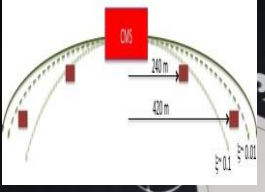


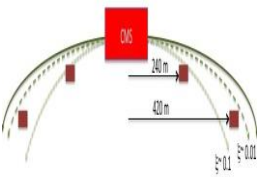
13 December 2013

Dear Colleagues,

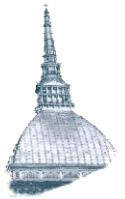
I am pleased to tell you that

The CMS and TOTEM collaboration boards approved today the CMS-TOTEM Memorandum of Understanding.

You are all invited to share with us great physics results starting in 2015



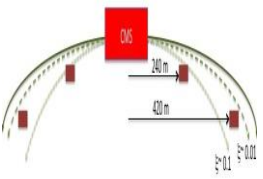
PPS-TOTEM Spectrometer



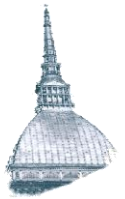
After less than 10 years, we have now reached a working agreement between CMS and TOTEM for a common data taking.

The agreement is to build a "high luminosity" spectrometer:

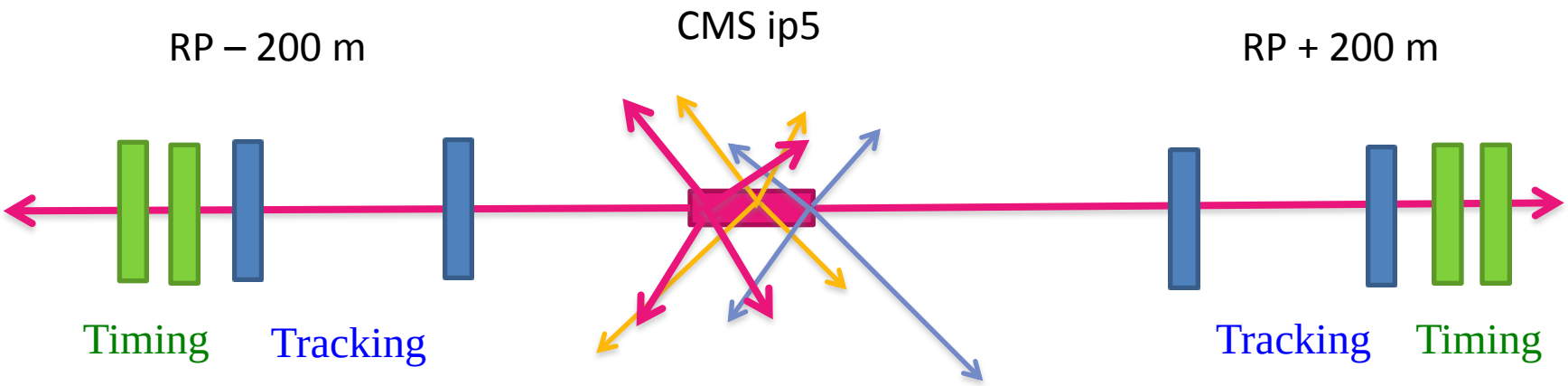
1)Replace the current TOTEM silicon strips with a radiation-hard silicon pixel tracker,
2)Use timing detectors to be able to work in high pile-up conditions



PPS by CMS & TOTEM= CT-PPS



Leveraging on the TOTEM experience, the PPS-TOTEM project can be considered an "upgrade", where the previous experience of the past 10 years is used to produce the next version of a detector.



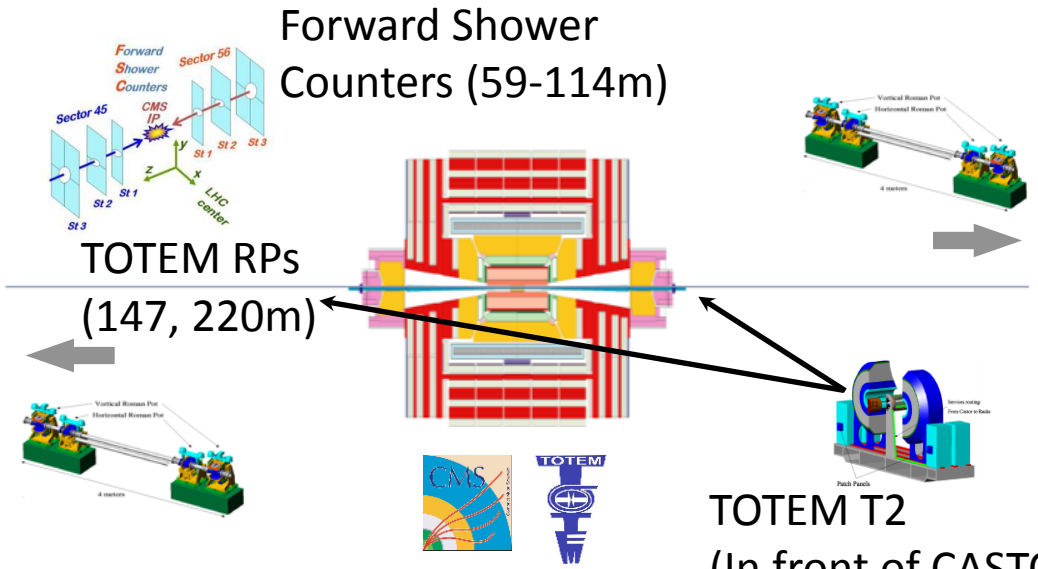
The past: 2012 CMS-TOTEM common data taking

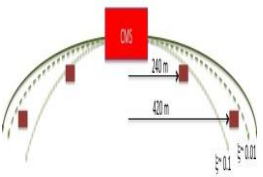
TOTEM Roman Pots (RPs): detect protons scattered from diffractive and photon induced processes

