

Status of the LHCb experiment

*Andrei Golutvin (Imperial & ITEP & CERN)
On behalf of the LHCb collaboration*

Outline:

- *Introduction*
- *Detector Subsystems*
- *Experimental Area*
- *Commissioning*
- *Cost and funding issues*
- *Collaboration matters*



- ❑ *For all sub-detectors >95% channels are working*
- ❑ *Calo and Muon L0 is fully operational and heavily used during commissioning*
- ❑ *On line was fully operational for 2008 needs (currently readout at up to 70 kHz)
Completion of the installation is planned for spring 2009 to optimize
cost performance*
- ❑ *LHCb had run shifts (24 hours/7 days) since middle of August to September*

Beam Pipe (CERN)

23 m long beam pipe consisting of 3 Be and 1 stainless steel sections

- ❑ *Installation and commissioning completed in summer 2007*
- ❑ *The beam pipe was under vacuum since June (till November) 2008*

Beam Pipe with protection and two OT stations closed



Beam Pipe protection removed



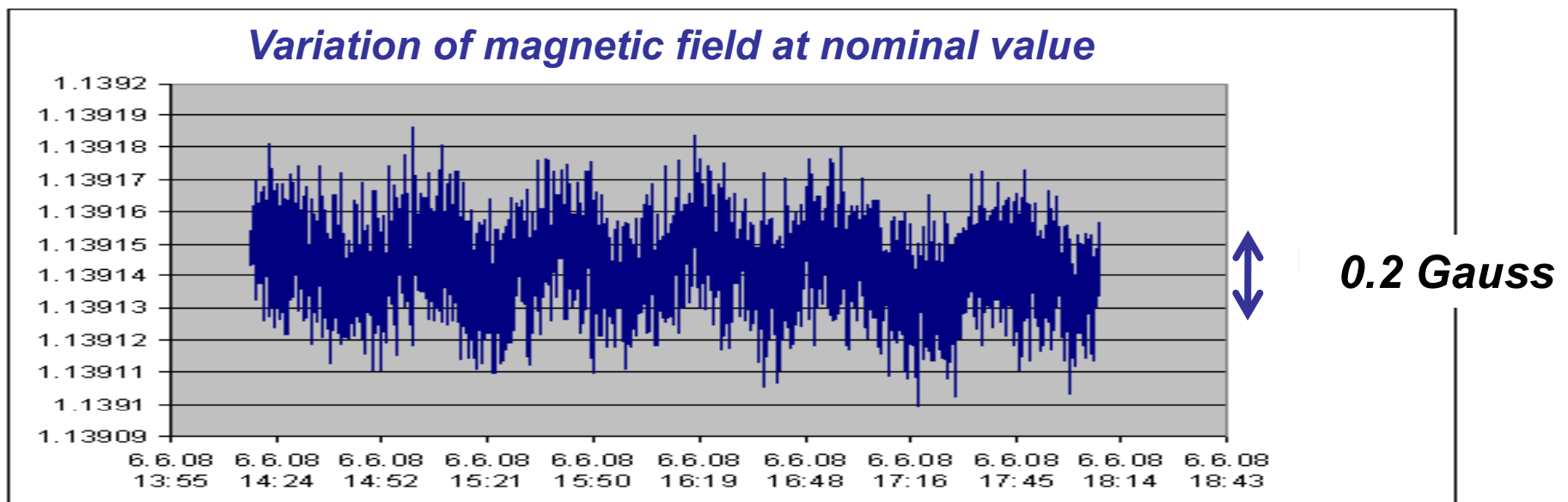
- ❑ *Identified leak fixed currently by varnishing. For long term a replacement of the third section has to be procured. Following discussions with potential manufacturers a tender for a replacement of UX85/3 Be beam pipe was launched*

Magnet (CF)

*Warm dipole magnet with 4 Tm bending power
along the beam axis*

- ❑ *Measured stability of magnetic field is well within specifications
Symmetry of the B-field between two polarities was measured to be better than 10^{-4} , a special demagnetizing cycle for switching polarities is not necessary*
- ❑ *The beam dump trigger, in case of magnet failure, has been tested together with the LHC operators*

Measured stability of the LHCb magnetic field (for both polarities)



