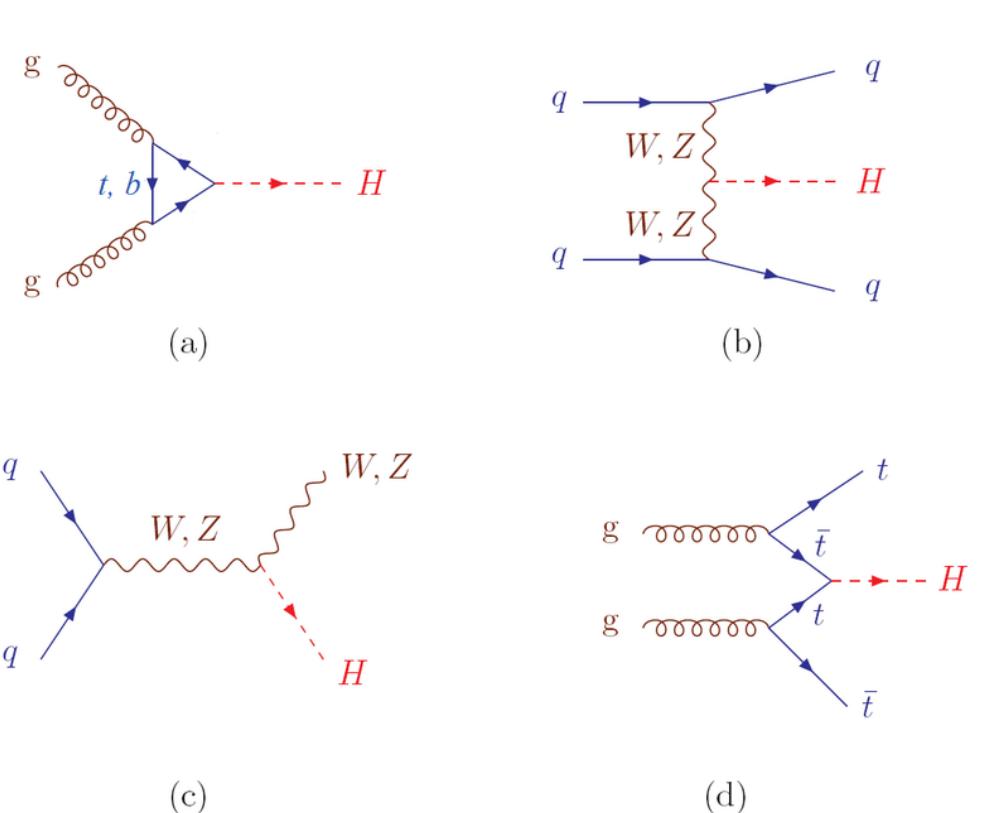
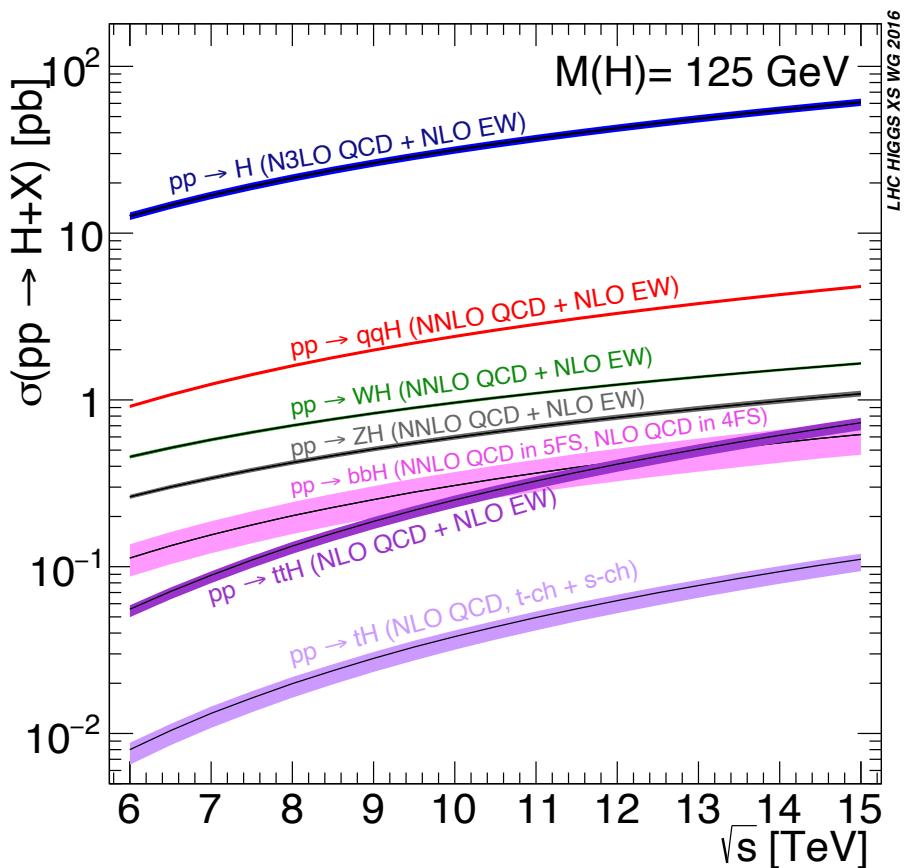


