

CSCS workshop
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EPFL

29.04.2010

23-Nov-2009 18:03:46	Fill #: 883	Energy: 0.450 TeV	I(B1): 4.72e+09	I(B2): 4.72e+09
	ATLAS	ALICE	CMS	LHCb
Experiment Status	STANDBY	STANDBY	STANDBY	COLLIDING!
Instantaneous Luminosity	3.154e+00	0.000e+00	-1.068e-03	6.725e+01
Integrated Luminosity	3.154e+00	0.000e+00	0.000e+00	0.000e+00
BKGD 1	0.000	0.001	0.001	0.051
BKGD 2	25002.000	0.000	0.000	0.141
BKGD 3	0.000	0.012	0.000	0.050
LHCf	STANDBY	Count(Hz): 0	LHCb VELO Position	OUT
			TOTEM:	No info

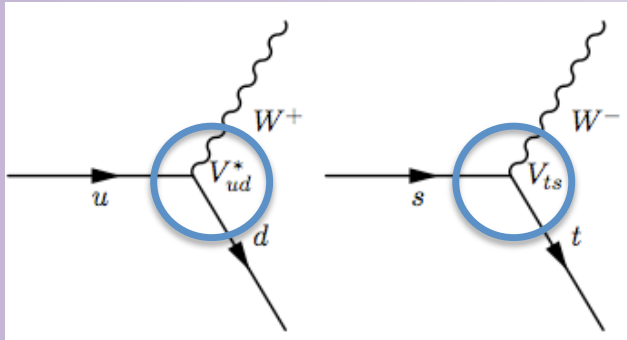
Data Analysis at LHCb

One question ?



One of the main questions LHCb attempts to answer (amongst others) is:
"Why is there so much matter in the Universe?"

CKM Matrix



Weak
Interaction

Cabibbo



Nobel Prize 2008

Maskawa



Kobayashi

$$\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \cong \begin{pmatrix} 1 - \lambda^2/2 & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1 - \lambda^2/2 & A\lambda^2 \\ A\lambda^3(1 - \rho - i\eta) & -A\lambda^2 & 1 \end{pmatrix} + \delta V$$

Wolfenstein parameterisation ³

CKM Triangle(s)

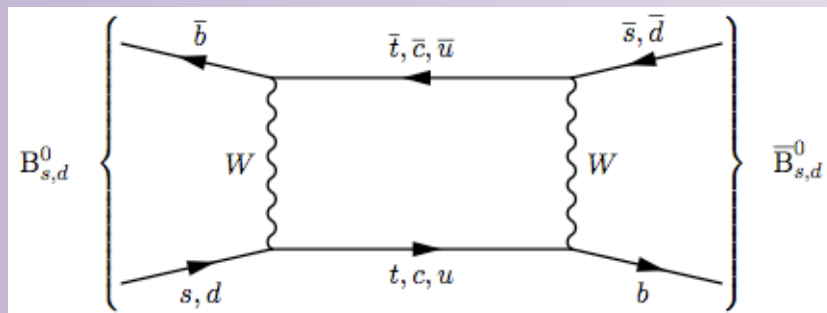
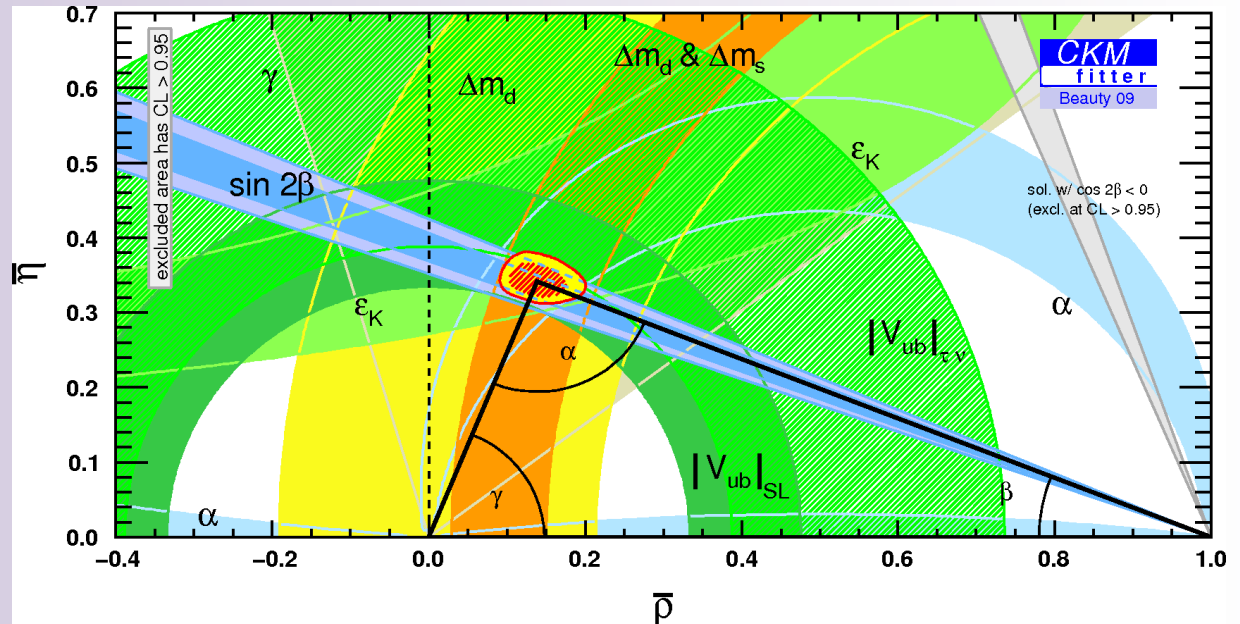
The CKM matrix must be unitary to preserve probability: $V^H V = 1$

This gives us 9 constraints:

- 6 sums to 0 for the off-diagonal elements
- 3 sums to 1 for the diagonal elements.

It turns out that only two of the 0-sum constraints produce "open" triangles.

Both of which are the same to order λ^3



The ratio of the mixing frequencies, Δm_s & Δm_d is proportional to $|V_{ts}/V_{td}|^2$

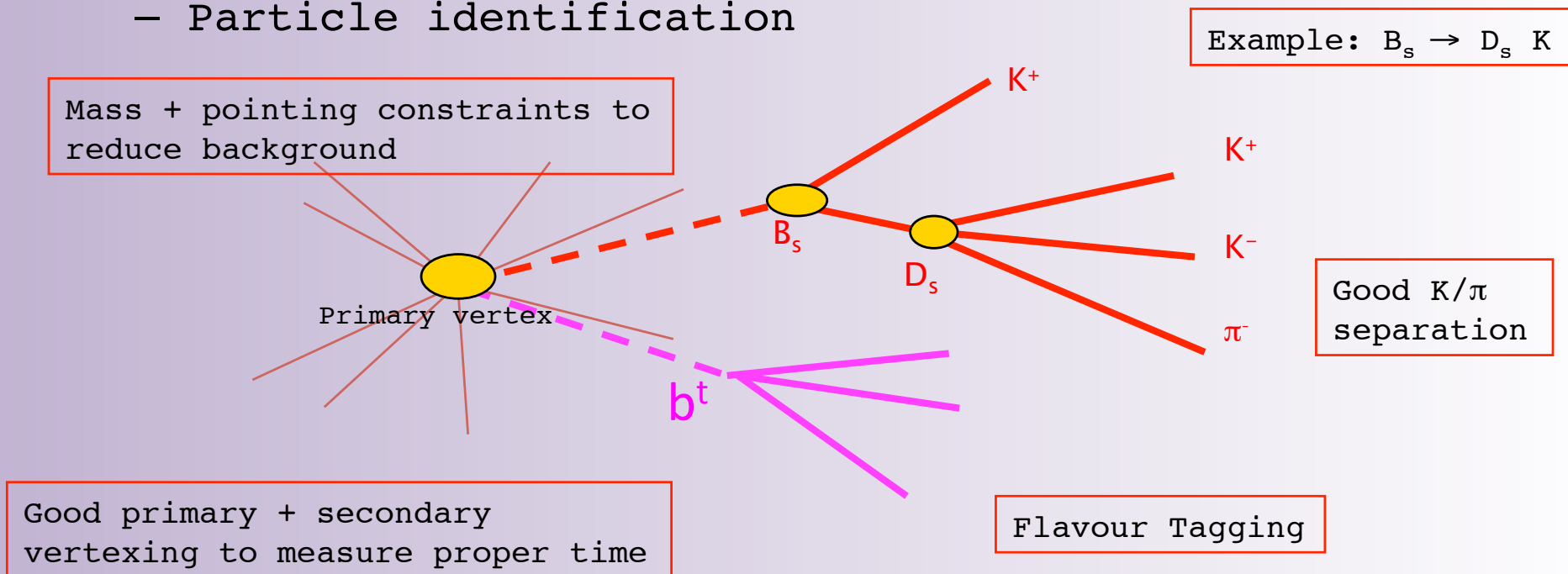
Direct search



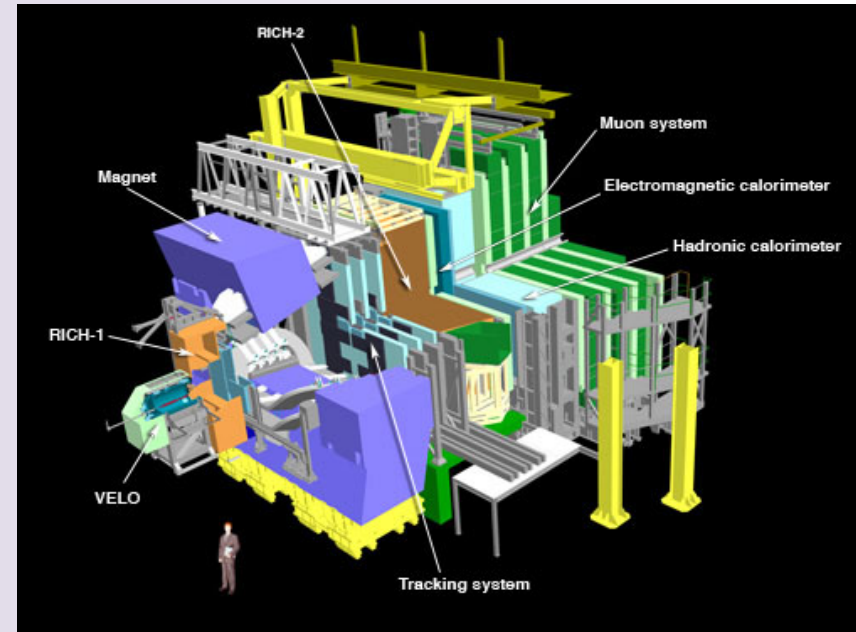
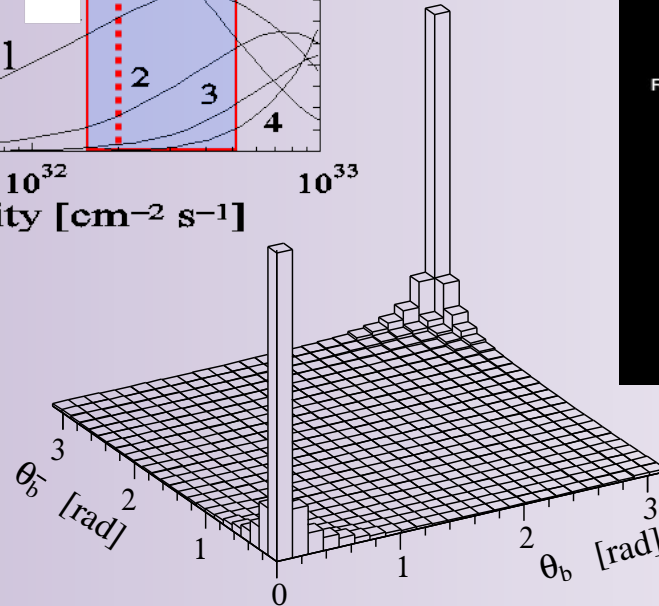
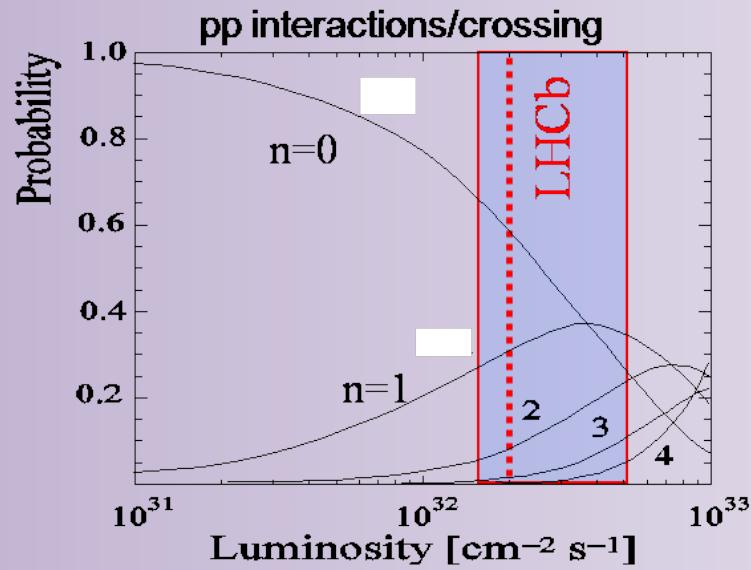
Indirect search