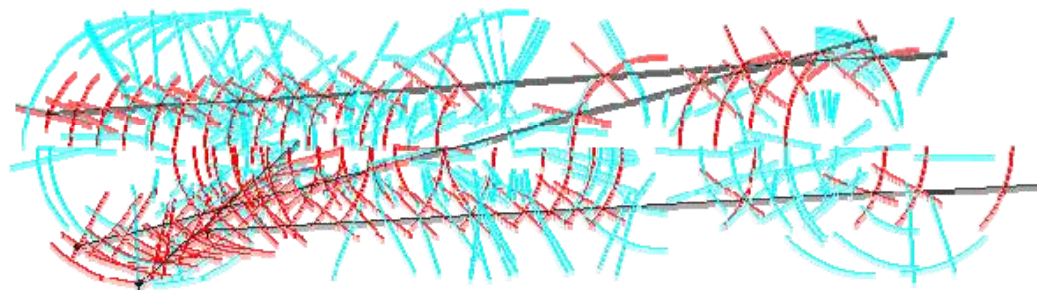
VERtex Locator (CH,DE,GB,NL)

2 21 pairs of Si sensors arranged in 2 halves; each pair consists of one sensor with R- and one sensor with ϕ -strips

- ❑ Since last RRB:
 - Both VELO halves independently commissioned
 - ✓ Total system noise as expected
 - CO2 cooling system fully commissioned
 - ✓ Operated under full load at -25 C
 - ✓ Setting point was -5 C for 2008 run
 - Minimizing effects of thermal cycling
- ❑ The HV and LV systems fully checked

- ❑ The VELO was able to record hits and reconstruct tracks during the beam synchronization tests in August 2008

24th August
Run 30933 Event 8
Full detector powered



ST: Trigger Tracker & Inner Tracker

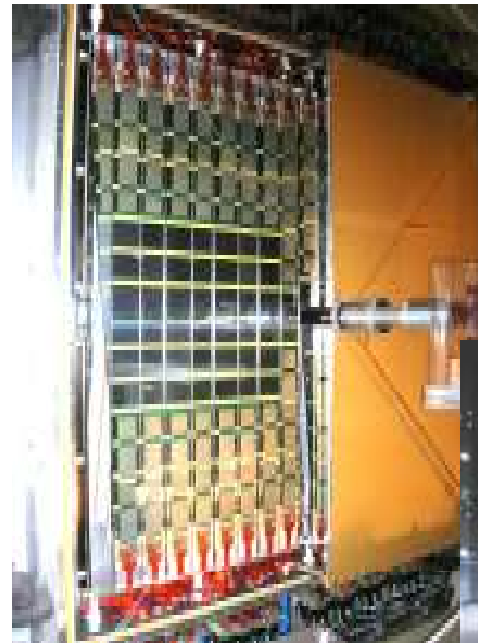
(CERN,CH,DE,ES,UA)

TT covers area of 1.4×1.2 m²; 4 stereo layers with ladders consisting of 3 or 4 chained Si-sensors with strip pitch 183 micron; 143k channels

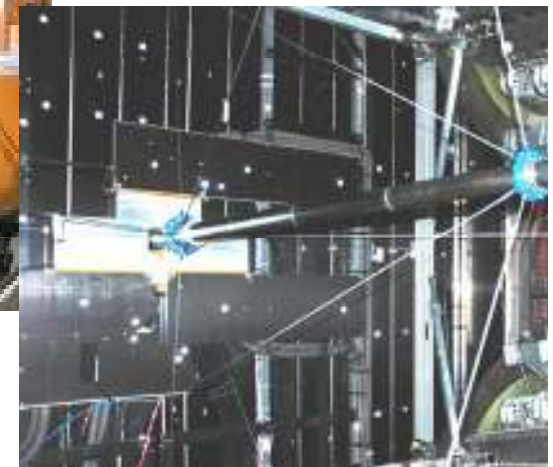
IT: 3 stations with 4 boxes each arranged around beam pipe; each box has 4 stereo layers x-u-v-x, modules with one or two chained Si-sensors; strip pitch 198 micron; 130k channels

TT

- All modules + service boxes installed*
- Detector surveyed with magnet on*
- Detector cooled to operating $T = 0^{\circ} \text{C}$*
- Currently 99% of TT and 97% of IT channels commissioned and operational*
- Remaining faults are mostly due to individual malfunctioning components In the Service Boxes close to the detectors; will be fixed in the coming weeks*



