CMS Job Matching Event September 2020

HELMHOLTZ
SPITZENFORSCHUNG FÜR
GROSSE HERAUSFORDERUNGEN

Junior-Faculty Positions at DESY-CMS

Top Quark + Jet Physics

Phase-II Upgrade of the CMS Outer Tracker + Detector R&D

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RESEARCH CENTRE: DESY

HELMHOLTZ
SPITZENFORSCHUNG FÜR GROSSE HERAUSFORDERUNGEN

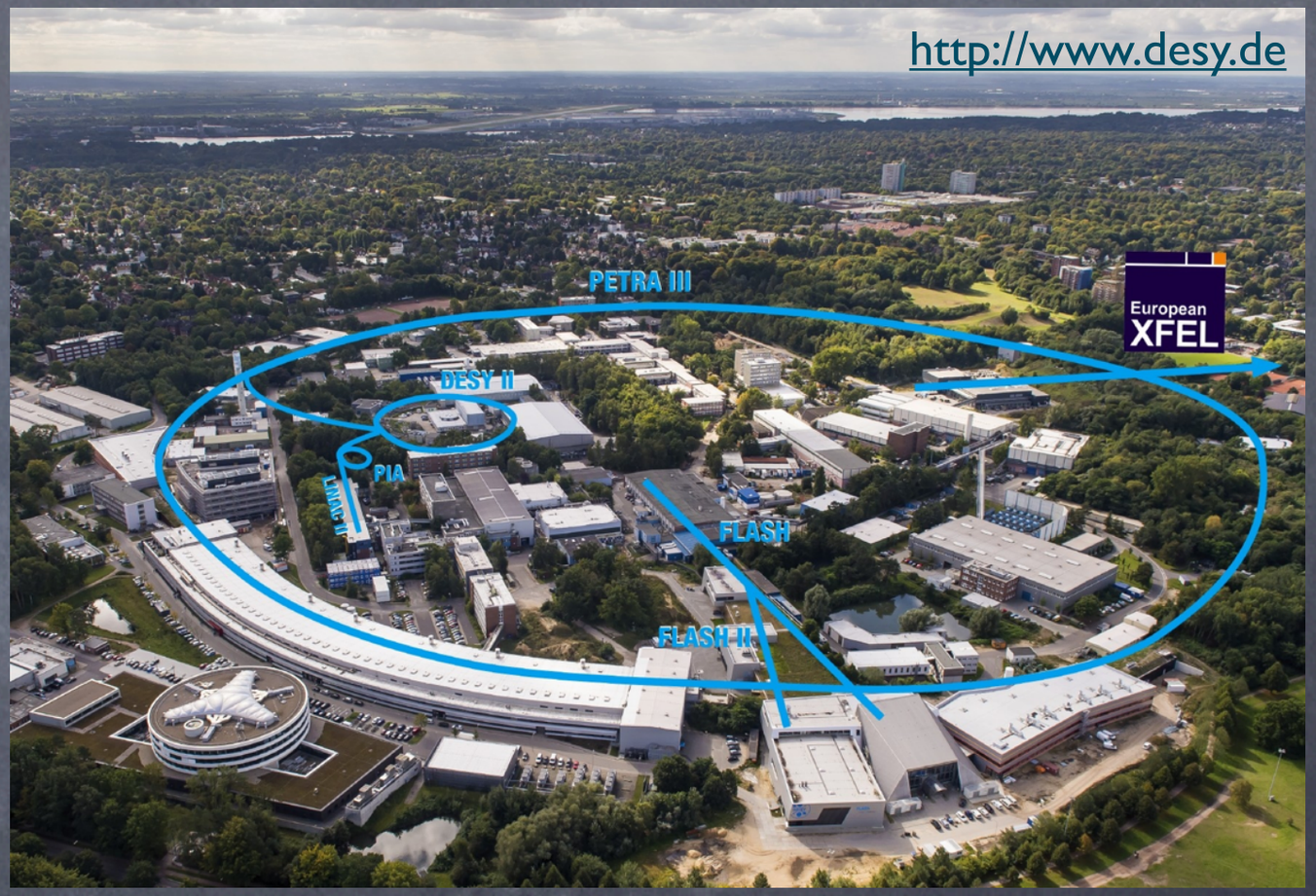
DEUTSCHES ELEKTRONEN SYNCHROTRON

Research centre of Helmholtz Association

One of Germany's largest laboratories for basic research with large-scale facilities

Founded 1959,
located in Hamburg and Zeuthen

650 staff scientists, 700 young scientists
3000 guest scientists from 40 countries



Fundamental & Applied Science:

- accelerator development & operation
- photon science
- particle and astroparticle physics

Leading the Helmholtz Research Programs in the Field "Matter": "*Matter and the Universe*" and *"Matter and Technology"*

Positions are associated to DESY, enrolment in PhD in a german university (div. options)

DESY INVOLVEMENT IN THE LHC PHYSICS

Analysis of the LHC data

- **DESY-CMS: top-quark and Higgs physics**
  leading role in the CMS TOP and TOPLHC
  focus on measurement of tt, tt+H, tt+jets,

- **DESY-CMS: properties of jets**
  leading CMS analyses of inclusive
  jet, jet+EW bosons, W+charm,

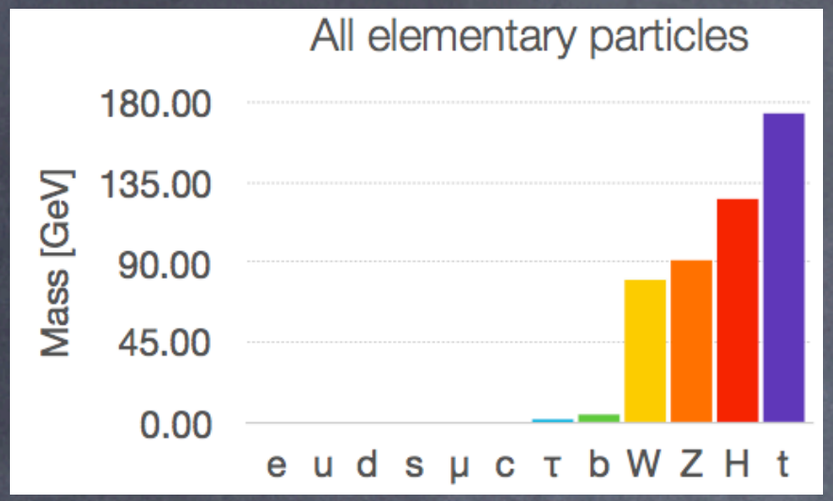
Interpretation: proton structure, top mass, strong coupling, EFT, new physics

Grid Computing: Tier-2 center

LHC Detector upgrade DESY-CMS provides major contribution in building the new silicon outer tracker (R&D, maintenance and integration in CMS)

Collider Physics Theory in Hamburg
Scientific exchange programs with phenomenology-groups in USA and Europe

TOP QUARK PHYSICS

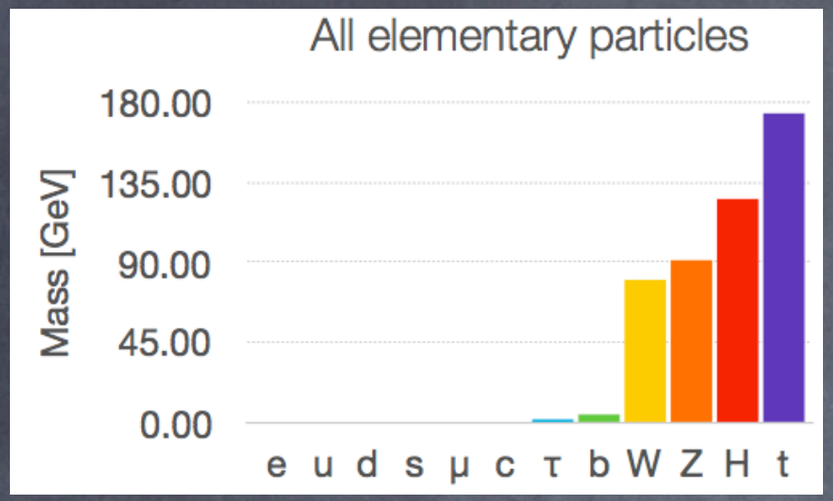


Most massive elementary particle known to date

Decays before hadronizing, does not form bound states

➔ ideal to study ‘bare quark’ properties

TOP QUARK PHYSICS



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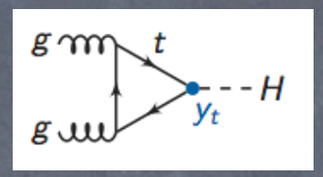