Detector Requirements

- Key features:
 - Highly efficient trigger for both hadronic and leptonic final states to enable high statistics data collection
 - Vertexing for secondary vertex identification
 - Mass resolution to reduce background
 - Particle identification



The LHCb Experiment



Relatively "small" detector:
Length: 20m
Weight: $4.5 \times 10^6 \text{ kg}$

- High b -particle rate.
- Good Vertexing and lifetime measurement.
- Excellent PID.

VeLo & Tracking

The Velo (Vertex Locator) provides precise measurements of track coordinates close to the interaction region.

Tracks are identified using $220\ \mu\text{m}$ Si strip sensors.

Radial and Azimuthal sensors mounted in a Module.

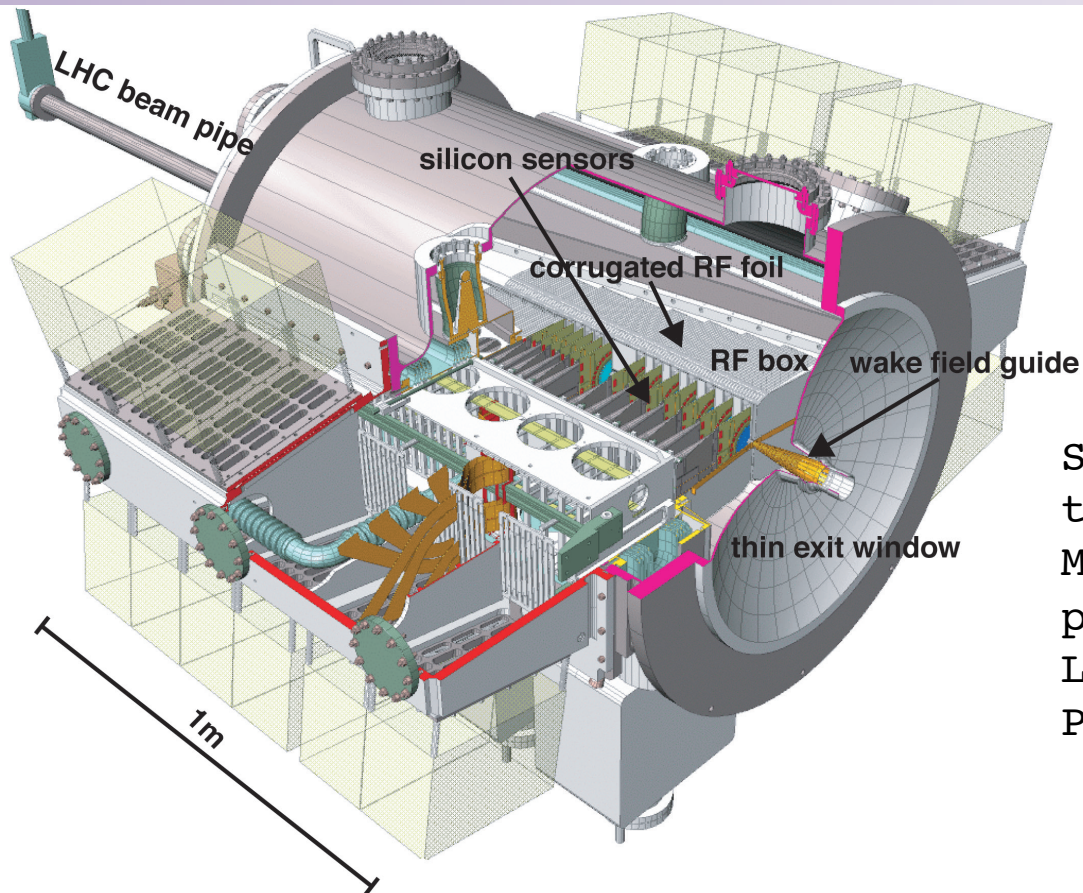


A Velo Module, 4096 channels/module.

Sensors cover $\sim 182^\circ$, overlap used to align VeLo halves.

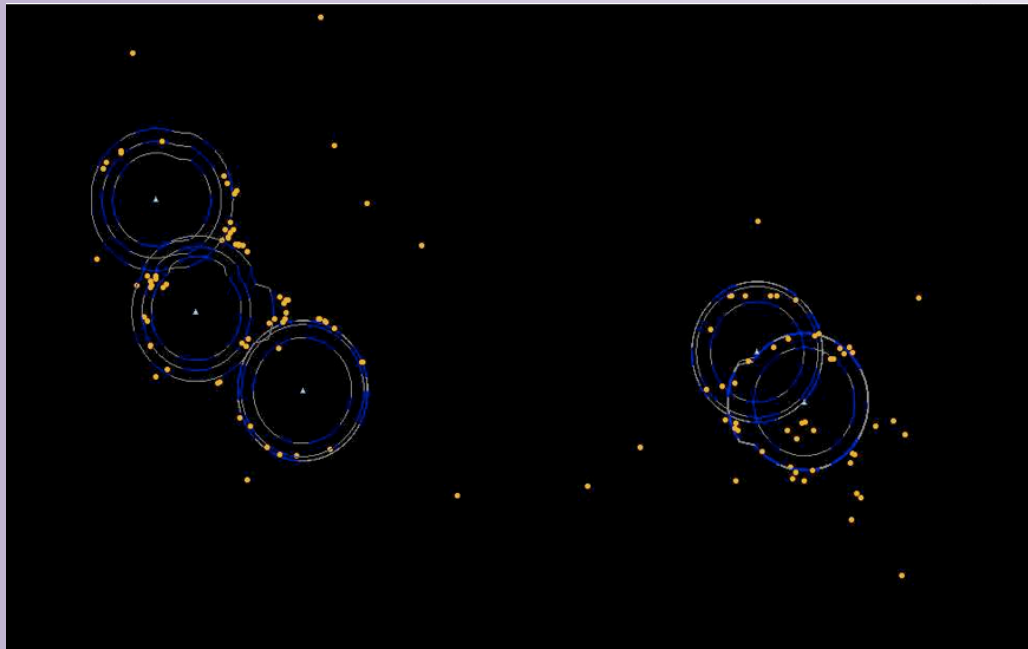
Modules mounted on retractable platform to reduce damage during LHC fill.

Platform accurate to $10\ \mu\text{m}$ at 21°C

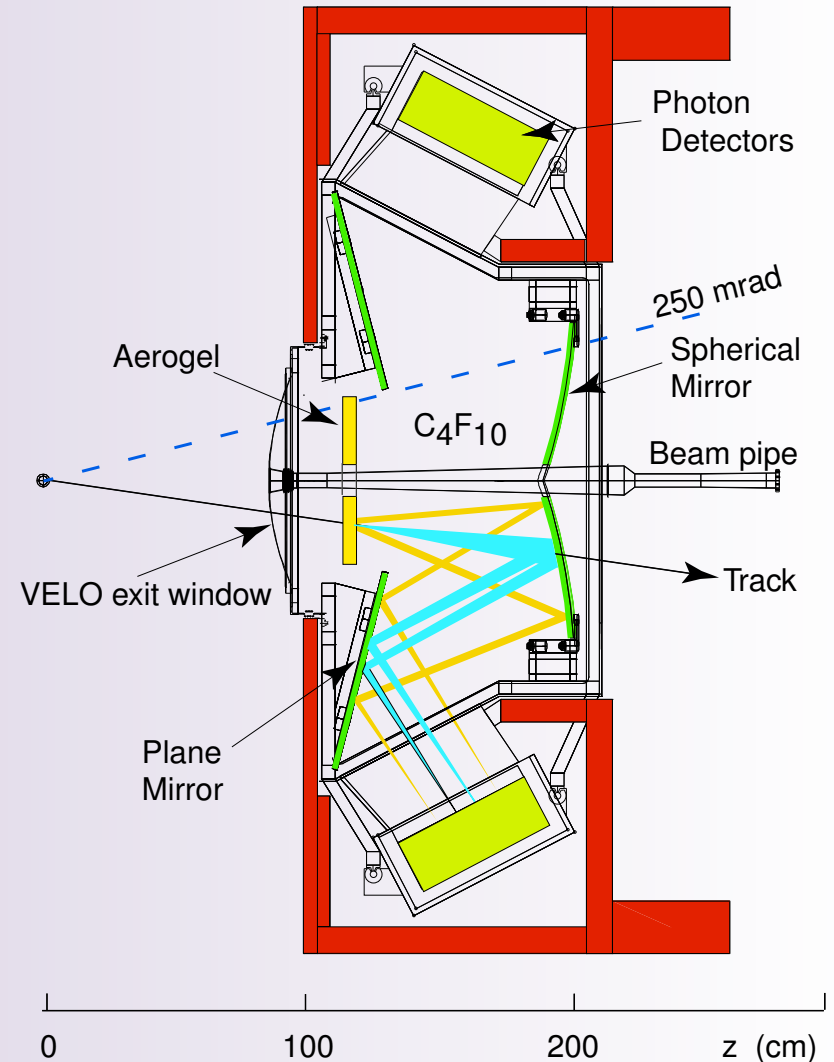
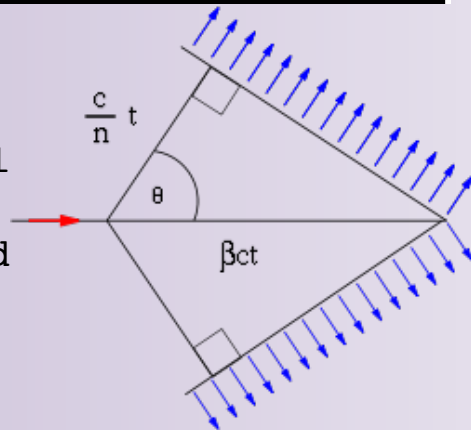


Particle Identification

PID mainly achieved through the two RICHes
 Using track as seeds, rings centered on the
 tracks are found and a particle likelihood
 is assigned for each track hypothesis.

