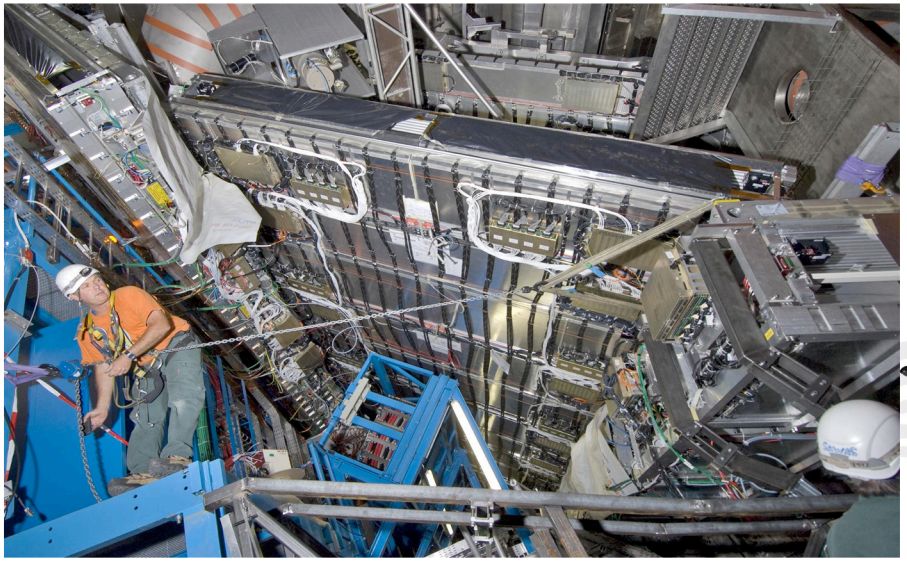
LHC colloquium : ATLAS



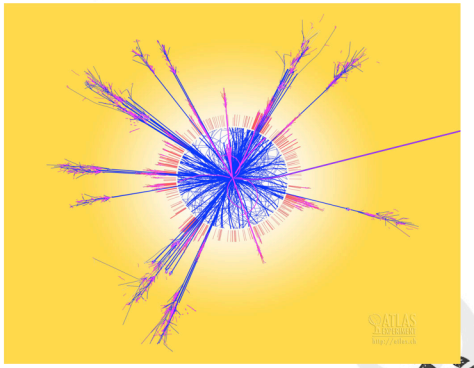
Hiking program

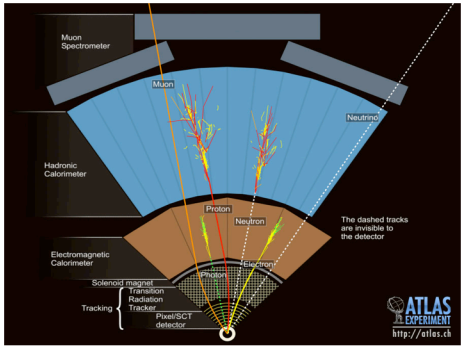
Aim

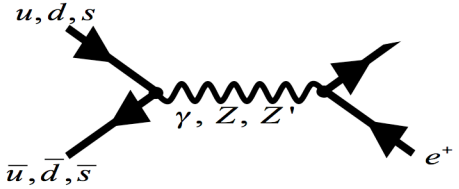
Review of the activities of the LPSC ATLAS group

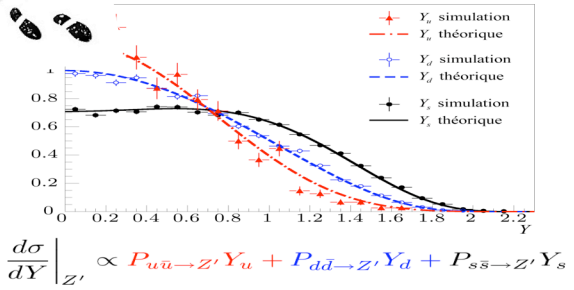
Pathway

Walking along the different steps necessary to complete a physics analysis







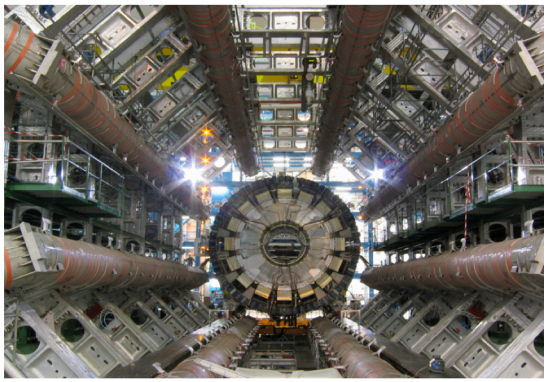


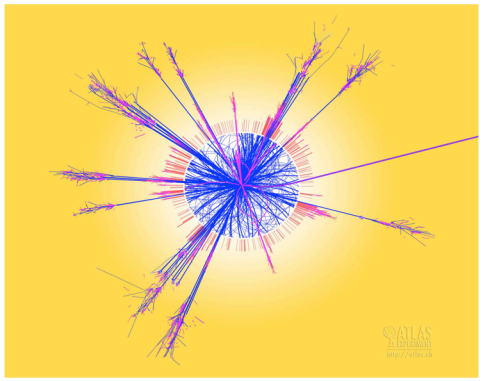
$$\left.\frac{d\sigma}{dY}\right|_{Z'} \propto P_{u\bar{u}\to Z'} Y_u + P_{d\bar{d}\to Z'} Y_d + P_{s\bar{s}\to Z'} Y_s$$

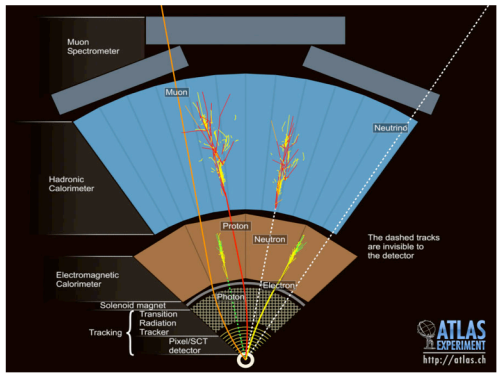
The road to physics

Plan

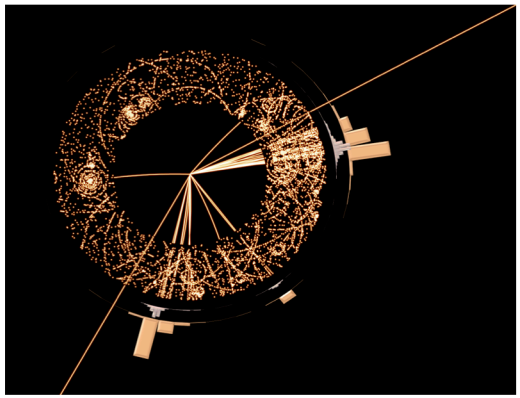
- From collisions to the data to analyze

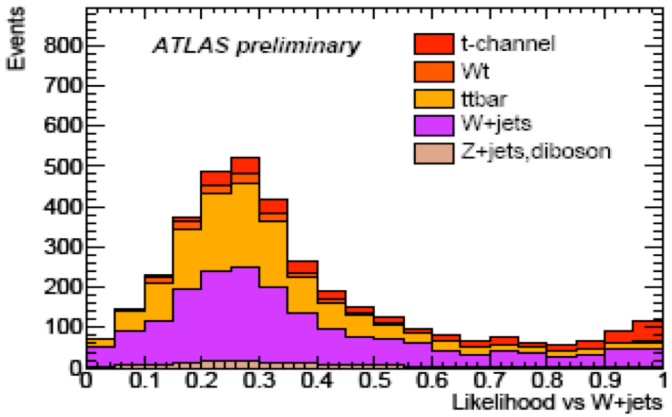


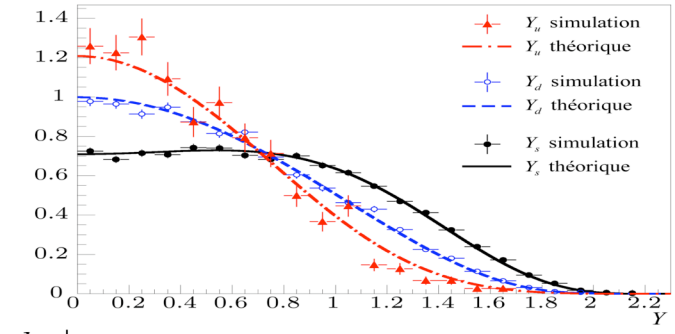




- From the data to the physics results







$$\left.\frac{d\sigma}{dY}\right|_{Z'} \propto P_{u\bar{u}\to Z'} Y_u + P_{d\bar{d}\to Z'} Y_d + P_{s\bar{s}\to Z'} Y$$

Data event path

LHC
- Commissioning phase

Collision
- Collision proton-proton: complexity

Detector
- Ready for data taking
- A lot done (tests, commissioning with cosmics, calibration)
- A lot to do (real conditions, noise, calibration …)

Trigger selection
- crucial

Reconstruction : from signal in the detectors to particle
- A lot done (MC), need to be confronted to real data

Selection and distribution
- Datasets
- Grid

Analysis

LHC

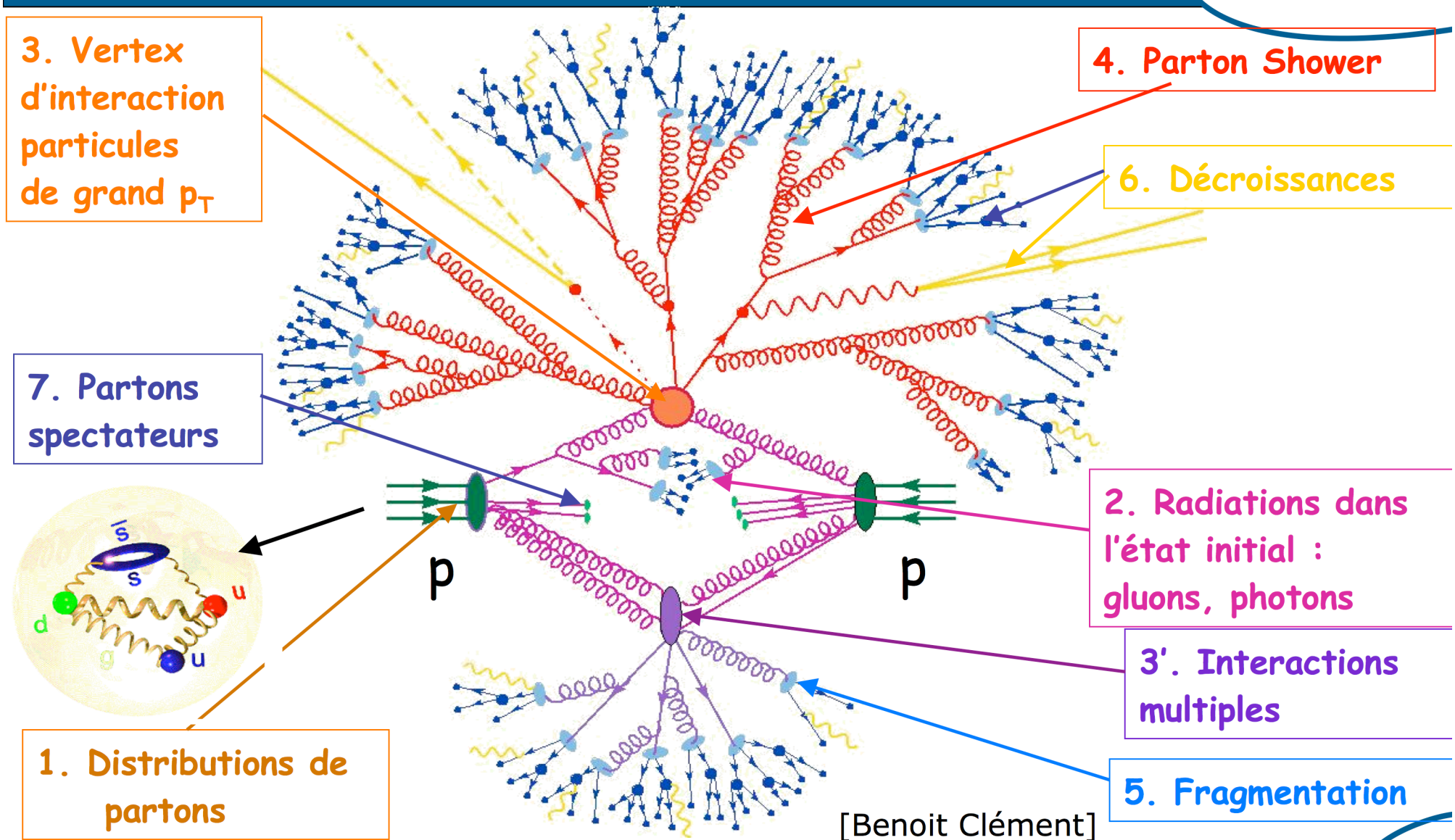
Collision rate

- Now : 0,05 Hz @ 900 GeV
- 2010 : 3,5 TeV ? 7 TeV ? Every 25 ns
- Nominal : collision every 25 ns with ~ 20 hard interactions @ 14 TeV => 600 million collisions/s !

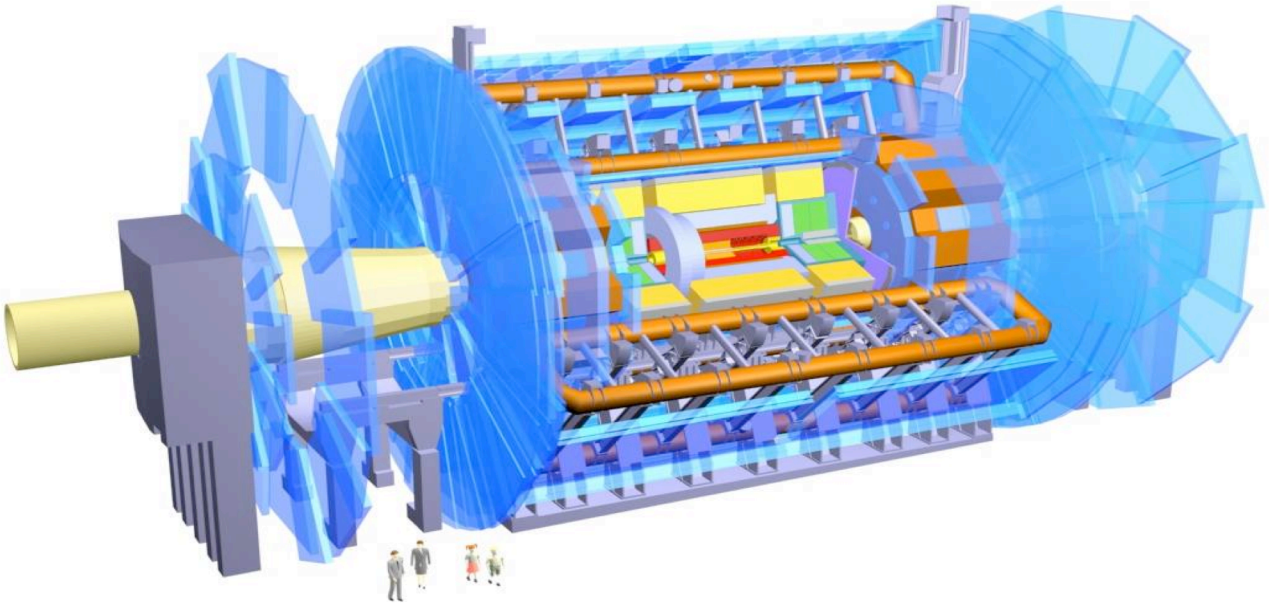
Proton-proton collisions

[Karl Jakobs]

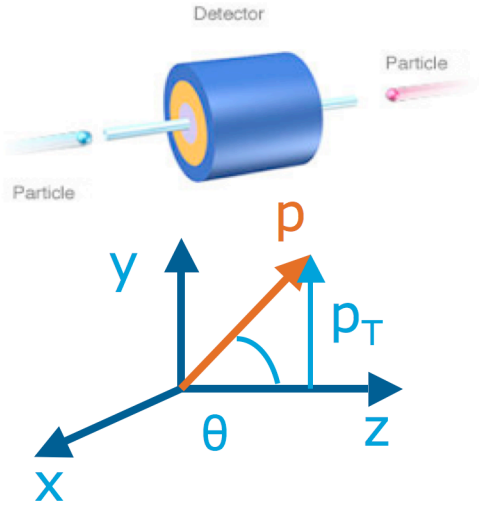
Hadronic collisions



ATLAS detector



25 m high
46 m long
7000 tons



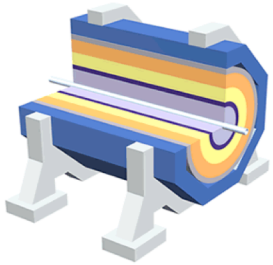
Useful variables :