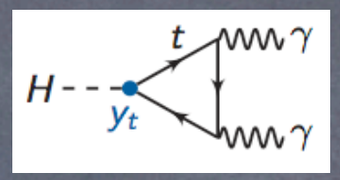

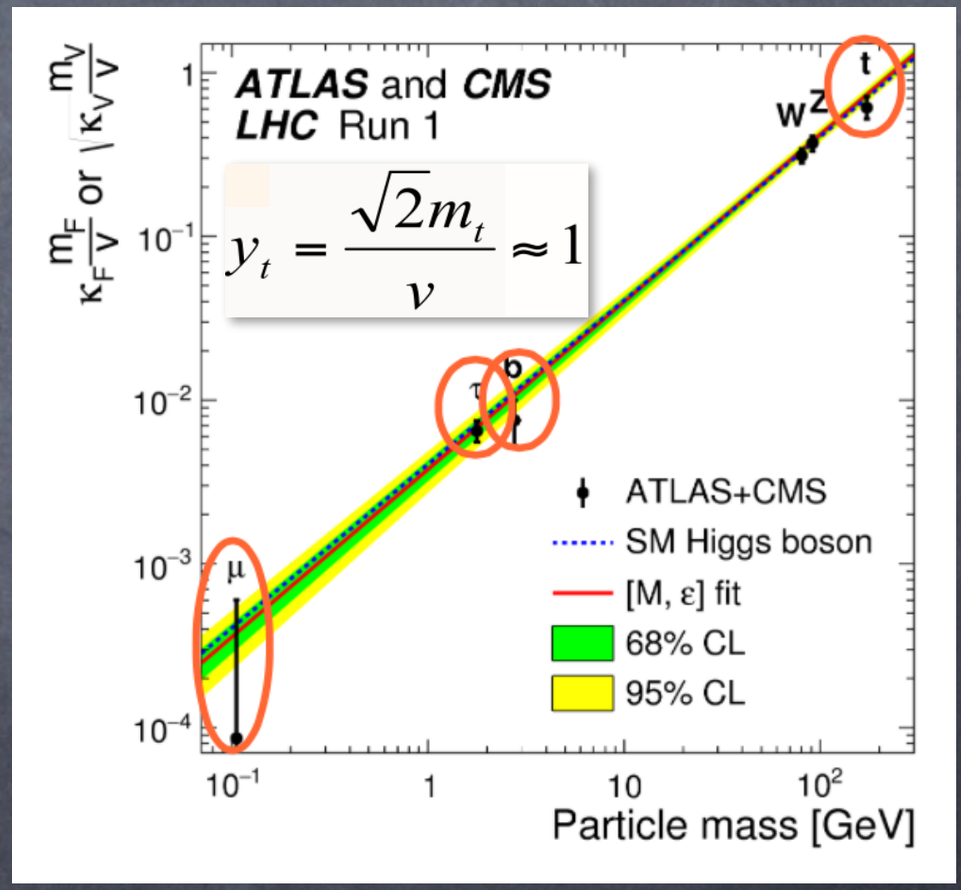

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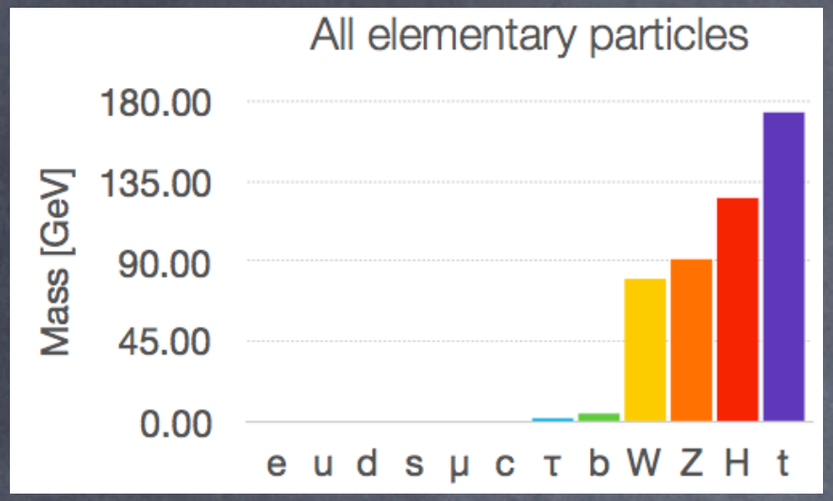

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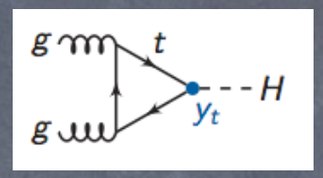
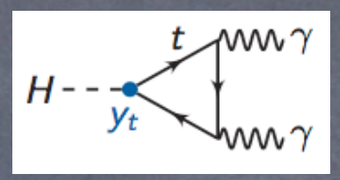
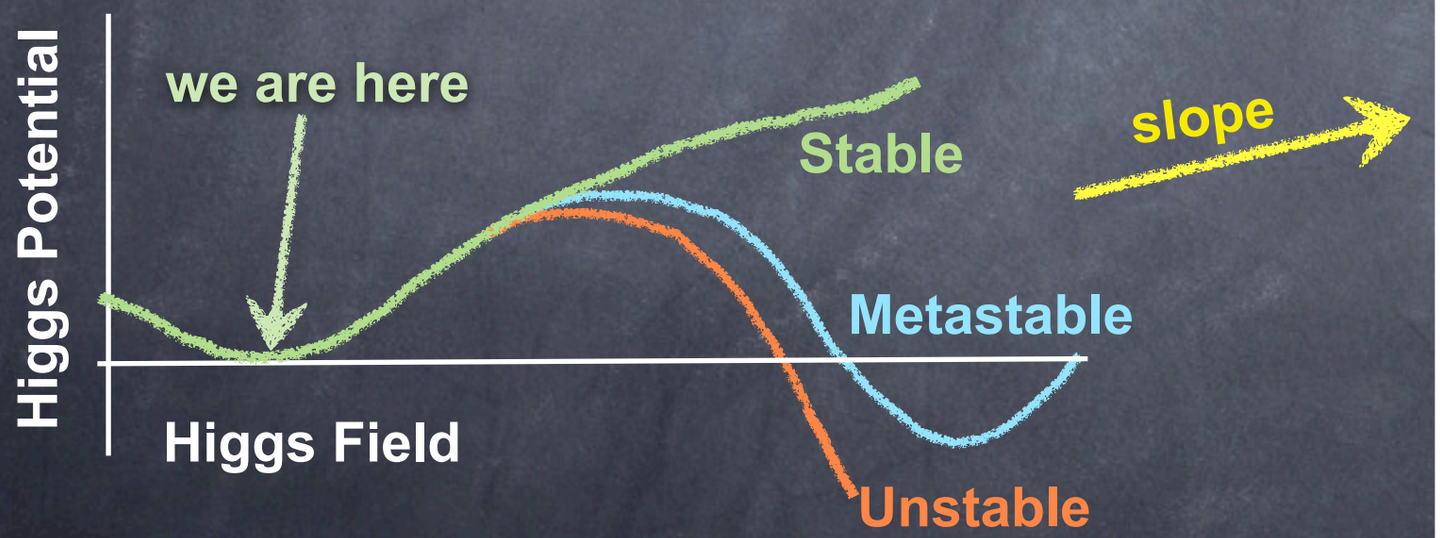