TOTEM T1/T2 tracking stations at very forward angles

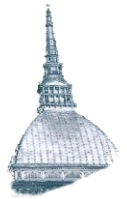
CMS Forward Shower Counters (FSC) covering $|\eta|$ ~ 6-8

CMS full event information $|\eta| < 5$





CT-PPS Basic Design: Tracking



A tracking detector (silicon based) to measure position

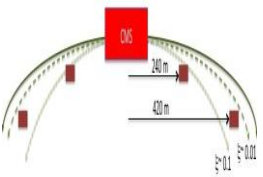
Position and angle, combined with the beam magnets, allow to determine the momentum of the scattered proton and in turn the missing mass

For optimum results: two pockets ~ 10 meters apart:

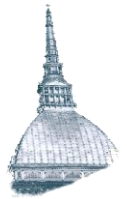
Momentum reconstruction: $Dp/p \sim 2\ 10^{-4}$

➔ Position precision of 10 micron

➔ Angular resolution of 1-2 mrad



CT-PPS Basic Design: Timing

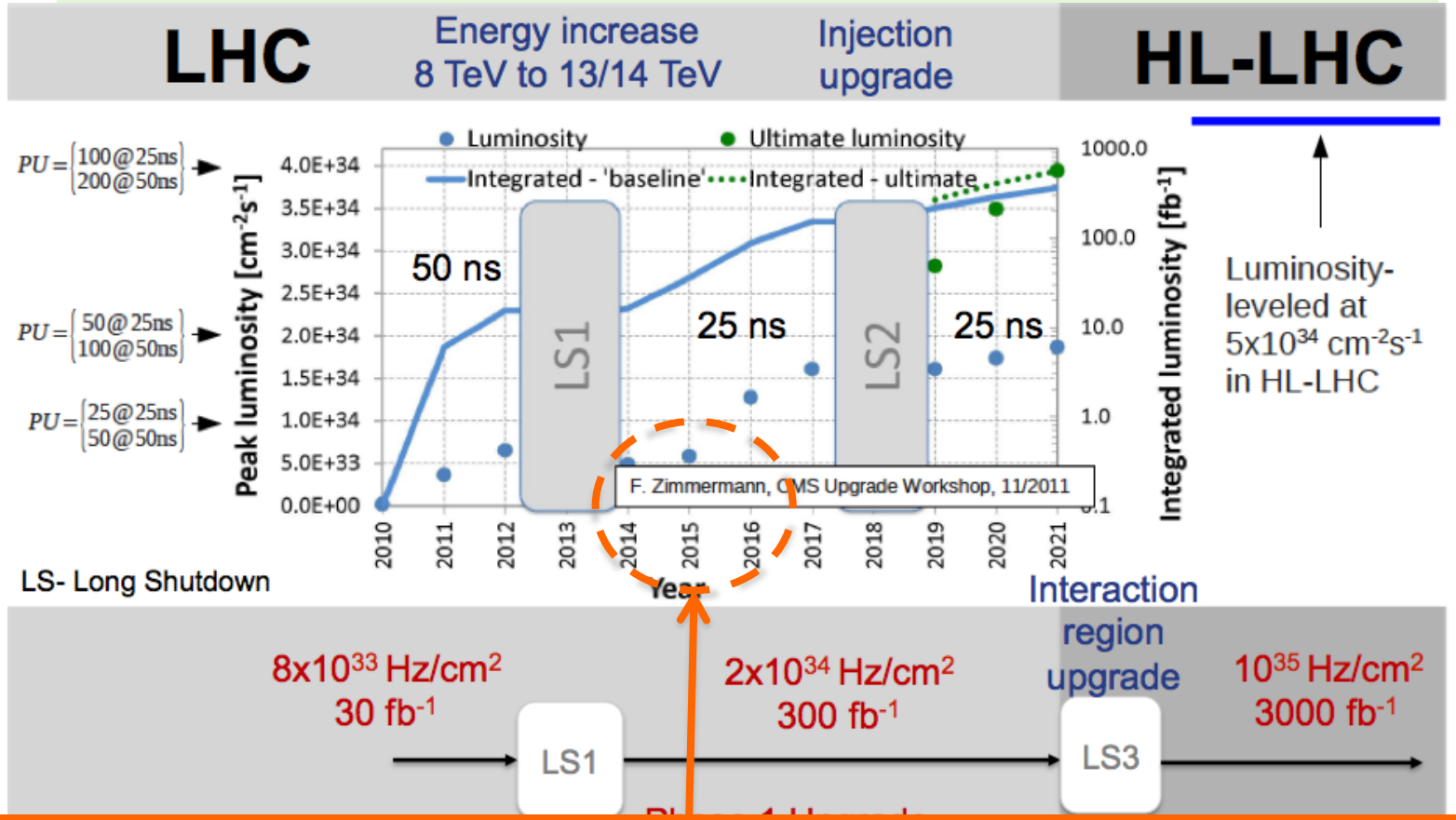


Timing measurement from both sides of CMS allows to determine the vertex of the protons and reject pile-up (proton from different pile-up collisions)

Vertex z-by-timing: ~ 2 mm:

Time resolution ~10 ps
Segmentation for > 1 proton/bunch
Edgeless, active to ~ 200 micron from pipe
Radiation hard
Lifetime > ~ 1 year at LHC at 10^{34}
Rate: 25 ns sensitivity

CT-PPS Schedule



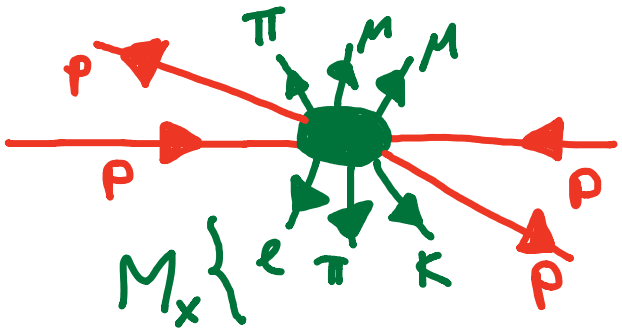
This is our best period: as LHC increases the luminosity, data taking becomes more difficult for near-the-beam detectors.