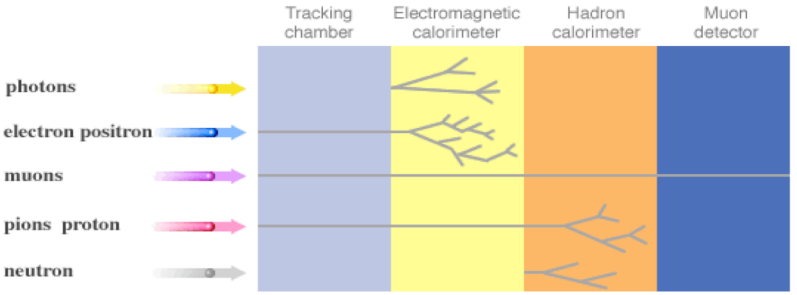
- p_T is a Lorentz invariant
  - Particles along beam pipe (θ<3°) have p_T ~0
  - Momentum is conserved $\Sigma p_{Ti} \sim 0$
- Polar angle, rapidity & pseudo-rapidity: θ, y, η
  - θ is not Lorentz invariant
  - y is an invariant, η = y(M=0)

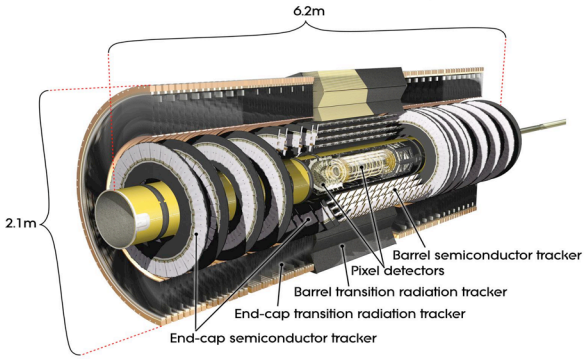
$$y = 1/2 \log (E + p_z)/(E + p_z)$$

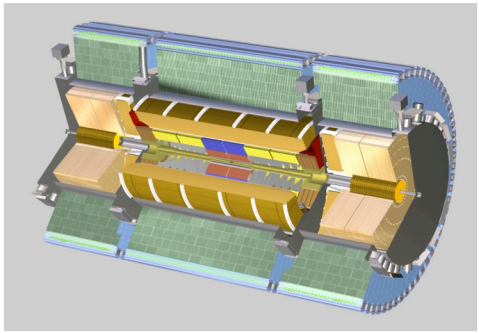
$$\eta = 1/2 \log \tan (\theta/2)$$

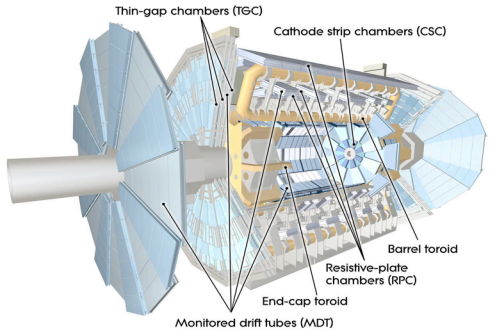
Detectors inside the detector











Trackers

(2 T, $|\eta| < 2,5$)

- silicium pixel detector
  80 000 000 pixels
- semiconductor tracker
  6 000 000 channels
- transition radiation tracker,
  400 000 channels

Calorimeters

($|\eta| < 4,9$)

- electromagnetic
  Lar / Pb,Cu,W
  170 000 channels
- hadronic
  Scintillateur/Fe
  20 000 channels

Muon chambers

(0,5 T, $|\eta| < 2,7$)

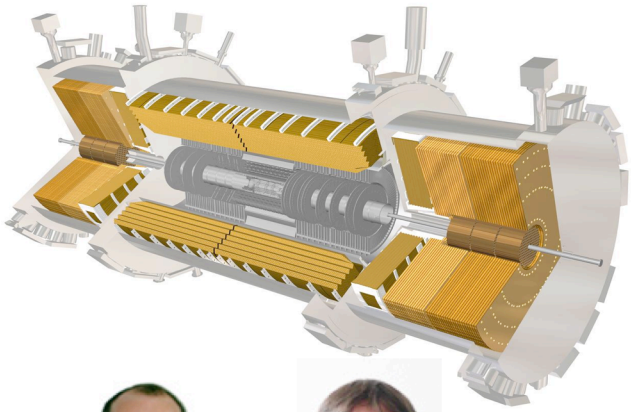
- MDT and CSC chambers
- RPC and TGC chambers
  triggers

Works on detectors

What need to be done after building :

- Commissioning
  - Noise measurement
  - Performance measurement
- Alignment
  position and timing
  - Mechanics, optics …
  - Cosmics
  - First data
- Calibration
  - Electronics
  - Data
- Monitoring
- Data quality

LPSC is involved in electromagnetic calorimetry

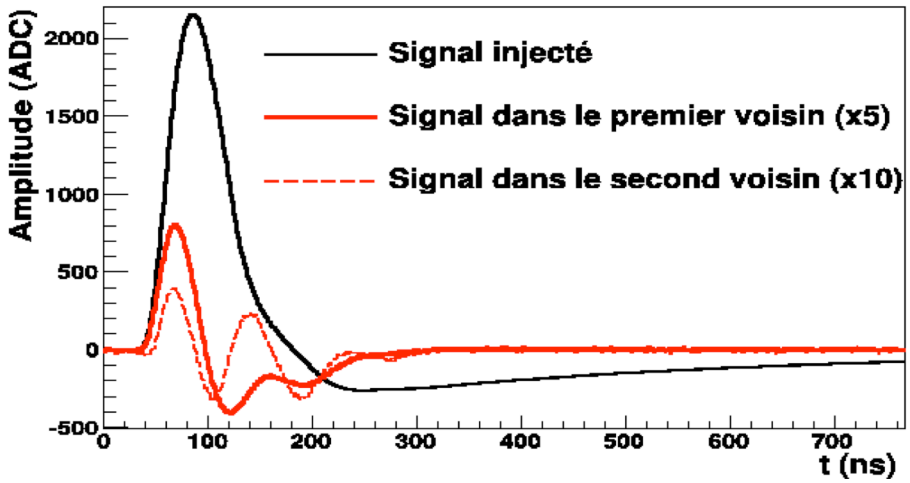


+ Julien Labbé

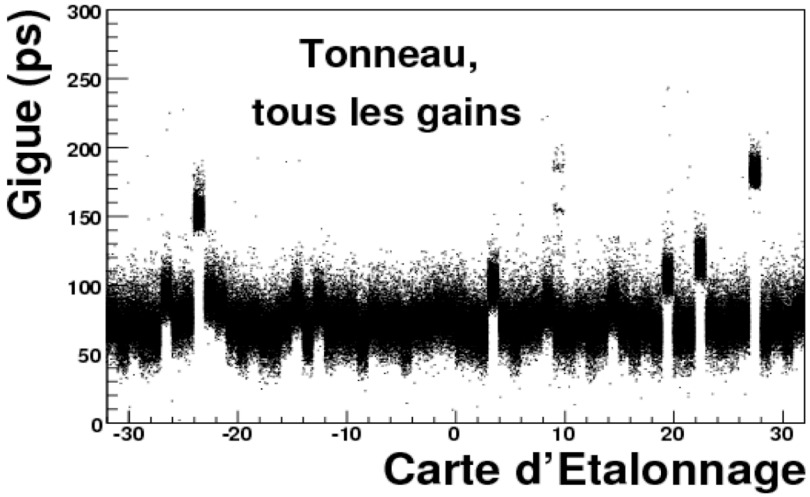
LPSC work on calorimetry

Examples :

Crosstalk measurement



Jitter



Julien Labbé

Precision on energy, position and time measurement are crucial for analysis

ex: H → γγ

$$\frac{\sigma_m}{m} = \frac{1}{2}\left(\frac{\sigma_{E_1}^2}{E_1^2} + \frac{\sigma_{E_2}^2}{E_2^2} + \frac{\sigma_\alpha^2}{\tan^2(\alpha/2)}\right)$$

Triggers

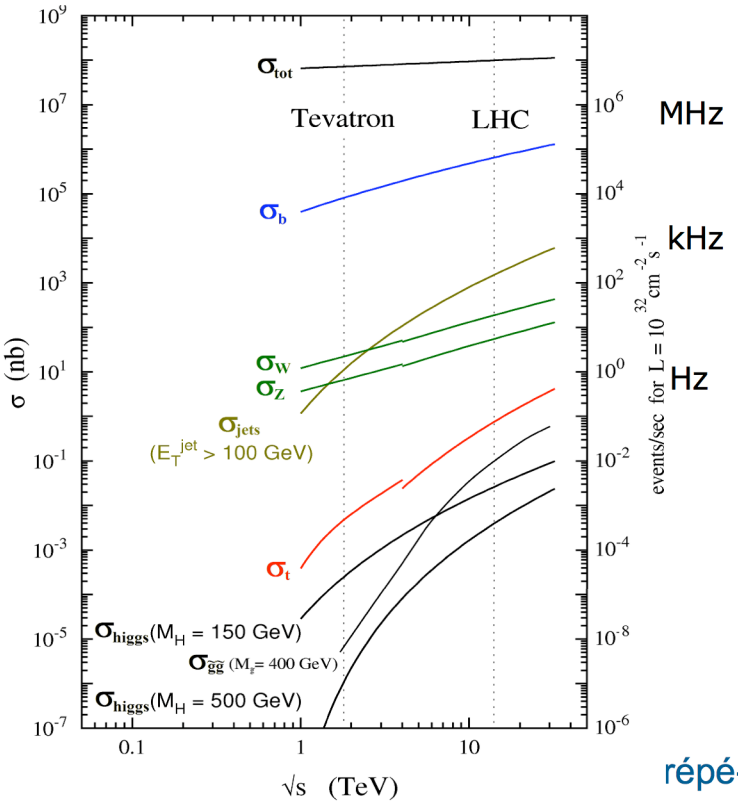
Physics signal are rare : ~1/10^{10}

➜ High luminosity

➜ Event sorting is necessary

no trigger = 250 TB/s

keep 5 in 10^6 events (reject 99.9995%)



How ?

- Synchronisation with the machine and 3 steps :

detector

40 MHz

Level 1 (hardware) — 2 µs

75 kHz + ROI

Level 2 (hardware)

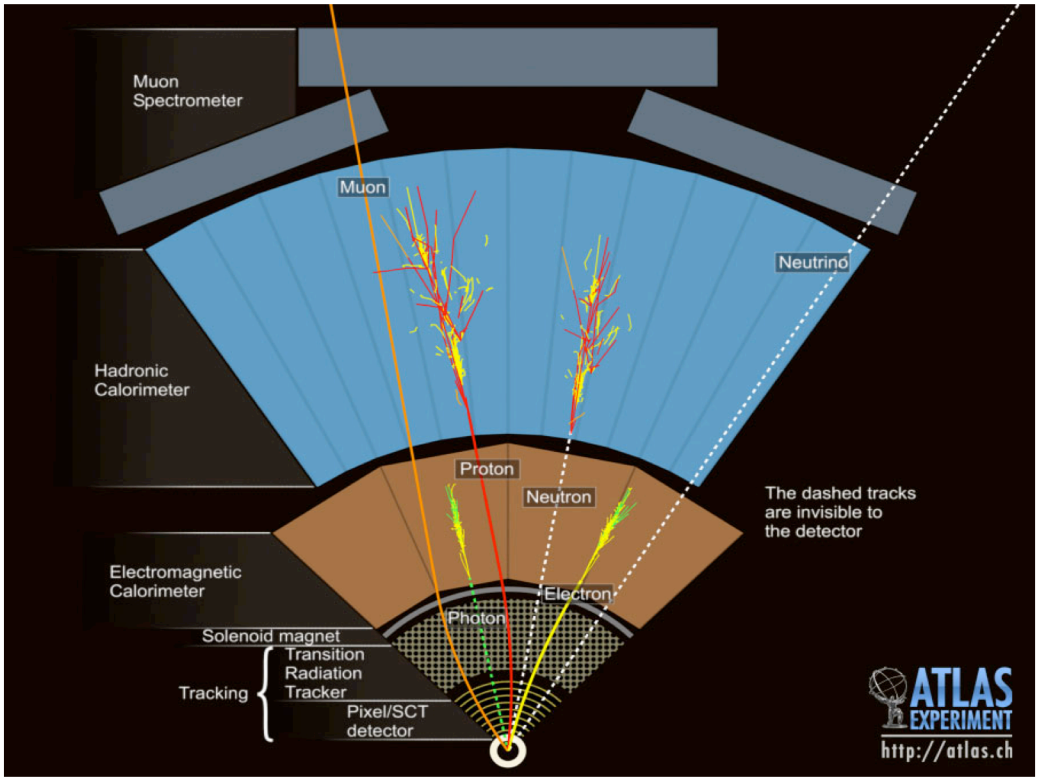
3 kHz

Level 3 (software) — 10 ms

200 Hz

ATLAS HLT Trigger

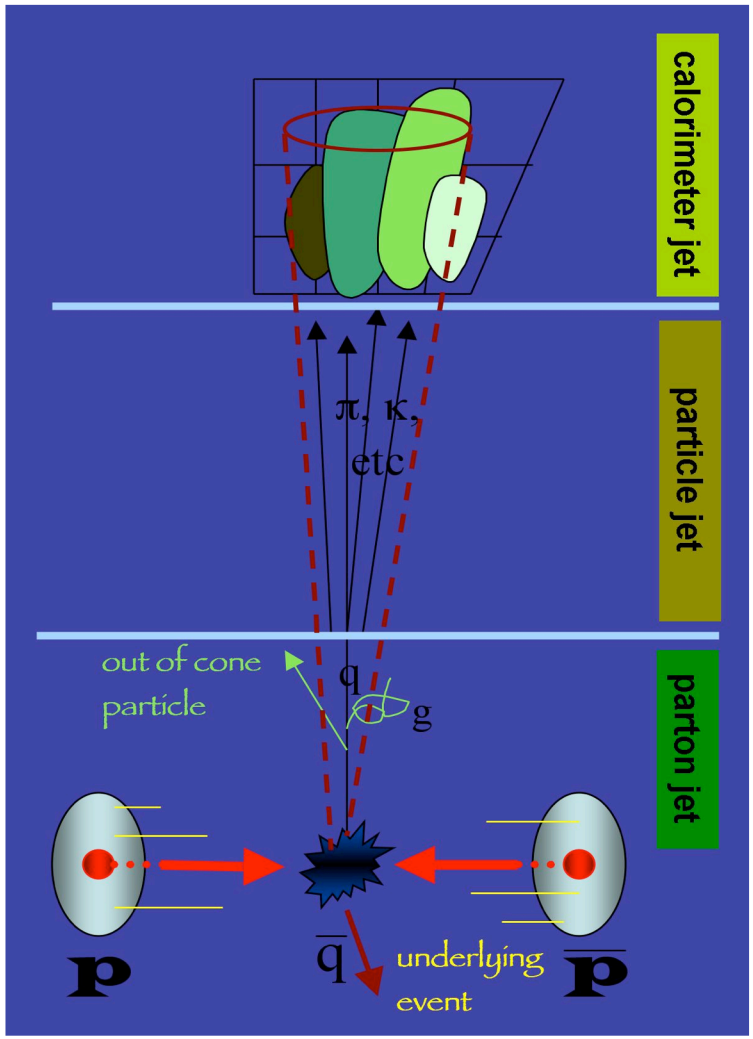
From hits to particles

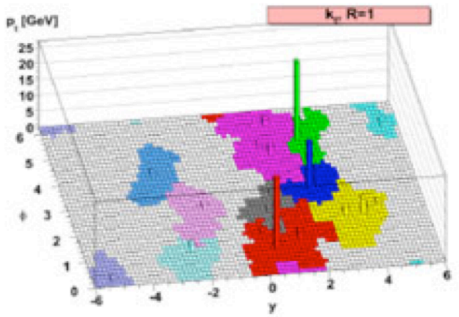


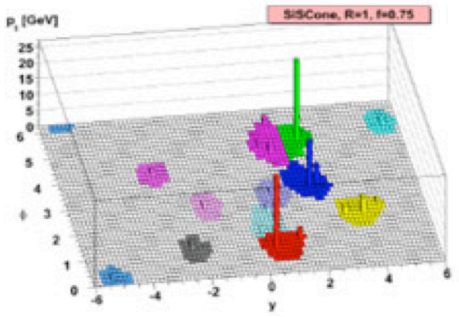
Reconstruction

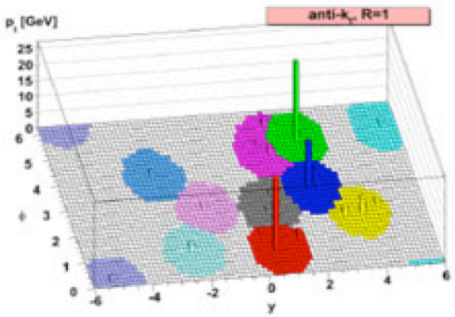
- Take signals from detectors cells/wire
- Reconstruct objects
  - Clusters for calorimeters
  - Tracks for trackers and muon chambers
  - Vertex
- Apply calibration
- Identification of objects
  - Clusters : electrons, photons or jets ?
  - Tracks : which charged particle ?
  - Tagging : b or light jet ?
- Apply calibration

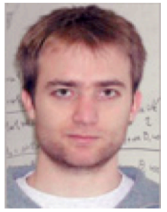
Electrons, photons, muons and ... jets











See Pierre-Antoine talk ...

