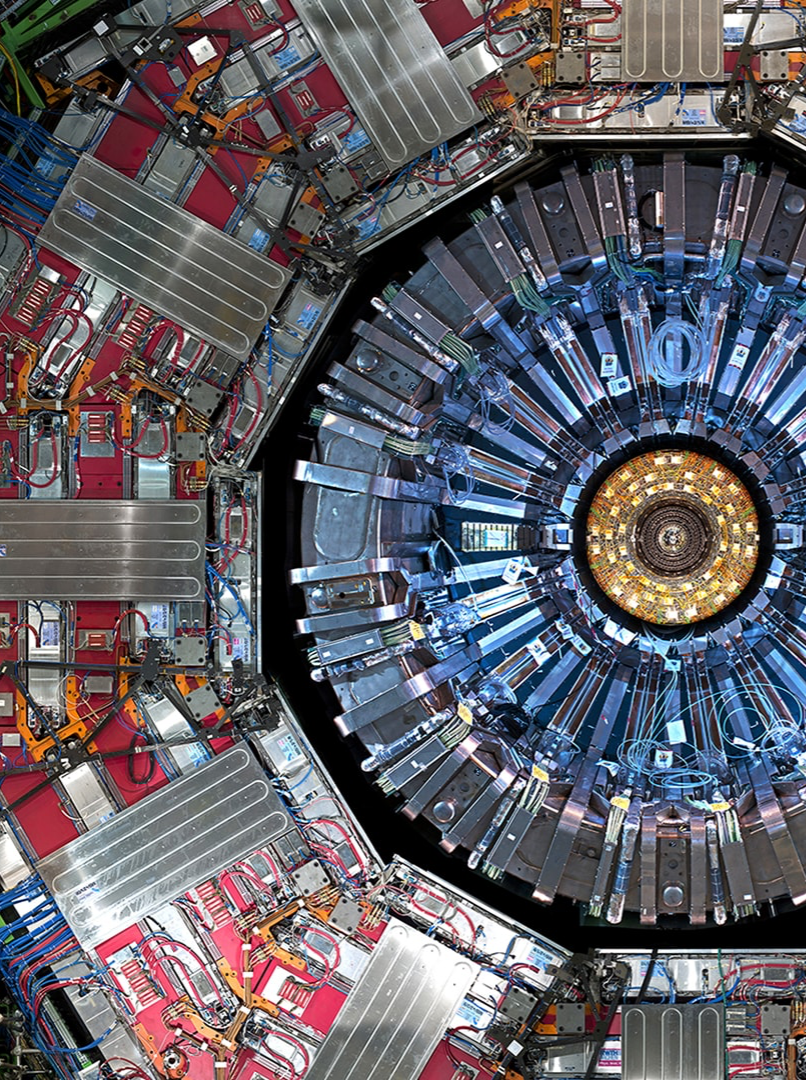


THESIS MIDTERM

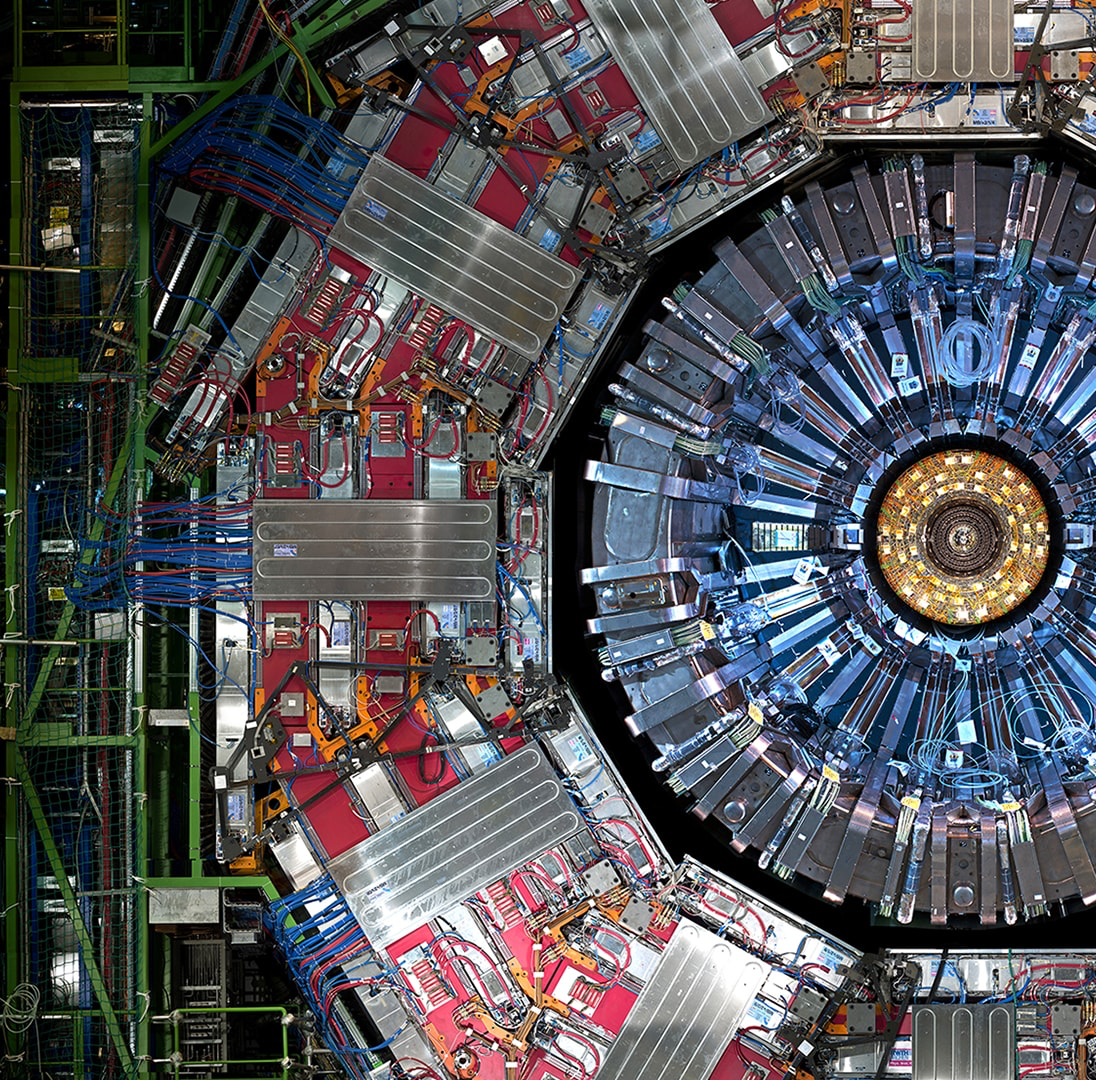
Topological trigger
Search for Heavy Higgs Bosons
Teaching, Supervision, Outreach
Schools, Conferences
Outlook

CLUSTER OF EXCELLENCE
QUANTUM UNIVERSE
Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