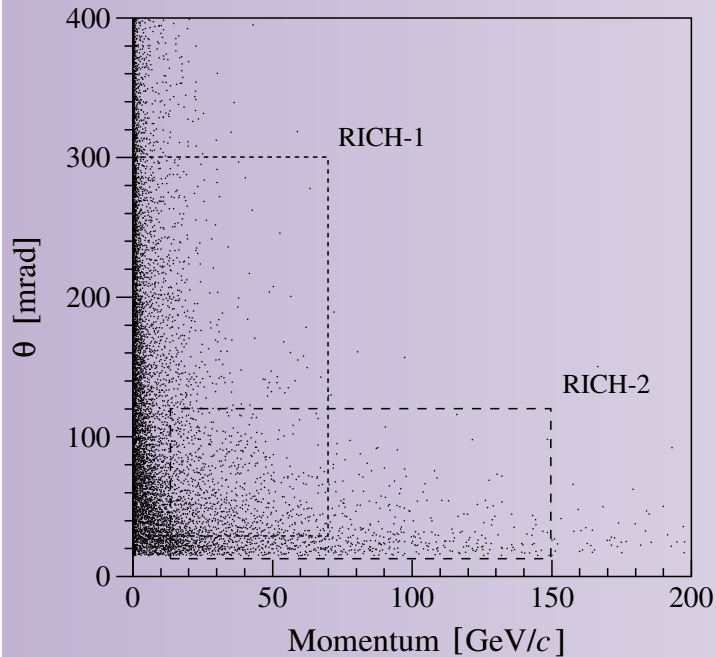


Cone formed by superluminal
 particles in the radiator.
 Rings formed when projected
 onto the detector plane.



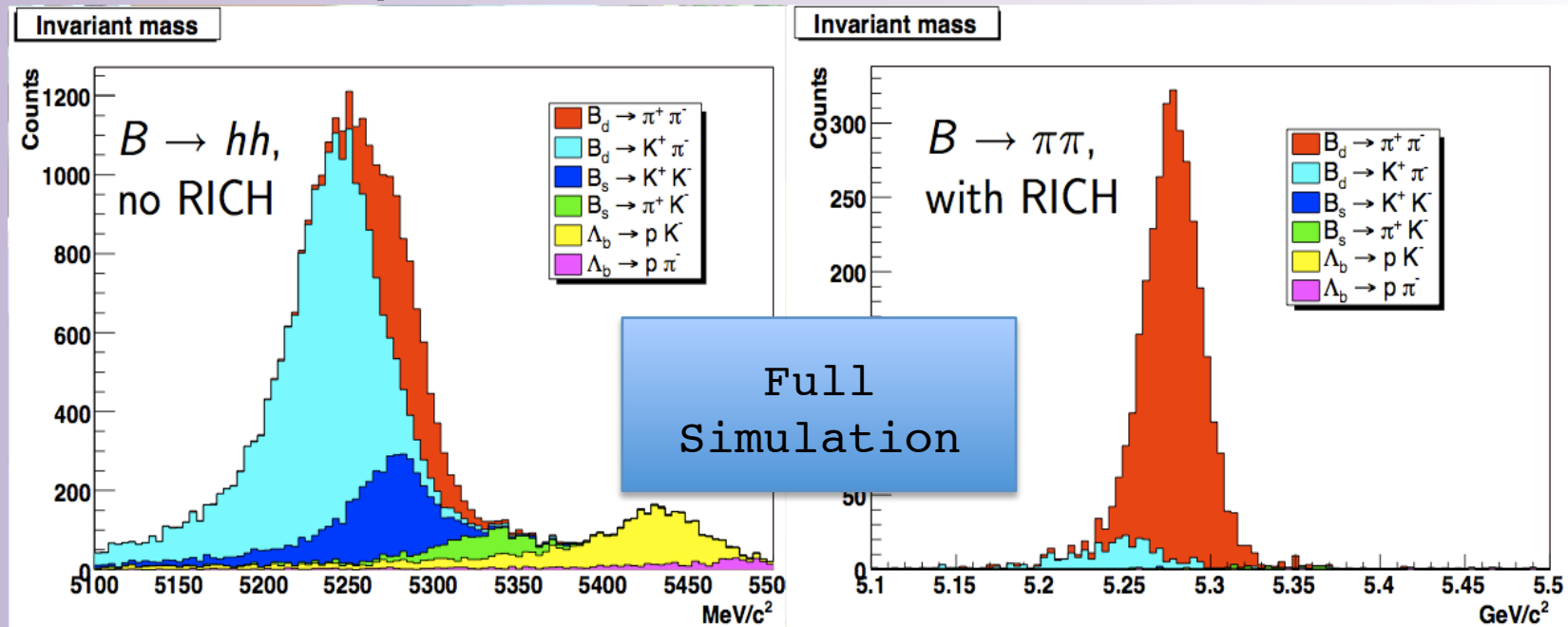
In other words, we can
 calculate the speed of a
 particle once we've measured
 the diameter of the ring.⁹

RICHes



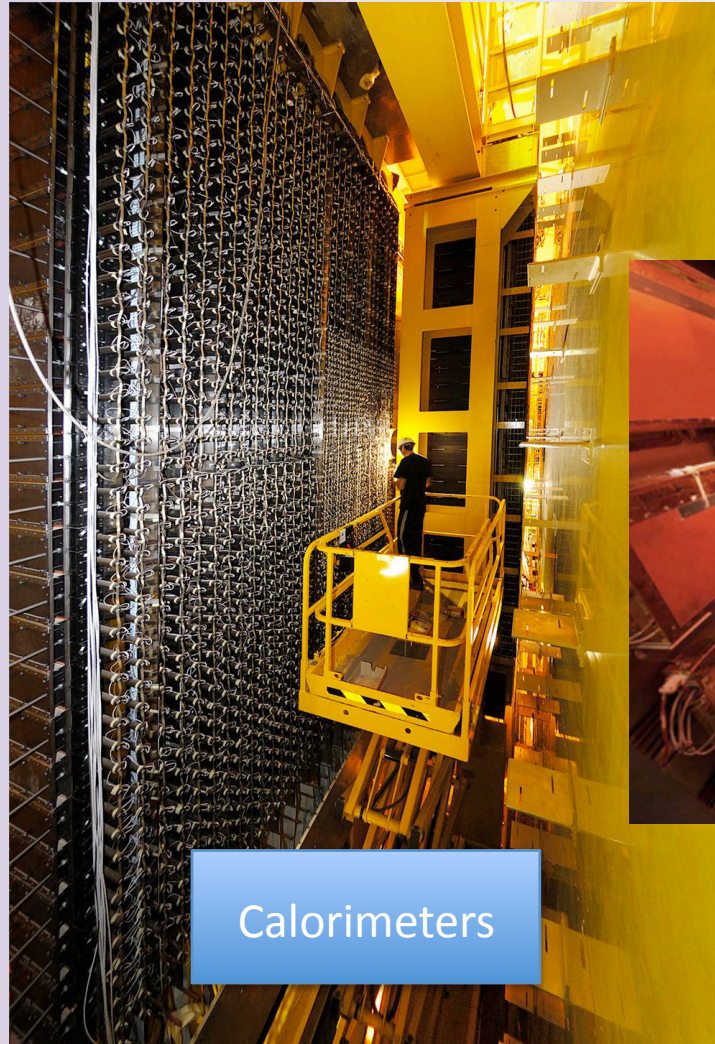
- Two RICHes cover most of the expected phase space
- RICH 1 covers low-momentum particles
- RICH 2 covers high-momentum particles
- Using both RICHes LHCb can achieve excellent Particle Identification.

$B \rightarrow hh$ selection, showing effect of RICH to ID Pions.





Trackers



Calorimeters



Muons

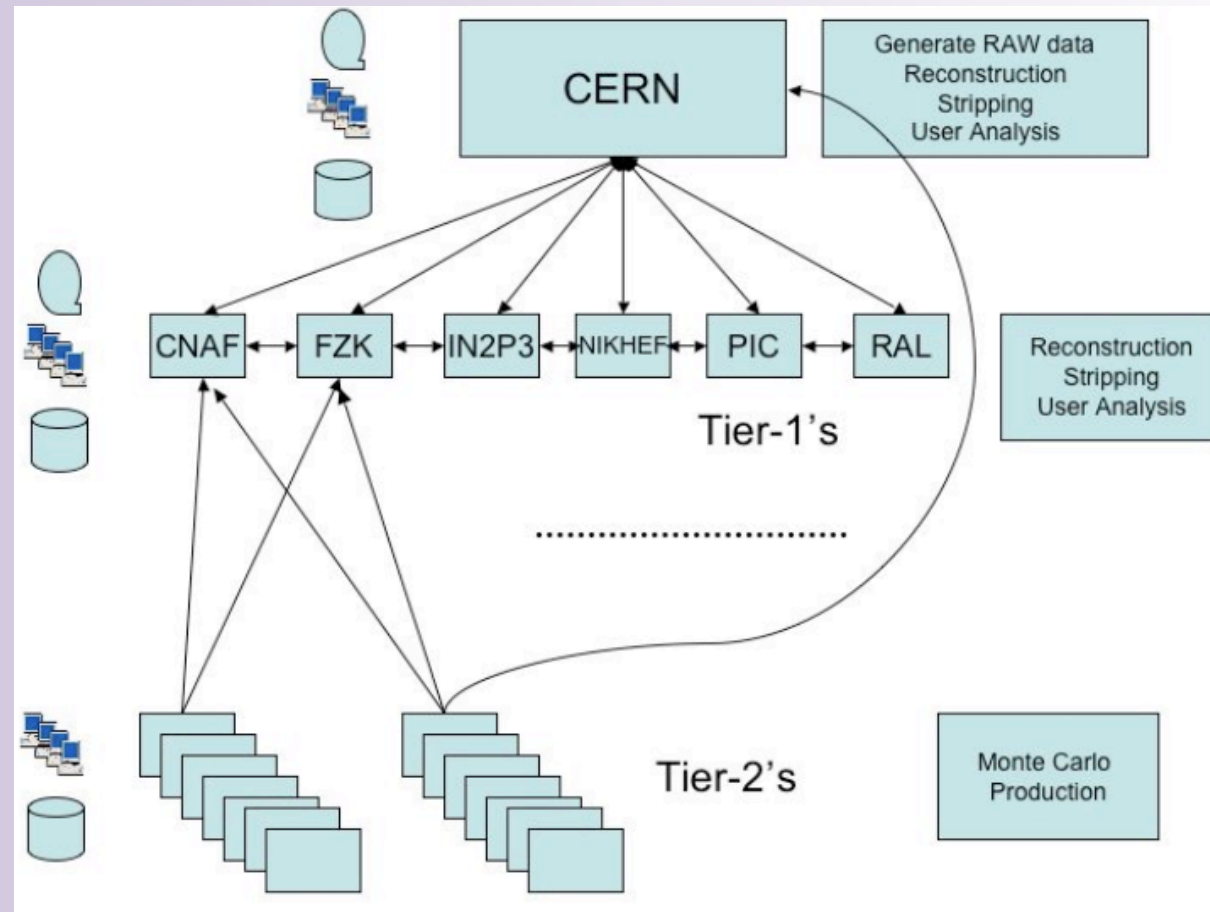
LHCb Computing Model

Tier1 sites perform:

- Reconstruction
- Stripping
- User-Analysis

Tier 2 sites, such as CSCS are used for:

- MC Production
- Some User-Analysis

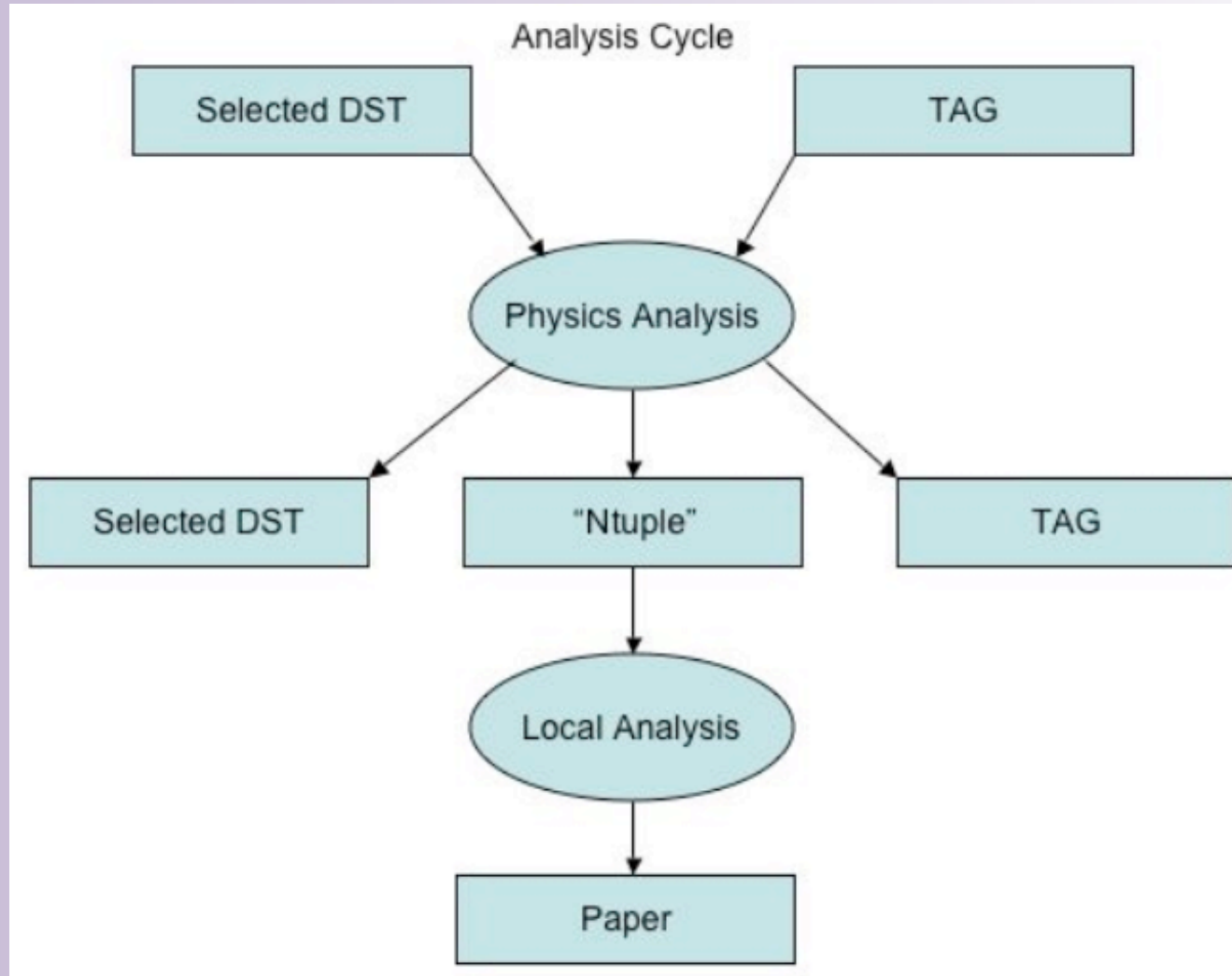


Don't worry, MC data will be required throughout the lifetime of the experiment. ;)

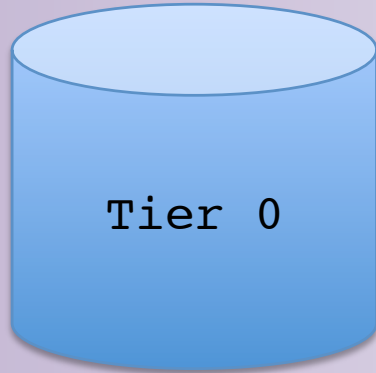
LHCb requires 23 Tb spread across all Tier2 sites for stripped DST storage.

This may change if many users wish to use Tier2 sites for analysis. 12

LHCb Physicist Analysis Cycle

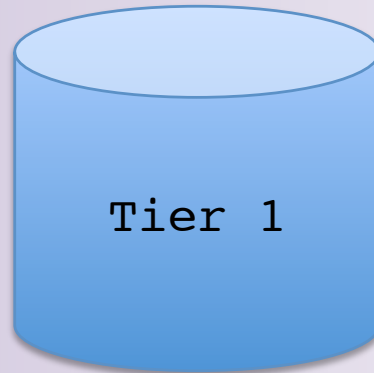


Flags used in the talk



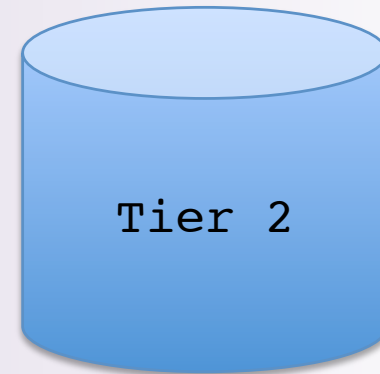
Tier 0

CERN.ch



Tier 1

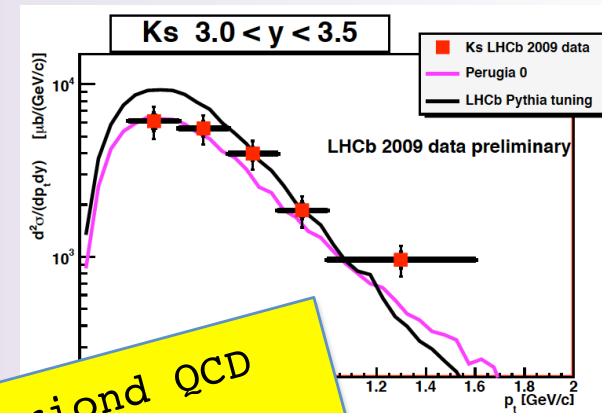
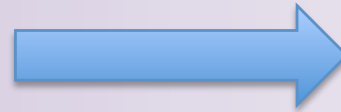
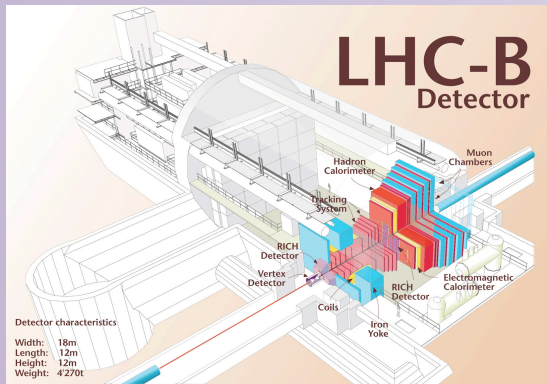
CNAF.it
CERN.ch
GridKa.de
Nikhef.nl
RAL.uk
in2p3.fr



Tier 2

CSCS.ch ;-)

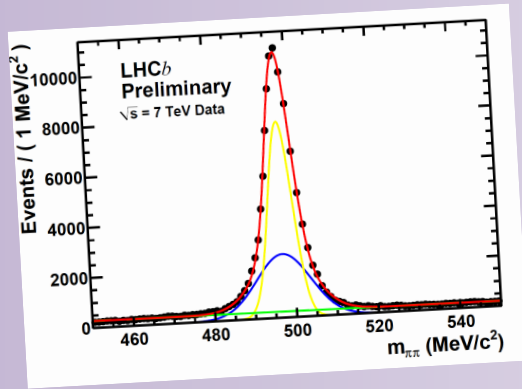
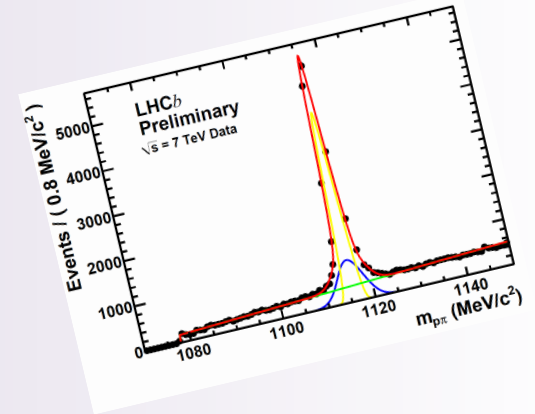
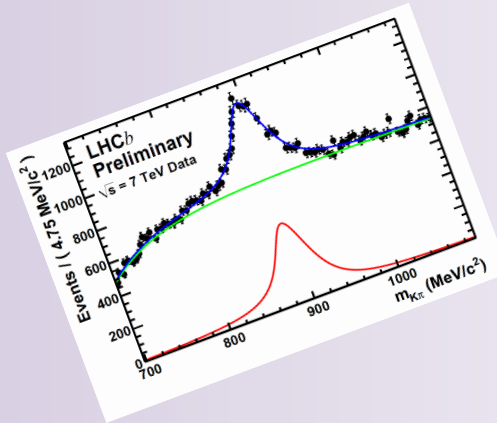
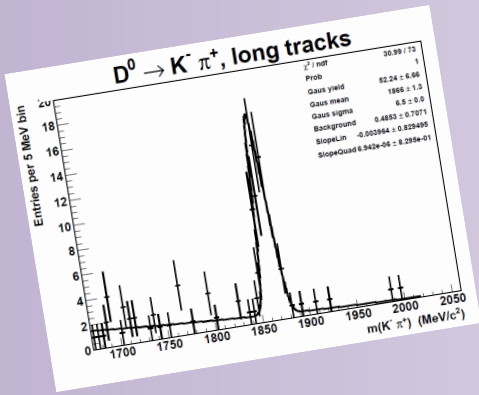
From submitting jobs to getting a publication



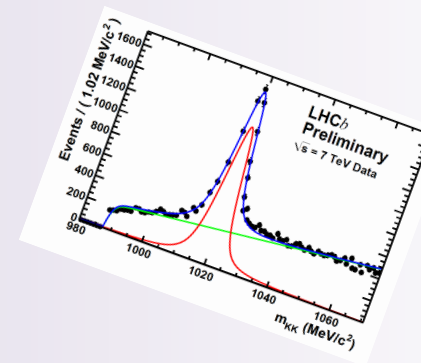
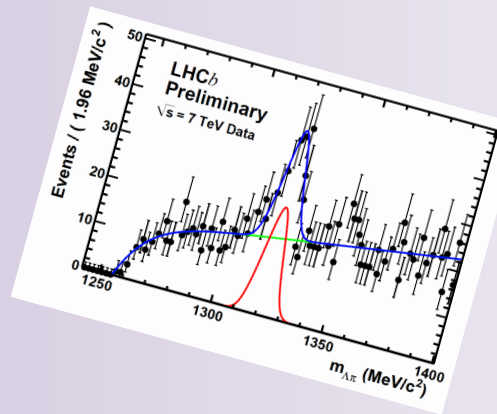
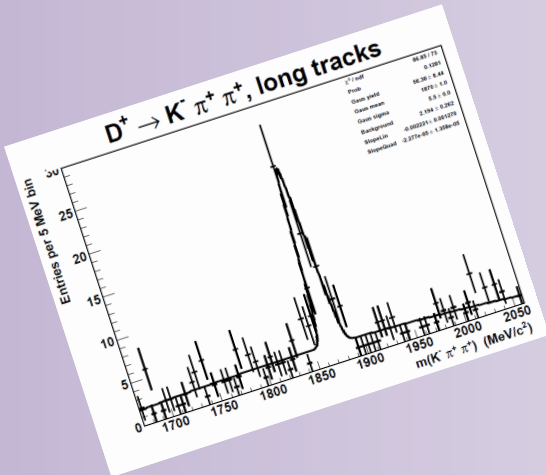
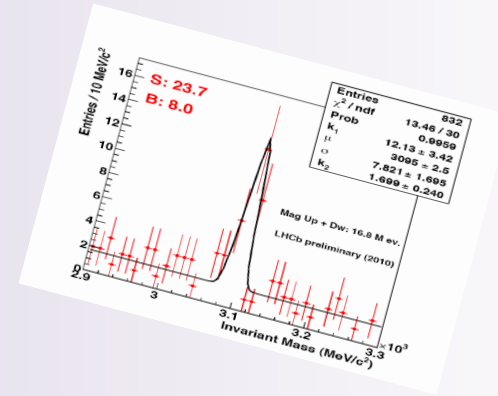
Moriond QCD 2010

K_s cross section measurement at 900 GeV

LHCb propaganda !