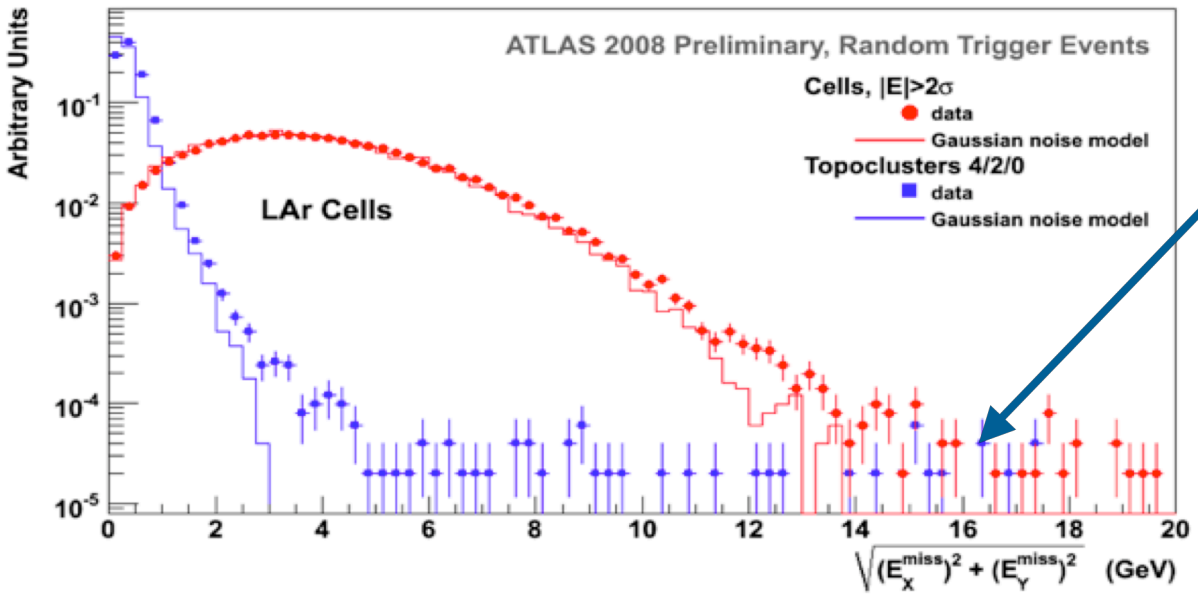
Missing E_T

Only tools to identify and measure non interactive particles

- Neutrinos
- Susy LSP

Need to understand perfectly

- All objects measured in the calorimeter
- Noise (individual cell noise and coherent noise)
- Dead regions



Coherent noise in presampler due to damaged HV cable (replaced and fixed)

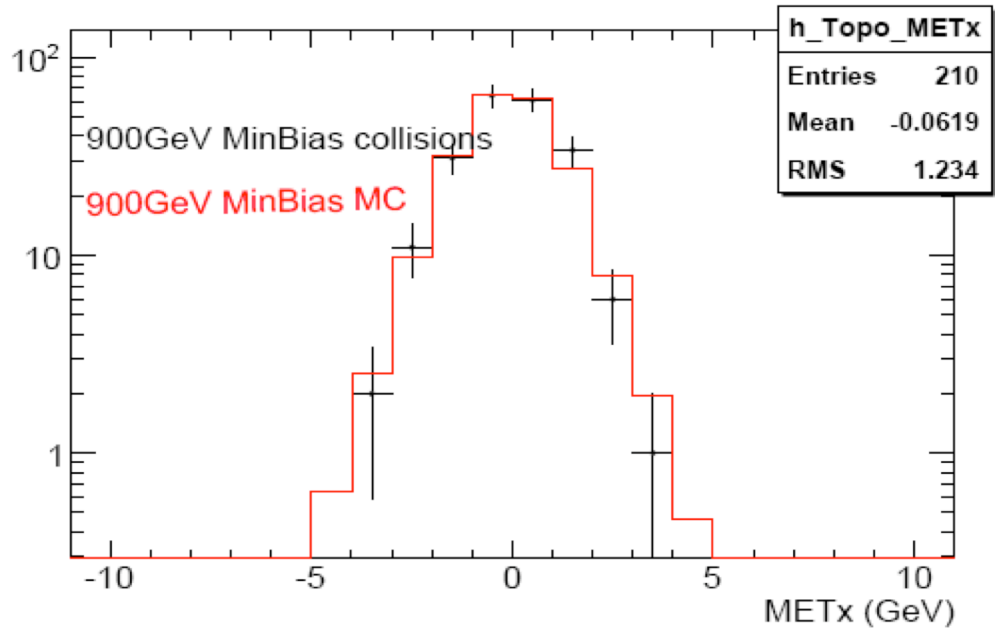
Missing E_T

Only tools to identify and measure non interactive particles

- Neutrinos
- Susy LSP

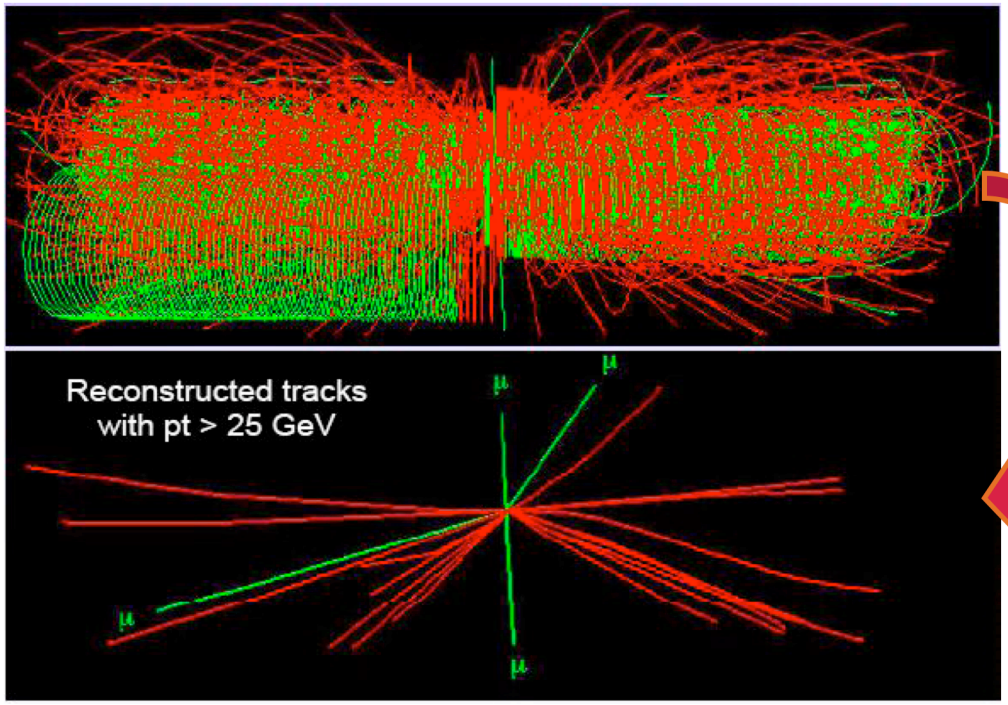
Need to understand perfectly

- All objects measured in the calorimeter
- Noise (individual cell noise and coherent noise)
- Dead regions



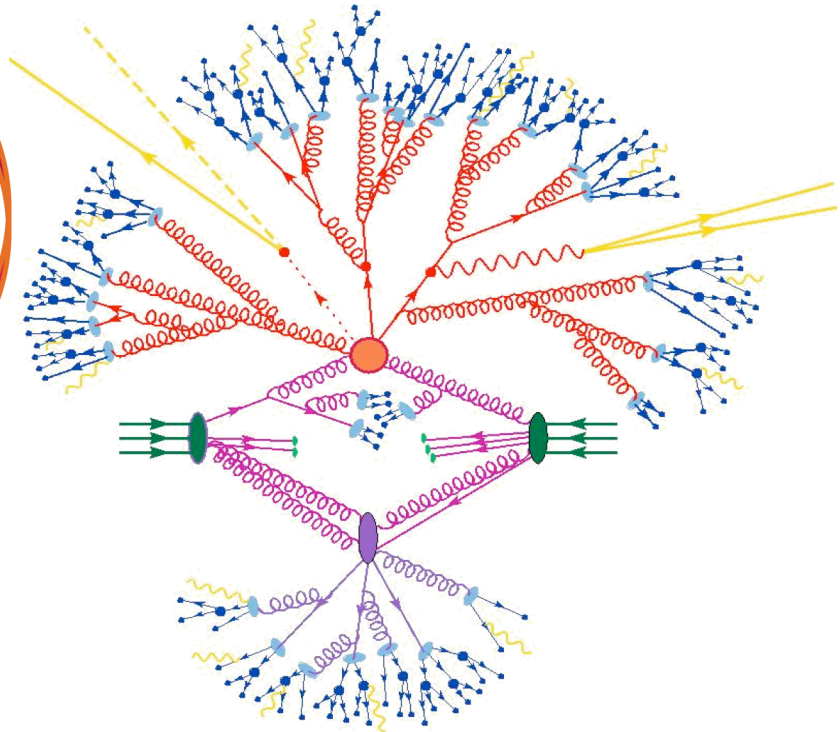
Underlying event and pile-up

H → ZZ → μ+μ-μ+μ-



Need to understand

- underlying event
- pile-up

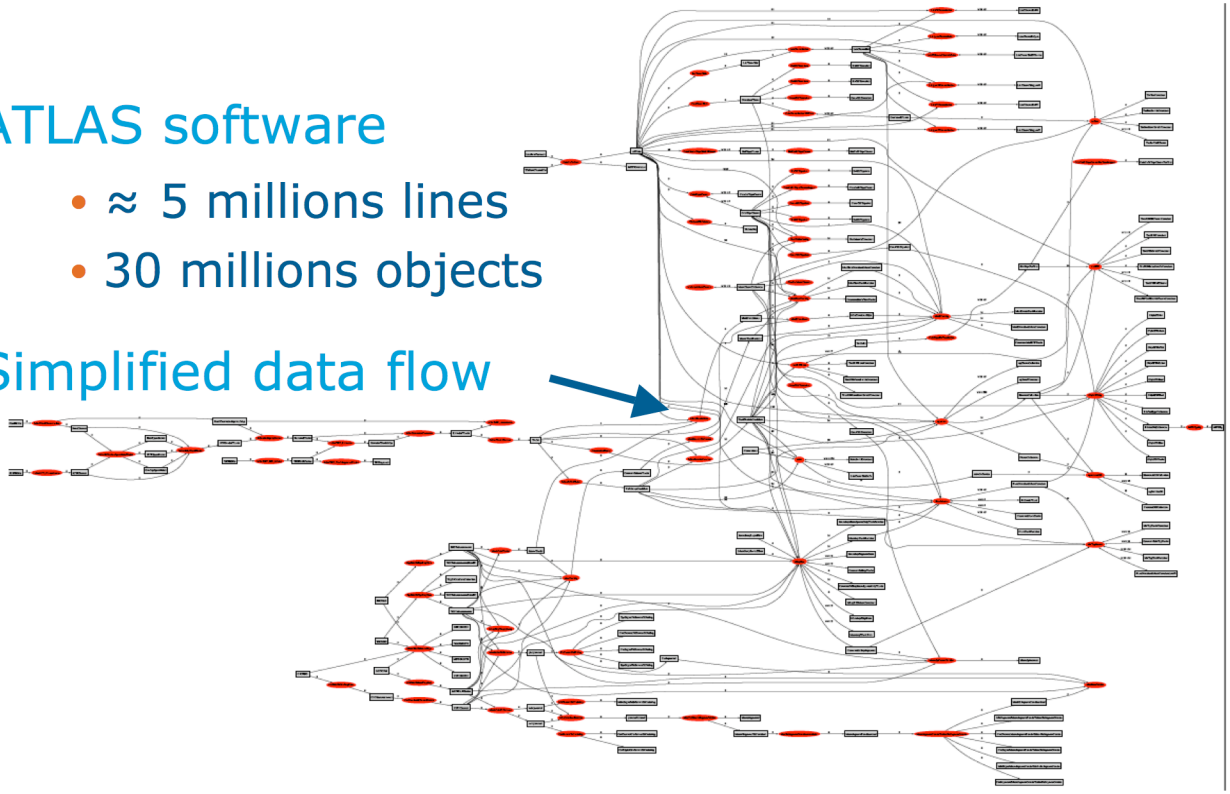


ATLAS software and releases

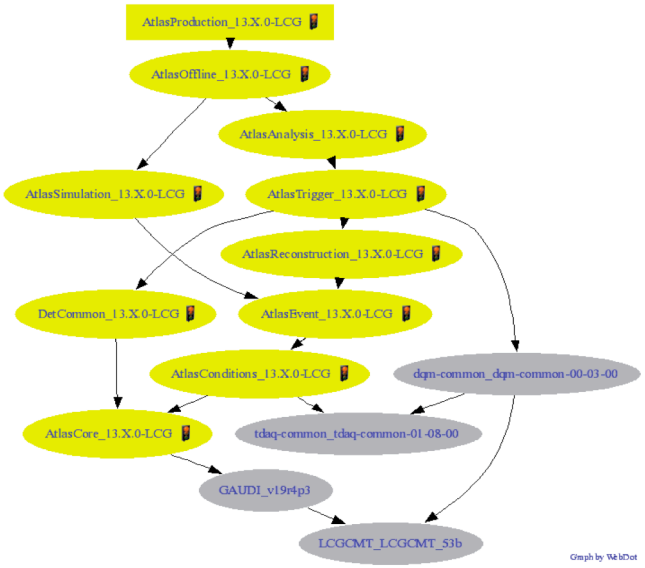
ATLAS software

- ≈ 5 millions lines
- 30 millions objects

Simplified data flow



Tag Collector
Solveig, Jérôme

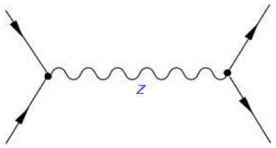


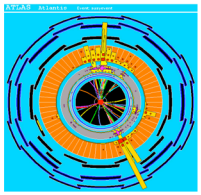
Package responsibility
Release build : shifts

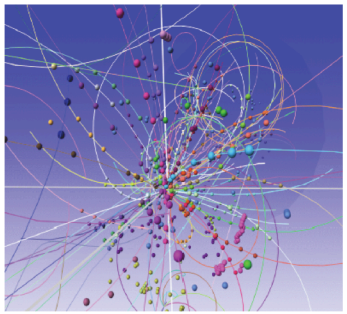


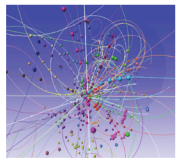

Francesco

ATLAS Data









Monte Carlo

- Event generator output

[James Catmore]

Digits/RAW

- Simulation/detector output

Event Summary Data (ESD)

- Output of reconstruction

Analysis Object Data (AOD)

- Summary of reconstruction - primary analysis data

Tag

- Thumbnail of each event used for identifying interesting events at the analysis stage

dESD, dAOD

- Data derived from ESD or AOD

Where to find ATLAS data ?

Home Searches Tools Bookmarks ?