# Redécouverte du boson $H$ dans le canal $H \rightarrow ZZ^{(*)} \rightarrow l^+l^-l'^+l'^-$

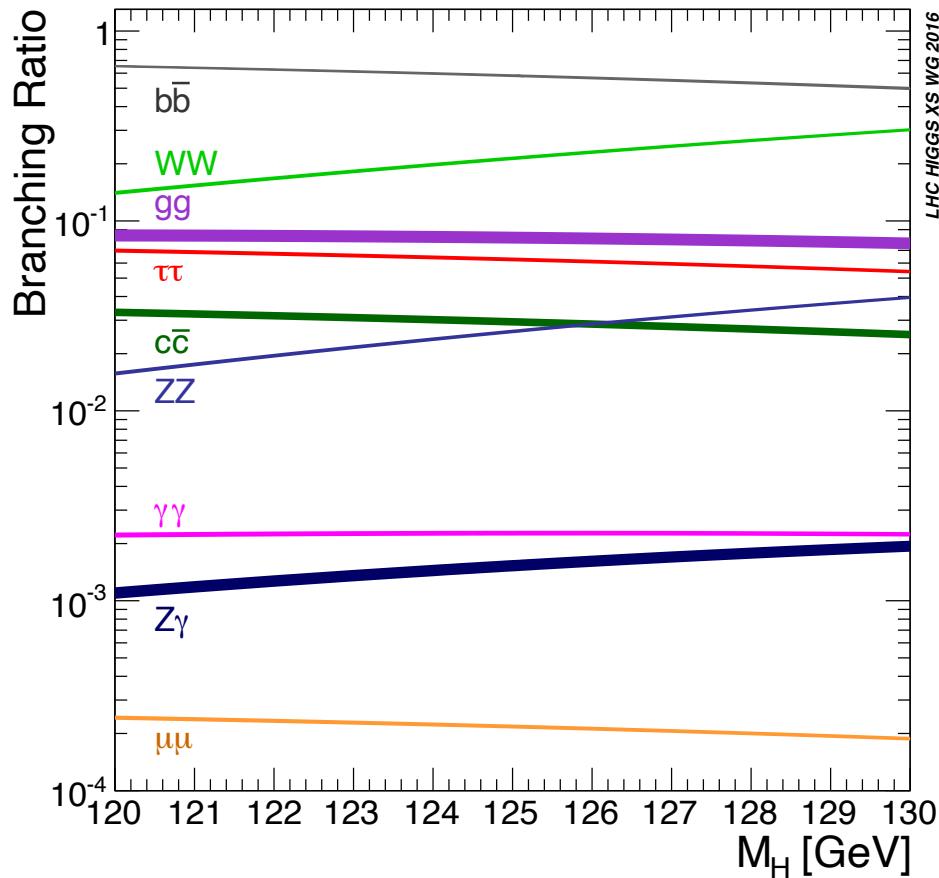
stage BA3

18 février 2025

# Production du boson H du modèle standard au LHC



# Modes de désintégration du boson H du modèle standard

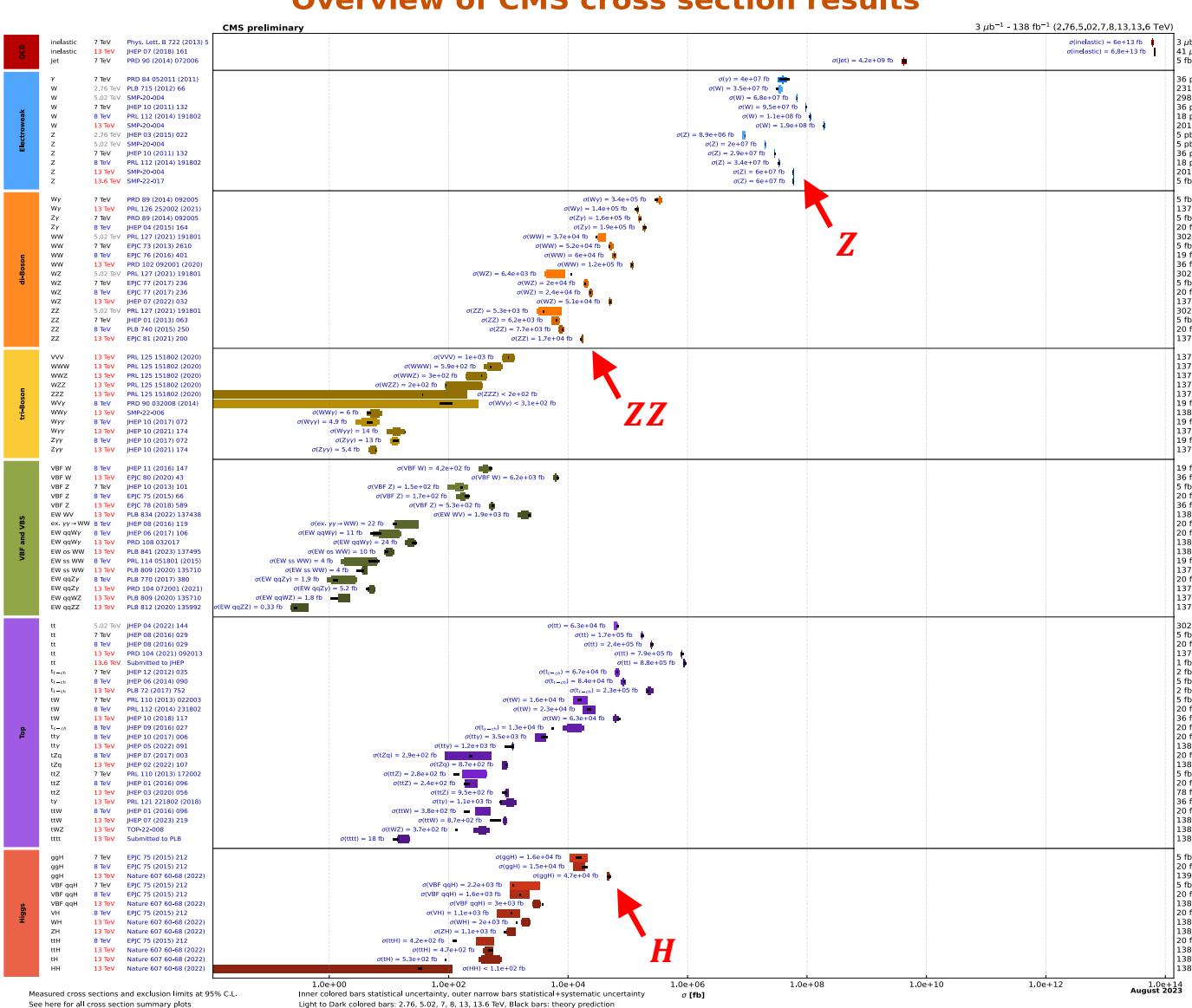


$m_H = 125 \text{ GeV}:$   
 $BR(H \rightarrow ZZ^{(*)} \rightarrow l^+l^-l'^+l'^-) ; (l, l' = e, \mu) = 1.25 \times 10^{-4}$   
 $BR(Z \rightarrow l^+l^-) = 3.37\%$

Nombre d'événements attendus pour  $\int \mathcal{L} dt = 140 \text{ fb}^{-1}$ ?

