



# PERFORMANCE OF THE DIAMOND DETECTORS FOR THE TOTEM UPGRADE

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## INTRODUCTION

The TOTEM experiments [1] timing upgrade [2] for the vertical Roman Pots (RP) adds the capability to measure the Time-Of-Flight (TOF) of protons in the very forward region. The timing detector [3] consists of four layers of single crystal Chemical Vapor Deposition (scCVD) diamonds, which is an ideal option for the detector material for its fast and efficient charge collection properties and radiation hardness.

## MATERIALS AND METHODS



The detector grade scCVD sensors are metallized with TiW. The quality of all diamond sensors was tested using **visual inspection** with microscope, **Current-voltage** measurement systems in Helsinki and CERN, and long term **stability** of the signal from a Sr-90  $\beta$ -source.

The **efficiency** and **time resolution** of the sensors with dedicated electronics was determined with **beam tests** at DESY and CERN SPS.

**Roman Pot integration** was tested in vacuum tests and beam tests with a Roman Pot.

## CONCLUSION

The quality of the installed sensors was verified using current-voltage measurement and stability of radiation induced current. The time resolution measured in beam tests and confirmed from data taken after installation to the LHC meets the project specifications. Research on improving the time resolution is ongoing.

## REFERENCES

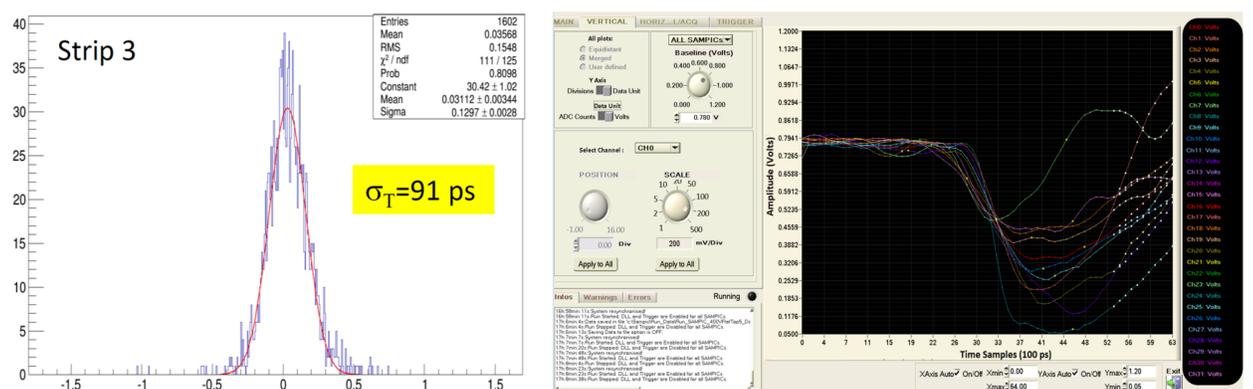
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## ACKNOWLEDGEMENTS

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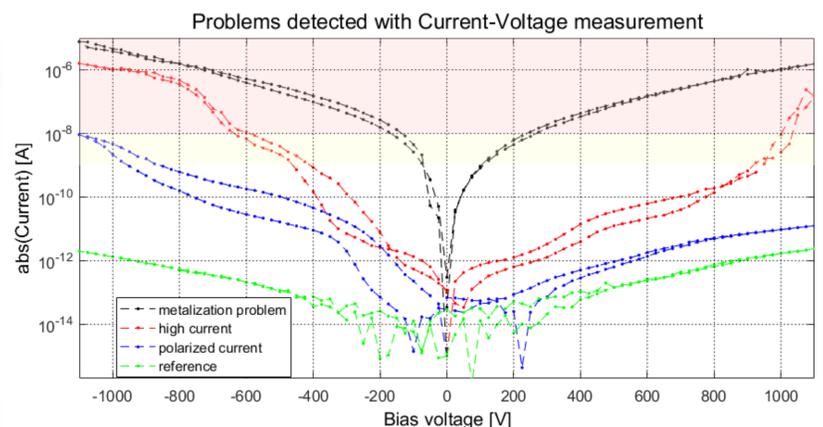
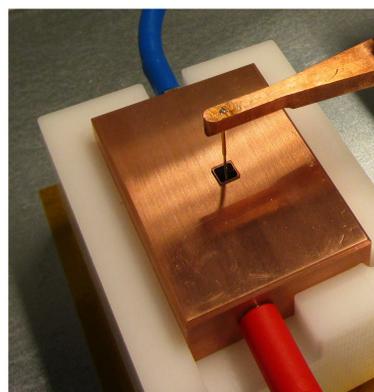
## PERFORMANCE IN THE LHC

The first package of diamonds was **installed into a Roman Pot in the LHC tunnel in November 2015**. Further two packages were installed in **June 2016** and are operated as a part of the CT-PPS project [4]. The detectors have taken **2 fb<sup>-1</sup>** of data as a tracking device in 2016.



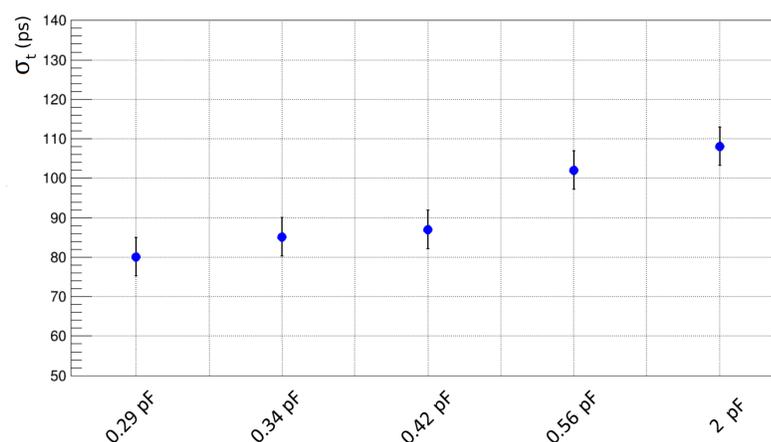
**Figure 1:** Detector performance in the LHC: time resolution measurement (left); Event display showing shower of particles hitting the diamond detector (right)

## QUALITY CONTROL AND BEAM TESTS



**Figure 2:** Diamond in current-voltage measurement in Helsinki (left); Examples of measured leakage currents (right)

In the current-voltage measurement 80% of sensors had **leakage current below 1nA** at 1kV. The **time resolution** measured at beam tests varied from 80 to 108 ps per sensor, depending on the pixel size. This gives the full detector with four sensor layers a total time precision in the order of 50 ps. Operating **HV in vacuum** environment requires special board design, additional EMI suppressor shielding from KEMET and protective insulating coating compound (Dow Corning SE918L) around the sensors. For more details see ref. [3].



**Figure 3:** Time resolution in beam tests [3] (left); diamond module ready for beam test and installation(right)



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