This fact has been demonstrated by TOTEM (more on this later)

Physics aide-memoires

CENTRAL EXCLUSIVE PRODUCTION

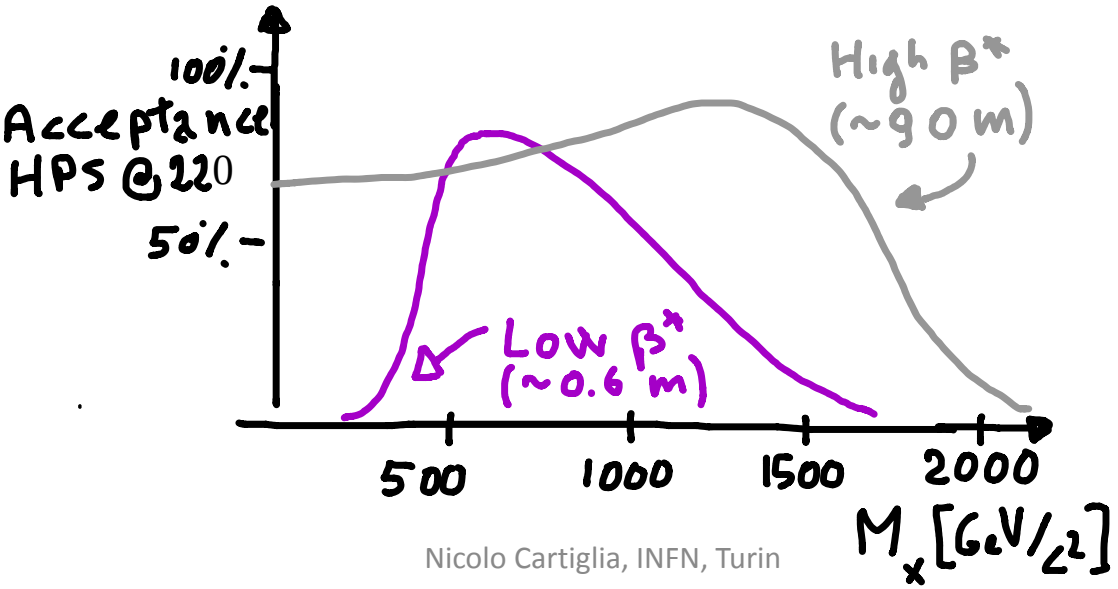
$pp \rightarrow ppX$

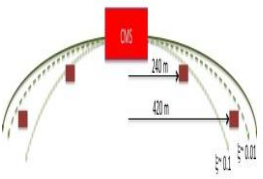


$\xi_1 = p_1$ momentum lost

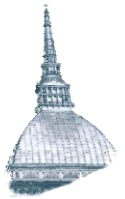
$t_1 = -p_\perp$ of p_1

$M_X = \sqrt{\xi_1 \xi_2 s}$





The two phases of the project



Phase I (LS1 + 1 day): good physics and exploration phase

TOTEM's RP and silicon detector && CMS central detector

High beta* runs

- Study of large cross section CEP processes
- Explore beam condition
- Full mass range (M_x < 2000 GeV),
- High cross section processes (1-3 day of dedicated luminosity optics)

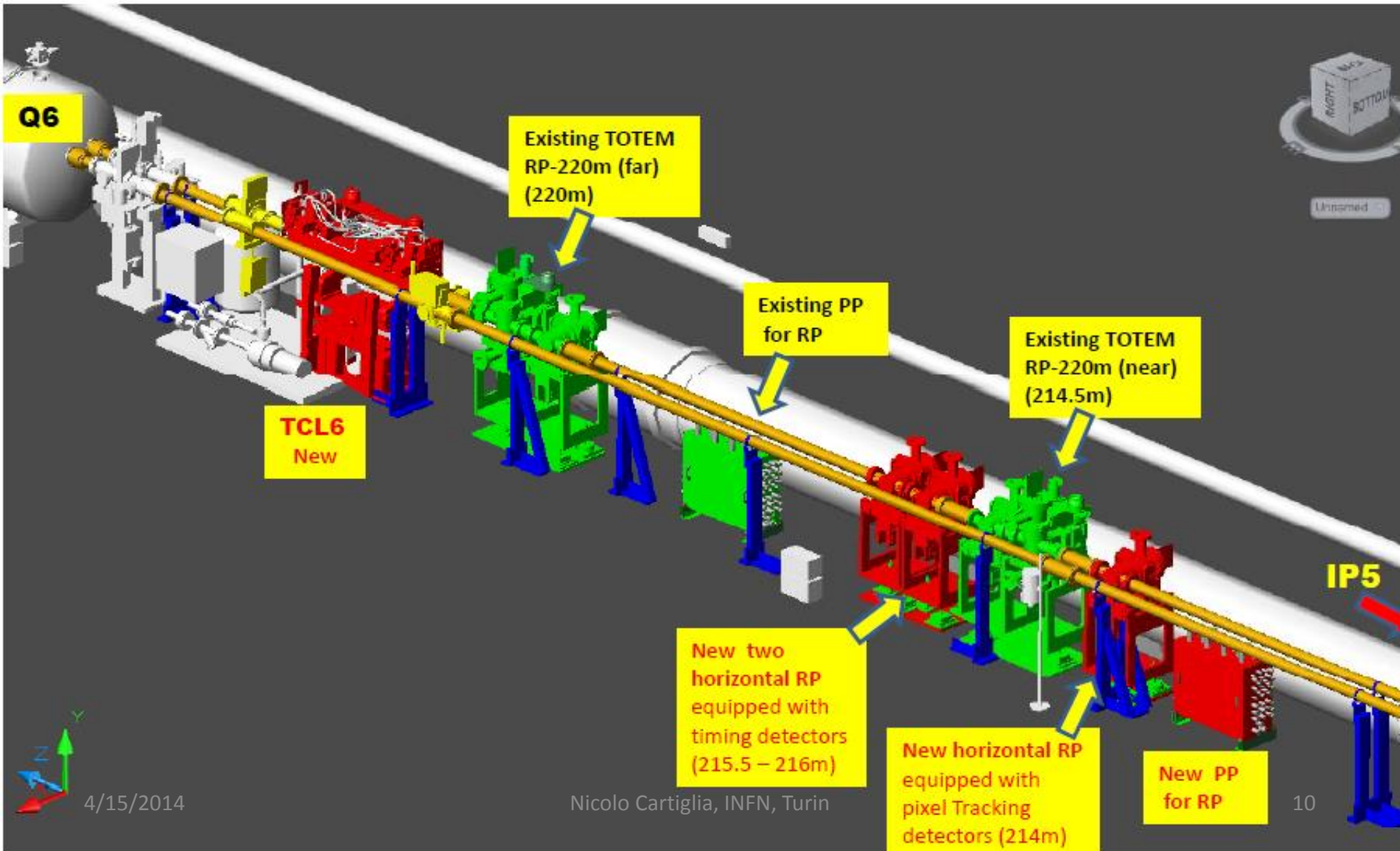
Phase II (LS1+1 year): great physics,high luminosity data taking

