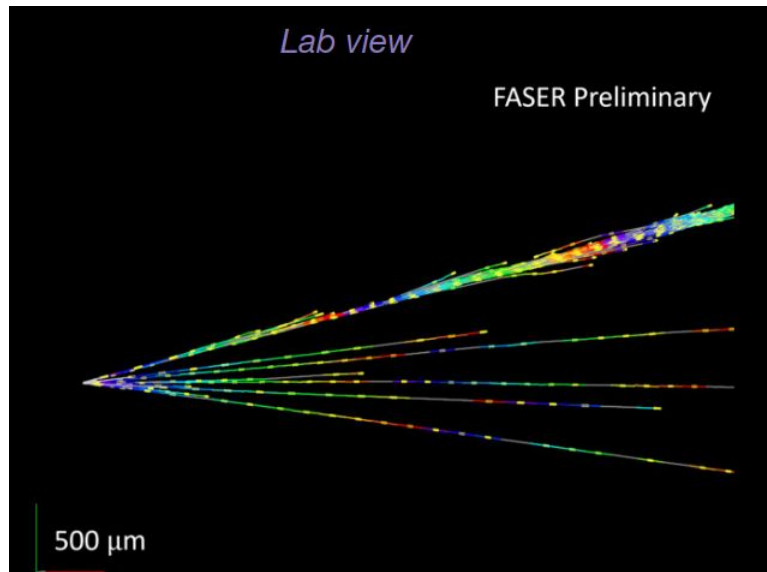
## Muon neutrinos



Observation with  $16\sigma$  significance  
(1 in  $10^{57}$  it could happen by chance?)

