

Bruno Mazoyer LAL Orsay 2019

Designing real-time data analysis for fundamental science and industry



1st Real Time Analysis Workshop

July 15-26, 2019

Institut Pascal, Université Paris-Saclay, Saint-Aubin



European Research Council
Established by the European Commission



Organizing Committee 1st Real Time Analysis Workshop

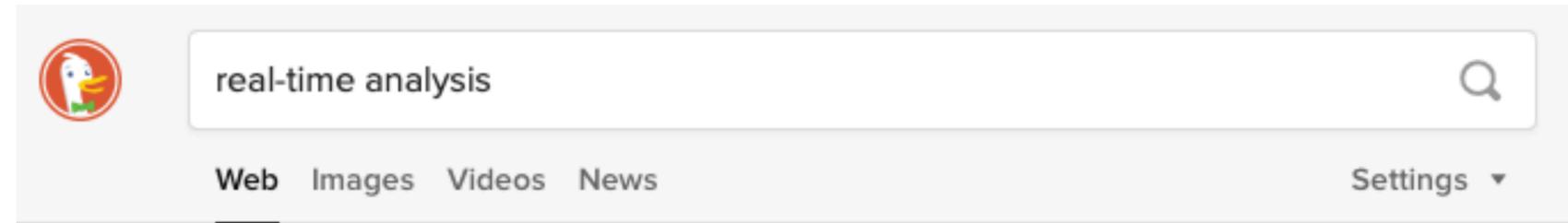
Johannes Albrecht (TU Dortmund)	Silvia Borghi (U. of Manchester)
Joao Coelho (LAL/CNRS)	Caterina Doglioni (Lund University)
Tom Gibbs (NVIDIA)	Vava Gligorov (LPNHE/CNRS)
Maurizio Pierini (CERN)	Sebastien Ponce (CERN)
David Rousseau (LAL/CNRS)	Alexandros Sopasakis (Ximantis)
Mike Williams (MIT)	

Advisory Committee 1st Real Time Analysis Workshop

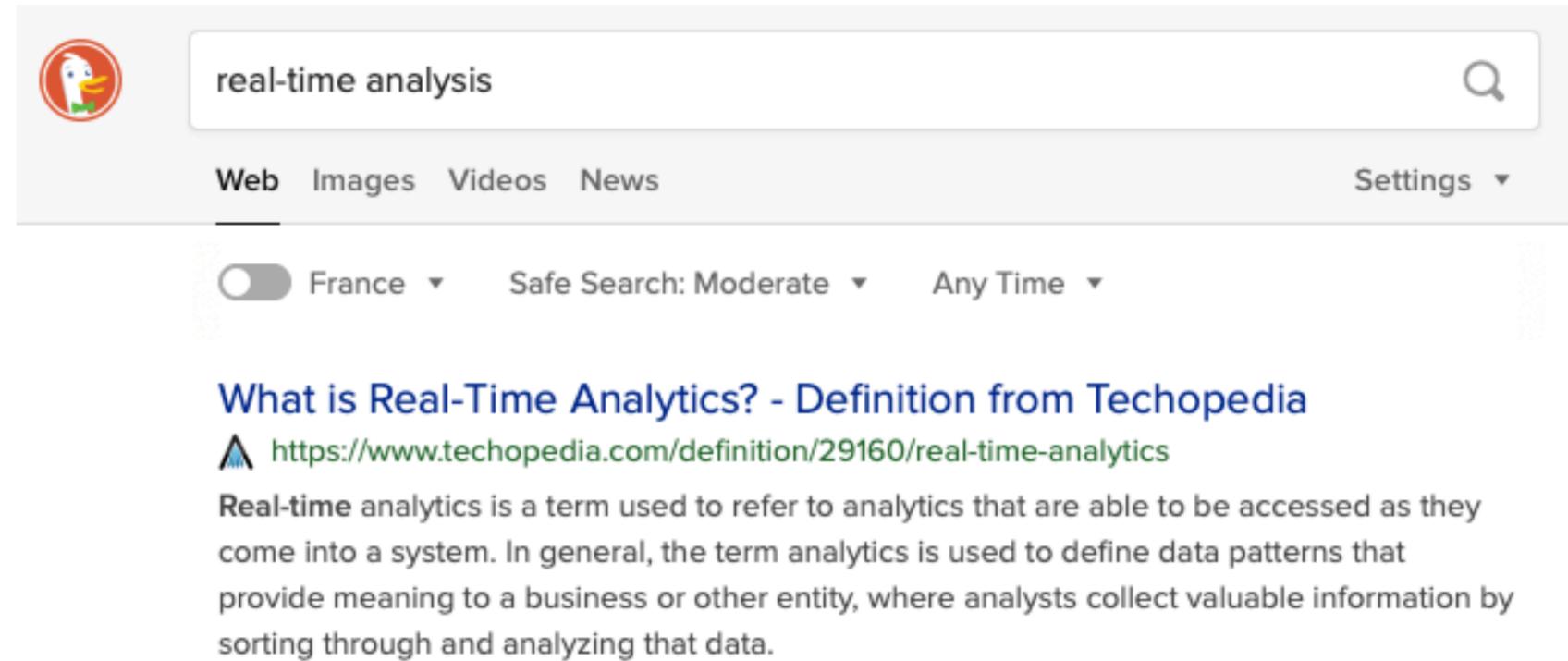
Cecile Germain (UPSud)
Isabelle Guyon (UPSud)
Balazs Kegl (LAL/CNRS)
Mike Sokoloff (U. of Cincinnati)

Introduction
V. V. Gligorov, CNRS/LPNHE

What is real-time analysis?