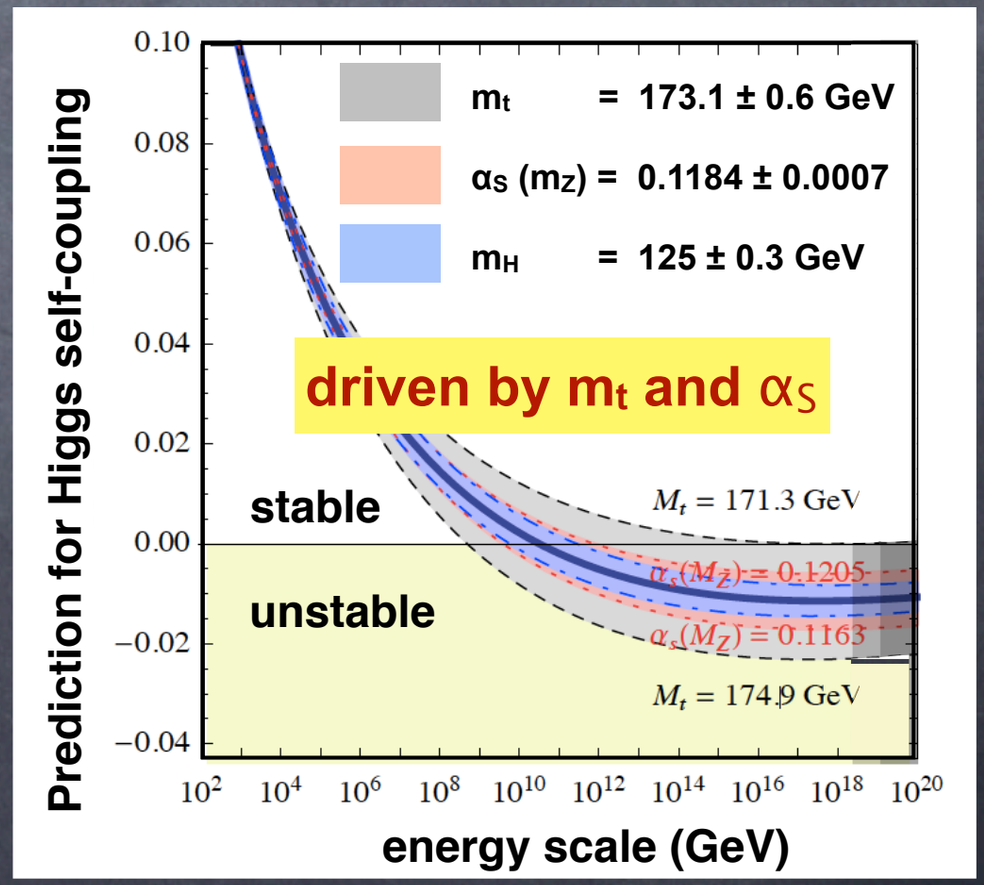
Special role in the Standard Model

- **EW vacuum stability: Higgs quatric coupling λ > 0**



NB: New Physics would change this picture

e.g. G.Degrassi et al, JHEP 1208 (2012) 098



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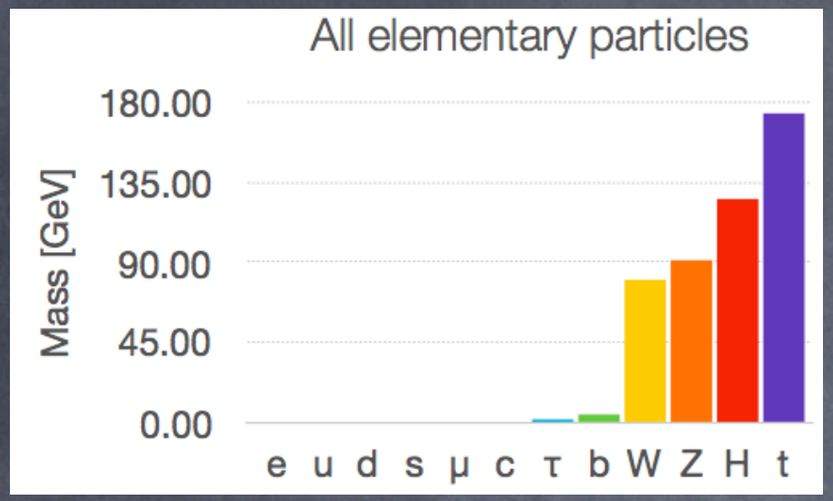

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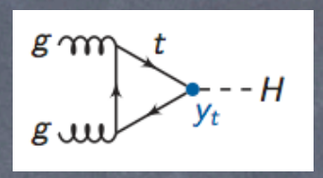
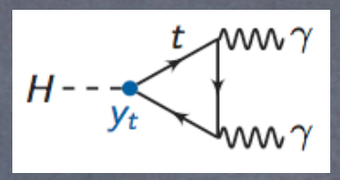


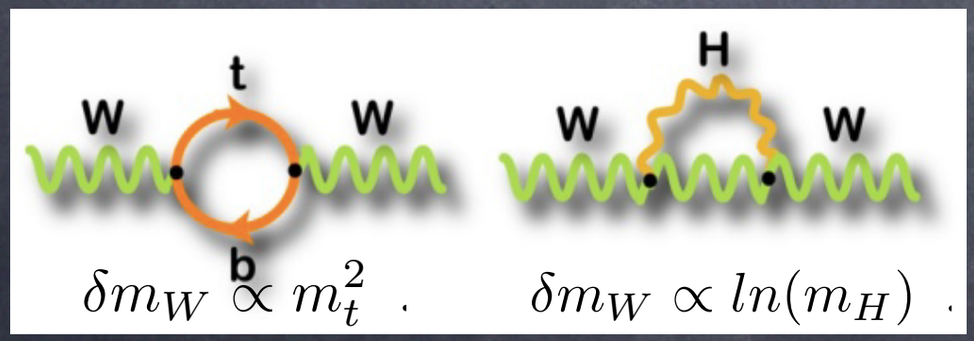


Special role in the Standard Model

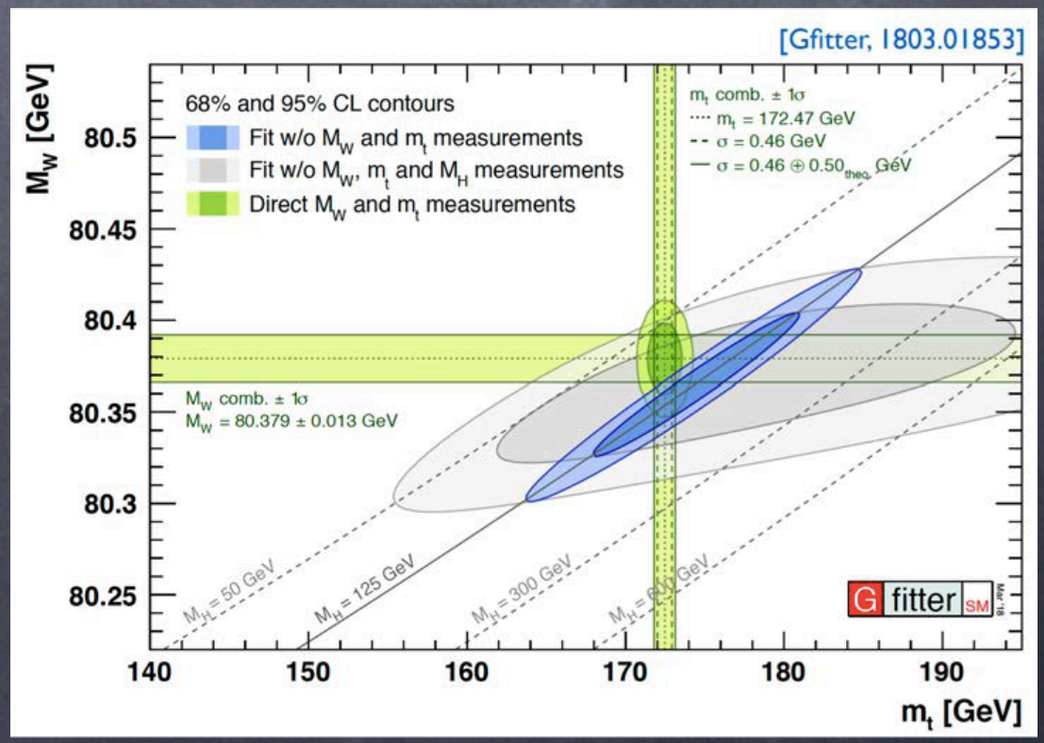
- **EW vacuum stability: Higgs quatric coupling $\lambda > 0$ is driven by m_t and α_S (+ uncertainty)**
- **Fundamental SM parameters: m_t , m_H and m_W**

