

Summary of ATLAS Activities in Sweden

Partikeldagarna 2018, Lund

October 17, 2018

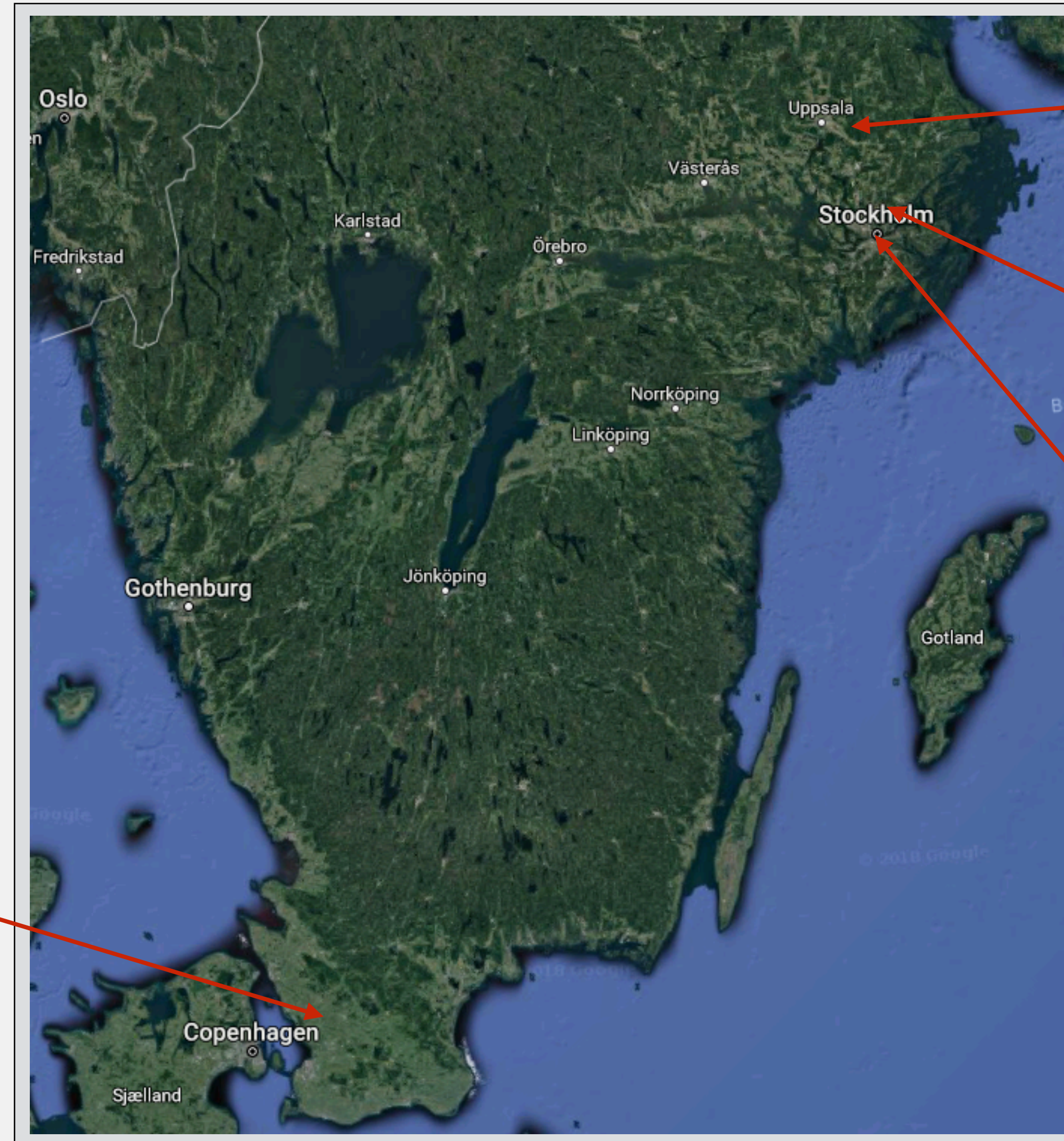


Ruth Pöttgen
on behalf of the Swedish ATLAS Groups



LUNDS
UNIVERSITET

Who are we?



~15 members

UPPSALA
UNIVERSITET



~5 members



~25 members



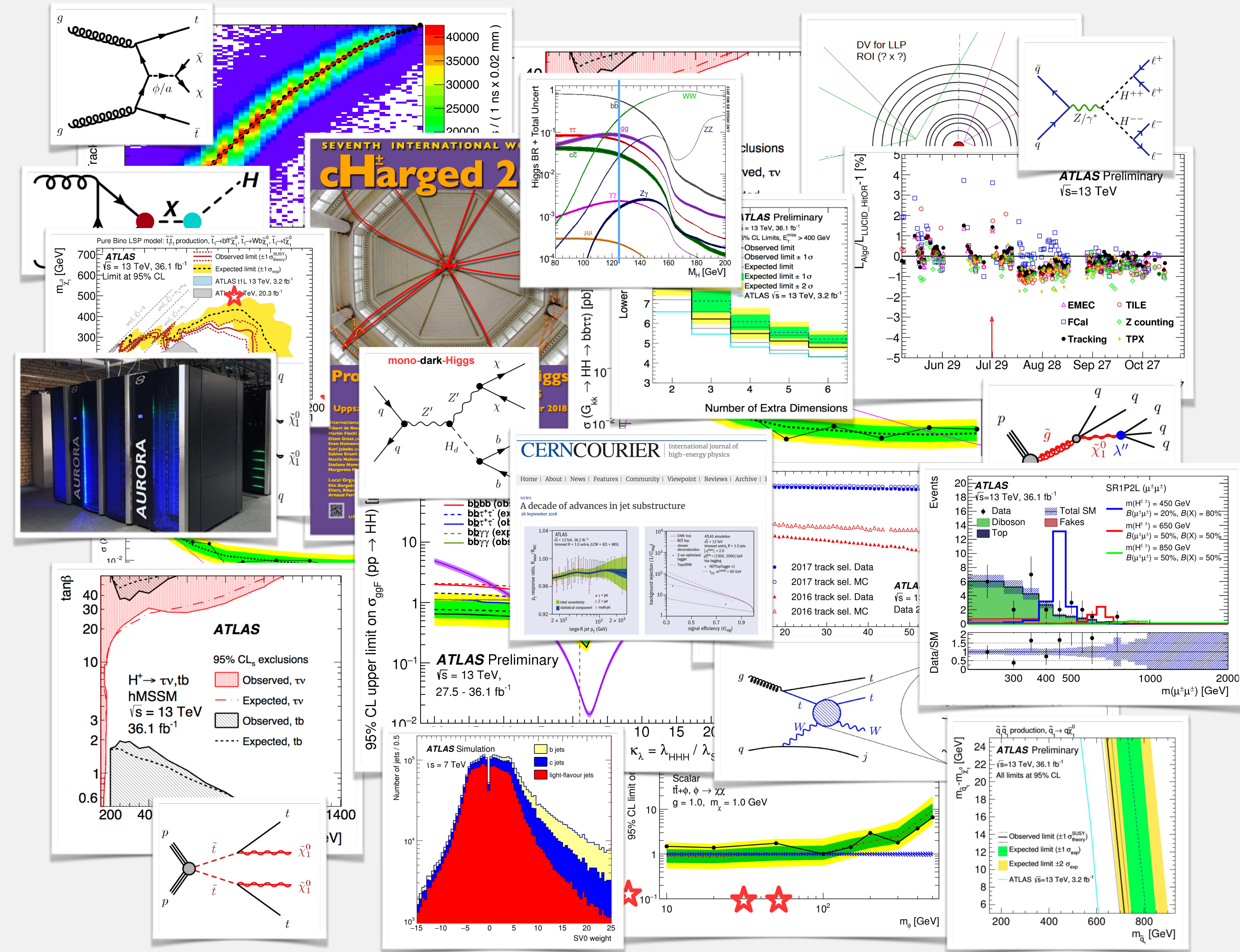
LUNDS
UNIVERSITET

~20 members

* numbers not well normalised

Many things going on!

09:00	Introduction
09:05	Overview of physics and combined performance topics at KTH Speaker: Jonas Strandberg (KTH Royal Institute of Technology (SE)) KTH-ResearchTopic...
09:25	Overview of physics and combined performance topics at LU Speaker: Kristian Damlund Gregersen (University College London (UK)) Lund.pdf
09:45	Overview of physics and combined performance topics at SU Speaker: Alex Kastanas (Stockholm University (SE)) SU.ATLAS.PhysicsA...
10:05	Overview of physics and combined performance topics at UU Speaker: Rebeca Gonzalez Suarez (Uppsala University (SE)) UU_ATLASSwedenD...
10:20	Break
10:40	Brainstorming in small groups

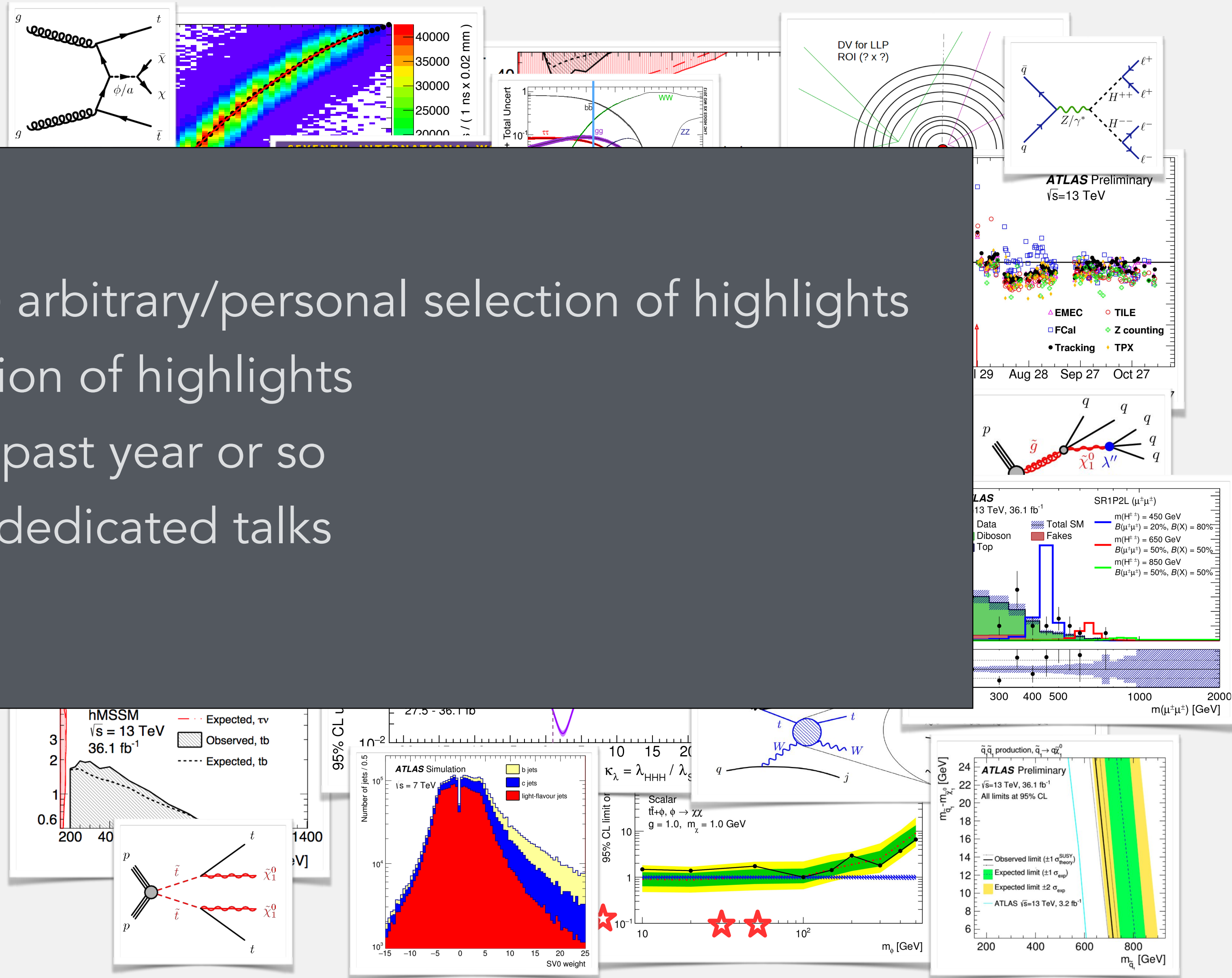


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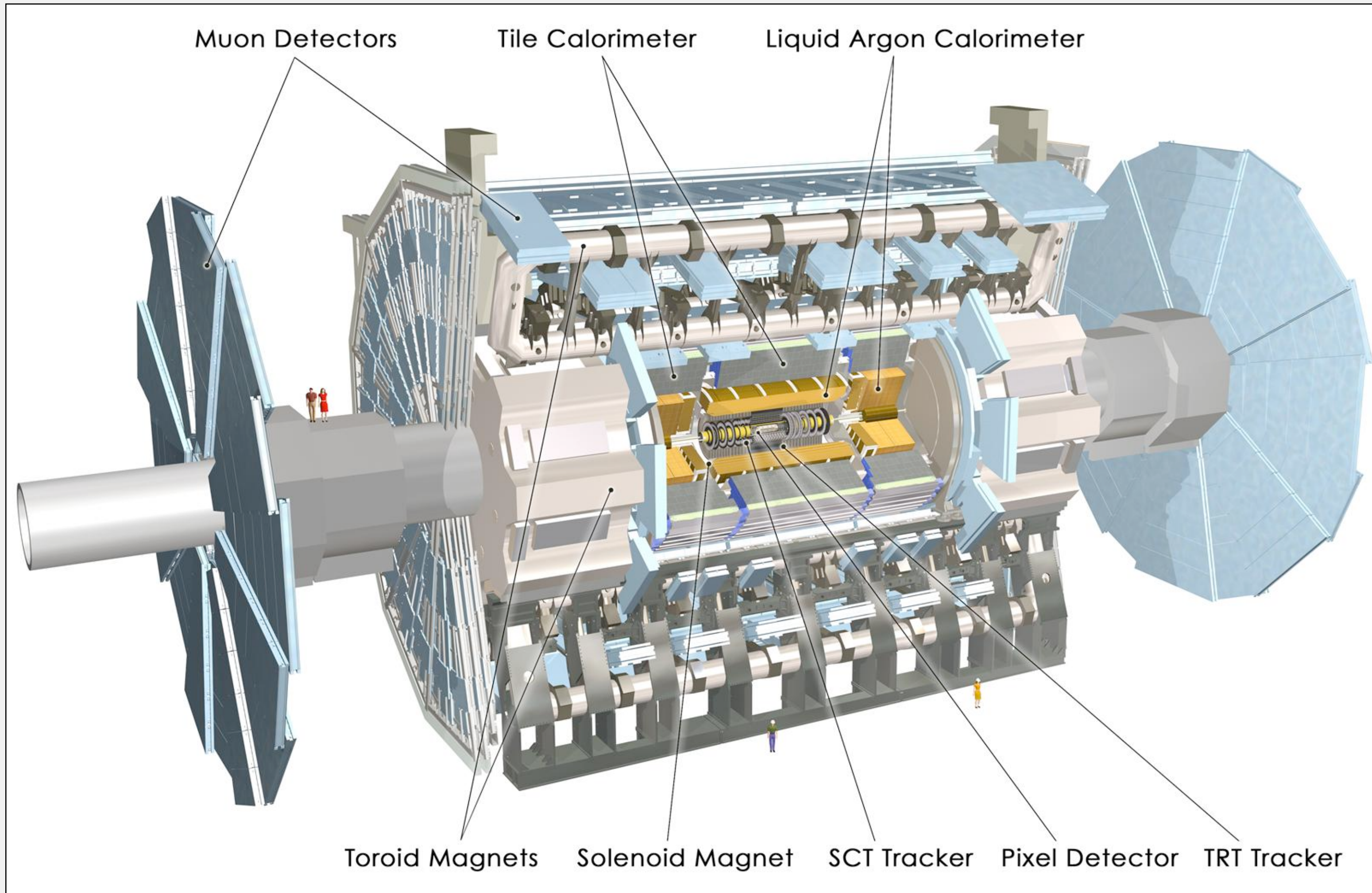
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here:

- only (somewhat) arbitrary/personal selection of highlights
- out of a selection of highlights
- snapshot of the past year or so
- please see also dedicated talks
- and talk to us!

