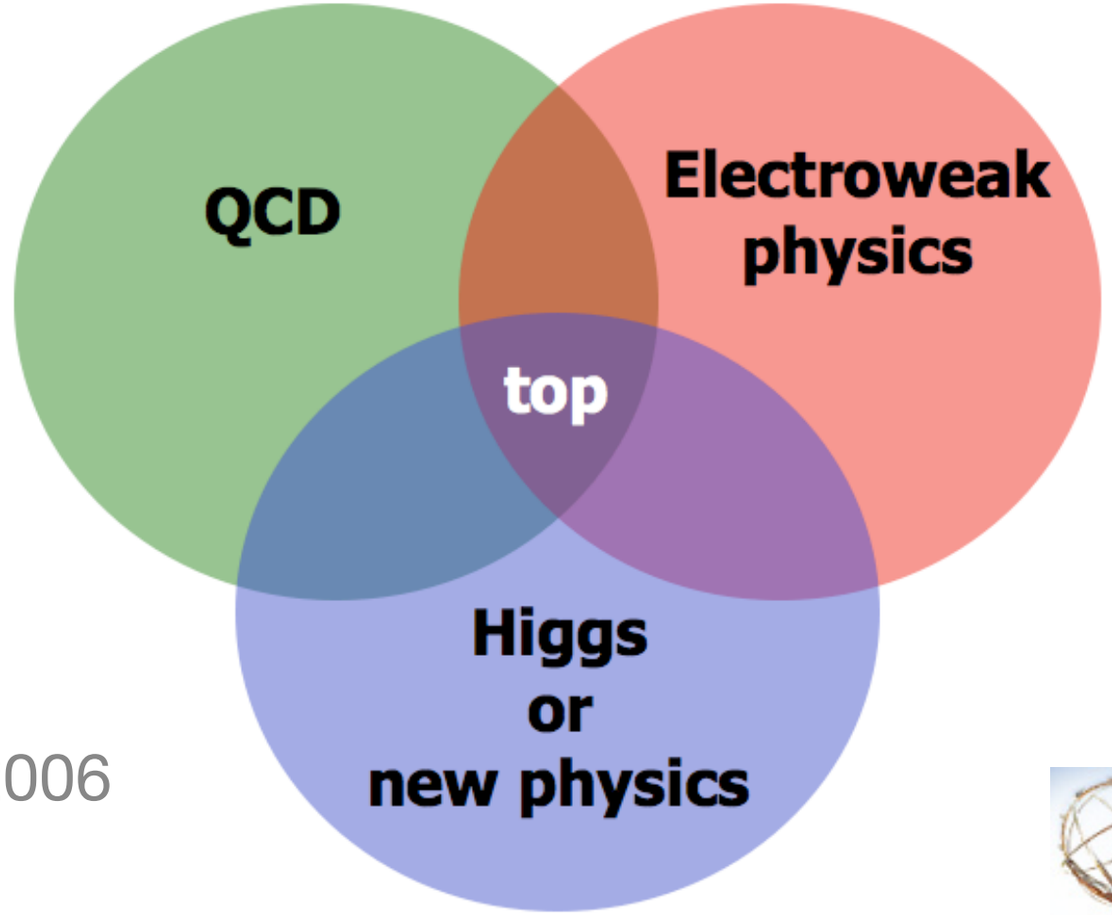
Status of Top Quark Physics at Dortmund

Reiner Klingenberg
University of Dortmund

ATLAS-D top, MPI Munich, 18-19 May 2006



Status of top quark physics at Dortmund

Overview

- Our group
- What we did so far
- How to continue

Our group

- our present top physics group, some of them are just starting

  - Moritz Bunse (diploma student)
    Daniel Dobos (PhD student)
    Claus Gößling
    Reiner Klingenberg
    Ingo Reisinger (PhD student)
    Jörg Walbersloh (PhD student)

- we will hire a post-doc on analysis by autumn of 2006

Our group

- we have a strong background in the pixel detector of the ATLAS experiment

- we have a study on spatial resolution improvements
  in the pixel detector;

  it is part of the tool development for tracking and b-tagging
  which is especially useful for top physics

What we did so far

- improvements of the track fitting

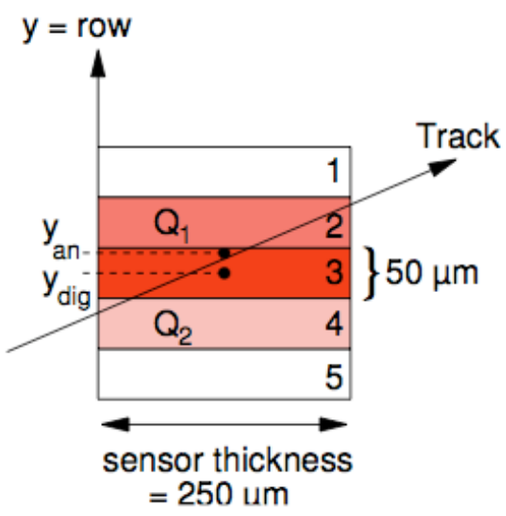
- first look at ATLAS DC2 (data challenge) ntuples
  regarding top-anti-top production
  and their decay in the (semi-)leptonic channel

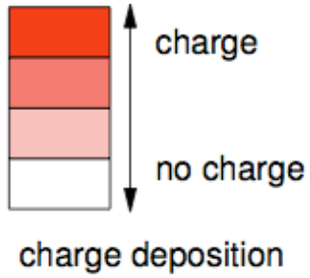
- analysis in the ATHENA ATLAS s/w environment
  using AODs (analysed object data)

Aim of ‘our’ tracking study

- so far ATHENA (10.4.0), the ATLAS reconstruction/analysis frame did not use the full information provided by the inner detectors, i.e. the charge information from the individual cells of the pixel detector

- but detector provides ‘analogue’ to improve on the spatial resolution of tracks and the vertex/secondary vertex determination





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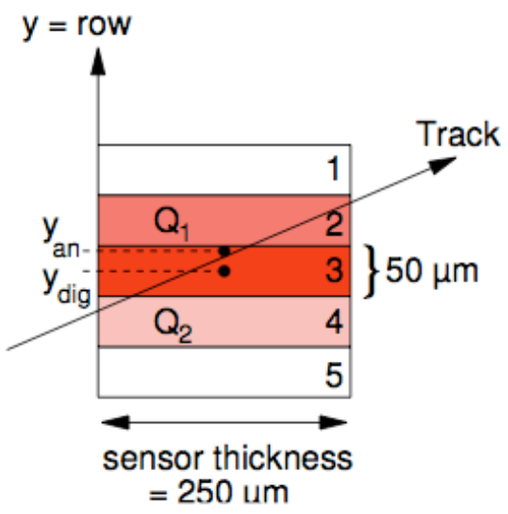
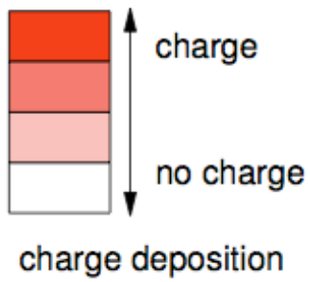
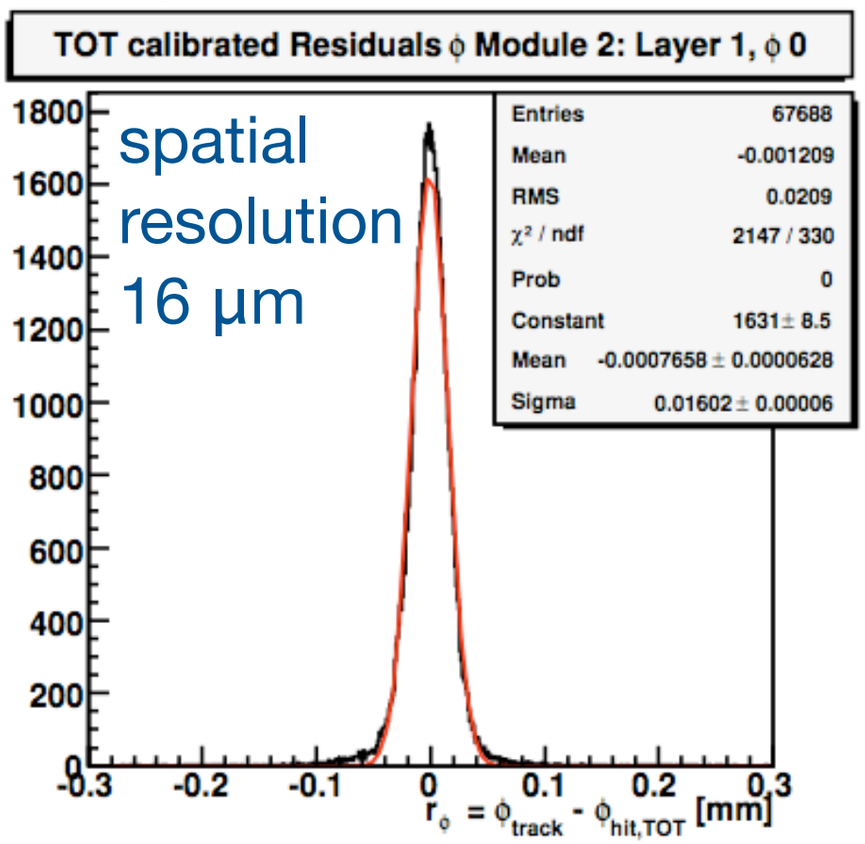