values to be measured experimentally

their relation is predicted in the SM



➔ ideal to test self-consistency of the Standard Model



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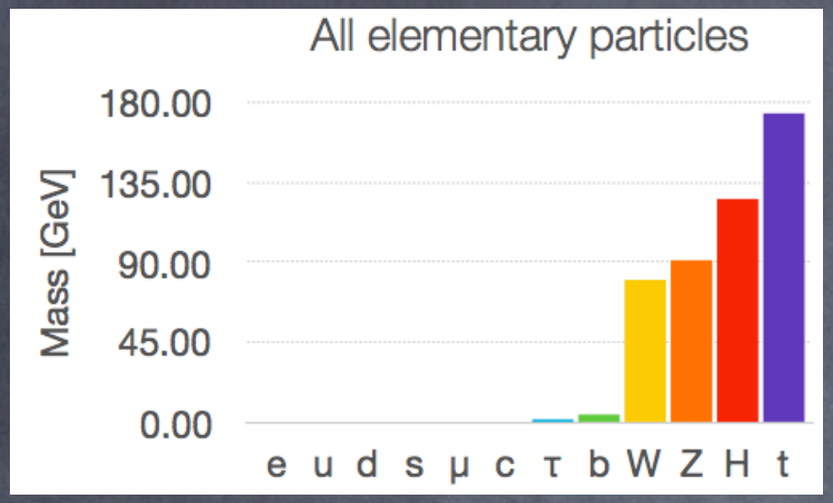

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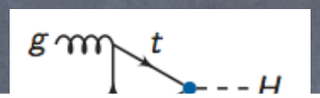
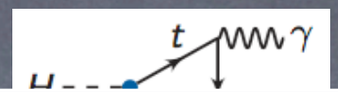




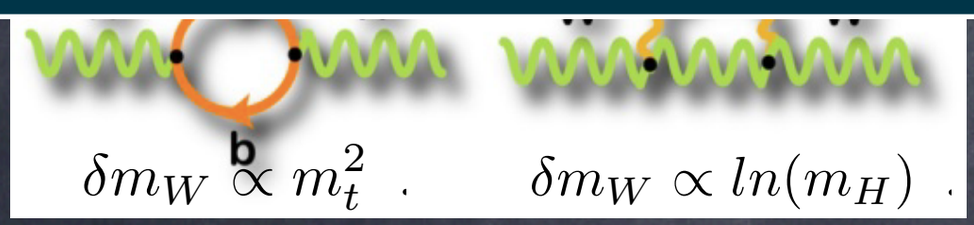
Top quark: the object for precise tests of Standard Model self-consistency !

DESY-CMS: leading in QCD parameter extraction using tt and ttj:

most precise top quark mass in pole and MS schemes,

top quark mass running, strong coupling, PDFs, EFT interpretation,...