TOTEM's RP&& Quartic && New 3D Pixel && CMS central detector

Low beta* runs

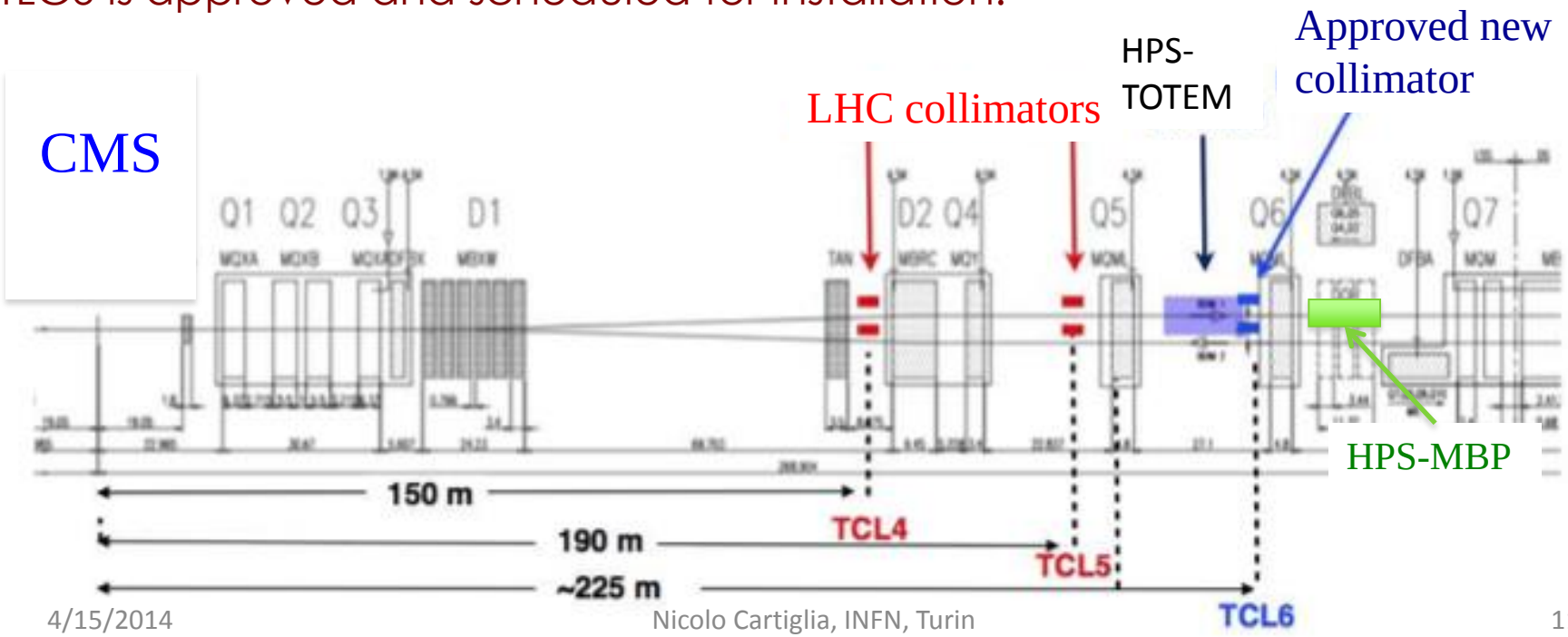
- Study of small cross section CEP processes
- High mass states (M_x > 300 GeV),
- High & small cross section processes (standard luminosity optics)

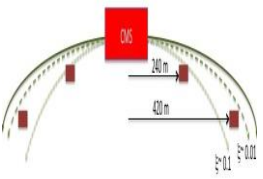
Roman Pots for CT-PPS



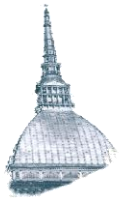
Protection against quenches

TCL4 has been designed to protect the separation dipole D2 and also the first matching section quadrupole Q4 from physics debris.
TCL5 has been designed to protect Q5 and possibly other superconductive elements down to the dispersion suppressor (DS) at about 400 m.
➔ If closed, TLC-5 will prevent to perform physics measurements downstream.
TLC6 protects Q6 from the debris from PPS-TOTEM
TLC6 is approved and scheduled for installation.