- Improvements ~10% first version is part of ATHENA 11.0.1

I. Reisinger, Dortmund
in collaboration w/
T. Lari, Milano

First look at ATLAS DC2 ntuples

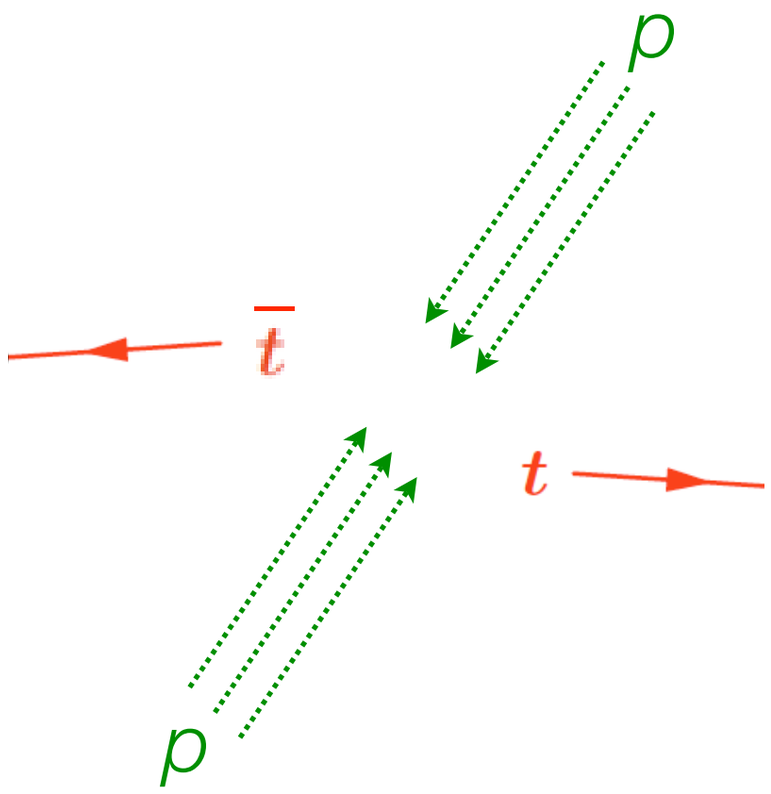
- we become familiar with simulation data available
  from the ATLAS data challenge 2 (DC2) in respect to top quark production
  and decay

- had some first look at the samples including full- and semi-leptonic
  top-anti-top decays

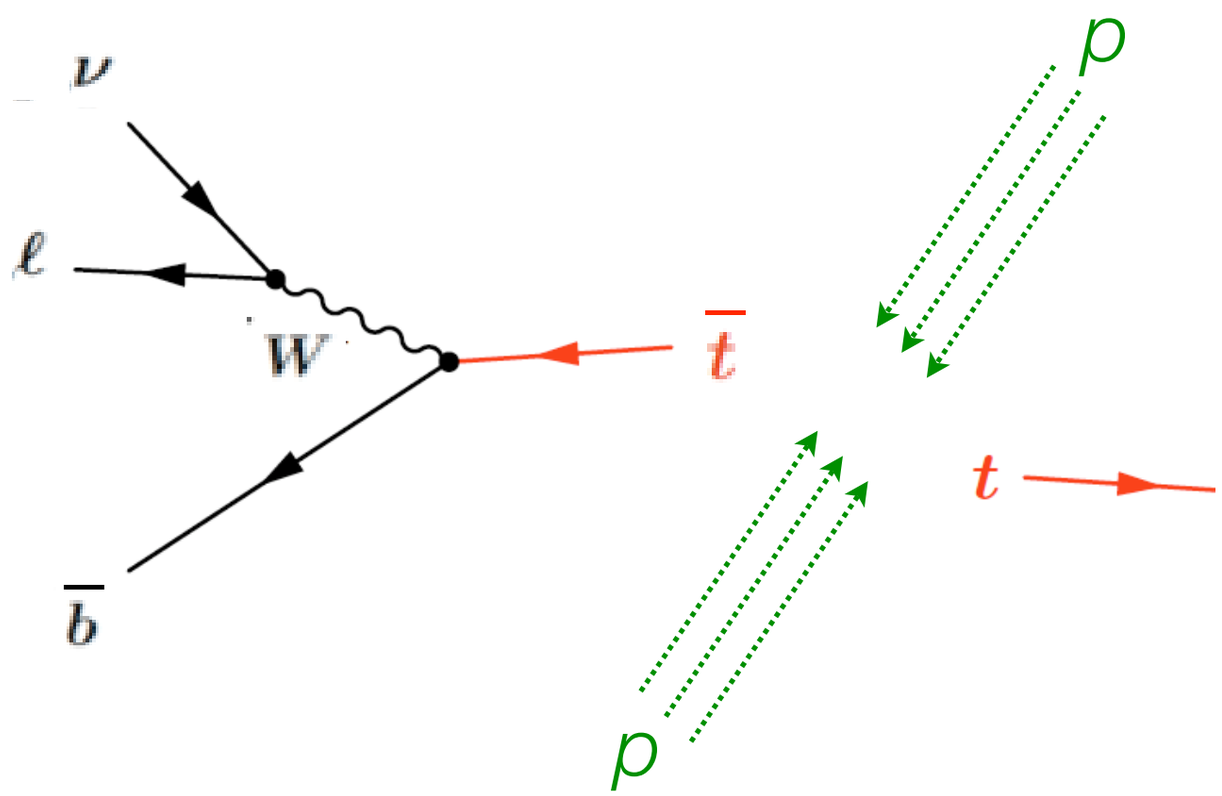
- reconstruction of invariant masses of top and W-boson;
  a rudimentary study of angular correlations between jets, leptons

- data and useful analysis skeleton from NIKHEF
  and some additional coding for our own learning phase

Example: leptonic and hadronic top reconstruction



Example: leptonic and hadronic top reconstruction



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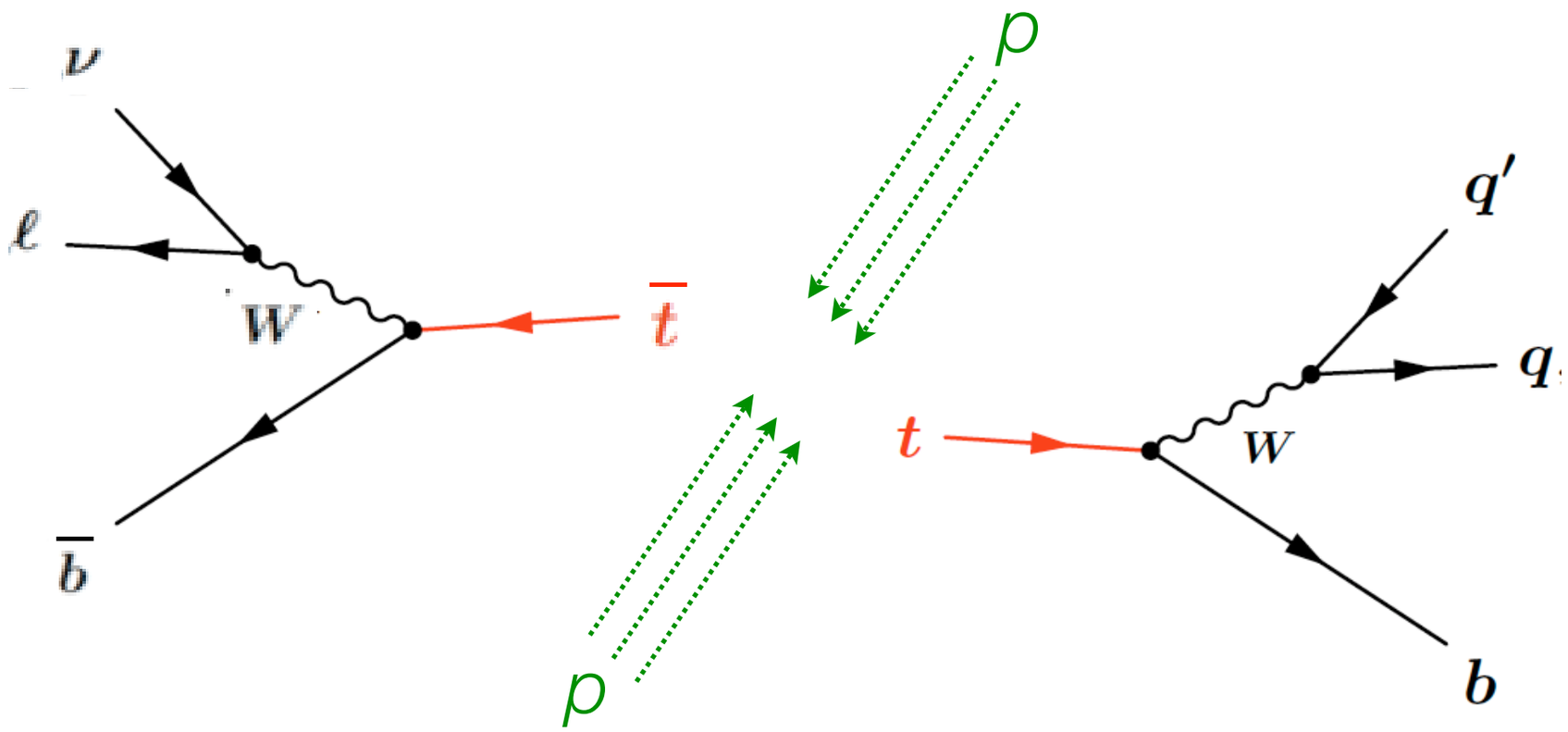