IT

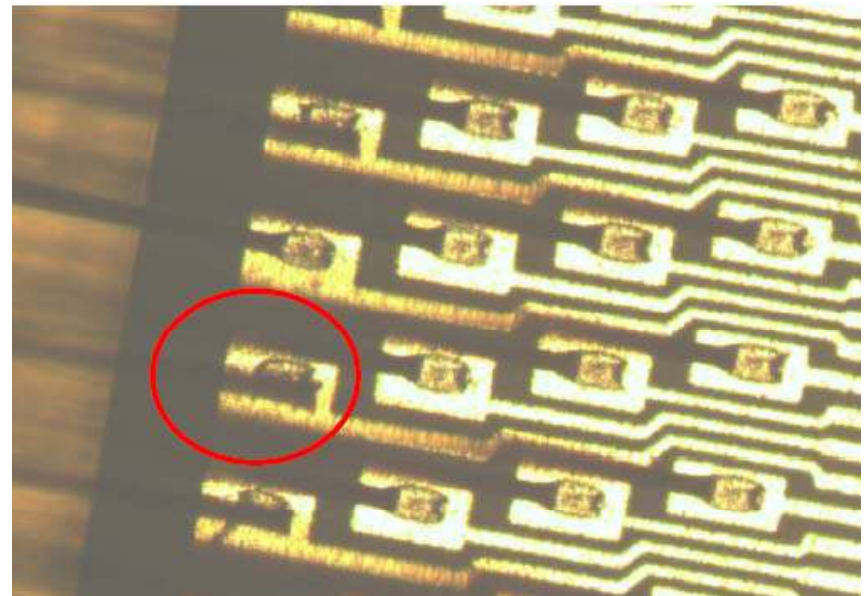


Silicon Tracker

- ❑ *Both TT and IT participated successfully in global commissioning*
- ❑ *Time alignment within a few ns and initial spatial alignment using LHC synchronization tests*

Concerns:

*A number of wire bonds have broken on 6 out of 280 TT FE readout hybrids
Production of further spares is being prepared (for the case if this spreads to other hybrids)*



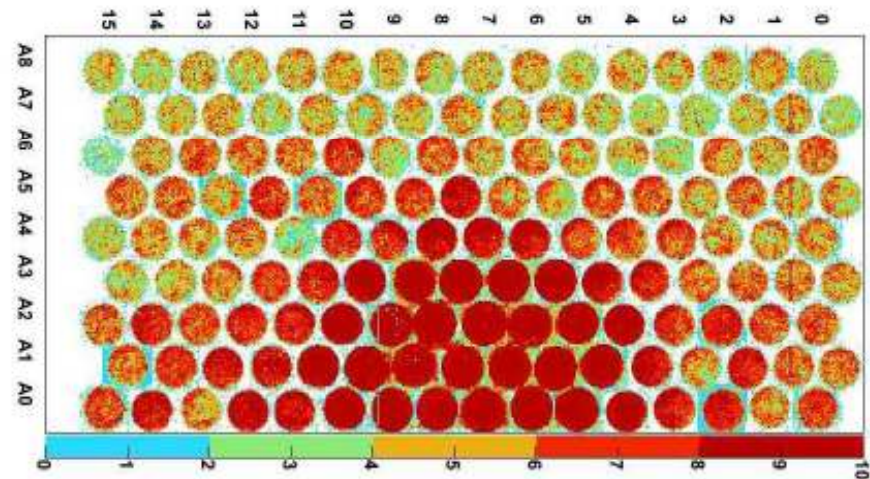
RICH (CERN,CF,GB,IT)

RICH1 and RICH2 with 3 radiators covers momentum range 2-100 GeV; RICH1: 5cm aerogel with $n=1.03$ & 4m^3 C4F10 with $n=1.0014$; RICH2: 100m^3 CF4 with $n=1.0005$; ~500 HPD to readout

- ❑ *Both RICH detectors are complete and routinely taking laser-pulsed and cosmic data.*
- ❑ *Internal timing of RICH system has been determined using pulsed laser light (<1 ns) piped onto HPDs by optical fibre. Coarse time alignment to the rest of LHCb has been achieved using LHC beam dumped onto the beam stopper (TED). Photon hits were observed with first circulating beams on Sept.10*

*Hits in one HPD plane of RICH2
(30 events from Beam 1 on collimator)*

Fine alignment still to be done



- ❑ *RICH calibration procedures are well advanced and waiting for final verification with collisions*

Global Commissioning

- ❑ *The muon and calorimeter triggers were used to get tracks and to perform initial alignment in time and space*
 - *VELO, TT, IT and OT were time aligned to a few nanoseconds*
Calorimeters and Muon were time aligned using cosmics
RICH was also time aligned (to ~15 ns)
 - *Initial spatial alignment indicated no major problem*
Resolution in the expected range
- ❑ *Now we are back to the commissioning with cosmics, fixing identified problems and preparing for an efficient 2009 run.*
Plan to restart global operations in April 2009

Physics: main objectives

Search for New Physics in CP-violation and Rare Decays

Key Measurements

Accuracy in 1 nominal year
(2 fb⁻¹)

