



THESIS MIDTERM

Topological trigger
Search for Heavy Higgs Bosons
Teaching, Supervision, Outreach
Schools, Conferences
Outlook

Gefördert durch:



CLUSTER OF EXCELLENCE
QUANTUM UNIVERSE

Universität Hamburg

DER FORSCHUNG | DER LEHRE | DER BILDUNG

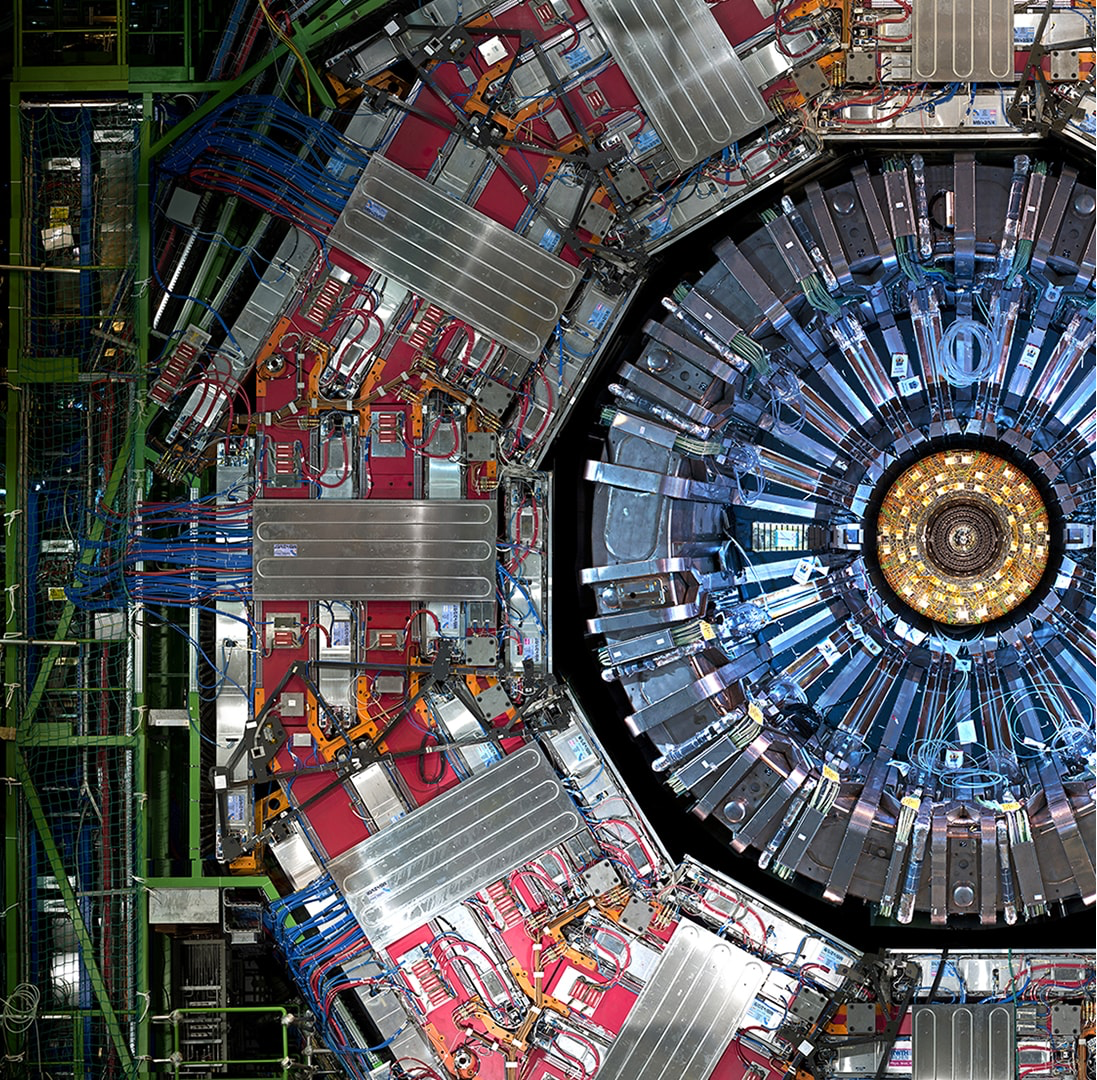


FSP