Tracking and timing detectors



There are three main aspects to PPS-TOTEM phase II detectors:

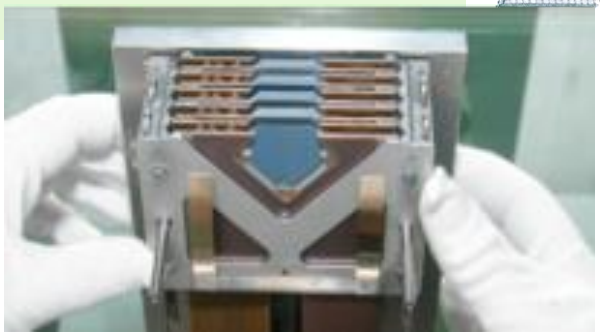
1)Silicon Sensors and DAQ chain: this is mostly a CMS effort, leveraging on the forward pixel development.

2)Timing detectors are proposed by CMS-FERMILAB, while TOTEM is developing a "diamond" alternative

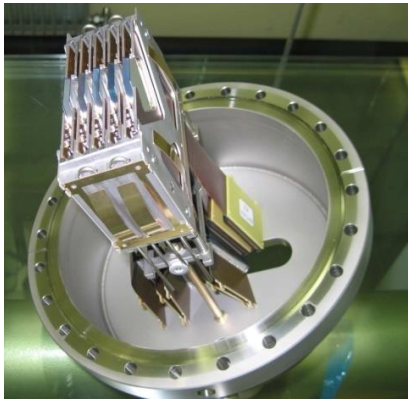
3)Infrastructure and installation, reference timing system will leverage on the past experience of TOTEM.

Tracking Detector

The tracking part fits well into Roman Pots, so no real need to change them.

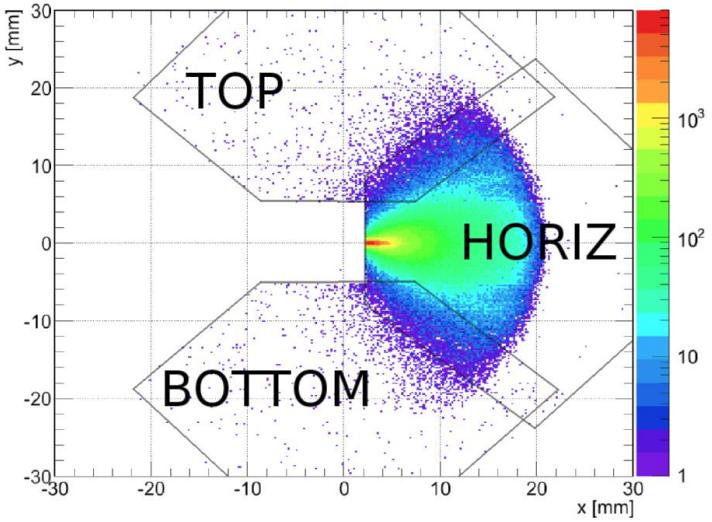


The TOTEM group has installed and operated successfully silicon detectors in the beam-line, TOTEM personnel willing to help.



For this part, the project can be considered an upgrade more than a new detectors

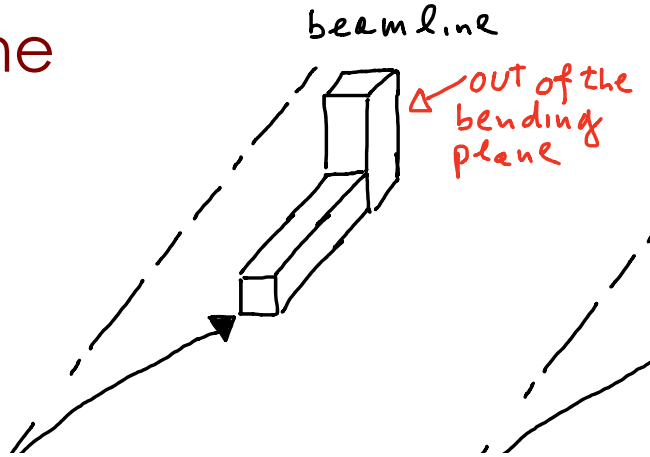
Low β^*: 0.5 – 2 m, ξ>2%



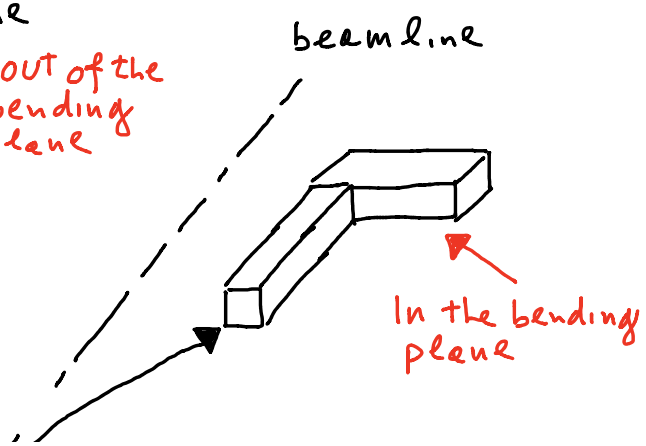
Timing Detectors

FERMILAB is leading the effort, Quartic is the baseline timing detector.