Michaela Queitsch-Maitland

## Electron neutrinos



3 candidate events,  
observation at  $5\sigma$

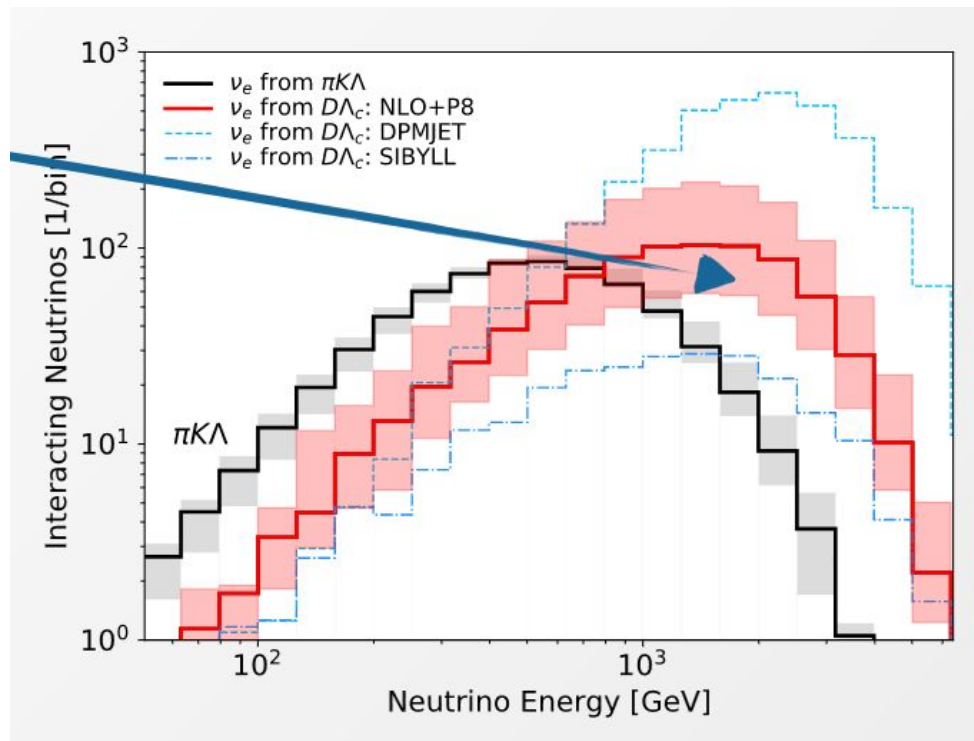
# Small-x vs collider neutrinos

Luca Rottoli

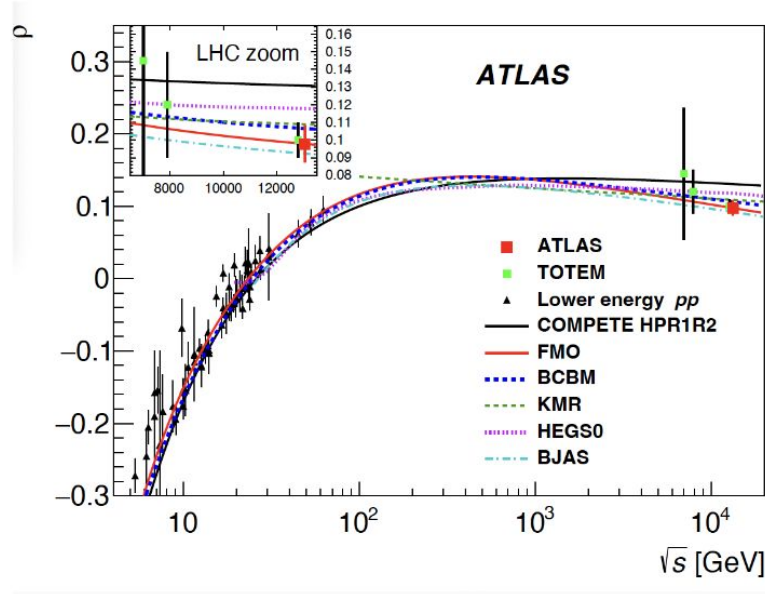
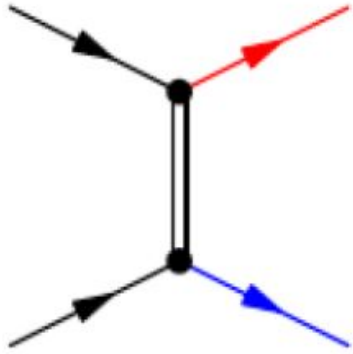
Electron neutrinos from charm decay,  
**NNLO+NLLx pQCD prediction**

*Dream corner to test small-x evolution?*

**NB:** MC predictions not covered by  
pQCD uncertainty band!

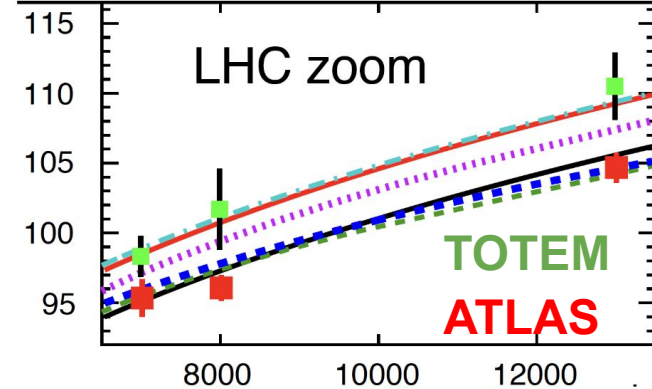


# Elastic pp scattering at the LHC



Christophe Royon

$\sigma_{tot}$  vs sqrt(s)



Tension with  $\sigma_{tot}$  at three energies! Luminosity bias?

**ATLAS/TOTEM:** increasing cross section & decreasing  $\rho = \text{Im}(A)/\text{Re}(A)$  with  $\sqrt{s}$ , consistent with odderon hypothesis