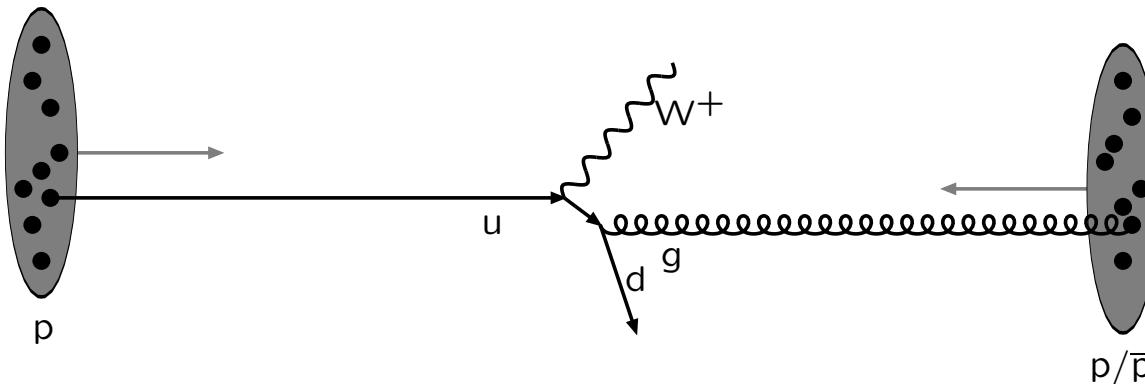
# Bruits de fond

- ZZ
  - Z + jets



# Effets dus à la QCD

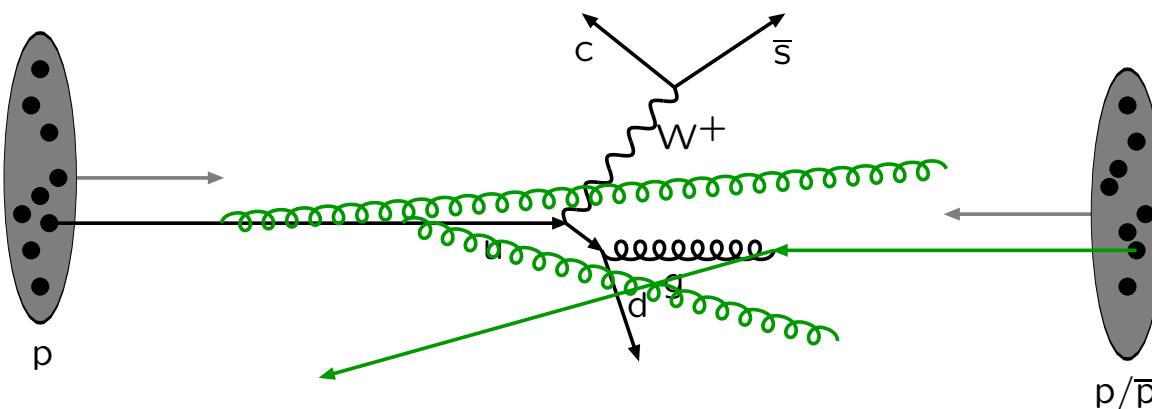
## Processus partonique



Sjostrand, T., *Monte Carlo Generators for the LHC*,  
Academic Training Lectures, CERN, 2005