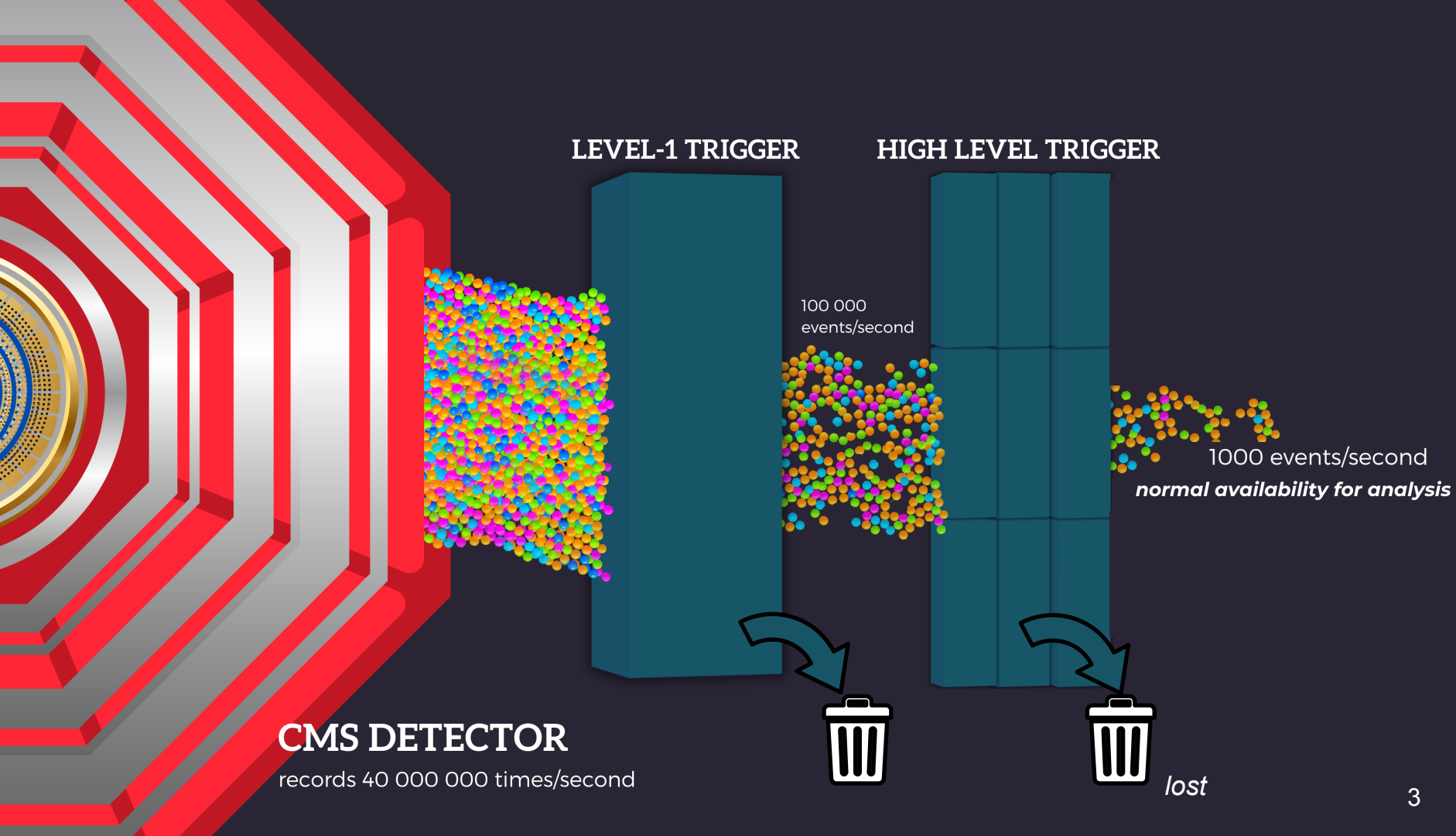
Erforschung
von Universum
und Materie



Bundesministerium
für Forschung, Technologie
und Raumfahrt



TOPOLOGICAL TRIGGER

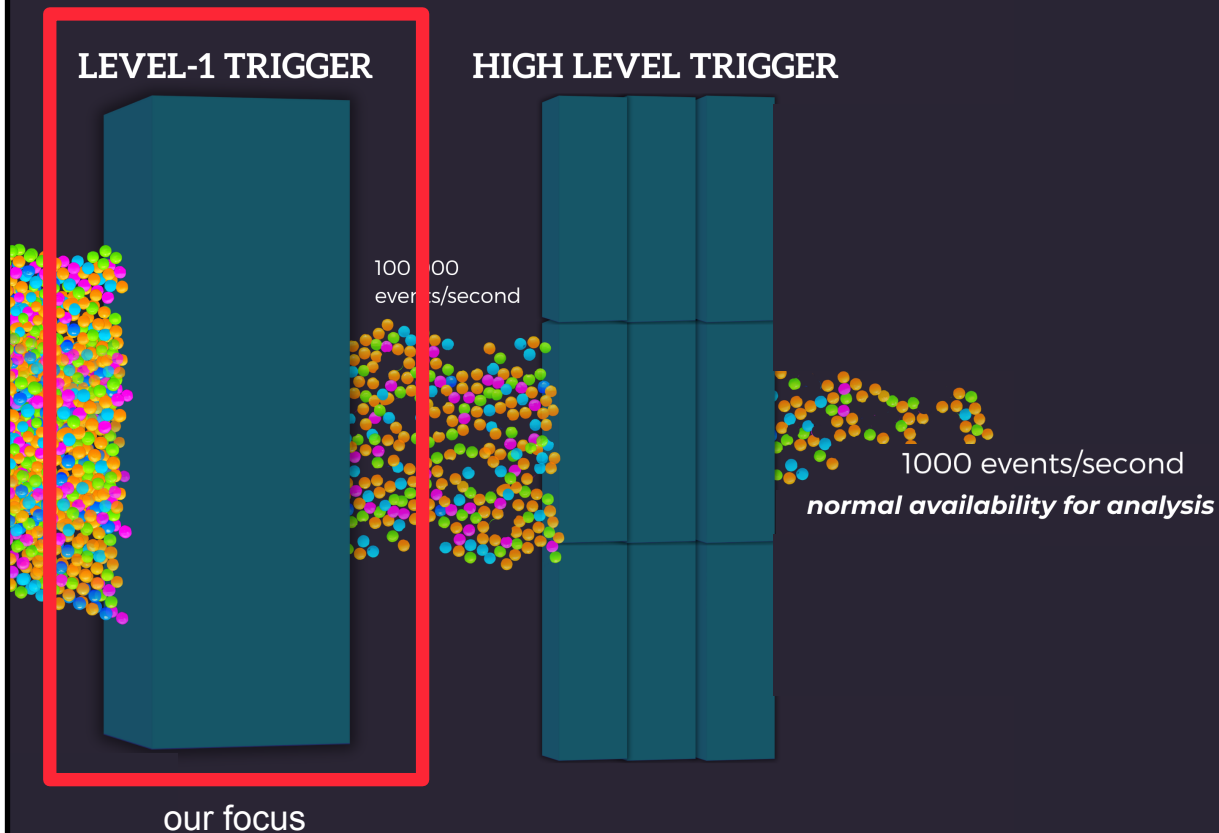


level-1 system

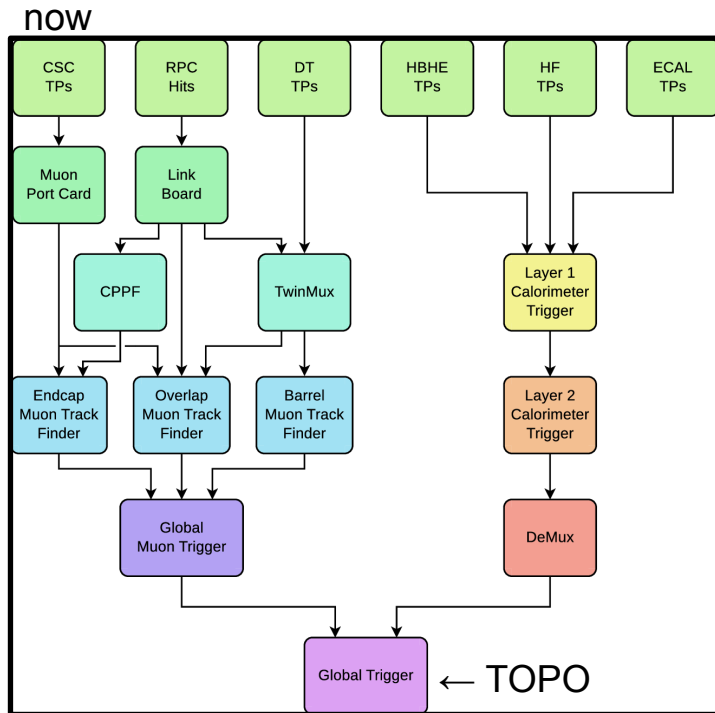
classic trigger algorithms
cut on single object
properties (e.g. momentum)