Datasets Selection ATLAS

atlas Login

Overview of catalogued datasets

(valid = 92577 , total = 135375)

Catalogue	Datasets	Series	Start Date	Manager	Status
data08_001-real_data	(Browse) 45151	All (Browse)	2008-3-4	nairz	open
mc08-production	(Browse) 6922	All (Browse)	2008-2-19	amiadmin	open
fdr08-real_data	(Browse) 2030	All (Browse)	2008-2-1	amiadmin	open
data07_cosM5-real_data	(Browse) 7126	All (Browse)	2007-11-5	Nairz	open
Cos07_M4_01-real_data	(Browse) 2529	All (Browse)	2007-9-24	Nairz	open
StreamTest_2007-production	(Browse) 1215	All (Browse)	2007-1-31	Hinchliffe	open
csc-production	(Browse) 6051	All (Browse)	2006-9-26	hoecker	open
POOL_Cond-2007	(Browse) 31	All (Browse)	2006-8-30	Hawkings	open
LArCalorimeter-real_data	(Browse) 89	All (Browse)	2006-7-3	Hong	closed
mc11-production	(Browse) 8293	All (Browse)	2006-4-10	Hinchliffe	open
mc11test-production	(Browse) 1146	All (Browse)	2006-3-15	nevski	open
CTB_RealData-reconstruction	(Browse) 5505	All (Browse)	2005-5-16	Farilla	closed
CTB_MonteCarlo-reconstruction	(Browse) 632	All (Browse)	2005-5-16	Farilla	closed
CTB_MonteCarlo-simulation	(Browse) 762	All (Browse)	2005-5-16	Farilla	closed
CTB_MonteCarlo-digitization	(Browse) 718	All (Browse)	2005-5-16	Farilla	closed
CTB_EC2-testbeam	(Browse) 2963	All (Browse)	2005-5-16	Albrand	archive
DC2-production	(Browse) 63	All (Browse)	2005-3-16	Albrand	archive
ID_CTB_MonteCarlo-simulation	(Browse) 387	All (Browse)	2004-8-1	Albrand	archive
ID_CTB_MonteCarlo-digitization	(Browse) 387	All (Browse)	2004-8-1	Albrand	archive
DC1-generation	(Browse) 440	All (Browse)	2003-3-16	Albrand	archive

AMI
Solveig
Fabian
Jérôme

Grid

ATLAS data production :

- 200 events/s
- 1 à 10 MB per event
- ~ 300 MB/s thus 27 TB/day, 15 PB/year

Processing time :

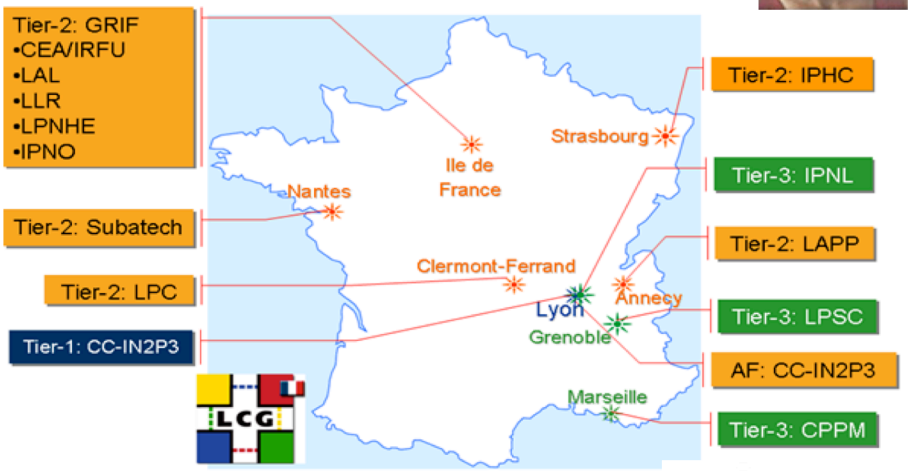
- ~25 kSi2k s/event

⇒ Grid

36 000 processors needed for ATLAS

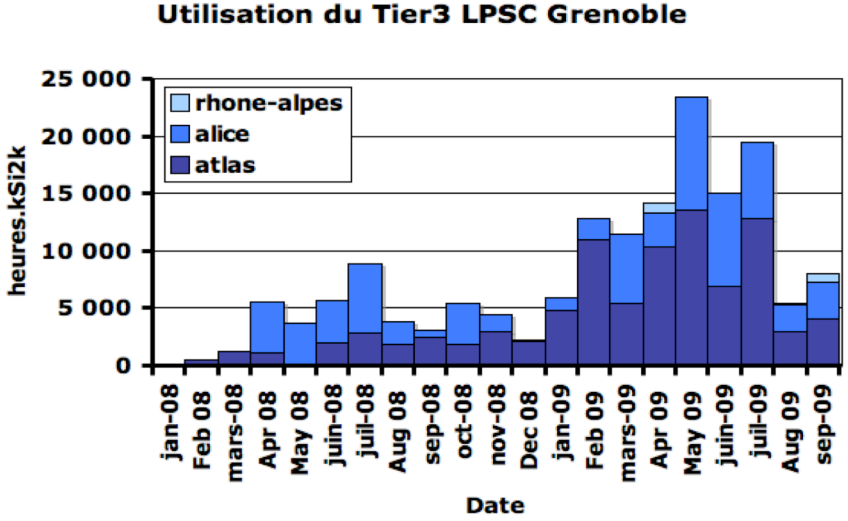
LCG : LHC Computing Grid

- LCG France



ATLAS French Cloud support

LPSC Tier 3



CPU :

- 600 cores
  (6000 HEP SPEC06)

Stockage :

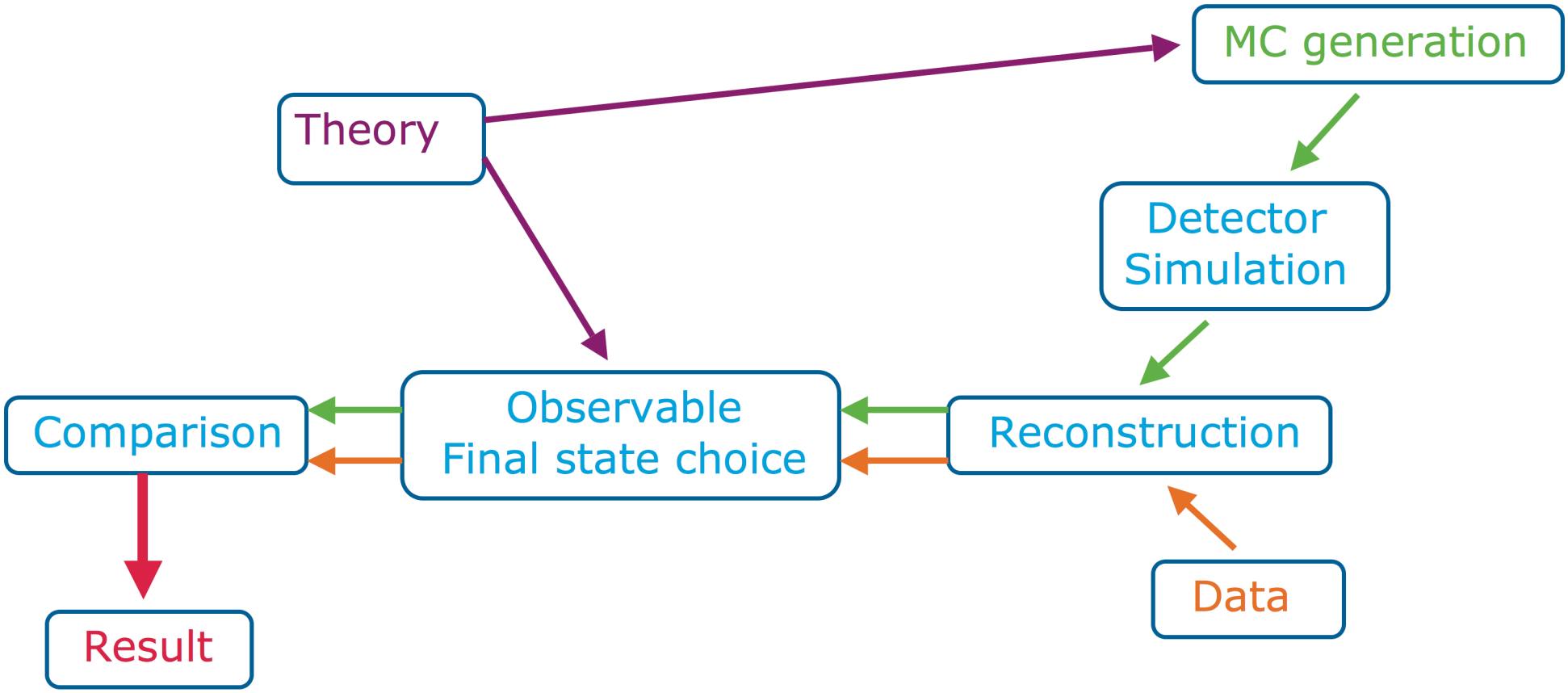
- 260 TB

➜ ATLAS ~ 55%

- MC prod
- Top group analysis data processing
- Analysis

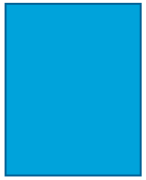
Analysis

General analysis scheme



Our Analysis plans

- $H \rightarrow \gamma\gamma$



Francesco

- $Z' \rightarrow e^+e^-$

- top :
  - Pair production
    - Polarisation du W

  - Single production

  - $H^{+/-}$ search

tt resonance search

Analysis Path

All

Data

Monte Carlo

Background

Signal

Selection

Comparison

Statistical analysis

Paper

Topaz
Mefisto
General tools for LPSC top group

Top group correspondent

Collaboration

Analysis strategy

Depends on

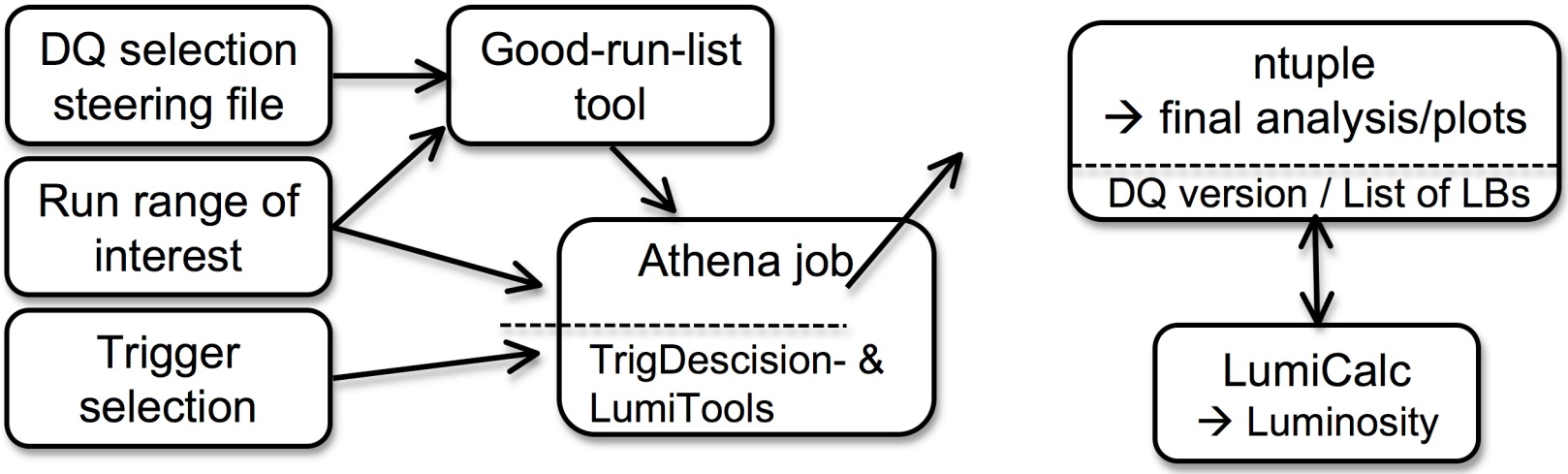
- The study to do
  - New phenomena search ?
  - Precision measurement ?
  - Counting measurement ?
  - …
- The signal vs background
  - Signal easy to extract ?
  - Well known and well simulated background ?
  - Signal vs background ratio ?
- Errors !
  - Choose strategy which minimizes errors : statistics and systematics

Data ?

Main starting point are AOD objects : output of reconstruction

- AOD sample, AOD contained in dESD, dAOD samples

Typical analysis proceeds as:



Start from preprocessed and preselected events

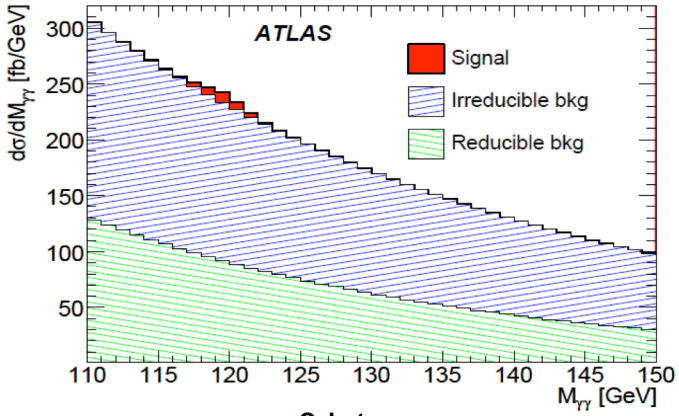
- root ntuples

Backgrounds : Higgs example

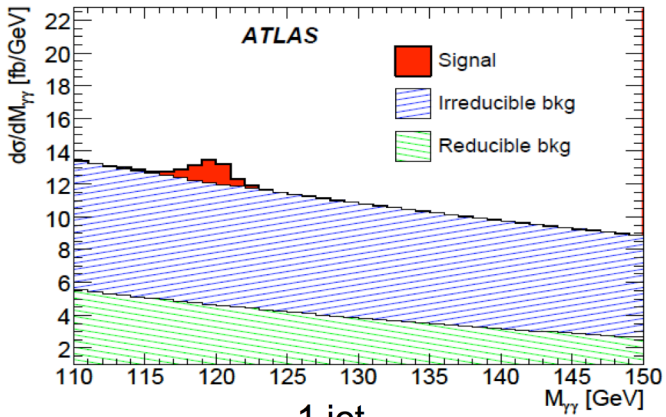
Final state : γγ

Background

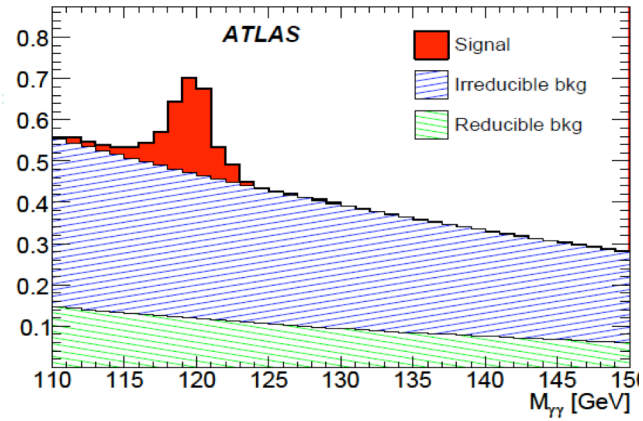
- QCD qq->2 photons (« irreducible background »)
- Badly reconstructed event (ex Z->ee) (« reducible background »)



0 jet



1 jet



2 jets

Reconstructed invariant mass

Monte Carlo ?

Which generator ? which parton shower and hadronization program?

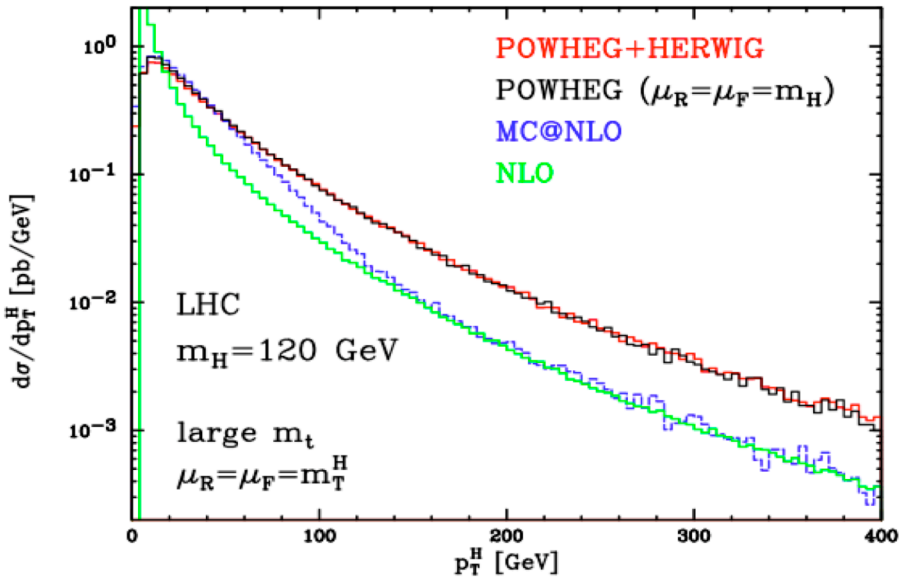
Ex : top

- Generators
  - MC@NLO vs POWHEG, AcerMC: for single-top et ttbar
  - Alpgen : QCD, Wjets
  - Sherpa : Wjets
- PDF
- Showering, underlying event
  - Pythia/Herwig

➜ MC validation

Higgs

- See next slides



Example : Higgs signal

I.1.a- Total NkLO cross sections (for all subprocesses gg, VBF, associated).
INPUT: Various programs (Higlu, ggHTotal, Fehip, hnnlo, resbos,…)
OUTPUT: s_H (120, 130,140) → **IV**

I.1.b- Branching with all corrections including EW.
INPUT: Various programs (Hdecay, FeynHiggs, Profecy4f,…)
OUTPUT: BR_H (120, 130,140) → **IV**

I.2.a- Reconstruction efficiencies and acceptances.

