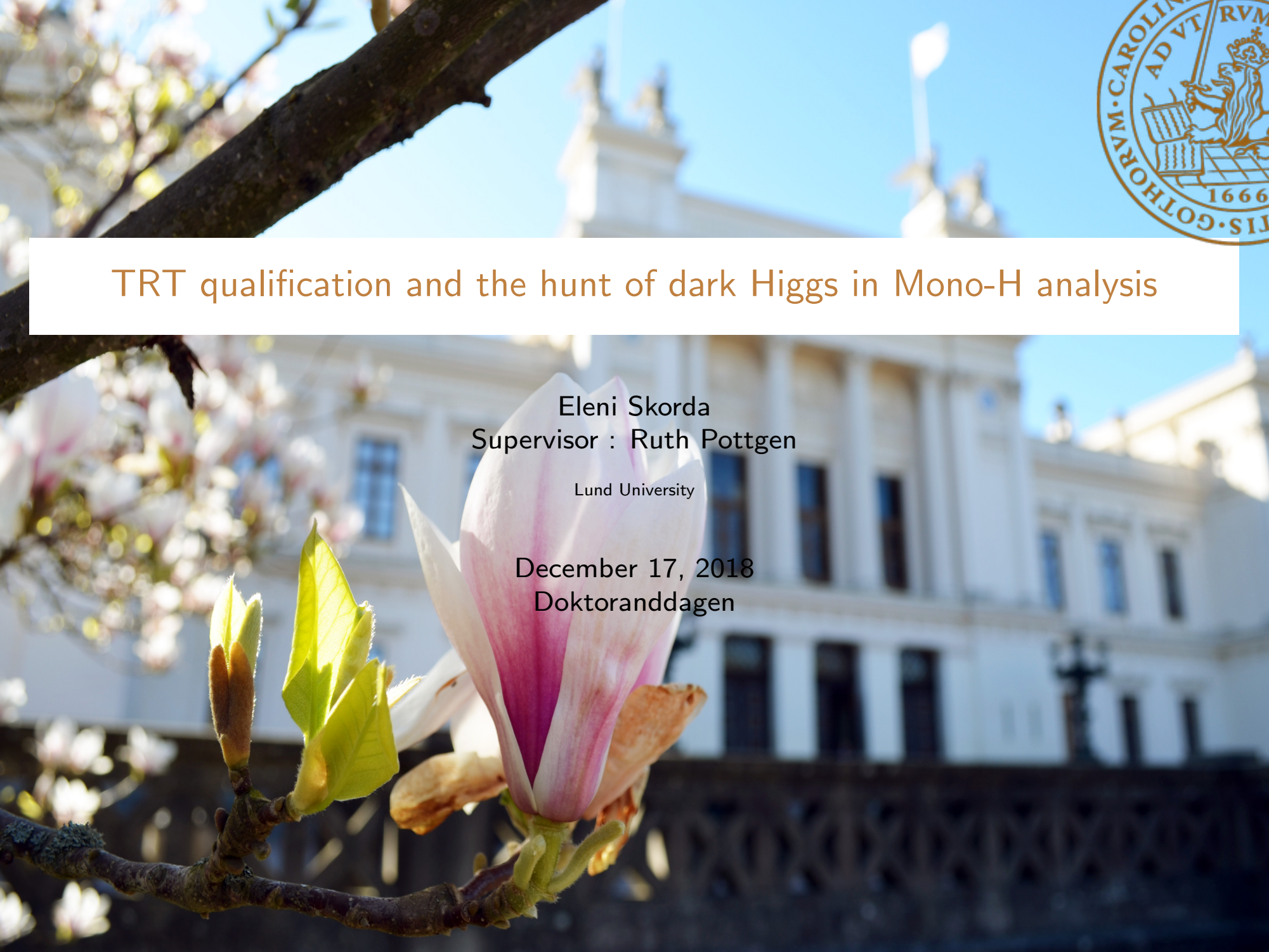

TRT qualification and the hunt of dark Higgs in Mono-H analysis

Eleni Skorda
Supervisor : Ruth Pottgen

Lund University

December 17, 2018
Doktoranddagen

Outline