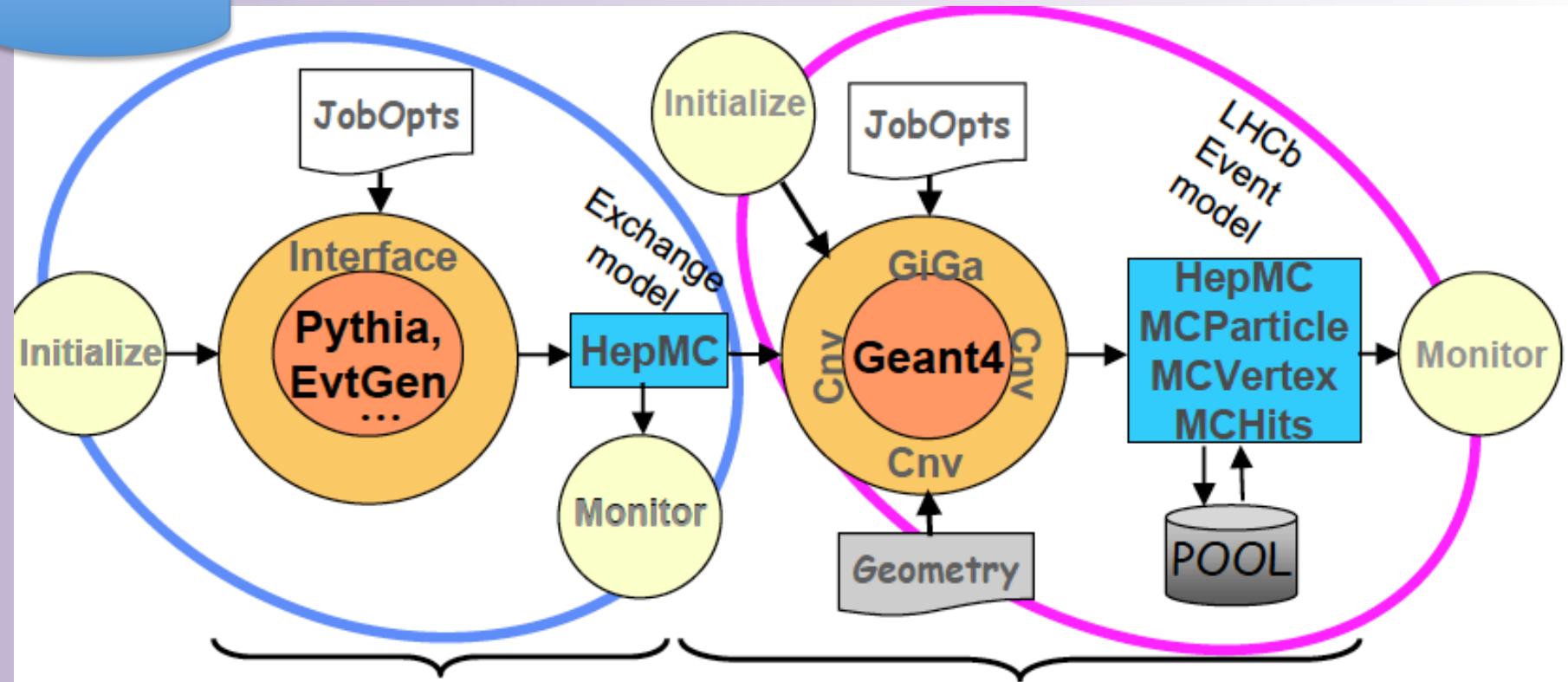


7TeV



Tier 1,2

Analysis Preparation



Event Generation
 primary event generator
 specialized decay package
 pile-up generation

Detector Simulation
 geometry of the detector (LHCb → Geant4)
 tracking through materials (Geant4)
 hit creation and MC truth information (Geant4 → LHCb)

Analysis Preparation



Systems Jobs Production Data Web Help

Registered Production Requests **Edit request 111**

Request

Name: F WG: inclusive Lambda_c
Type: Simulation State: New
Priority: 2b Author: phicharp

Simulation Conditions(ID: 61833)

Description: Beam5TeV-VeloClosed-MagDown-Nu1

Beam: beta* = 2 m, crossingAngle = 329 Magnetic field: -1
Beam energy: 5 TeV Detector: VeloClosed
Generator: Pythia Luminosity: nu = 1, bunch spacing >

Processing Pass (not registered yet)

Description: MC09-Sim04Reco02-withTruth

Step 1

Application: Gauss v37r3p1 CondDB: sim-20090402-vc-md100
Option files: \$APPCONFIGOPTS/Gauss/MC09-b5TeV-md DDDDB: MC09-20090602
Extra packages: AppConfig.v3r0

Step 2

Application: Boole v18r1 CondDB: sim-20090402-vc-md100
Option files: \$APPCONFIGOPTS/Boole/MC09-WithTruth DDDDB: MC09-20090602
Extra packages: AppConfig.v3r0

Step 3

Application: Brunel v34r7 CondDB: sim-20090402-vc-md100
Option files: \$APPCONFIGOPTS/Brunel/MC09-WithTruth DDDDB: MC09-20090602

Event

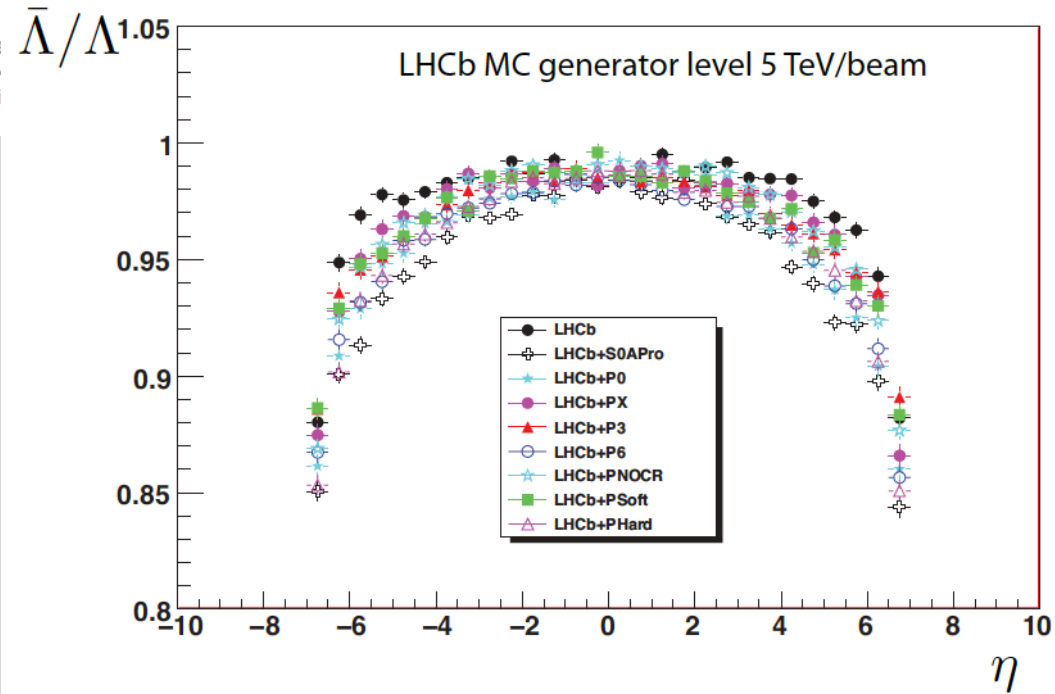
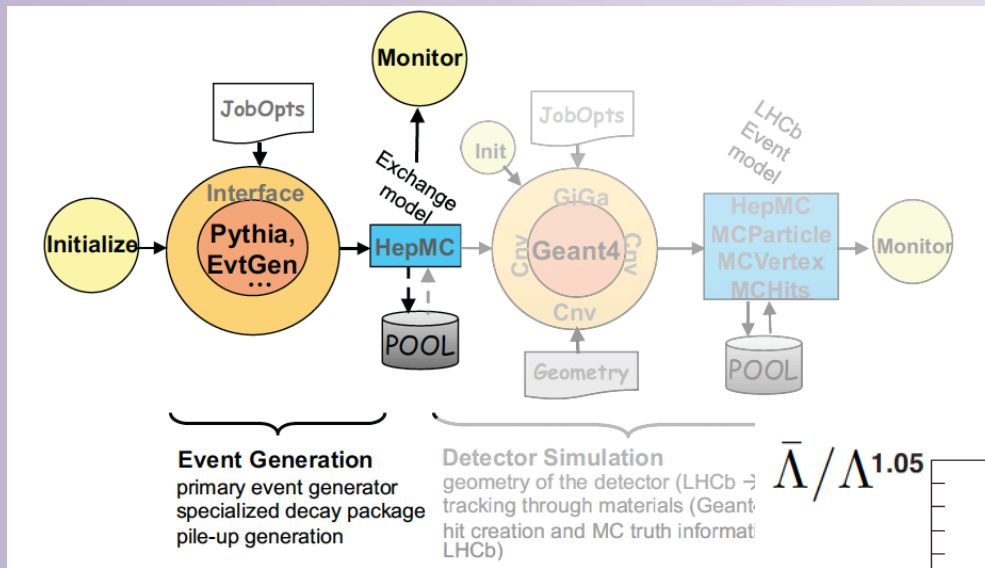
Type: Select event type (i
Number:

Comments

Requested by Raluca
Pending release of new DecFile

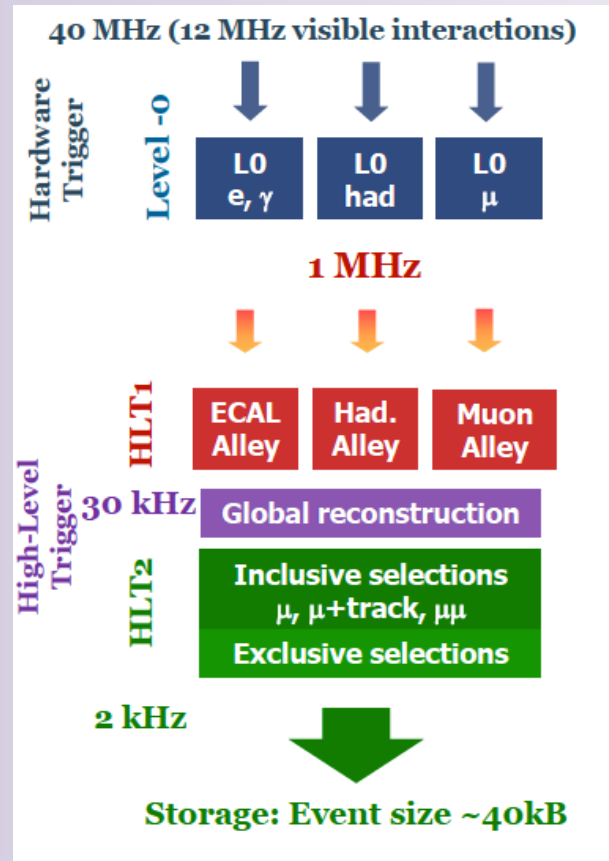
Central production requested by Physics Working Groups