multivariate techniques
optimally combine multiple
object information

fully implemented on
hardware

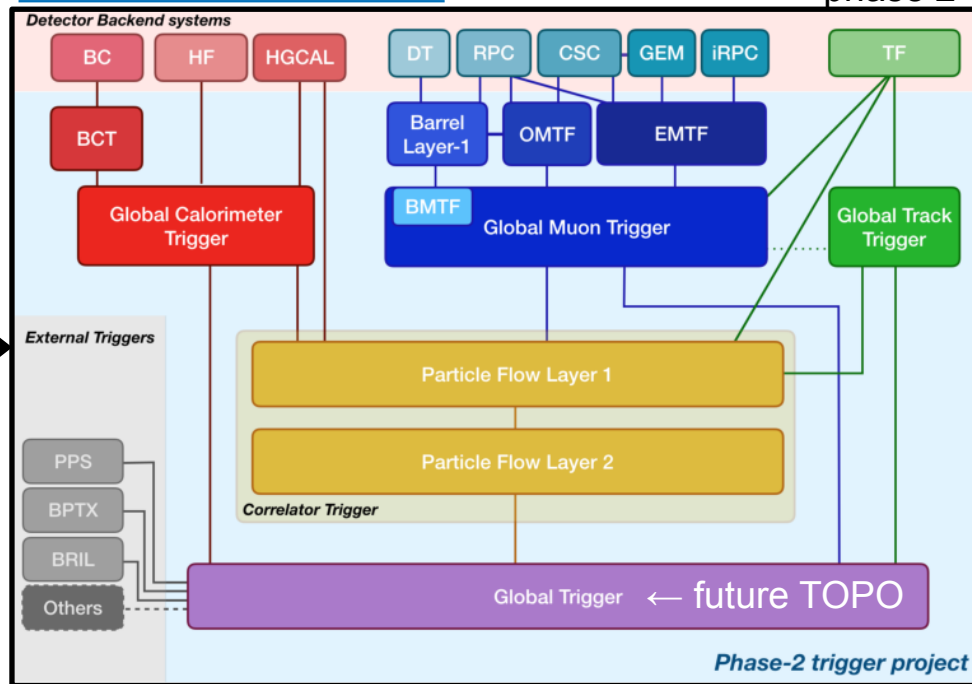


L1 during phase two



trigger primitives, 3.8 us total latency,
100 kHz rate, 7 FPGA boards

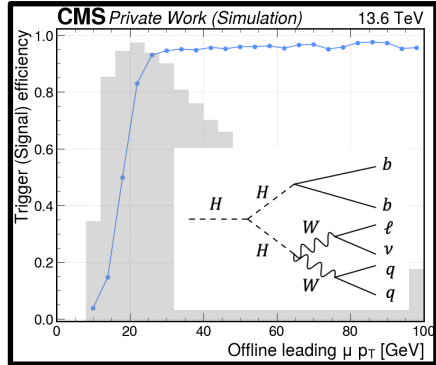
CMS TRIGGER FOR HL-LHC



particle flow objects, 12 us total latency,
750 kHz rate, 12 FPGA boards

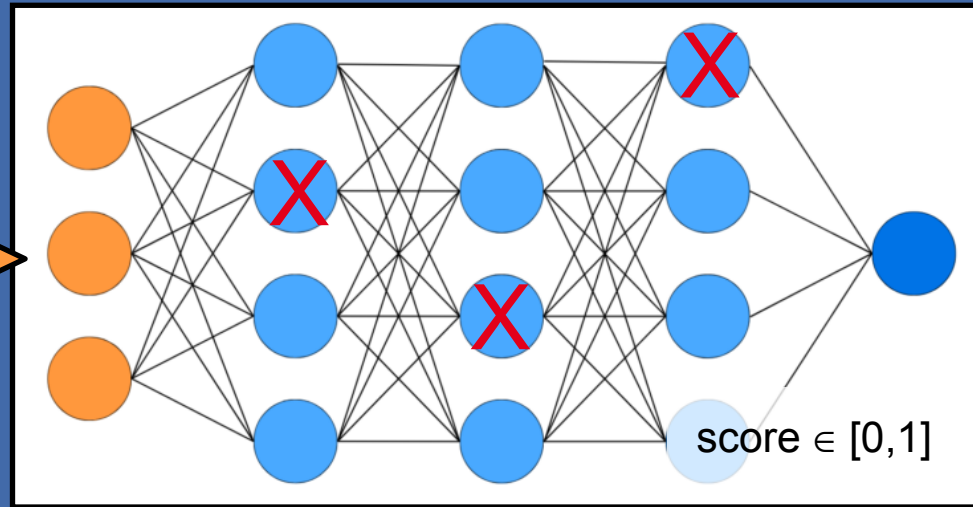
architecture - baseline

object	variable
L1 EtSum	H_T
L1 EG/Mu (x2)	p_T, η, φ
L1 jets (x4)	p_T, η, φ



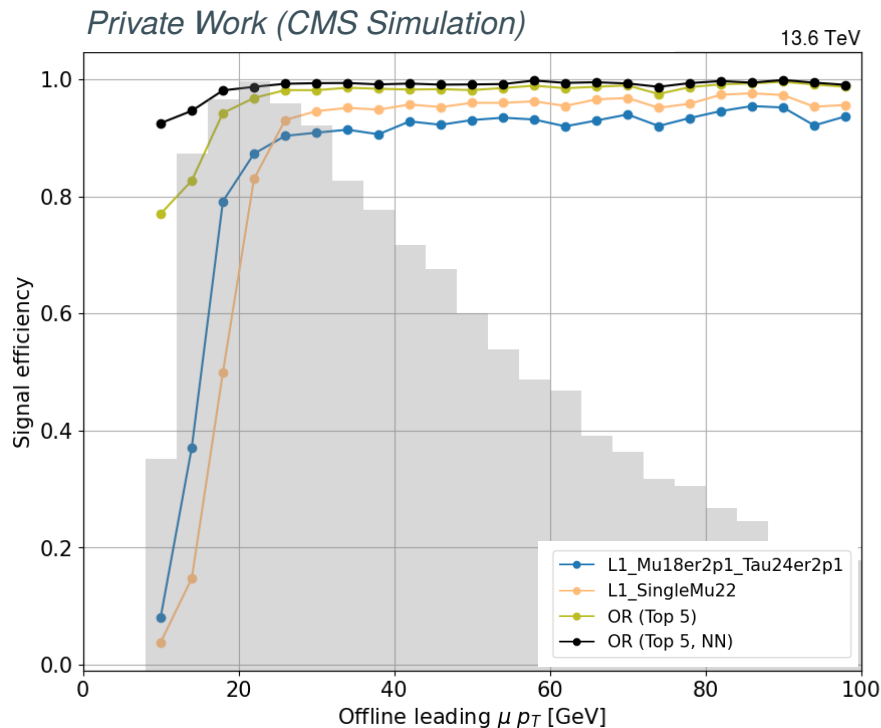
background

minimal bias events



- feed-forward binary classifier
- cross-entropy loss function
- 80% pruning of smallest weights