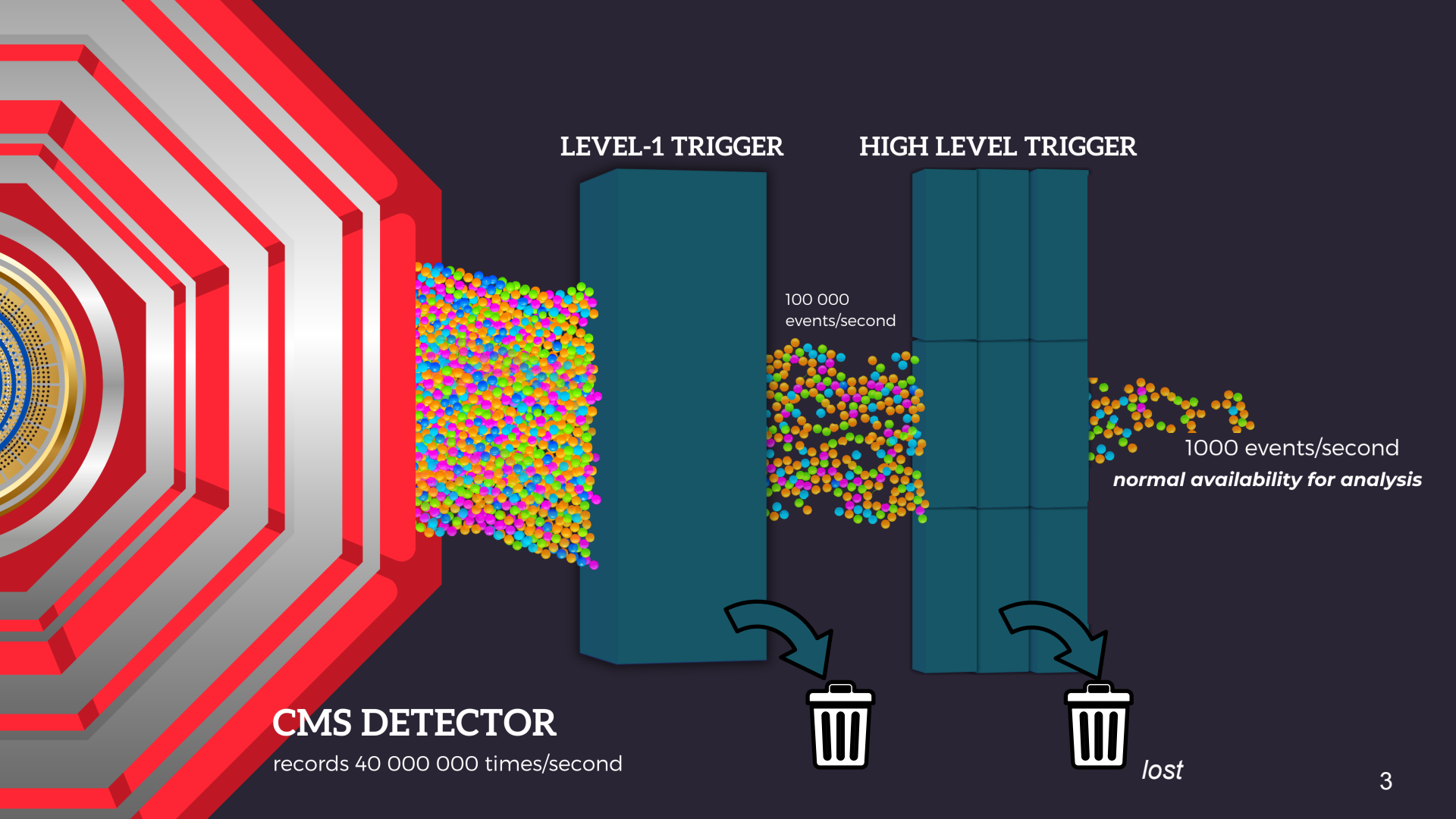
FSP
Erforschung
von Universum
und Materie