1. Qualification Task: ATLAS Transition Radiation Tracker (TRT)

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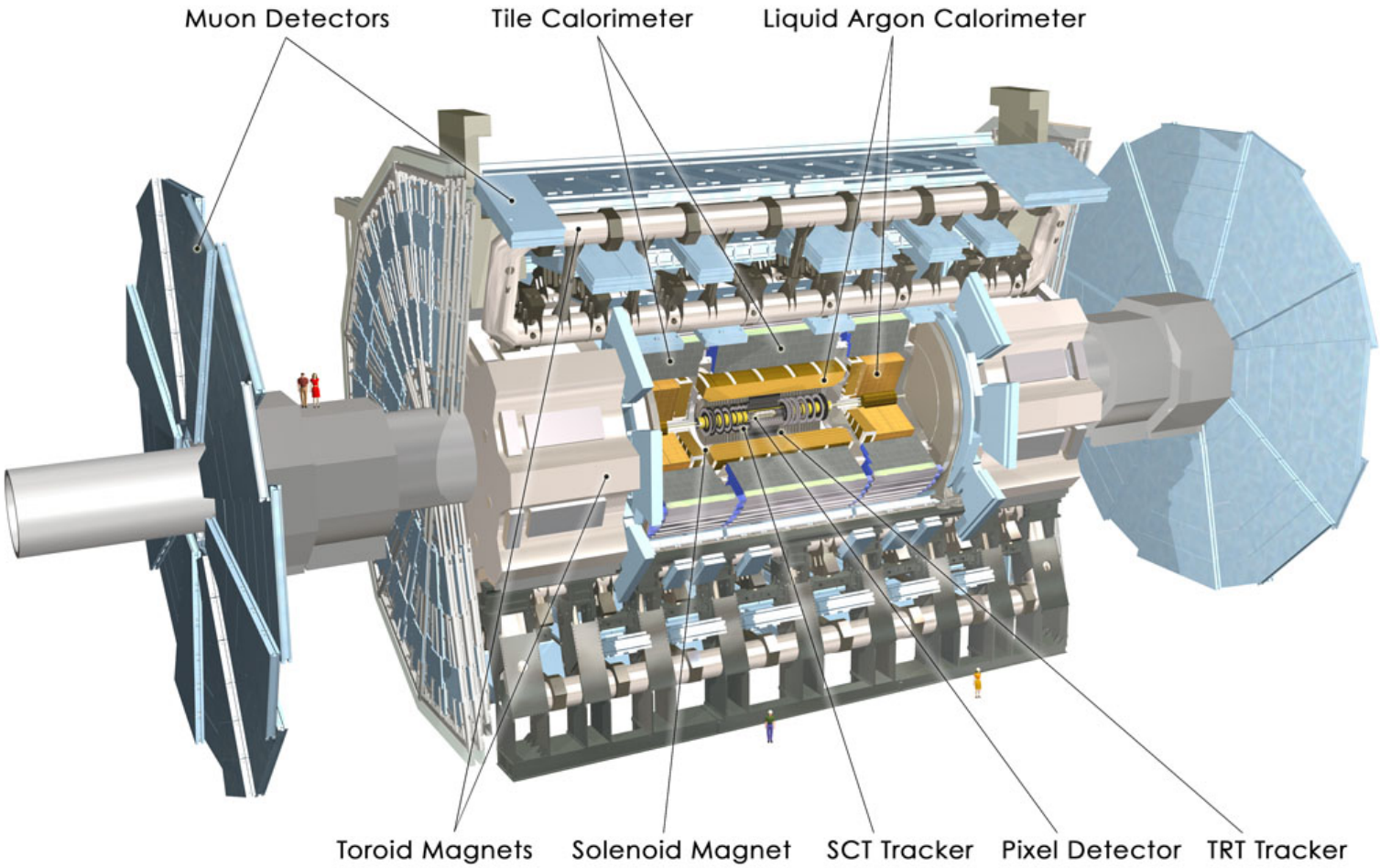
6. Courses

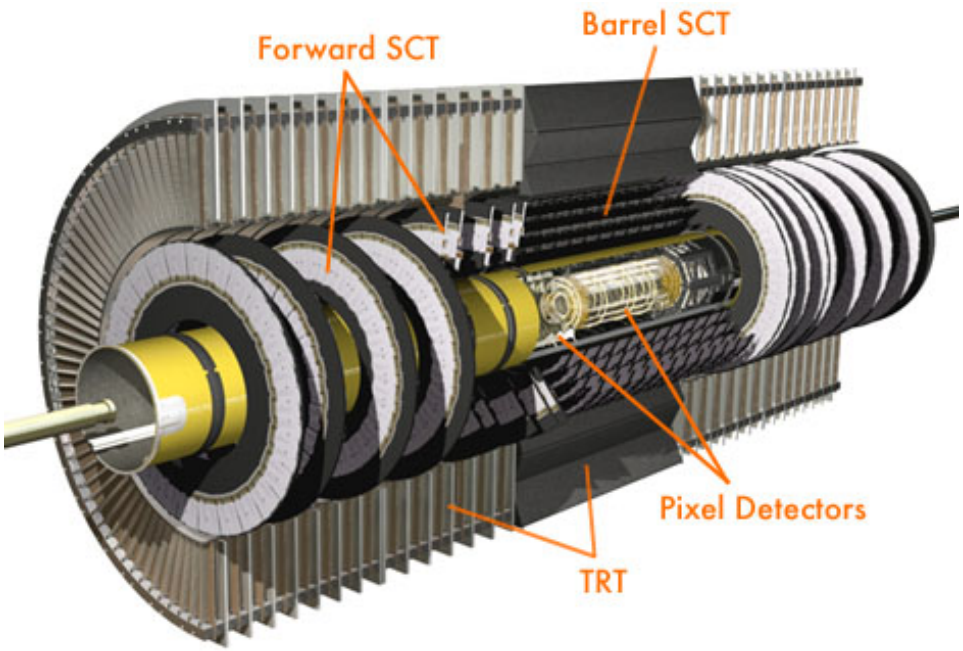
Qualification task on Transition Radiation Tracker (TRT)