movable beam-pipe



Roman Pots



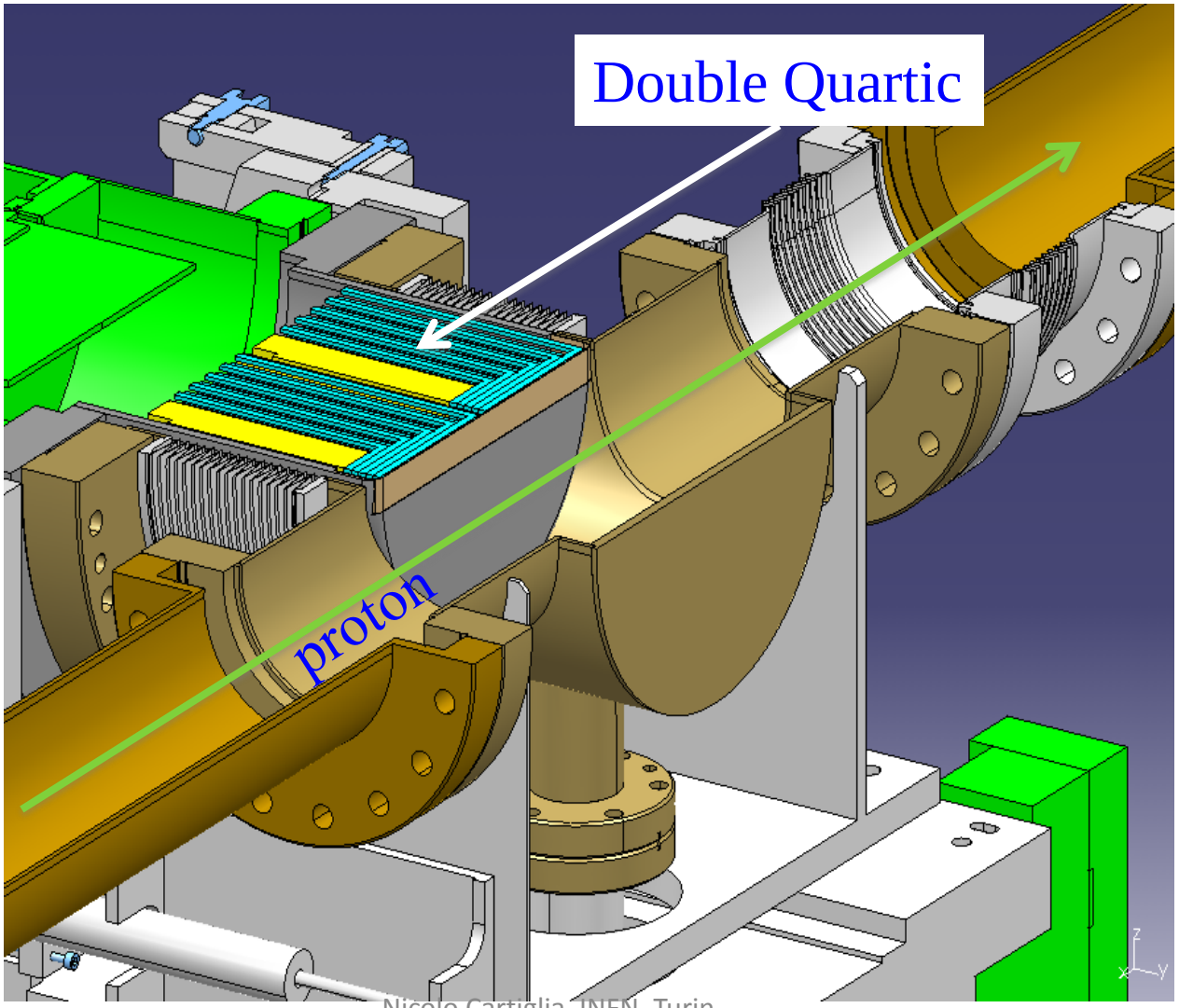
➔ Roman pots is the baseline installation, as they exists and they are a proven technology.

➔ The Movable Beam Pipe has the advantage that the quartz light guides are not in the particles bending plane, so there is less background.