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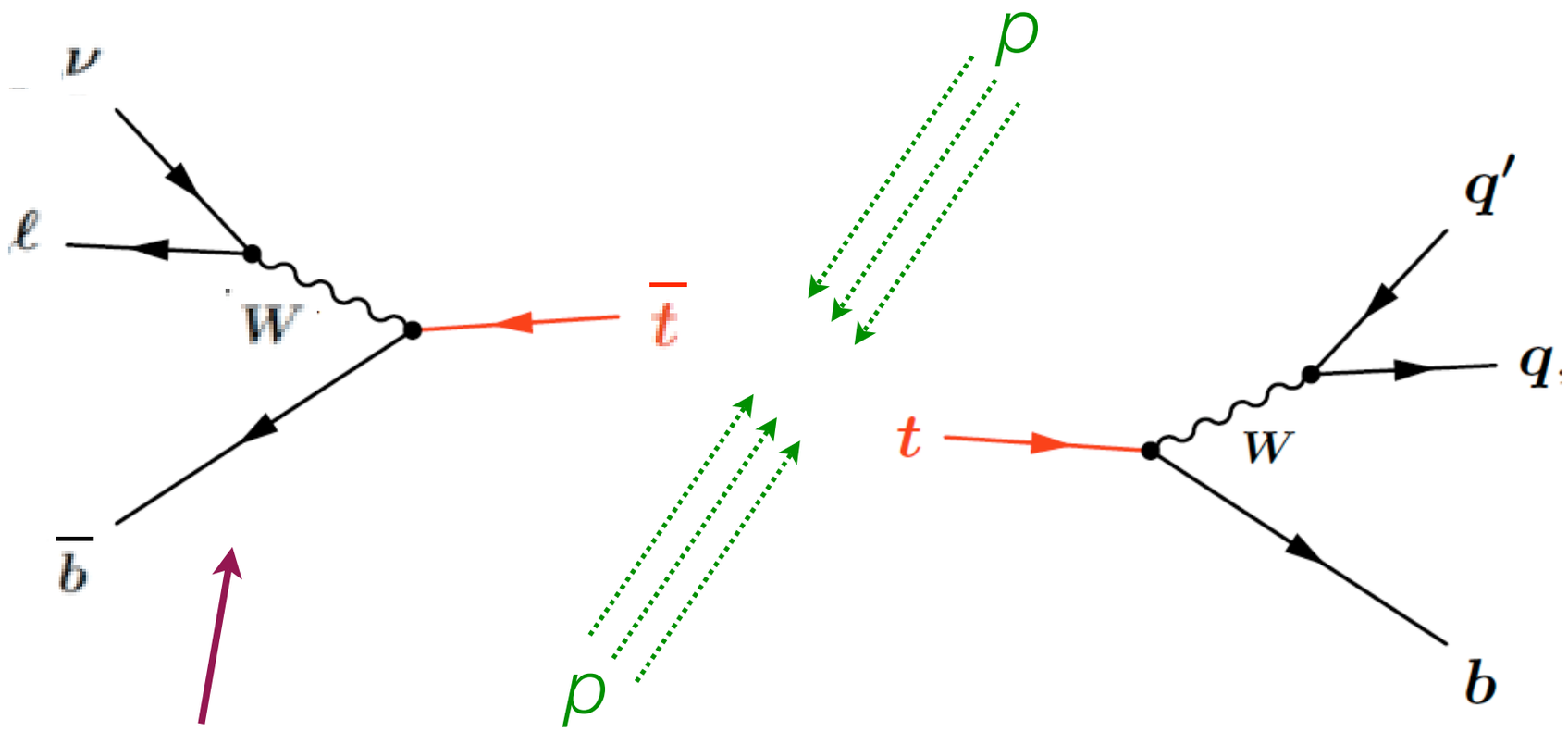
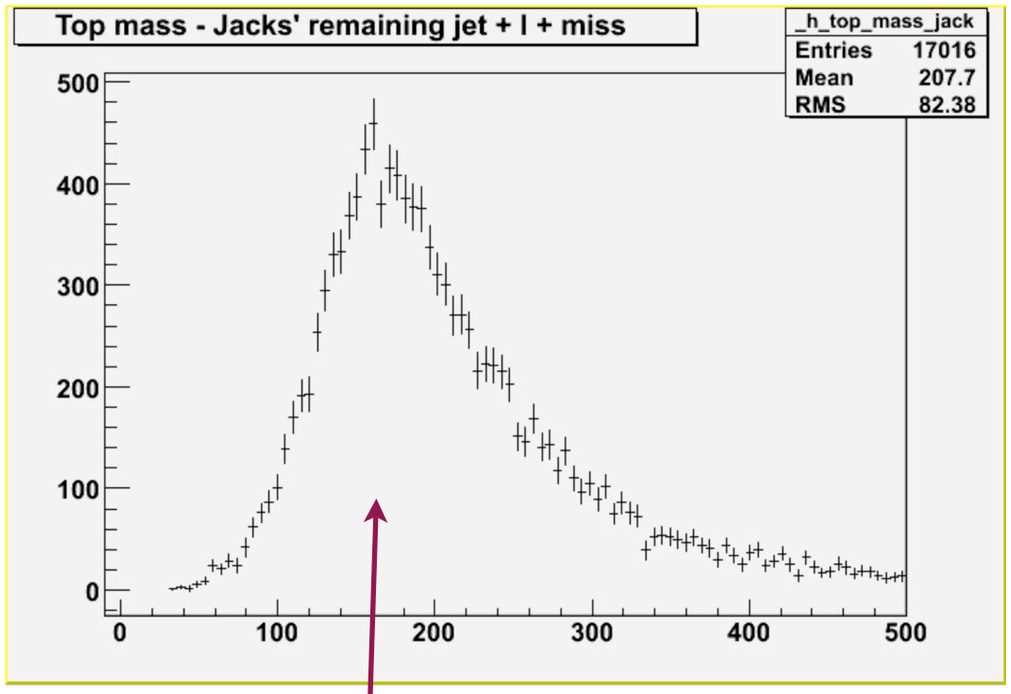


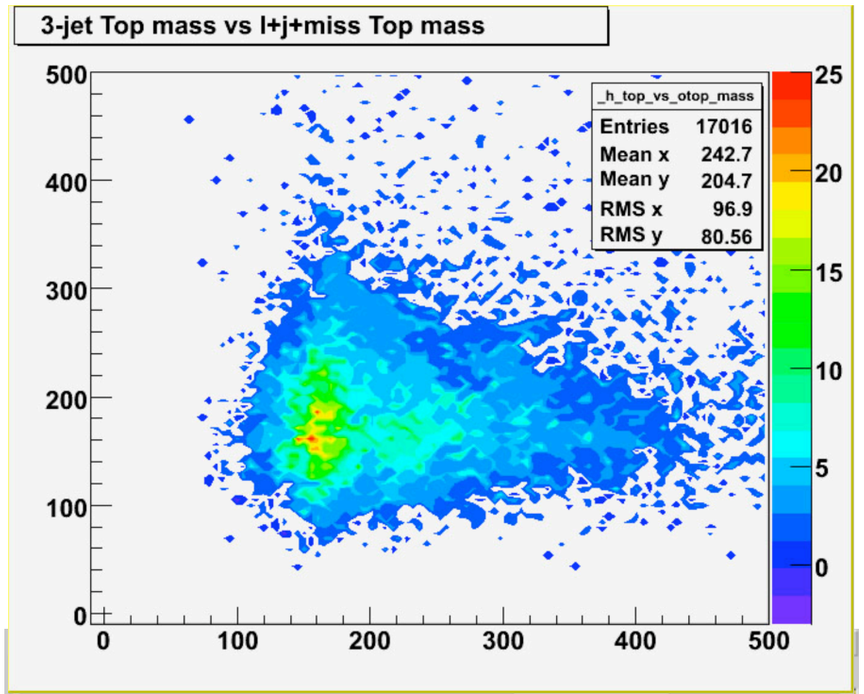
- reconstruction of the ‘leptonic‘ top:
  transverse invariant mass of
  neutrino + ch. lepton + 4th jet

    - reconstruction of the ‘hadronic‘ top:
      highest vectorial transverse momentum sum
      of 3 out of 4 jets

Example: leptonic and hadronic top reconstruction

D. Dobos





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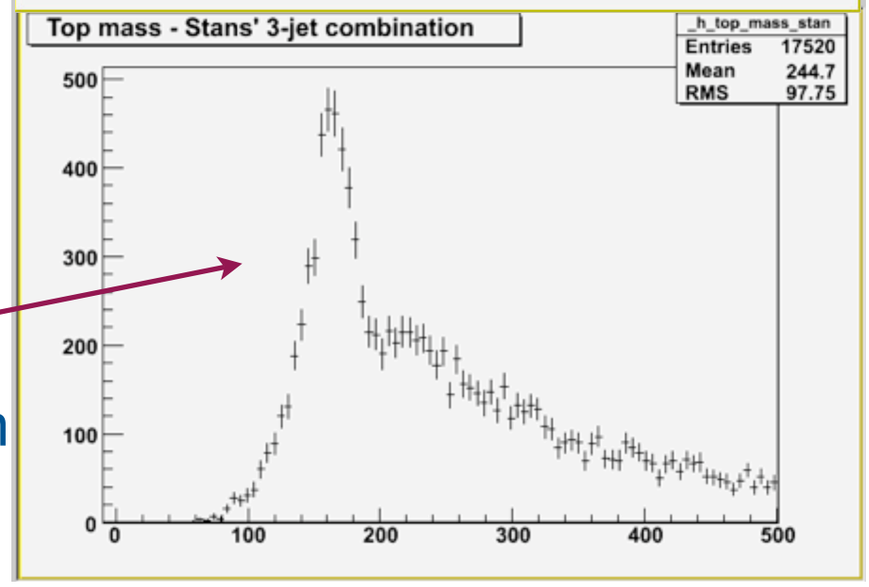
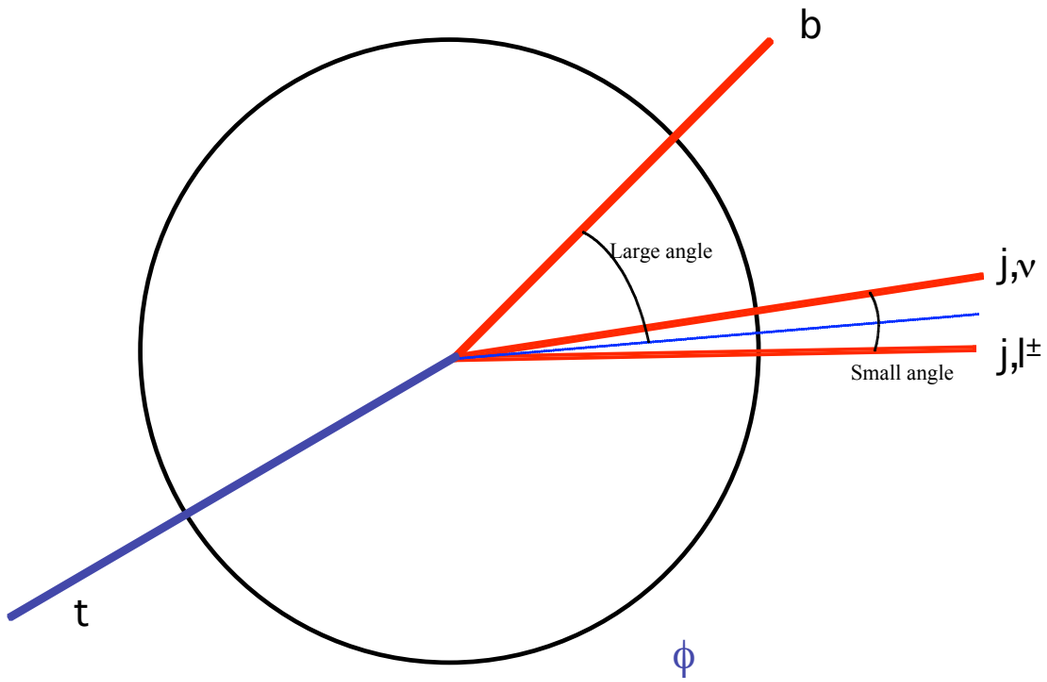