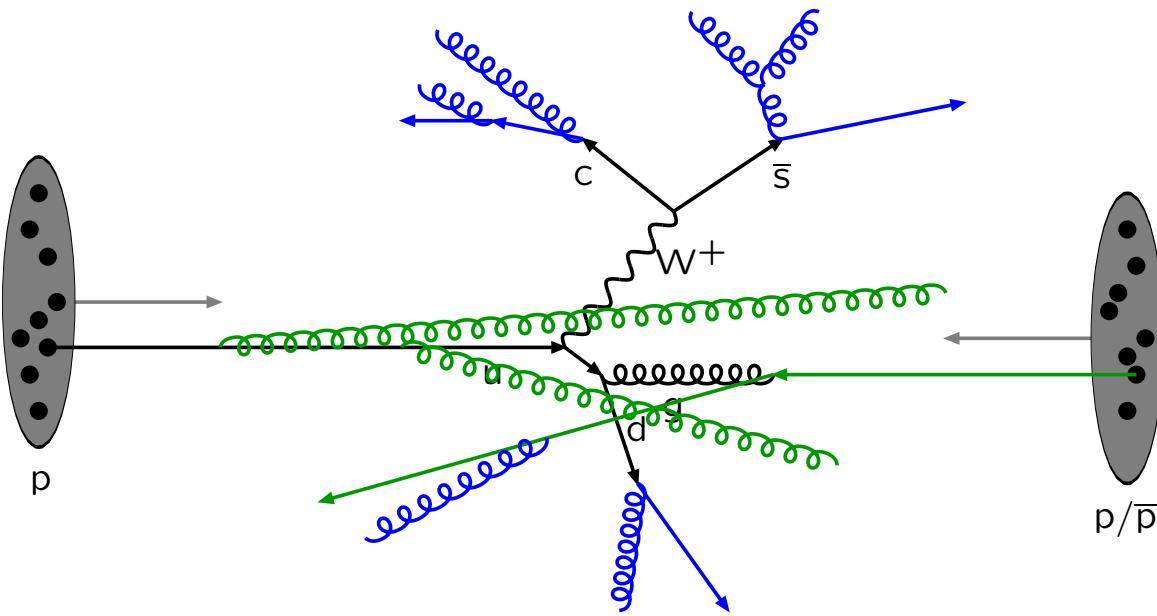
# Effets dus à la QCD

## Radiations de gluons et quarks dans l'état initial



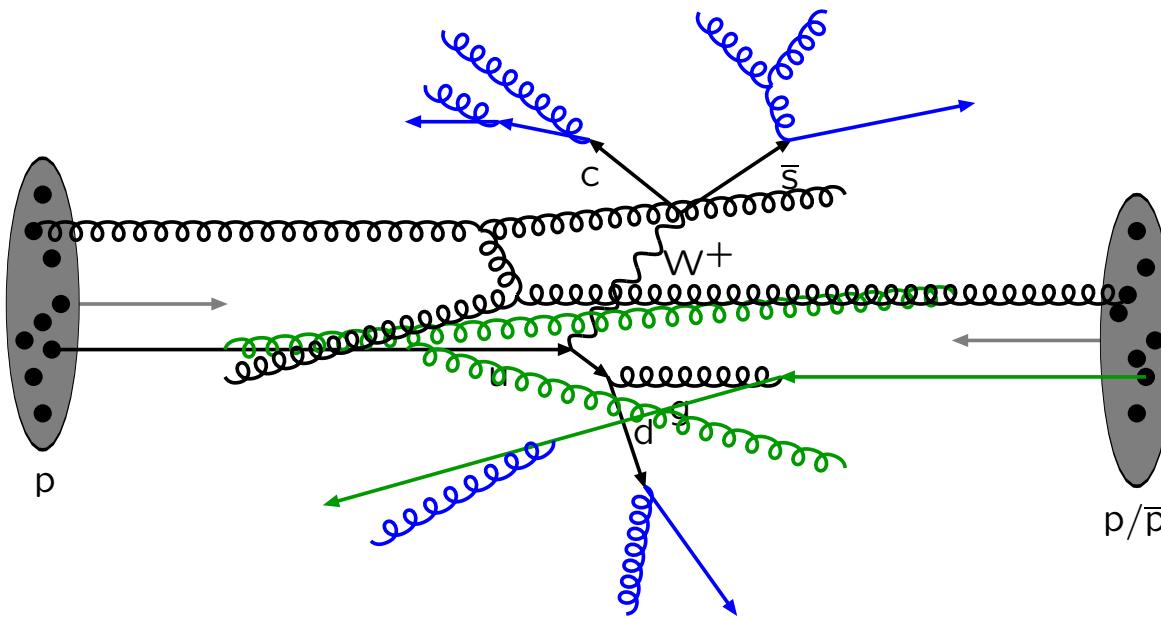
# Effets dus à la QCD

## Radiations dans l'état final



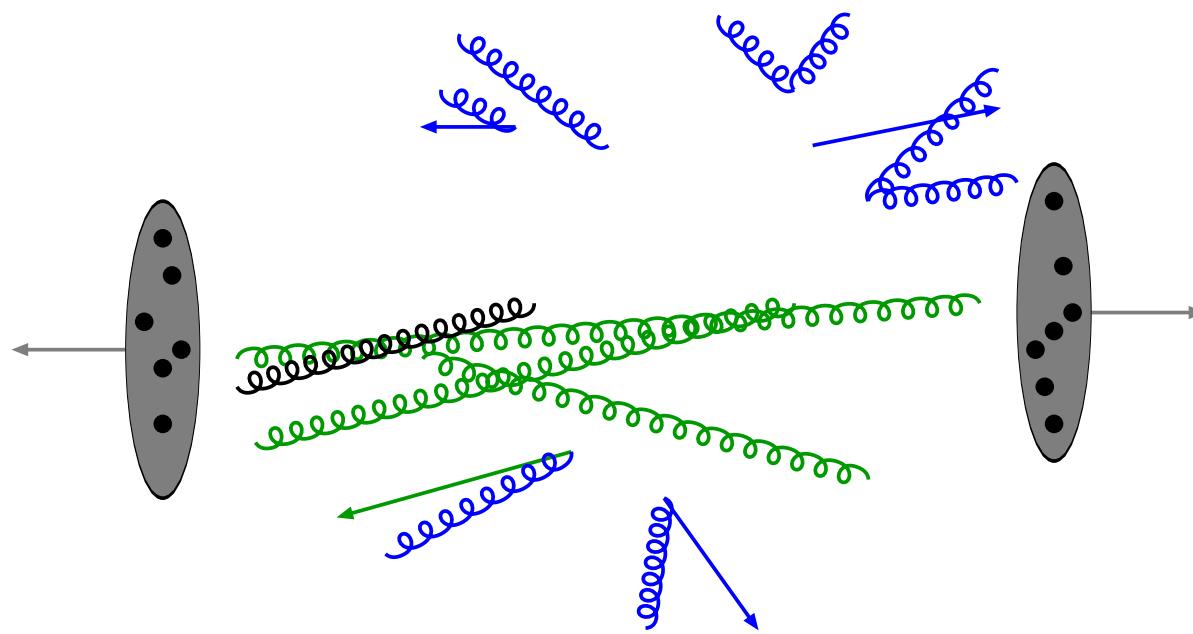
# Effets dus à la QCD

## Interactions partoniques multiples



# Effets dus à la QCD

Restes des faisceaux; partons dans l'état final