The ATLAS detector,the Inner detector and TRT



http://atlasexperiment.org/images_atlas1/what-is-atlas/atlas_lg.jpg

Inner Detector

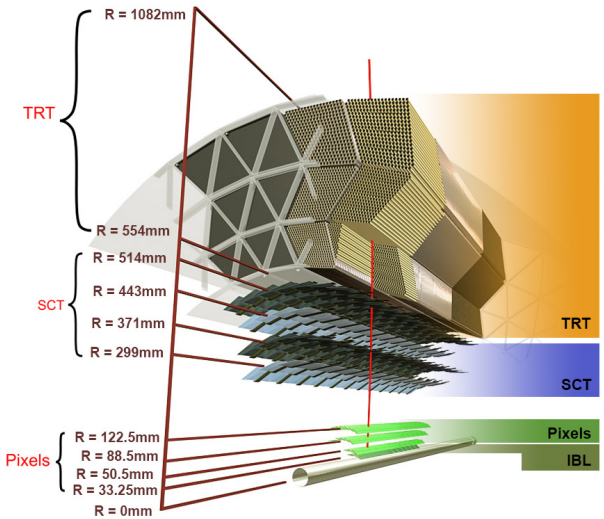


- length $6.2m$, diameter $2.1m$, coverage $:\eta < 2.5$
- embeded in $2T$ magnetic field
- consists of : Pixel detector , silicon microstrip detector and the transition radiation tracker
- determination of the momentum of charged particles

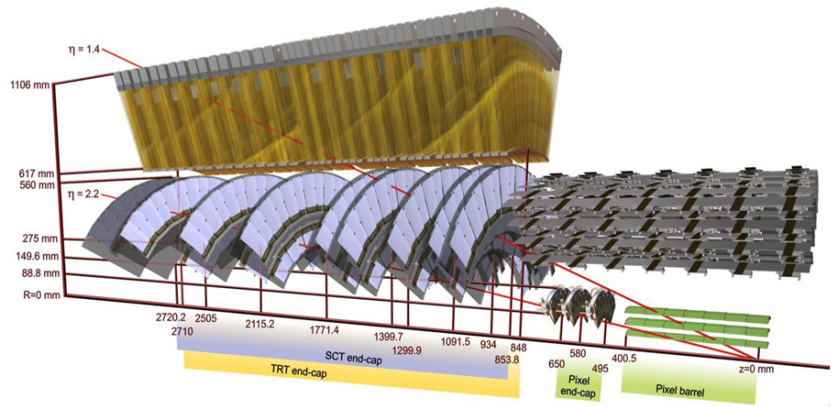
Transition Radiation Tracker

- Is the outermost part of the inner detctor and the largest
- It is made of thin layered straw drift tubes, between the straws, a radiator is placed
- Contributes to momentum measurement
- Particle identification : transition radiation produced by charged particles when they traverse material with different dielectric constant
- Consists of three parts : barrel and 2 end-caps

Barrel: $|\eta| < 1$, straws parallel to beam axis

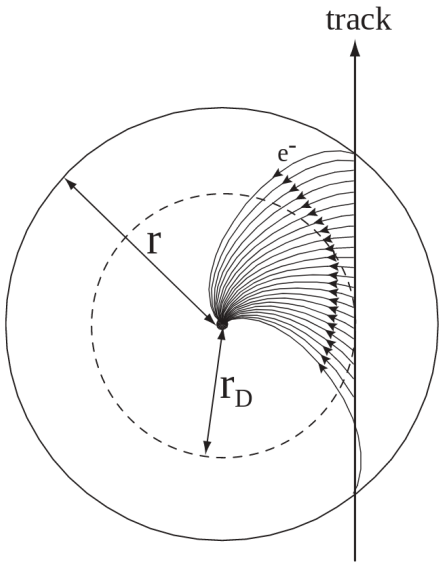


End-caps: $0.8 < |\eta| < 2$, straws perpendicular to beam axis

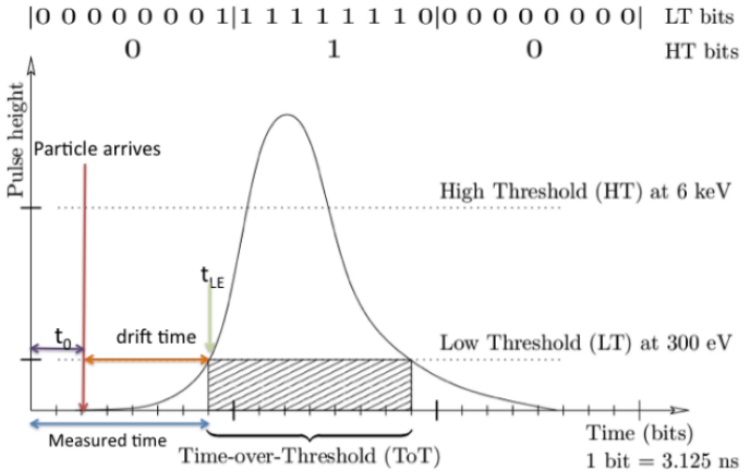


http://atlasexperiment.org/photos/inner-detector-combined.html

When a particle crosses a straw tube ...



https://cds.cern.ch/record/2224514

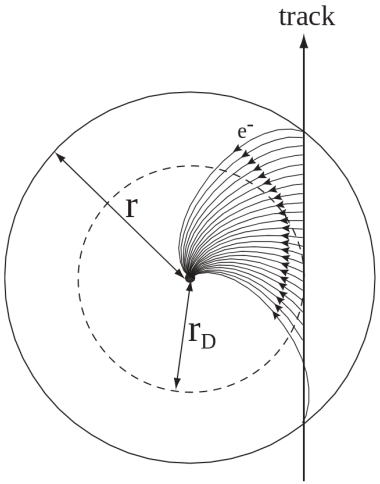


https://cds.cern.ch/record/1452211

First electron drift time : $t = t_{LE} - (t_{collision} + t_{ToF} + t_{SP}) = t_{LE} - T_0$