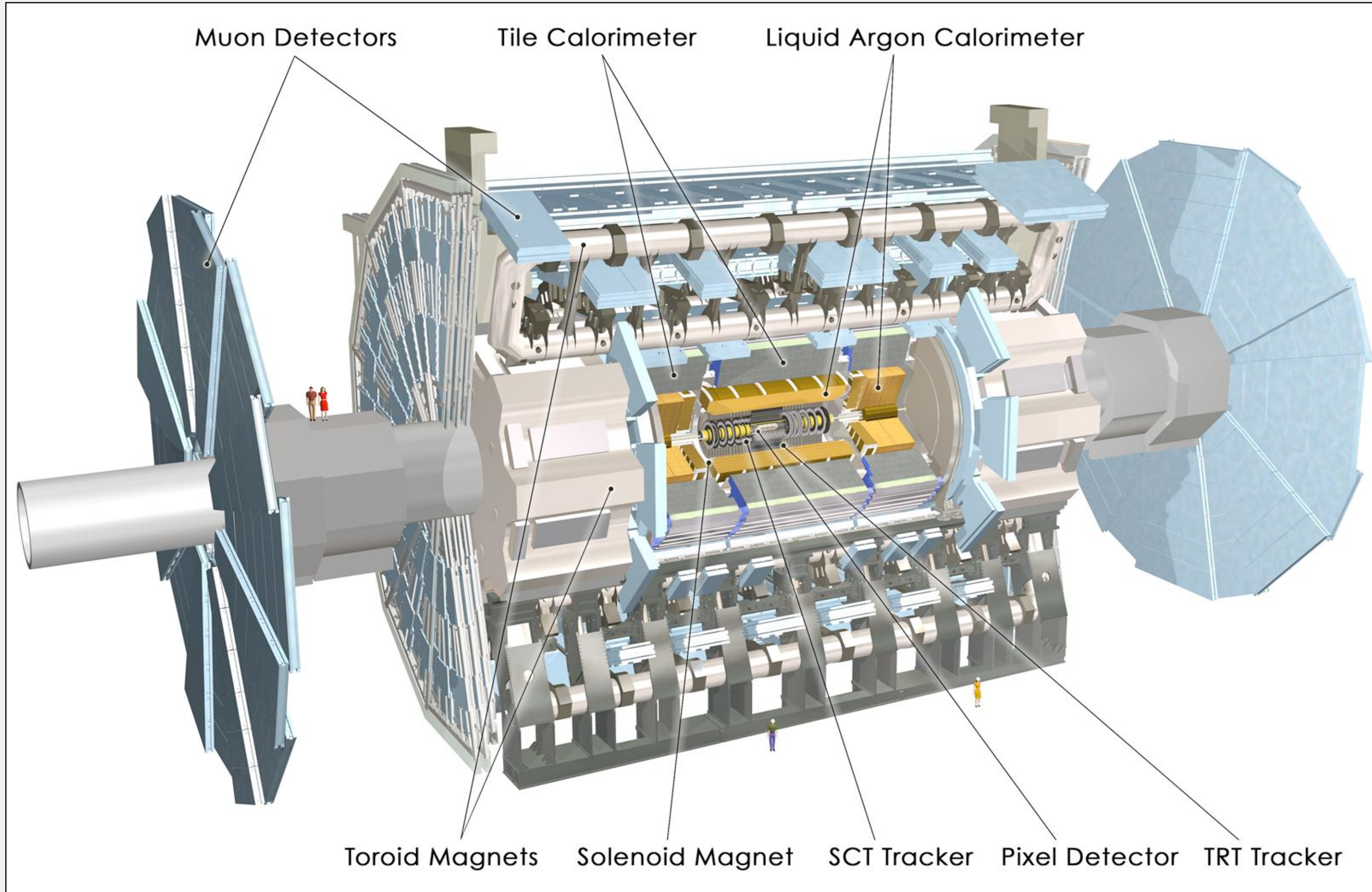


What is ATLAS?



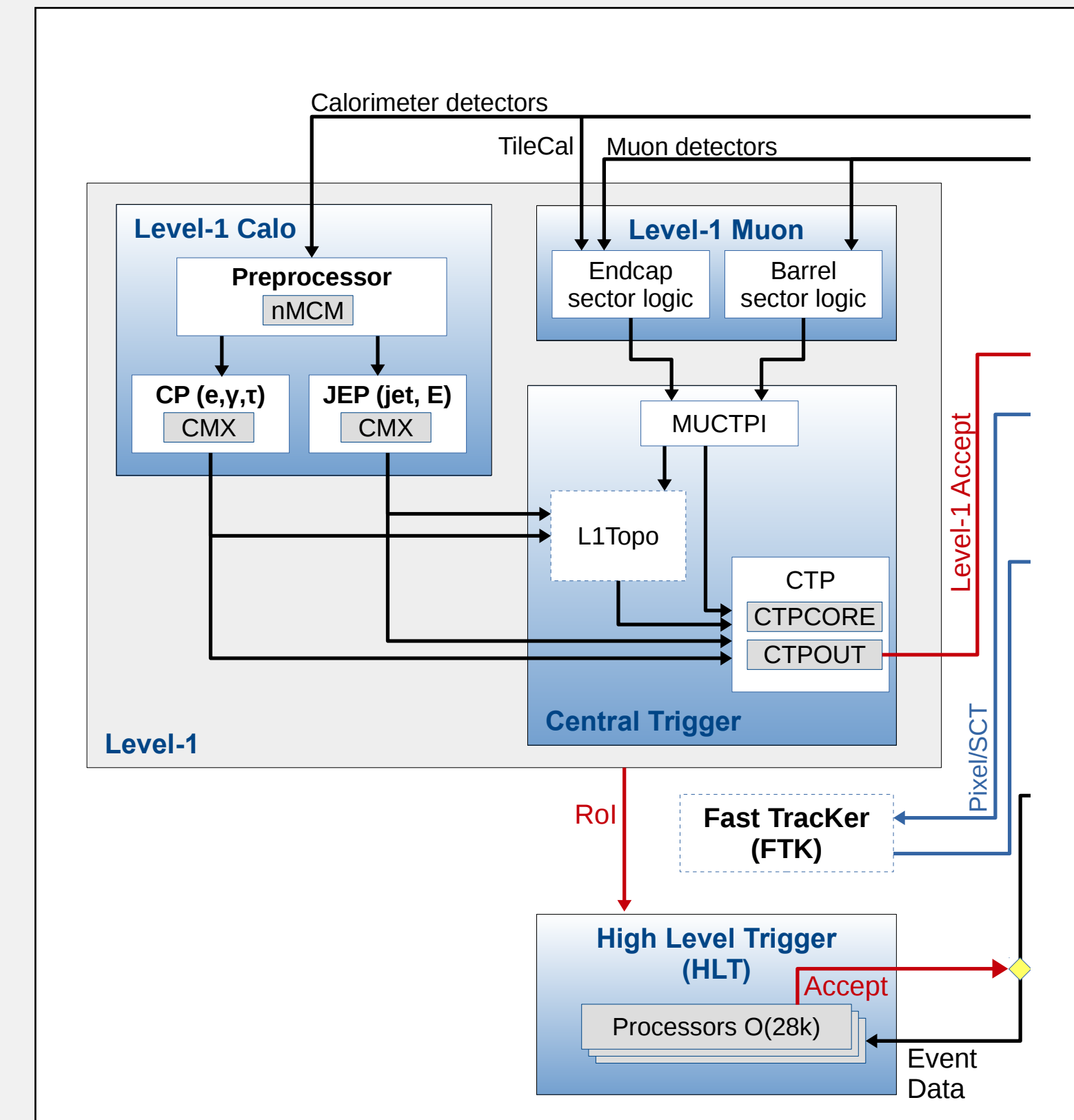
<https://cds.cern.ch/record/1095924>

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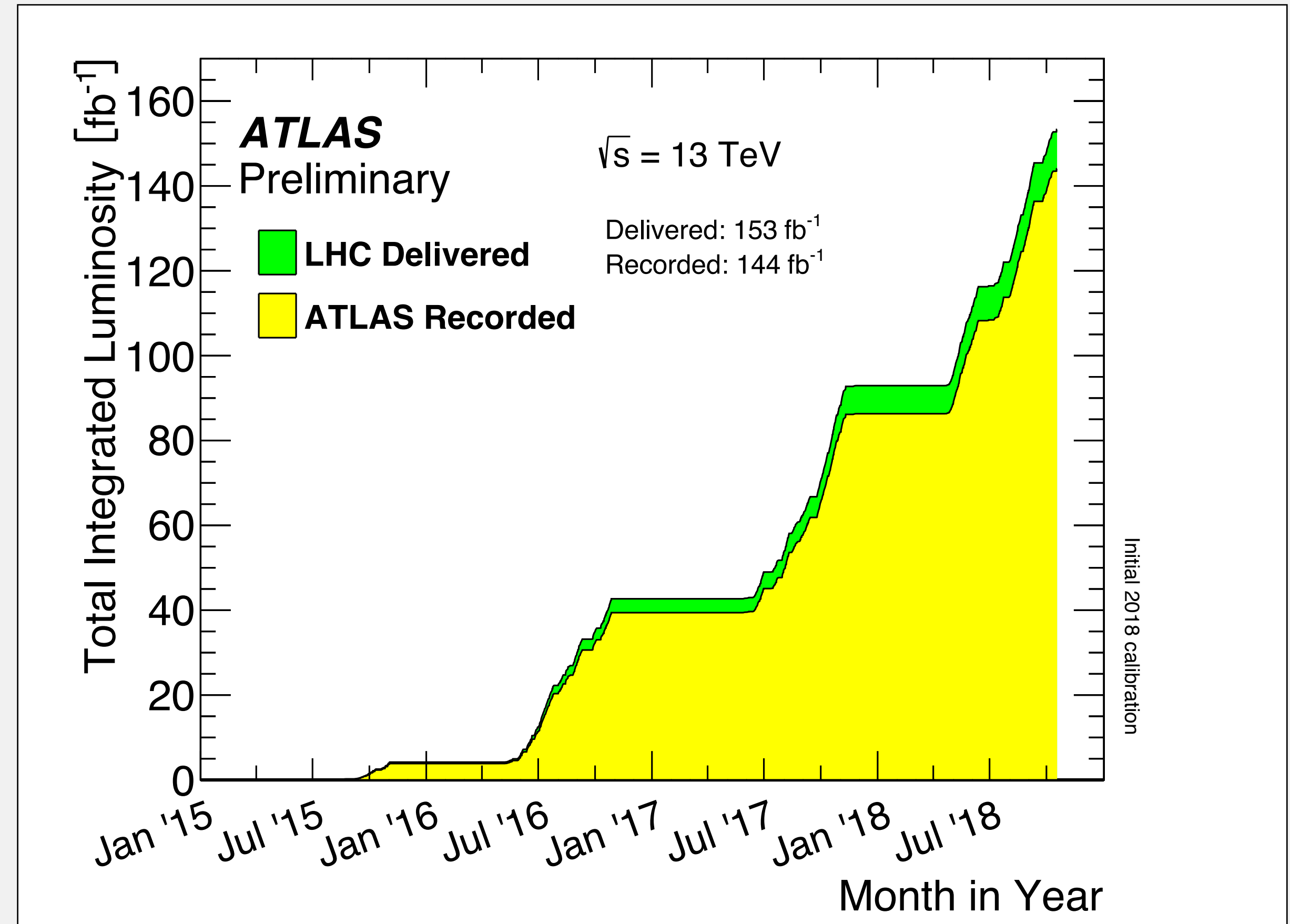
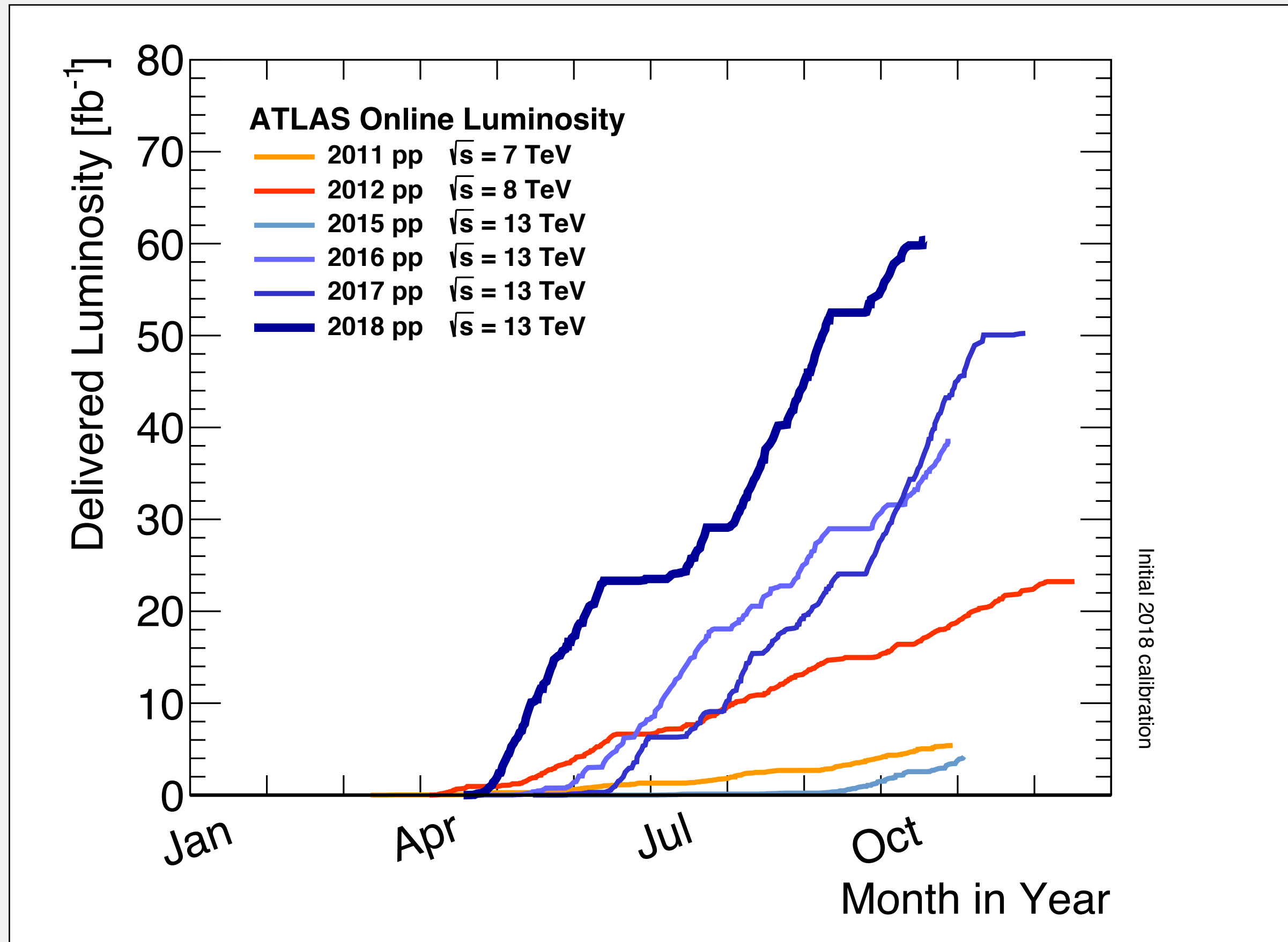
+

Trigger System



<https://cds.cern.ch/record/1095924>

What does this give us?



fantastic LHC and ATLAS performance \rightarrow at end of run-2: $\sim 150/\text{fb}$ to analyse!

