

# 3D-FLOW OPRA for Level-1 Trigger: A Breakthrough Invention Capable of Extracting ALL Valuable Information from Radiation Providing a Very Powerful Tool to Discover New Particles, Reduce HEP Costs, Advance Science and Benefit Humanity

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## Abstract

The 3D-Flow OPRA Level-1 Trigger system is capable of extracting ALL valuable information from radiation, which can save taxpayers millions of dollars in HEP experiments. Unlike the traditional Level-1 Trigger algorithm implementation in “cabled-logic”, or the CERN-CMS approach of executing 128 algorithms, or the costly lower performant FPGA approach, the 3D-Flow architecture allows the execution of billions of different algorithms like a generic processor but has the advantage over any Pentium, Hypercube, or other processor/architecture in that it can execute specialized instructions (or “OPRA steps” for an optimized Object Pattern Real-Time Recognition Algorithm) to identify particles with the capability to execute at each “step” up to 26 operations in less than 3 ns. The 3D-Flow performance is further increased by its bypass switch and North East West South communication channels with neighbors. The 3D-Flow pyramid provides reduction from thousands of input channels to one or a few output channels. A 3D-Flow system with 10,485 Gbps input bandwidth, 8,192 electronic input channels, 43,000 × 3D-Flow processors and the capability to execute up to 40 “OPRA steps” on each processor is technology-independent, feasible in a 36 cm cube of electronics consuming less than 5 kW at a cost of less than \$10.70 per channel. The 3D-Flow conceptual design allows the input data rate and the complexity of the real-time algorithm to increase satisfying the most stringent requirements, and can be used for tracking applications. It was proven feasible and functional in hardware using two FPGA chips in 2001 and two modular electronic boards in 2003, suitable to build 3D-Flow systems for detectors of any size. The inventor has faced many adversities and suppressions that have delayed its implementation. This caused a monetary burden on taxpayers and curbed the advancement of science that calls for an investigation to fix science as stated in the October 2018 issue of Scientific

American.

## Introduction

The verifiable 3D-Flow OPRA Level-1 Trigger System [1], [2] capable of extracting ALL valuable information from radiation at the lowest cost per valid signal captured can replace many crates of electronics of the current experiments at CERN with a single crate, providing a much more powerful system and a staggering increase in performance at a much lower cost. The proposal also details the verifiable capabilities of not only checking the functionality and performance of the 3D-Flow system but also whether the electronics installed in the detector at CERN (or other site) are working properly by recording the trigger raw data at the LHC bunch-crossing rate and analyzing whether each of the 8,192 channels provide the expected value. This feature is also important for the calibration of all parts of the instruments (CMS, Atlas, etc.). This is essential to avoid discrepancies in data such as the Higgs boson-like particle whose energy was recorded as 125.3 GeV and 126.5 GeV in different experiments.

## Review process “Detection & Imaging Technology”

The 3D-Flow OPRA shows superiority in efficiency and cost-effectiveness to any other approach in High

Energy Physics applications [3], [4] and in Medical Imaging applications [5] and can prove it by comparing the 17 answers of the following questionnaire on *Detection and Imaging Technology* for the Detection of unknown particles in HEP. The 20 projects claiming highest performance and cost-effectiveness in this form should be called for a public debate to support their claims, including Q&A among themselves and the top-level expert reviewers:

1. Total # of physical channels: **8192**
2. System Input bandwidth (Gbps): **10485**
3. Are the # of output channels flexible? **YES**
4. Time to execute an algorithm step in nanoseconds: **2.5**
5. Can it execute CMS, ATLAS and PET algorithms to detect particles /photons? **YES**
6. How many steps (each step can execute up to 26 operations) are required to execute CMS, Atlas, L-1 Triggers (40MHz-16bit-IN), first part of the algorithm of pedestal subtraction, local maxima, total energy, centroid calculation (x,y coord)? **14**
7. Provide two examples of Algorithms: **page 114 and 116 of (goo.gl/ggGGwF)**
8. # of additional programmable steps available: **26**
9. Cost per physical channel in Euros: **10.7**
10. Cost of the system in Euros: **87500**
11. Power consumption in kW: **<5**
12. Dimensions of the electronics in cm: **36x36x36**
13. Can be used in HEP Tracking applications? **YES**
14. Does the conceptual design allow to increase the input data rate? **YES**
15. Does the conceptual design allow to increase the # of additional steps of the algorithm? **YES**
16. Is the system modular and scalable? **YES**
17. To prove reproducibility of results and performance, do you consider it fair to test the HEP system by receiving data in real time from a ER/DSU unit that were recorded from LHC? **YES**

## References

- [1]. Crosetto D. NIM-Sec. A, vol. 436, (1999) pp.341-385. [goo.gl/bqhD4R](http://goo.gl/bqhD4R)
- [2]. Crosetto D. Complete design & implementation ([goo.gl/w3XIZ1](http://goo.gl/w3XIZ1))
- [3] Crosetto D. Response to IEEE-NPSS Short URL [goo.gl/XPNHh7](http://goo.gl/XPNHh7)
- [4] Crosetto D. Response to CMS Spokesperson [goo.gl/EU9qGQ](http://goo.gl/EU9qGQ),
- [5]. Johnson J, Crosetto D. Focus Daily News, 10/22/2017. [goo.gl/EJD9yU](http://goo.gl/EJD9yU)

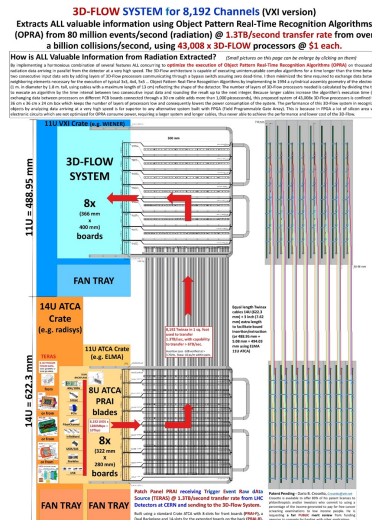


Figure 1: The inventor refuted with scientific evidence the rejection claims by the 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022 IEEE reviewers [3], [4], however, no scientific calculations, evidence, or proofs were provided by the reviewers to support their rejection claims.