working closely to leading theory groups in the field



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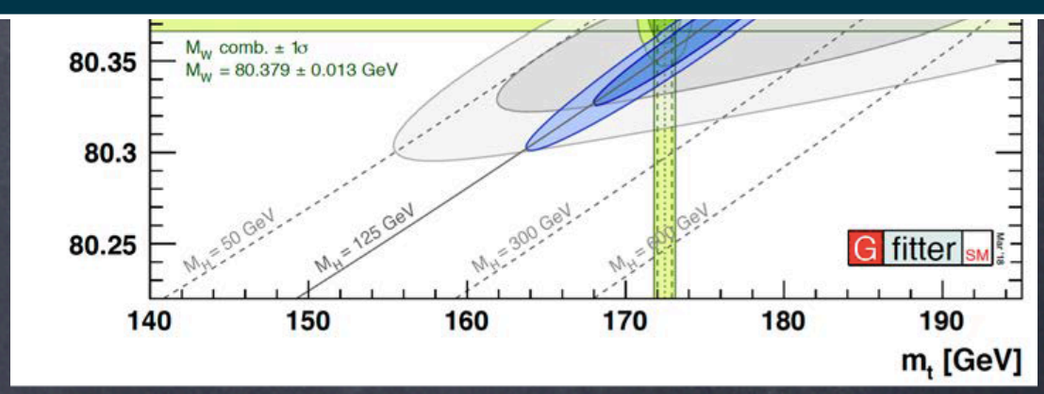
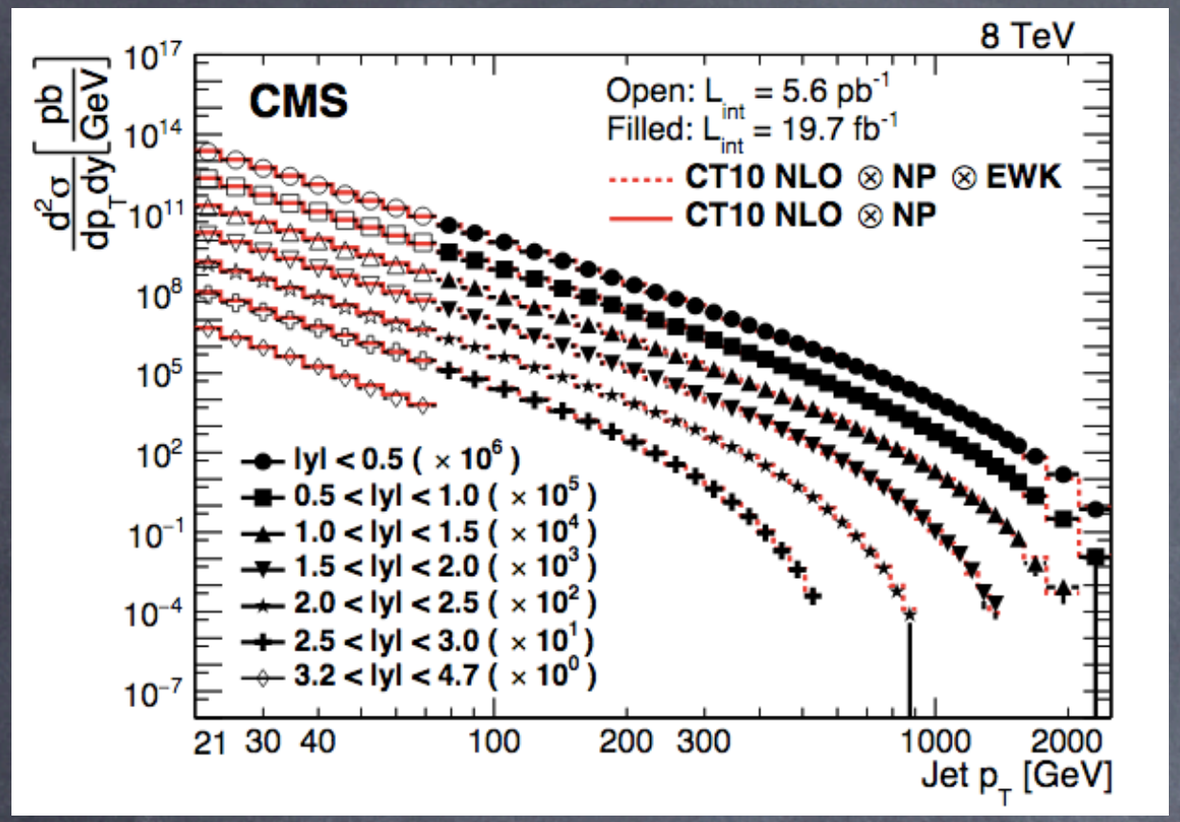
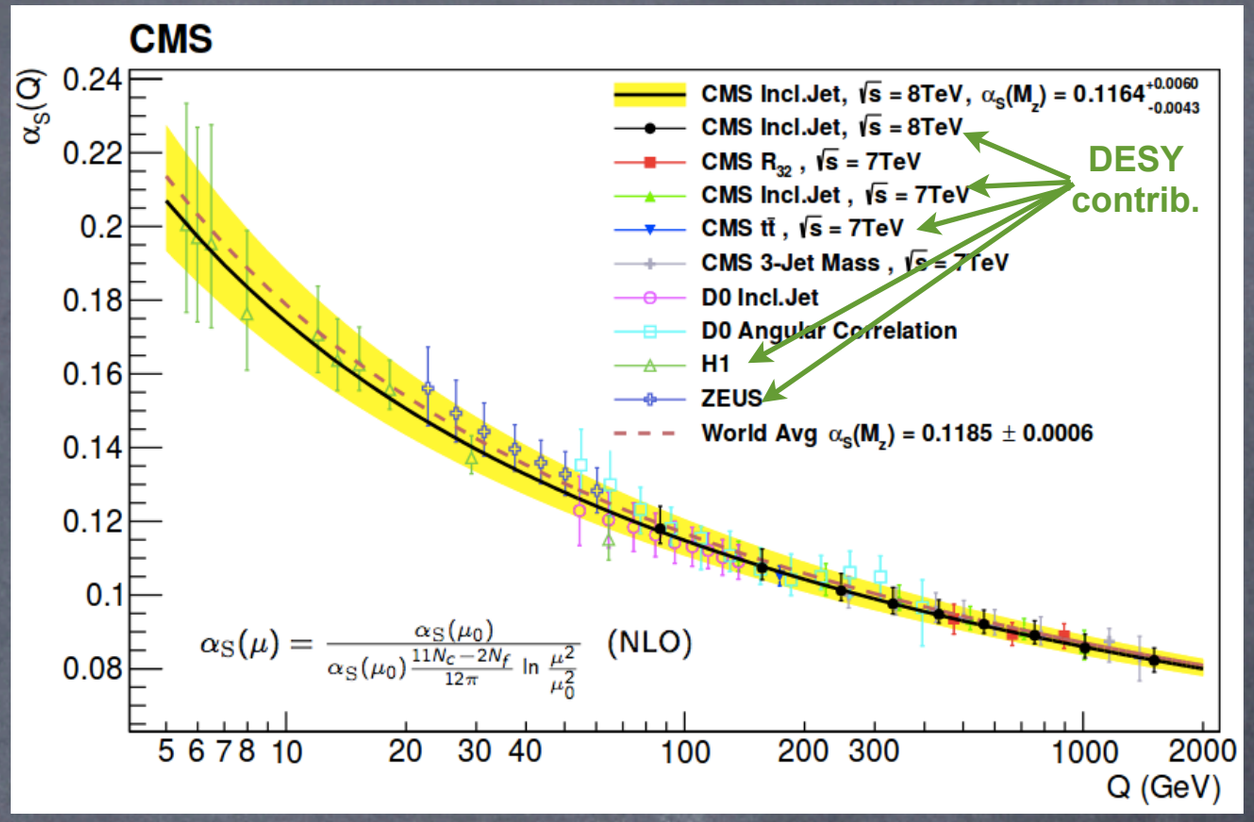


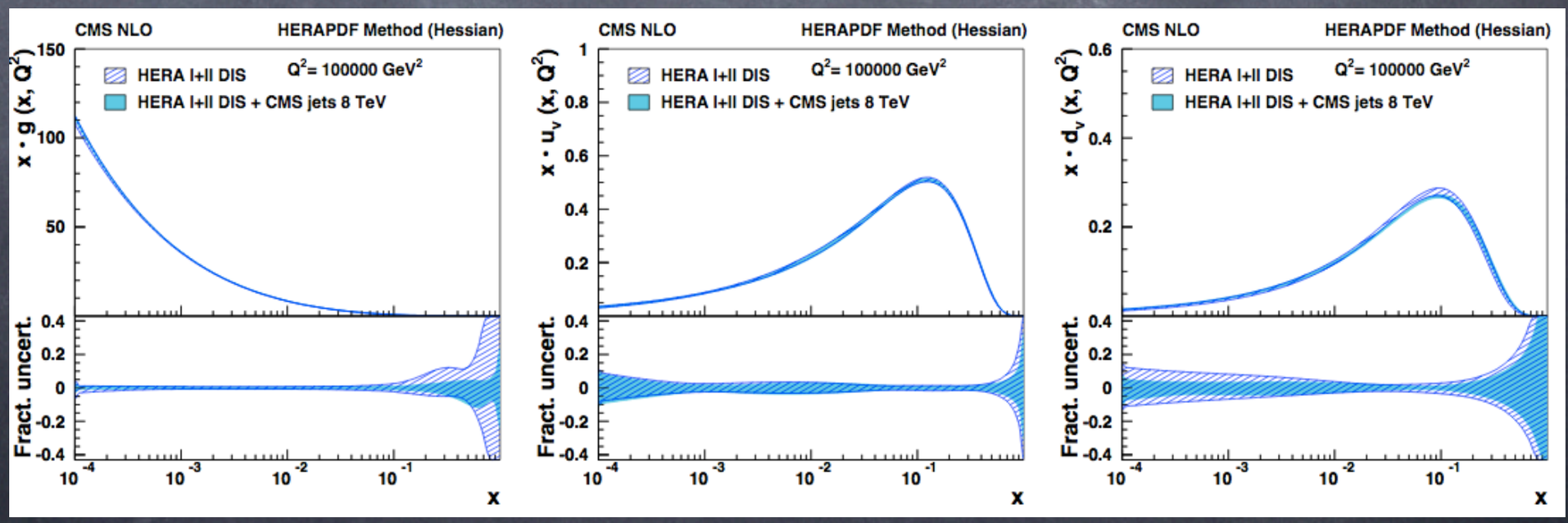
JET PRODUCTION, QCD AND NEW PHYSICS

Most fundamental process to study QCD, extract strong coupling and its running,





and improve precision of the proton structure



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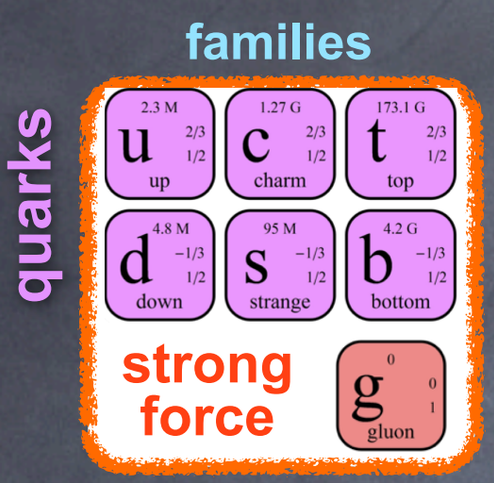


Most powerful probe of New Physics via indirect search!