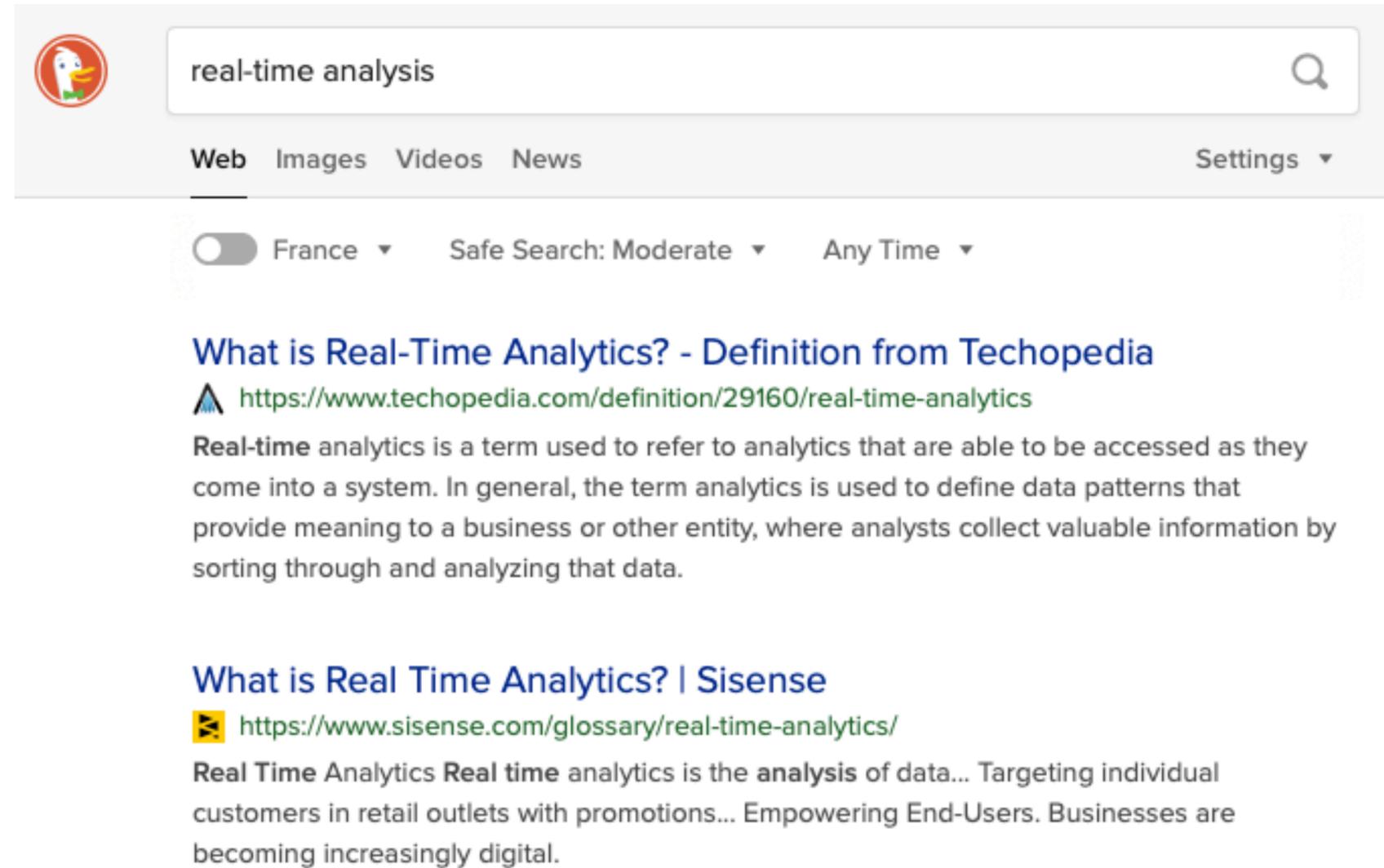


What is real-time analysis?



The screenshot shows a search engine interface with a search bar containing the text "real-time analysis". Below the search bar, there are navigation tabs for "Web", "Images", "Videos", and "News", with "Web" being the active tab. To the right of these tabs is a "Settings" dropdown menu. Below the navigation tabs, there are three settings: a toggle switch for "France" (which is turned on), "Safe Search: Moderate", and "Any Time". The search results section displays a single result with the title "What is Real-Time Analytics? - Definition from Techopedia" and a URL: <https://www.techopedia.com/definition/29160/real-time-analytics>. The description of the result states: "Real-time analytics is a term used to refer to analytics that are able to be accessed as they come into a system. In general, the term analytics is used to define data patterns that provide meaning to a business or other entity, where analysts collect valuable information by sorting through and analyzing that data."

What is real-time analysis?

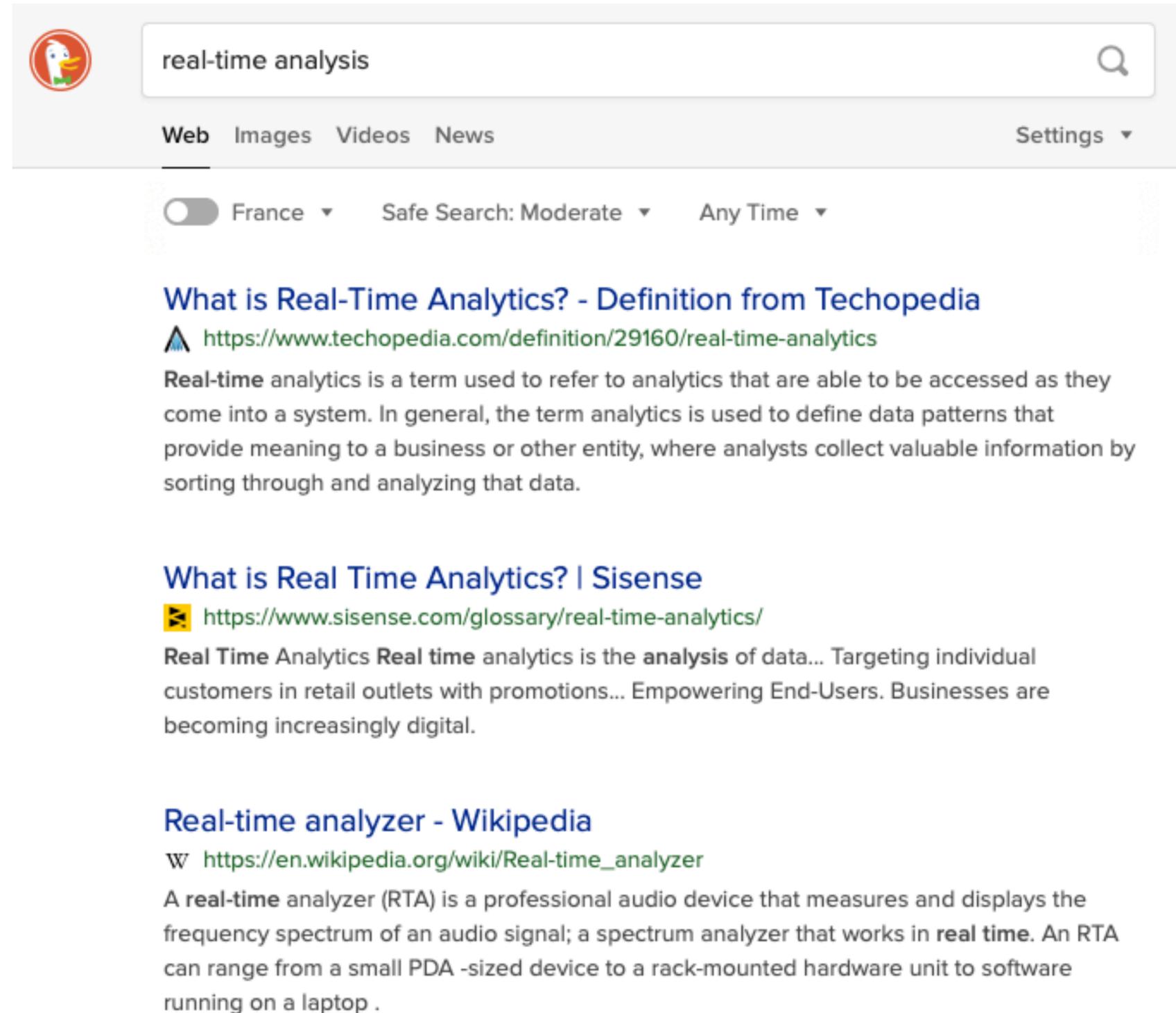


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What is Real-Time Analytics? - Definition from Techopedia
<https://www.techopedia.com/definition/29160/real-time-analytics>
Real-time analytics is a term used to refer to analytics that are able to be accessed as they come into a system. In general, the term analytics is used to define data patterns that provide meaning to a business or other entity, where analysts collect valuable information by sorting through and analyzing that data.

