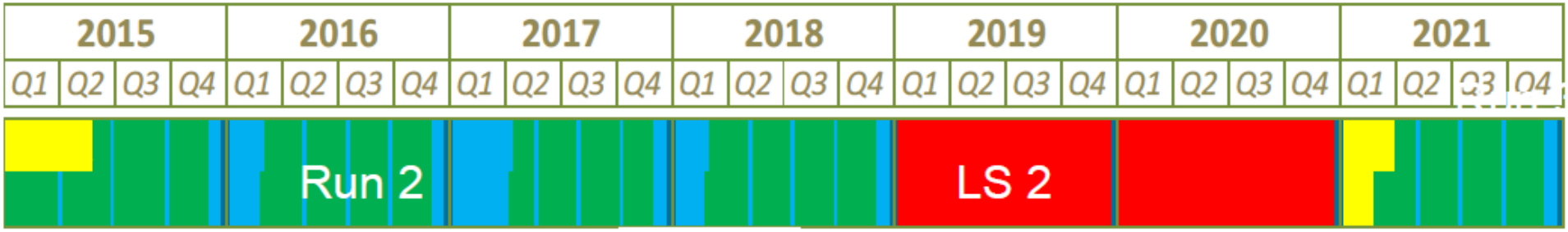
Joint HiLumi LHC-LARP Annual Meeting 2015

Oct. 29 2015 - CERN

LHCb request for running at 'nominal' LHC luminosity

E. Thomas, on behalf of LHCb Collaboration
Contributors: Rolf Lindner, Guy Wilkinson, Pierluigi Campana, Vincenzo Vagnoni

LHCb medium and long term plans



Lumi **4 x 10^{32} cm^{-2} s^{-1}**

➔Aim for ~$8fb^{-1}$ at the end of run 2

- **LHCb Major Upgrade**
- **40 MHz readout**
- **New detectors**
- **New r/o electronics**

Lumi **2 x 10^{33} cm^{-2} s^{-1}**

LHCb LS2 Upgrade parameters

Luminosity

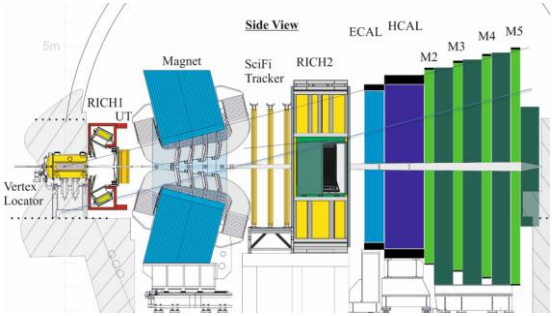
2 x 10^{33} cm^{-2} s^{-1} (Run2 x 5)