- many publications on full run-2 data set being worked in Sweden
- will keep us busy during upcoming shutdown (2019/20)

What do we do?

main areas of *ongoing* ATLAS activities (i.e. not upgrade related)

see Christian's talk

- detector operations & data acquisition
- (physics objects) performance
- data analysis
- computing
- sometimes separation not clear cut

all groups very active in all three of these

- collaboration in various places
- discussed on Monday where more synergies could be exploited

work made possible and supported by

Knut-and-Alice-Wallenberg foundation, European Research Council, Vetenskapsrådet

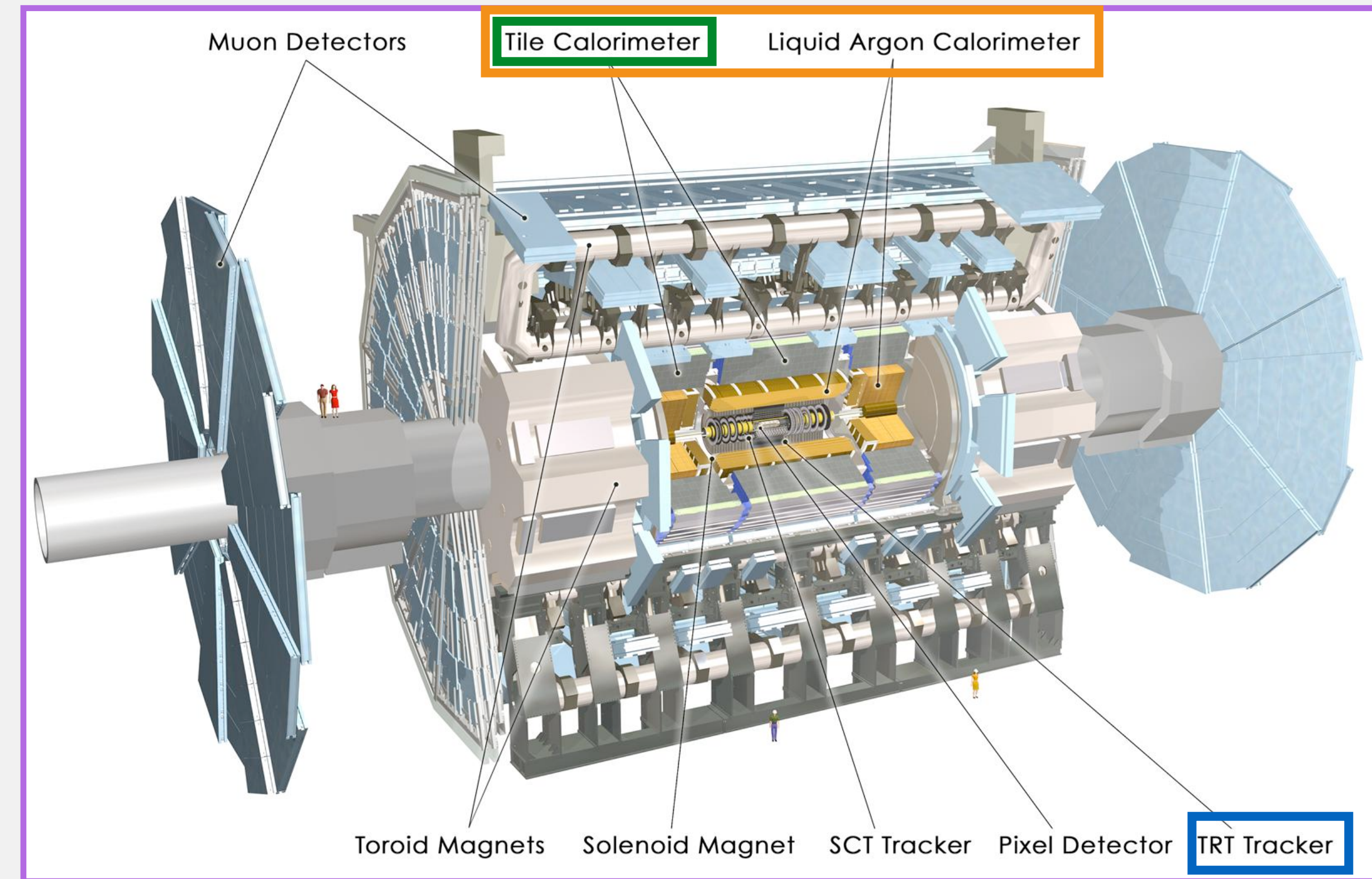
individual and project grants, fellowships

Operations

the entire collaboration has to take part in running the experiment and ensuring we take good data

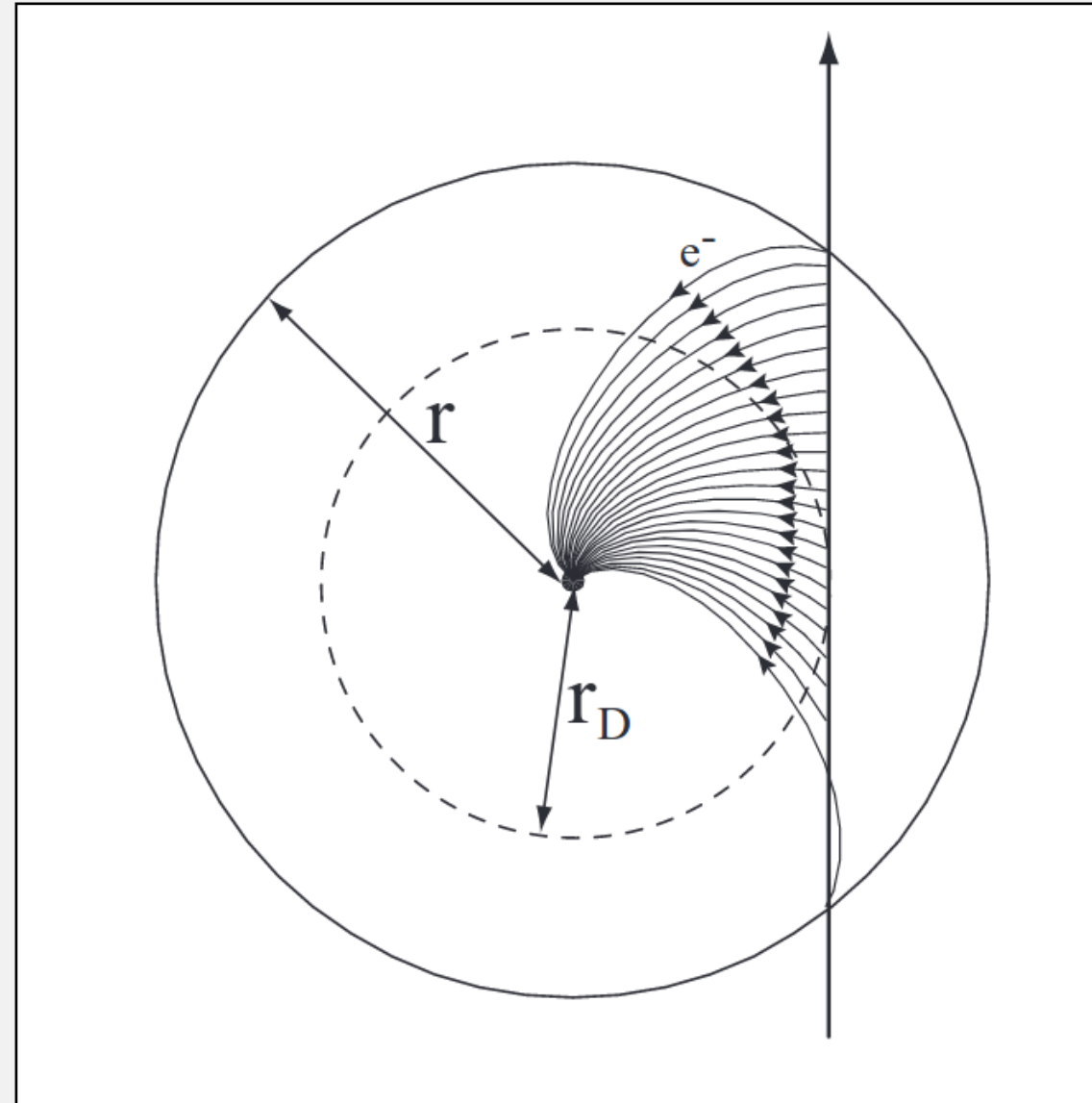
Swedish groups involved in

- transition radiation tracker (TRT): LU
- hadronic (tile) calorimeter: SU
- level-1 calo trigger (L1Calo): SU
- presampler (LAr): KTH
- triggering (jets, taus, data quality (DQ)): LU, UU
- luminosity: LU, SU, KTH
- online and offline **shifts**: all
- ...



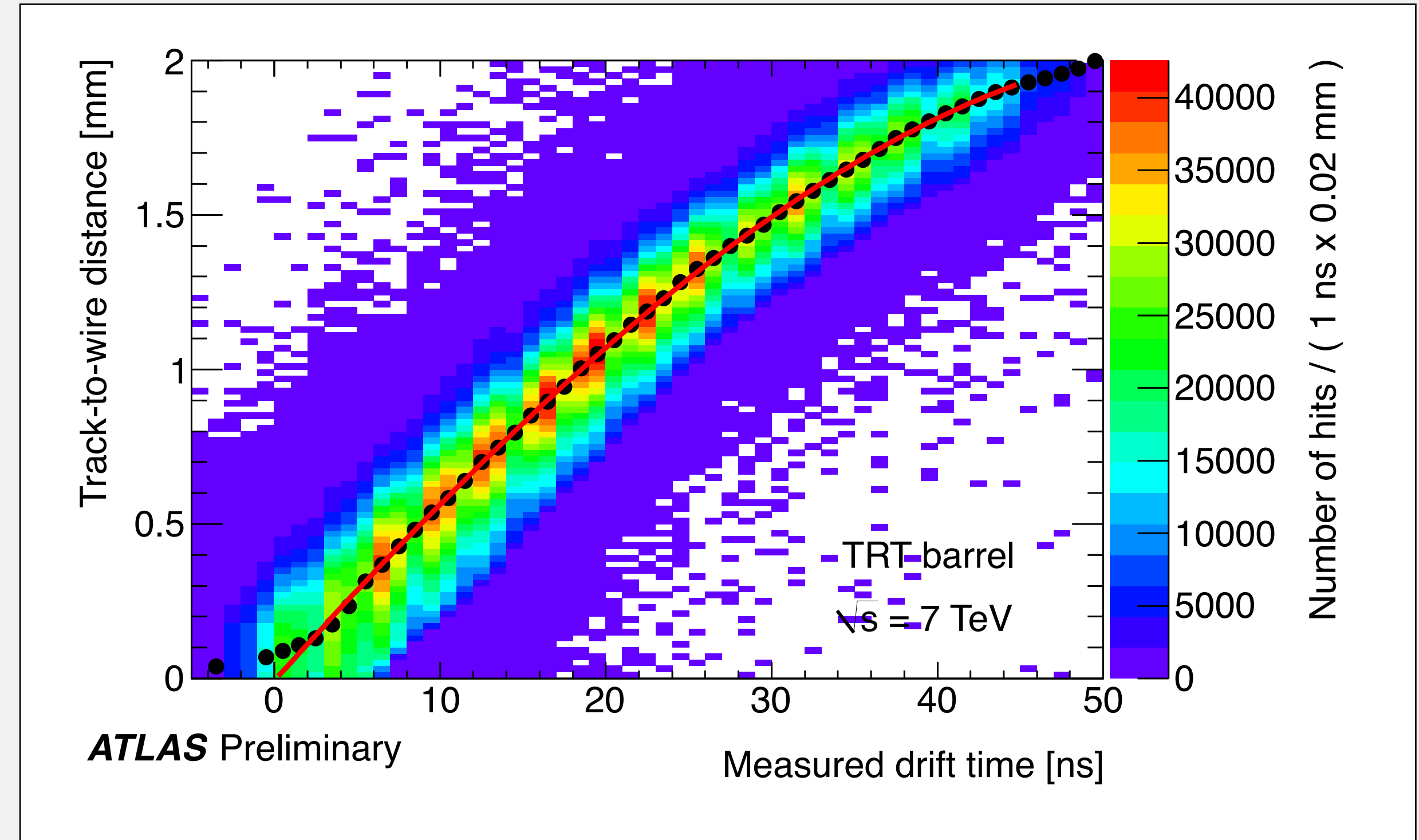
Operations — Example: TRT

TRT information important for ATLAS tracking



- measured: drift time
 - wanted: position
- > calibration of $r(t)$ relation
(iterative fit procedure)

ATLAS-CONF-2011-006



this relation is determined for every run we take
(and for MC as well)

Lund Ph.D. students very active in this

Operations — Example: Luminosity

luminosity measurement important for ~all ATLAS analyses!

Lund: coordination of luminosity analysis,
leading role in design/construction of LUCID luminometer

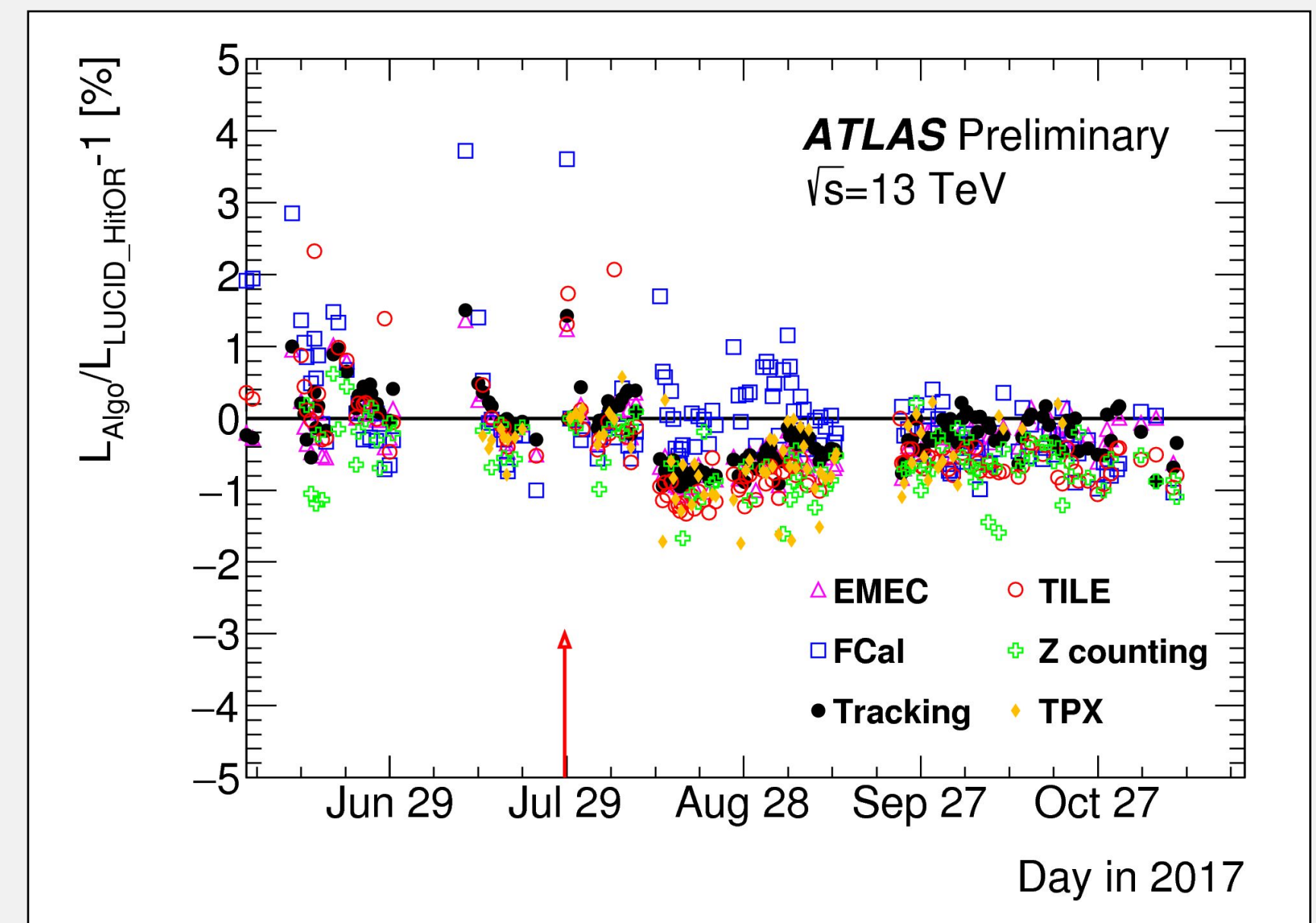
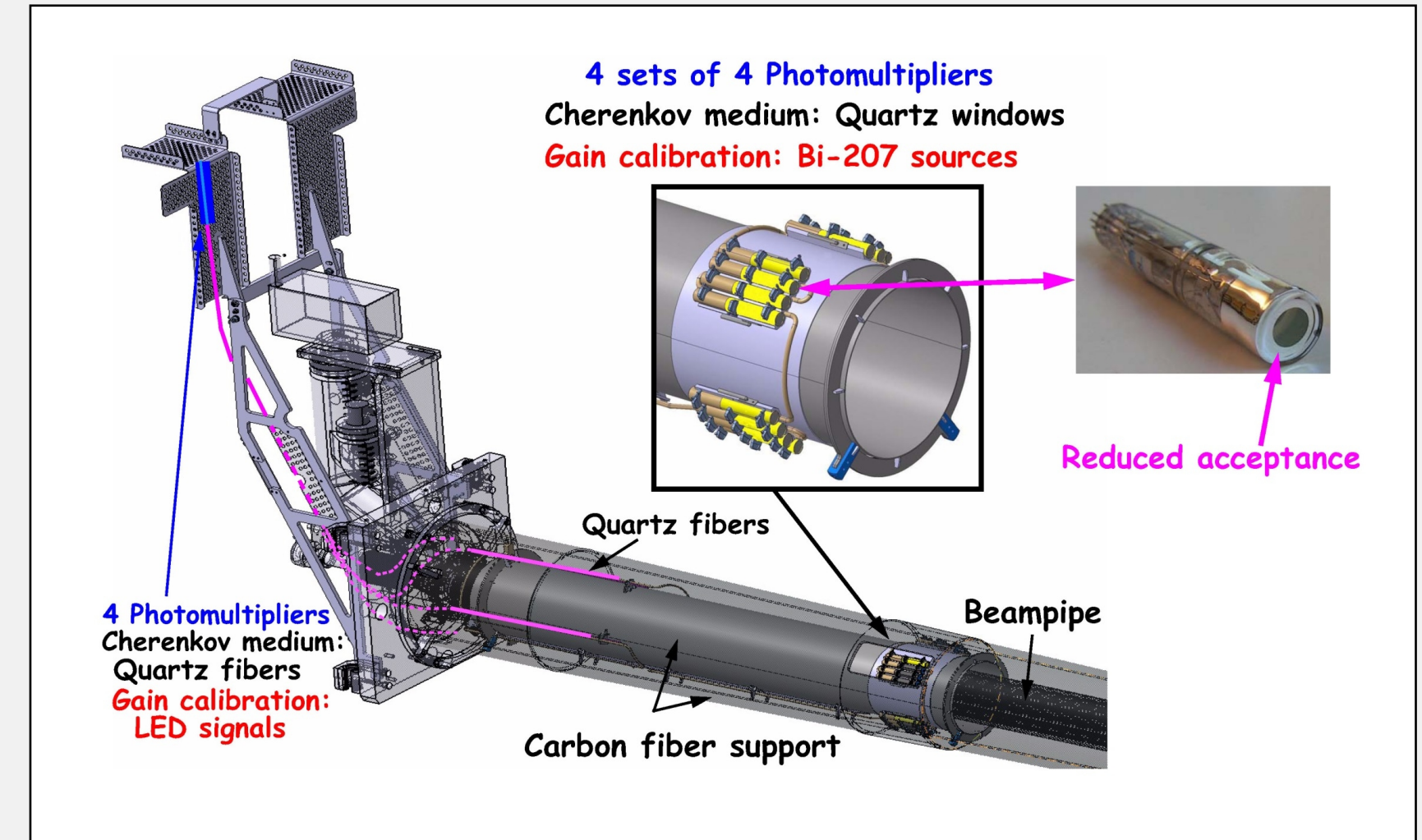
KTH/SU:

luminosity track counting

- #(tracks) proportional to #(pp collisions per bunch-xing)
- calibrated lumi measurement provided (with DESY)
- new, more robust tracking working point
- updated s/w framework

online luminosity

- development/maintenance of s/w and infrastructure
- [Outstanding Achievement Award](#) for Alex Kastanas