CMS

Gefördert durch:
Bundesministerium
für Forschung, Technologie
und Raumfahrt



TOPOLOGICAL TRIGGER



CMS DETECTOR

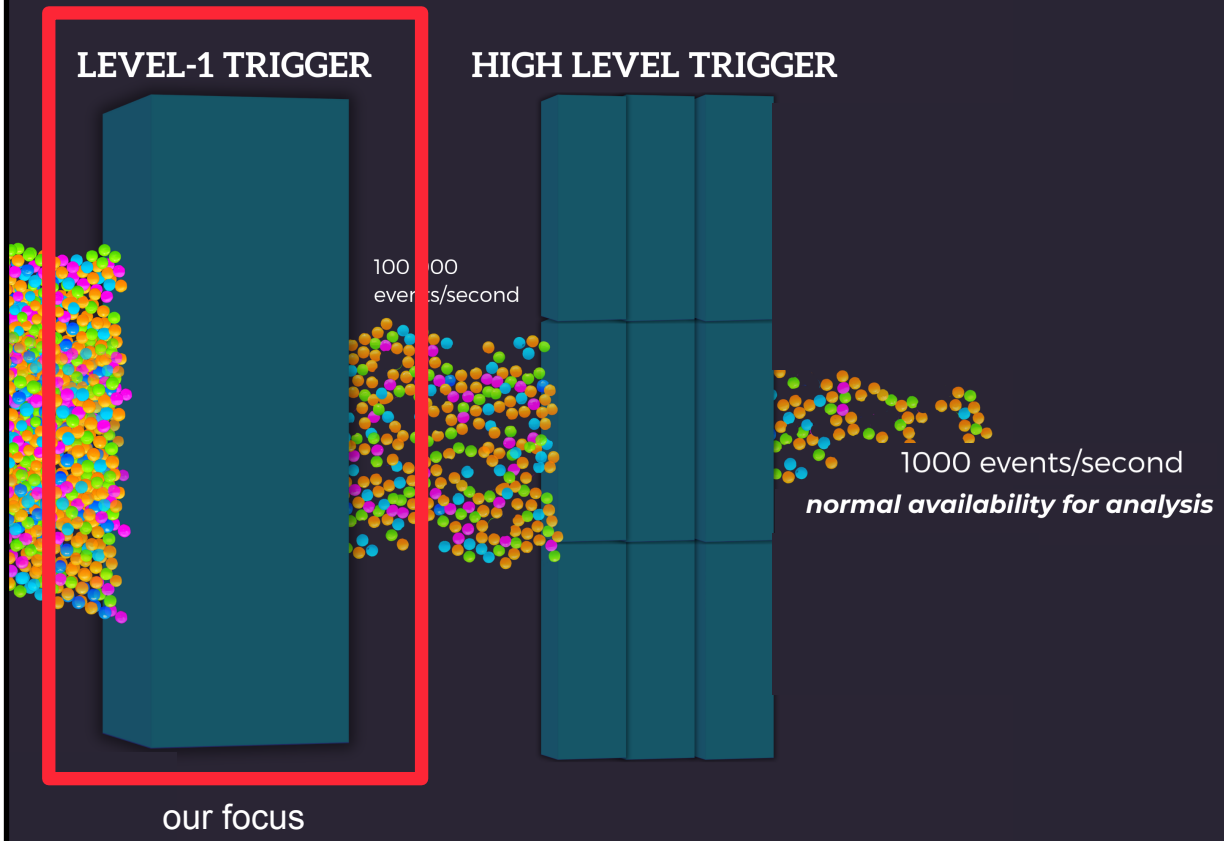
records 40 000 000 times/second

level-1 system

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

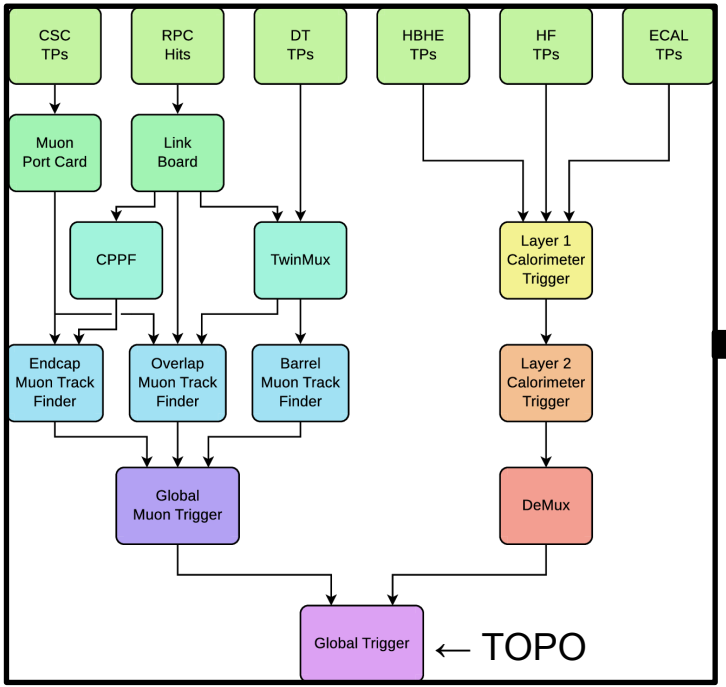
multivariate techniques optimally combine multiple object information

fully implemented on **hardware**



L1 during phase two

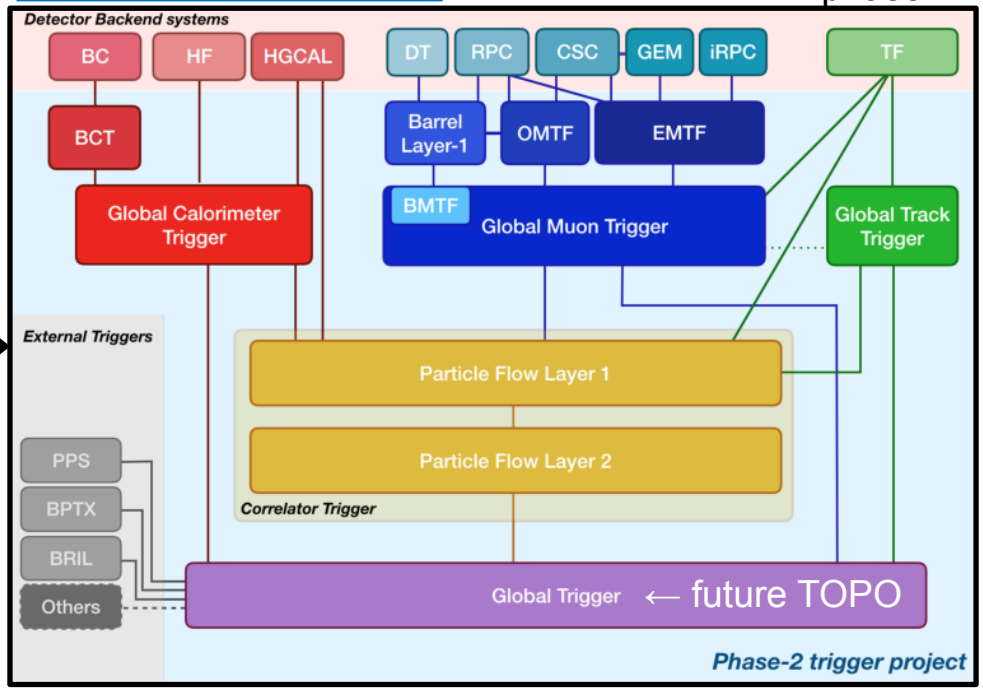
now



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

CMS TRIGGER FOR HL-LHC

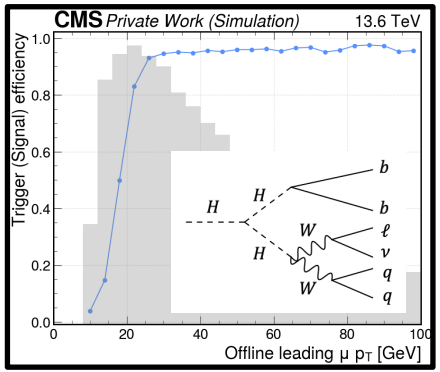
phase 2



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

architecture – baseline

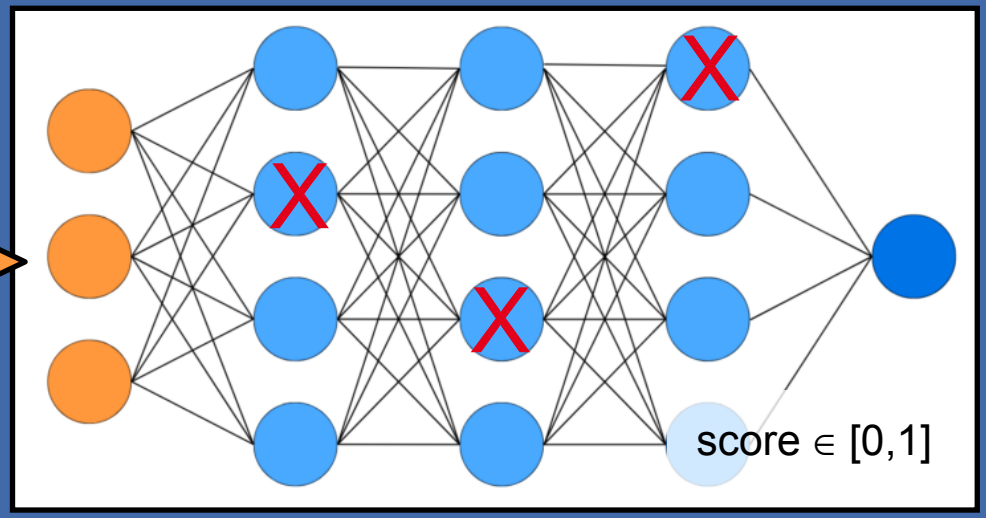
object	variable
L1 EtSum	H_T
L1 EG/Mu (x2)	p_T, η, φ
L1 jets (x4)	p_T, η, φ