What is Real Time Analytics? | Sisense
<https://www.sisense.com/glossary/real-time-analytics/>
Real Time Analytics Real time analytics is the analysis of data... Targeting individual customers in retail outlets with promotions... Empowering End-Users. Businesses are becoming increasingly digital.

What is real-time analysis?



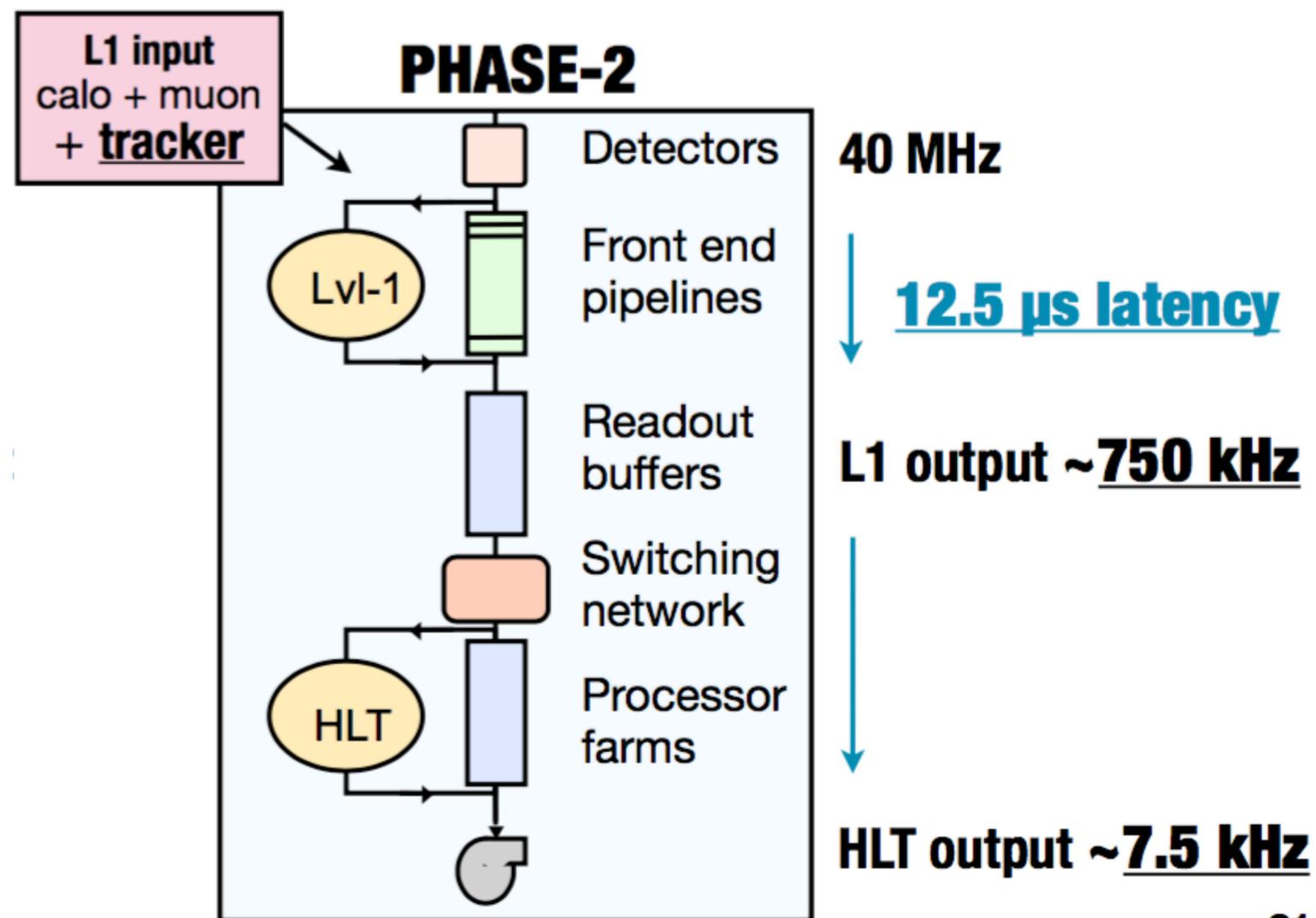
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Real-time analyzer - Wikipedia
https://en.wikipedia.org/wiki/Real-time_analyzer
A real-time analyzer (RTA) is a professional audio device that measures and displays the frequency spectrum of an audio signal; a spectrum analyzer that works in real time. An RTA can range from a small PDA -sized device to a rack-mounted hardware unit to software running on a laptop .

OK that wasn't very helpful — what do we mean by it?



21

But also...



Engineering Applications of Artificial Intelligence

Volume 74, September 2018, Pages 166-185



The model of an anomaly detector for HiLumi LHC magnets based on Recurrent Neural Networks and adaptive quantization

