

# Particle Collisions one level deeper

The invisible world of particle physics

**ERIK JOHANSSON**  
**STOCKHOLM UNIVERSITY**

**CERN OCTOBER 2012**

# PROTON COLLISIONS AT LHC

## Start with the proton

- The proton is a rather complex object
- Three quarks and numerous gluons

## It is the quarks and gluons that interact

- A gluon is exchanged between the protons (actually between two quarks)
- A gluon from each of the proton collide (merge)

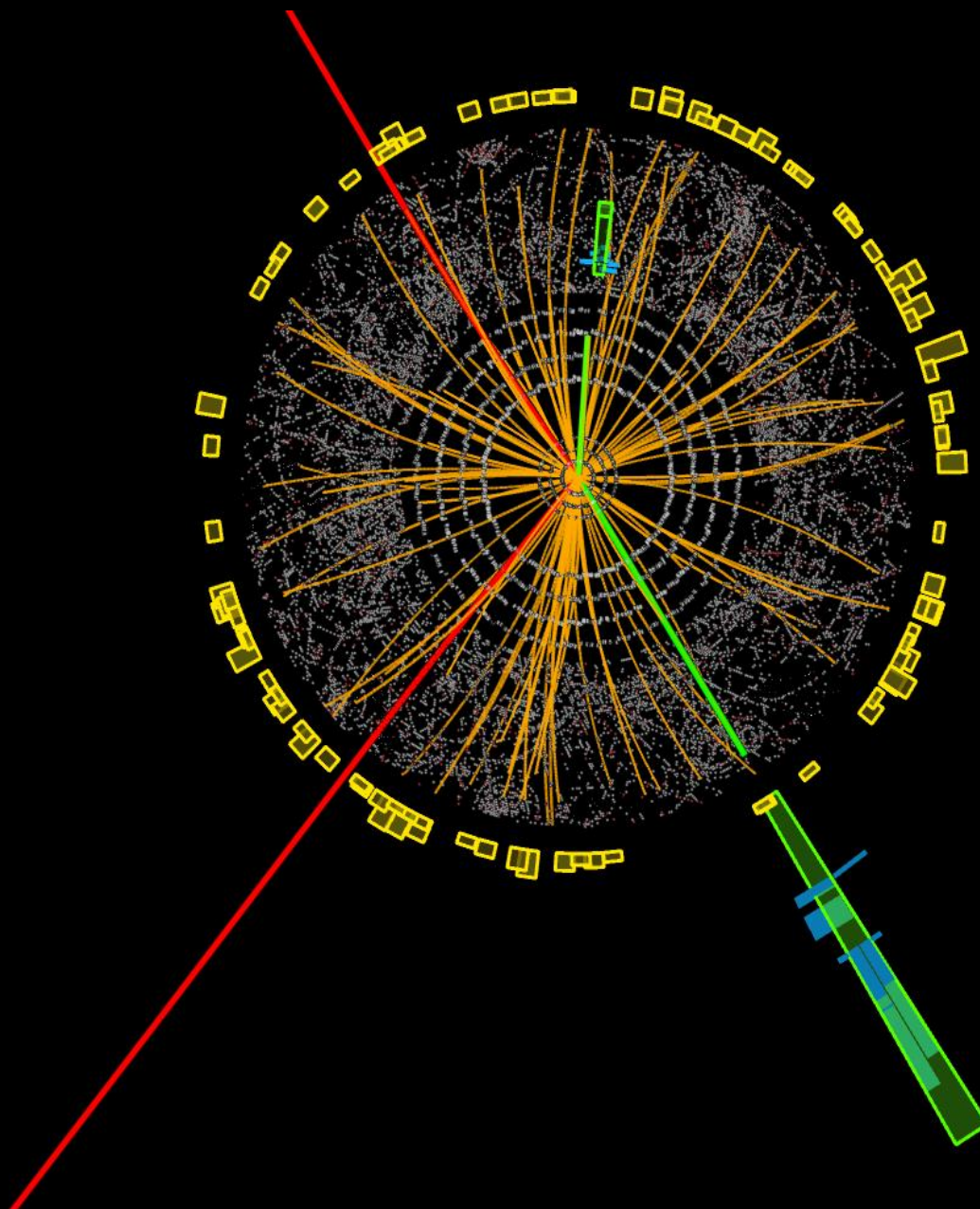
# QUARK AND GLUON COLLISIONS

## Dynamics

- Gluon exchange
- Gluon fusion
- Quark-antiquark annihilation

## Quark and gluon interactions

- Higgs particle production (on the verge of being discovered at LHC)
  - Decaying to  $ZZ$
  - Decaying to  $\gamma\gamma$



Run: 205113  
Event: 12611816  
Date: 2012-06-18  
Time: 11:07:47 CEST

## **ANOTHER EXAMPLE – TOP QUARK PRODUCTION**

**Production of a top and an antitop quark**

**A complex sequence of decays to almost  
all the quarks and leptons of the Standard Model**

**To appear in Physics Education**

**”Exploring Quarks, Gluons and the Higgs  
particle” by Erik Johansson**

## EXPLORING THE ATLAS WEBSITE



**Atlas.ch**

**Multimedia**

**Images**

**Events**

**Multimedia**

**Videos**

**ATLAS Physics**

**More related videos**

**Multimedia**

**Angels and Demons**

## **DIRECT LINKS TO ANIMATIONS**

The animations at Department of Physics, Stockholm University

<http://www.physto.se/~kej/animations>

The animations on atlas.ch/multimedia

<http://www.atlas.ch/multimedia/#jets-of-particles> (to be updated)

<http://www.atlas.ch/multimedia/#a-higgs-particle-decaying-2-Z-particles>

<http://www.atlas.ch/multimedia/#a-higgs-particle-decaying-2-photons>

<http://www.atlas.ch/multimedia/#the-top-quark>

<http://www.atlas.ch/multimedia/#the-z-particle>