- $t_{collision}$:time the collision took place (relative to LHC clock)
- t_{ToF} : the time that the particle travels from interaction point to te straw
- t_{SP} :time of signal propagation in both directions in the wire

Translating time to distance



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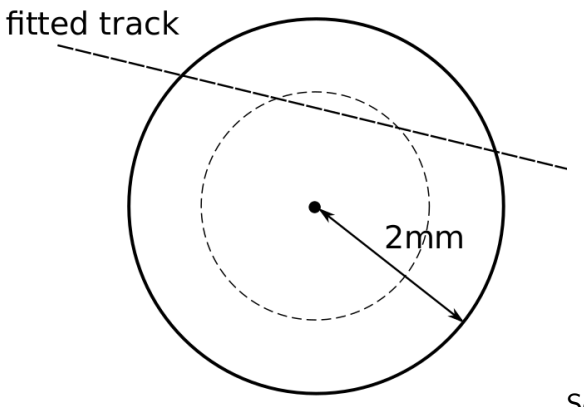
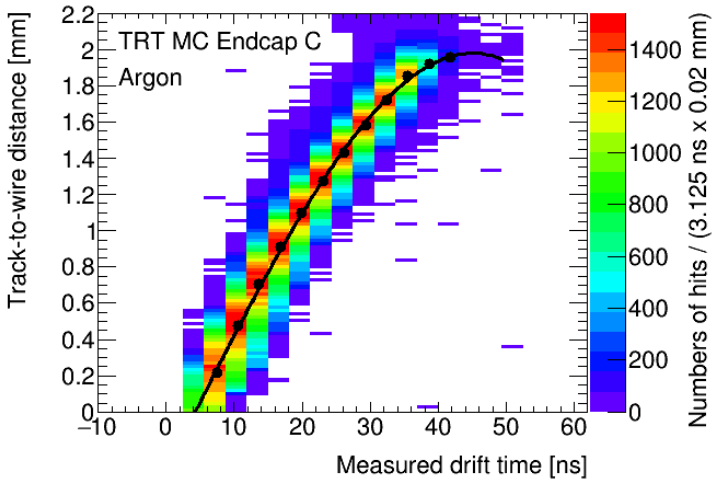


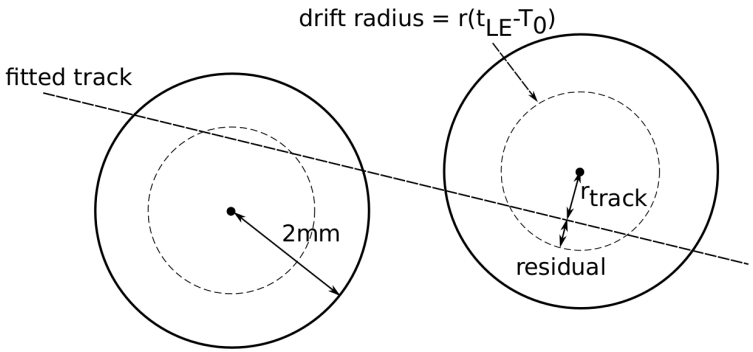
Source:

https://cds.cern.ch/record/1452211

Drift radius from $r = r(t)$ called "r-t" relation, obtained by data and fitted to a third degree polynomial



Tracking with TRT



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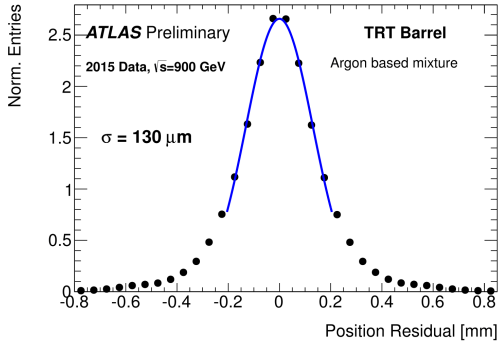
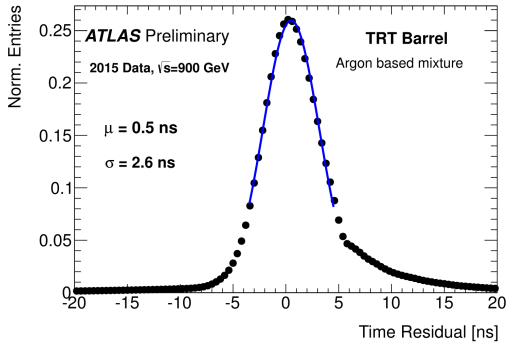


https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PLOTS/TRT-2016-001/

Momentum relative uncertainty

$$\frac{\sigma(p_T)}{p_T} \propto \frac{\sigma(r)p_T}{BL^2}$$

L: lever arm,$\sigma(r)$ the position resolution and B the field strength



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Calibration: calculating T_0 and r-t

Highest position resolution , best momentum reconstruction

Parabola Plots

There were two questions we had to answer:

- Does the T_0 from the calibration give the minimum σ_r?