□ In CP – violation

- ✓ ϕ_s **0.023**
- ✓ γ in trees 4.5°
- ✓ γ in loops 10°

□ In Rare Decays

- ✓ $B \rightarrow K^* \mu \mu$ $\sigma(s_0) = 0.5 \text{ GeV}^2$
- ✓ $B_s \rightarrow \mu \mu$ **3 σ measurement down to SM prediction**
- ✓ Polarization of photon
in radiative penguin decays $\sigma(A\Delta) = 0.2$ (in $B_s \rightarrow \phi \gamma$)

Physics: main objectives

Search for New Physics in CP-violation and Rare Decays

Key Measurements

Sensitivity with 10 fb^{-1}
(few years of data taking)

□ In CP – violation

- ✓ ϕ_s **0.01**
- ✓ γ in trees $2-3^\circ$
- ✓ γ in loops 5°

□ In Rare Decays

- ✓ $B \rightarrow K^* \mu \mu$ $\sigma(s_0) = 0.28 \text{ GeV}^2$
- ✓ $B_s \rightarrow \mu \mu$ **5σ measurement down to SM prediction**
- ✓ Polarization of photon
in radiative penguin decays $\sigma(A\Delta) = 0.09$ (in $B_s \rightarrow \phi \gamma$)

**If NP is discovered by LHCb with 10 fb^{-1} the NP models should be studied
Plan for LHCb upgrade to collect $\sim 100 \text{ fb}^{-1}$**

There are many observables where we are not limited by theoretical uncertainties

Expected LHCb sensitivities for 100 fb^{-1}

Observable	Sensitivity
$S(B_s \rightarrow \phi\phi)$	0.01 – 0.02
$S(B_d \rightarrow \phi K_S^0)$	0.025 – 0.035
$\phi_s (J/\psi\phi)$	0.003
$\sin(2\beta) (J/\psi K_S^0)$	0.003 – 0.010
$\gamma (B \rightarrow D^{(*)} K^{(*)})$	$< 1^\circ$
$\gamma (B_s \rightarrow D_s K)$	$1 - 2^\circ$
$\mathcal{B}(B_s \rightarrow \mu^+ \mu^-)$	5 – 10%
$\mathcal{B}(B_d \rightarrow \mu^+ \mu^-)$	3σ
$A_T^{(2)} (B \rightarrow K^{*0} \mu^+ \mu^-)$	0.05 – 0.06
$A_{\text{FB}} (B \rightarrow K^{*0} \mu^+ \mu^-) s_0$	0.07 GeV^2
$S(B_s \rightarrow \phi\gamma)$	0.016 – 0.025
$A^{\Delta\Gamma_s} (B_s \rightarrow \phi\gamma)$	0.030 – 0.050
charm x'^2	2×10^{-5}
mixing y'	2.8×10^{-4}
CP y_{CP}	1.5×10^{-4}

Also studying Lepton Flavour Violation in $\tau \rightarrow \mu\mu\mu$

Cost and Funding

No change since last RRB in April 2008

The overall cost remains unchanged with 75 MCHF

The LHCb experiment will be fully financed with the contribution of 200 kUSD from US-NSF on behalf of the Syracuse group for the CPU's in the pit (93 kUSD have been already paid; the remainder will be paid later this year)

VELO Replacement Modules

□ *Production of spare modules has been launched in May*

~ 75% of hybrids fabricated (well within specs and expected yield)

~ 15% of the phi-sensors received and under tests. First bunch of r-sensors due for delivery in late October