Example: reconstruction of the W boson

J. Walbersloh



- choose jet combination of smallest angle, reconstruct invariant mass, get mostly W boson

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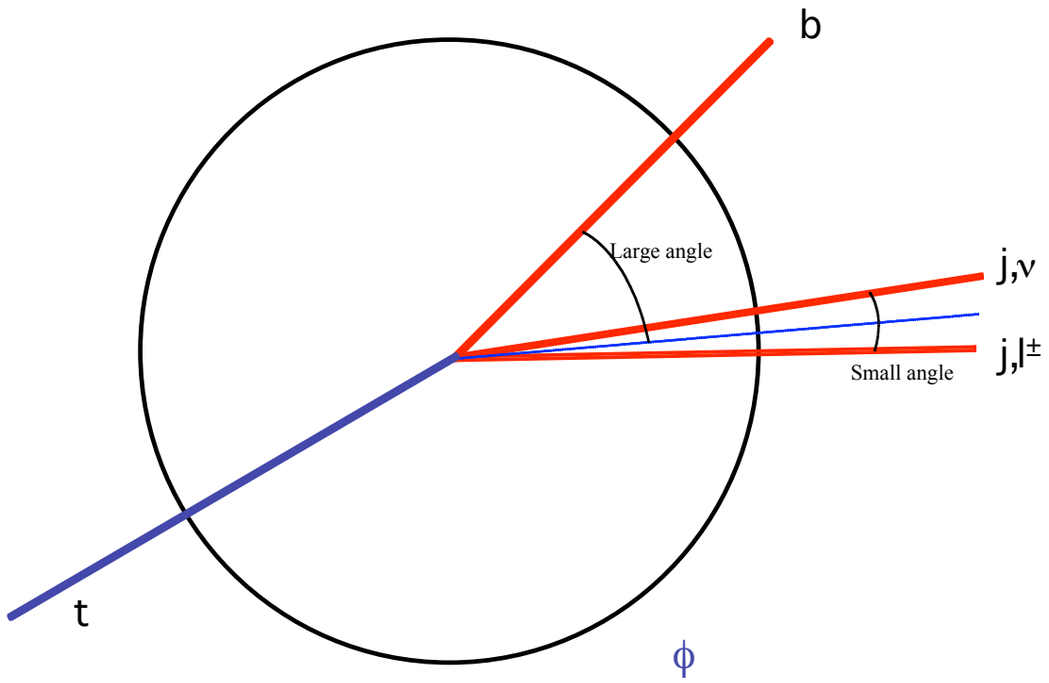

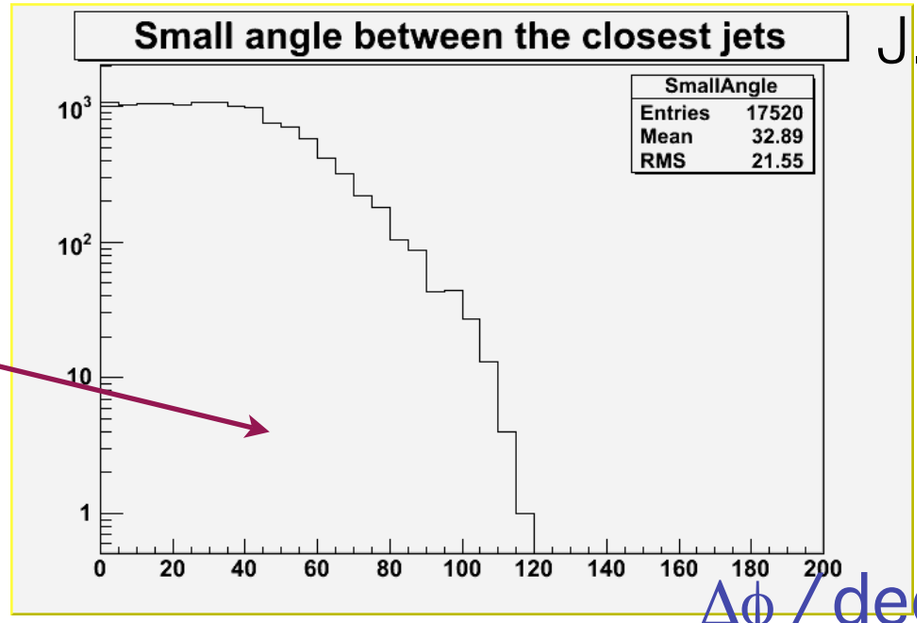

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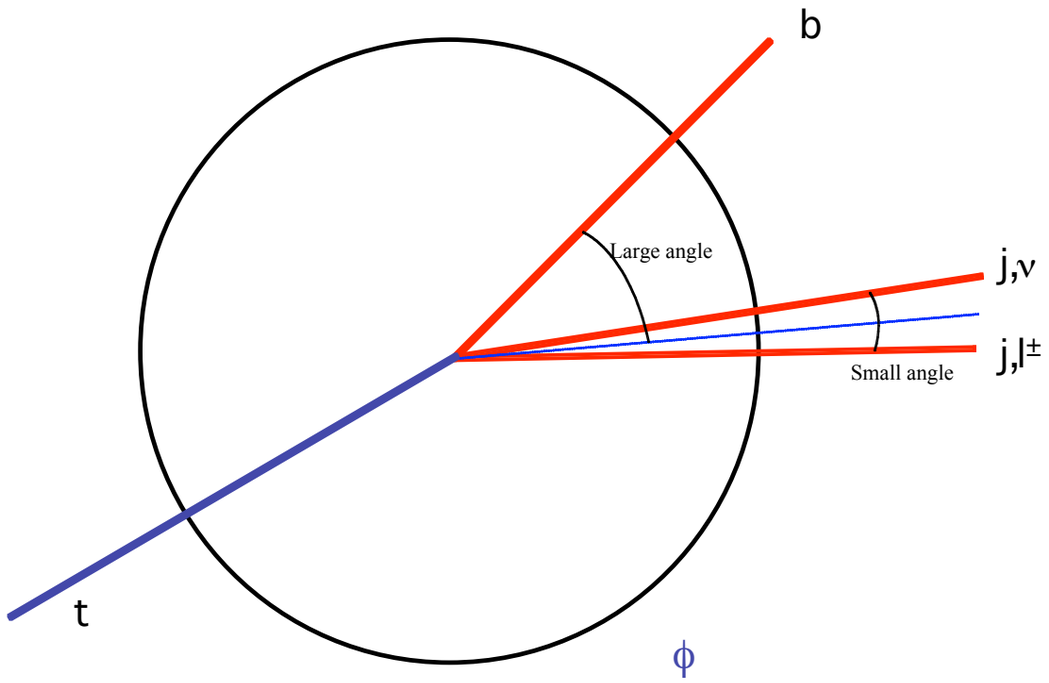