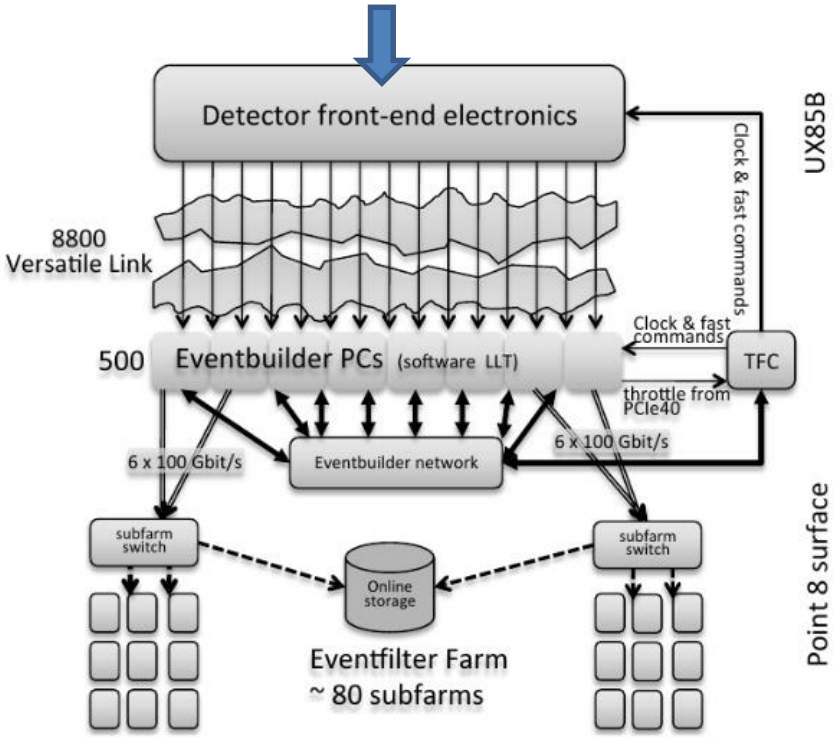
Read-out

40 MHz (Run2 x 40)

The LHCb upgrade in short:

1. **Replace all detectors which cannot stand the rate (occupancy) and the corresponding infrastructure**
2. **Replace all Read-Out Electronic**
3. **New Data Center**