access to low p_T space



logic or: top 5
→ 95% efficiency at about **20 GeV**

logic or: top 5 + NN
→ 95% efficiency at about **16 GeV**

analysis impact

test in full analysis chain

current strategy

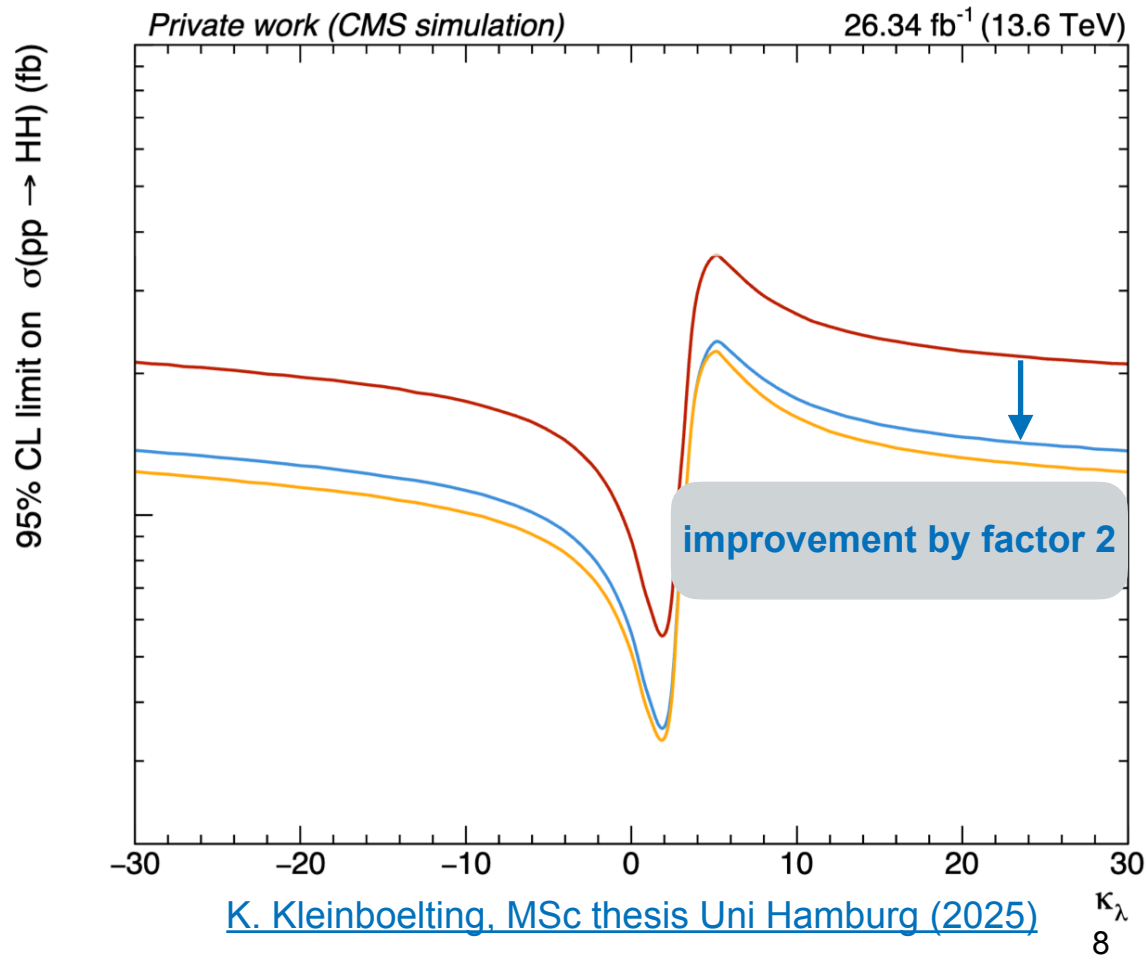
single lepton trigger path

topological trigger

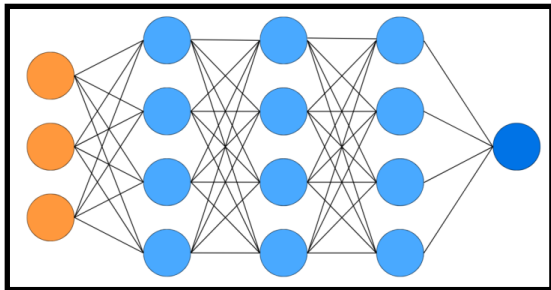
assuming HLT is 100% efficient → **to do list**

passthrough

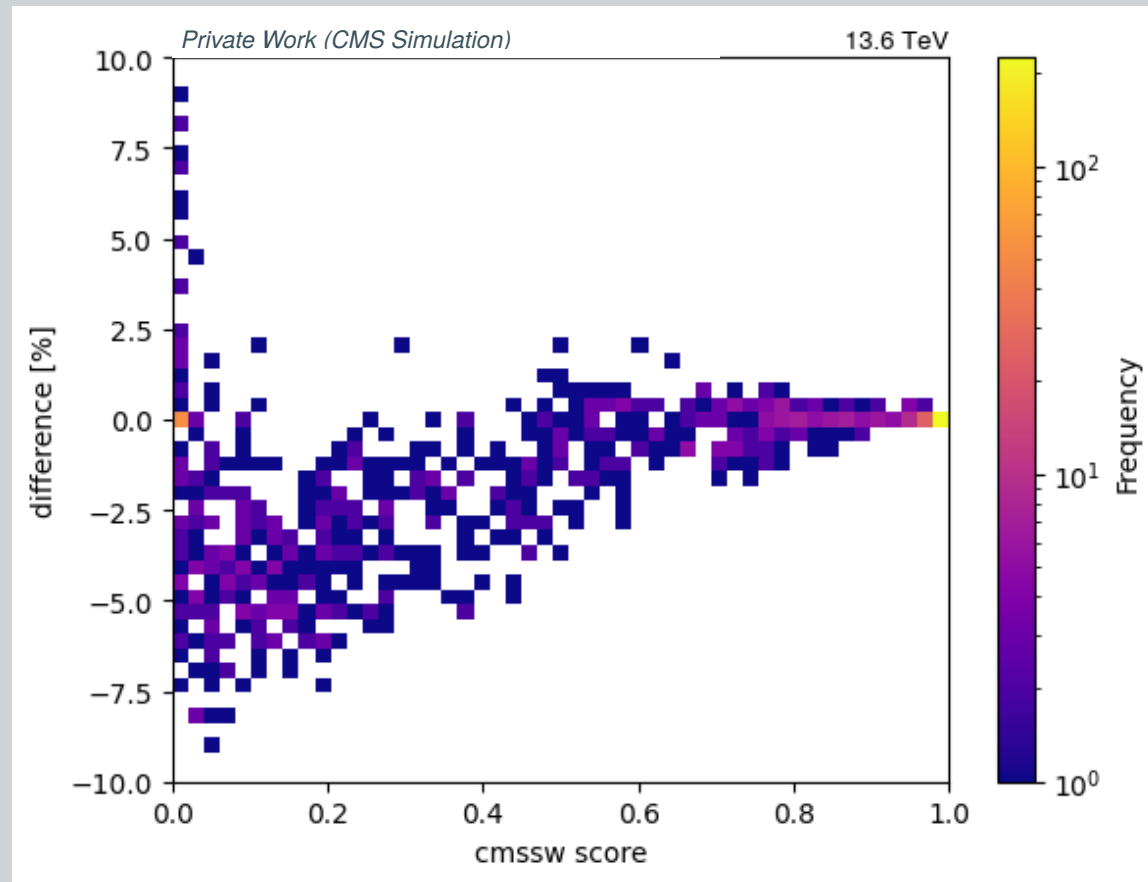
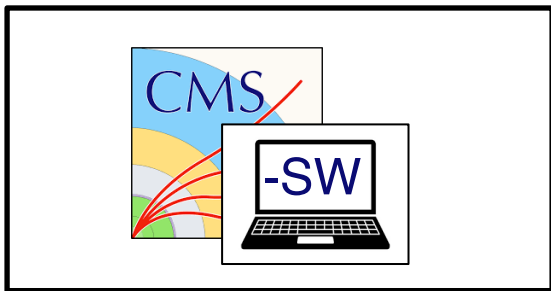
assuming 100% trigger efficiency / unlimited bandwidth



