INtelligent, Fast, Interconnected and Efficient devices, for frontier exploitation in Research and Industry

Funding Scheme: FP7-PEOPLE-2012-ITN

Grant Agreement number: 317446

Project acronym: INFIERI

DELIVERABLE NAME: *Feasibility Studies for a Level 1 trigger (real time selection) based on the signal information provided by the Silicon Pixel Vertex detector for High Energy Physics experiments at LHC (CERN).*

DELIVERABLE REF. N°: 1.1

WORK PACKAGE: WP1

NATURE OF THE DELIVERABLE: ☐**R**= Report

BENEFICIARY(IES) CONTRIBUTOR(S): CNRS, LIP, FNAL, SNU

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DELIVERY DATE FROM ANNEX 1: M12

DISSEMINATION LEVEL: ☐**RE,** ☐ **CO**

PU = Public N/A IN THE INFIERI CONTEXT

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Abstract:

Based on the full simulation framework of the CMS experiment at the LHC at CERN, feasibilities studies are done to show the interest of reconstructing the path of charged particles within the detector closest to the beam pipe. The aim is to send this fast-reconstructed track information to the overall Level 1 trigger system for further refining the real time selection of events expected from the new physics to be explored at the high luminosity LHC, in a very harsh environment.

Work description

The vertex detector closest to the beam pipe is a technologically very challenging device based on very small pixels The use of this detector information includes 1) identifying and reconstructing the electrons (Level-1 electron trigger) (Fig 1) and 2) reconstructing with high precision the interaction point where the event has originated (Fig 2) and 3) identifying (tagging efficiency) the b-quarks by the

secondary vertex at which they decay and thus can be "visualized" in the detector (Fig 2). The feasibility studies are instrumental for showing the crucial potential of such a real time selection and as basis for developing the related real time algorithms (see next deliverables related to this WP1)
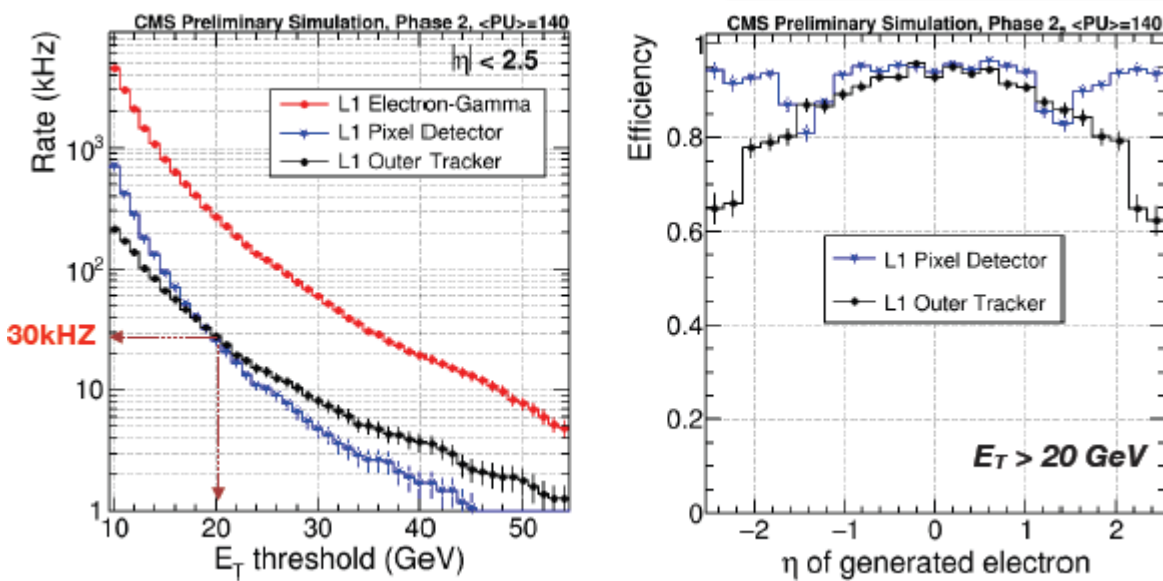