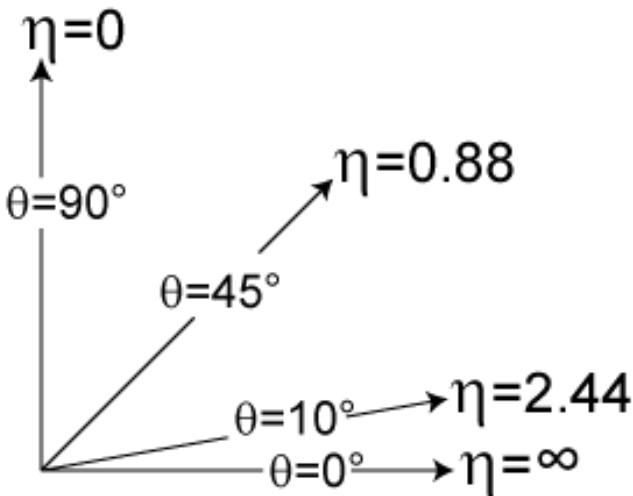


# Cinématique: $\vec{p} = (p_T, \eta, \varphi)$

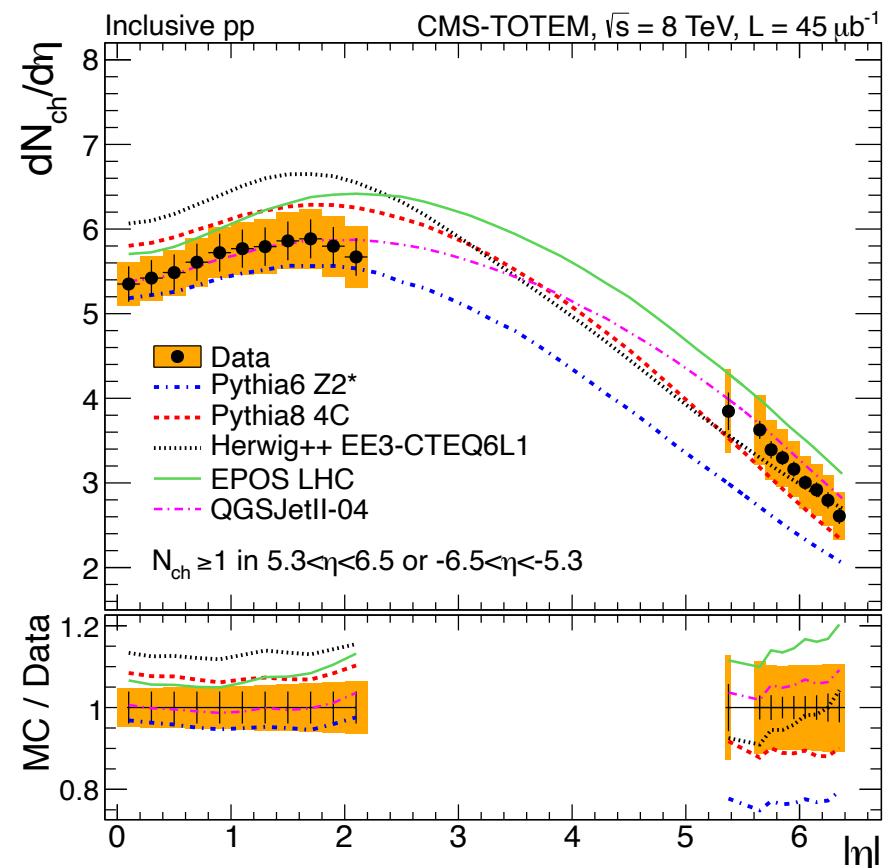
arxiv:1405.0722

$$\eta \equiv -\ln \left[ \tan \left( \frac{\theta}{2} \right) \right] = \frac{1}{2} \ln \left( \frac{|\mathbf{p}| + p_L}{|\mathbf{p}| - p_L} \right) = \operatorname{arctanh} \left( \frac{p_L}{|\mathbf{p}|} \right)$$