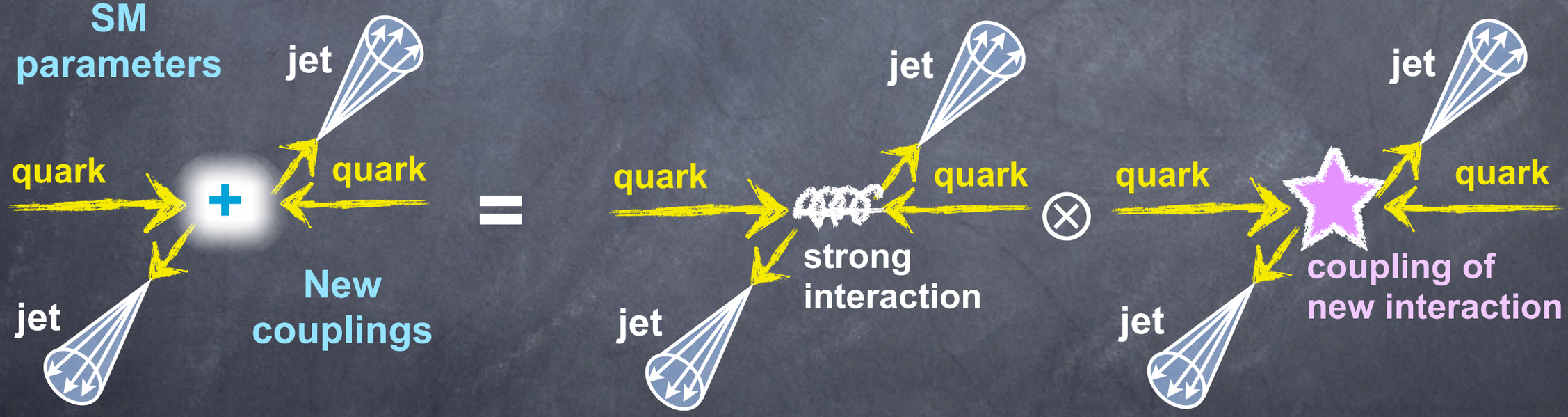
Standard Model: 3 "families" of elementary particles

But only 1st makes up stable matter → Hint to New Physics?

Idea: quarks could be composed of more fundamental objects

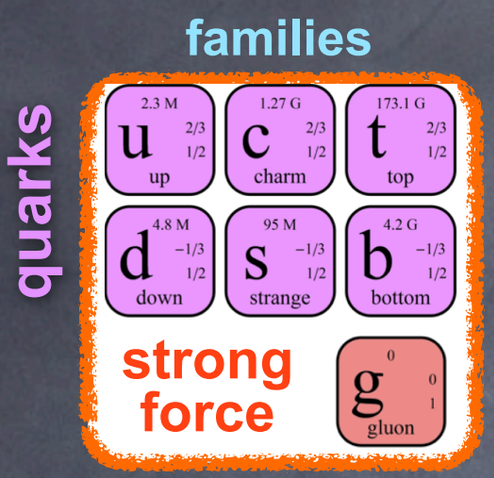
→ fundamentally new interaction of quarks at very high energy

Signature of new physics: deviation from Standard Model expectation



Ongoing analysis: first unbiased search for contact interactions at 13 TeV in a SMEFT fit

JET PRODUCTION, QCD AND NEW PHYSICS



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Signature of new physics: deviation from Standard Model expectation

Jets production: the process for QCD tests and CI searches

DESY-CMS: leading in jet measurements and QCD parameter extraction

strong coupling, PDFs, SMEFT fit

working closely to leading theory groups in the field

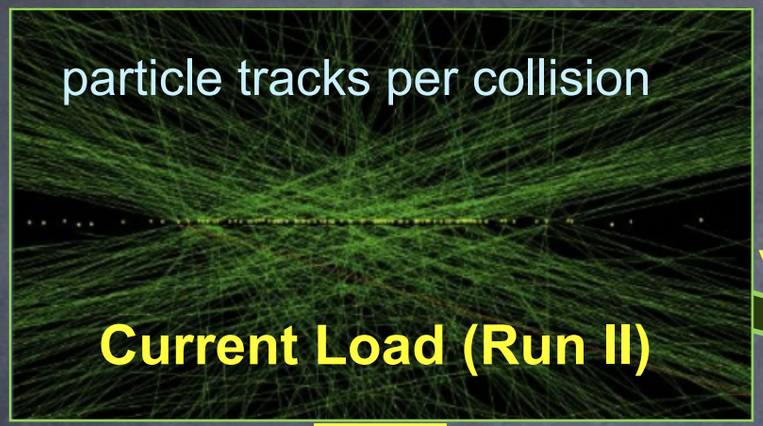
Ongoing analysis: first unbiased search for contact interactions at 13 TeV in a SMEFT fit

DESY INVOLVEMENT IN CMS UPGRADE

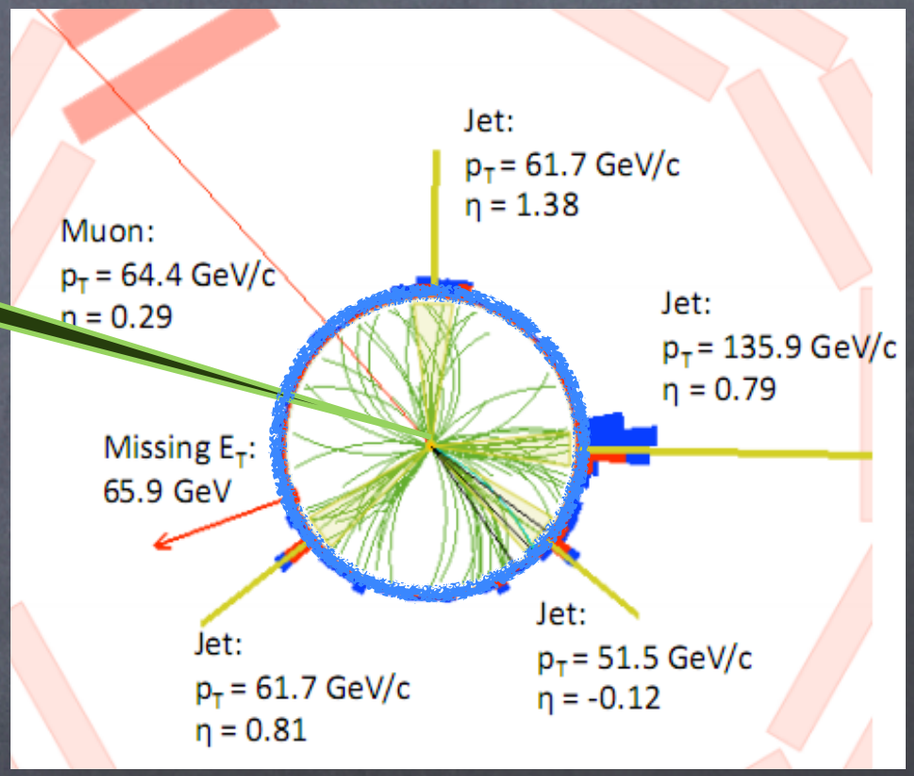
LHC: collider at frontiers of collision energy & rates ➜ the facility for precision

2026 ➜ High-Luminosity LHC: increase of the detector load ***~ 7 x higher rates***

Technological challenge for the experiment: unprecedented radiation level, extreme hit rates, huge data volumes



side view



top quark decay seen in the CMS tracking detector

Complete redesign of the CMS tracker: high granularity, light weight and rigid!