Figure 1. *Left:* **Pixel Electron trigger (blue) rates compared to the one using only calorimetry (red) or the calorimetry combined with the outer tracker (black) and with stronger constraints (electron track isolation).** *Right*: **Pixel electron trigger efficiency (blue) compared to outer tracker efficiency (black) at all angles (η).**
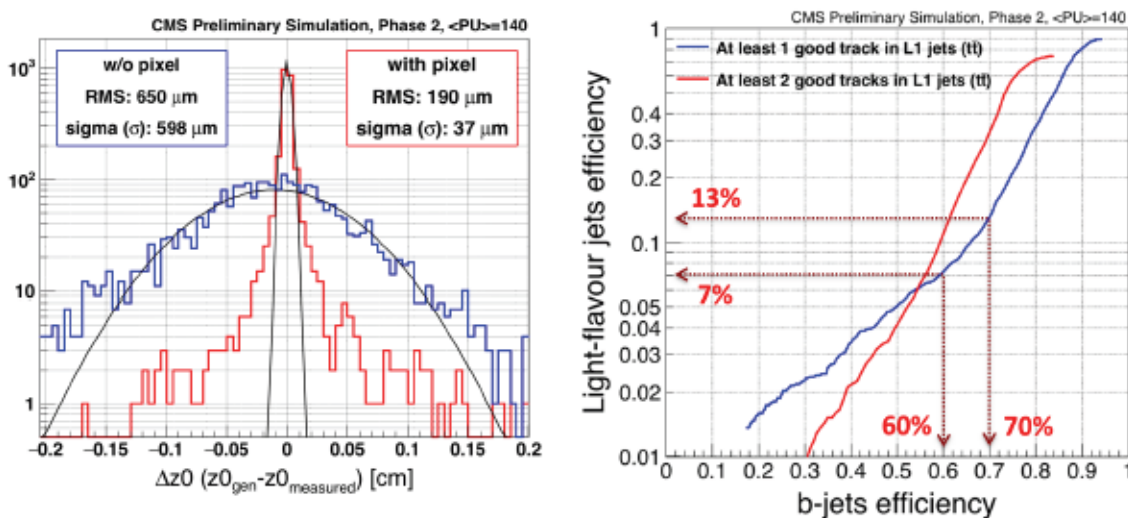

Figure 2. Left: resolution on the z-component along beam axis of the vertex of the event, given by the pixels (37μm) vs given by the outer tracker (598 μm); right: Pixel tagging efficiency of b-jets versus light quark jets: 65% at 20 GeV jets.

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Dissemination: the feasibility studies and presentations have been carried on over the whole duration of the INFIERI program.

Talks

- Large series of internal CMS talks during weekly working group meetings, CMS collaboration and CMS upgrades general and annual meetings (restricted access to CMS collaboration)

- Presentations at the Annual Korean Physics Society Workshops by SNU collaborators (2013, 2014, 2015 and 2016).

- Presentations at the INFIERI workshops (Paris, Oxford, Madrid, NIKHEF, CERN, Pisa, Lisbon) see INFIERI website.

- C.S. Moon, *A level-1 pixel based track trigger for the CMS upgrade, Chicago (USA),* talk at the ICHEP 2016 Conference, Chicago Aug 4, 2016, https://indico.cern.ch/event/432527/contributions/1071437/

Poster Presentations

D. Vadruccio (LIP) Development of a Pixel Tracking Trigger in the CMS experiment at LHC, 4th INFIERI Workshop & Mid-Term Review, 10-12 December 2014, Amsterdam, The Netherlands.

J. Kim (SNU), *CMS Level-1 pixel track trigger for HL-LHC*, 129th LHC Committee Session at CERN, Feb 20-22, 2017: see poster session in: https://indico.cern.ch/event/609156/other-view?view=standard.

Publications:

C. S. Moon, A. Savoy-Navarro, Level-1 pixel based tracking trigger algorithm for LHC upgrade, Proceedings of 2nd International School on Intelligent Signal Processing for Frontier Research and Industry, Journal of Instrumentation, Volume 10, October 2015, http://dx.doi.org/10.1088/1748-0221/10/10/C10001
C. David et al., "*CMS Level-1 pixel track trigger for High Luminosity LHC*", Internal CMS Note: DN-15-008.