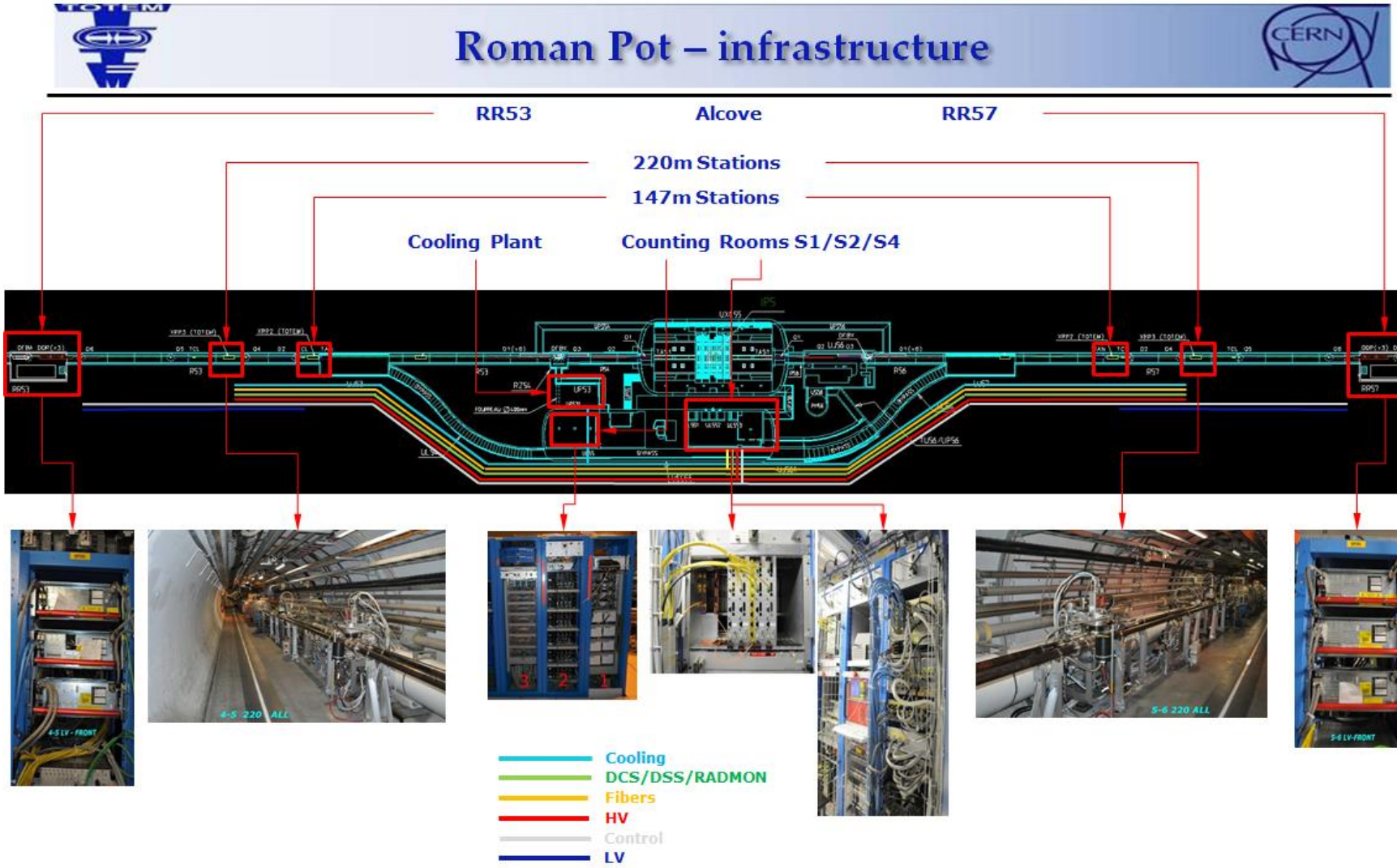
Alternatives to Quartic timing detectors are being explores, but they are in a development stage.

Roman Pot -> Integration study

- cylindrical RP in horizontal station

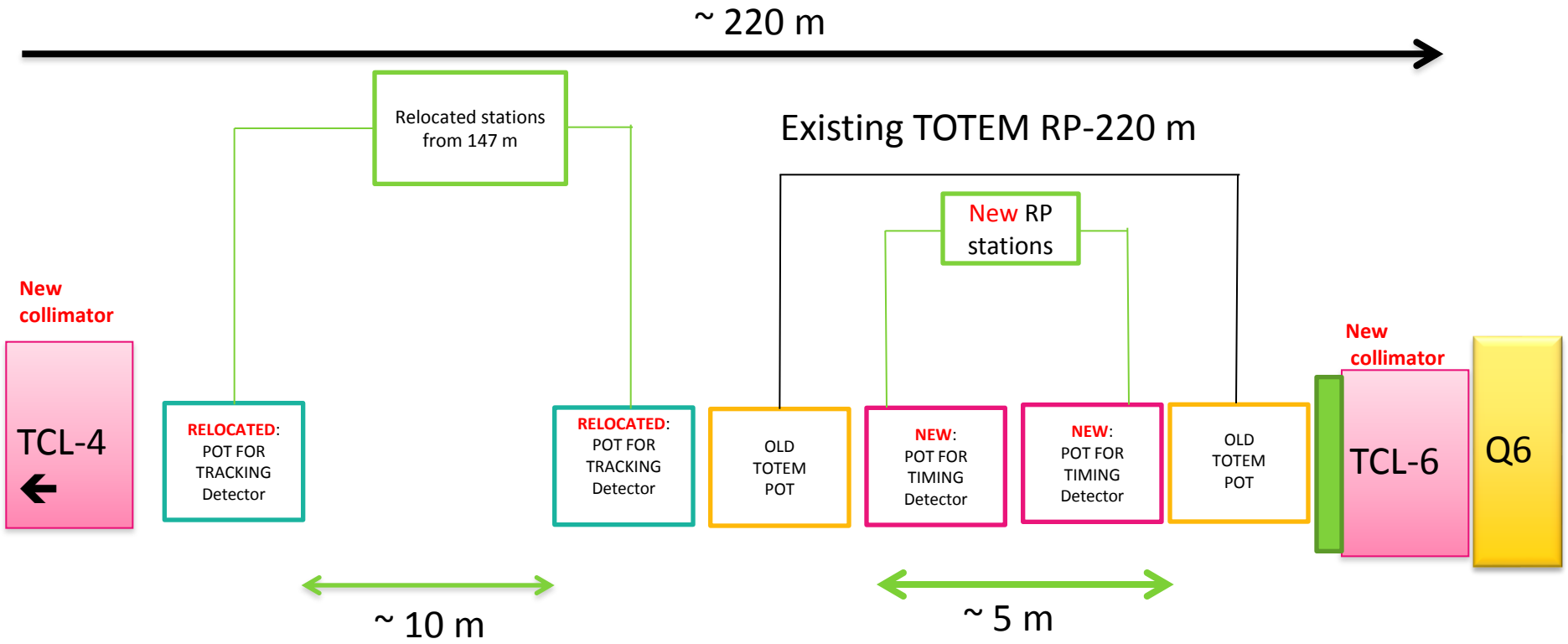


Roman Pots infrastructure



Roman Pots CT-PPS

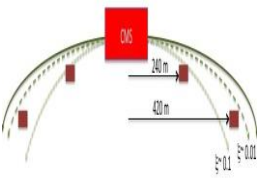
A simplified version of the PPS-TOTEM project in 3 steps…