I.2.b- Relative trigger efficiencies and acceptances.
INPUT: Pythia ntuples? Maybe also others for the other processes?
OUTPUT: e_H(120,130,140) (→**IV for systematics studies)**

I.3.a- Mass shape (G+CB) and PrimaryVertex reconstruction.
INPUT: Pythia ntuples, MC@NLO & Jimmy, Herwig (VBF) ? (120)?
OUTPUT: Tree with selected events, fitted mass histo, pdf formula and table of fit parameters results →**IV**

I.3.b- Pt Shape (not obvious for all subprocesses).
INPUT: Pythia ntuples, MC@NLO & Jimmy, Herwig (VBF) ? (120)?
OUTPUT: Tree with selected events, fitted pT histo, pdf formula and table of fit parameters results → **IV**

Francesco

Example : Higgs irreducible background

II.1.a- ResBos/Alpgen reweighting (as function of Pt). (no box)
INPUT: ResBos, ALPGEN (full sim)
OUTPUT: Reweighted histo of brem and born → **II.3.a, II.3.b**

II.1.b- Correction for the double fragmentation (using Diphox). (NOT CSC)
INPUT: Diphox, output of II.1.a
OUTPUT: Weights as function of pt (histo?) → II.3.a, II.3.b

II.1.c- Specific treatment of box using Pythia and resBos.
INPUT: Pythia, ResBos box samples
OUTPUT: Reweighting function of box → **II.3.a, II.3.b**

II.2.a- Reconstruction efficiencies and acceptances.
II.2.b- Trigger efficiencies and acceptances.
INPUT: Pythia samples
OUTPUT: ϵ_{gg} function of eta, pT (If we use no fullsim → II.1.a, III.1.b)

II.3.a- Reweighted Pt shape.
INPUT: outputs from II.1.a, (II.1.b), II.1.c
OUTPUT: Tree with selected events, fitted pT histo, pdf formula and table of fit parameters results → **IV**

II.3.b- Reweighted Mass shape.
INPUT: outputs from II.1.a, (II.1.b), II.1.c
OUTPUT: Tree with selected events, fitted mass histo, pdf formula and table of fit parameters results → **IV**

Example : Higgs reducible background

III.1.a- Estimate of the rejections and efficiencies (function of initial parton, Pt and possibly eta).

INPUT: Pythia and Herwig samples gamma-jet and jet-jet

OUTPUT: Table of rejection factors function of parton, pT, eta → **III.1.b, III.1.c**

Table of efficiencies function of pT, eta → **III.1.b**

III.1.b- Application of the rejection to fast simulated samples gamma- jet (Normalisation, Mass and Pt shapes).

INPUT: ALPGEN samples, output of III.1.a

OUTPUT: Tree with selected events, fitted histo, pdf formula and table of fit parameters results, both for mass and **pT → III.2.a**

III.1.c- Application of the rejection to fast simulated samples jet-jet (Normalisation, Mass and Pt shapes).

INPUT: Pythia samples, output of III.1.a

OUTPUT: Tree with selected events, fitted histo, pdf formula and table of fit parameters results, both for mass and **pT → III.2.b**

III.2.a- k-factor and fragmentation scaling for the gamma-jet (JetPhox)

INPUT: JetPhox, ALPGEN, output of III.1.b

OUTPUT: Tree with selected events, fitted histo, pdf formula and table of fit parameters results, both for mass and **pT → IV**

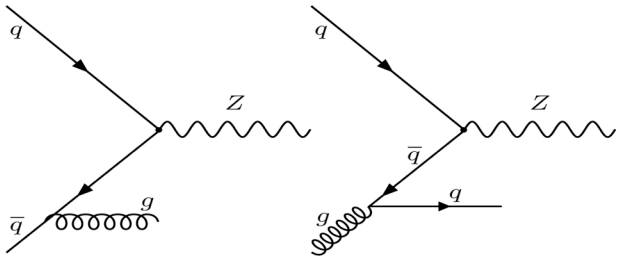
III.2.b- k-factor for the jet-jet process (NLOjet++)

INPUT: NLOjet++, Pythia, output of III.1.c

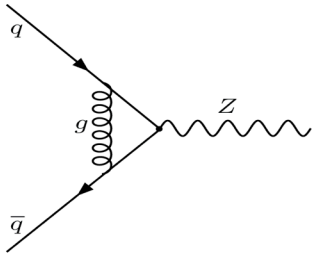
OUTPUT: Tree with selected events, fitted histo, pdf formula and table of fit parameters results, both for mass and **pT → IV**

Theory-experiment collaboration : Z'

Real particle emission

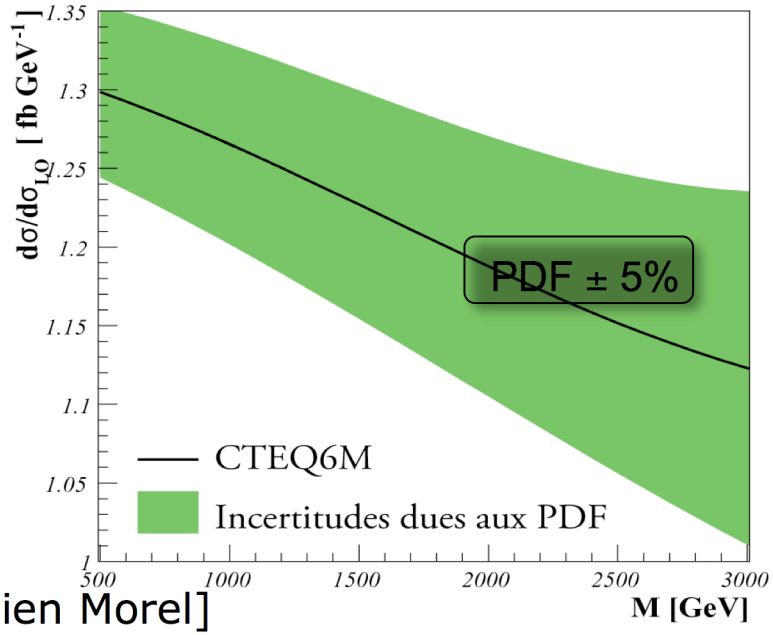


Vertex corrections



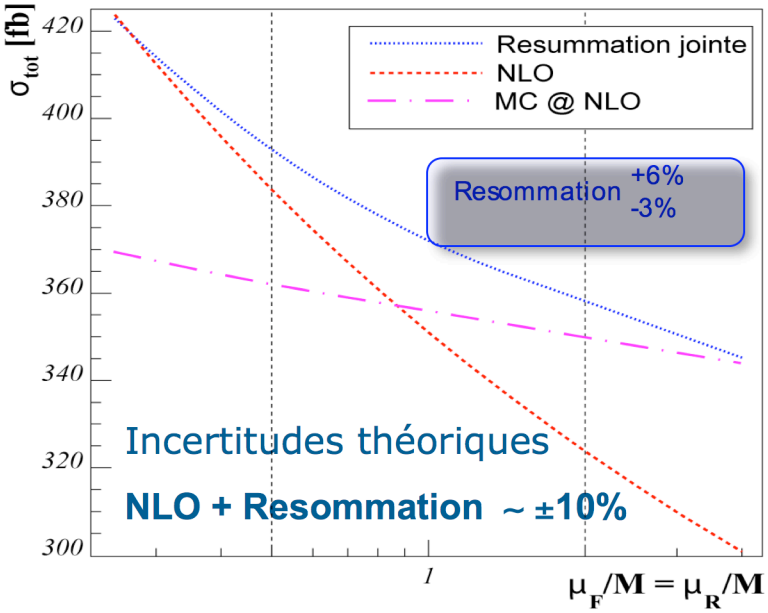
Calculs théoriques :
Ordre fixe + resommation
Approche MC :
Ordre fixe (MC@NLO)
+ Parton shower (Herwig)
Benjamin Fuks, Qiang Li

K Factor



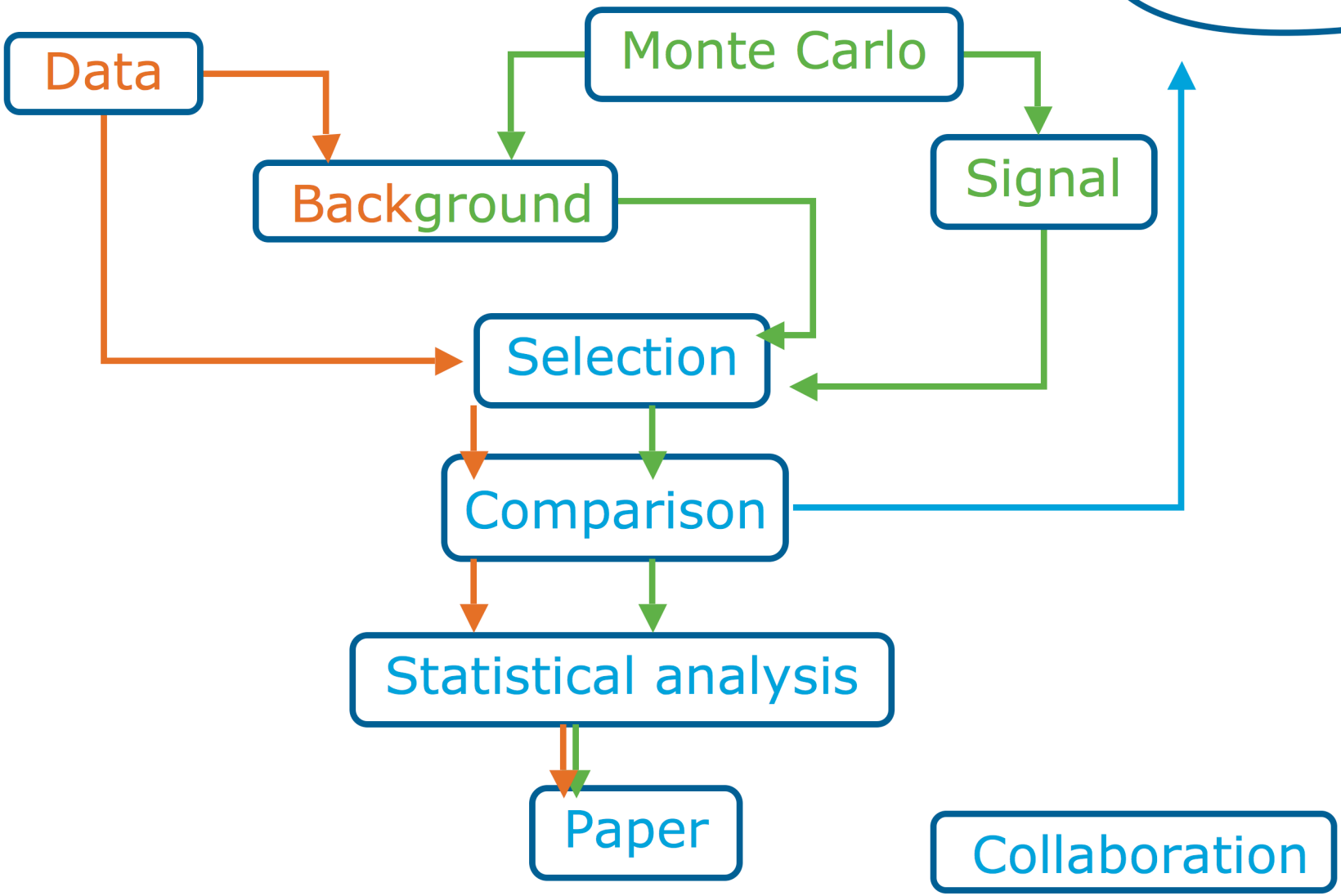
[Julien Morel]

Scale variation



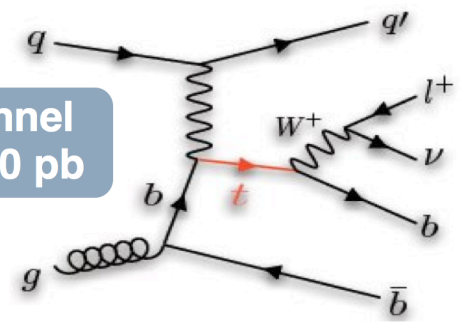
➜ Same kind of work (NLO calculation) for tH^+ production in progress

Analysis Path



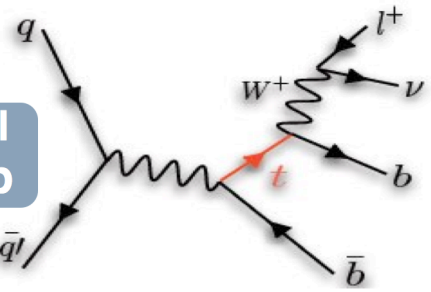
Selection : single top example

t-channel
σ ~ 240 pb



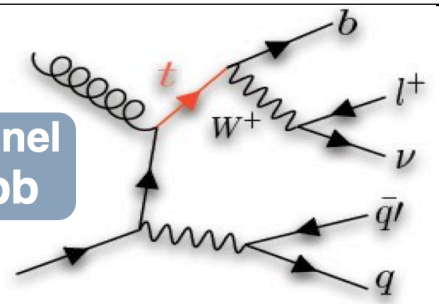
– 1 lepton+missing ET (W decay)
– 2-3 high pT jets
– 1 bjet

s-channel
σ ~ 10 pb



– 1 lepton+missing ET (W decay)
– 2-3 high pT jets
– 2 b-jets

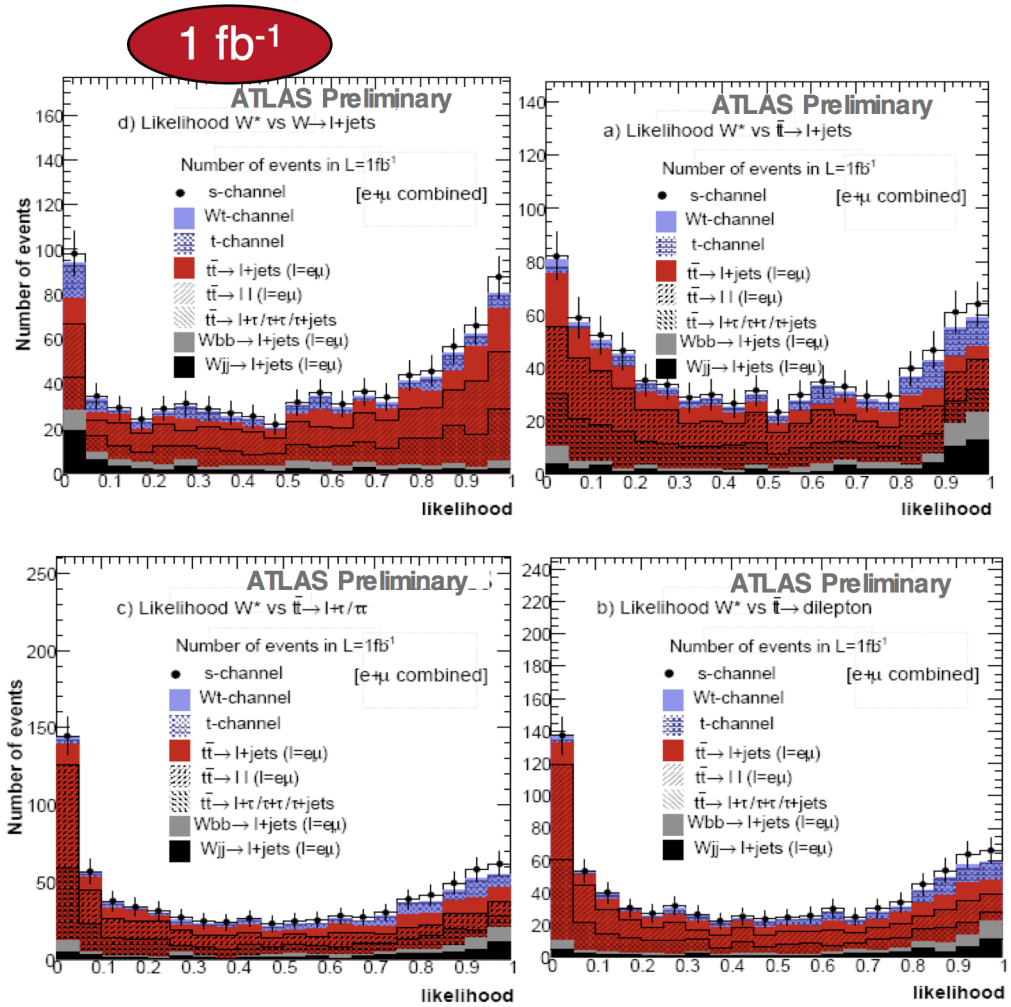
W+t channel
σ ~ 60 pb



– 1 lepton+missing ET (W decay)
– 2 high pT light jets (W decay)
– 1 b-jet

[Arnaud]

Data-MC comparison



Single top
s-channel

[Arnaud]

If MC and data do not match where they should ?

MC is never perfect: several level of discrepancies

- Generator level: LO/NLO, showering model, multiple interaction …
- Detector level: missing material, bad description of physical properties, error in geometry…
- Digitization level: detector response, electronic noise …

The right solution: fix everything

- requires a long time : months? years? decades?

The practical solution: correcting MC to model data

- Smearing: ET_smeared= ET_raw x S+O
  - S: shift, random number following a gaussian distribution : $\sigma = \sigma(\text{data}) - \sigma(\text{mc})$
  - O: constant offset
- Correct shape
- applied to jets, EM objects, muons and propagate to Etmiss

For difference in efficiencies

- Use weights !
- Very useful : trigger efficiency, btagging …

Systematics !!