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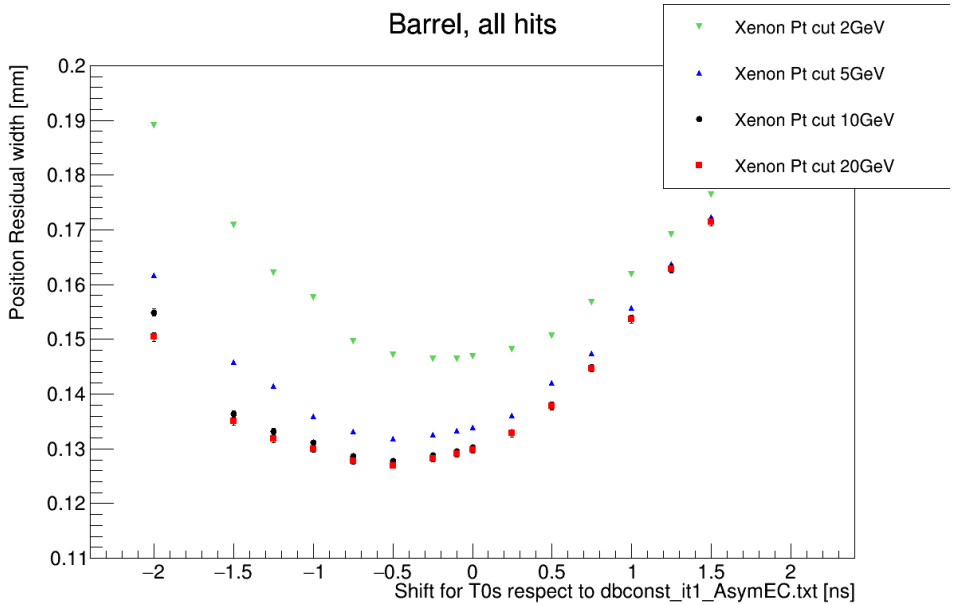

$$\sigma_r(\delta T_0) = \sigma_r^{min} + a(\delta T_0 - \delta T_0{}^{min})^2$$

The end of Qualification task ...

After completing the study described above for MC simulated events I wrote a report a TWiki page (Only I read it ... and maintain it) and got QUALIFIED !!!

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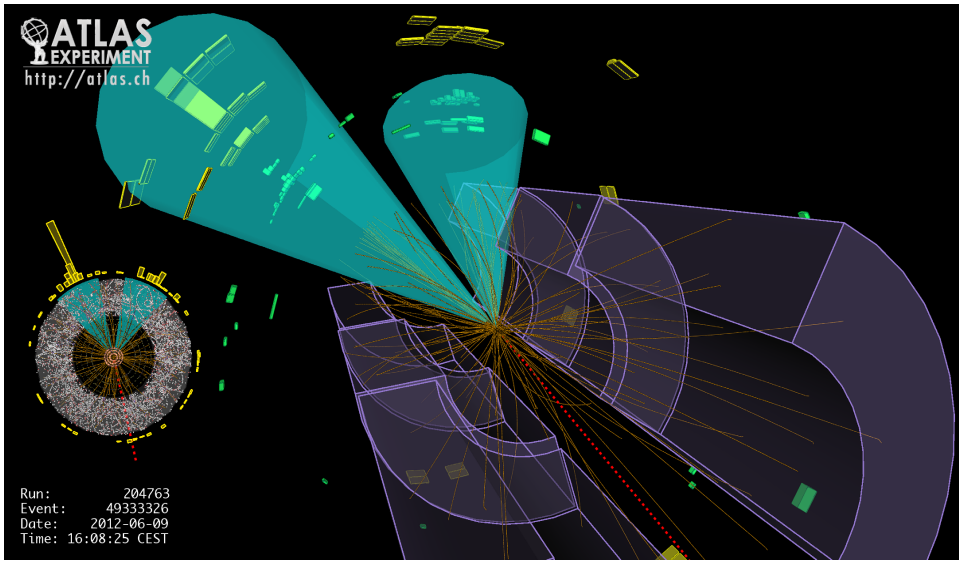
I will try to keep my promise of less time dedicated to TRT work...

Mono-H(bb) Search and Dark Higgs

Mono-H(bb) searches : E_T^{miss} + b jets



https://atlas.cern/updates/atlas-blog/what-happens-when-energy-goes-missing

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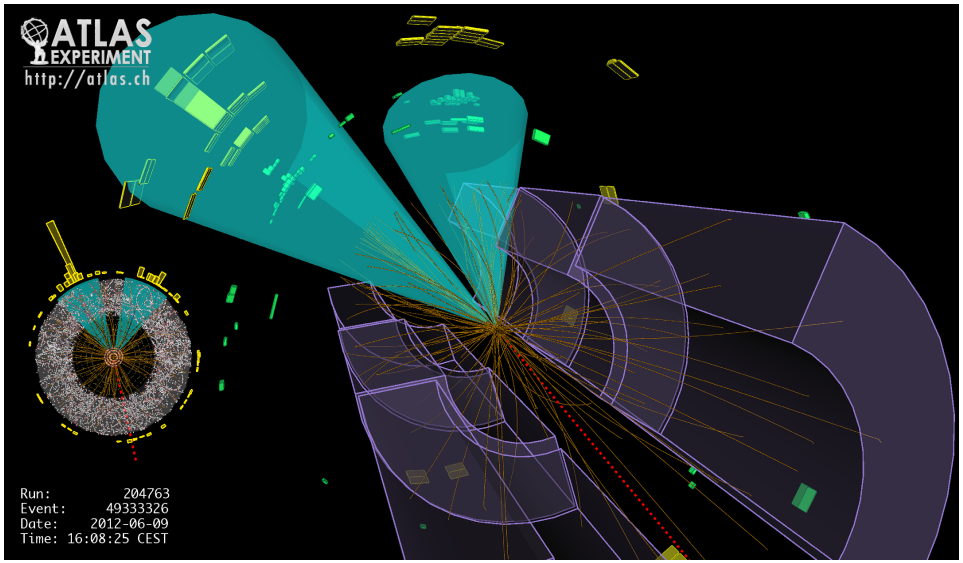