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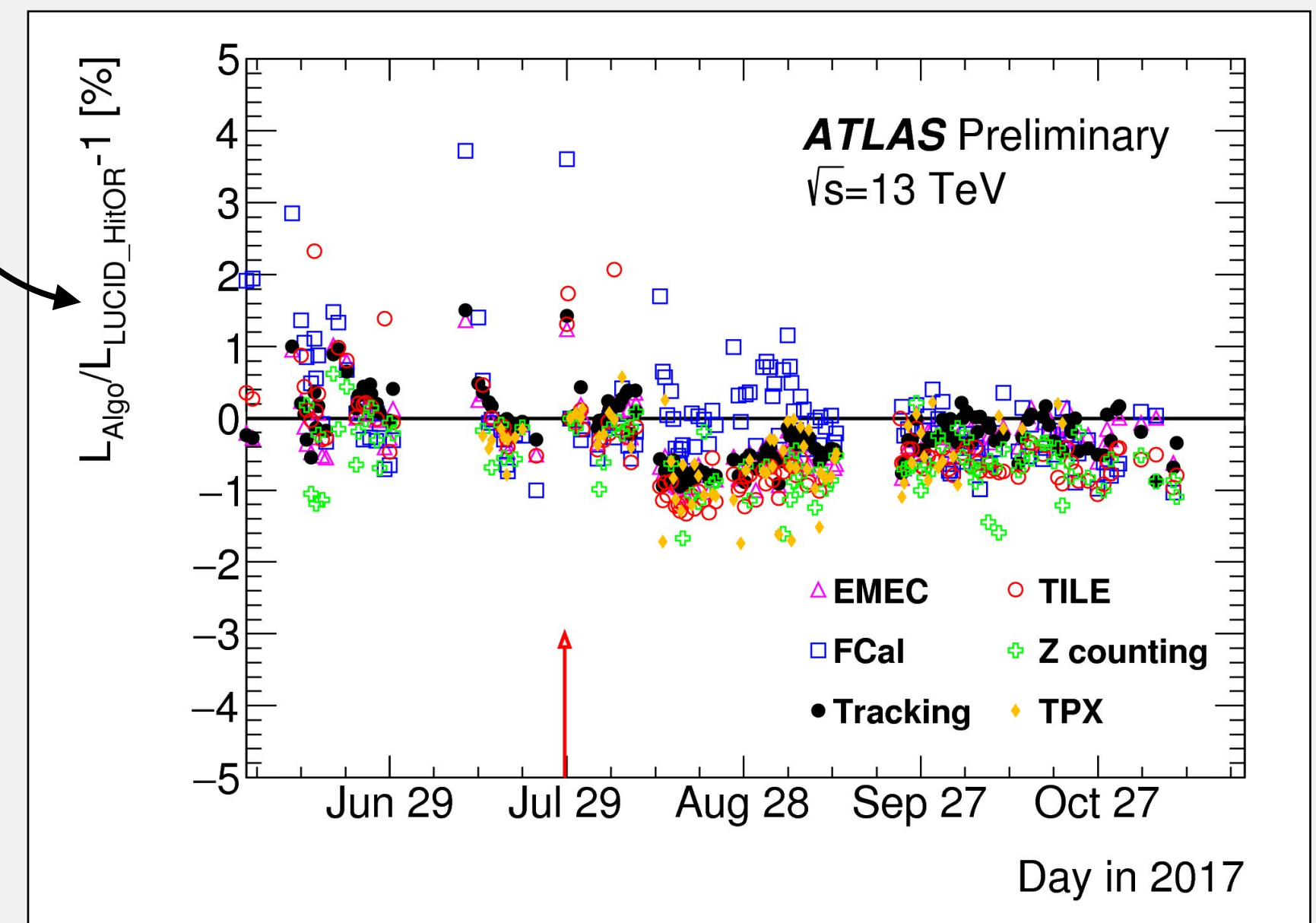
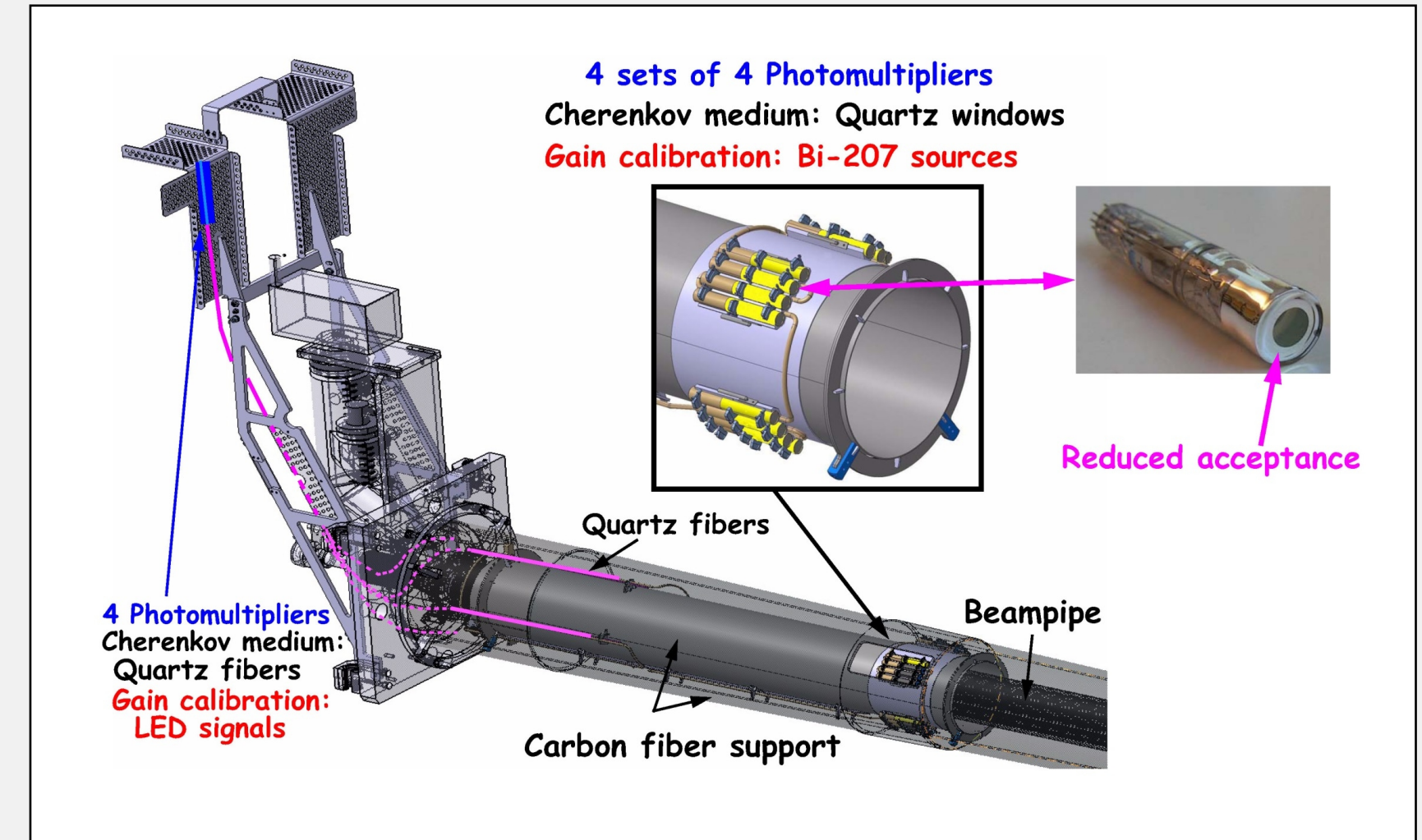
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Performance

understand how *physics objects* (**jets**, electron, muons, **taus**) behave in the detector/trigger
provide this knowledge to all of ATLAS as foundation for data analysis
Swedish groups/members have (had) leading roles in various areas for a long time

main performance areas in Sweden (snapshot):

- jets
 - SU: tile calorimeter response *at cell-level* as input to **jet energy scale** calibration, **jet+ E_T^{miss} group** convener (C. Clement), identification of **jets from b-quarks** (and DQ, S. Strandberg)
 - LU: (combination of) jet energy scale calibration for fat + narrow jets, calibration of trigger-level jets
- taus:
 - UU: fake tau task force (created early 2018, lead by A. Ferrari)
—> aims to develop unified method for all ATLAS
- trigger
 - LU: jet trigger performance (jet trigger coordinator W. Kalderon)
 - UU: tau trigger (DQ contact)

Performance

also (at least in this talk):

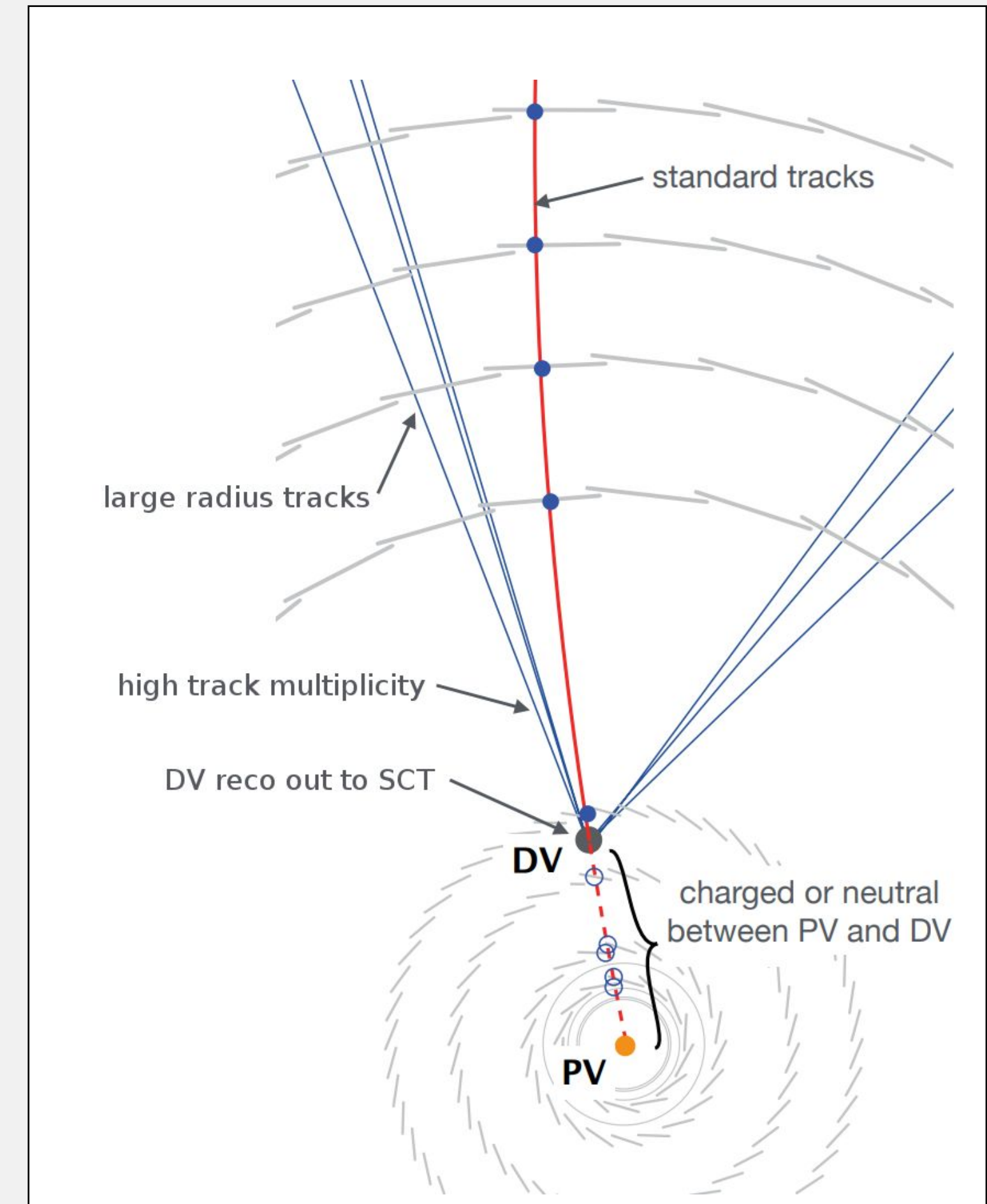
understand detector usage for *unconventional signatures*
(long-lived particles (LLPs), displaced decays)

challenges:

- triggering (usual triggers not designed to capture such events)
- knowledge of inner detector material distribution
(background from vertices due to material interactions)
- special tracking for tracks with large impact parameter
(CPU intensive, subset of data: DRAW_RPVLL)

KTH+SU:

- long-standing interest and expertise in these signatures
- expertise in (special) reconstruction
- future possibilities to include in trigger? (also UU)



Analyses

very broad, diverse spectrum of physics topics and analyses covered across the universities

UU

- charged Higgs
- di-Higgs
 - leptoquarks
 - combination
- top-Higgs interplay
- displaced signatures
- SHIFT (compositeness/VLQ)

KTH

- $H \rightarrow WW$
 - measurement/search
- DM + SUSY
 - particular:
LLPs/displaced vertices

Lund

- same-sign dilepton
- leptoquarks
- Dark Matter
 - dijet, TLA, mono-H
- resonances
 - dijet, ttbar

SU

- ttW, ttZ
- leptoquarks
- SUSY (RPC, RPV)
 - stop pair, mono-jet,
displaced vertices (DV)
- Dark Matter + other Exotics
- SHIFT (SUSY, indirect stop)