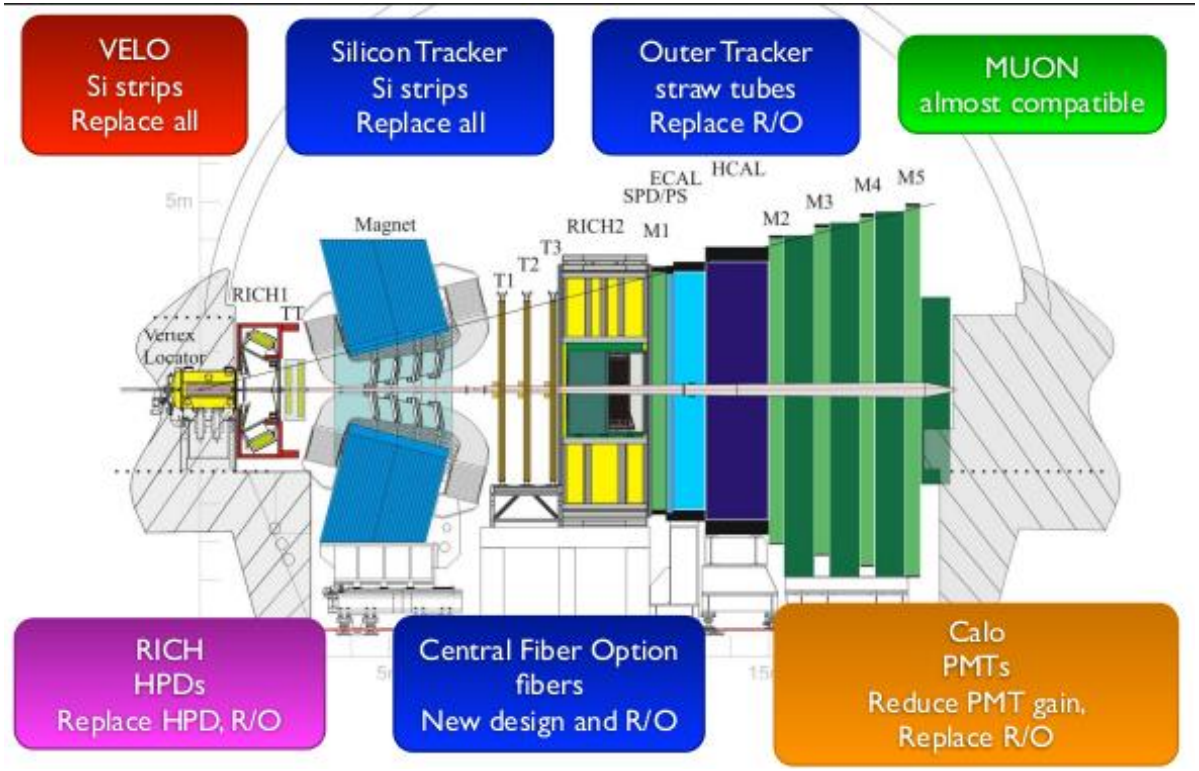
LHCb LS2 Detector Upgrade

Systems to be removed

- VELO
- TT
- IT
- OT
- M1
- SPD
- Lead
- PS
- PC farm

New systems to be installed

- VELO Pixel
- UT
- SciFi
- Data Center



Systems to be partly modified/removed

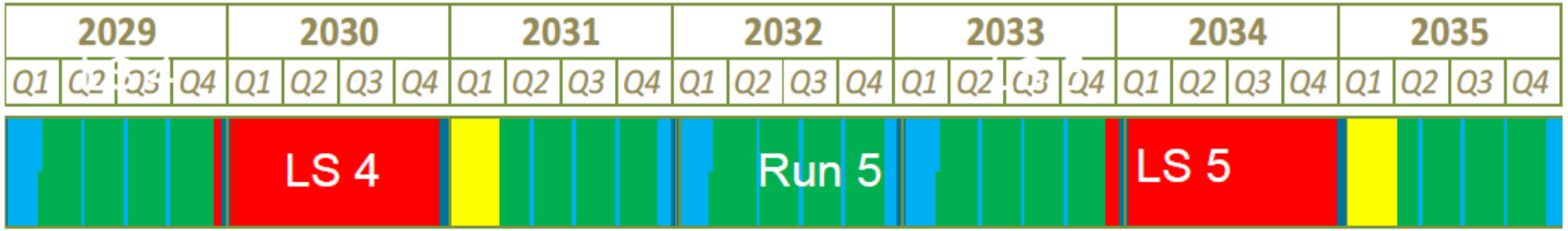
- MUON Electronics
- CALO Electronics
- RICH1 & RICH2 HPDs

LHCb medium and long term plans

Lumi **2 x 10^{33} cm^{-2} s^{-1}**

- **Repair and maintenance**
- **Modest detector improvements**

Lumi 2 x 10^{33} cm^{-2} s^{-1}
➔Aim for ~50fb^{-1} at the end of run 3+4



Enable full exploitation of flavour potential of LHC
➔Modify key detector elements

Lumi 1-2 x 10^{34} cm^{-2} s^{-1}
➔Aim for ~300-500 fb^{-1} integrated lumi

LHCb physics with ~300 fb^{-1}

Even with giant leap forward provided by LS2 LHCb Upgrade, many key flavour observables will still not be measured with the 'ultimate' precision, in the sense that either theoretical uncertainty not reached, or indirect prediction will be more precise (recall that theory, *e.g.* lattice QCD advances as does experiment), *e.g.*:

- CKM angle γ – a pure observable; measure to ~0.1°, exploiting $B \to DK$, $B_s \to D_s K$ (and B_c decays which are currently too rare)
- Φ_s, which quantifies CPV in B_s decay-mixing interference, can be measured to current SM precision in $B_s \to J/\Psi KK$, $J/\Psi\pi\pi$ decays, and cross-checked in complementary channels such as $B_s \to D_s D_s$.
- CPV in B_d and B_s mixing, with semileptonic decays
- $BF(B_s \to \mu\mu)/BF(B_d \to \mu\mu)$, CPV in $Bs \to \mu\mu$
- Decays with gluonic Penguins: $B_s \to \Phi\Phi$, K^*K^* *etc*

Rare, or forbidden decays, will need searching for to ever lower BFs, *e.g.* :

- $\tau \to \mu\mu\mu$
- $D^0 \to \mu\mu$
- $B \to e\mu$, $D^0 \to e\mu$

LHCb physics with ~300 fb^{-1}

Some anomalies which exist now may persist and warrant precise studies (and new ones may appear…), in the same & related channels, e.g.:

- $B \to D^{(*)} \tau \nu$, $B_s \to D_s \tau \nu$, $\Lambda_b \to \Lambda_c \tau \nu$
- Electroweak Penguins, *i.e.* $b \to s l^+ l^-$ family

And beyond flavour physics, LHCb's capabilities & acceptance gives it powerful / unique reach in many areas where more integrated lumi may be crucial

- Hadron spectroscopy
- Electroweak physics, e.g. $A_{FB}(qqbar \to \mu\mu)$ & $\sin^2\theta_W$
- Forward top and Higgs physics
- H→ccbar ??