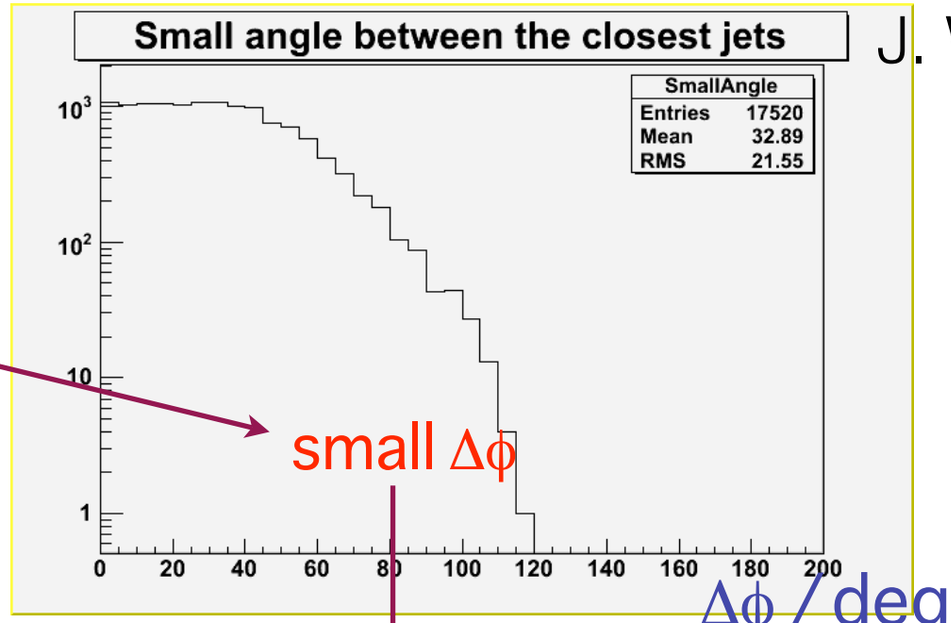

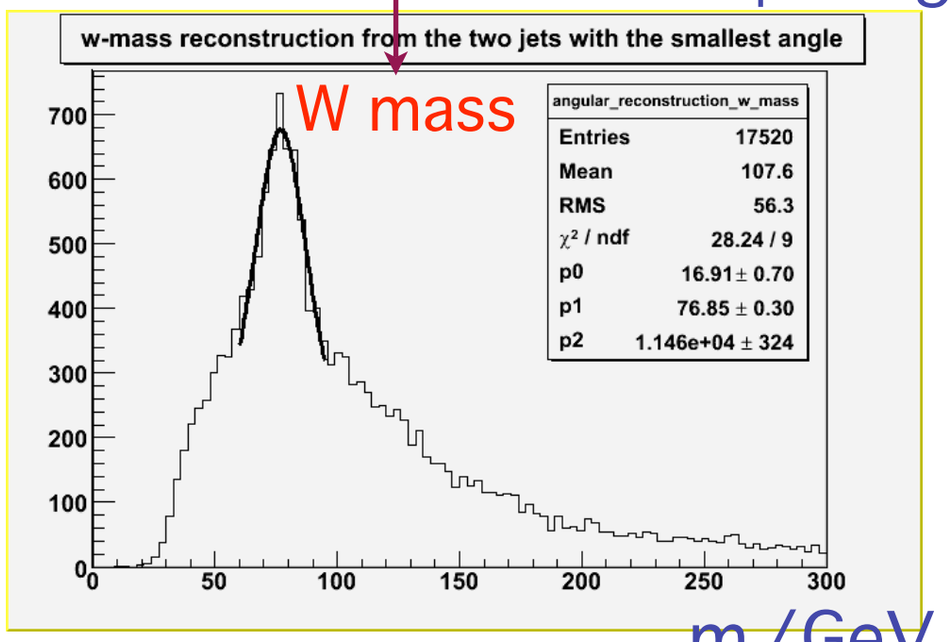

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next step

- using ATHENA
  as the ATLAS simulation / reconstruction / analysis framework

Setting up the ATHENA environment

M. Bunse

- started with local computer environment
  reused Duron + Pentium IV (32bit), Scientific Linux CERN 3.0.6
  and Sempron (64bit), SLC3 & SuSE10

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- *Computer Division of the University:*
  Linux Cluster w/ 224 nodes / 464 CPUs, 64bit, SuSE10
  cluster not fully in operation yet, no ATHENA installation yet (later Tier3?)

Setting up the ATHENA environment

- Installation of ATLAS s/w framework ATHENA 11.0.42
- Tutorials
- Create an analysis environment for first studies with AODs

A word on our tutorials

D. Dobos

- two interactive ATHENA tutorials organised within our groups to learn
  - structure and philosophy of the ATHENA framework
  - ATHENA terminology (Algorithms, Tools, Data Objects, Transient Data Store, Services, Data Converters, Properties ...)
  - the ATHENA full chain of data processing
  - package structure, checkout, modify, create, build and run
  - usage of CMT
  - usage of ATHENA services:
    e.g.: Message, RandomNumber, Histogram and NTuple services
  - detailed study of an t-tbar analysis example
  - AnalysisSkeleton as own analysis starting point

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  - detailed study of an t-tbar analysis example
  - AnalysisSkeleton as own analysis starting point
- **our experience: a very useful starting point to become familiar, however, prefer learning by working on own tasks**

Examples of the AOD studies (as snapshot from our playground)

D. Dobos
M. Bunse
J. Walbersloh

- read AOD collections and fill preselected collections
- apply kinematic cuts, e.g. E_t, P_t, η, charge, ...
- apply particle type specific cuts: Jet (em. calo), μ χ^2, ...
- histograms for all, MC truth and preselected particles
- residuals of kinematics

"preselection"

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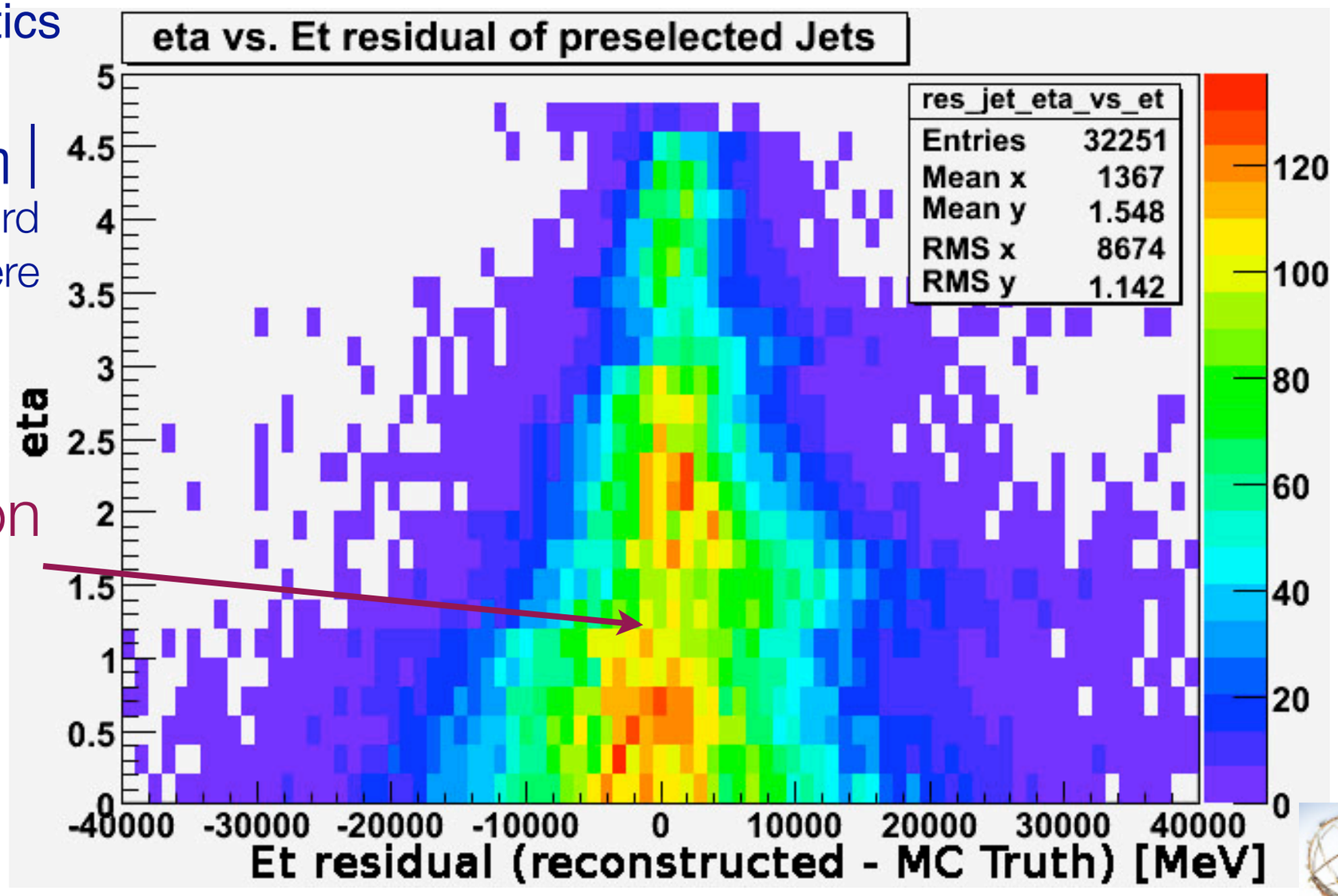
$|\eta|$
forward and backword hemnisphere

gab in the hadron calorimeter



t-tbar reconstruction
(first try to learn Athena methods)

D. Dobos

- reconstruct W→ j j candidates with highest P_t vector sum and W mass constrain
- reconstruct W→ ℓ ν candidates from missingE_t, lepton and W mass constrain
- reconstruct t→ W j and t→W b candidates and take combination with smallest deviation from expected top mass

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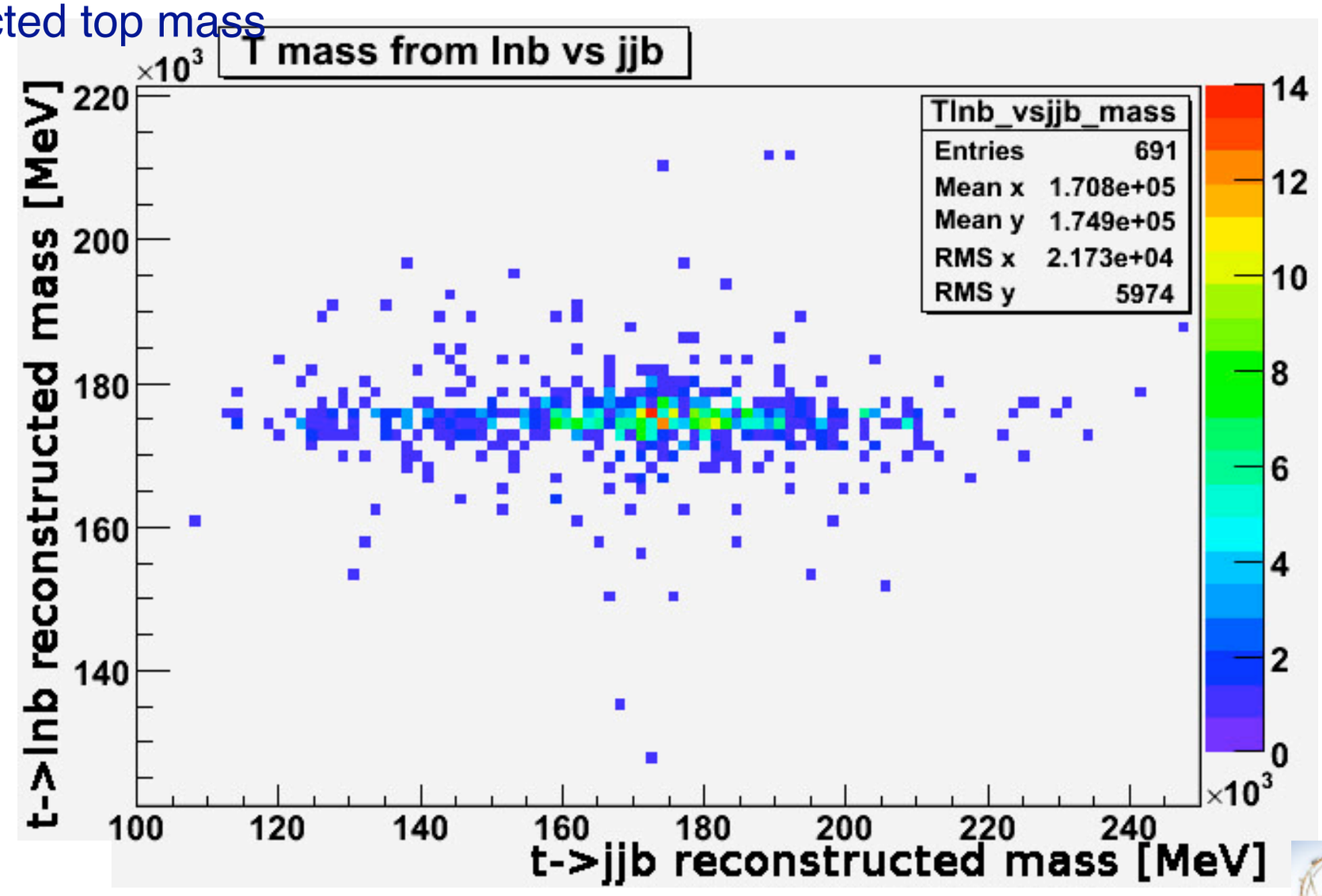
tags on b-jets!