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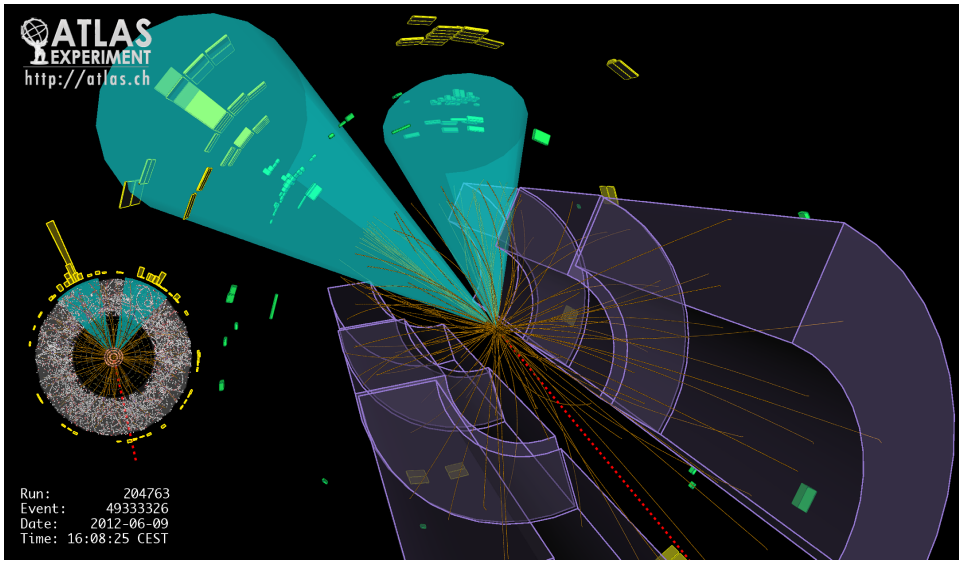
- Signature for most of the DM searches : $E_T^{miss} + X$, where X is γ, W, Z, h, jet
- $E_T^{miss} + h$, h initial state radiation is Yukawa suppressed $\rightarrow$ direct probe the hard interaction with DM

https://cds.cern.ch/record/2301321

Mono-H(bb) searches : E_T^{miss} + b jets



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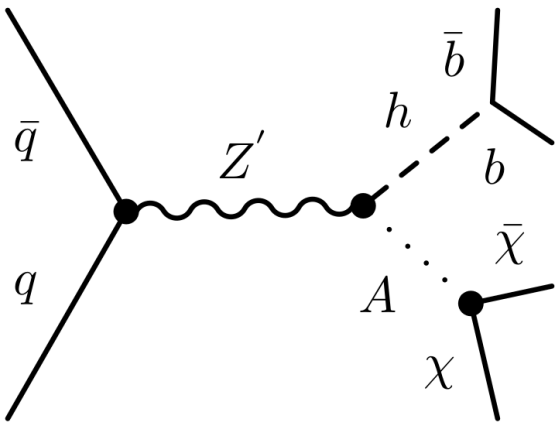

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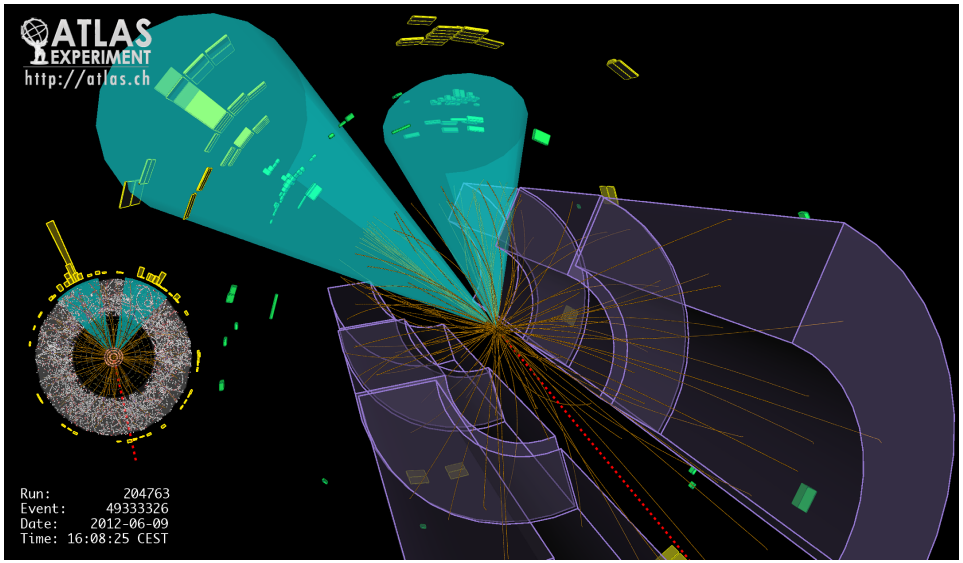