trigger limited signal

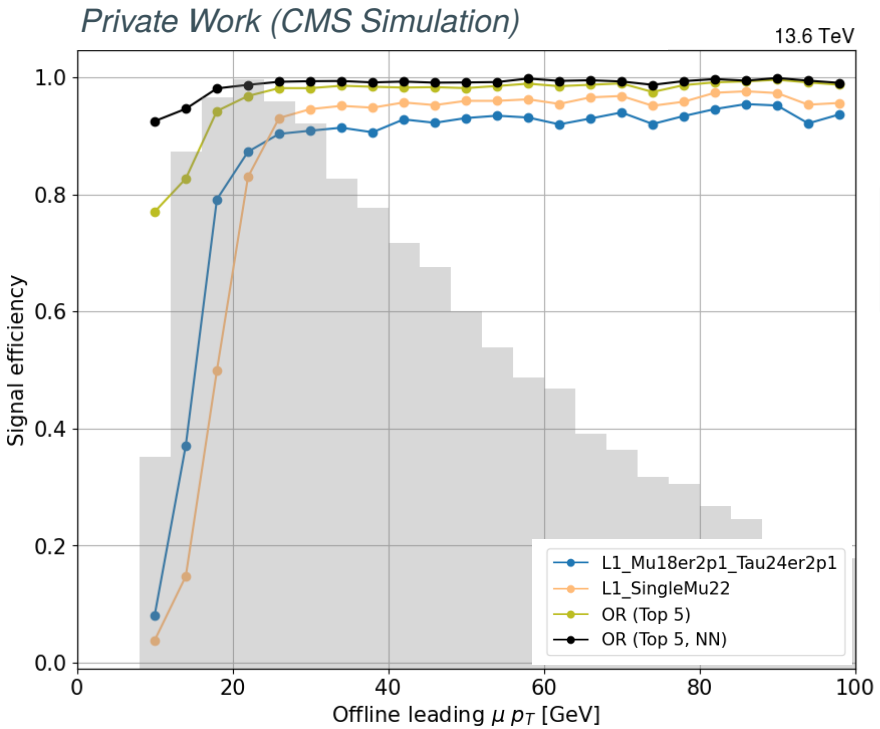
background | minimal bias events

nodes: 64 ⊕ 32 ⊕ 32



- 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**

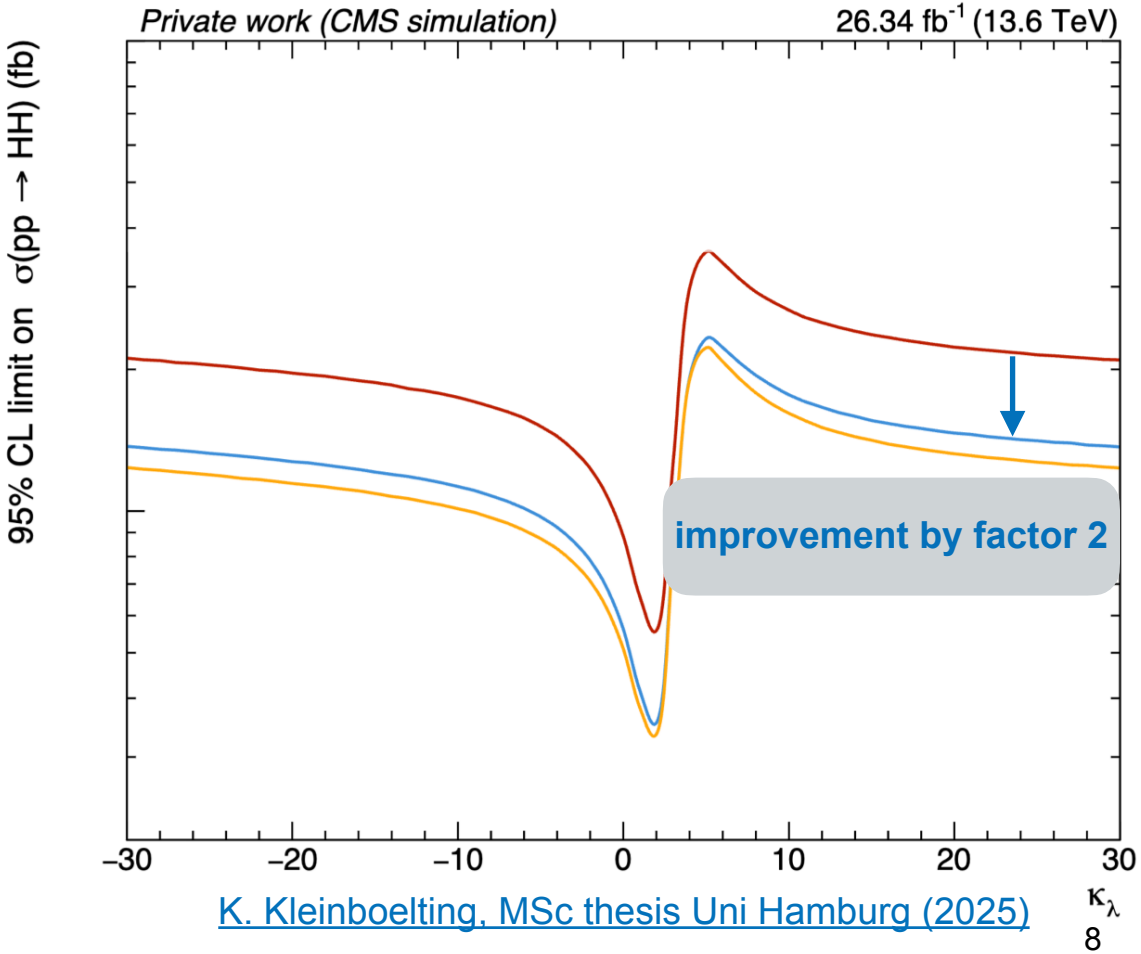
analysis impact

test in full analysis chain

current strategy
single lepton trigger path

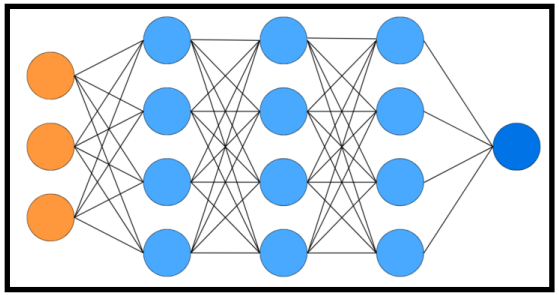
topological trigger
assuming HLT is 100% efficient → **to do list**