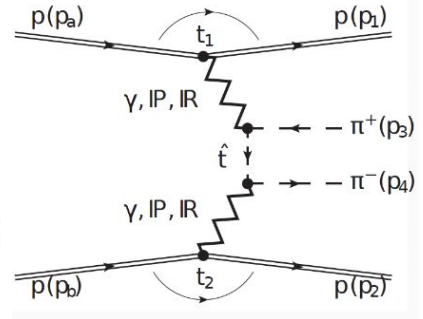


# Soft diffraction

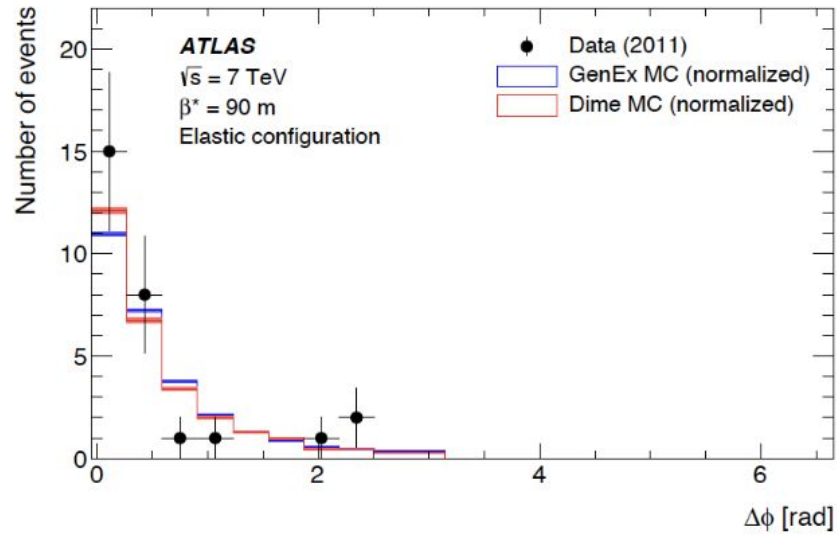
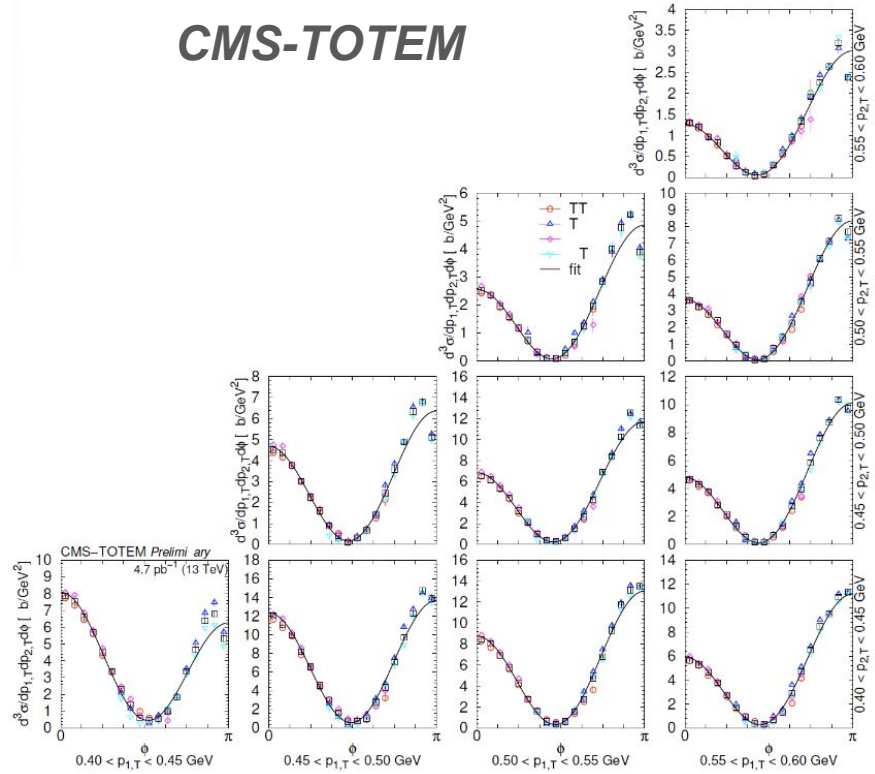
$$pp \rightarrow p h^+ h^- p$$

Christophe Royon

CMS-TOTEM



ATLAS

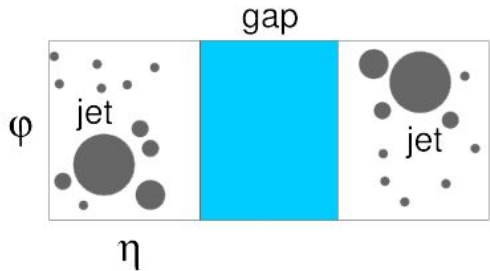
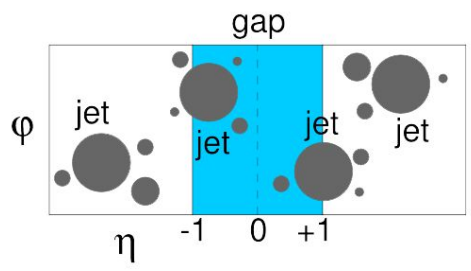


Predictions for pomeron-pomeron interactions.