next: l1 menu

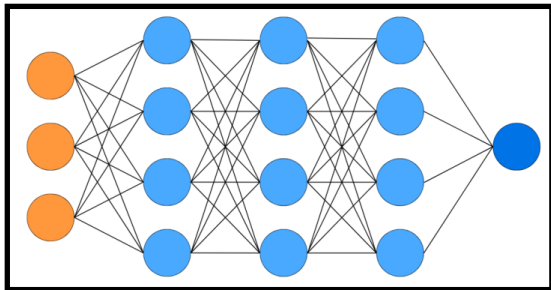


level-1 menu emulator

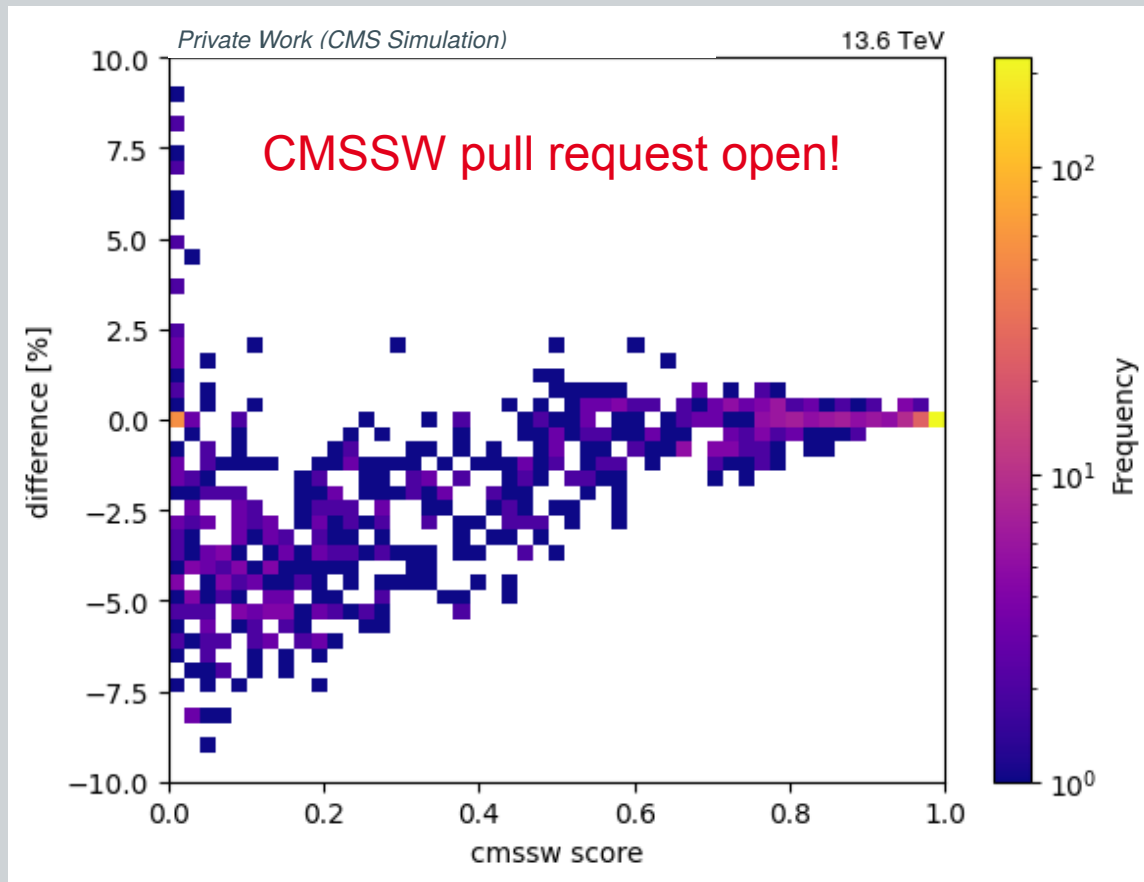
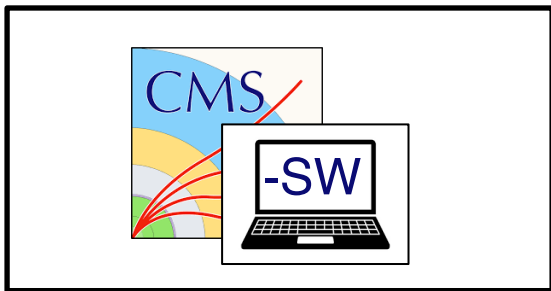


difference between keras score and cmssw
emulator $\leq 2.5\%$ (at relevant scores)