Maciej Wielgosz^a, Matej Mertik^b, Andrzej Skoczeń^c, Ernesto De Matteis^d

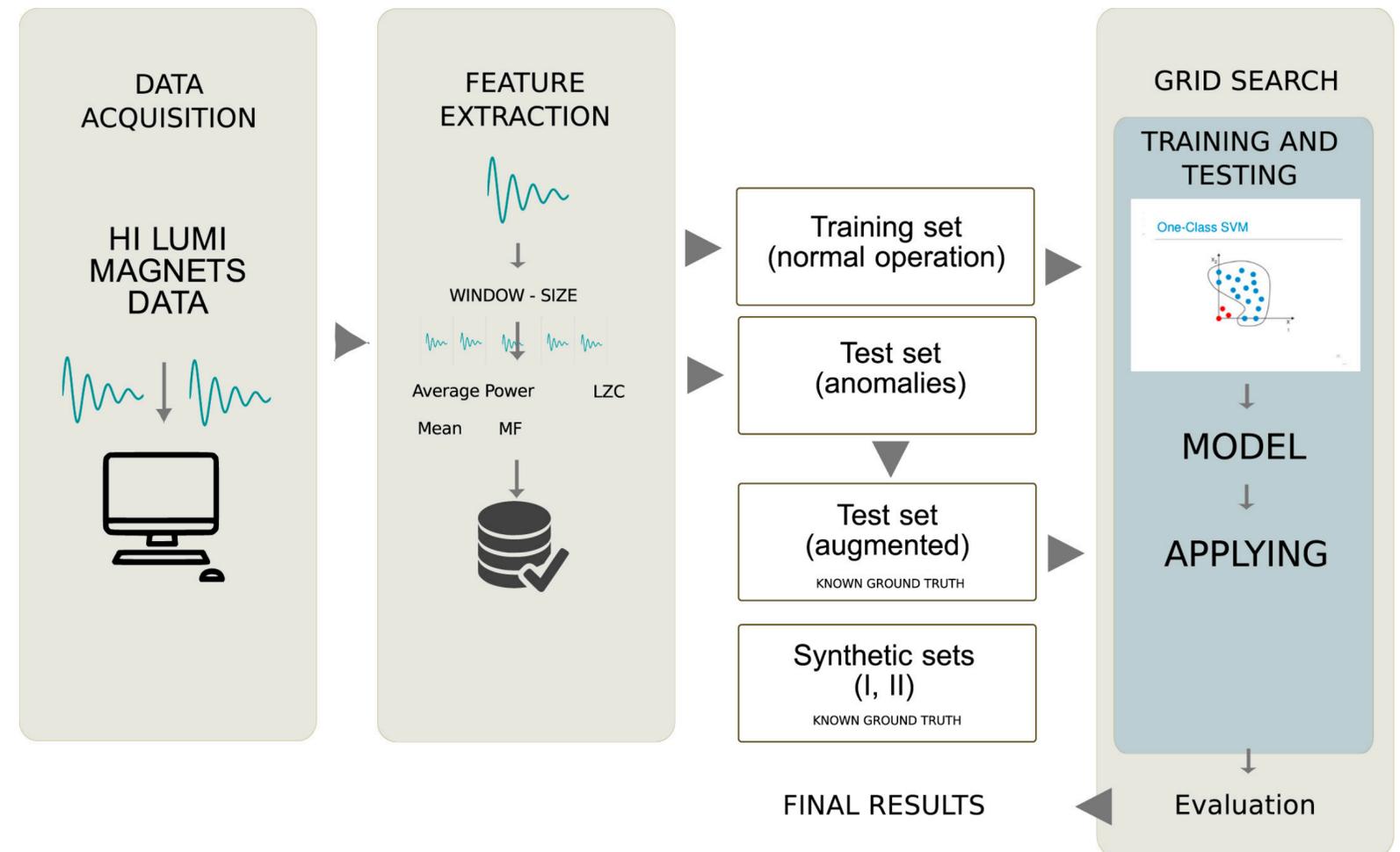
Show more

<https://doi.org/10.1016/j.engappai.2018.06.012>

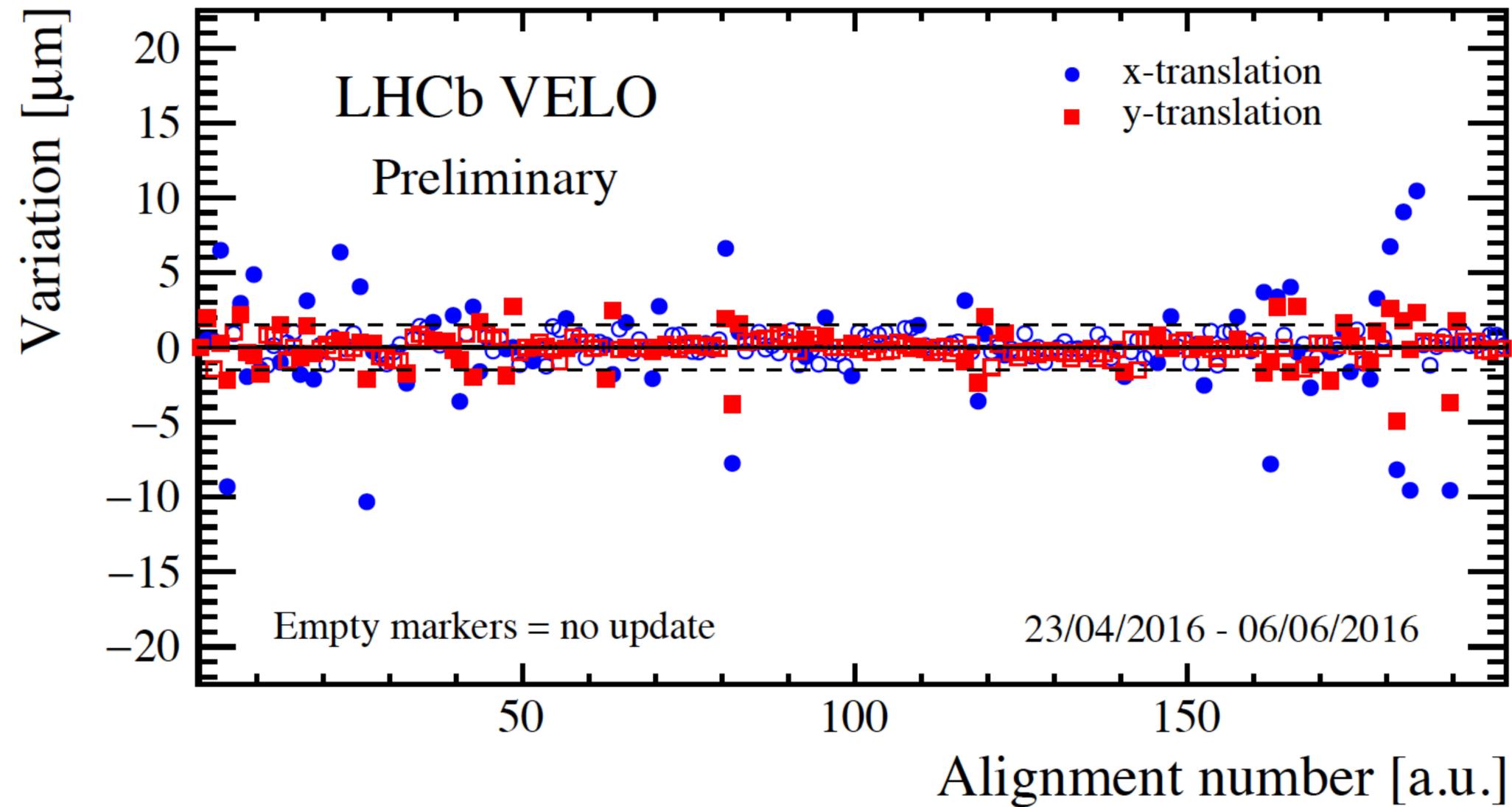
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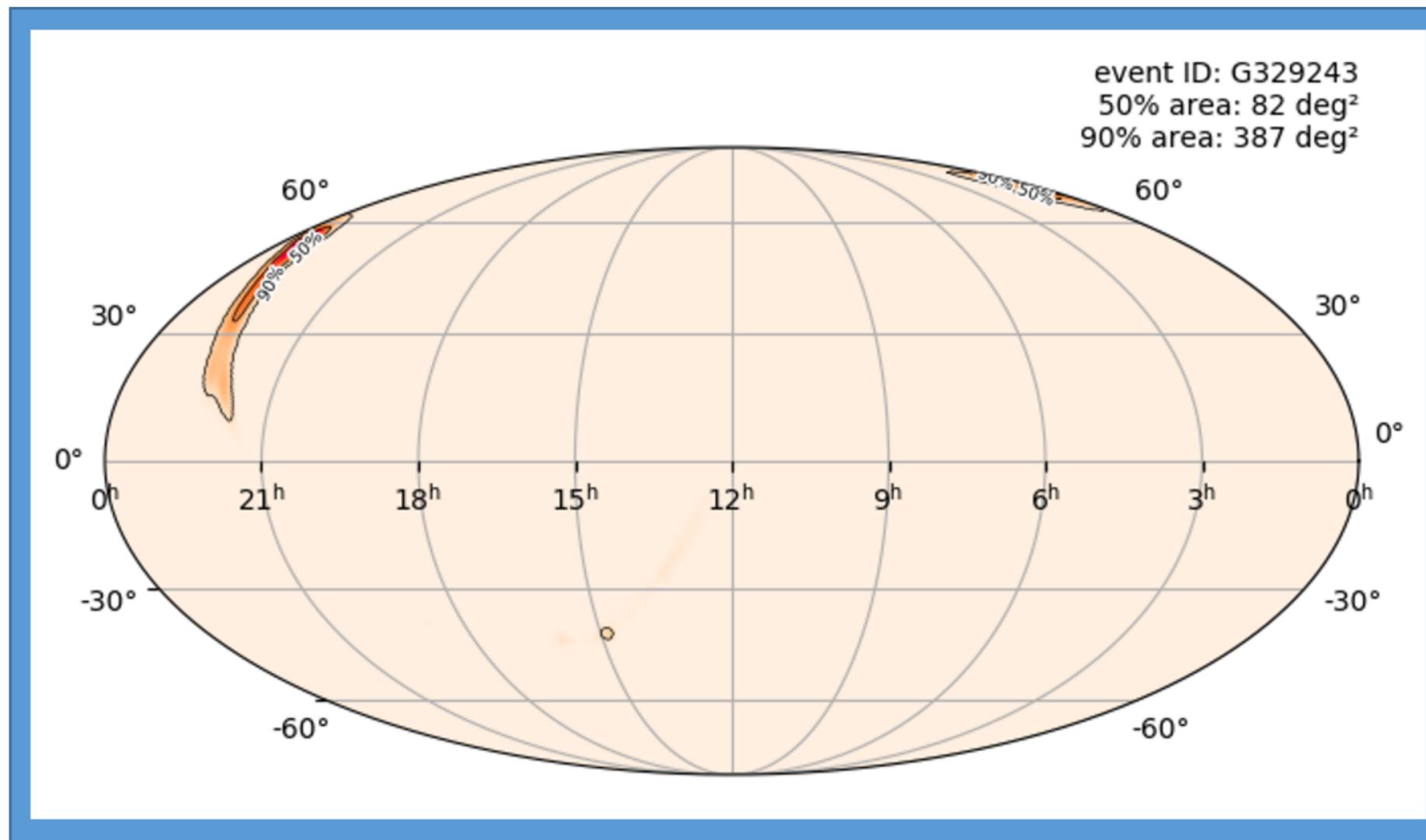
open access