Monte Carlo Tuning



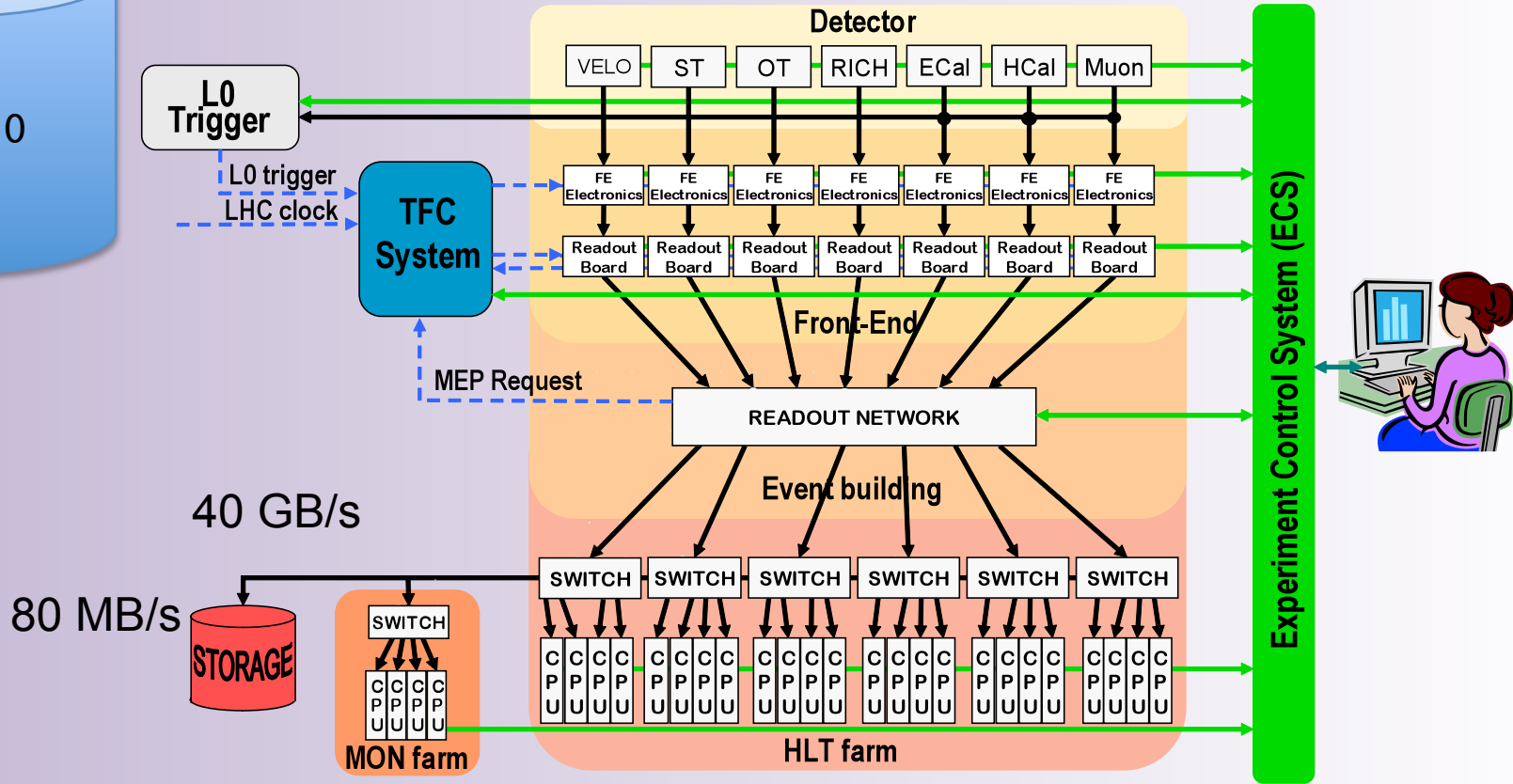
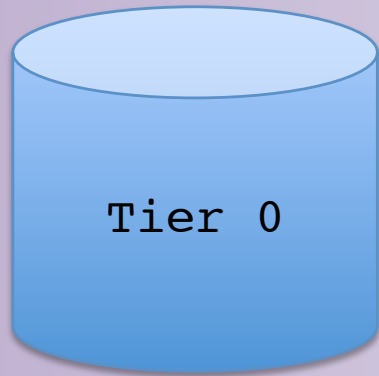
Trigger

Data reduction



Fundamental for a
Hadronic experiment!

Data Acquisition

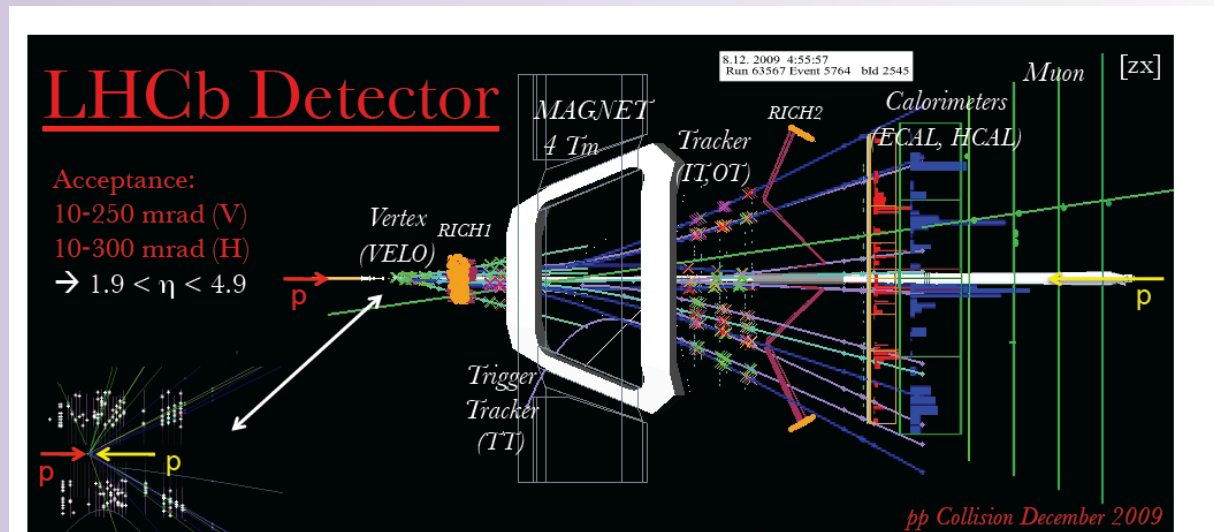


- Event data
- - - Timing and Fast Control Signals
- Control and Monitoring data

Average event size 40 kB
 Average rate into farm 1 MHz
 Average rate to tape 2 kHz



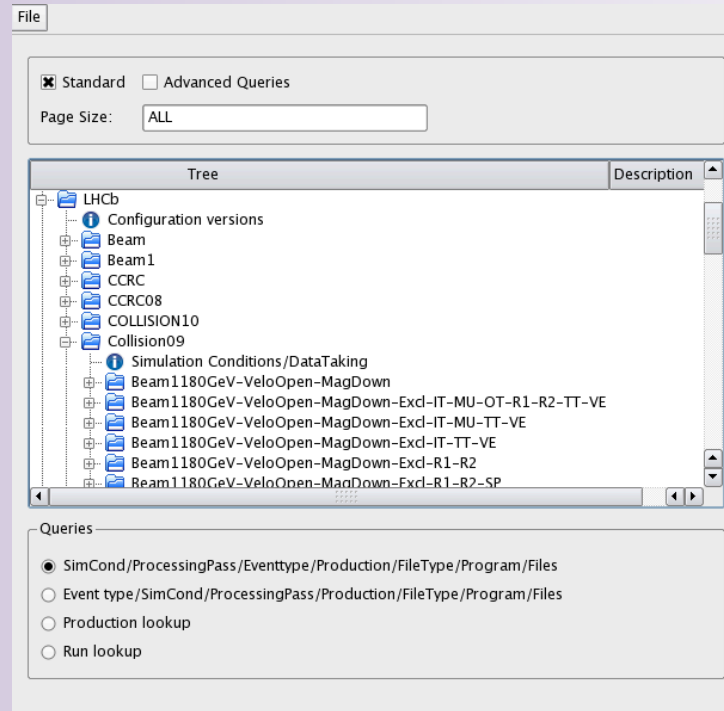
Event Reconstruction



- First reconstruction done in the pit.
- Data are sent to CERN.
- Register in a File Catalog (LFC)
- Replicas are sent to Tier 1 (CNAF.it ...)



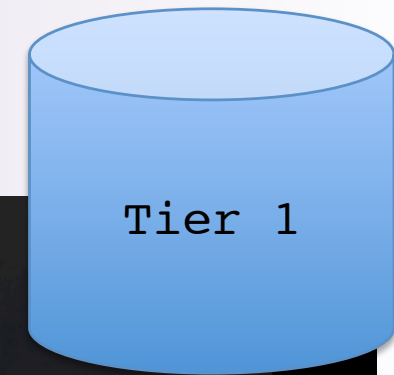
Accessing the data -bookkeeping-



The user selects a specific production via the web interface or a gui.

Requires a grid Certificate

In Practice..



```
#-- GAUDI jobOptions generated on Thu Apr 15 09:36:47 2010
#-- Contains event types :
#-- 90000000 - 1 files - 64179 events - 3.06 GBytes

from Gaudi.Configuration import *

EventSelector().Input = [
#run 63949
" DATAFILE='LFN:/lhcb/data/2009/DST/00006296/0000/00006296_00000002_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
#run 63915
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000066_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000067_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
#run 63814
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000065_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
#run 63813
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000057_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000058_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000059_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000060_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000061_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000062_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
" DATAFILE='LFN:/lhcb/data/2009/DST/00006282/0000/00006282_00000063_1.dst' TYP='POOL_ROOTTREE' OPT='READ' ",
```