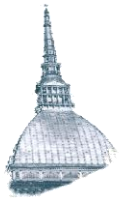
STEP 1: The pots from 147 m are relocated at ~ 204 and 214 meter to house tracking detectors

STEP 2: The new collimators are installed

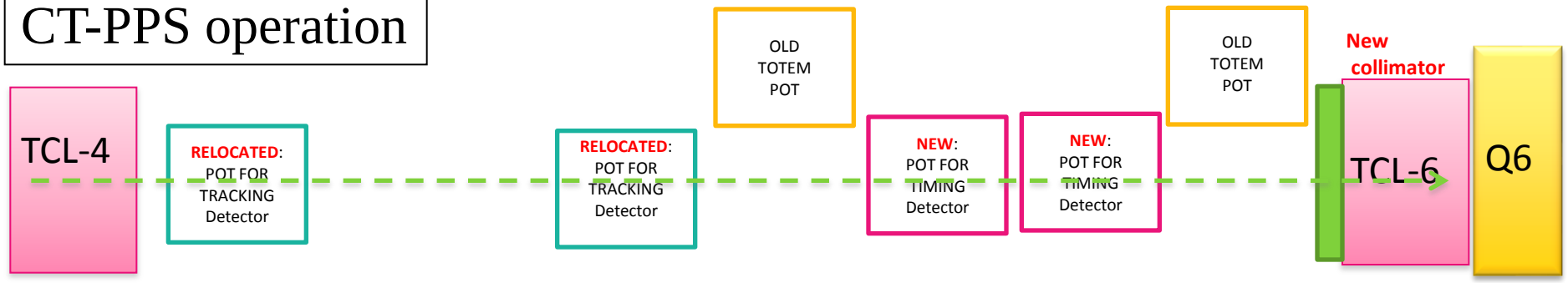
STEP 3: Two new pots are installed at ~ 220 meter to house the timing detectors



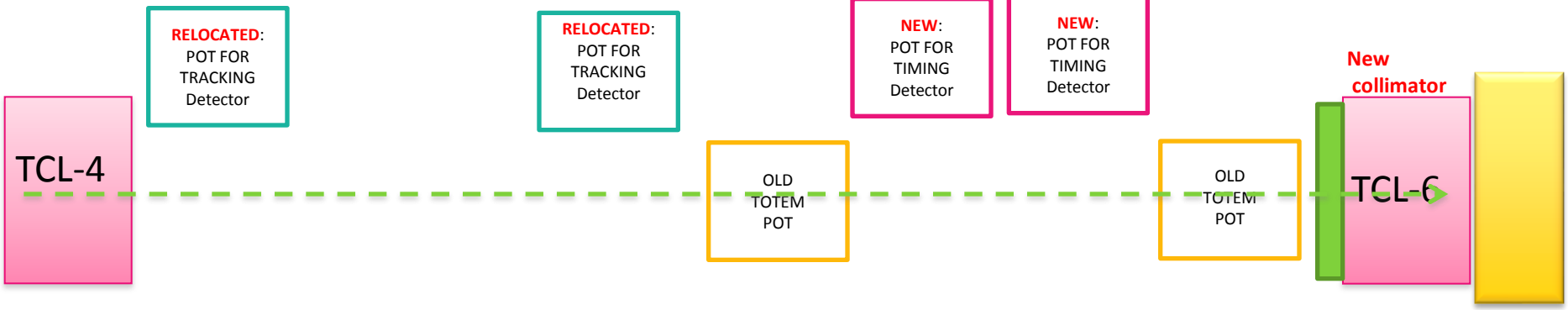
RP positions



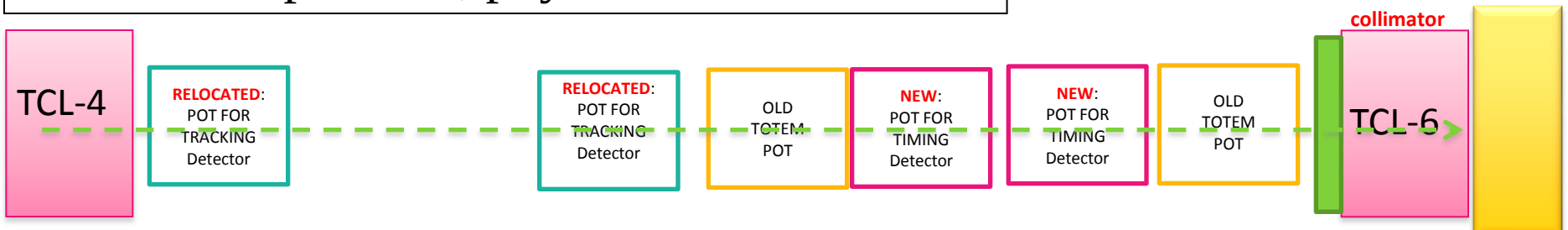
CT-PPS operation

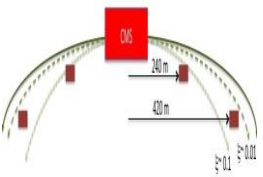


TOTEM operation

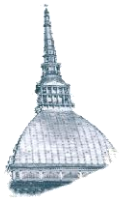


Combined operation, physics and calibration





Summary



The PPS-TOTEM collaboration has been formed:

1. The detector R&D will define the configuration for High-luminosity running. The TDR is now being written.
2. Need to start planning for 2015 data taking at low luminosity

CT-PPS data taking phases:

1. There will be a first data taking period, 2015-2016, where we expect to collect a few days of low luminosity running (1-10 pb^{-1} ??)
2. CT-PPS High luminosity data taking: > 2016++, hopefully 1-n fb^{-1}