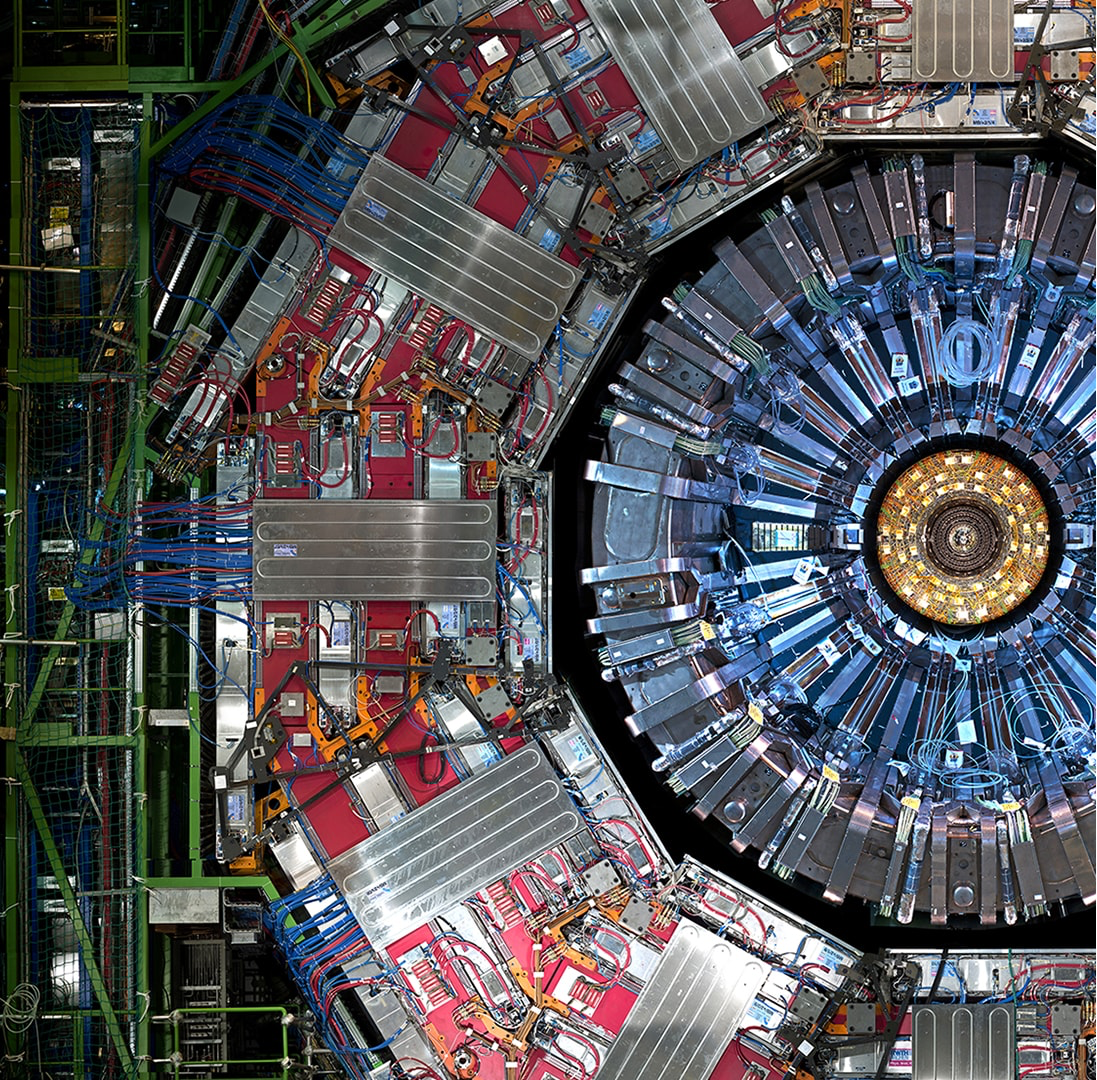
next: l1 menu



level-1 menu emulator



difference between keras score and cmssw emulator $\leq 2.5\%$ (at relevant scores)



SERVICE WORK

automation framework

check twice per day:

new runs recorded



produce histograms



merge weeks/eras

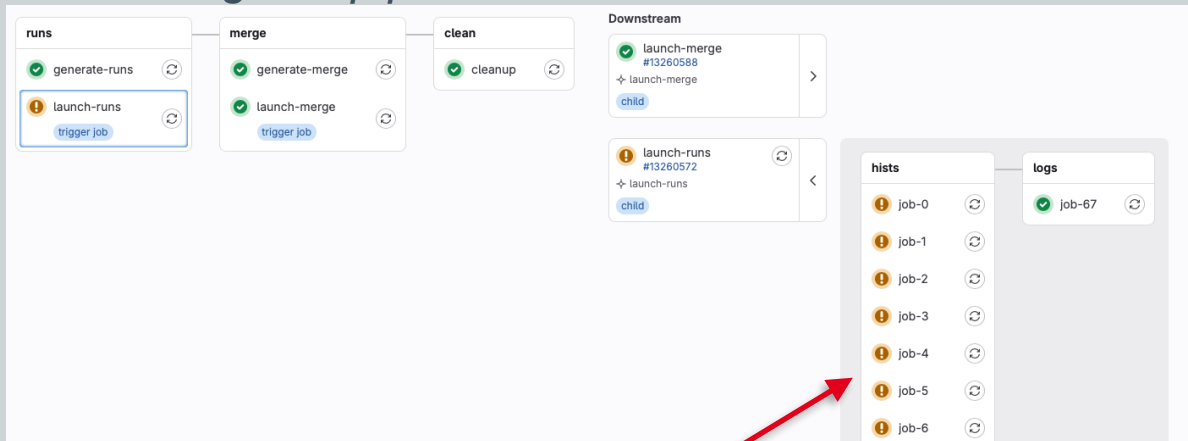


plotting scripts



cernbox/webpage

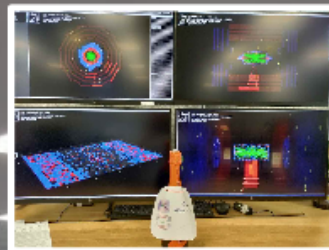
based on gitlab pipelines:



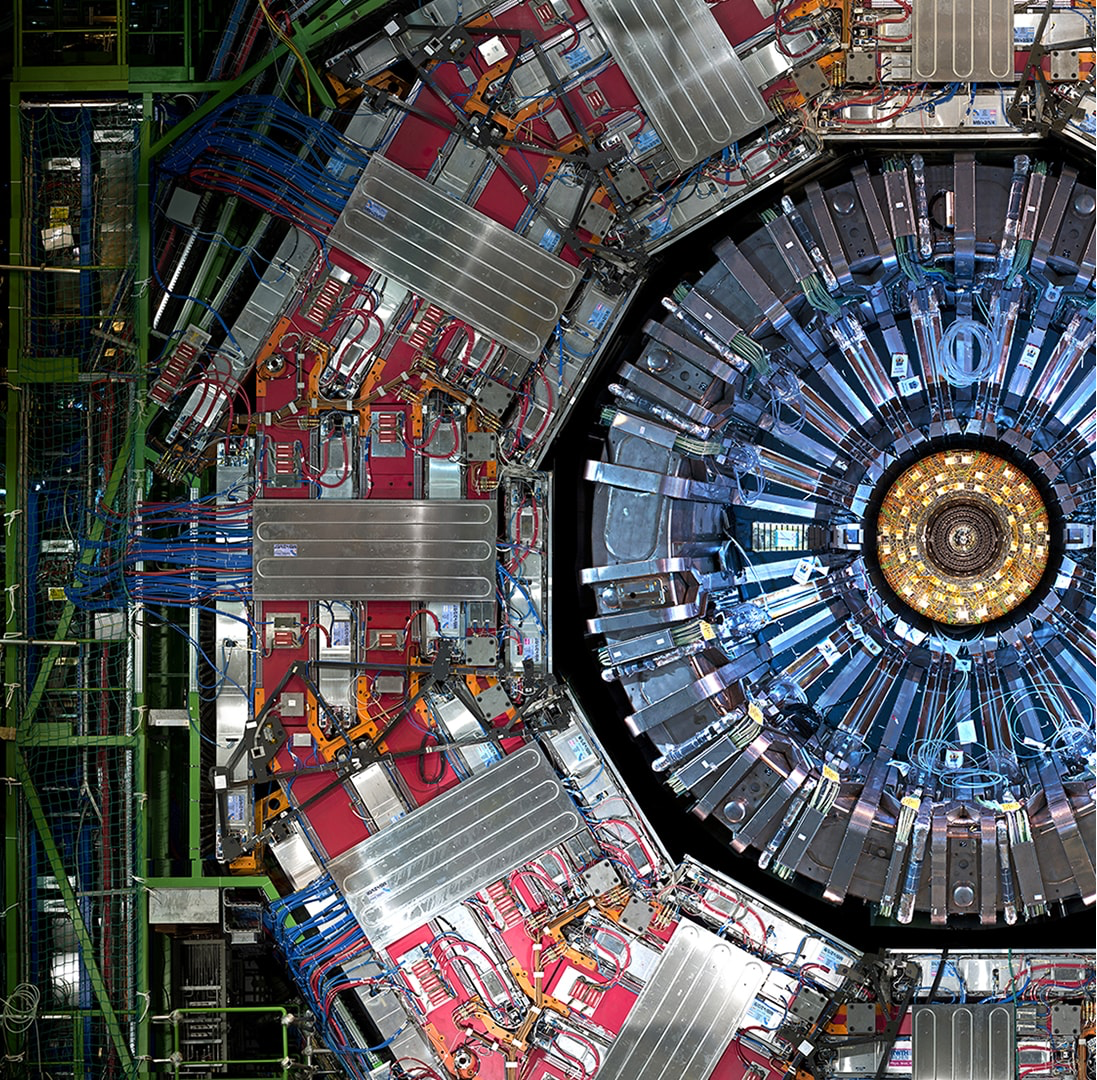
child-pipeline: jobs
scheduled at run time

5 + 1 EPR (shifts) $\Rightarrow$ authorship since September

End of 2024 pp Running!

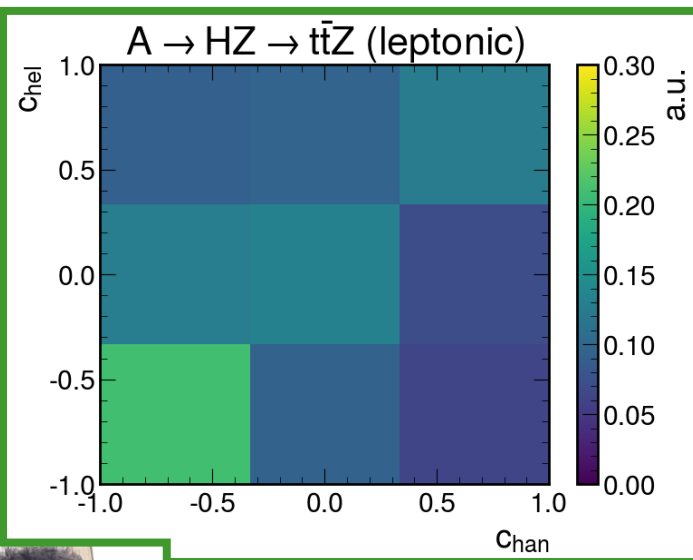
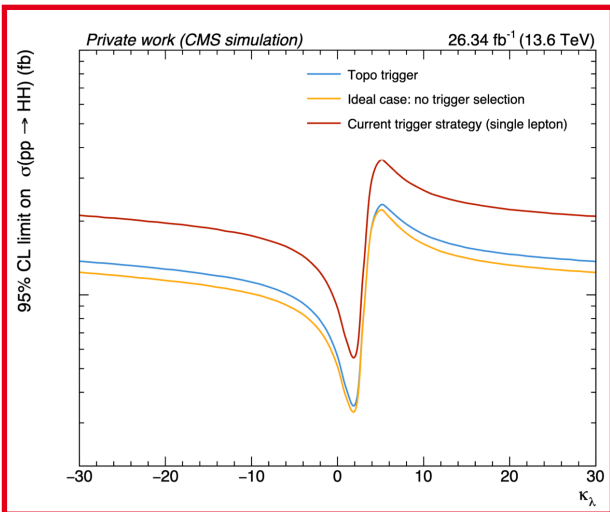


Wed 16 Oct 2024



**SUPERVISION
TEACHING
OUTREACH**

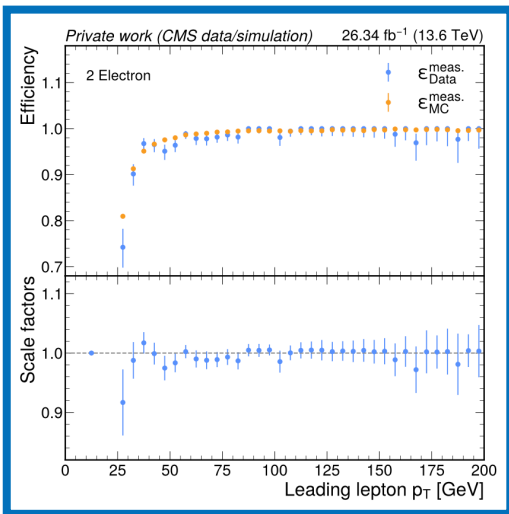
Karla Kleinbölting: Master thesis on topological trigger