passthrough
assuming 100% tigger efficiency / unlimited bandwidth

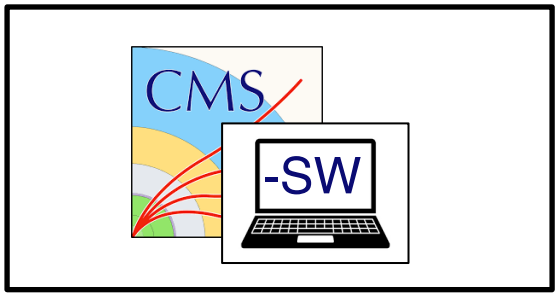


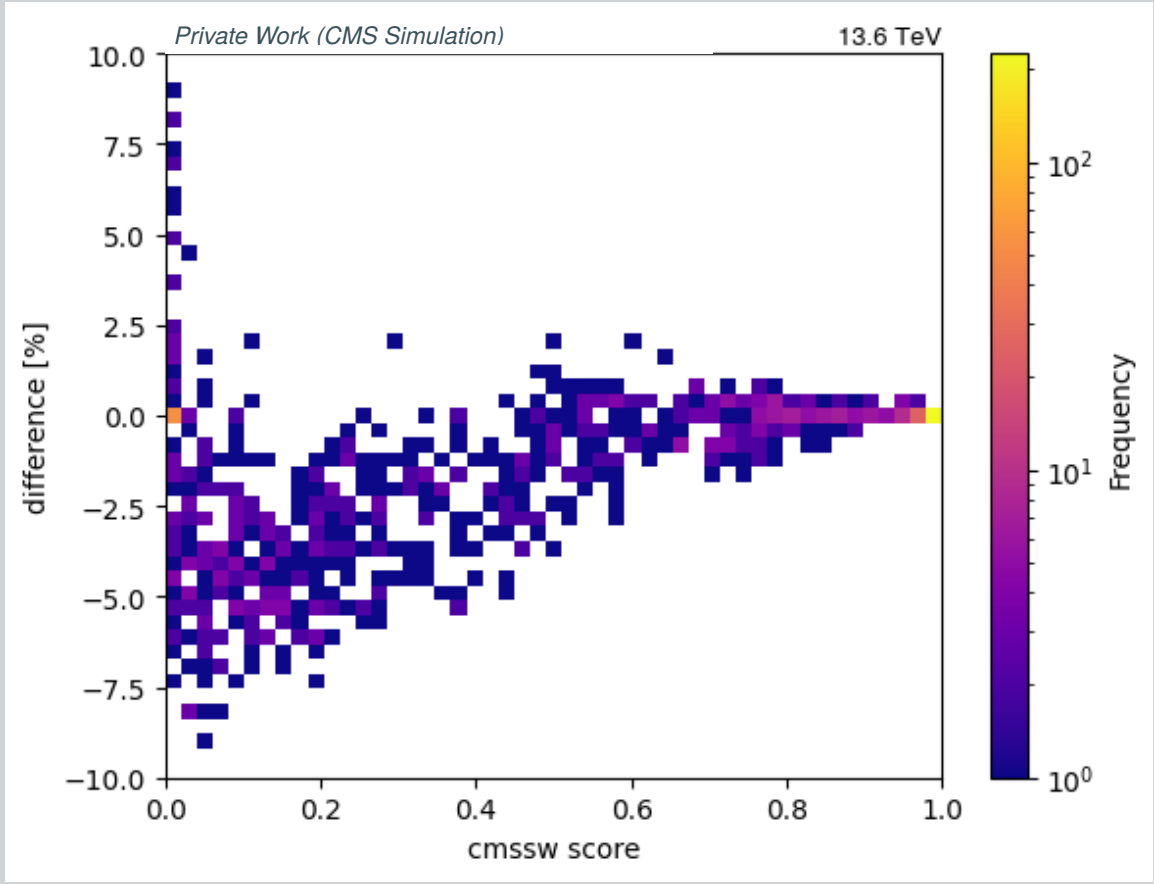
K. Kleinboelting, MSc thesis Uni Hamburg (2025)

next: l1 menu



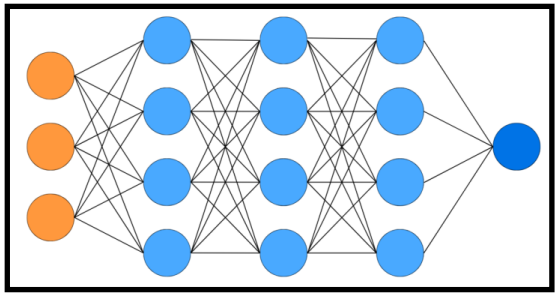
level-1 menu emulator



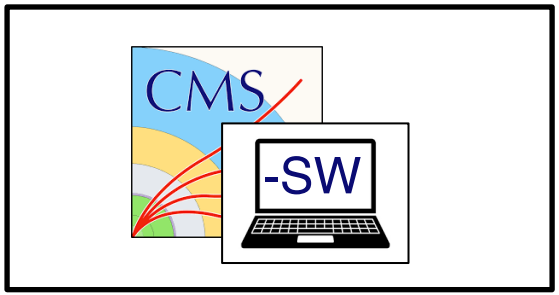


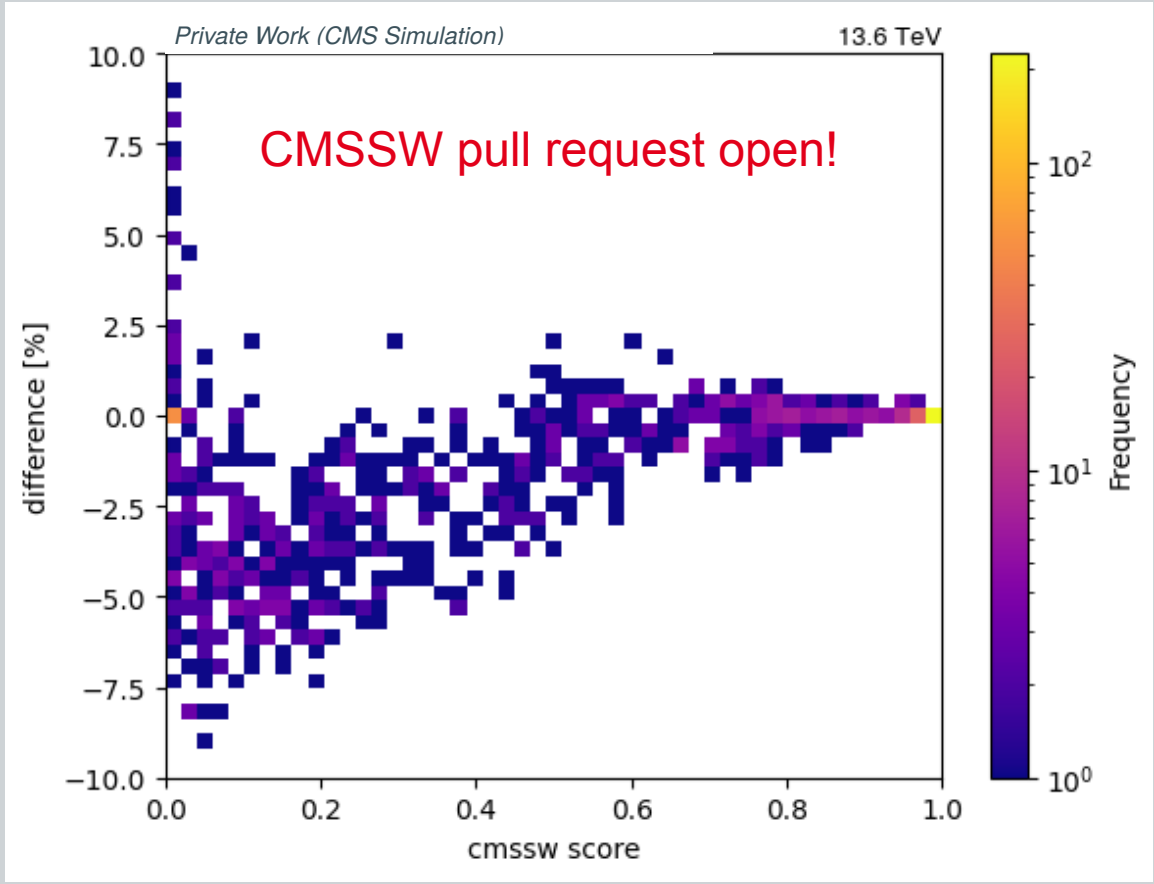
difference between keras score and cmssw emulator ≤ 2.5% (at relevant scores)