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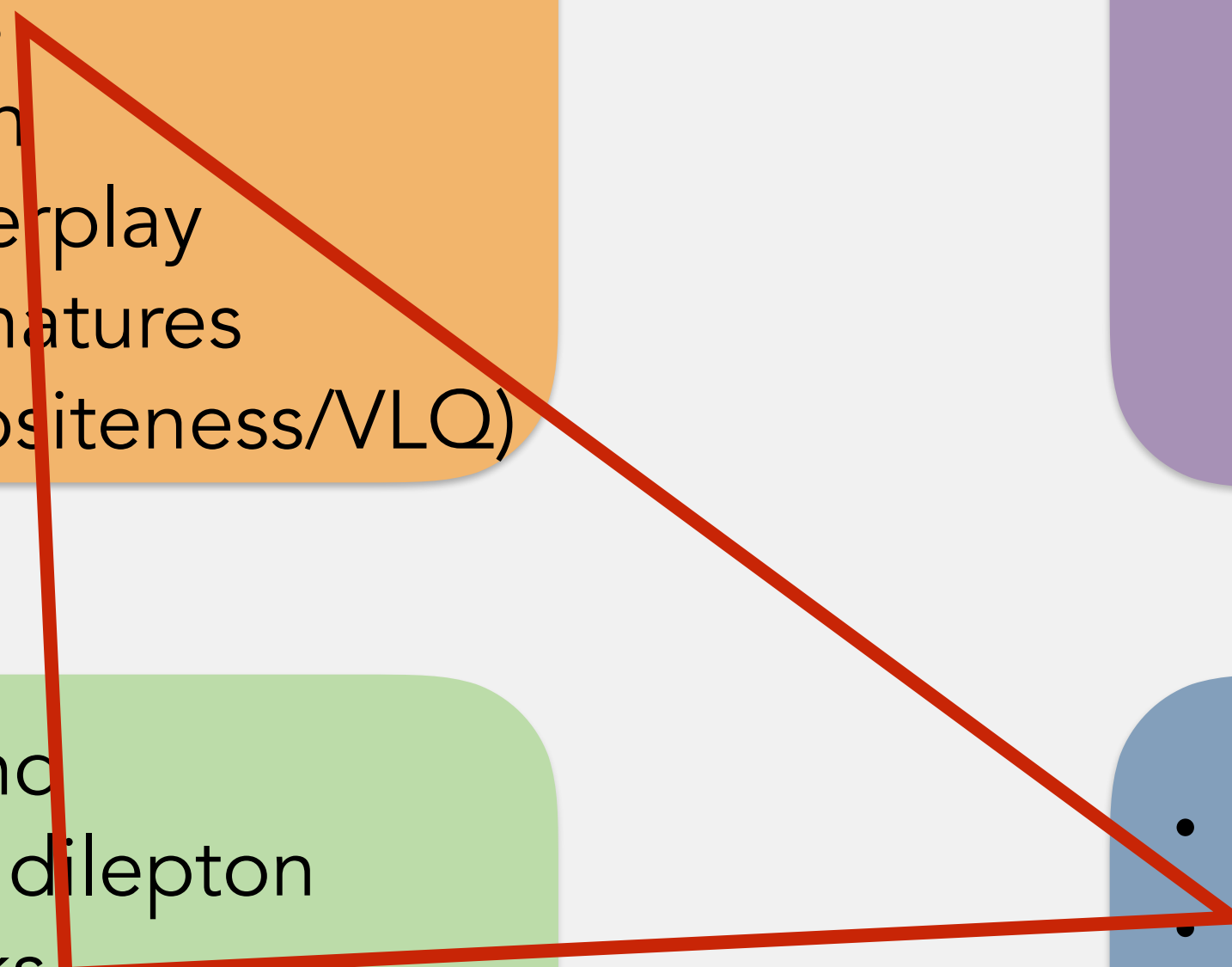
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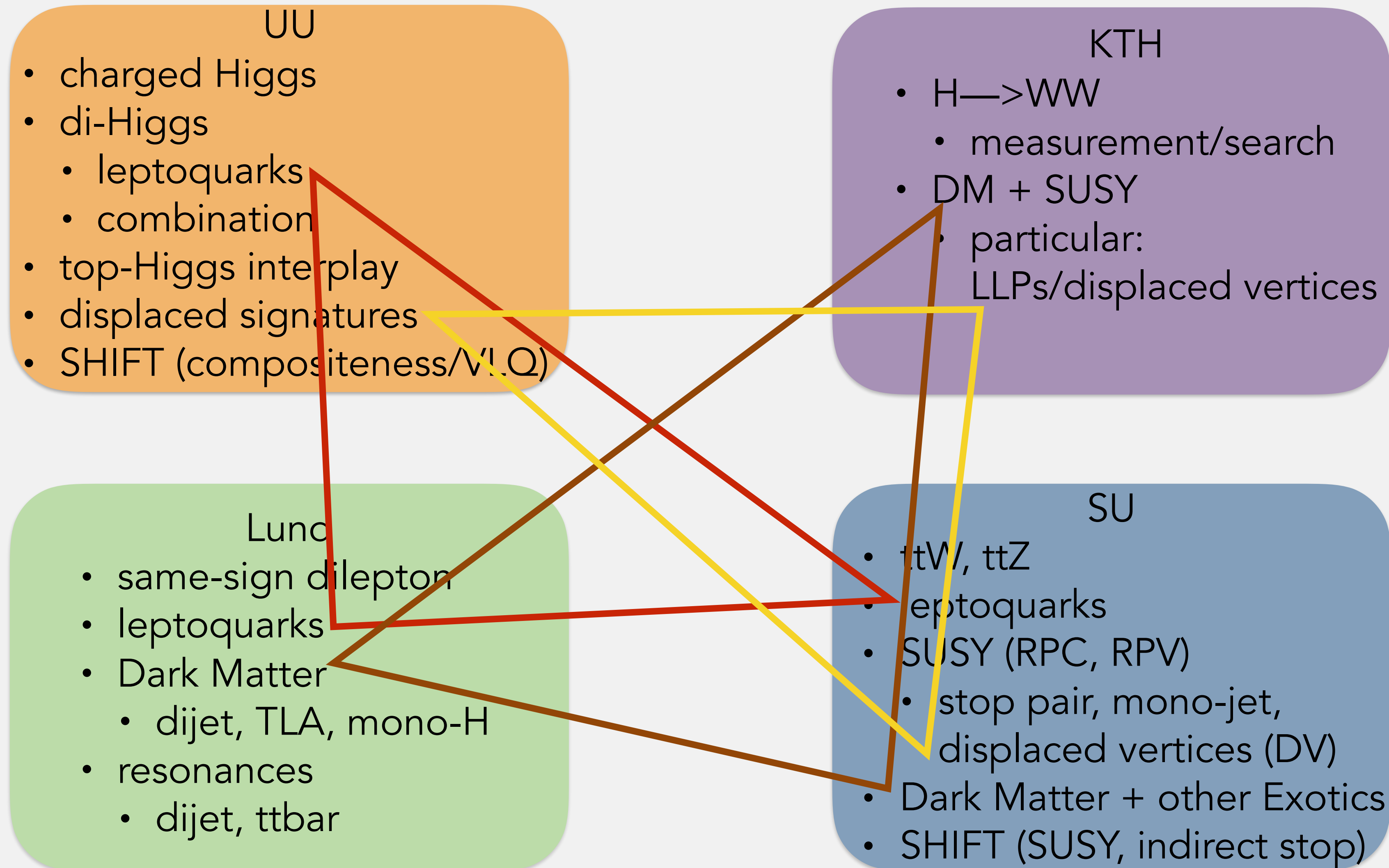
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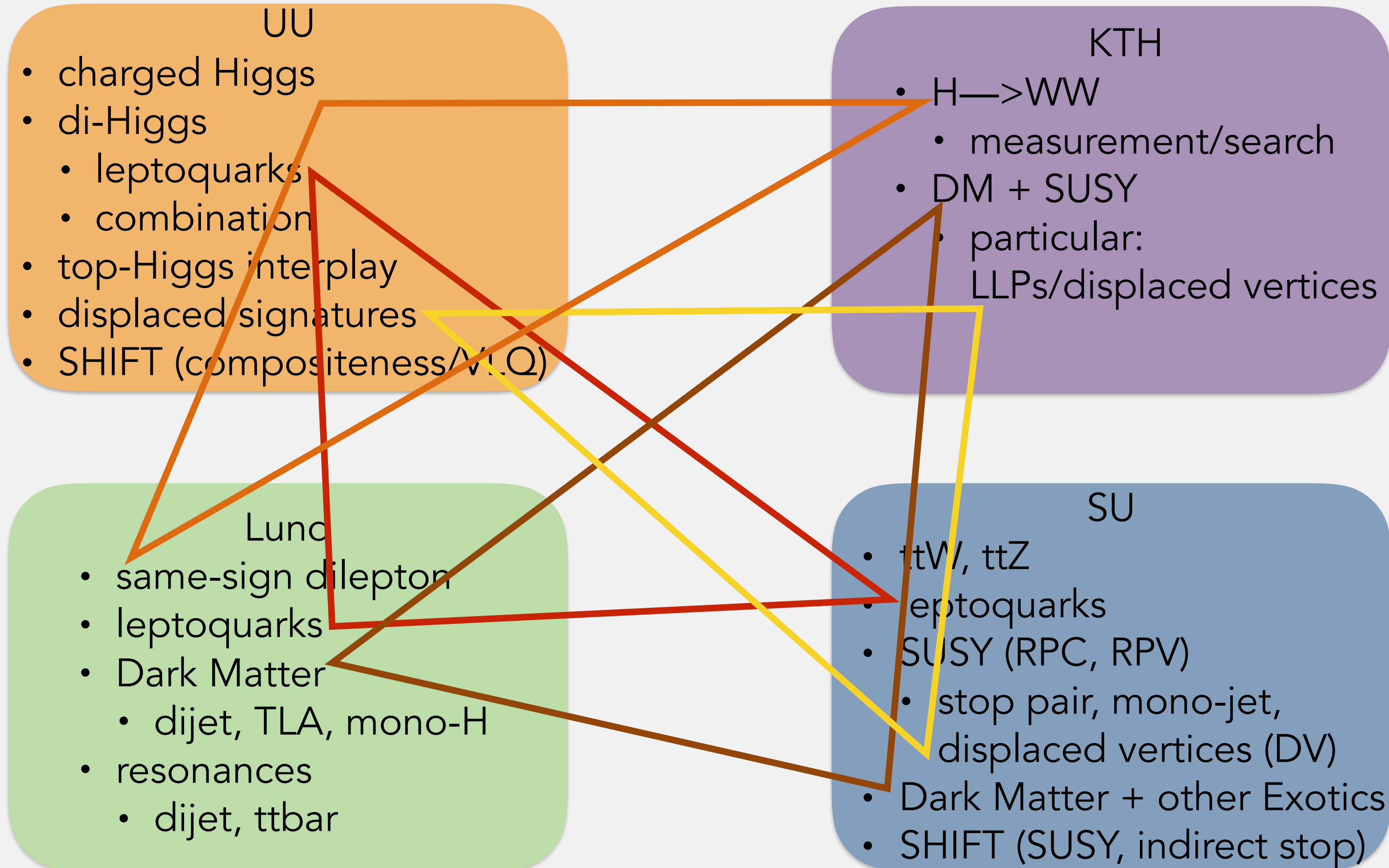
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Dark Matter

ATLAS (collider experiment) provides many different angles

now being collected in a "Common Dark Matter" working group, C. Ohm (KTH) one of the conveners, also organiser of the LHC DM working group (previously C. Doglioni (LU))

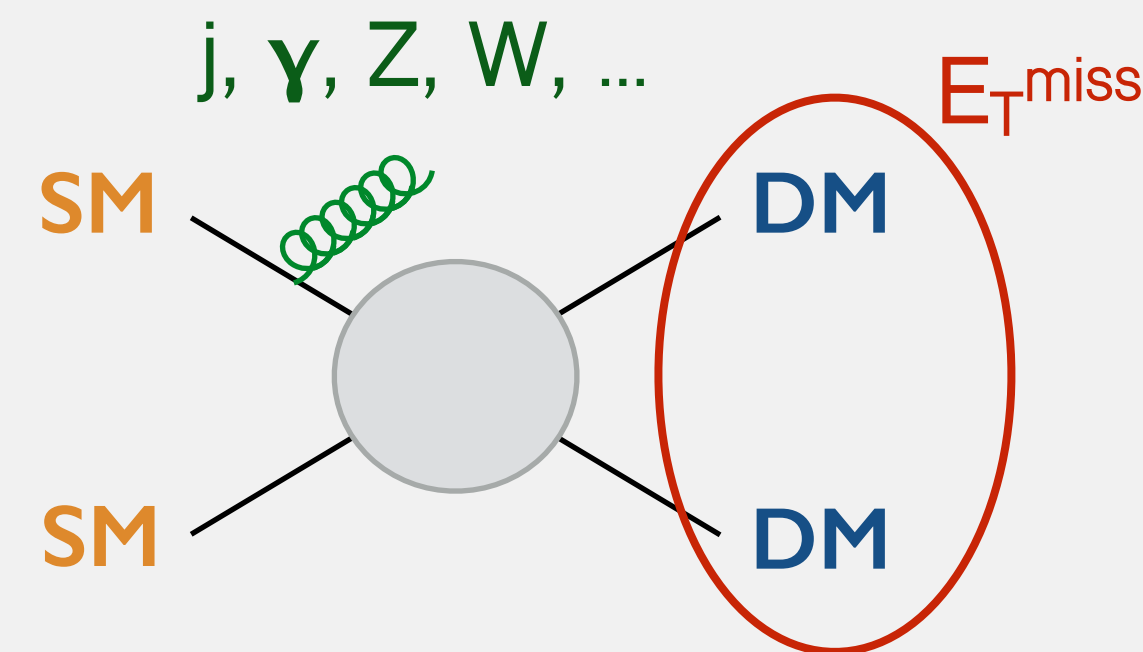
within Swedish groups:

"conventional": missing transverse energy

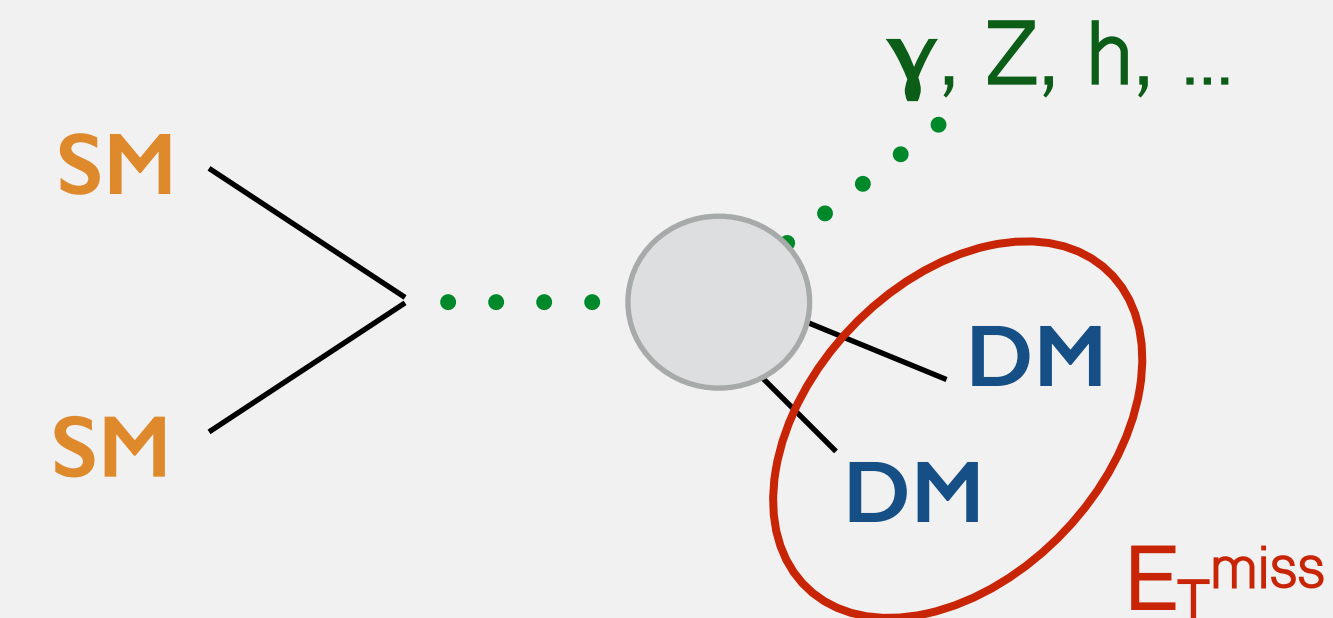
SU: stop pair, mono-jet

LU: mono-Higgs(bb) (and WW)

initial state radiation (ISR)