[Benoit]

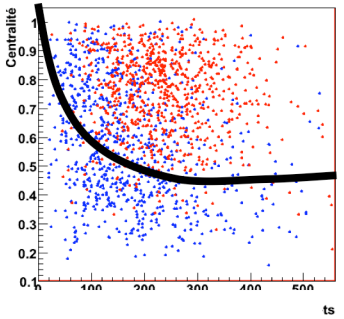
Multivariate analysis

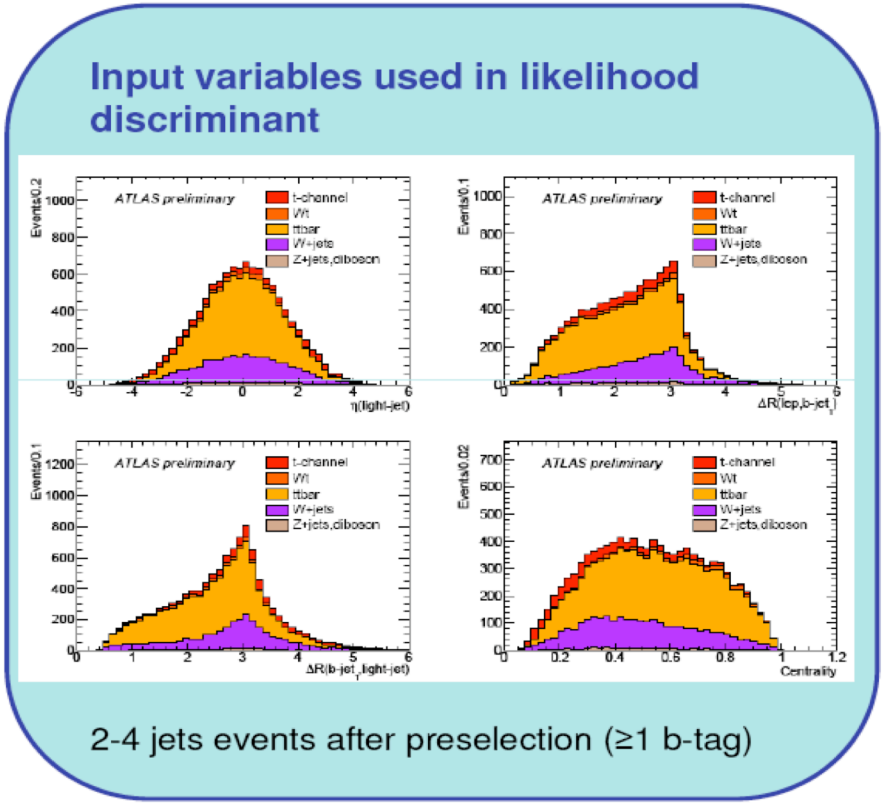
Necessary when signal extraction from background difficult

Lots of methods :

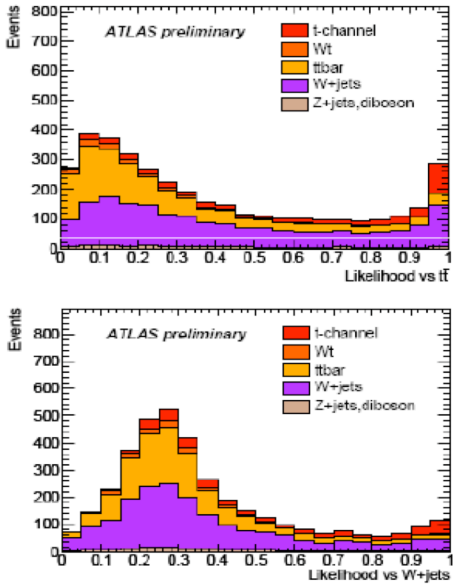
- Fischer discriminant, Likelihood,
  Neural Network,Boosted decision tree

Ex :





LL output (200 pb^{-1}) for 2-jets events



Single top t-channel

[Julien Donini]

Errors

Statistical and systematical errors have to be evaluated for all the steps described previously !

Error on cross section determination

- **Estimation of cross section uncertainty**
  - Monte Carlo method used for propagation of uncertainties

Source of uncertainty	$\Delta\sigma/\sigma(\%)$ Sequential cuts	Likelihood
Data Statistics	19%	18%
MC Statistics	10%	11%
JES	16%	16%
b-tagging	30%	20%
BG x-section	19%	14%
ISR/FSR	10%	10%
PDF	18%	15%
Lep. ID, trigger	5%	4%
Luminosity	12%	11%
Total	52%	43%

Expected uncertainties (200 pb^{-1})

Error	Variation
JES	±5% on jet energy
b-tagging	±5% b-tag eff. (absolute), ±10% mistag (relative)
BG error	Data-driven (W+jets, ttbar) and theory
ISR/FSR	specific t-ch and ttbar MC samples with low/high ISR/FSR
PDF	t-ch samples with different CTEQ and MRST PDF sets
Lep. ID, trigger	±1% error on S and B rates
Lum.	±10% integrated luminosity

Single top t-channel

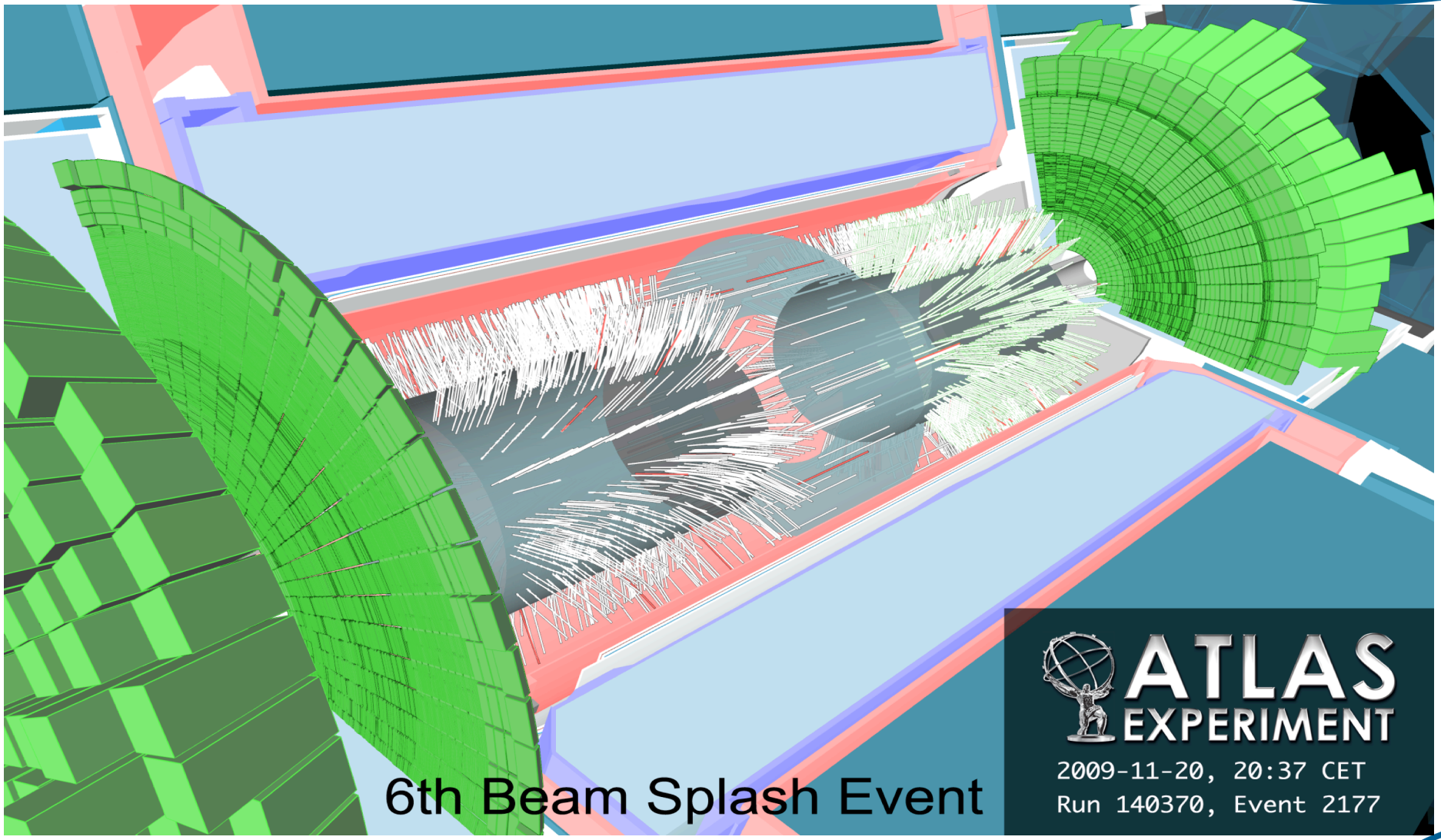
[Julien Donini]

Result and publication

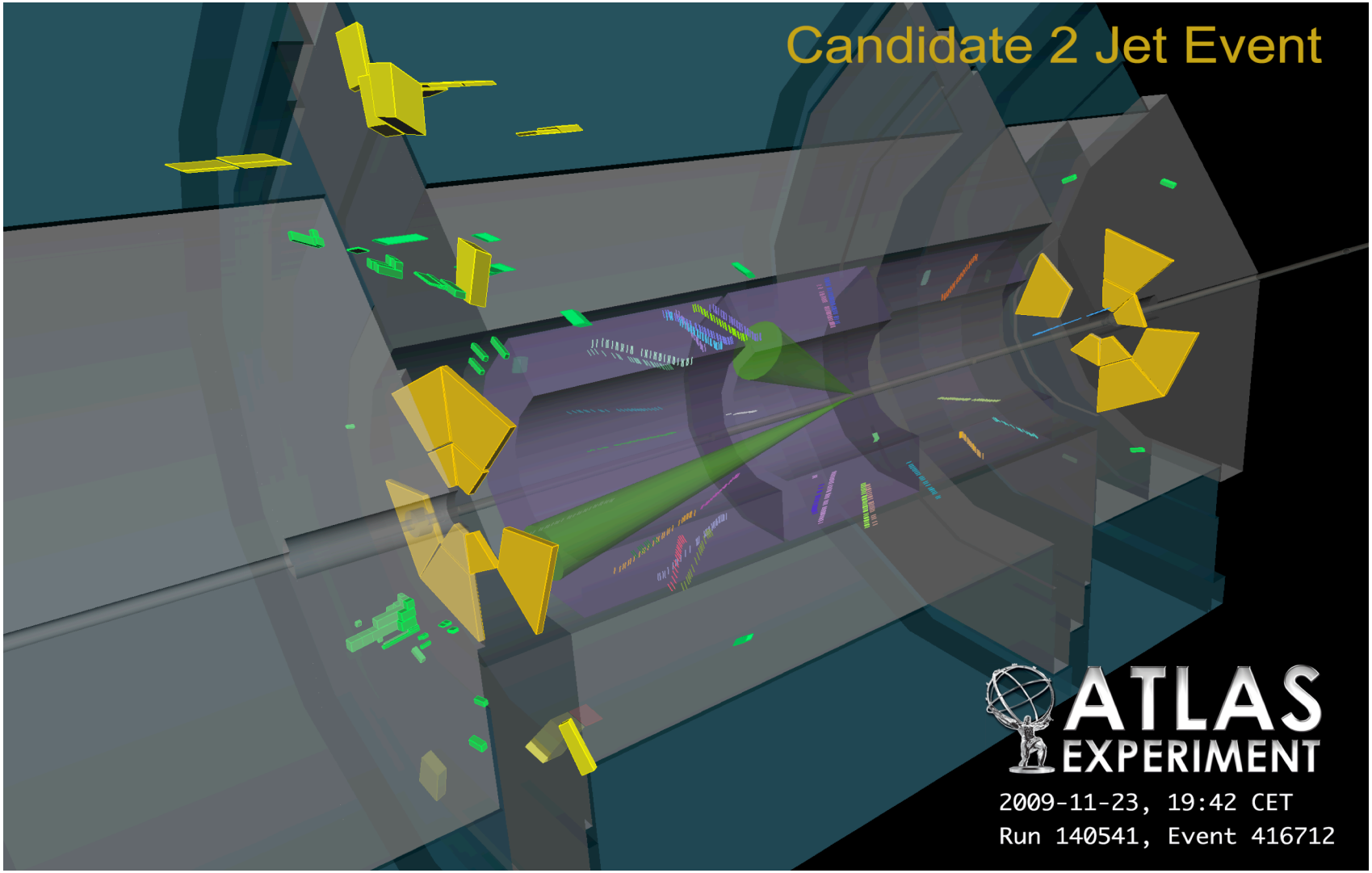
… an other story

- All steps have to be validated by the collaboration
- You have to participate to the experiment life
  - Shifts
  - General tasks
  - ….

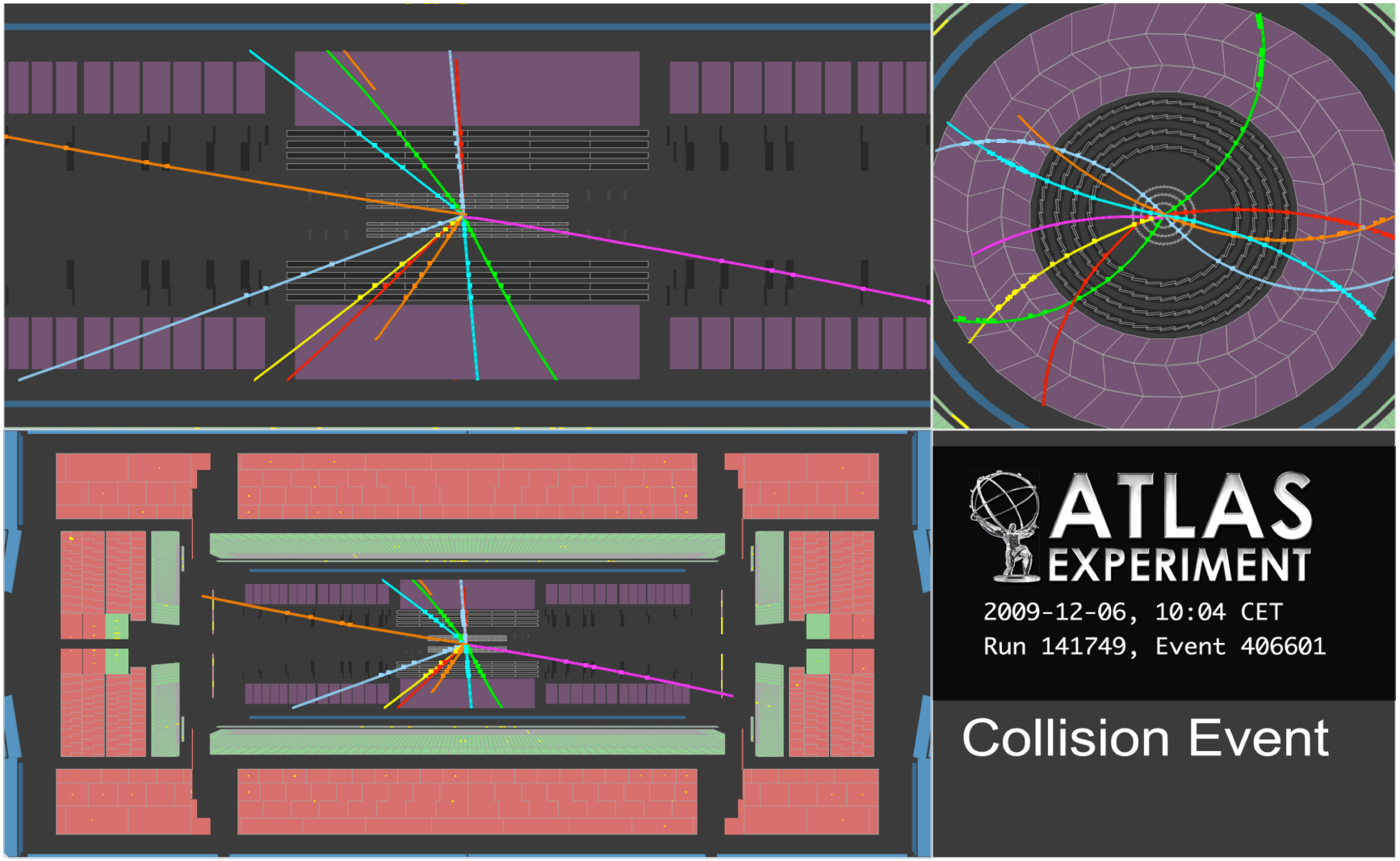
Y'a plus qu'à ...


6th Beam Splash Event
ATLAS
EXPERIMENT
2009-11-20, 20:37 CET
Run 140370, Event 2177

Y'a plus qu'à ...


Candidate 2 Jet Event
ATLAS
EXPERIMENT
2009-11-23, 19:42 CET
Run 140541, Event 416712

Y'a plus qu'à ...



http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

Y'a plus qu'à ...