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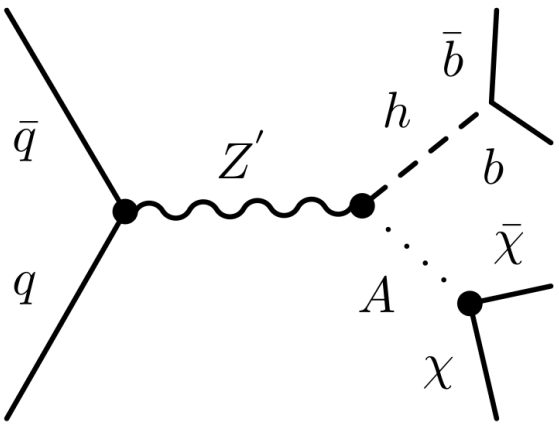
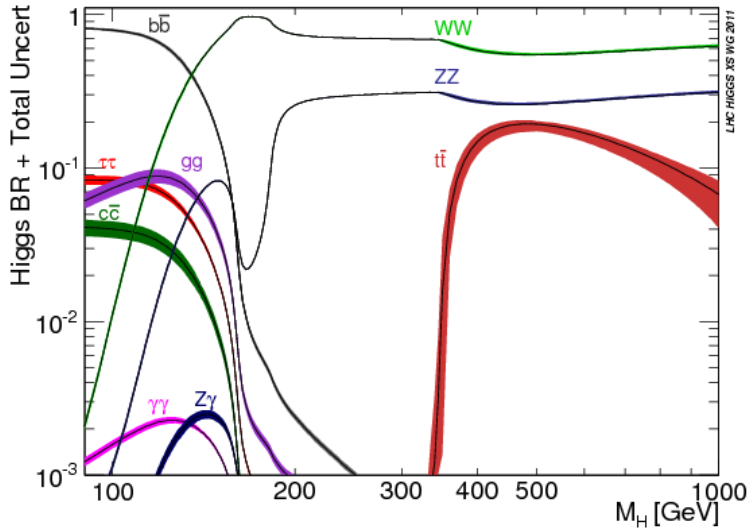


https://twiki.cern.ch/twiki/bin/view/AtlasPublic/HiggsTheoryPlots

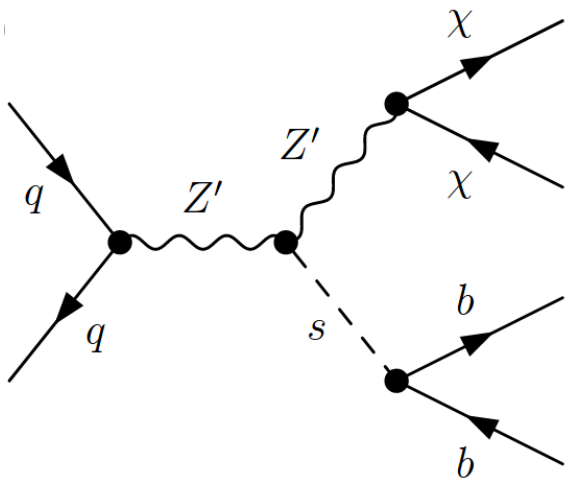


Dark Higgs production

"Hunting the dark Higgs" : `https://arxiv.org/abs/1701.08780`

- Higgs mechanism that generates DM mass in the dark sector ($m_{DH} < m_{DM}$)
- Couplings within dark sector large → DH strahlung → DH lightest in dark sector → decays to SM

Promising way to probe at the LHC : via Z' mediator that radiates a dark Higgs boson



Background Studies

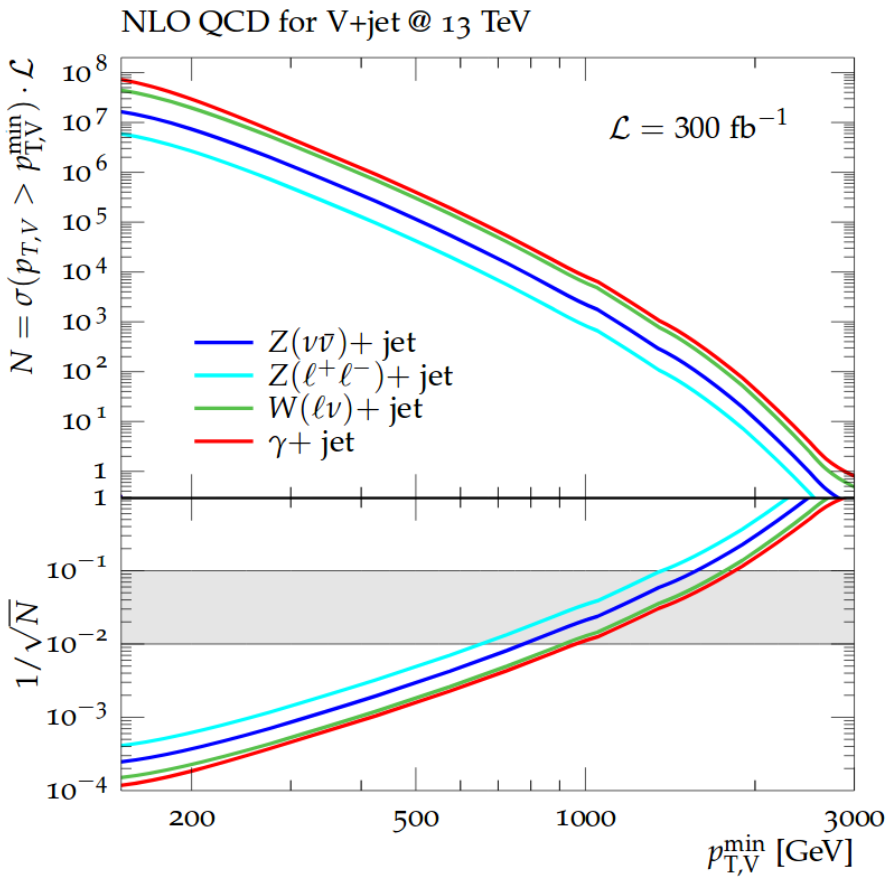
Background studies

Missing energy production in standard model:

- neutrinos by Z, W decays
- SM particles that decay to Z and W

Modeling of V+jets background:

- Leading background $Z(\nu\nu)$+jet production (followed by $W(\ell\nu)$ (particular for $\ell = \tau$))
- Most direct way to measure : $Z(\ell\ell)$+ jets , but statistically limited due to smaller br .



https://arxiv.org/pdf/1705.04664.pdf

Estimate $Z(\nu\nu)$+jets from γ+jets

Estimate $Z(\nu\nu)$+jets from γ+jets

$$N^{estimate}(Z(\nu\nu) + jets) = \frac{N(\gamma + jets)}{TF^{\gamma}_{Z\to\nu\nu}}$$

where $TF^{\gamma}_{Z\to\nu\nu}$ transfer function

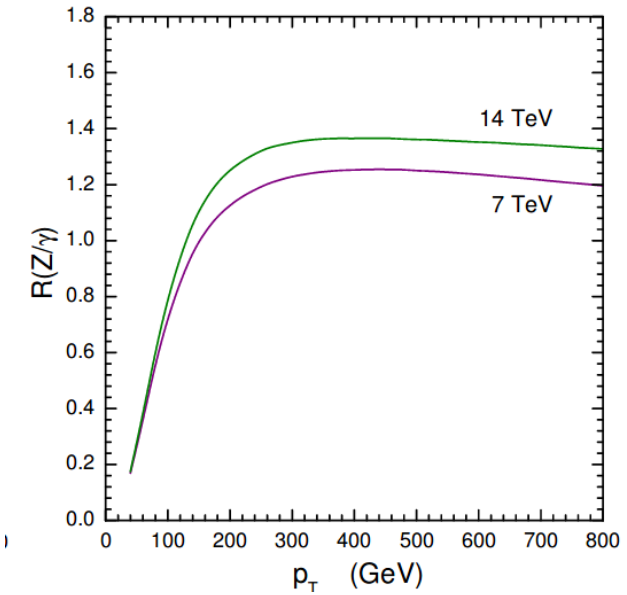
Ref: `https://cds.cern.ch/record/1507150/`

The Transfer function is the ratio :

$$R = \frac{d\sigma(\gamma + jets)/dp_T}{d\sigma(Z + jets)/dp_T}$$

used to translate between the two processes

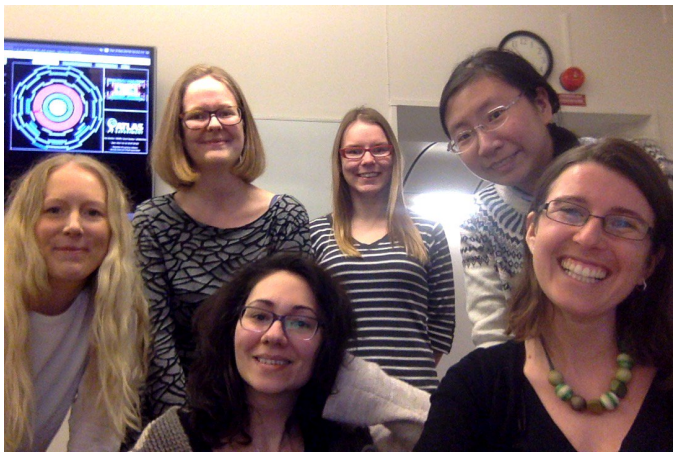
$$R = R_0 \left(\frac{p_T^2}{p_T^2 + M_Z^2} \right)^n$$



Theoretical calculation of the ratio using GAMBOS

Master Classes

Master Classes 2018



SEKTIONEN FÖR ASTRO- OCH PARTIKELFYSIK

Bild från vårens internationella mästarklasser i Lund då deltagarna i slutet av dagen diskuterade och samarbetade med grupper som gjort samma övning i Frankrike, Italien, Storbritannien, Tjeckien och forskare på plats på CERN.

Detta tillfälle sammanföll med den av FN instiftade Internationella Dagen för Kvinnor och Flickor inom Vetenskap (http://www.un.org/en/events/women-and-girls-in-science-day/), och leddes av kvinnliga forskare för att visa att de utgör en viktig del av forskningsfältet.

"Pröva på" forskning i partikelfysik

från KTH och Stockholms universitet. Chalmers arrangerade regelbundet internationella mästarklasser fram till 2016, och de vill gärna fortsätta traditionen och välkomnar lokala gymnasieskolor att ta kontakt om de är intresserade.

International Particle Physics Outreach Group (IPPOG) har organiserat mästarklasser i partikelfysik sedan 2005,

Courses

Courses

List of courses from the previous year :

- Scientific Writing 1.5 credits:
  3 Days Long
  All the work is done during these days
  Very useful
- Geant 4 tutorial 3 credits:
  1 week of lectures and Hand On
  More than 1 week project
  Very useful but time consuming
- **Detector school in Copenhagen/Helsinki** 10 credits
- Phenomenology 7.5 credits
  Full semester
  Lots of homework and studying
  Very useful $\rightarrow$ in understanding concepts around MC processes

Next semester :

- Learning and teaching in higher education-theory and practice(`https://www.science.lu.se/internal/research-and-education/training-in-higher-education-teaching-and-learning`) 4.5 credits