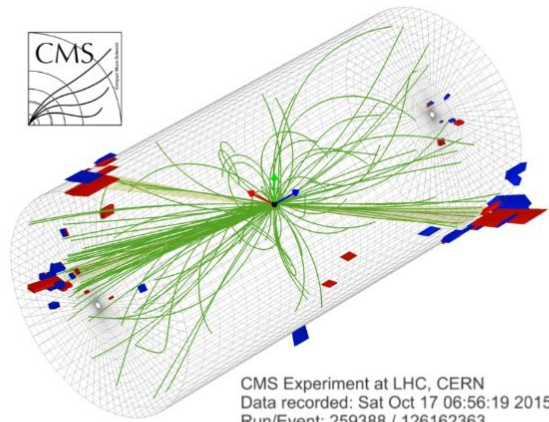
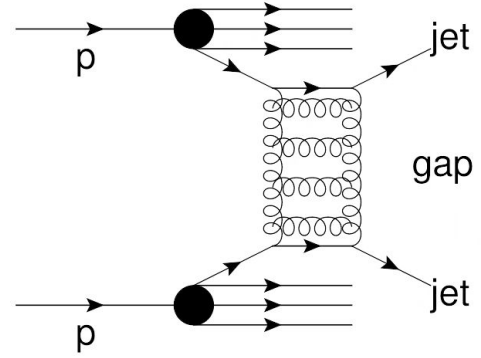
Highly-gluey environment! Opportunities to study glue-rich soft collisions?

# Hard diffraction with jets

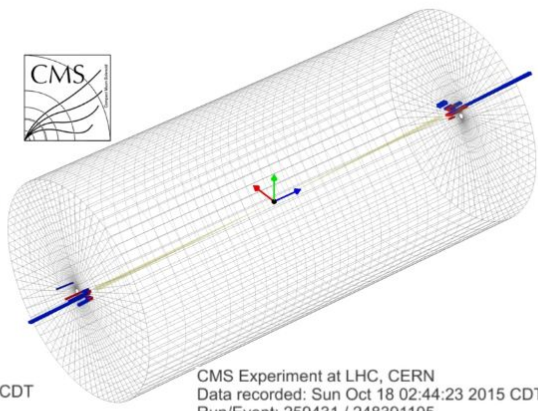
*Christophe Royon*



Color-singlet exchange  
(two-gluon in *t*-channel)



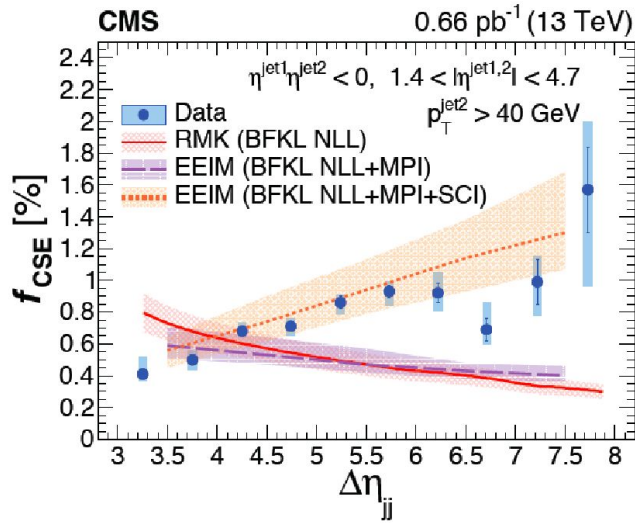
CMS Experiment at LHC, CERN  
Data recorded: Sat Oct 17 06:56:19 2015 CDT  
Run/Event: 259388 / 126162363