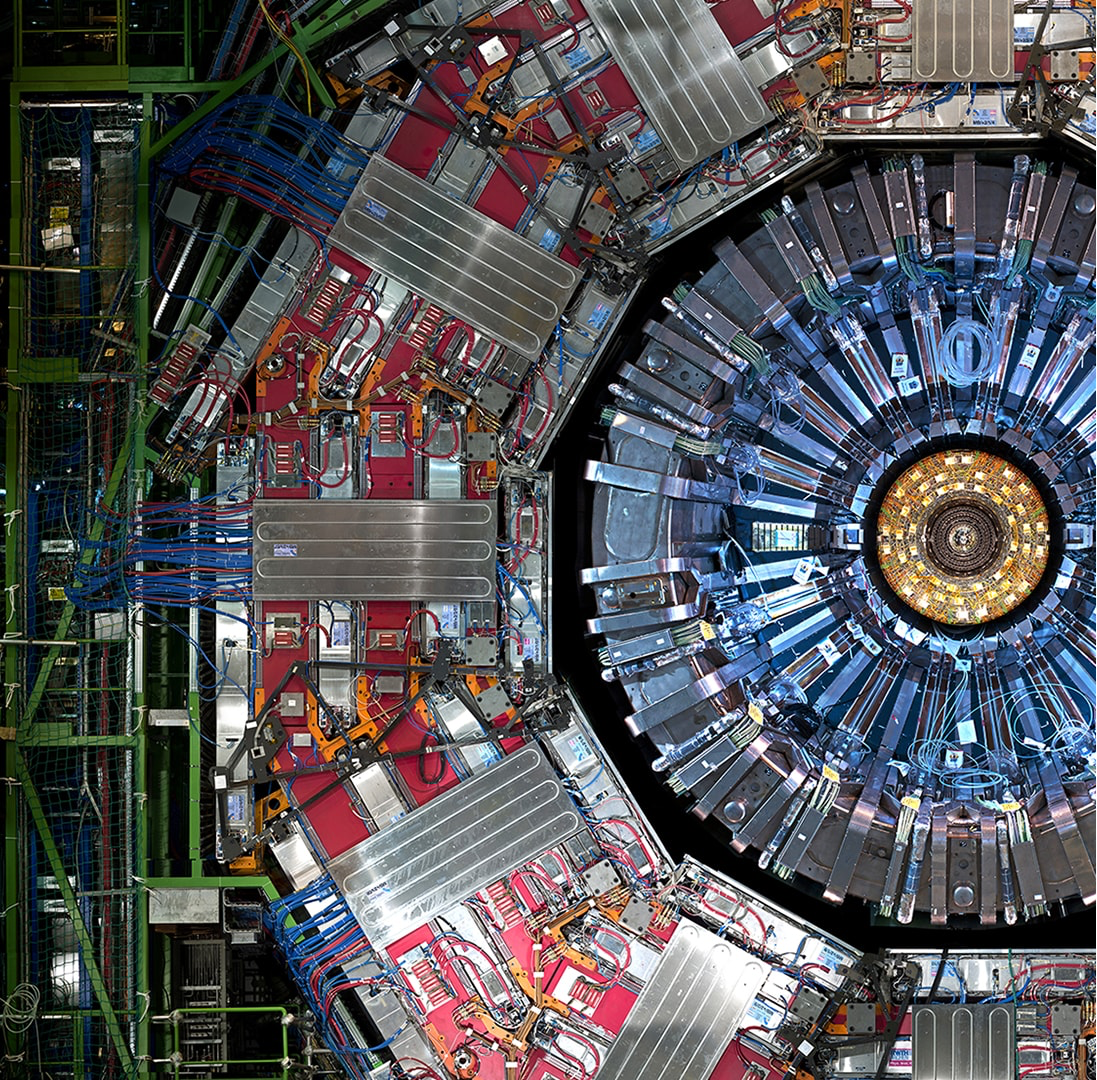
Elias Aramesch: Upcoming bachelor thesis on spin variables in AZH analysis



Balduin Letzer: Master thesis on di-Higgs analysis, Trigger efficiencies



in addition: Physics 5 exercises,
HEP Masterclasses



SUMMARY OUTLOOK

The 2025 European School of High-Energy Physics

Benasque, Spain,
15 - 28 October 2025

Scientific Programme

Cosmology and Dark Matter - Diego Blas (IFAE/ICREA)
Particle Accelerators for Hadron Therapy - Juan Fuster (IFIC/CSIC-U. València)
QCD - Nigel Glover (Durham University/CERN)
Prospects at LHC & Beyond - Andreas Hoecker (CERN)
Field Theory & the EW Standard Model - José Ignacio Illana (U. Granada)
Higgs, Top & Beyond - Fabio Maltoni (UCLouvain/U. Bologna)
Ground-based Gamma-ray Astronomy - Abelardo Moralejo Olaizola (IFAE/BIST)
Flavour Physics & CP Violation - Gilad Perez (Weizmann)
Statistics & Machine Learning - Troels C. Petersen (NBI/U. Copenhagen)
Heavy-Ion Physics - Alba Soto Ontoso (U. Granada)
Neutrino Physics - Mariam Tórtola (IFIC/CSIC-U. València)

Discussion Leaders

Joson Auböcher (CERN)
Maximilian Dotto (CERN)
Javier Fuentes Martin (U. Granada)
Victor Martin Lezama (IFIC/CSIC-U. València)
Clara Murgui Galvez (Catech/CERN)

Standing Committee

S. Abreu (CERN)
M. Diez (CERN)
M. Elsing (CERN)
M. Mulders (CERN)
K. Posa (CERN)
S. Stahl (CERN)

Local Committee

B. Alvarez González (ICTEA/U. Oviedo)
M. Asorey (CAPA/U. Zaragoza)
A. Escalante del Valle (CIEMAT)
P. García Abía (CIEMAT)
S. González de la Hoz (IFIC/CSIC-U. València)
S. Martí García (IFIC/CSIC-U. València)
F. Materra (IFCA/CSIC-U. Cantabria)
M. Pérez-Vicente (U. Granada)
I. Riu (IFAE)
A. Ruiz Jimeno (IFCA/CSIC-U. Cantabria)
C. Santamarina Ripa (IFAESU, Santiago de Compostela)
T. Sánchez Schröder (IFAE)
A. Wulzer (IFAE)

<https://indico.cern.ch/e/eshep2025>

schools and conferences

CMSDAS at CERN

HEP School in Bad Honnef (formerly Maria Laach)

FSP Meeting Aachen

Level-1 Trigger Workshop in Oviedo

Talk at FSP Meeting Hamburg

ESHEP in Benasque

my contributions

automised plotting for offline trigger shifters

shifts at point 5, cms authorship

implemented **cmssw emulator** for topological trigger

assisted in supervising Karla and Balduin

supervision of Elias (and Lucas)

exercises **physics 5** + masterclasses

outlook 2026

supervision: bachelor student working on BDT based topological trigger

CERN stay ~ 1/2 year, trigger on-call?

Commissioning of **topological trigger** in data taking 2026

overtake **AZH** analysis from Yannick

discussion points

Is the thesis on the right track?

Feedback

QU Formalia

Career
Development

Possible to focus more on
statistics?

Five month report?

What to add to written report?

Computing School?
Conference talks? CERN?