As well as...



And let's not forget...



"In O3 we transitioned to a system whereby LIGO and Virgo alert the electromagnetic (EM) astronomy community almost immediately that we have a statistically significant trigger; that is, a potential gravitational wave (GW) detection. The rationale for this is simple: The sooner we reveal a GW source, the sooner EM telescopes (X-ray, UV, optical, radio) can search for and hopefully find an electromagnetic signal from the same source. Capturing the EM signal as soon as possible is, in many cases, the key to understanding the dynamics of the event, revealing its true nature."

Or indeed...



Google Search

I'm Feeling Lucky

Google offered in: [Français](#)

What is the common theme in all this?

In the most general sense, real-time analysis refers to the processing of data before this data can be recorded to permanent storage.

The reasons *why* any given analysis happens in real-time are diverse: a lack of resources to store all the data, a need to signal anomalous or interesting events to other systems, need to maintain optimal detector performance...

Depending on the physical constraints of the how the data is collected and recorded, real-time analysis may be performed with a fixed or variable latency.

Why a real-time analysis workshop?

The steadily increasing power of both computer hardware and processing techniques (not least AI/ML-driven) mean that we are able to infer more and more complicated and interesting properties of our data in real time.

Despite this, real-time analysis depends on a wide set of skills and techniques which are today scattered across various scientific domains.

Forming a community of people interested in real-time analysis can help us to learn from each other, and to develop a more coherent vision of optimal real-time analysis architectures which can address our diverse problems.

This workshop's primary goal is to help build such a community.

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Workshop structure

Plenary lectures in the morning — and after lunch today

Otherwise work organised in four parallel tracks, chosen to emphasize four key areas of real-time analysis which span experiments and domains

Plenary recap of the parallel sessions each evening, to allow people to follow tracks which they are not participating in

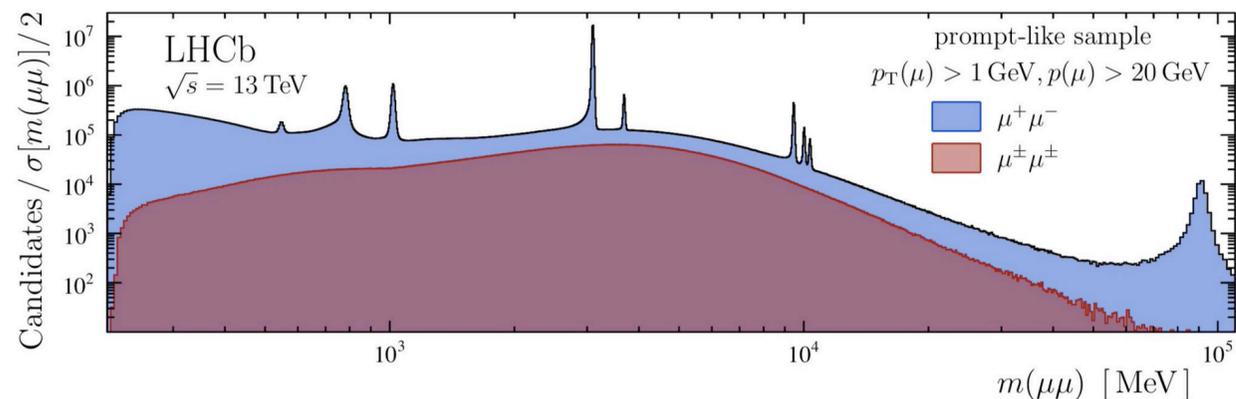
And a special session on Friday where we will learn about optics-based computing hardware with colleagues from lighton.ai

The second week of the workshop will focus on the development of real-time analysis software for the LHCb upgrade.