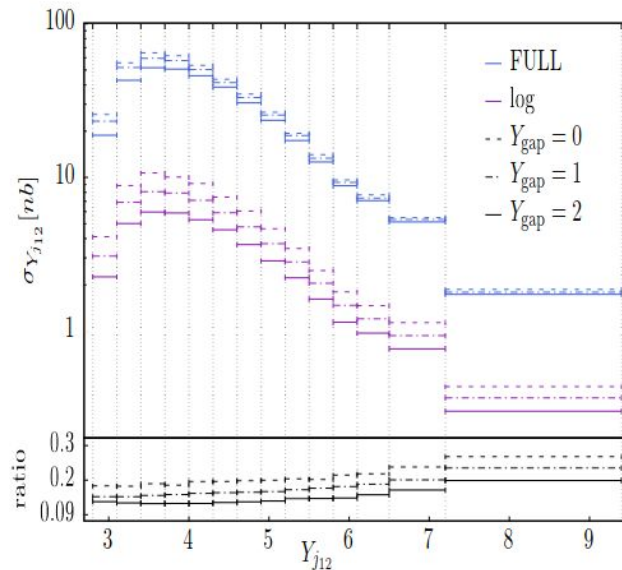
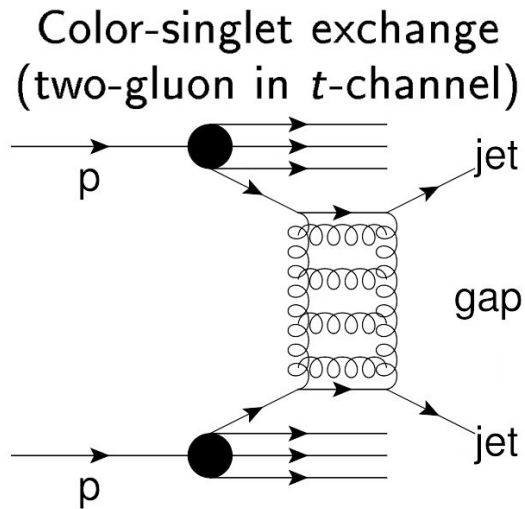
CMS Experiment at LHC, CERN  
Data recorded: Sun Oct 18 02:44:23 2015 CDT  
Run/Event: 259431 / 248391105

Color-exchange event candidate  
(Background-like)

Color-singlet exchange event candidate  
(Signal-like)



# NLO+NLL, violation of factorization for jet-gap-jet?



*Dimitri Colferai*

Challenging to describe theoretically from first-principles.

***Can a jet veto setup help bring stability to pQCD calculation?***

# Moving forward

Run-3 still ongoing! Fresh pp/PbPb data, pO data coming in 2024

Oscar Adriani

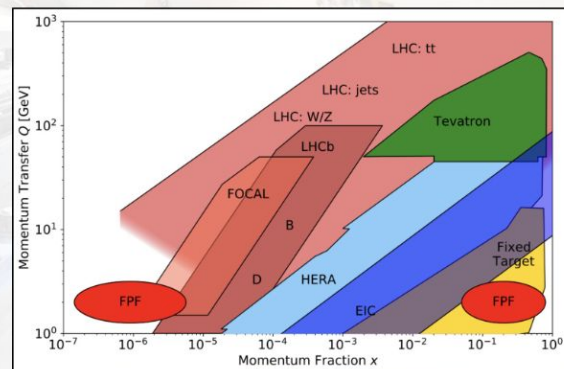
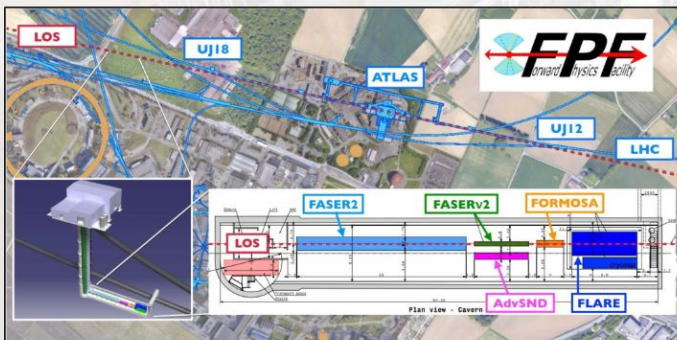
Forward physics facility (FPF)

Michaela Queitsch-Maitland

## Further forward (to the future)

### Forward Physics Facility (FPF):

- Proposed facility for the HL-LHC that could house a suite of experiments.
- Extend LHC's physics potential for BSM physics searches, neutrino physics, and **QCD**.



***Thanks to all the speakers!***