Last weekend :

~ 75 000 collisions collected @ 900 GeV (int. lumi ~2 μb^{-1})

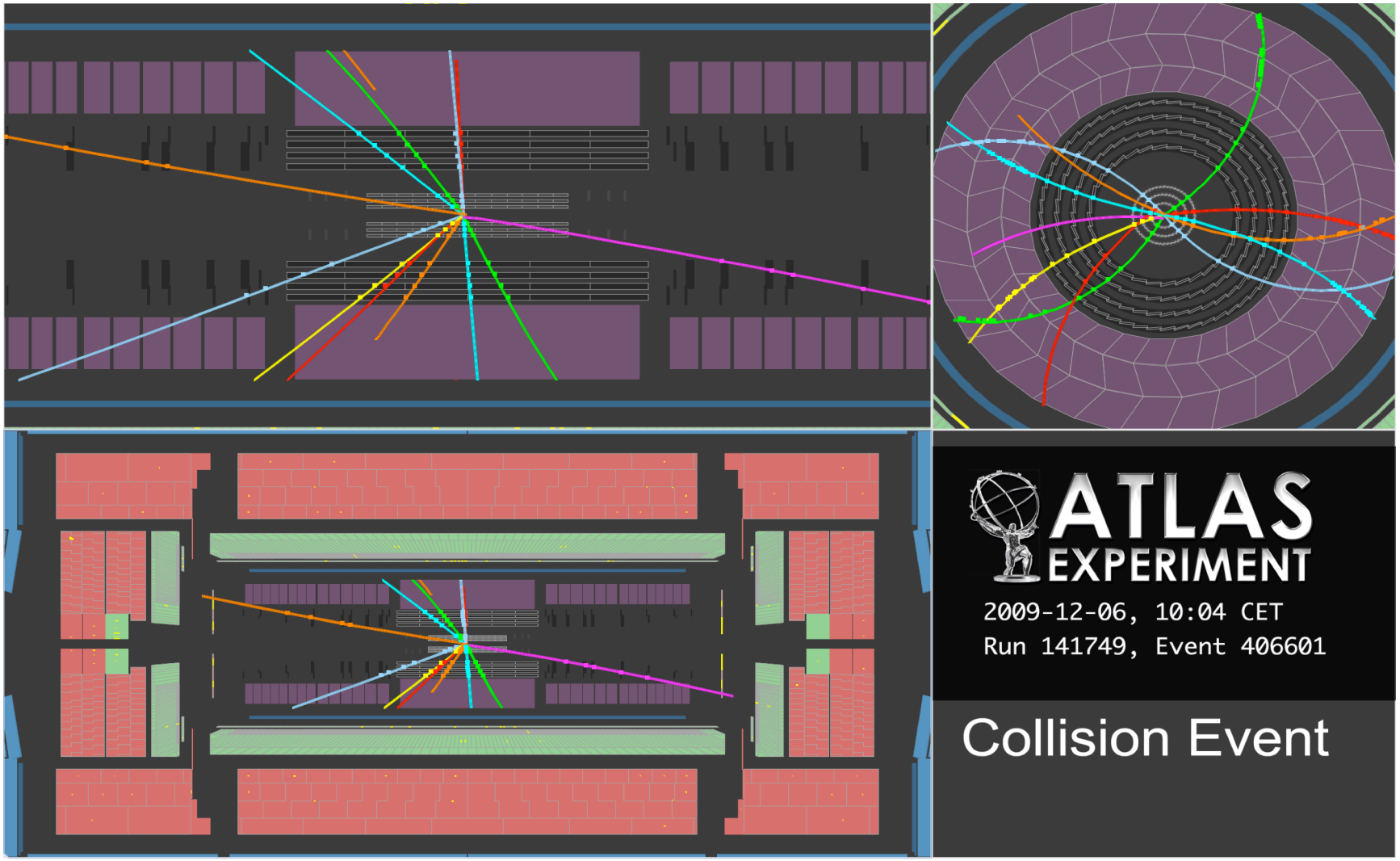
7-8th of December :

3 minutes of data with collisions at 2.38 TeV ... world's highest collision energy !!

With about 10^{10} p/bunch 2 bunches per beam.

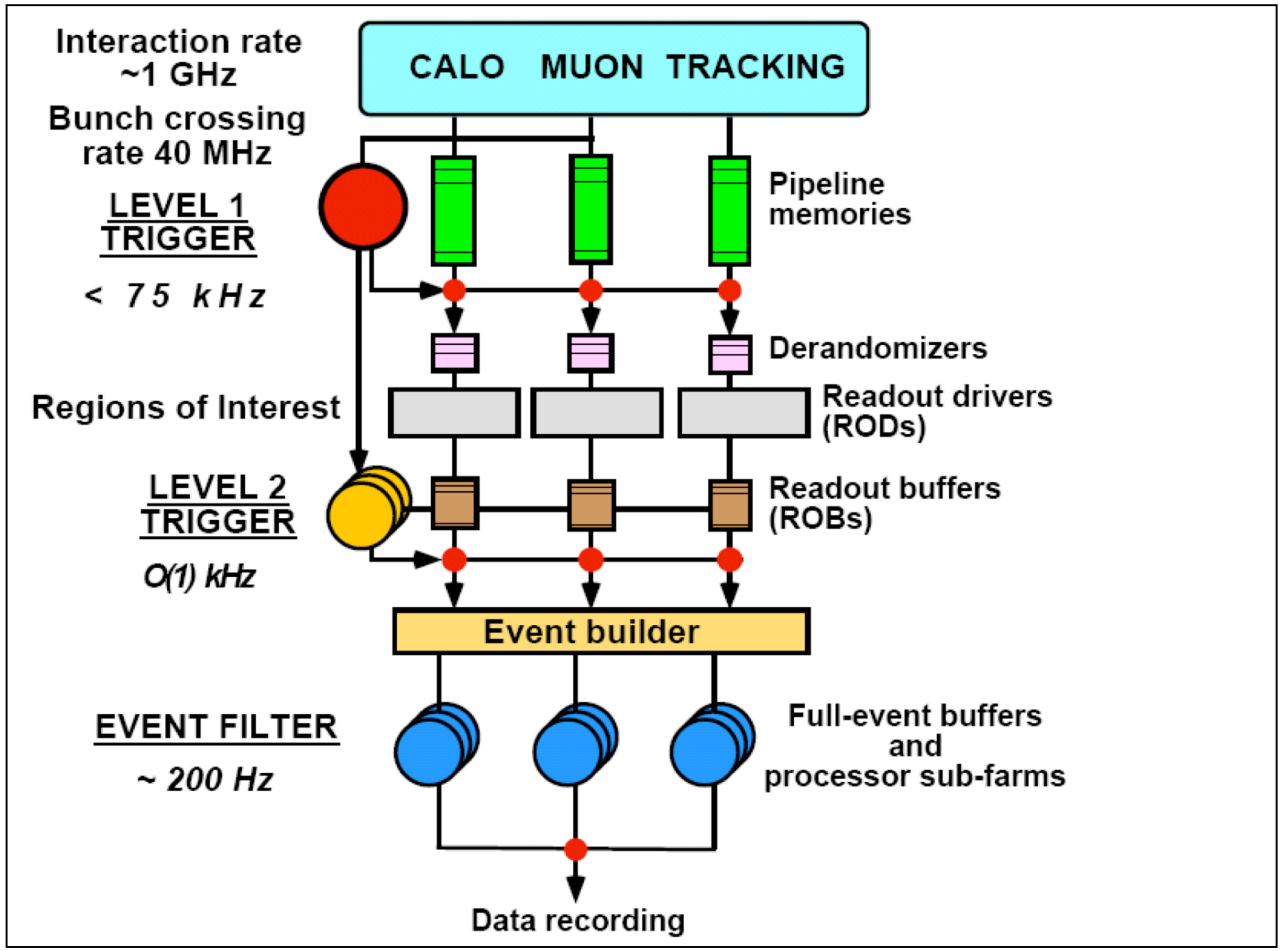
Merci à tous pour votre aide !

Merci à tous pour votre aide !



http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

Triggers (II)



1) **LVL1** decision based on data from calorimeters and muon trigger chambers; synchronous at 40 MHz
2) **LVL2** uses Regions of Interest identified by LVL1 (< 10% of full event) with full granularity from all detectors
3) **Event Filter** has access to full event and can perform more refined event reconstruction

[David Berge]

Theory-experiment collaboration : Z'

Discovery potential of Z Kaluza-Klein states (MC)

F.Ledroit, G.Moreau, J.Morel

Probing RS scenarios of flavour at LHC via leptonic channels, JHEP09 (2007) 071

NLO corrections to Z' production

B.Fuks, M.Klasen, F.Ledroit, Q.li, J.Morel

Precision predictions for Z' production at LHC: QCD matrix elements, parton showers and joint resummation, Nucl.Phys.B797:322-339, 2008

Z' Discovery potential and models distinction (MC)

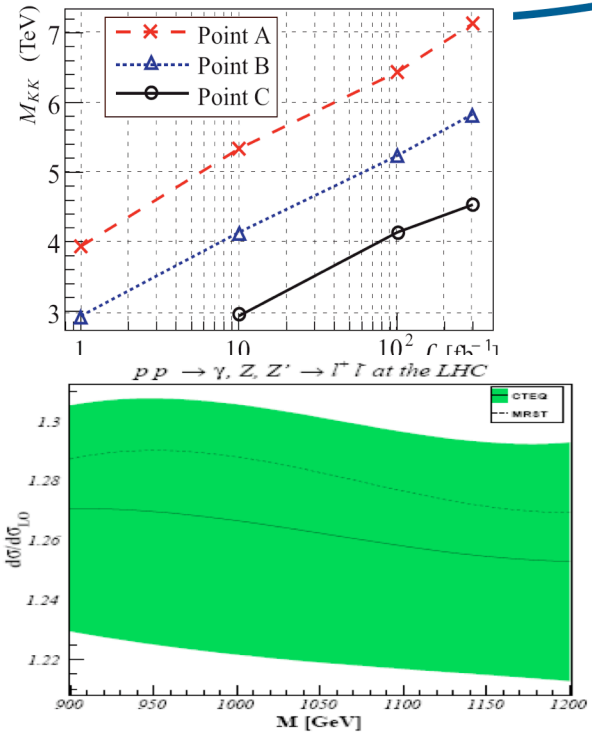
J.Morel

Recherche d'une nouvelle résonance Z' dans le canal diélectron avec ATLAS, PhD thesis 2008

Z' Discovery potential (MC)

ATLAS collaboration

Dilepton resonances at High Mass, CERN-OPEN 2008-020



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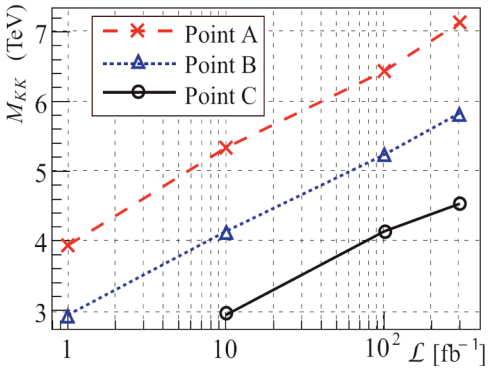

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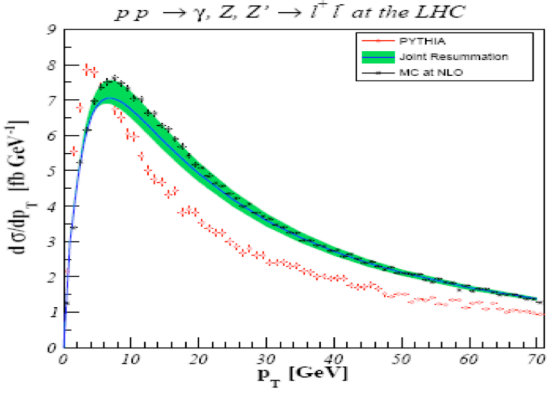

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ATLAS collaboration

Dilepton resonances at High Mass, CERN-OPEN 2008-020

MC : ATLAS use

Main Monte Carlo Generators Used in ATLAS

Generator	Version	Hadronization	Processes	Features
PYTHIA	6.4	own	Most Processes	
HERWIG	6.5	own	SUSY signals	
Sherpa	1.011	own	W,Z+jets and VBF Higgs	CKKW matching
AcerMC	3.4	Pythia/Herwig	tt,single top, ttbb, Zbb	Comb. w/ MC@NLO*
ALPGEN	2.13	Herwig/Jimmy	W, Z & tt+jets, VBF Higgs**	MLM Matching
MC@NLO	3.3	Herwig/Jimmy	Inclusive W,Z and Higgs	NLO+PS
MadGraph	4.15	Pythia	Multiple bosons + jets	Ampl. Gen.
Charybdis	1.003	Pythia	μ-Black Holes	
CompHEP	-	Pythia	Exotics	Ampl. Gen.
TopRex	4.11	Pythia	Top prod. (w/ FCNC)	Addition to PYTHIA
WINHAC/HORACE	1.21	Pythia	W hadro-production	QED/EW corr.

PHOTOS : for photon radiation by charged leptons.

TAUOLA : for τ decays.

*AcerMC was combined with MC@NLO for instance in the ttH channel where the overlap of MC@NLO tt events w/ gluon splitting to bb were removed to avoid overlap with AcerMC.

**Also vector diboson production

[Marumi Kado]

MC : ATLAS use

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AcerMC	3.4	Pythia/Herwig	tt,single top, ttbb, Zbb	Comb. w/ MC@NLO*
ALPGEN	2.13	Herwig/Jimmy	W, Z & tt+jets, VBF Higgs**	MLM Matching
MC@NLO	3.3	Herwig/Jimmy	Inclusive W,Z and Higgs	NLO+PS
MadGraph	4.15	Pythia	Multiple bosons + jets	Ampl. Gen.
Charybdis	1.003	Pythia	μ-Black Holes	
CompHEP	-	Pythia	Exotics	Ampl. Gen.
TopRex	4.11	Pythia	Top prod. (w/ FCNC)	Addition to PYTHIA
WINHAC/HORACE	1.21	Pythia	W hadro-production	QED/EW corr.

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**Also vector diboson production

[Marumi Kado]

MC : ATLAS use

Main Parton Level Cross Sections

Generator	Hard Scat.	Soft Treat.	Processes
FEWZ	NNLO	FO	Most W and Z inclusive
MCFM	NLO	FO	W, Z, H, WW, ZZ, and ZZ (excl. & incl.)
ResBos	NLO	NLL	Higgs Gluon Fusion, $\gamma\gamma$, inclusive Z
DiPhox	NLO	FO	$\gamma\gamma$ inclusive, single/double frag
JetPhox	NLO	FO	γ–jet inclusive/fragmentation
NLOJet++	NLO	FO	Jet Production
HiGlu	NLO	FO	HiggsGluon Fusion
VV2H	NLO	FO	Higgs VBF
V2HV	NLO	FO	WH, ZH
HQQ	LO	FO	ttH
Prospino	NLO	FO	SUSY
Whizard*	LO	FO	WW scattering

*Interfaced with O'Mega (Optimized Matrix Element GenerAtor)

HDecay : Higgs decays (partly NLO)

Mostly NLO (for consistency w/ backgrounds) mostly FO

[Marumi Kado]

MC : ATLAS use

Main Parton Level Cross Sections

Generator	Hard Scat.	Soft Treat.	Processes
FEWZ	NNLO	FO	Most W and Z inclusive
MCFM	NLO	FO	W, Z, H, WW, ZZ, and ZZ (excl. & incl.)
ResBos	NLO	NLL	Higgs Gluon Fusion, $\gamma\gamma$, inclusive Z
DiPhox	NLO	FO	$\gamma\gamma$ inclusive, single/double frag
JetPhox	NLO	FO	γ–jet inclusive/fragmentation
NLOJet++	NLO	FO	Jet Production
HiGlu	NLO	FO	HiggsGluon Fusion
VV2H	NLO	FO	Higgs VBF
V2HV	NLO	FO	WH, ZH
HQQ	LO	FO	ttH
Prospino	NLO	FO	SUSY
Whizard*	LO	FO	WW scattering