next: l1 menu

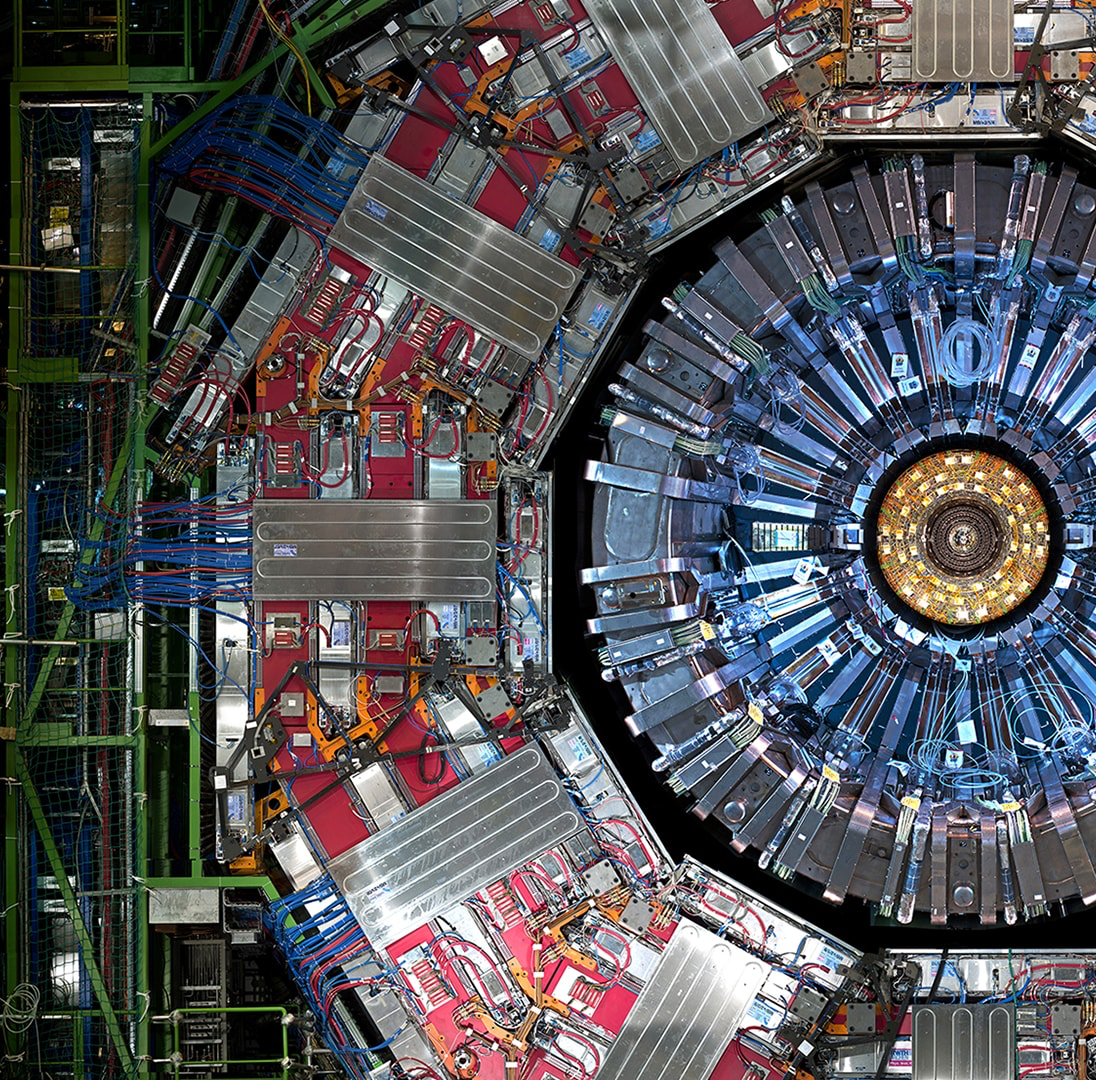


level-1 menu emulator





difference between keras score and cmssw emulator ≤ 2.5% (at relevant scores)



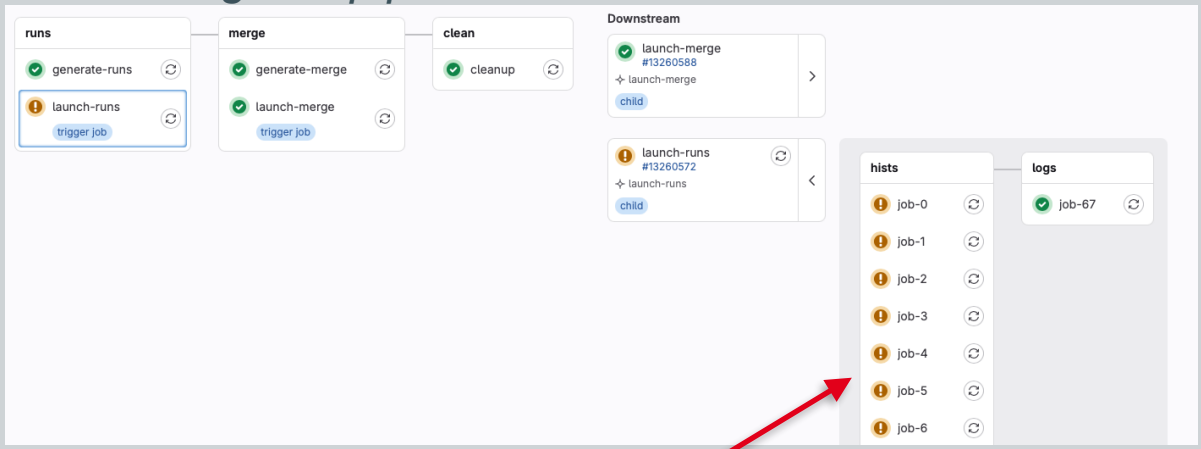
SERVICE WORK

automation framework

check twice per day:

new runs recorded
↓
produce histograms
↓
merge weeks/eras
↓
plotting scripts
↓
cernbox/webpage

based on gitlab pipelines:



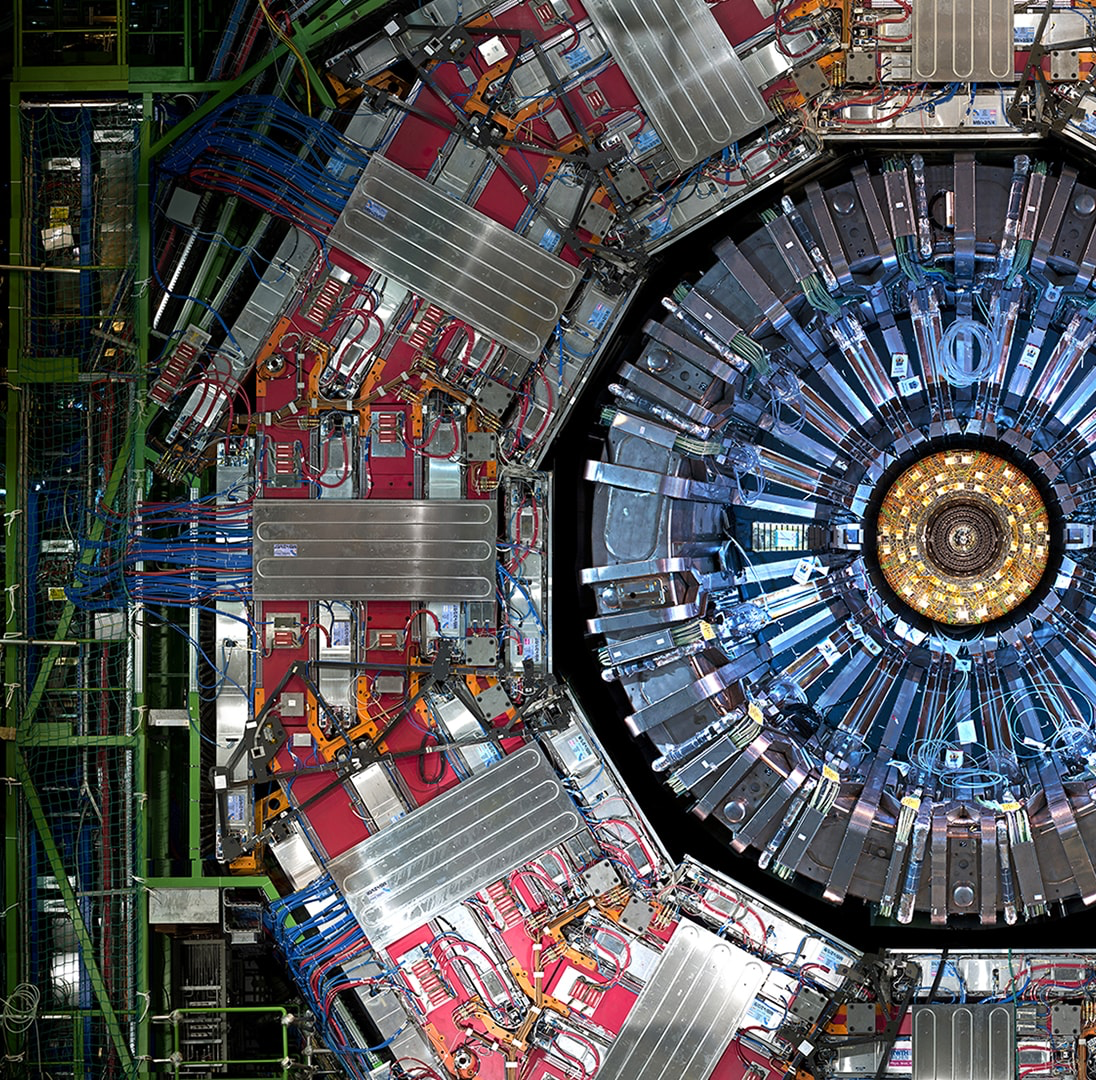
child-pipeline: jobs
scheduled at run time

5 + 1 EPR (shifts) ⇒ authorship since September

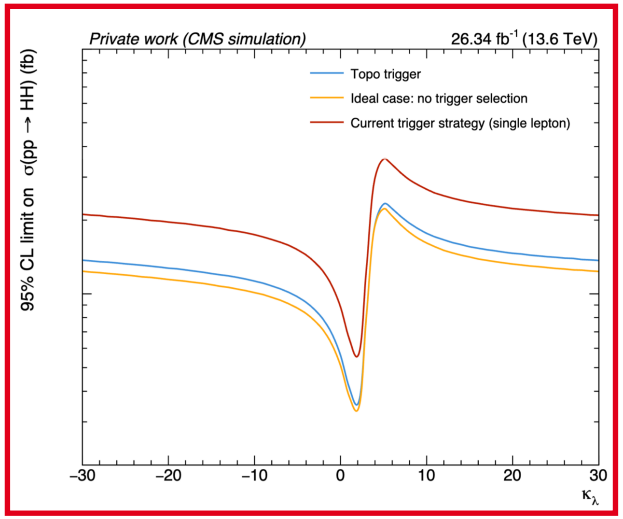
End of 2024 pp Running!