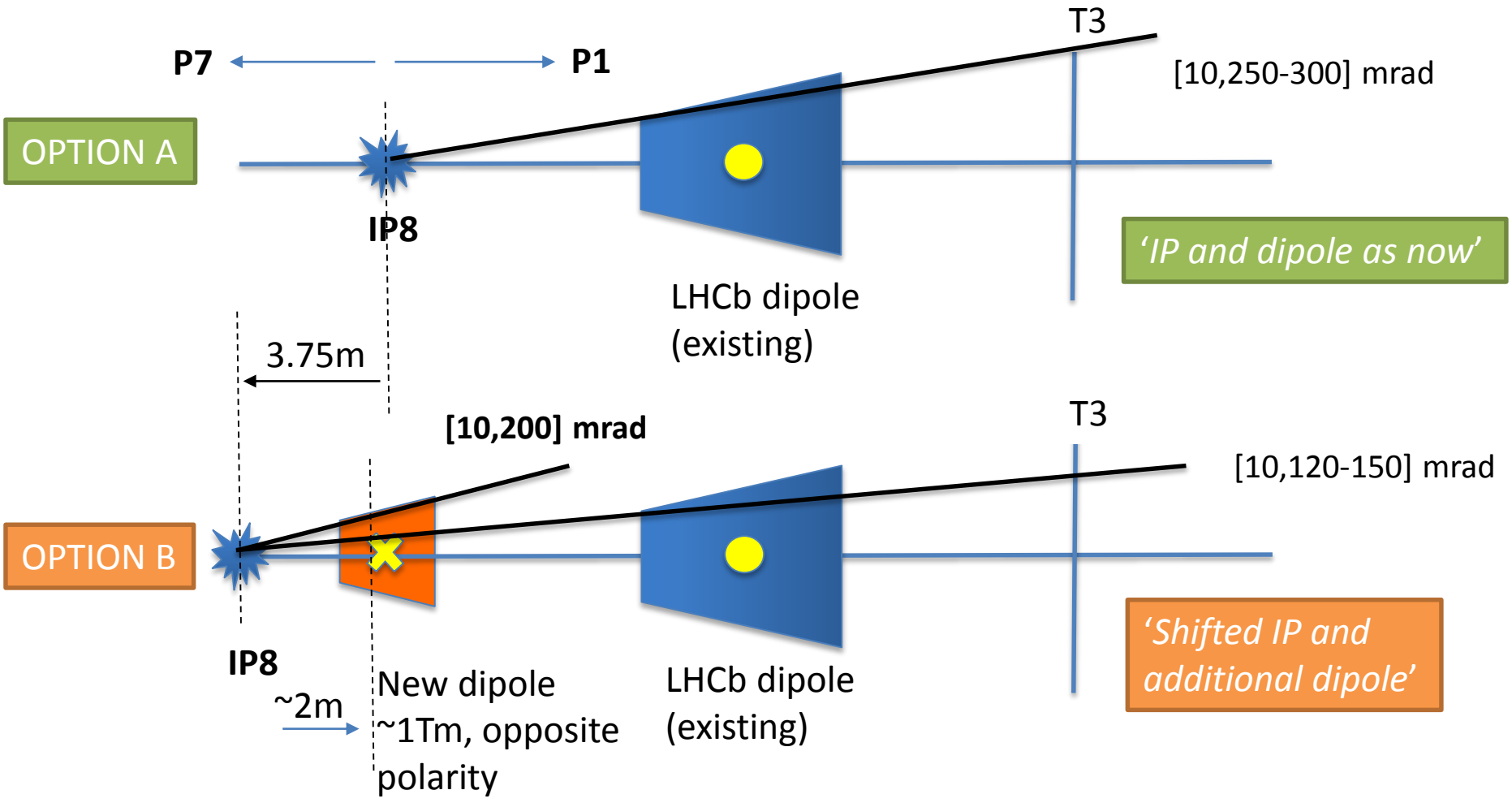
LHCb High Luminosity Options

Two options are under consideration to run at 10^{34} cm^{-2} s^{-1}
(*as presented by G. Wilkinson at 13th HL-LHC Coordination Group meeting*)

Option A : continue with the present geometry but re design the inner region of each detector to cope with the higher rate.

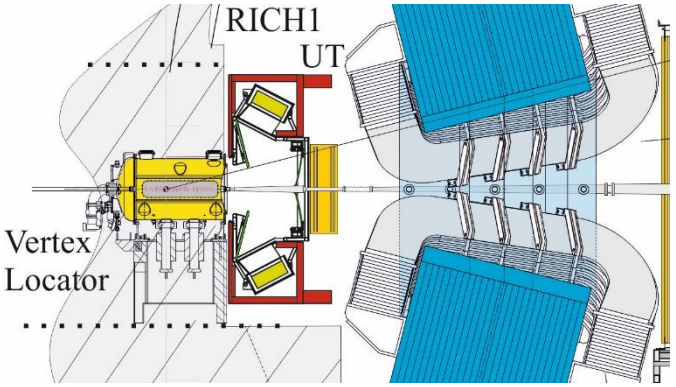
Option B : Displace VERTEX detector upstream (in direction of P7) by 3.75m to reduce the rate in the innermost region. Given the limited acceptance of the existing main dipole, this options requires the insertion of another dipole.

LHCb High Luminosity Layout

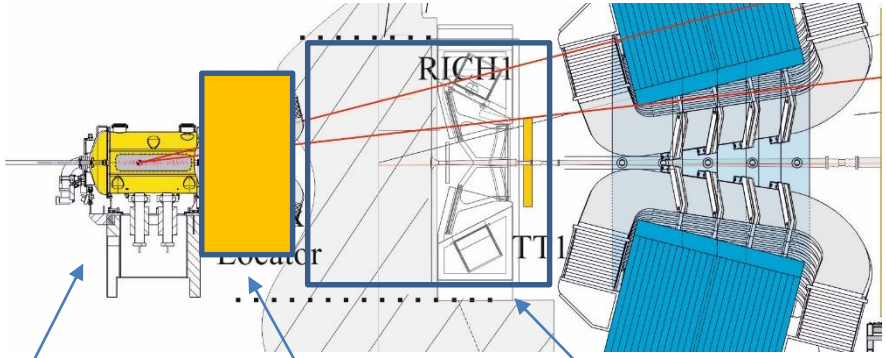


LHCb High Luminosity Layout

OPTION A



OPTION B



Shifted IP and VELO

New Dipole

Space available for detectors with wide angle coverage: tracking and RICH (as now) + Calo, Muon…

Pro and cons

	+	-
OPTION A (IP and dipole as now)	• Requires less modifications to the current layout of LHC machine. • Lower β^*	• Requires major changes in detectors technologies • High occupancy • High noise
OPTION B (Shifted IP + new dipole)	• Less changes to detector • Decreased occupancy in the downstream region • New dipole will sweep low energy particles	• Requires modification of machine layout around IP8. • Integration of shielding and machine element more difficult (space) • Small loss in acceptance • Higher β^*

Summary

- LHCb is currently focused on its first Lumi Upgrade (2 x 10^{33} cm^{-2} s^{-1}), to take place in LS2
- Running LHCb at Nominal LHC luminosity would enable the full flavour physics potential of LHC
- LHCb is investigating several options to optimise the detectors and the experimental layout
- LHCb is very grateful to the colleagues from the accelerator sector for their support in integrating LHCb in High Lumi machine.