Logical File Name : The jobs can run anywhere

Submitting Jobs via Dirac

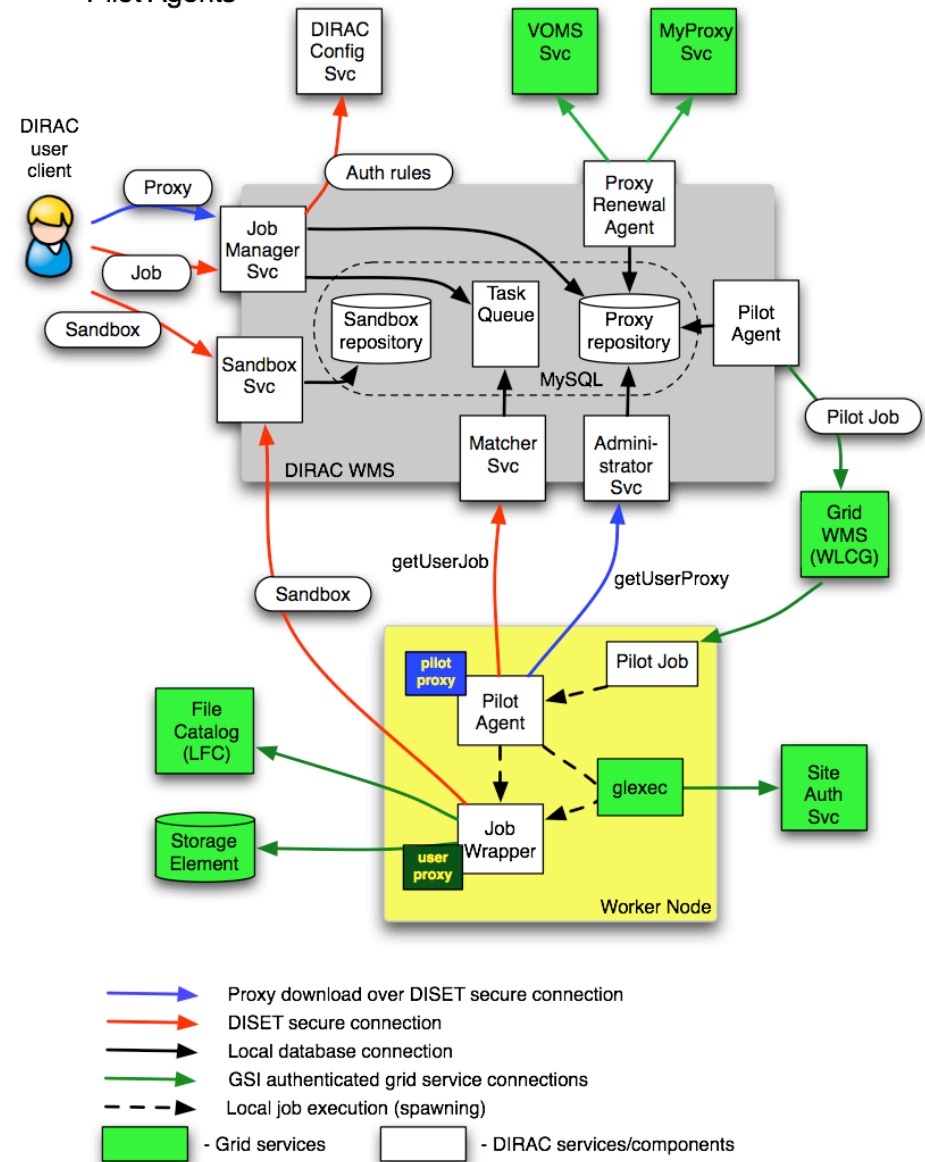
❑ Late job binding

- A job is fetched only when all is OK
 - Software and data present
 - Site capabilities matching

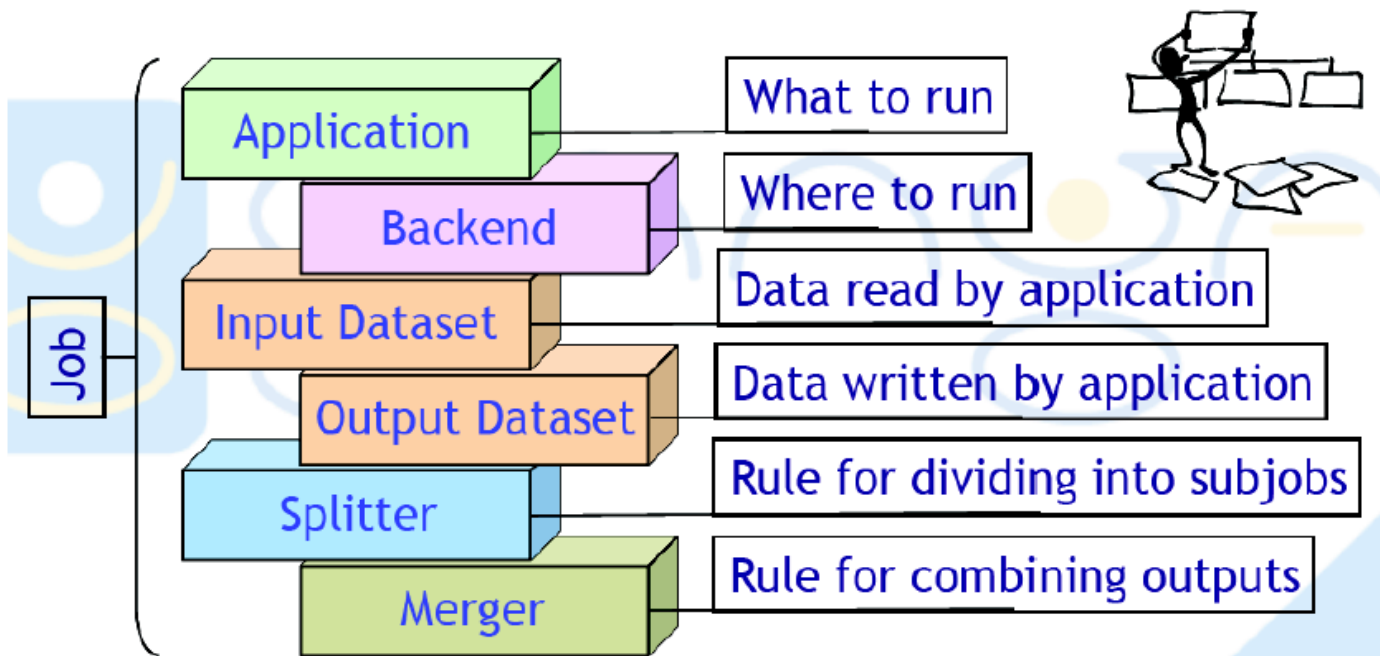
❑ Apply priorities centrally

- No site intervention
- Users and production jobs mixed

DIRAC WMS with generic Pilot Agents



From the user perspective



From the user perspective (bis...)



Job Create/Submit

```
[In:] j = Job()
[In:] j.application = Executable(exe='/bin/hostname')
[In:] j.name = "MyTest"
[In:] print j
[In:] j.submit()

# wait until job is completed and look
# at the output directory

[In:] j.status
[In:] j.peek()
[In:] j.peek('stdout')

# The syntax for peek is very flexible see
[In:] help(j.peek)
```

Job Monitoring

Selected setup: LHCb-Production

Reschedule Kill Delete

JobId	Status	MinorStatus	ApplicationStatus	Site	JobName	LastUpdate [UTC]	LastSignOfLife [UT]	Submission
7919449	Done	Execution Complet	gaudi-script.py (Da	LCG.CERN.ch	1209__(Ganga_Da	2010-04-26 15:44	2010-04-26 15:44	2010-04-2
7919448	Done	Execution Complet	gaudi-script.py (Da	LCG.CNAF.it	1209__(Ganga_Da	2010-04-26 15:42	2010-04-26 15:42	2010-04-2
7919447	Done	Execution Complet	gaudi-script.py (Da	LCG.RAL.uk	1209__(Ganga_Da	2010-04-26 15:42	2010-04-26 15:42	2010-04-2
7919446	Done	Execution Complet	gaudi-script.py (Da	LCG.CERN.ch	1209__(Ganga_Da	2010-04-26 15:43	2010-04-26 15:43	2010-04-2
7919445	Done	Execution Complet	gaudi-script.py (Da	LCG.CERN.ch	1209__(Ganga_Da	2010-04-26 15:42	2010-04-26 15:42	2010-04-2
7919444	Done	Execution Complet	gaudi-script.py (Da	LCG.CERN.ch	1209__(Ganga_Da	2010-04-26 15:45	2010-04-26 15:45	2010-04-2
7919443	Done	Execution Complet	gaudi-script.py (Da	LCG.GRIDKA.de	1209__(Ganga_Da	2010-04-26 15:41	2010-04-26 15:41	2010-04-2
7919442	Done	Execution Complet	gaudi-script.py (Da	LCG.CERN.ch	1209__(Ganga_Da	2010-04-26 15:42	2010-04-26 15:42	2010-04-2
7919441	Done	Execution Complet	gaudi-script.py (Da	LCG.GRIDKA.de	1209__(Ganga_Da	2010-04-26 15:45	2010-04-26 15:45	2010-04-2
7919440	Done	Execution Complet	gaudi-script.py (Da	LCG.CERN.ch	1209__(Ganga_Da	2010-04-26 15:40	2010-04-26 15:40	2010-04-2
7919397	Done	Execution Complet	gaudi-script.py (Da	LCG.CERN.ch	1309__(Ganga_Da	2010-04-26 15:46	2010-04-26 15:46	2010-04-2
7919394	Done	Execution Complet	gaudi-script.py (Da	LCG.GRIDKA.de	1309__(Ganga_Da	2010-04-26 15:43	2010-04-26 15:43	2010-04-2
7919391	Done	Execution Complet	gaudi-script.py (Da	LCG.GRIDKA.de	1309__(Ganga_Da	2010-04-26 15:45	2010-04-26 15:45	2010-04-2
7919388	Done	Execution Complet	gaudi-script.py (Da	LCG.GRIDKA.de	1309__(Ganga_Da	2010-04-26 15:41	2010-04-26 15:41	2010-04-2
7919385	Done	Execution Complet	gaudi-script.py (Da	LCG.GRIDKA.de	1309__(Ganga_Da	2010-04-26 15:42	2010-04-26 15:42	2010-04-2
7919382	Done	Execution Complet	gaudi-script.py (Da	LCG.CNAF.it	1309__(Ganga_Da	2010-04-26 15:39	2010-04-26 15:39	2010-04-2
7919380	Done	Execution Complet	gaudi-script.py (Da	LCG.CNAF.it	1309__(Ganga_Da	2010-04-26 15:39	2010-04-26 15:39	2010-04-2

Page 1 of 9 Items displaying per page: 25 Displaying 1 - 25 of 223

yamhis@lhcb (/DC=ch/DC=cern/OU=Organic Units/OU=Users/CN=yamhis/CN=644299/CN=Yasmine Sara Amhis)

Certificate loaded in the browser

Need to strip data

The image shows a screenshot of a data management interface with a tree view and a description column. The tree view is organized as follows:

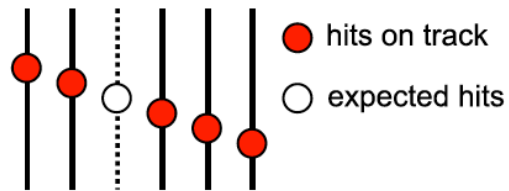
Tree	Description
Event types	
90000000	Full stream
File types	
BHADRON.DST	
BRUNELHIST	
CALIBRATION.DST	
CHARM.DST	
DAVINCIHIST	
DIELECTRON.DST	
DIMUON.DST	
DIPHOTONDIMUON.DST	
DST	
EW.DST	
MINIBIAS.DST	
RADIATIVE.DST	
RDST	
SEMILEPTONIC.DST	
V0.DST	
91000000	Express stream
Collision09	
Collision10	
Cosmics	
Physics	

A blue oval highlights the group of file types from 'DST' to 'V0.DST'. To the right of the interface is a blue cylinder labeled 'Tier 1'. At the bottom of the interface, the path 'SimCond/ProcessingPass/Eventtype/Production/FileType/Program/Files' is visible.