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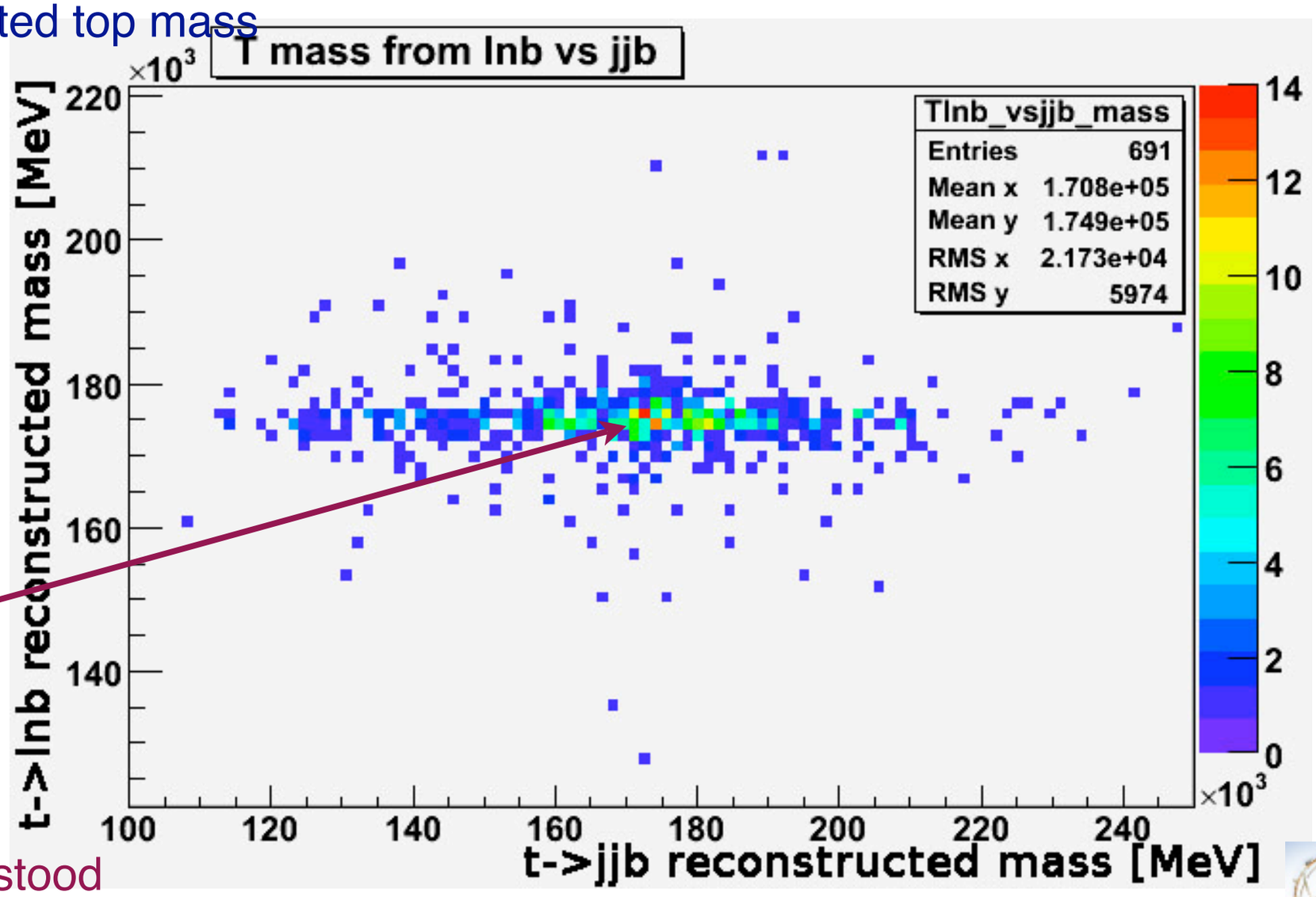


both tops @ 175 GeV

- Athena basics understood

How to continue?

- continue learning phase

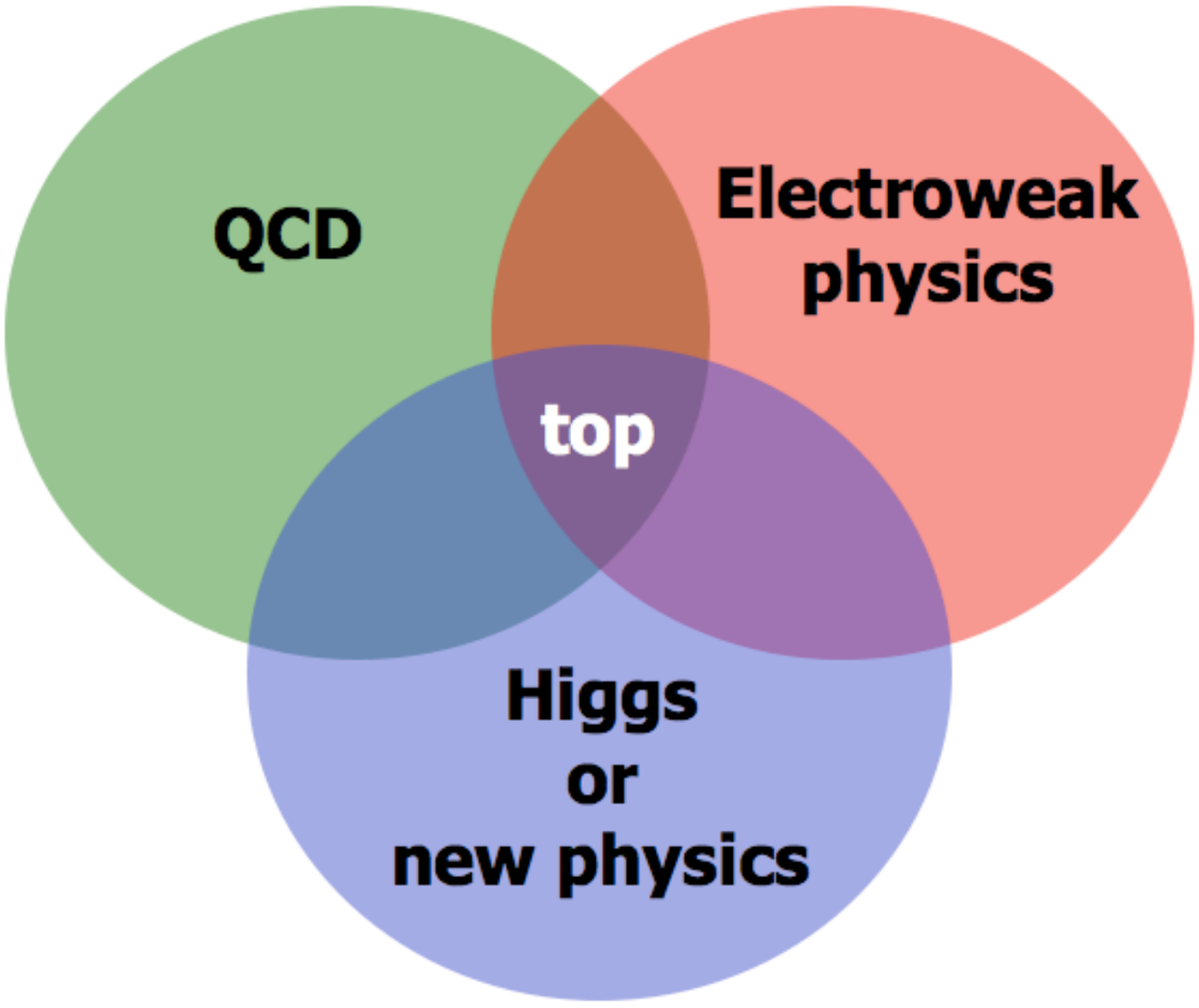
  concerning the s/w, analysis and data environment

- continue on analysis techniques:

  tool development

  validation of new ATLAS simulation data (DC3)