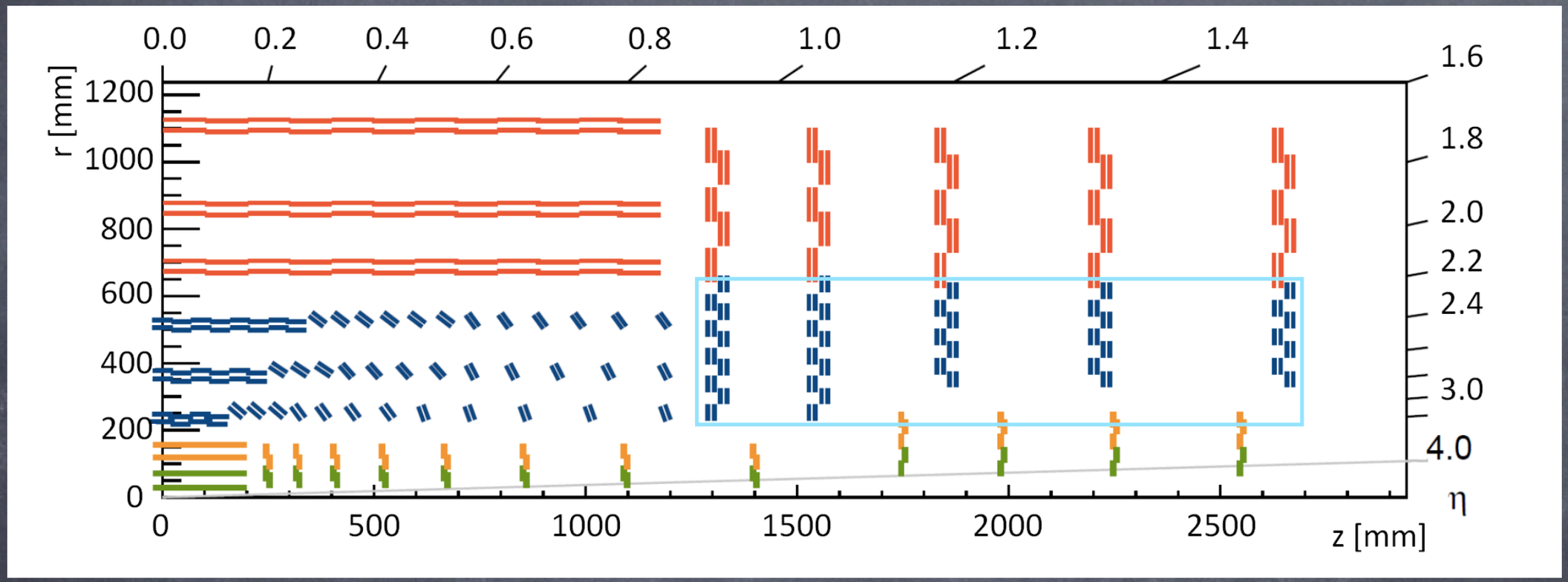
New ideas of data recording/trigger needed!

DESY INVOLVEMENT IN CMS UPGRADE

Silicon Tracking Detector Phase II Upgrade:

deal with ~200 collisions per 25 ns (~1200 charged tracks per unit of pseudorapidity)

quarter section of the new tracker:



rapidity increased (wrt current tracker) from |η|< 2.4 to 4

Outer Tracker: combination of silicon pixel and silicon strip technology

6 cylindrical barrel layers in the central region of |z| < 1200 mm

5 endcap double-discs on each side, in the region of 1200 < |z| < 2700 mm

DESY INVOLVEMENT IN CMS UPGRADE

Silicon Tracking Detector Phase II Upgrade:

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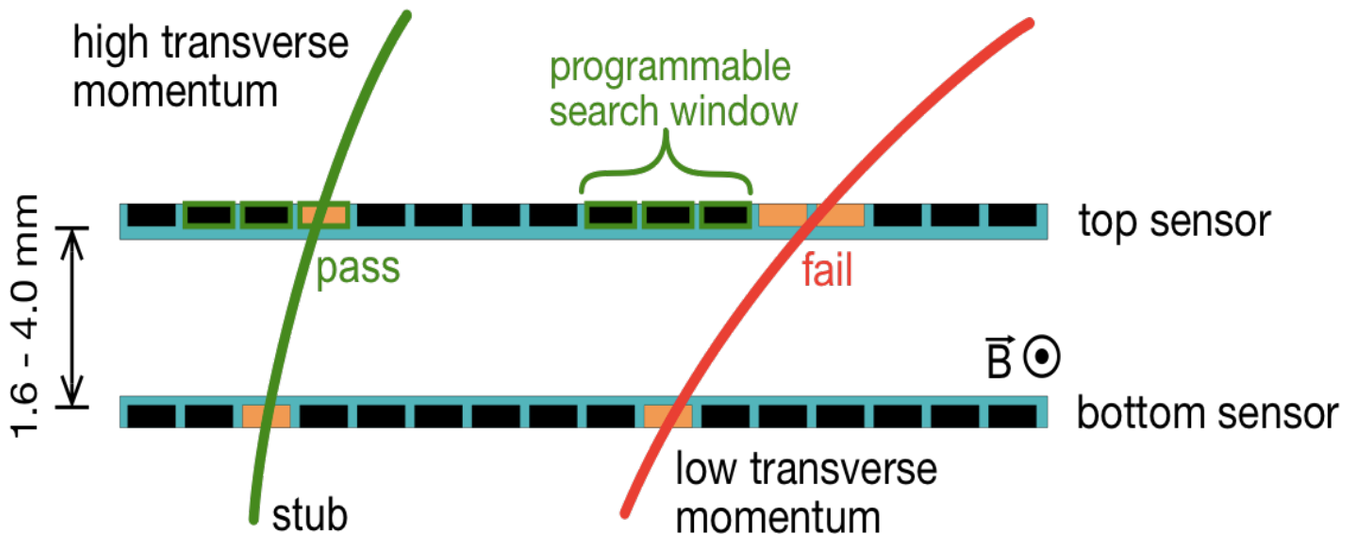
Detecting element: p_T module - selection of relevant information happens inside!

Level-1 trigger functionality implemented



2 GeV cut removed 99% of tracks

position + curvature transferred to the back-end and further to Track Finder

data processed and fitted track parameters provided to L1 in 4 μs

Modules:
2S: with two closely spaced parallel strip sensors
PS: with one macro-pixel and one strip sensor