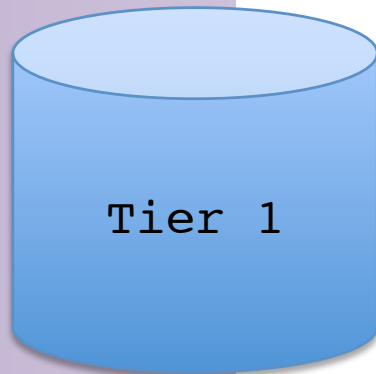
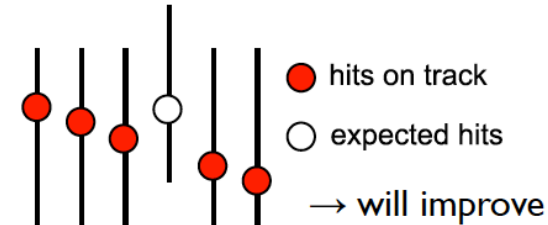
Users run their jobs on specific streams

Data Reprocessing

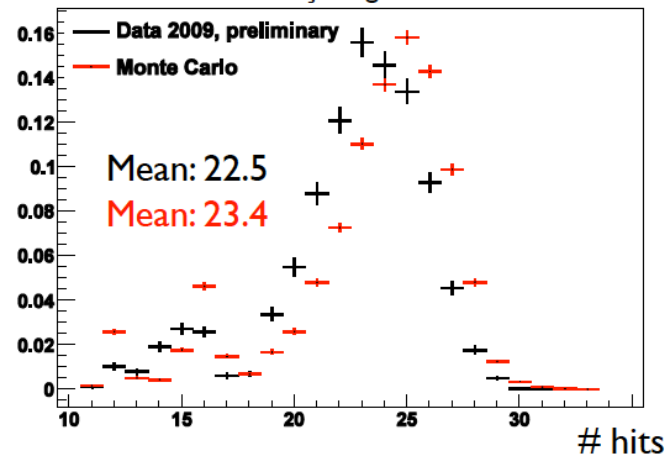
Dead channels (<1.0%)



▶ Misalignment / Calibration

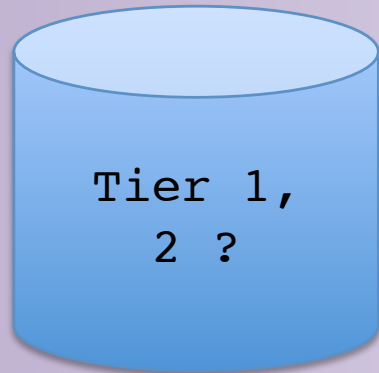


Number of hits on K_S daughter tracks:



Data reprocessed after
changes/improvements to the reconstruction

Micro-dst (next step)

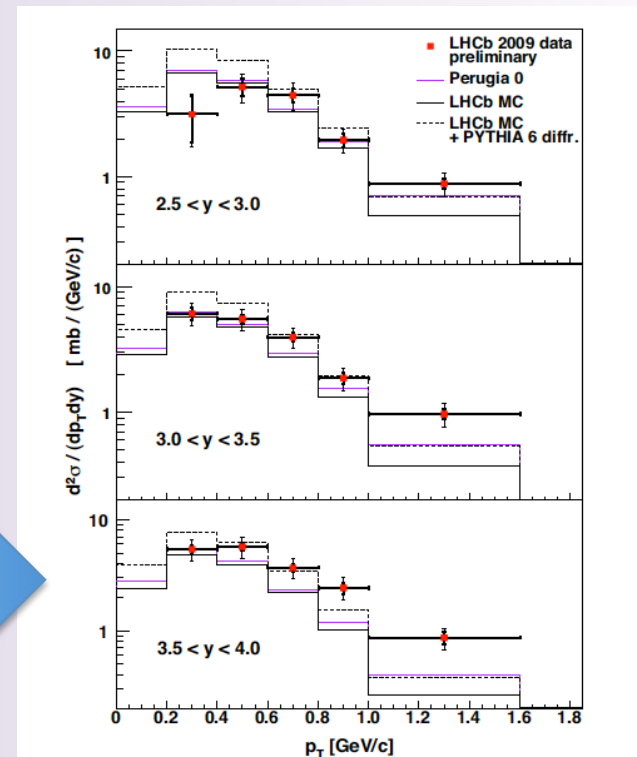
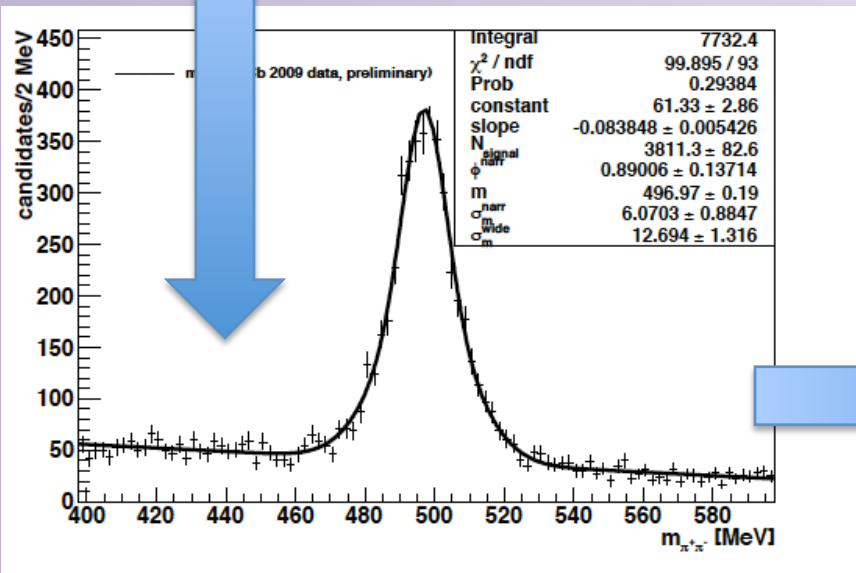


- Reduce more the data sets.
- Files shared within a physics working group.
- Files put in the Catalog and accessible via the grid.

Do the analysis


Variable	Requirement
Each π momentum	$> 2 \text{ GeV}/c$
Each π transverse momentum	$> 50 \text{ MeV}/c$
Each track χ^2/ndf	< 25
Each π impact parameter w.r.t. PV	$> 3 \text{ mm}$
K_S^0 decay vertex χ^2/ndf	< 25
z of K_S^0 decay vertex	$< 2200 \text{ mm}$
$ z $ of PV	$< 150 \text{ mm}$
$\cos \theta_{\text{pointing}}$	> 0.99995
$K_S^0 c\tau$	$> 5 \text{ mm}$

$$\sigma_i = \frac{N_i^{\text{obs}}}{\epsilon_i \times L_{\text{int}}}$$



Conclusion

- ✓ LHCb is FINALLY taking data.
- ✓ Detector commissioning.
- ✓ Reconstruction chain.
- ✓ Data efficiently processed and analysed with grid tools.
- ✓ First physics results.



LHCb-CONF-2010-0xx
10 April 2010

Prompt K_S^0 production in pp collisions at $\sqrt{s} = 900$ GeV¹

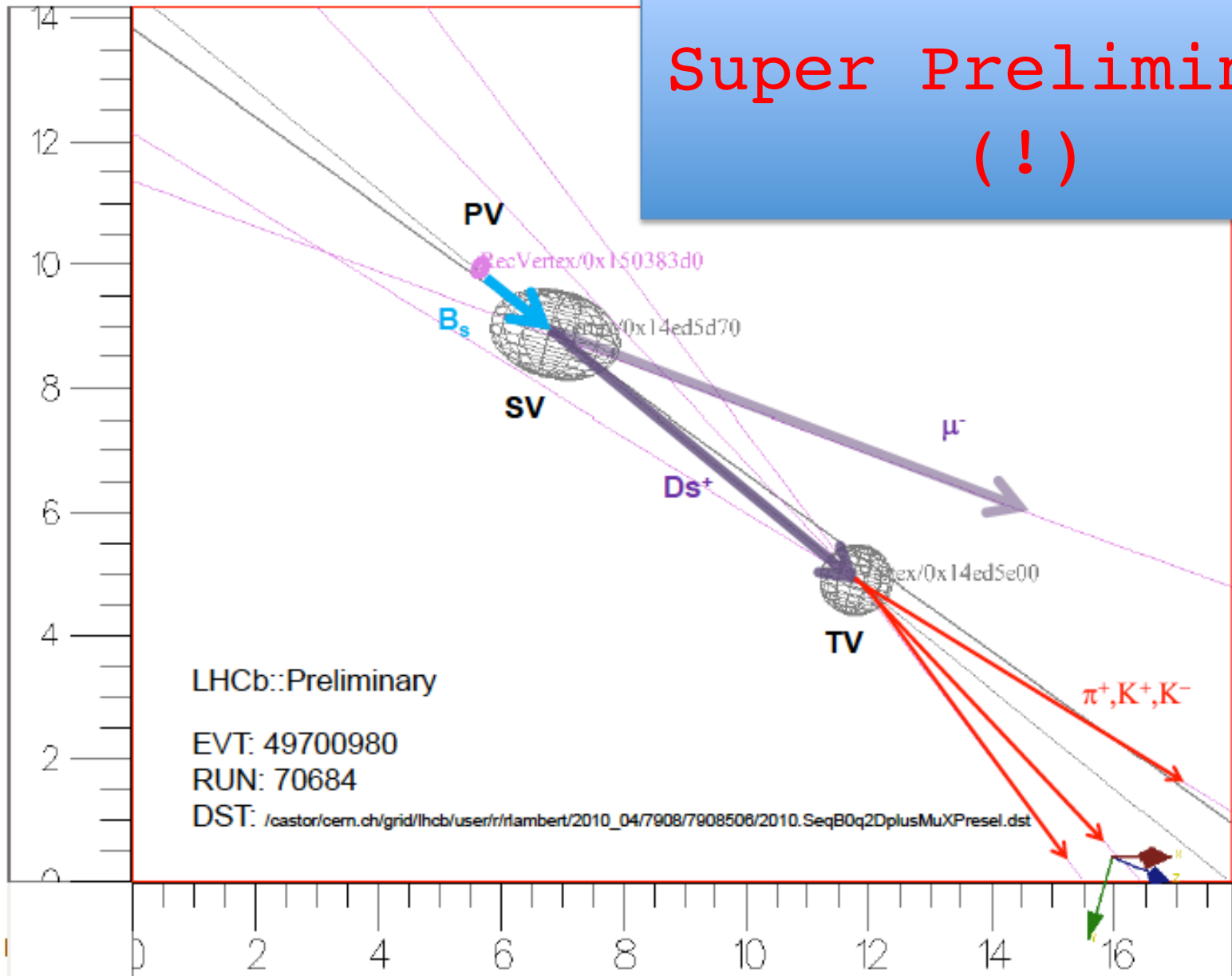
The LHCb Collaboration²

Abstract

The production of prompt K_S^0 mesons in inelastic pp collisions at a centre-of-mass energy of $\sqrt{s} = 900$ GeV is studied with the LHCb detector. The differential production cross section is measured as a function of the K_S^0 transverse momentum and rapidity in the region $0.2 < p_T < 1.6$ GeV/ c and $2.5 < y < 4.0$. The preliminary results are compared with specific tunings of the PYTHIA generator.

¹Conference contribution prepared for the Rencontres de Marland, QCD and High Energy Interactions, La Thuile, 13-20 March 2010.
²Contact author: Olivier Schneider.

Super Preliminary (!)



Backup slides



LHCb Physics

Assuming matter was created in equal amounts in the Big Bang, then we need some (CP violating) mechanism to change antimatter into matter.

CP violation requires, in general, particle interactions with complex phases.

Such interactions are only found in weak processes in the SM: flavour transitions

The link between the down-type quark mass eigenstates and the SU(2) partners of the up-type quarks is given by the CKM matrix, V .

Up to order λ^3 in the Wolfenstein parameterisation, the CKM matrix is as follows:

$$\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \cong \begin{pmatrix} 1 - \lambda^2/2 & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1 - \lambda^2/2 & A\lambda^2 \\ A\lambda^3(1 - \rho - i\eta) & -A\lambda^2 & 1 \end{pmatrix} + \delta V.$$