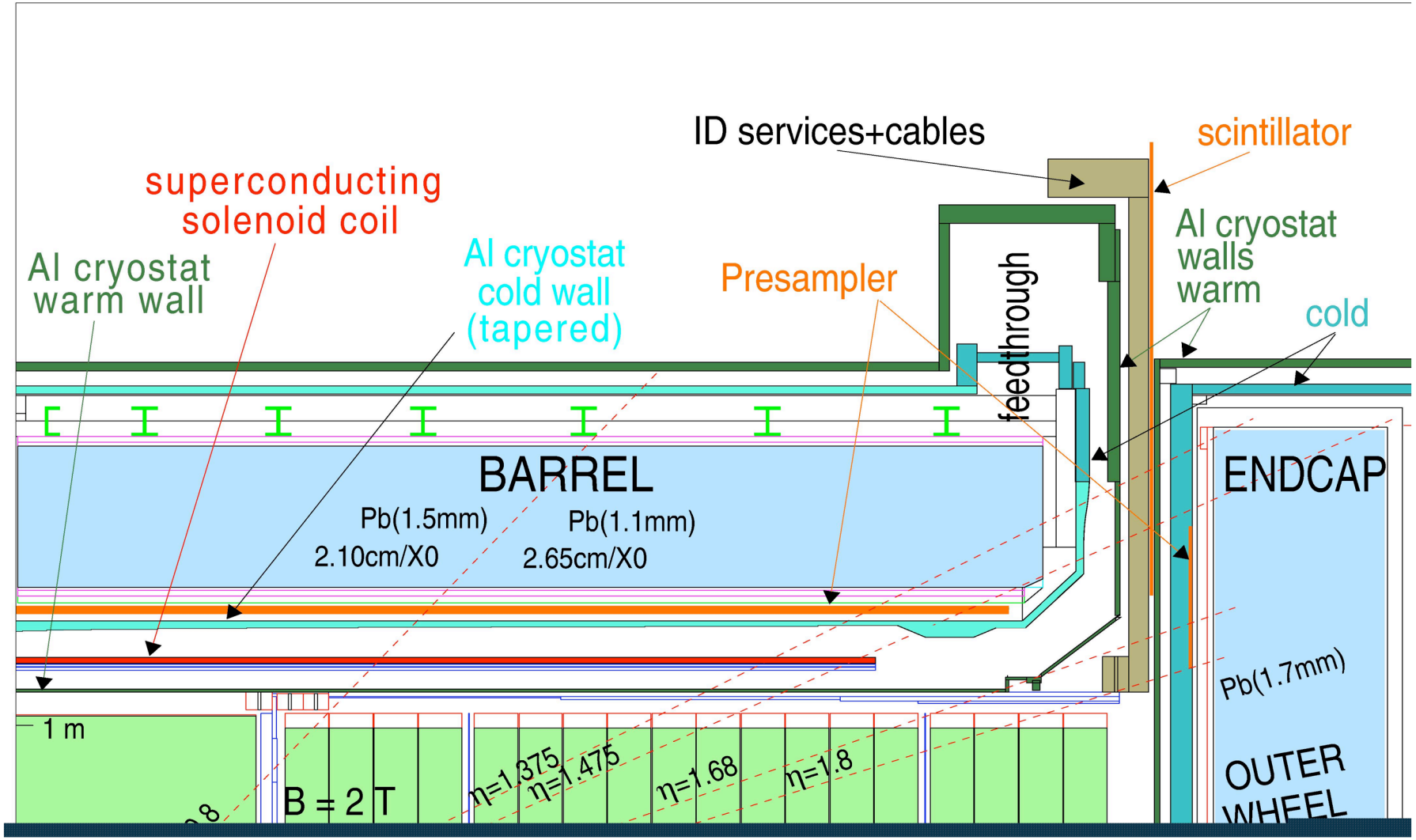
*Interfaced with O'Mega (Optimized Matrix Element GenerAtor)

HDecay : Higgs decays (partly NLO)

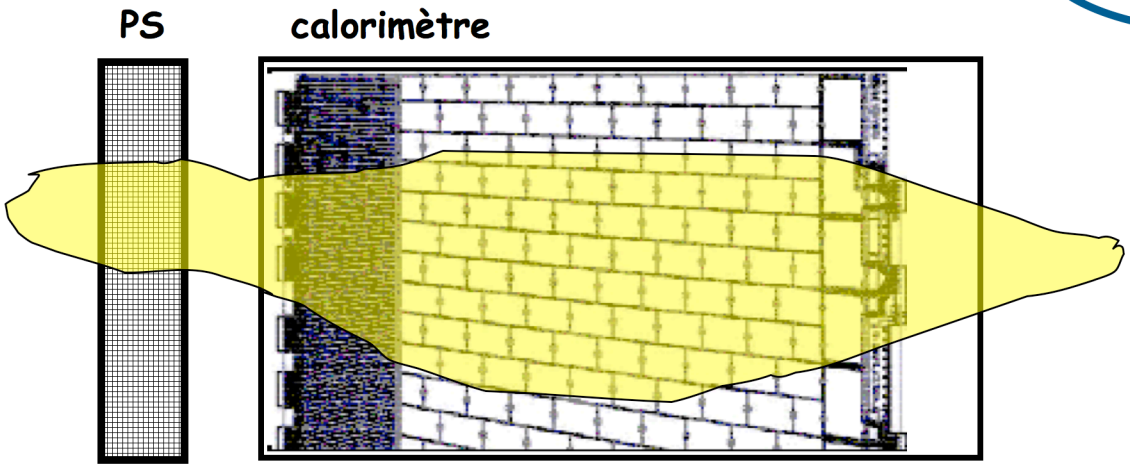
Mostly NLO (for consistency w/ backgrounds) mostly FO

[Marumi Kado]

Calorimetry



Cluster Calibration

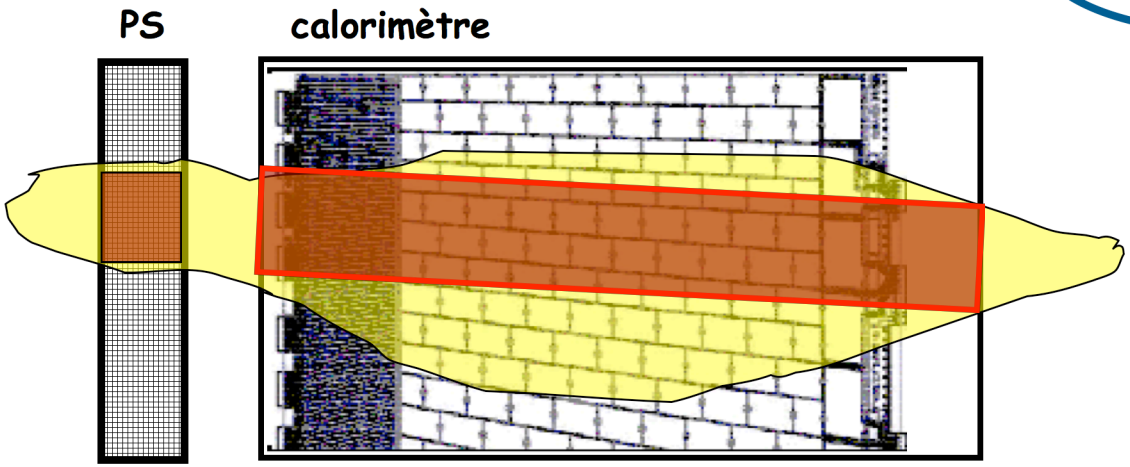


$$E_{rec} = E_{outcluster} + a + bE_{ps} + c\sqrt{E_{ps} * E_{strips}} + Eacc + Eleak$$

E_{rec}: to be corrected for loss

- Loss in matter before detector (central detector + cryostat)
- Loss in between presampler and accordeon
- Loss outside the cluster side : $E_{outcluster}$
- Loss in the rear of the calorimeter E_{leak}

Cluster Calibration



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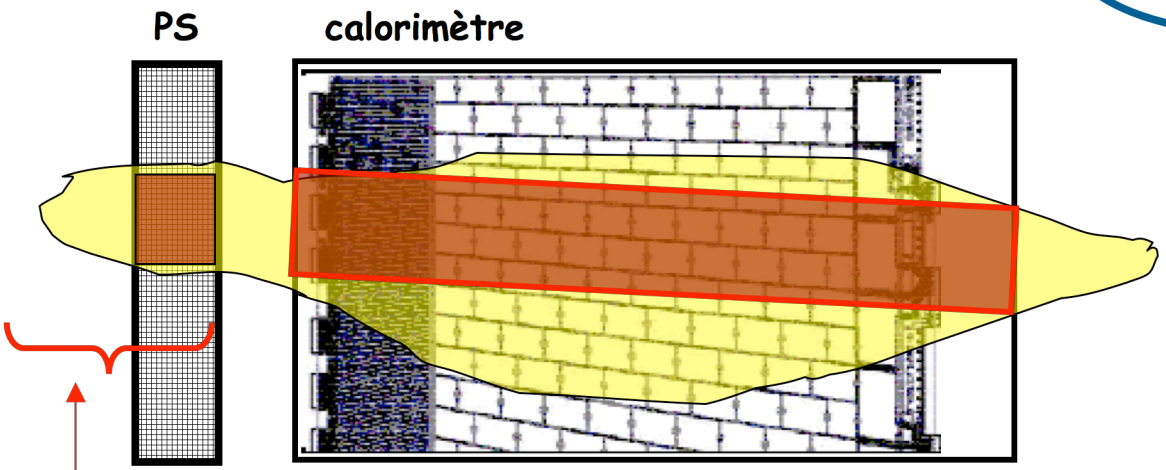

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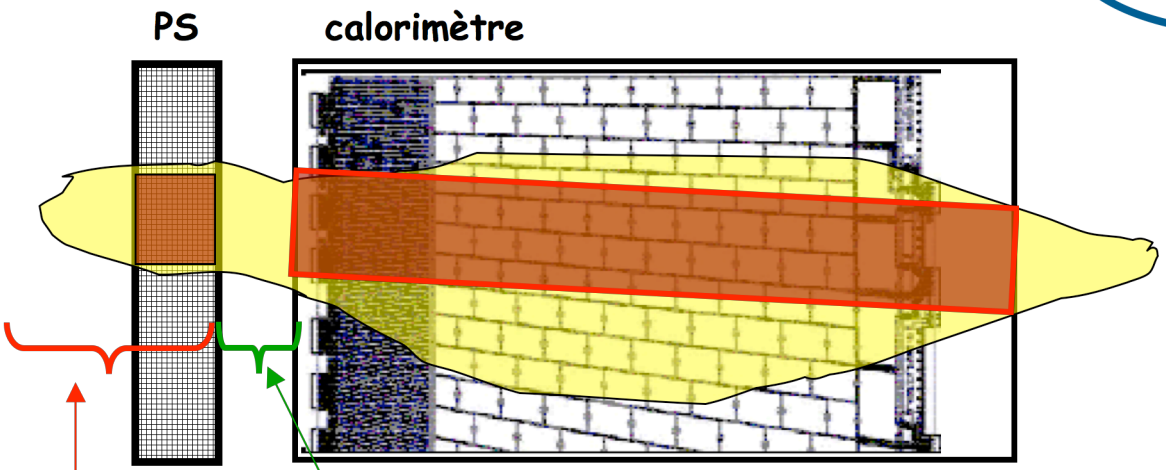

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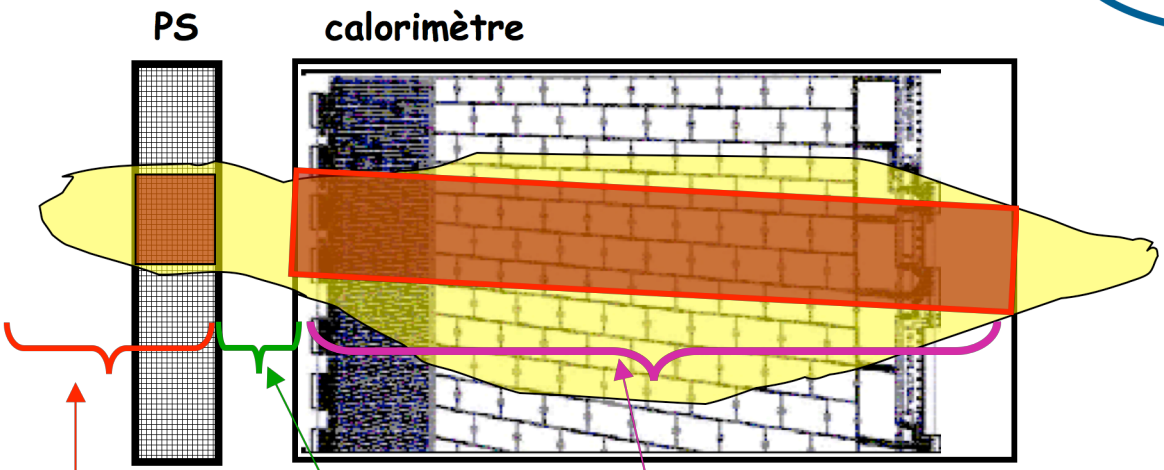

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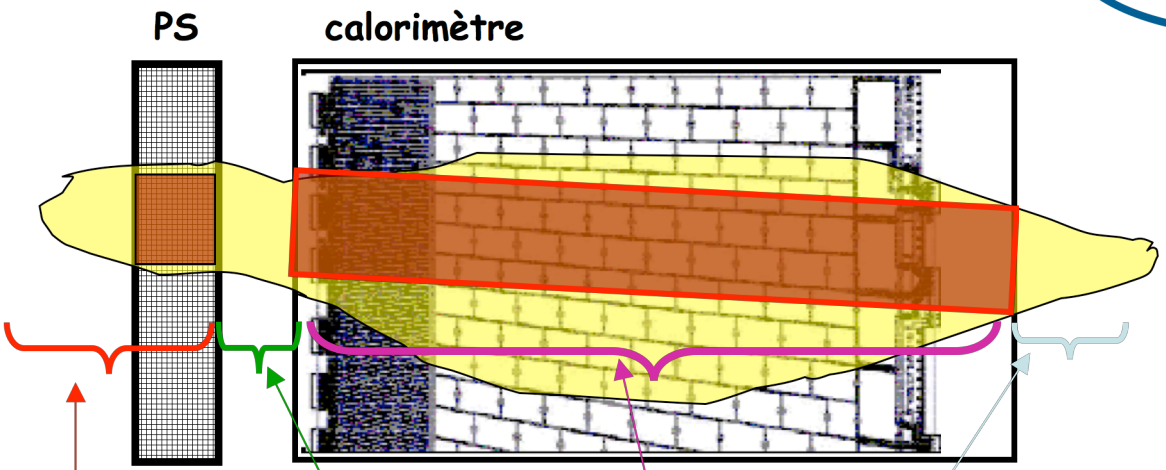

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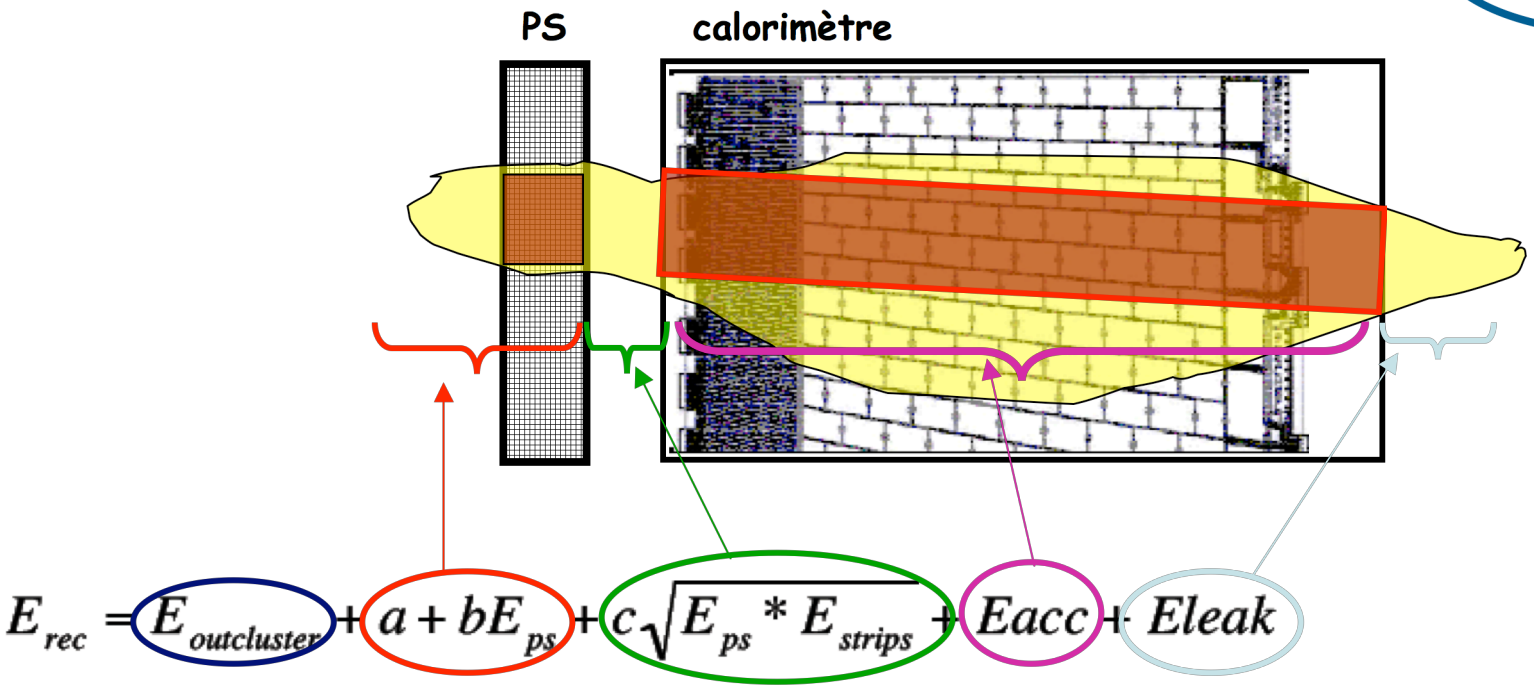

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