#### The CT-PPS Project and prospects for γγ exclusive production

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## Introduction

- In a special class of "exclusive" interactions at the LHC, the colliding protons stay intact and are scattered at small angles
  - Tagged gluon-gluon and  $\gamma\gamma$  interactions, with  $\sqrt{s} >> LEP$
  - Unique opportunity for new electroweak, QCD, and beyond Standard Model physics measurements







CERN European Organization for Nuclear Research

Organisation européenne pour la recherche nucléaire

PRECISION PROTON SPECTROMETER

- The CT-PPS project of the CMS & TOTEM experiments aim to detect the protons in these events using tracking and fast timing detectors
  - Project approved for baseline plan of
    - Installation of new Roman Pots in 2015
    - Staged installation of detectors in 2016
    - Physics operation by 2017

## **CT-PPS** infrastructure

- Forward protons are scattered at small angles
  - Roman Pots housing the detectors must approach the LHC beam to within ~3-4mm



- New Roman Pots already installed before 2015 LHC restart, optimized for high luminosity running
  - Insertion tests successfully conducted throughout 2015
  - No background/vacuum/RF impedance problems observed up to highest luminosities (20σ approach)

# **CT-PPS** detectors

- Timing detectors:
  - Diamond detectors already installed in 2015 for TOTEM upgrade, available for CT-PPS installation June 2016
    - ~90ps resolution/plane, ~50ps resolution from 4 planes
  - Timing upgrades/R&D under study: Ultrafast Silicon (UFSD), Quartz Cherenkov







- Baseline tracking detectors:
  - Radiation-hard, 3D silicon pixels
  - <30µm resolution => recoil mass resolution <1.5%</li>
  - Installation late 2016

# Selection of exclusive events

- Detailed physics simulations carried out with up to 50 overlapping interactions per bunch crossing ("pileup") in WW and dijet channels
- Timing selections:
  - Correlations between vertex position in central detector and vertex determined from ToF difference of protons





- Tracking selections:
  - Invariant mass correlations between central system and protons
  - Rapidity correlations between central system and protons

#### Physics prospects: yy->VV interactions

- Probing  $\gamma\gamma$ WW and  $\gamma\gamma$ ZZ couplings at the TeV scale
  - Indirect sensitivity to many types of new physics (composite Higgs, warped extra dimensions, heavy V/A resonances etc.) appearing as "anomalous quartic gauge couplings"
    - Expected sensitivity far beyond LHC Run 1
      and LEP/Tevatron searches

LEP (OPAL)





LHC Run 1 (CMS)

CT-PPS projected, 100fb<sup>-1</sup>

# Physics prospects: search for resonances in γγ->γγ

 Recent development - possible hints of an excess in diphoton events at 750GeV from CMS & ATLAS in 2015 data







- A resonance decaying to yy will also be produced in yy collisions
  - 750 GeV is well matched to the CT-PPS proton acceptance

### γγ->X(750)->γγ and accelerated CT-PPS program

- Several publications have shown γγ->γγ can be measured in the 750GeV range using only tracking detectors for the protons
  - Backgrounds rejected using invariant mass and rapidity matching, diphoton kinematics
  - Similar conclusions from preliminary simulations with CMS/CT-PPS



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- Accelerated plan to re-use TOTEM Si strip detectors (meant for low-luminosity running) for this measurement, already from the beginning of 2016 data-taking
  - Detectors are already installed
  - Work to integrate DAQ and software ongoing

## Summary

- The CT-PPS project will begin operations in 2016
  - Accelerated schedule aims to have limited tracking detectors in use already from start of 2016 LHC running
    - Goal of studying possible 750 GeV object in γγ collisions
  - Baseline detector with timing and pixel tracking will be installed by mid-late 2016 for the 2017 LHC run
    - Expanded physics program of electroweak/QCD measurements and Beyond Standard Model searches using tagged protons