Dortmund's top interests and plans



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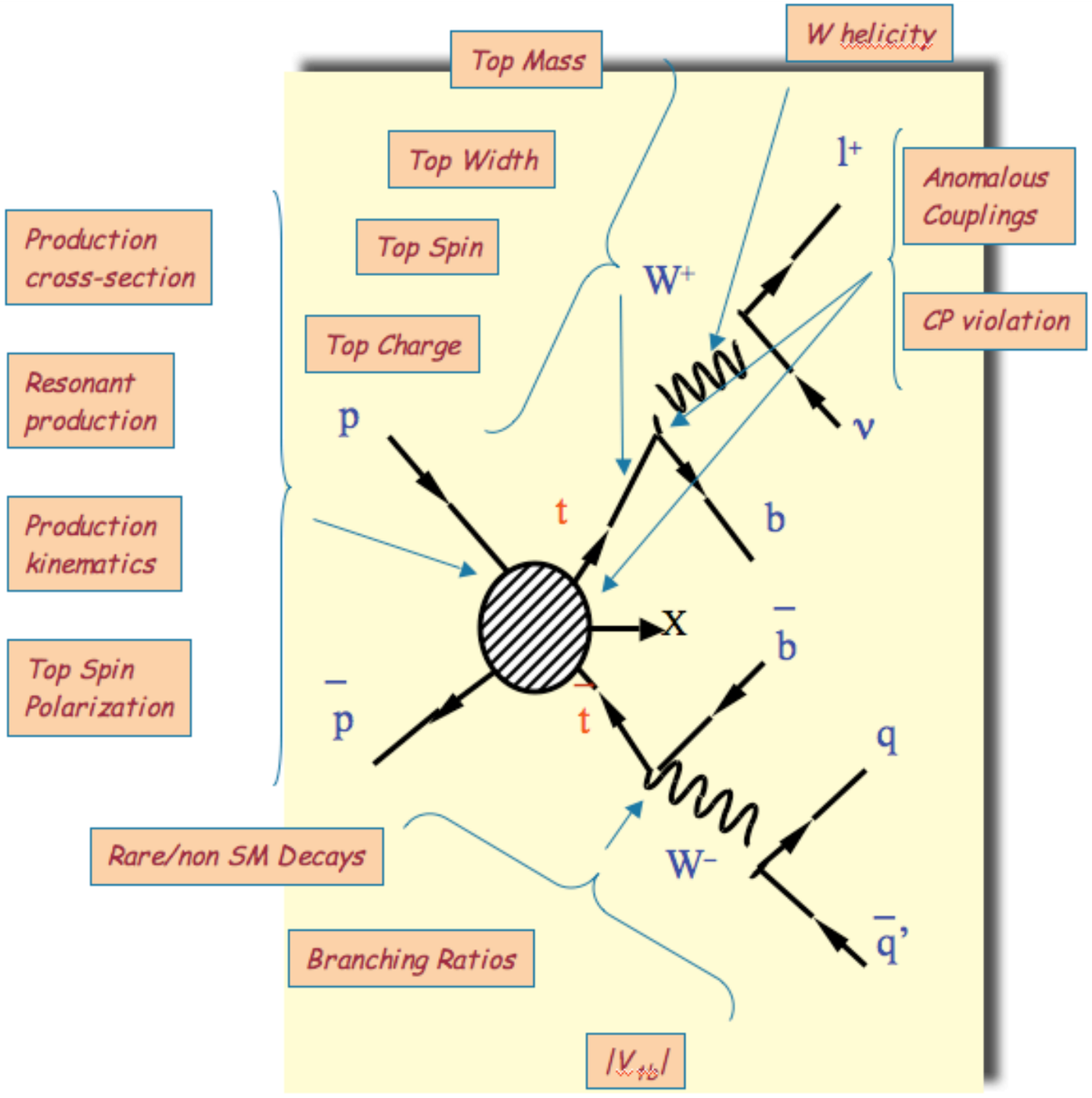
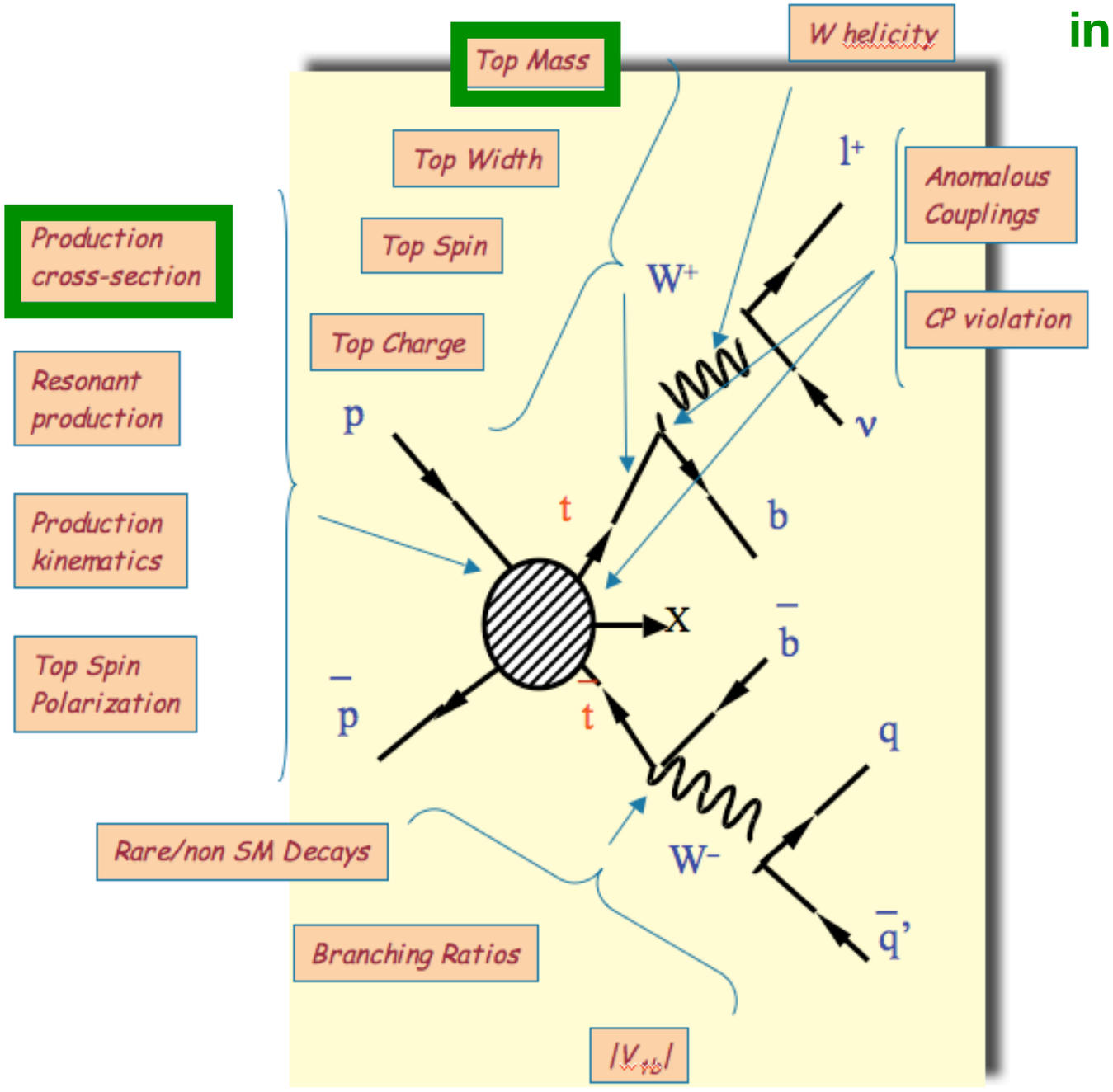


Dortmund's top interests and plans

in the leptonic / semi-leptonic channel



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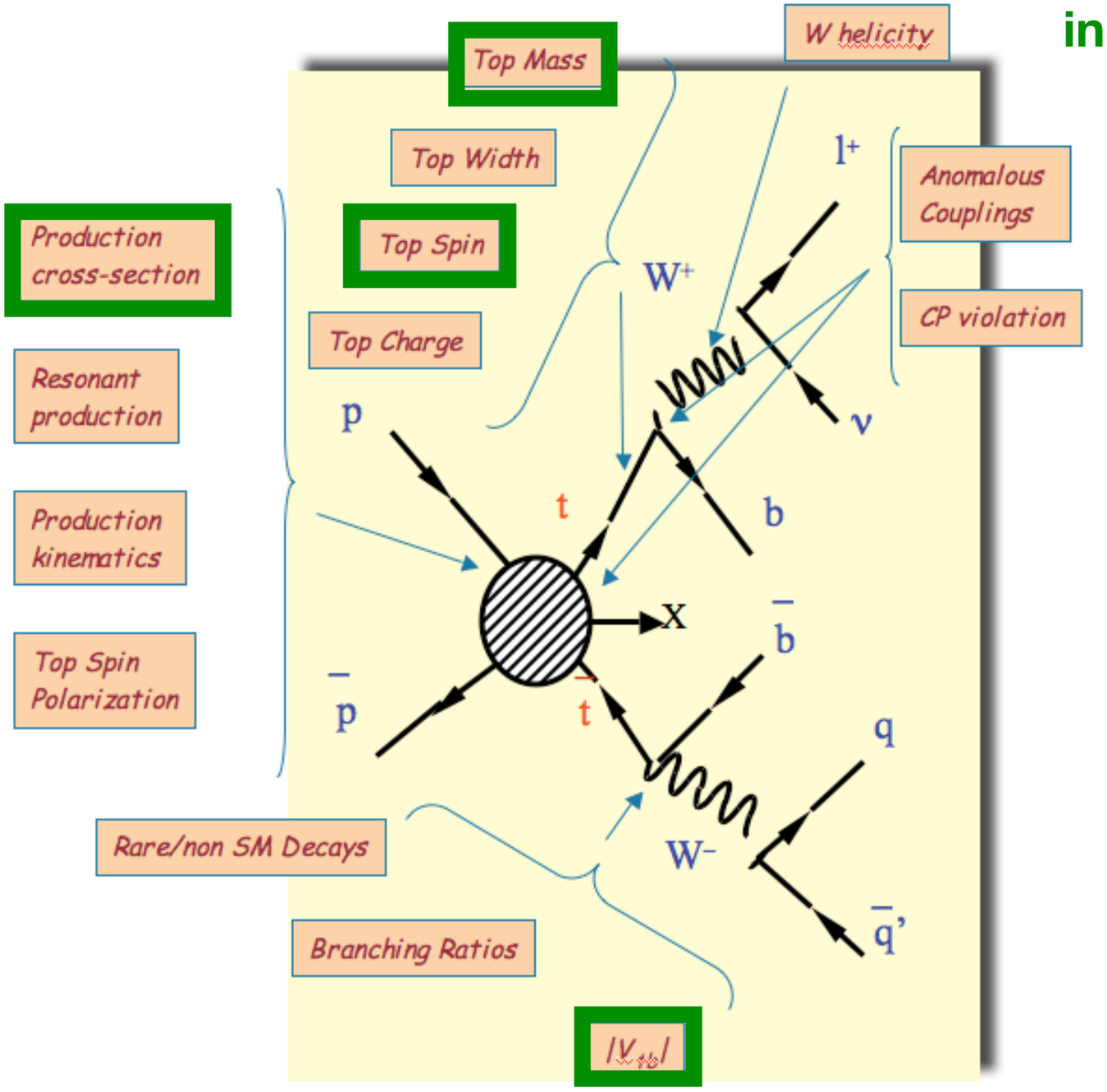