Track 1: Partial event building & persistency

PRL 120 (2018) 061801

LHCb

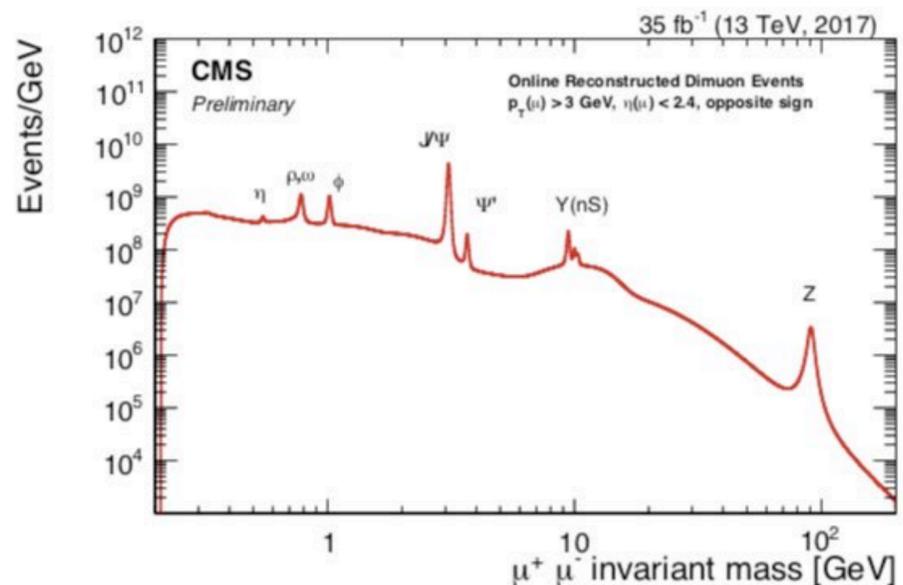


William Barter (Imperial College London)

EW Physics @ LHCb

EPS-HEP Meeting: 12/7/19

Slide 3



Shown is the dimuon invariant mass spectrum reconstructed in the High Level Trigger system of the CMS detector for data collected in 2017. Well known dimuon resonances from meson or Z boson decays are indicated. A small excess of events around 330 MeV corresponds to $\phi \rightarrow K^+K^-$ decays where Kaons are misidentified as prompt muons.

Track organisers



Caterina
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Senior Lecturer



Alec
Habig

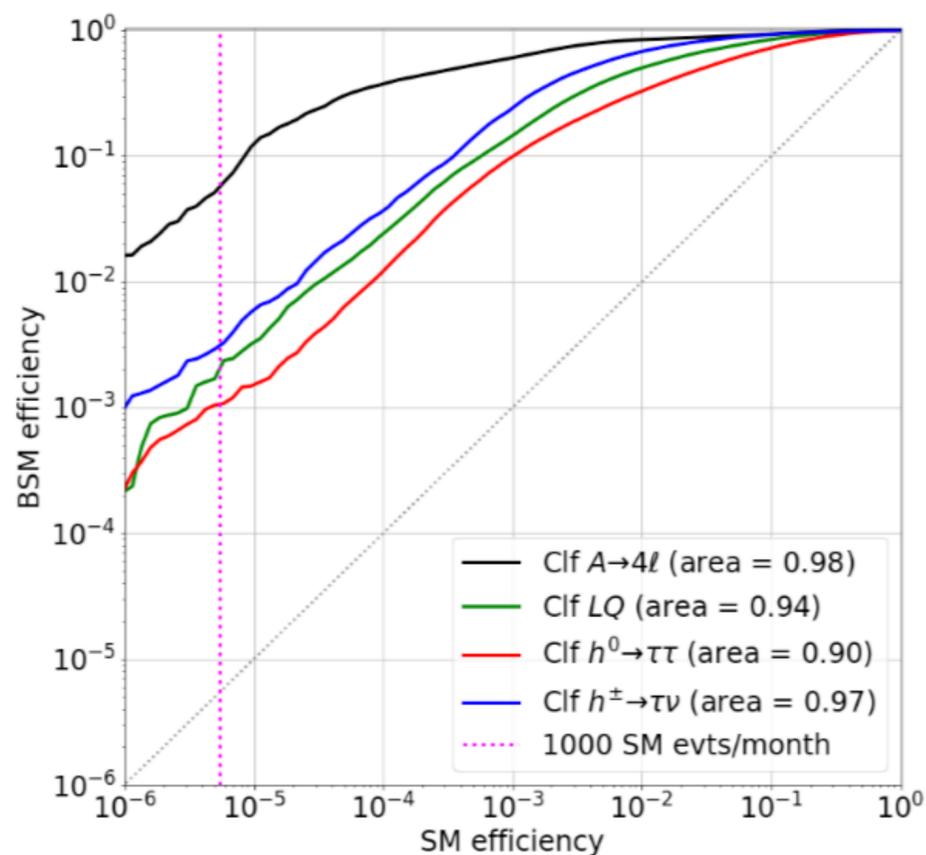
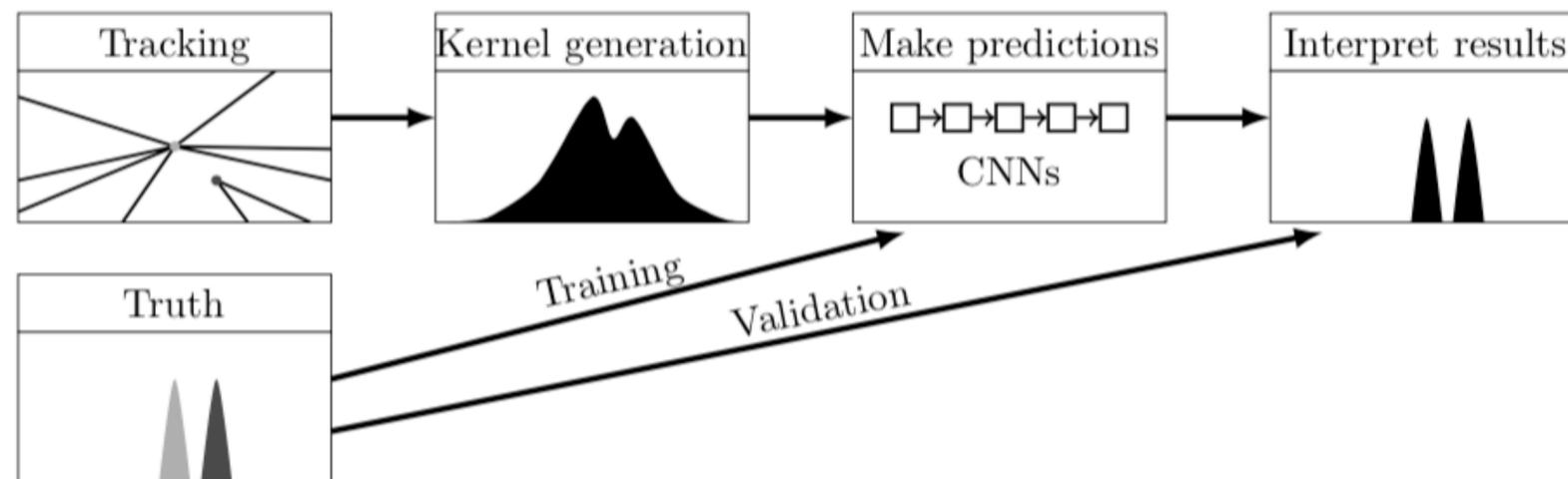
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Track 2: Real-time machine learning