$$y \equiv \frac{1}{2} \ln \left( \frac{E + p_L}{E - p_L} \right)$$

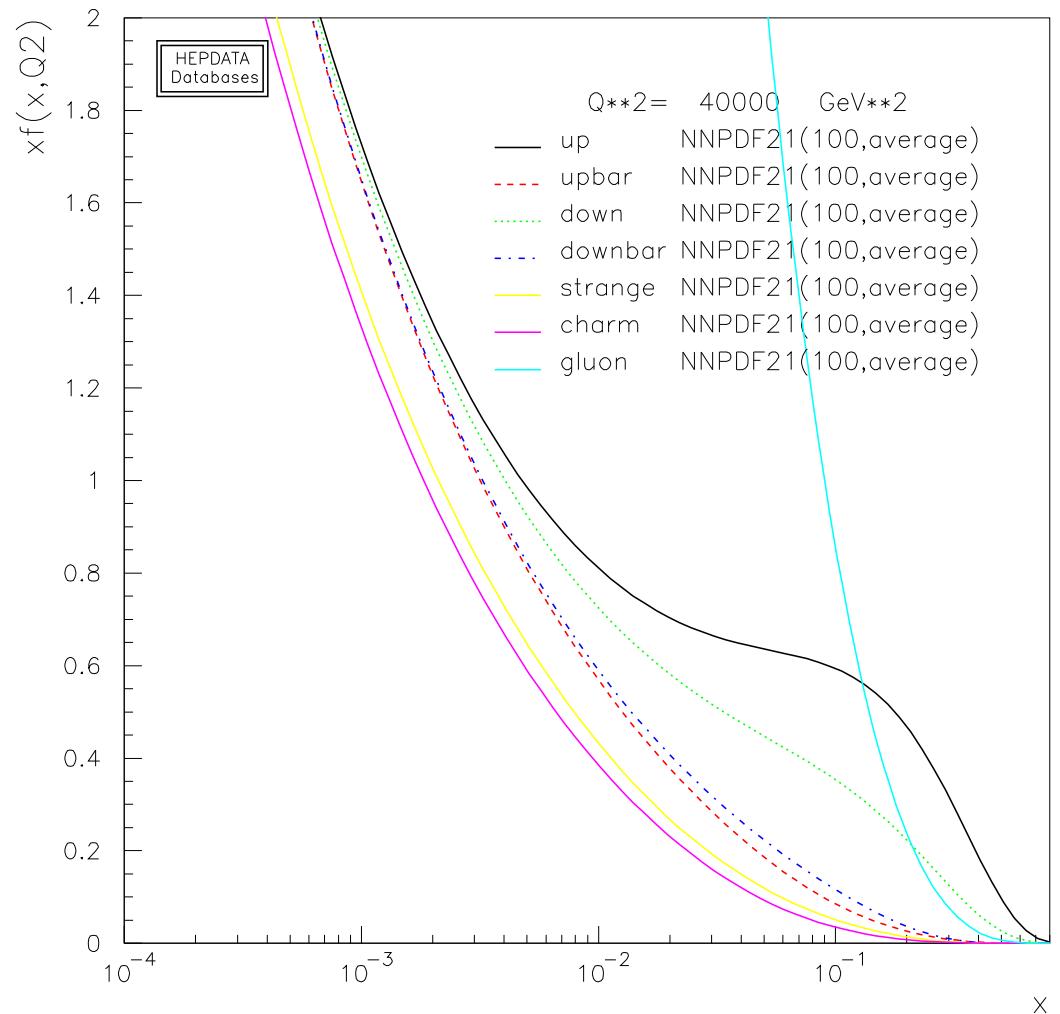


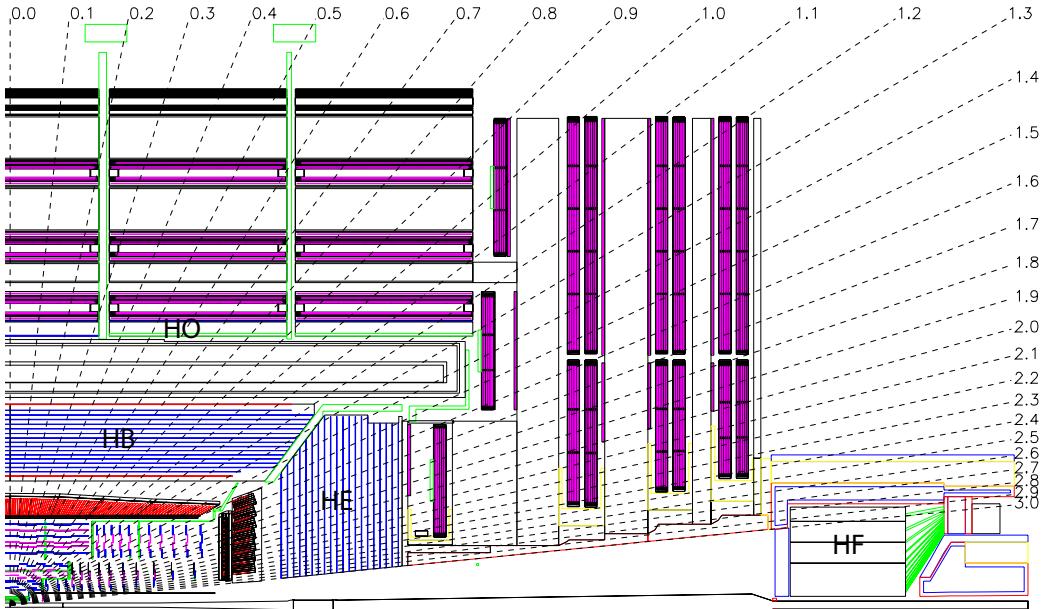
- $\Delta y$  est indépendante du boost du système partonique dans la direction des faisceaux
- $dN/d\eta$  est approx. constant



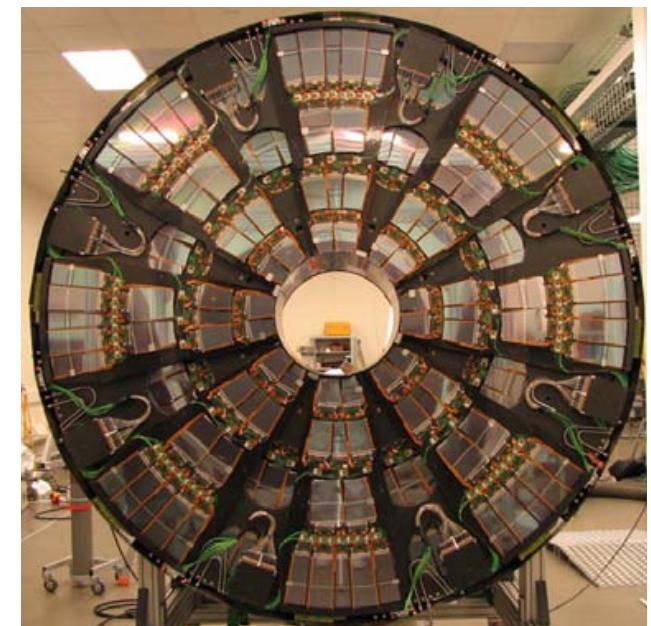
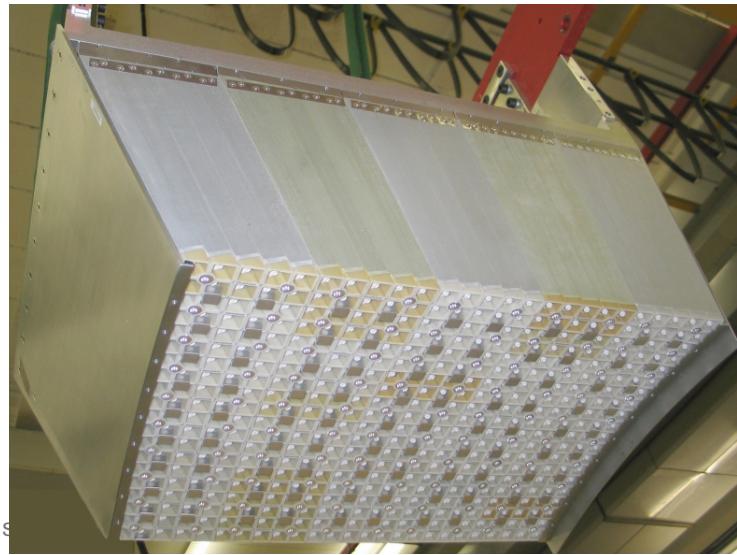
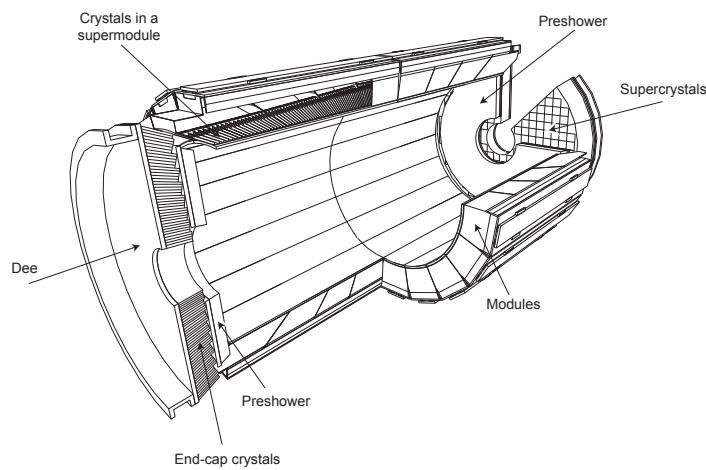
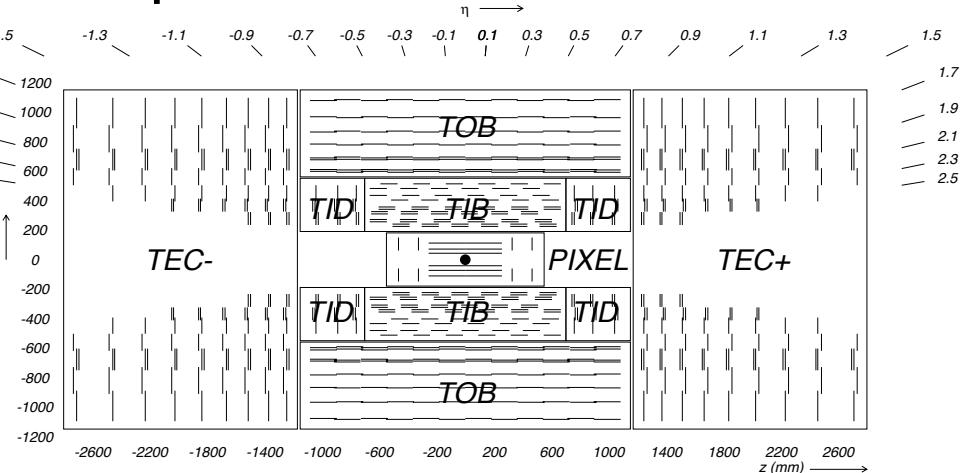
# Cinématique: densités de partons