associate production



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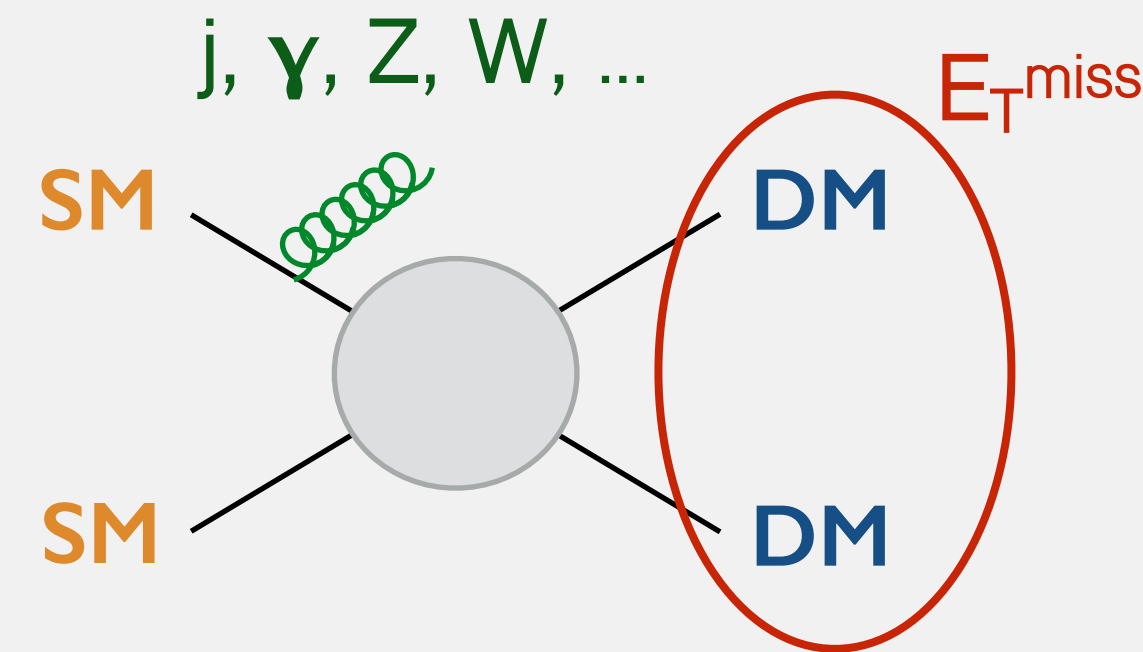
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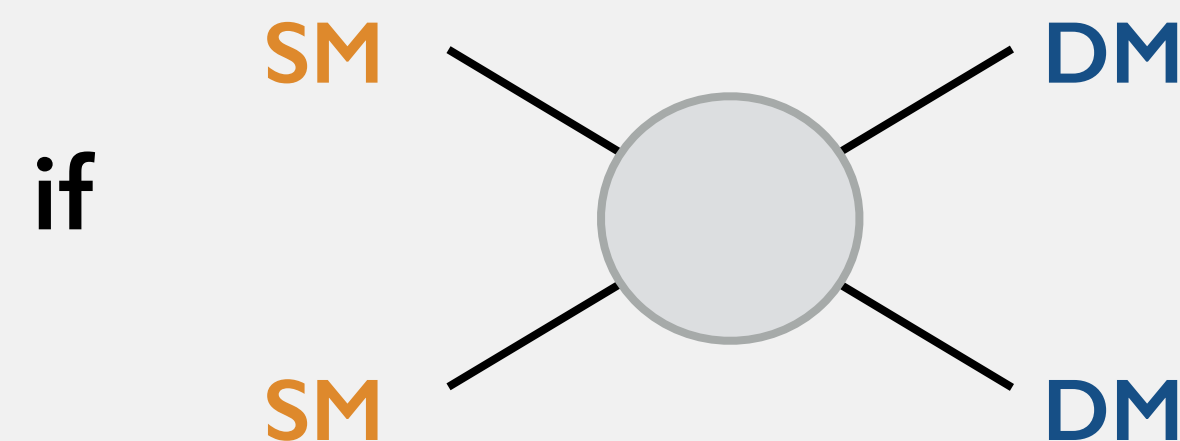
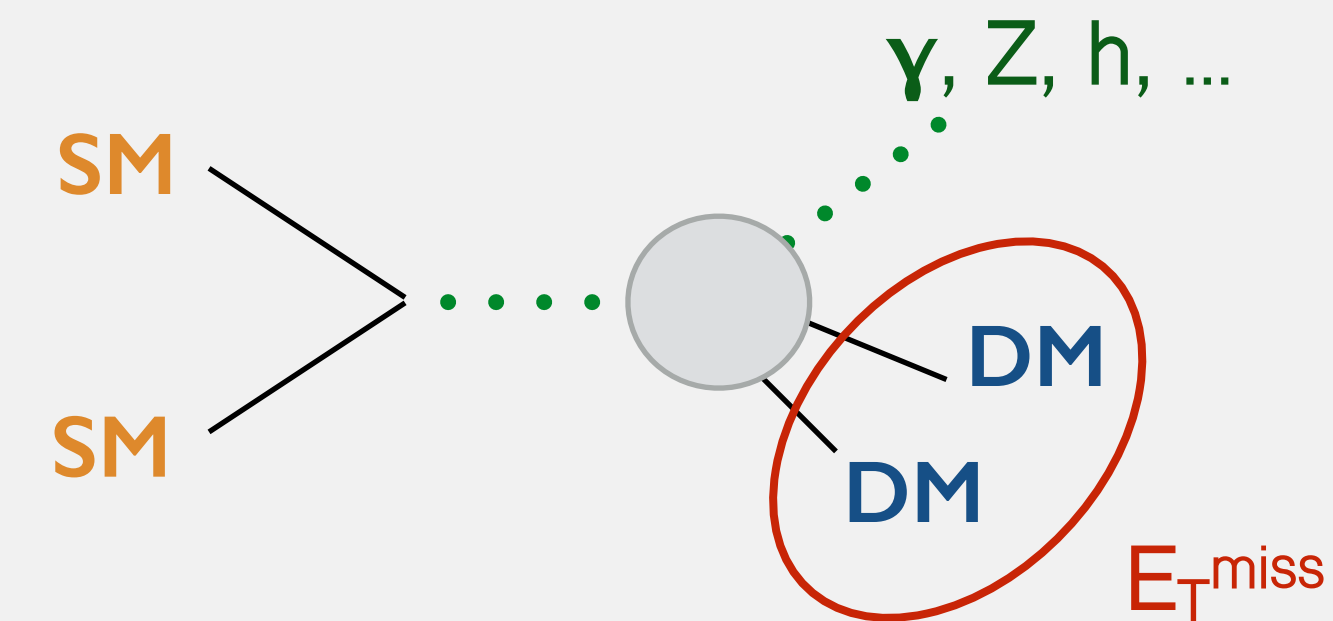
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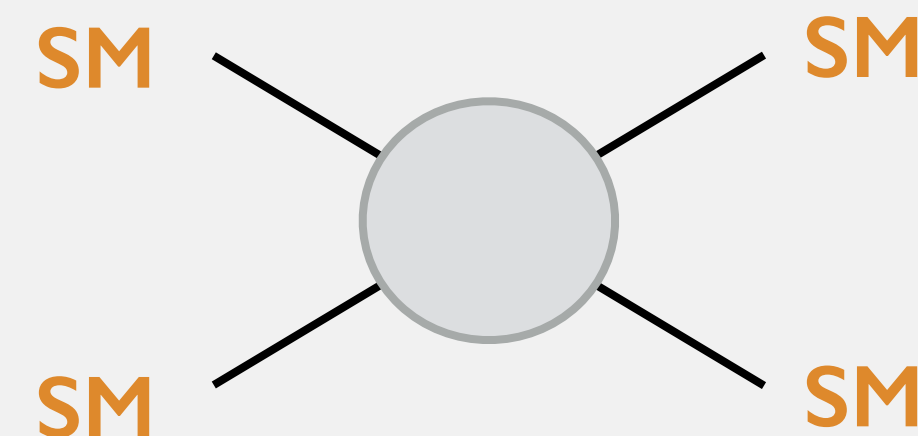
initial state radiation (ISR)



associate production



then



visible *mediator* searches

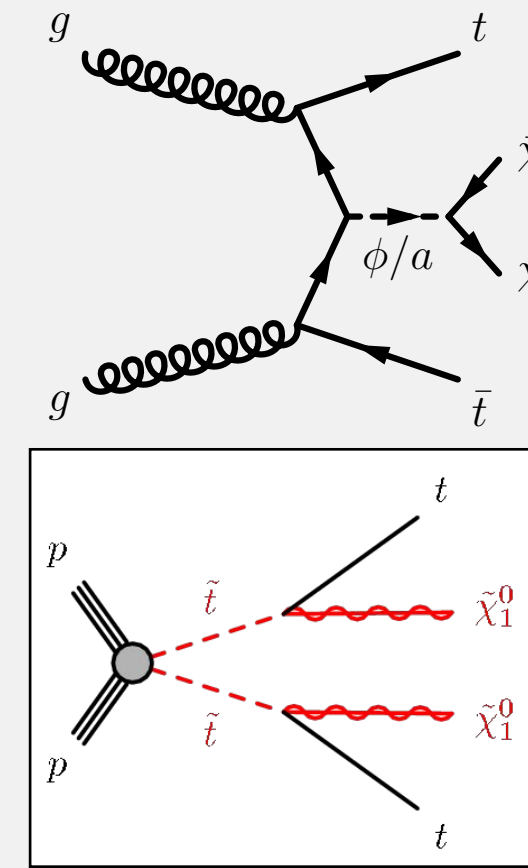
- various di-jet searches @LU
- including trigger-level analysis (TLA)

Dark Matter result tasting

di-jet mass search <1 TeV limited by trigger bandwidth

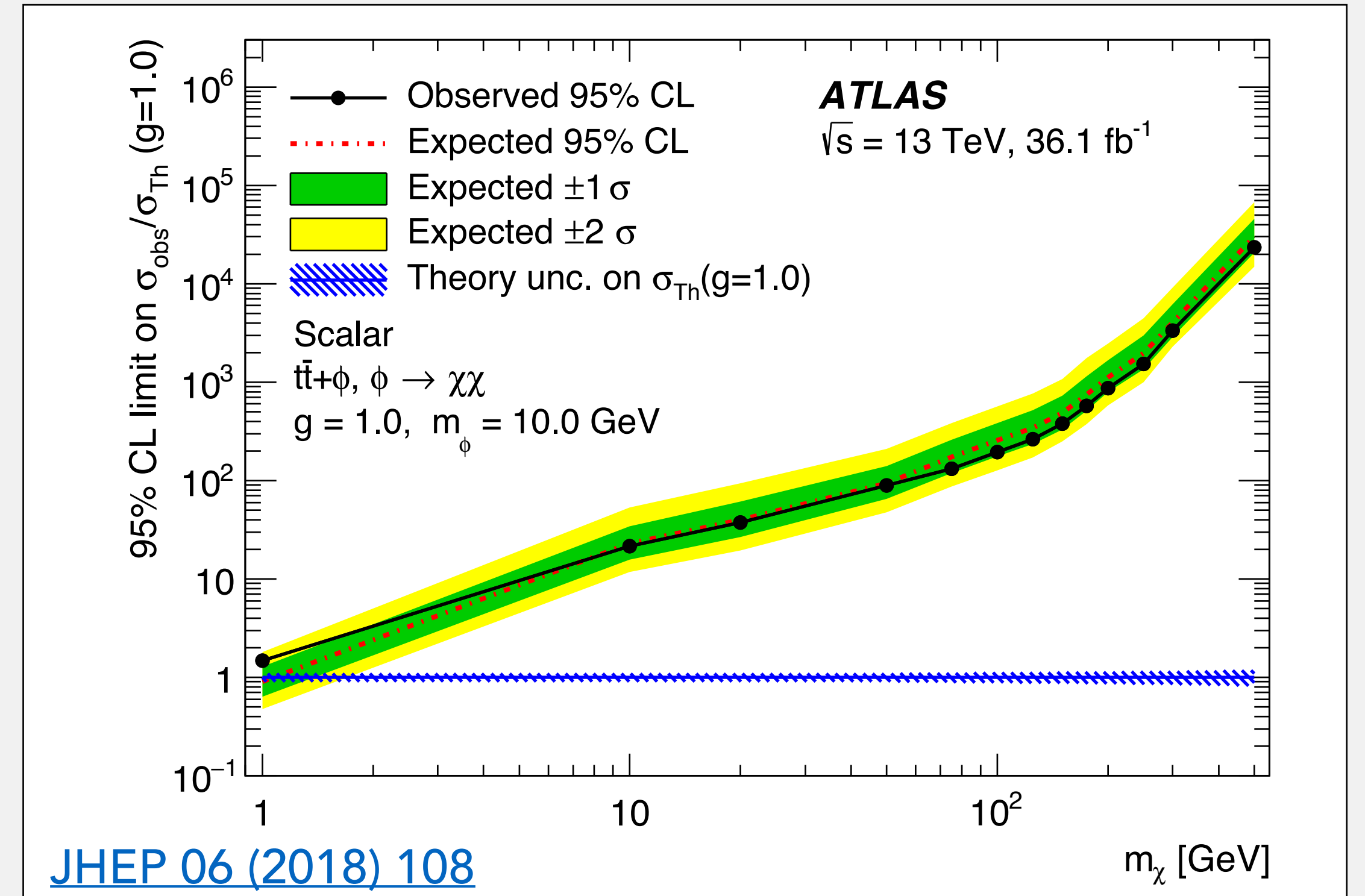
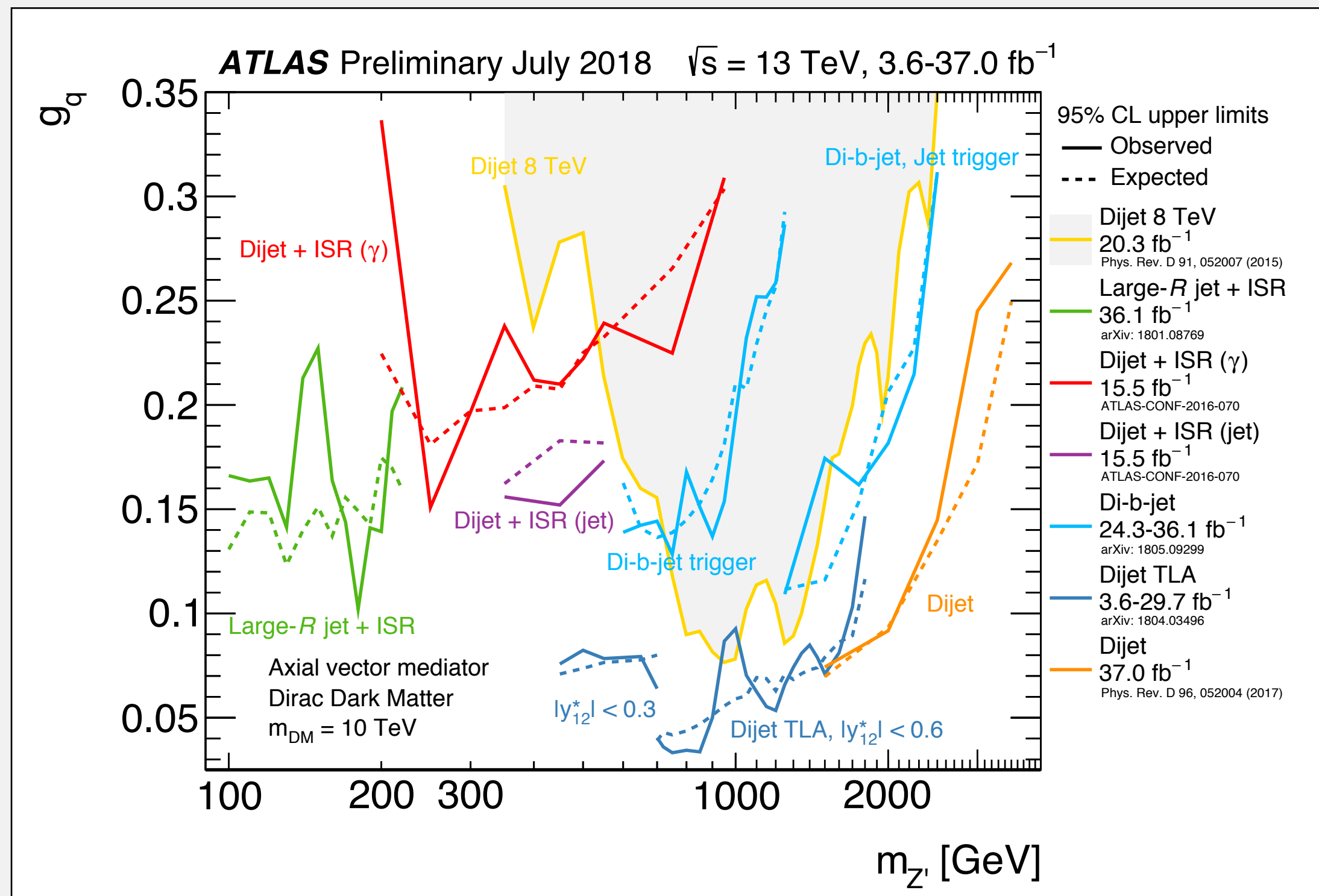
- use less information \rightarrow TLA
- use more complex final states (dijet+ISR, 4-jet)
- more ideas for future (TLA di-jet+ISR? ...)

LU



SU

same analysis also sensitive to other BSM signatures, e.g. stop pair, compressed SUSY, VLQs?