Track organisers



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Thong Nguyen

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PhD student



Elena Cuoco

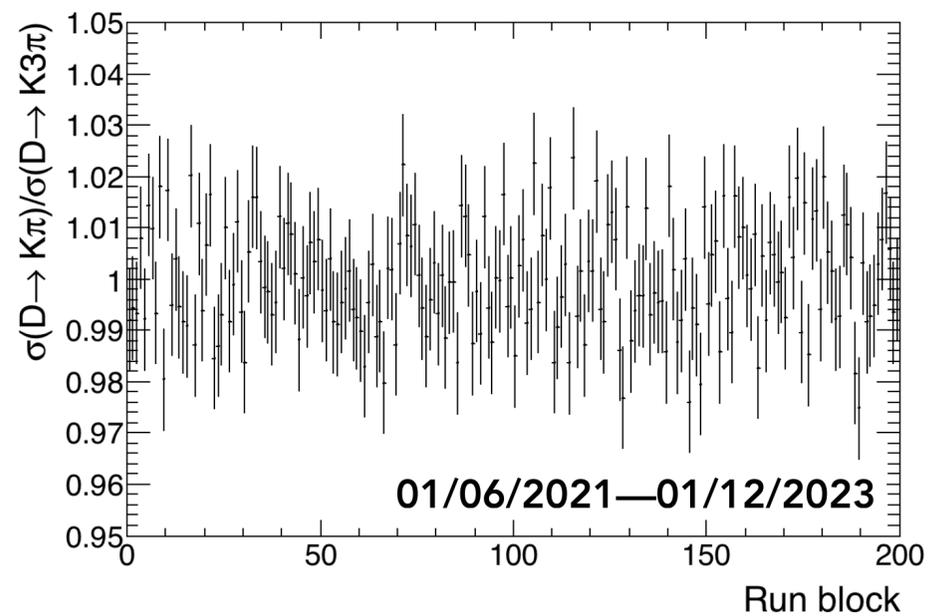
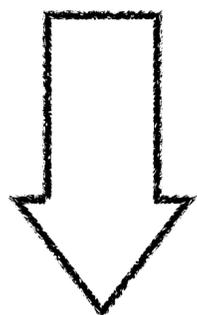
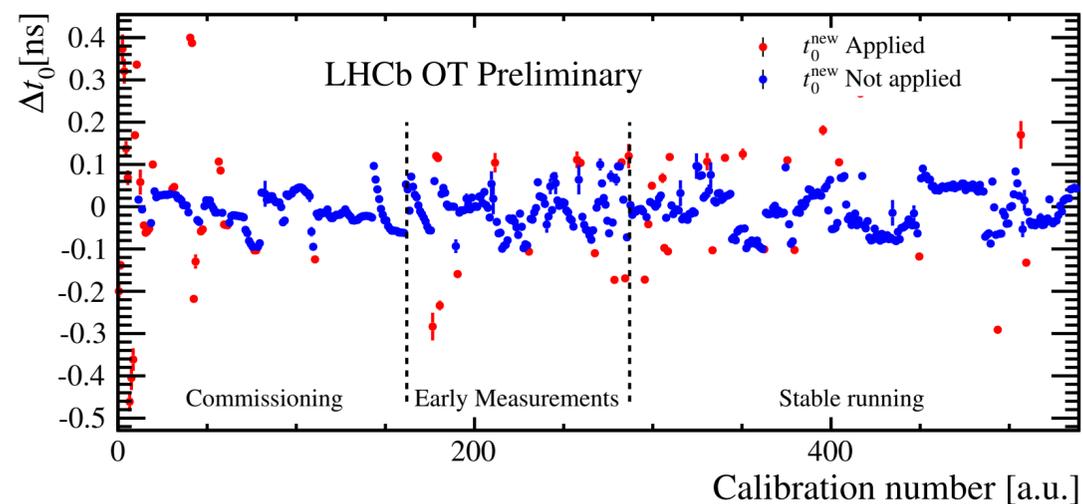
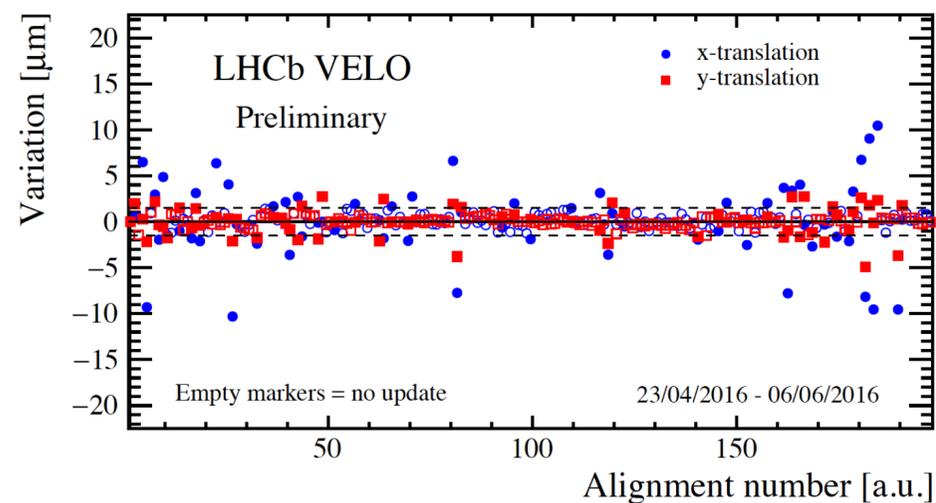
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elena.cuoco@sns.it
CA17137 action chair



Maurizio Pierini

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Research staff
@xmpierinix

Track 3: Real-time alignment & calibration



Track organisers



Emma
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Postdoc at the Ohio State University