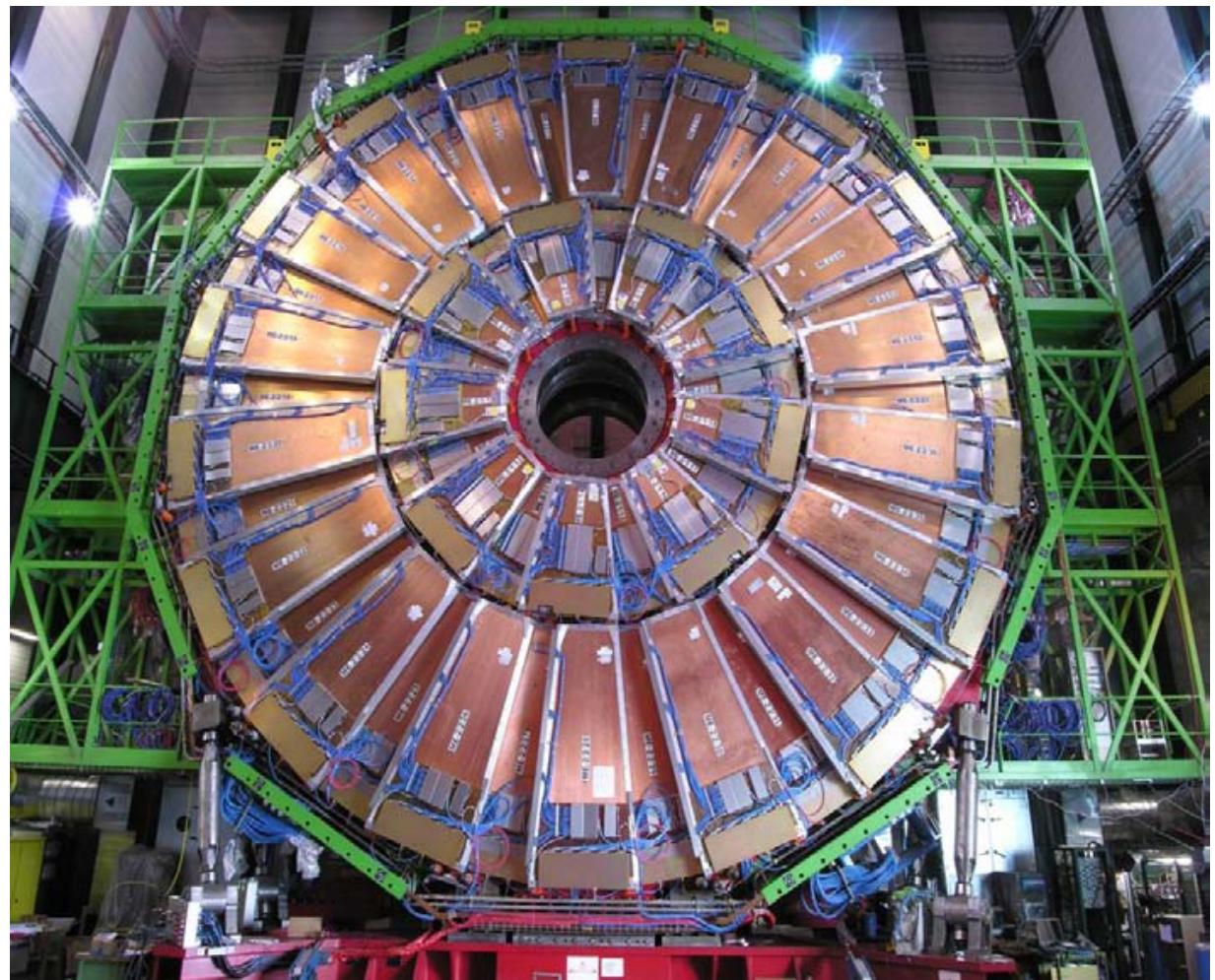
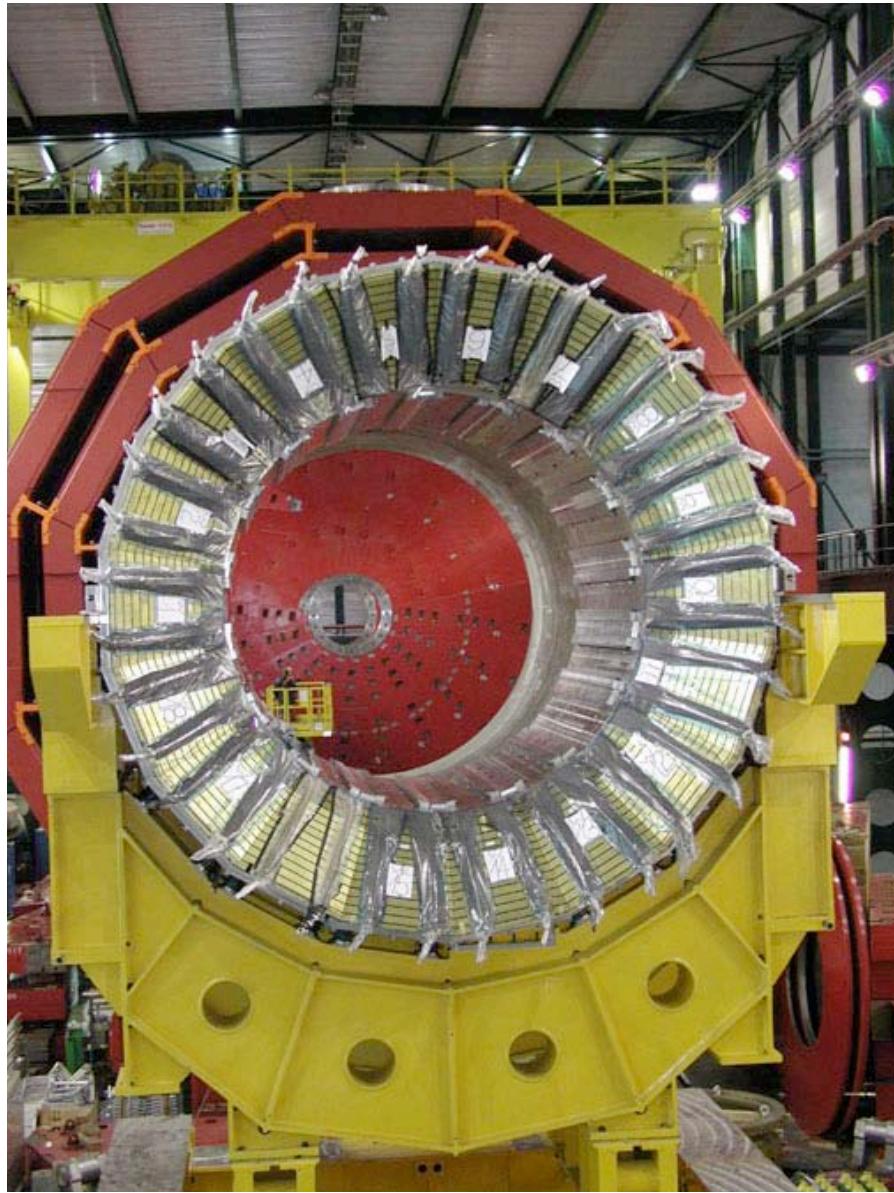
- $m_{ZZ} = \sqrt{s x_1 x_2}$  où  $\sqrt{s} = 13\text{TeV}$
- $p_z \cong p_{proton} \cdot (x_2 - x_1)$  où  $p_{proton} = 6.5\text{TeV}$