1 2 3 /fb

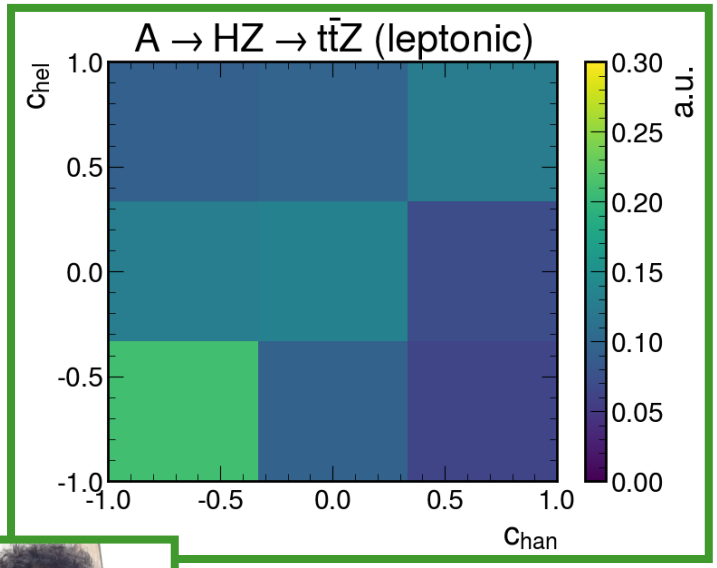
Wed 16 Oct 2024

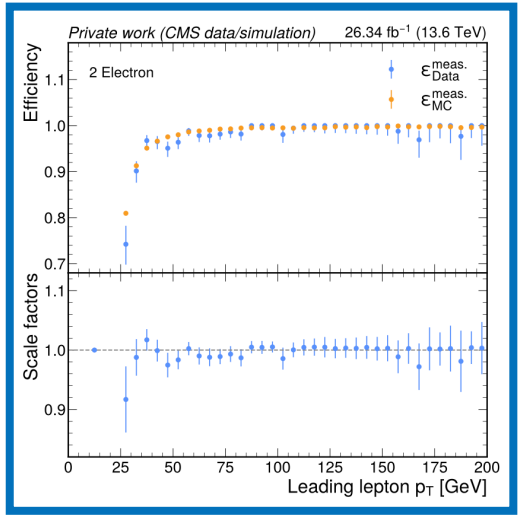


SUPERVISION
TEACHING
OUTREACH



Karla Kleinbölting:
Master thesis on topological trigger

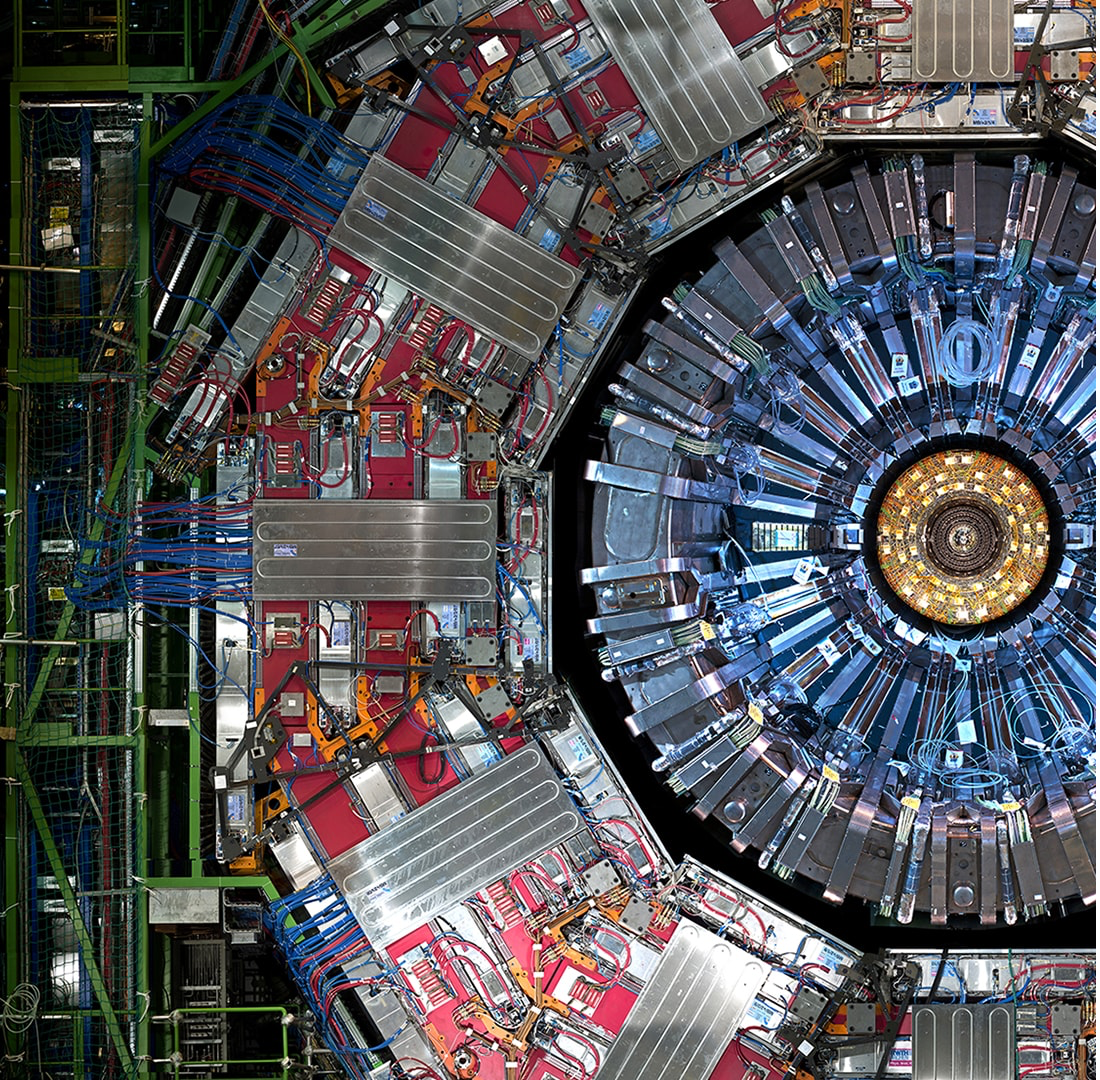




Balduin Letzer:
Master thesis on di-Higgs analysis, Trigger efficiencies

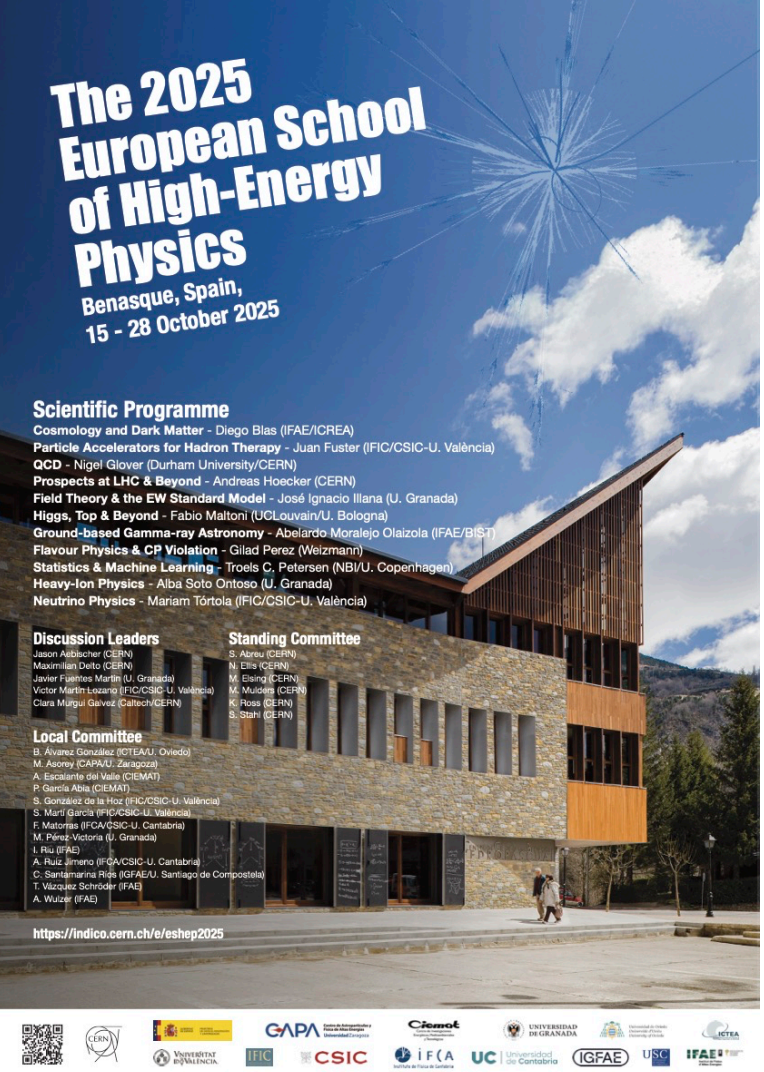
Elias Aramesch:
Upcoming bachelor thesis on spin variables in AZH analysis

in addition: Physics 5 exercises, HEP Masterclasses



SUMMARY
OUTLOOK

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?

Possible to focus more on statistics?

Five month report?

What to add to written report?

Computing School?
Conference talks? CERN?