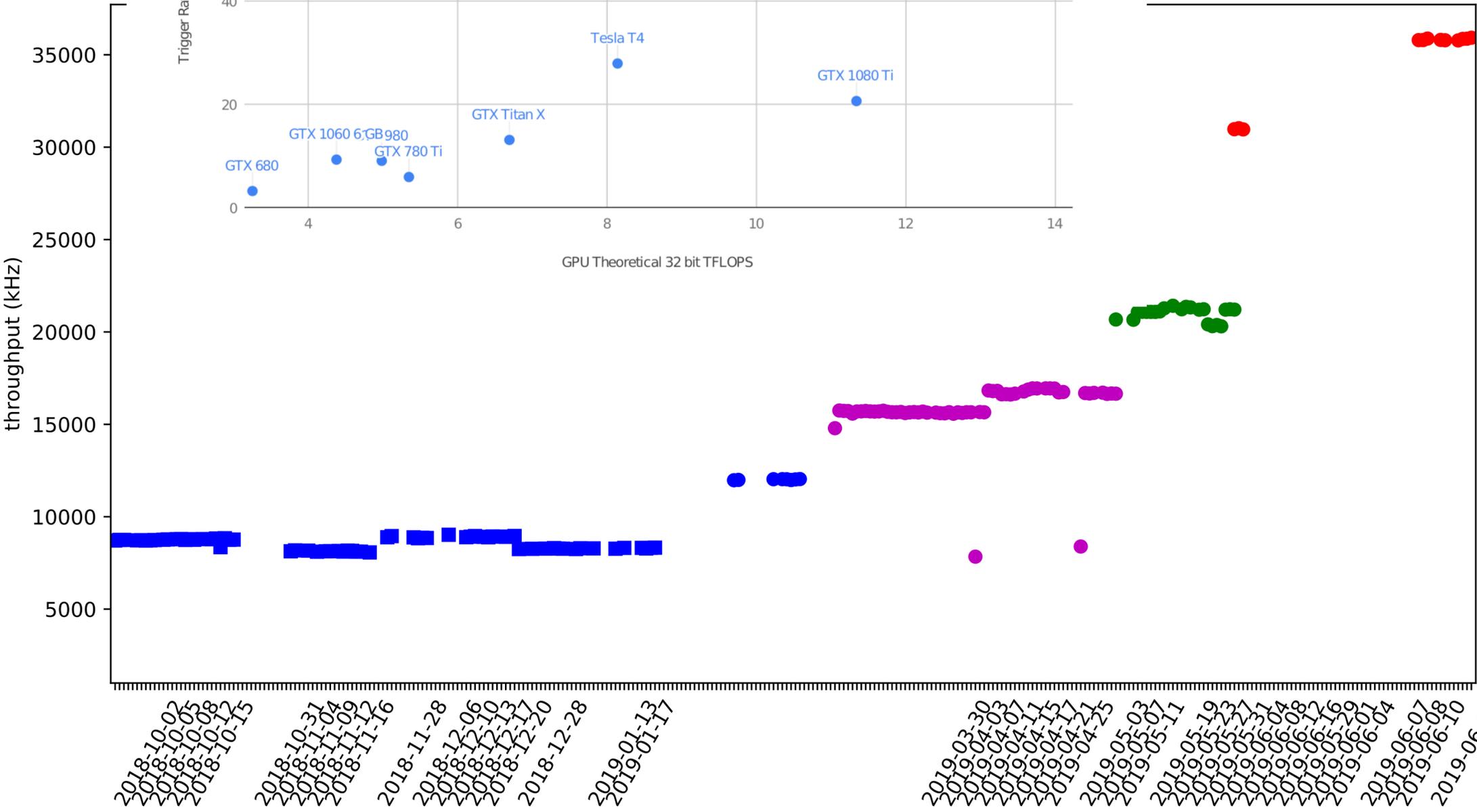
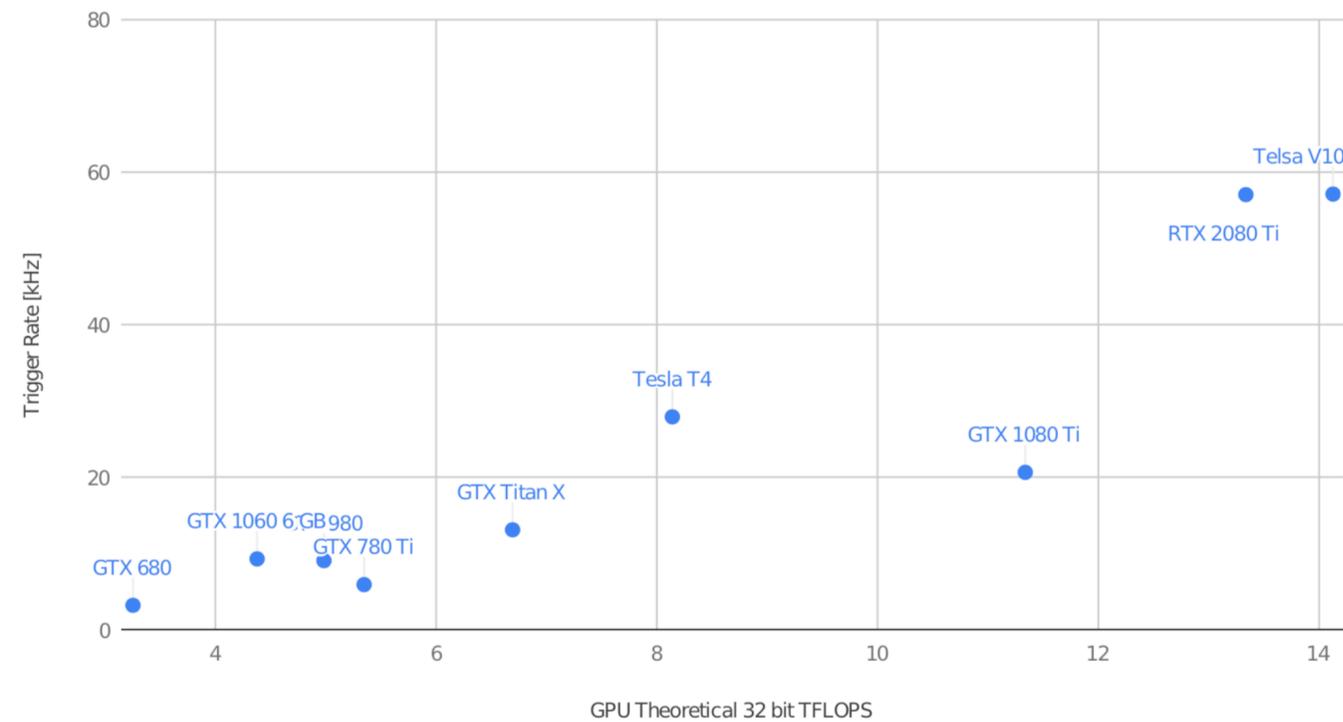
Will
Kalderon

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Postdoc at Lund University with Caterina Doglioni

Track 4: Efficient programming for real-time architectures

Trigger Rate [kHz] vs TFlops (32bit)



Track organisers



Sebastien Ponce

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Ivan Kisel

I.Kisel@compeng.uni-frankfurt.de
Professor in HPC algorithms, Uni-Frankfurt, FIAS, GSI



Felice Pantaleo

Applied Physicist at CERN, Experimental Physics Department, CMS Group
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Social activities at the workshop

1. Happy hour/welcome drinks tonight starting at 6pm
2. Workshop dinner on Thursday 18th (and Wednesday 24th for those staying for the 2nd week) at Le Gramophone. Please let one of the organisers know about any special dietary requirements as soon as possible.
3. We have also compiled a list of activities which we enjoy in Paris, particularly for those of you who are staying over the weekend.

Miscellaneous organisational points

- 1. If you need to use a fixed internet connection this week, please get in touch so we can whitelist your MAC address.**
- 2. If you do not have eduroam, we have wifi passwords for the local network, please get in touch with one of the organisers.**
- 3. Please get in touch on the Slack if you would like to have access to either the CERN OpenLab (for those who already have a CERN account) or cloud resources for the hands-on sessions this week.**
- 4. I will be driving to the workshop every morning — if those of you in the Orsay hotel would like to synchronise for a lift, let me know.**

Final remarks & getting to know each other

Sparking new collaborations is at the heart of this workshop — thanks to everyone who's uploaded a slide about themselves already!

Let's go around and do 1-minute verbal introductions after this talk to help us get to know each other.

And please do feel free to take advantage of the facilities here & have parallel discussions beyond what we have already organised.

Finally if you have any questions, get in touch with one of the organisers and we'll do our best to answer and help. I hope you all have a great and productive time at the Institut Pascal over the next weeks!