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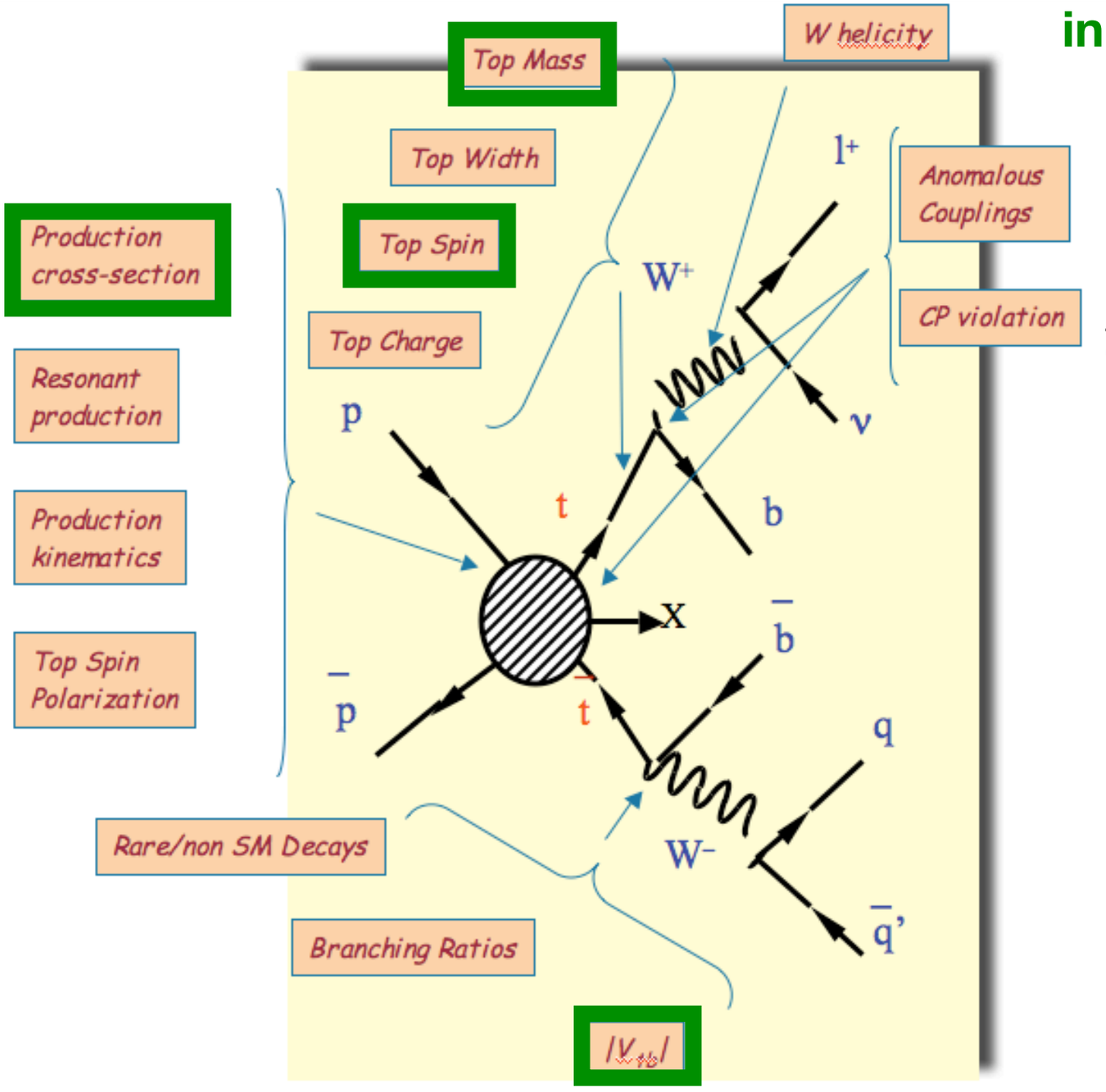
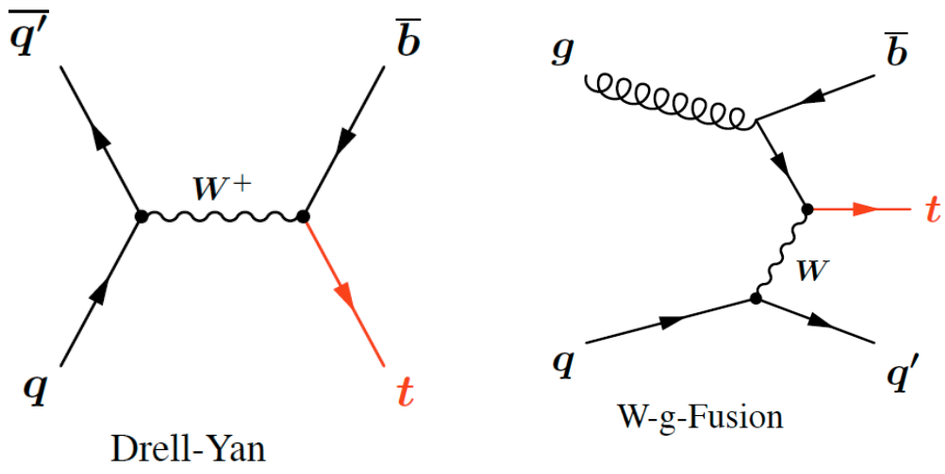
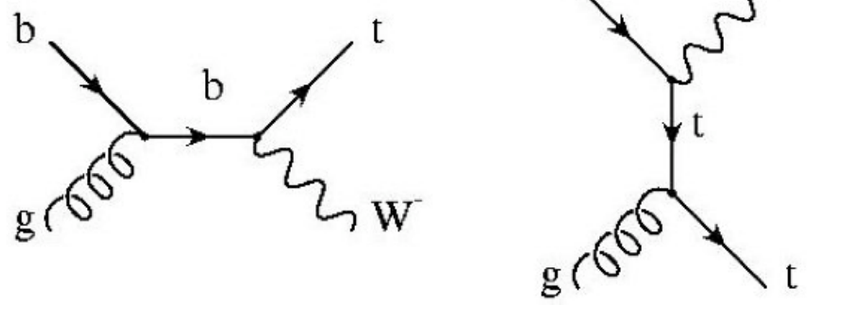


in the leptonic / semi-leptonic channel

single top / electro weak production

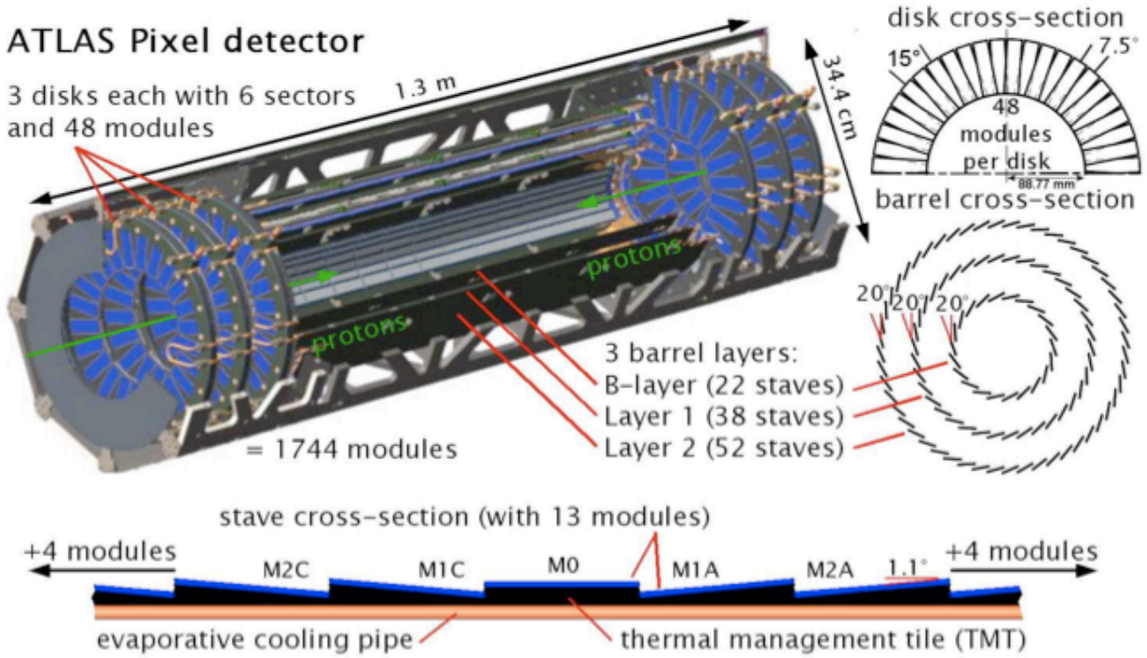




Wt associated production

End

Tracking studies



- ATLAS Pixel detector: innermost tracking detector with ~80 million 50x400 μm² cells

- provides three space points in barrel and/or disk layer

- a sector of the ATLAS barrel part has been used for detector performance studies

  combined test beam

- this emulates transversely (high $p_\perp$) emitted particles