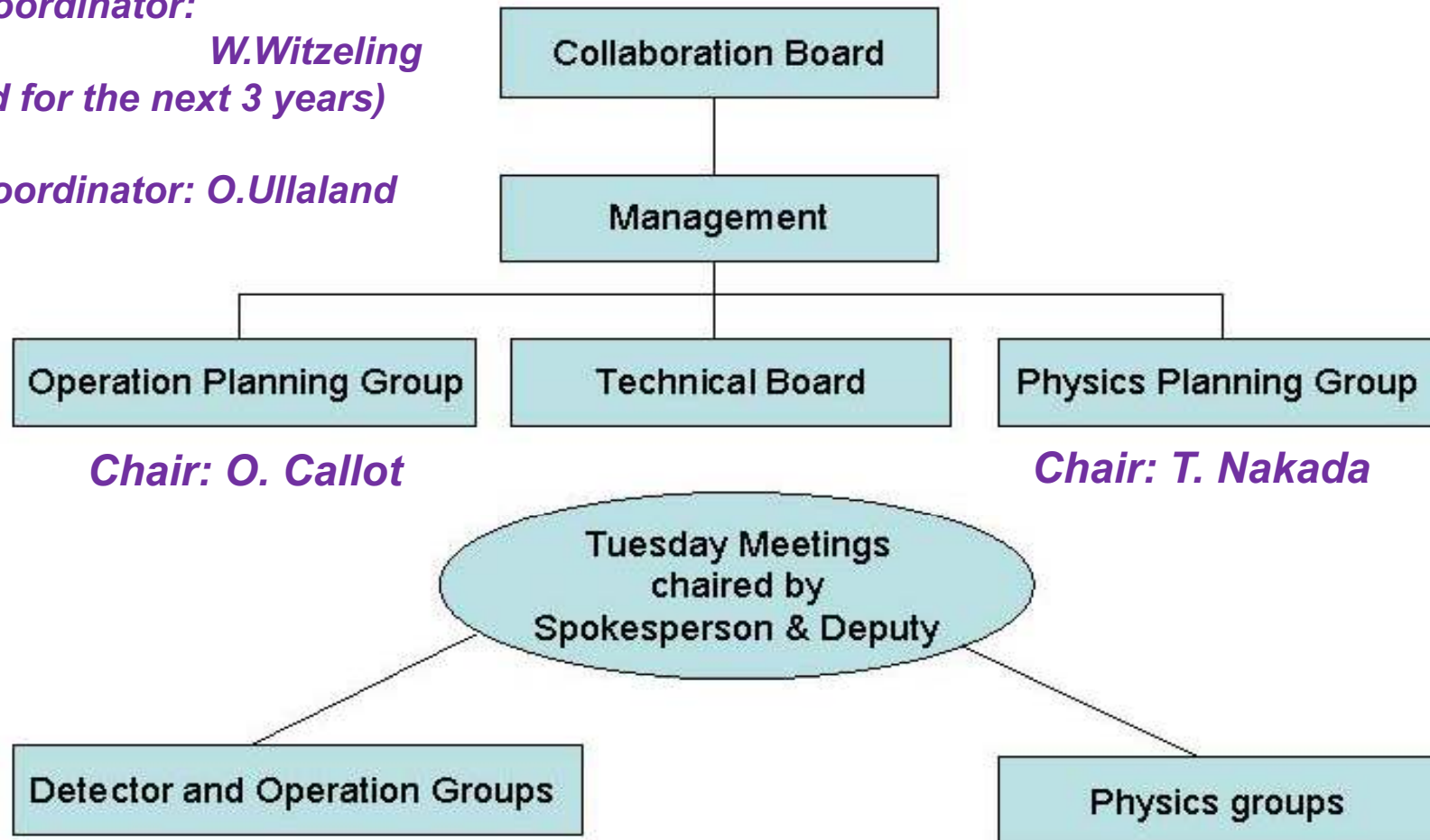
Collaboration Matters: LHCb organization

Management:

Spokesperson: A.Golutvin
Deputy: A.Schopper
Technical Coordinator: W.Witzeling
(reappointed for the next 3 years)

Resource Coordinator: O.Ullaland

CB Chair: U. Straumann
starting from November 1
Many thanks to Elie Aslanides



New group from the University of Bari, led by Prof. Antimo Palano, was accepted

Physics groups

CP-violation

Convener: Guy Wilkinson

Deputy: Marta Calvi

(with particular responsibility for tagging and proper time)

Coordinators of the key measurements:

ϕ_s O. Leroy

γ in loops V. Vagnoni

γ in trees J. Libby

Rare Decays

Convener: Ulrik Egede

Coordinators of the key measurements:

$B_s \rightarrow \mu\mu$ F. Teubert

$B \rightarrow K^*\mu\mu$ M. Patel

$B \rightarrow X\gamma$ I. Belyaev

Flavor Physics

(very 1st measurements)

Convener:

Olivier Schneider

Coordinators:

Soft QCD M. Schmelling
1st phys with min. bias

Quarkonium and B P. Robbe
1st phys. with J/ ψ

EW physics T. Shears

Higgs and exotica

C. Matteuzzi

Direct LUMI measurement

J. Panman

Conclusion

- *A clear experimental signature of New Physics unlikely to be discovered at currently operating experiments*
LHCb has many opportunities to discover NP in flavour sector within a few years of data taking (10 fb^{-1} sample); complementary to direct search by ATLAS & CMS
Preparing the upgrade to collect 100 fb^{-1} is very important to study NP models

- *LHCb was fully operational to start data taking in September 2008. First LHC beam induced data have been successfully taken and used for the time and space alignment*

- *Essential now to prepare for the effective start-up next year:*
 - *Complete M1 installation and commissioning*
 - *Upgrade DAQ system to its full capacity*
 - *A few other improvements for various subdetectors*