Long-Lived Particles

weak couplings — long lifetimes

e.g. R-parity violating (RPV) SUSY

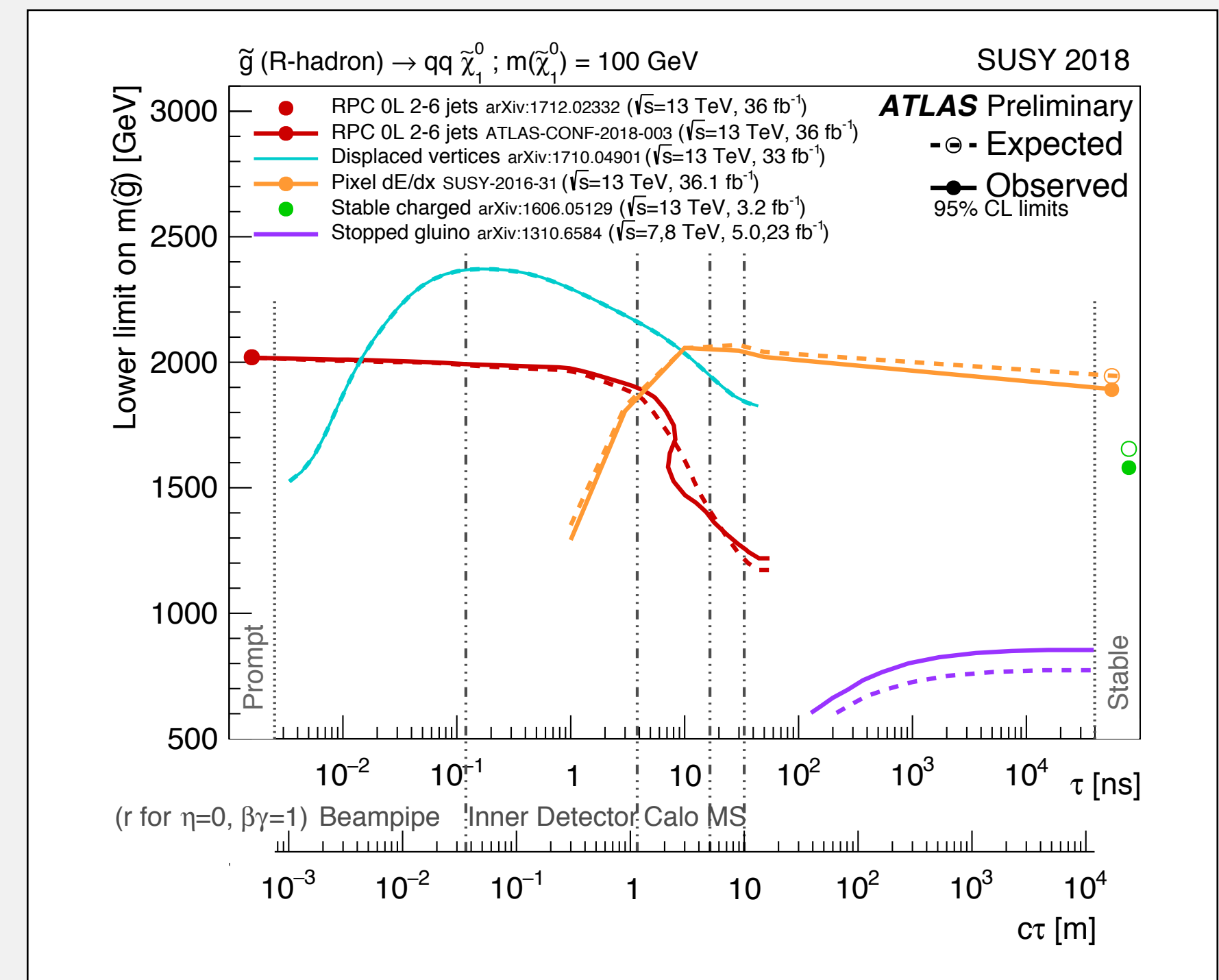
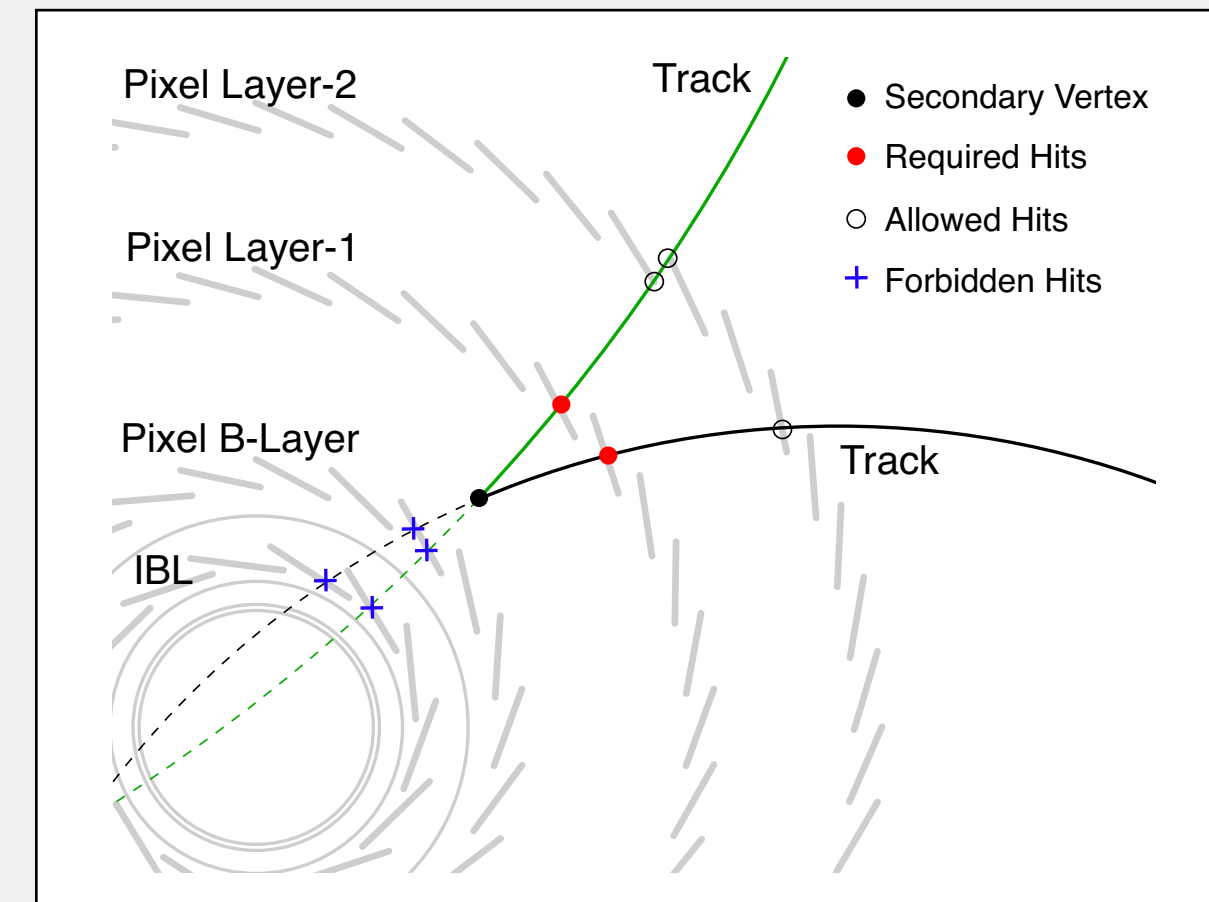
- R-parity conservation *imposed* to avoid proton decay
- lightest SUSY particle can't decay
—> stable, DM candidate
- but: proton stability allows various non-zero RPV couplings
- if small, SUSY particles become long-lived

various other scenarios, e.g. split-SUSY

in general: displaced signatures

(displaced vertices/jets, emerging jets...)

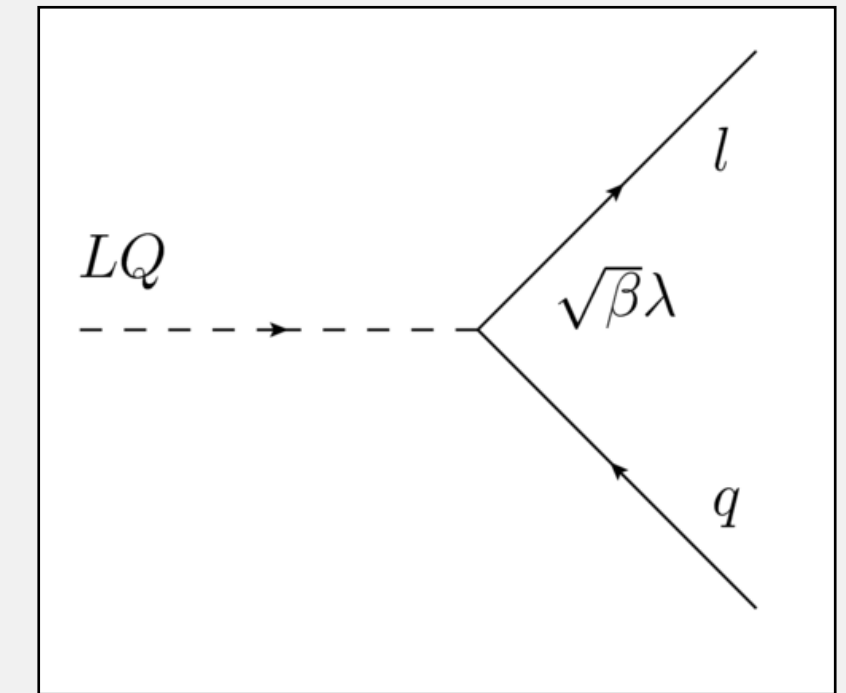
- usual trigger/reco/analysis cuts not designed for these!
- development of non-standard solutions
at KTH, SU and UU (future)



Leptoquarks

speaking of RPV SUSY...

part of many BSM theories, explain similarities between quark and lepton sectors in SM
renewed interest in past years due to anomalies in B-meson decays



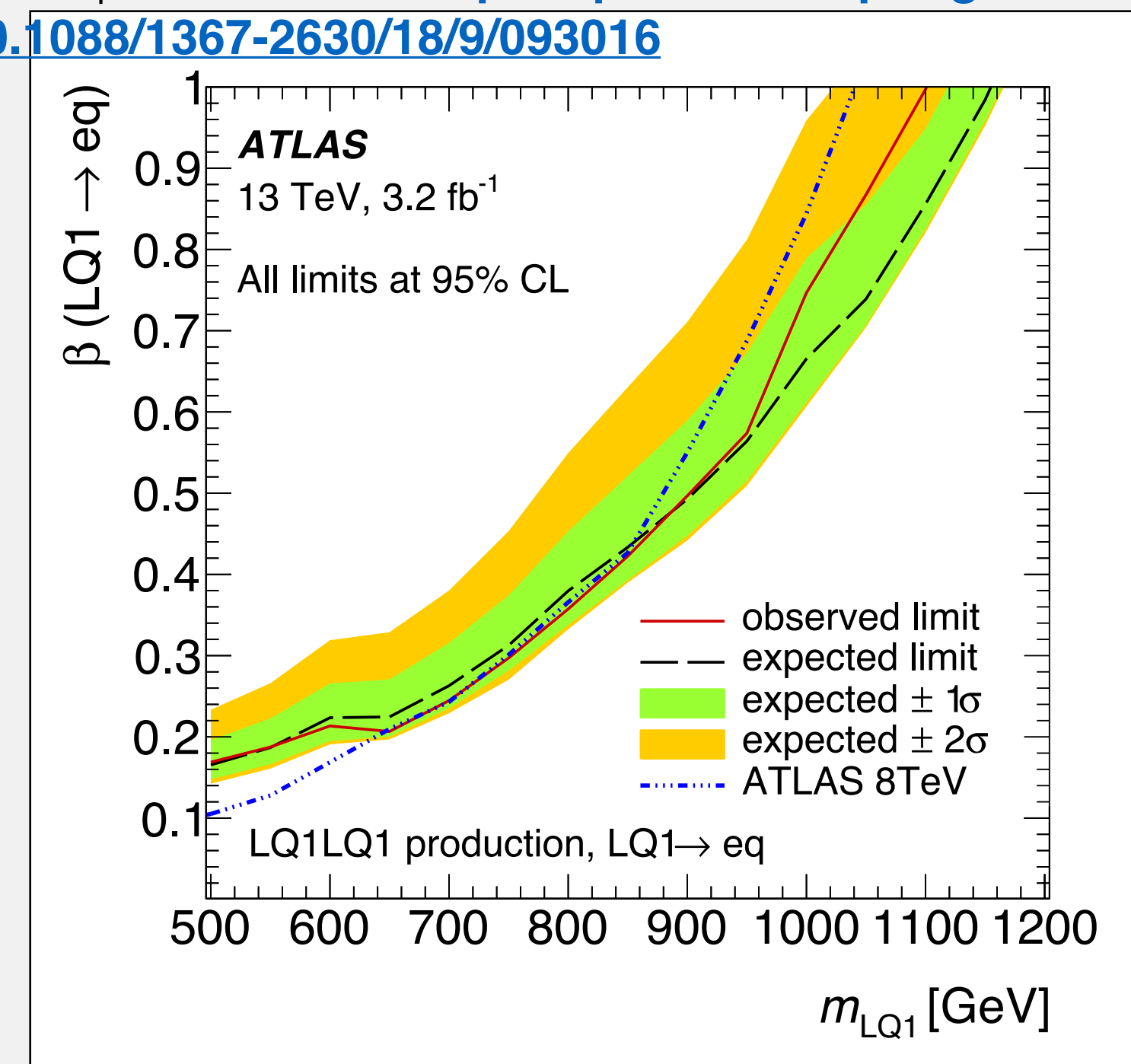
LU and SU: searches for 1st and 2nd generation (using 2015+2016 data)

- pair production of scalar LQs
- includes lepton-neutrino channel for first time since 2011
- introduces use of BDT for signal/background discrimination

re-interpretations of several other ATLAS analyses to search for 3rd generation LQ

- example: $HH \rightarrow bb \tau\tau$ done at UU

latest public result: <http://iopscience.iop.org/article/10.1088/1367-2630/18/9/093016>



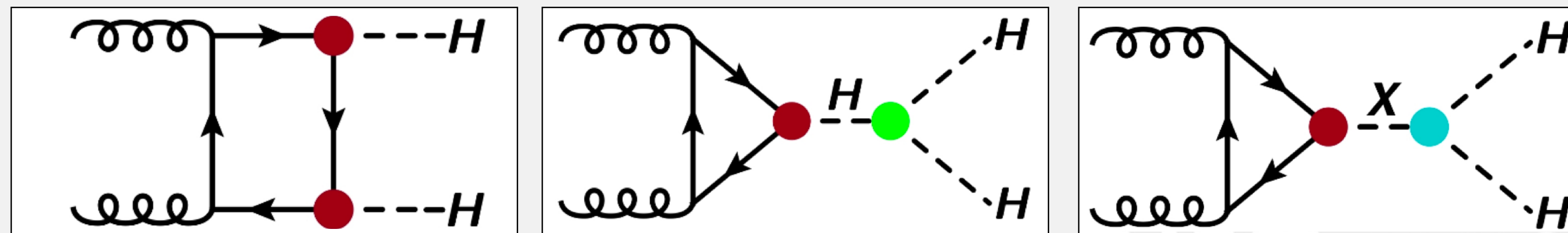
Di-Higgs

speaking of di-Higgs

one of the main topics at UU now (after traditional involvement in charged Higgs searches)

we have discovered a Higgs, but there still is a lot to learn about it

- currently Higgs properties can only be studied at LHC (or even HL-LHC)
- window to new physics!
 - enhanced HH production by BSM processes
 - new resonances decaying to HH