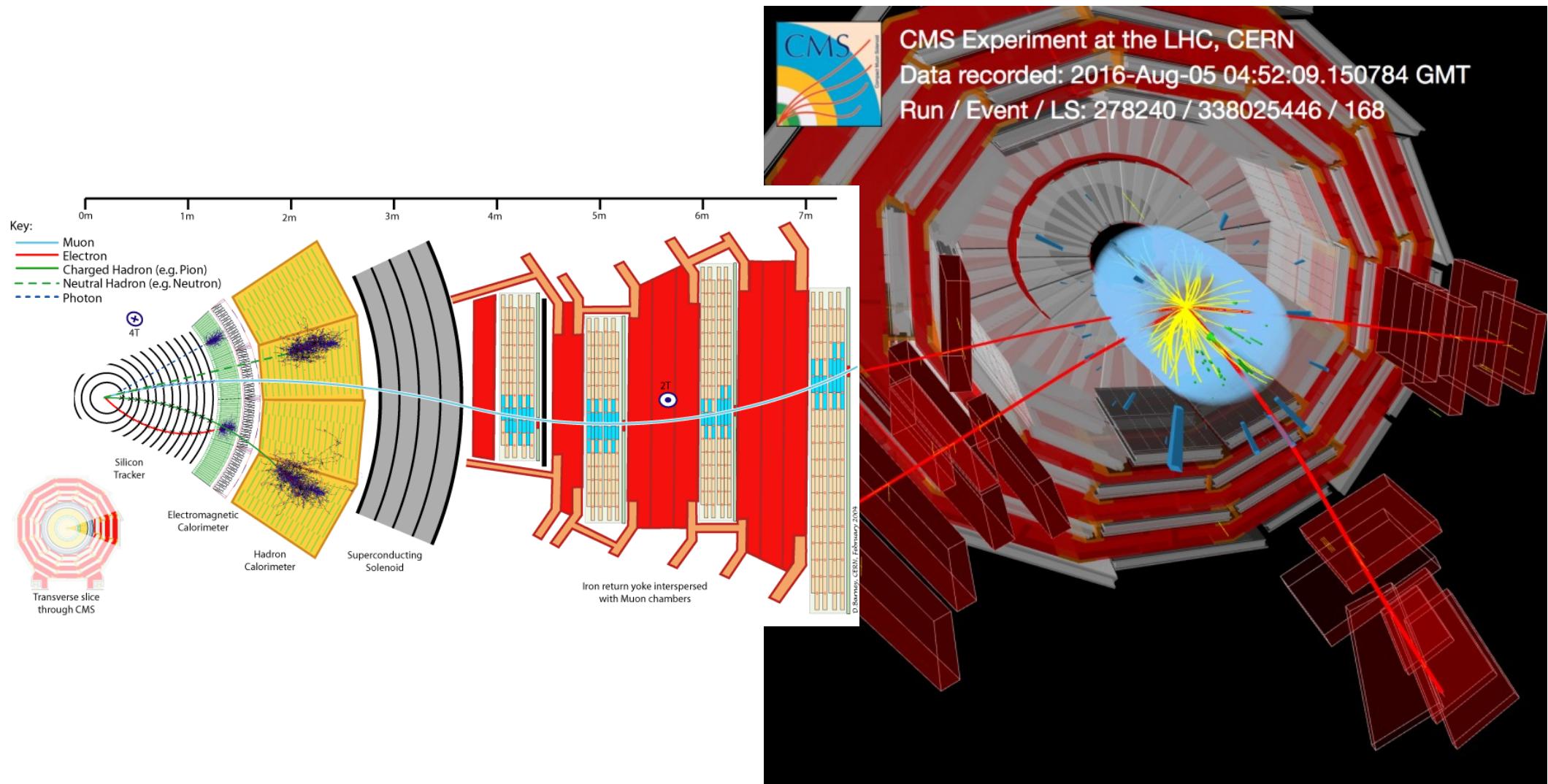


# L'expérience CMS





Andrea Malara, Laurent Thomas, Pascal Vanlaer



# Mesure des muons et des électrons