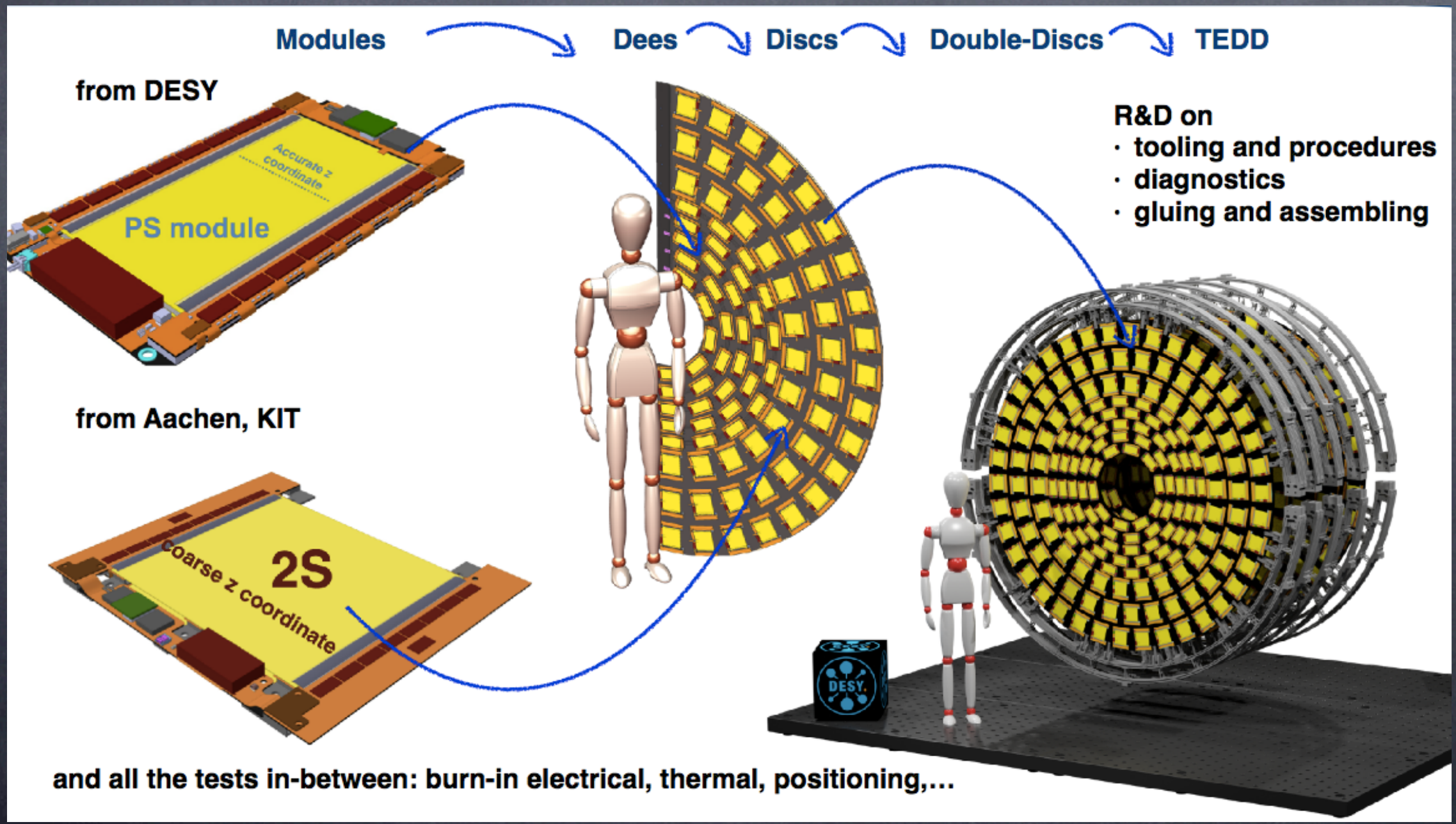
DESY INVOLVEMENT IN CMS UPGRADE

DESY-CMS:

assembly of 1250 PS modules,

burnin for modules from DESY, 1000 2S modules from Aachen

assembly of Tracker End Cap Double-Disks (TEDD)



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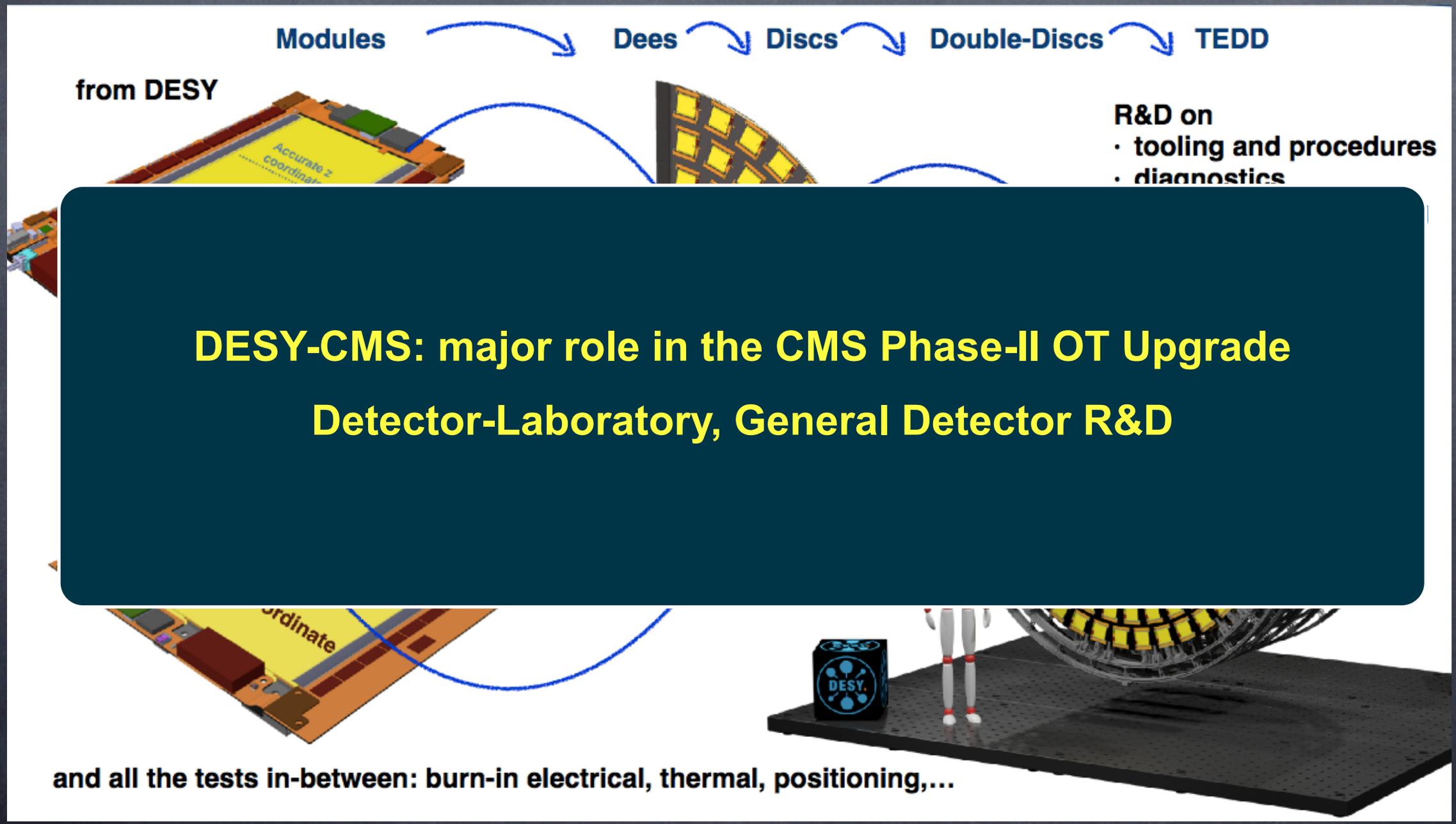

2 JUNIOR-FACULTY POSITIONS IN OCTOBER 2020

Within the Project of DESY and University of Wuppertal (Prof. K. Lipka)

Position 1: coordination and contribution to analyses in TOP and QCD groups at DESY collaboration with ATLAS and theory groups

Position 2: responsibilities in Outer Tracker assembly and testing, possibility to join R&D activities of novel CMOS sensor

Required post-doctoral experience in data analyses/detector developement

Positions based in Hamburg, hired by DESY

Costs: regular public service E13/ (+ step according to work experience)

Social insurance + unemployment, retirement, health care taken care of

Duration: 5 years, starting date (erliest) 01.01.2021

Possibility to attain teaching experience and further academic qualification (habilitation)

+ profit from: **Stays at CERN, conferences, schools (once COVID is gone)**
Exchange programs with IFIC Valencia, KSU Georgia, SMU Dallas

ADDITIONAL INFORMATION

You want to join us but not yet eligible to apply for 5-year position (just done PhD)

further possibilities to join our projects are:

DESY Fellowship (deadline 30. September / 31. May every year)

https://www.desy.de/career/career_programs/fellowships/experimental_particle_physics index_eng.html

Humboldt Fellowship

https://www.research-in-germany.org/en/research-funding/funding-programmes/avh-humboldt-researchfellowship-for-postdoctoral-researchers.html

CONTACT US:

Prof. Katerina.Lipka@desy.de position details, further possibilities

Dr. Maria.Aldaya@desy.de CMS-DESY TOP group, LHCTOP

Dr. Doris.Eckstein@desy.de CMS-DESY UPGRADE, Detector R&D