Di-Higgs

speaking of di-Higgs

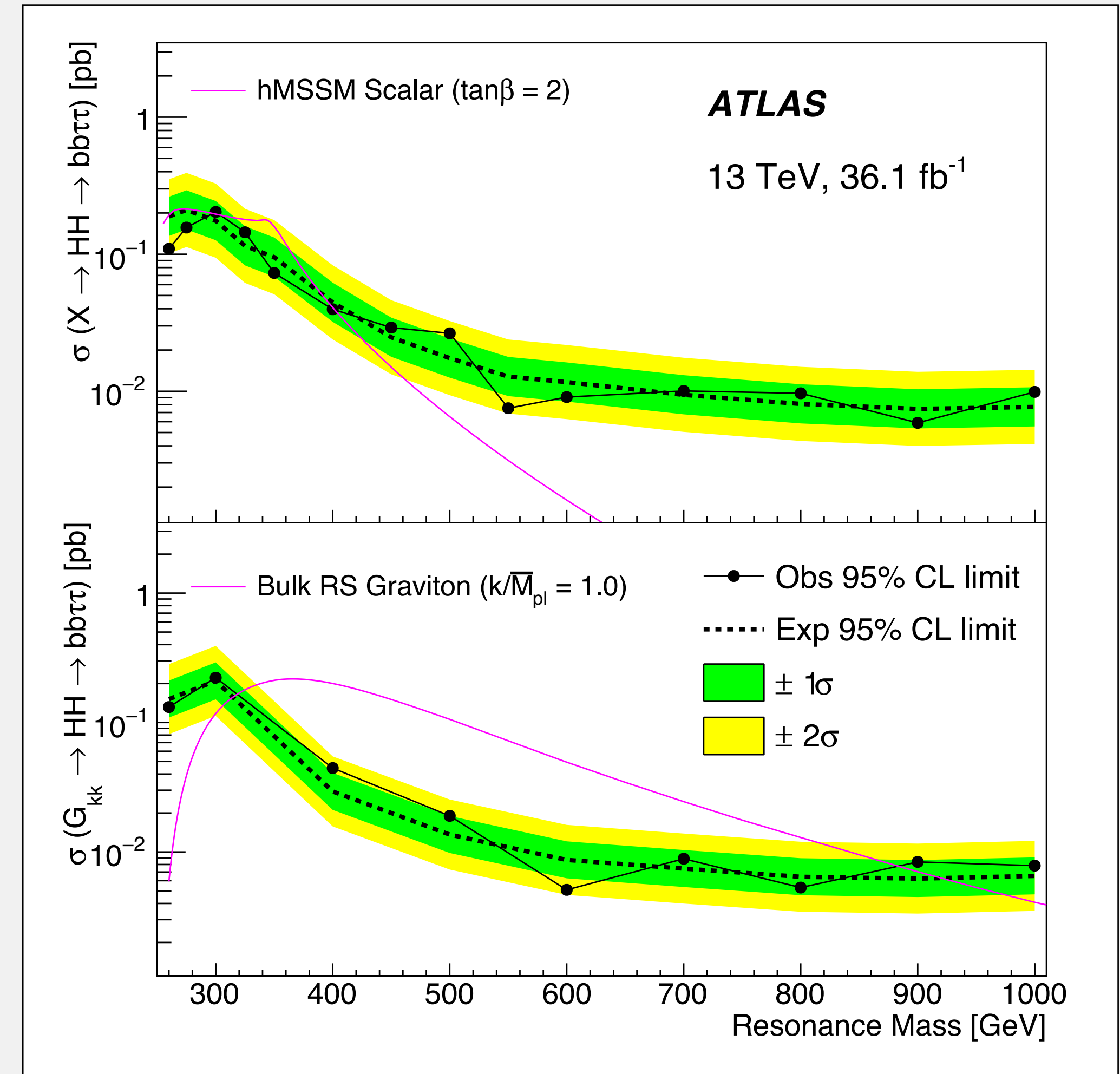
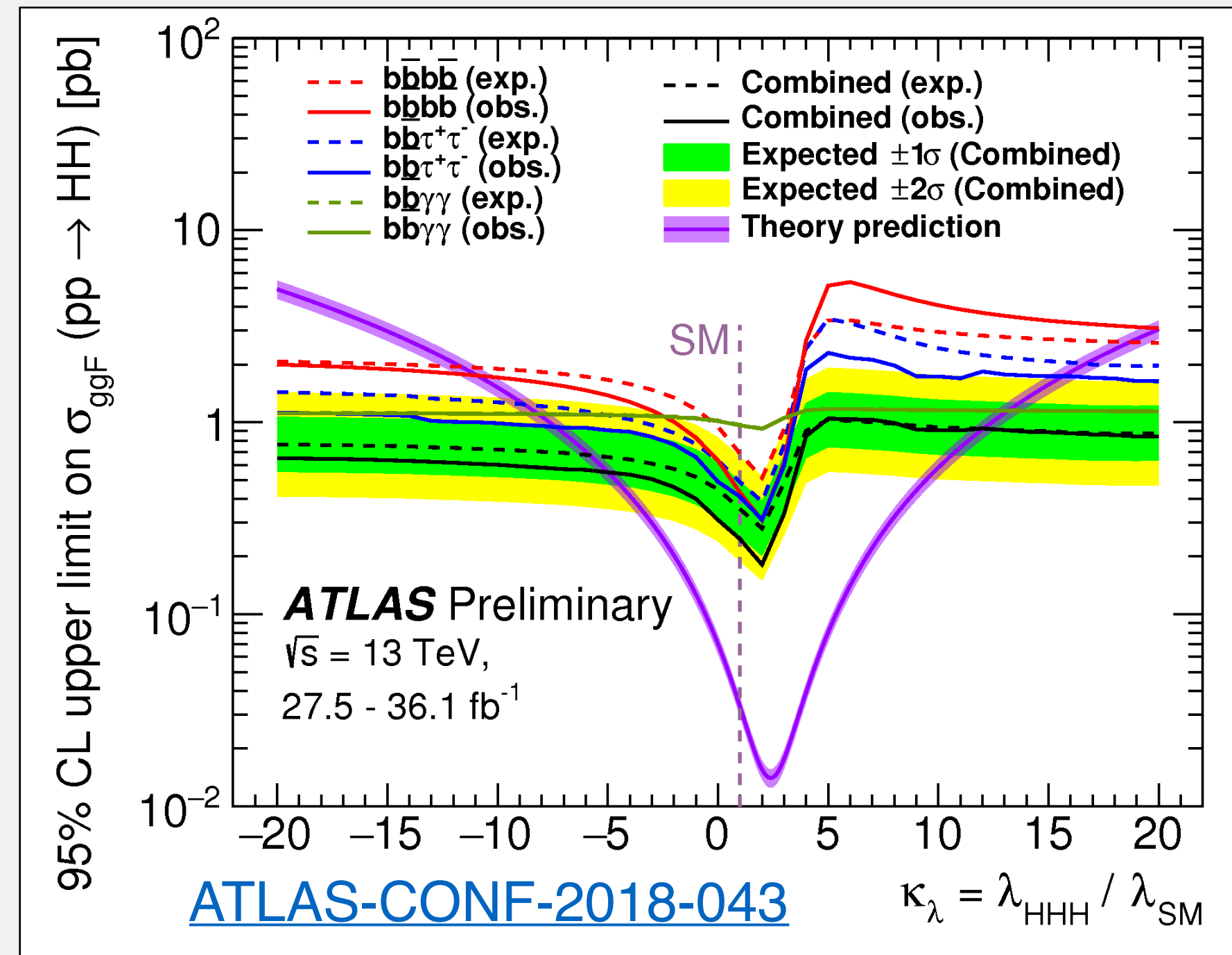
@UU: $HH \rightarrow bb \tau \tau$

similar challenges as H^\pm : (many) BDTs, fake taus..

extend to include boosted signature

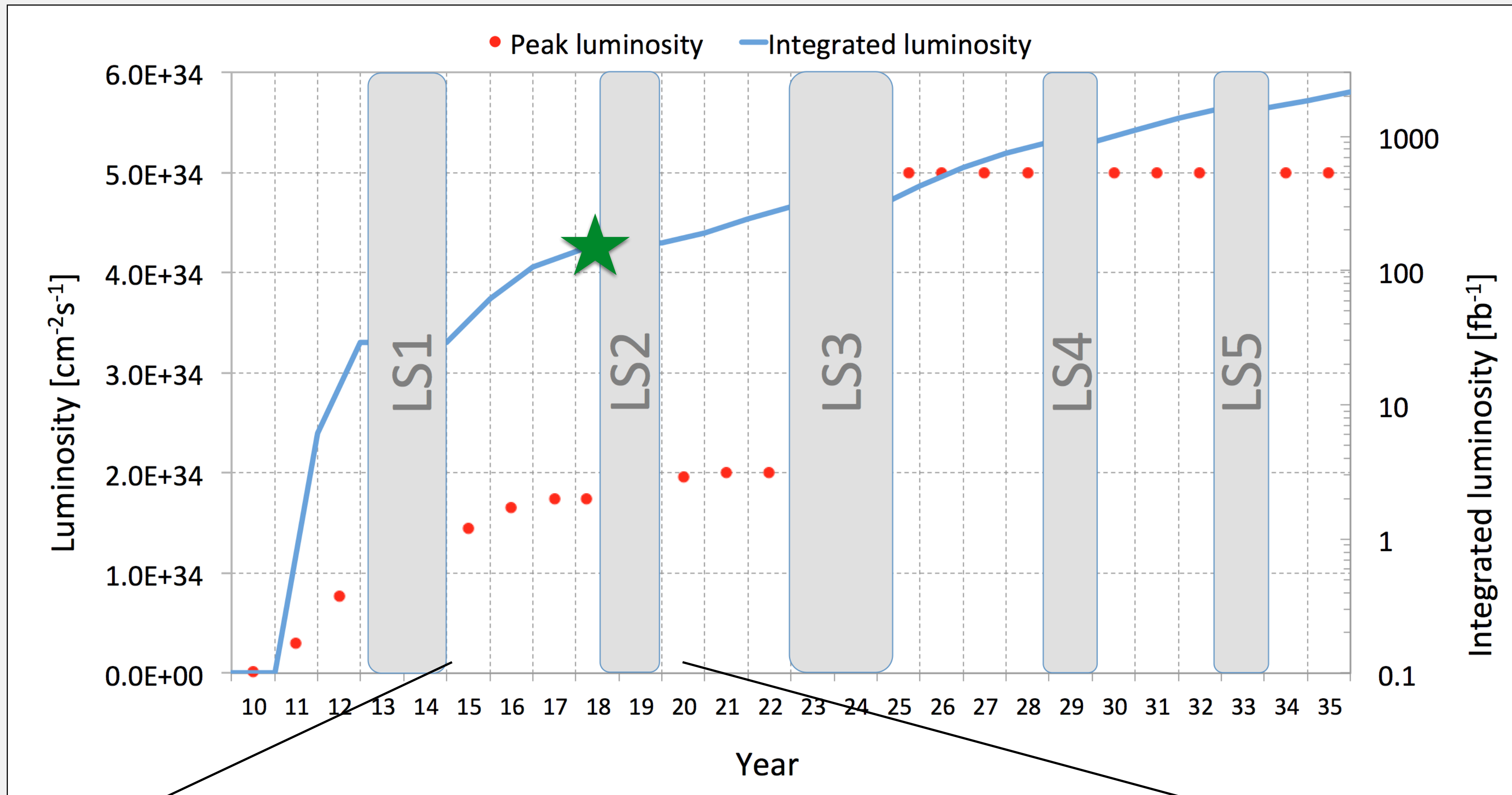
+ combination (bb + bb/ $\gamma\gamma$ / $\tau\tau$)

[arxiv:1808.00336](https://arxiv.org/abs/1808.00336)



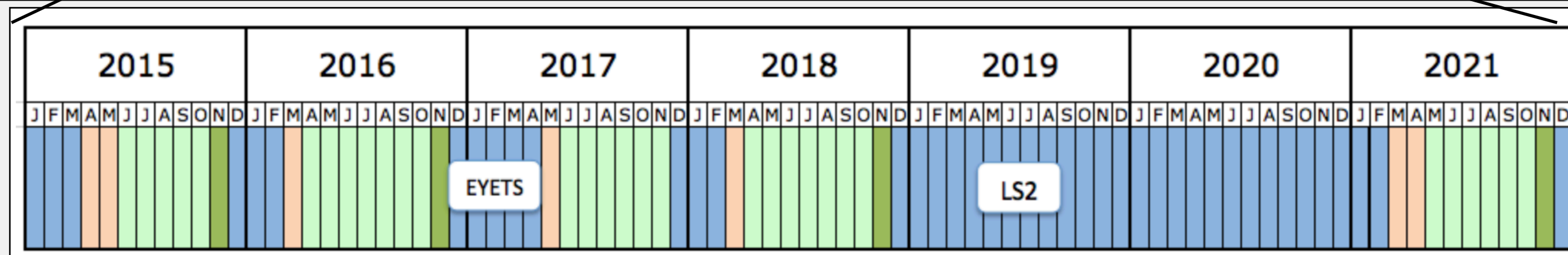
also interest in all other groups for the future!

LHC Schedule



another ~150/fb in run-3 (at 14 TeV)

planning and collection of ideas already started

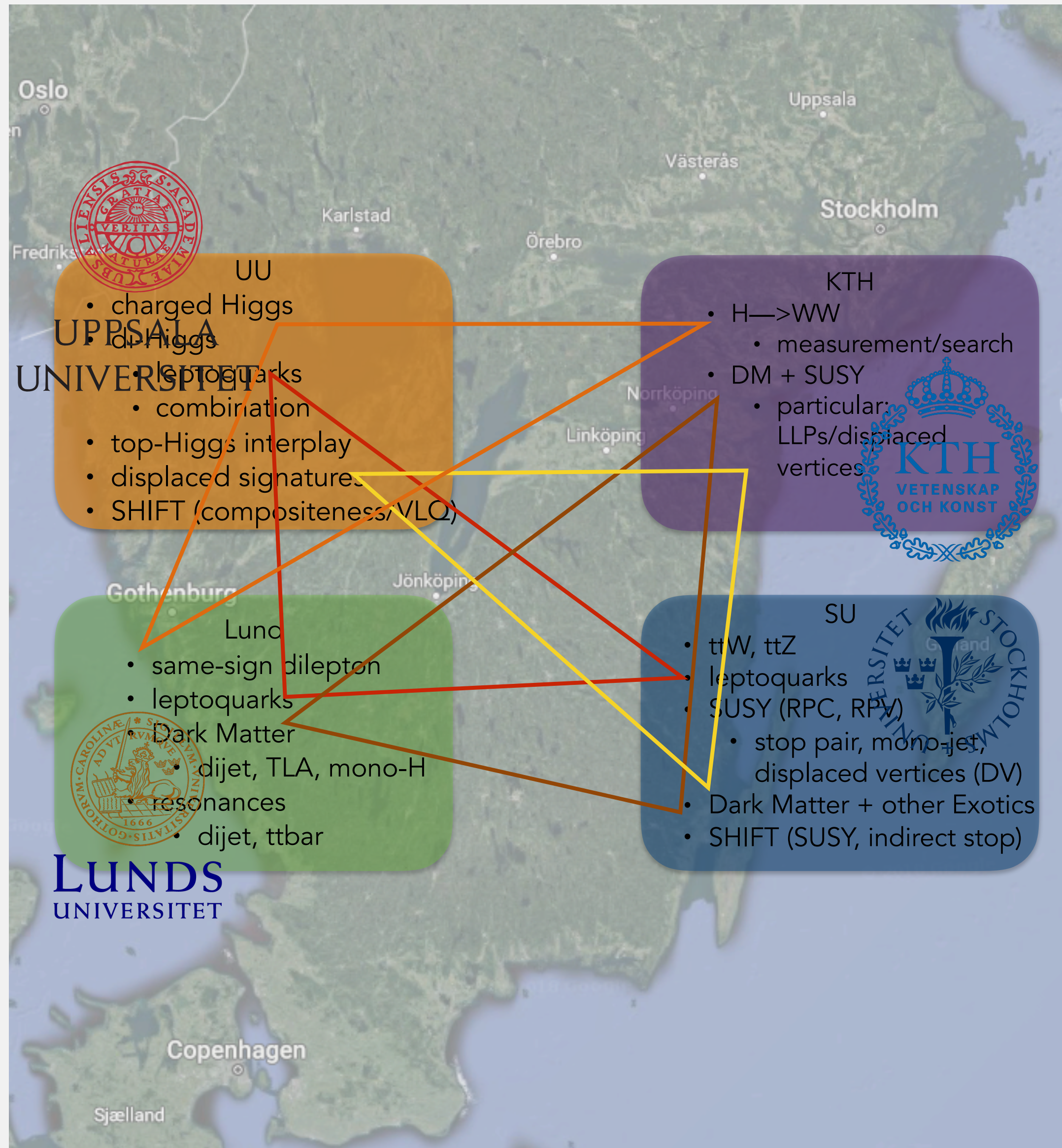


Further Synergies

brainstorming on Monday — is there more we can do with our collective expertise?

- long-lived particles:
 - KTH+SU already collaborating
 - interesting connections to Dark Matter programme in Lund
 - triggering using tracker information (all four groups)
 - performance studies on LLP signatures
- Higgs
 - $H \rightarrow WW$ (KTH), HH (UU), H^{++} (LU), mono-H (LU), SHIFT
 - exploit UU expertise with taus also in H^{++} (taus being added)
 - multi-lepton searches (connects back to $HH \rightarrow VVV$)
- 3rd generation
 - (s)tops (SU), VLQ (UU), $t\bar{t}$ (+DM) (SU), SM $t\bar{t}V$ (SU), SHIFT
 - top-tagging! (all but SM)
 - PF jets
 - $t + DM$

Summary



- very lively physics programme in Swedish groups
- important contributions to running of the experiment and understanding its performance
 - broad spectrum of data analyses
 - measurements
 - searches
 - SUSY
 - Dark Matter
 - Exotics (extra dimensions, VLQs..)
 - more exotics (LLPs, monopoles...)
 - ...
 - plans to tighten collaborations within Sweden

many results on full run-2 data set in the works
run-3 coming up fast!