

# Upgrade plans & tracking

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*Talk intended to stimulate discussion  
rather than to provide answers*

## LHC upgrade shutdowns

- LHCb upgrade must be synchronized with the machine shutdowns for LHC upgrades (even though LHCb doesn't need LHC luminosity improvements)
- Present LHC schedule:
  - Feb.9 CERN press release:
    - 5 TeV beam commissioning starts in late Sep., first collisions in late Oct.09, collect data through fall 2010.
  - Feb.10 Lyn Evans at CERN Theory Workshop:
    - Equip remaining 4 sectors with extra Pressure Relief Valves before starting 7 TeV (6.5 TeV?) operations.
    - Reach  $10^{34}$  luminosity adiabatically in ~5 years from today (2014?)
    - In principle ready for **Phase-I** LHC luminosity upgrade (Lx2, new IR triplets, LINAC4) by 2013, but experiments likely to request a delay of 1-2 years to collect more data at  $10^{34}$  before shutdown
    - **Phase-II 2018/2019** (SLHC, up to  $10^{35}$ , higher energy?, 18 months shutdown)
  - Shutdown schedules may easily change in the future

## LHCb Upgrade phases

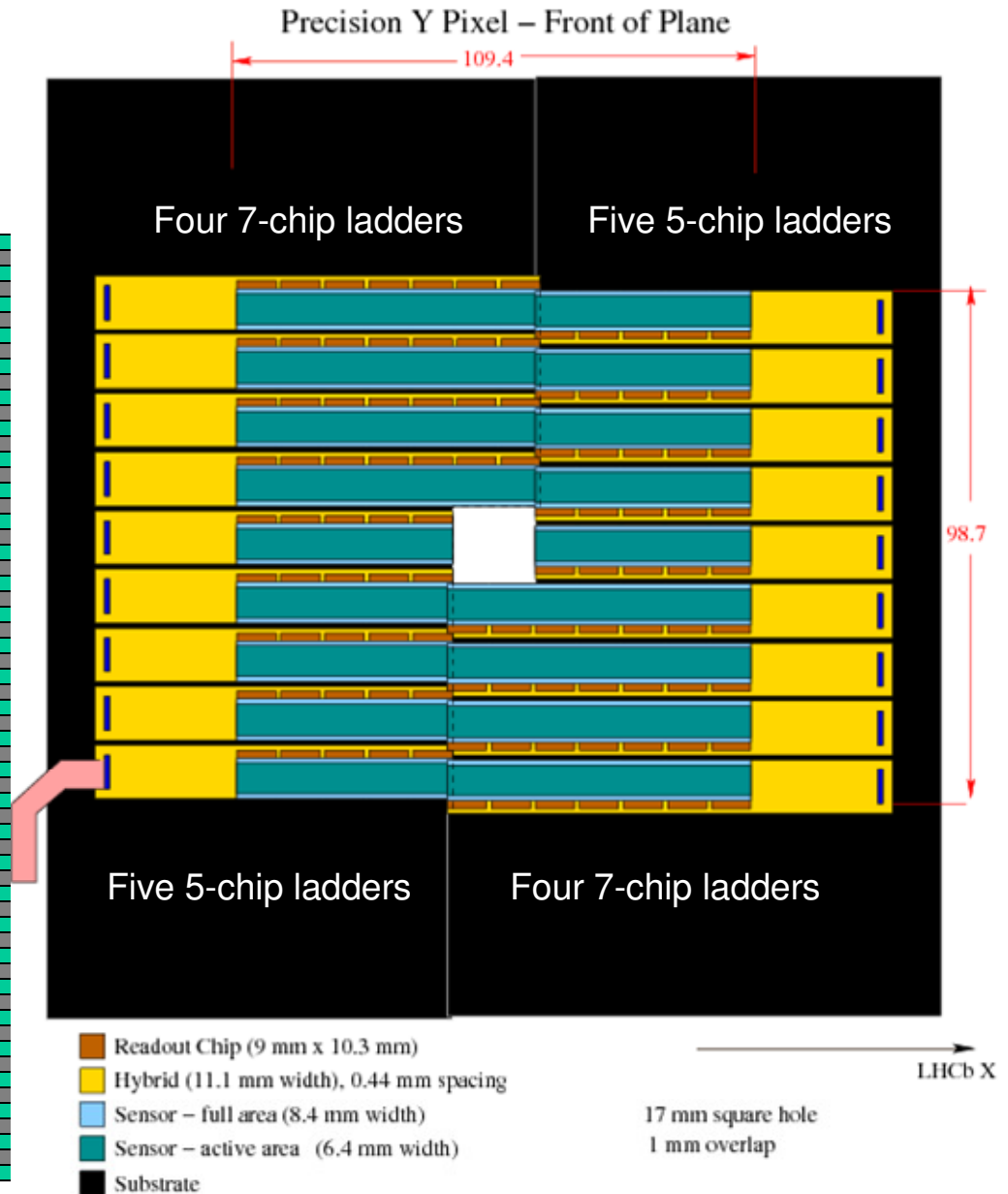
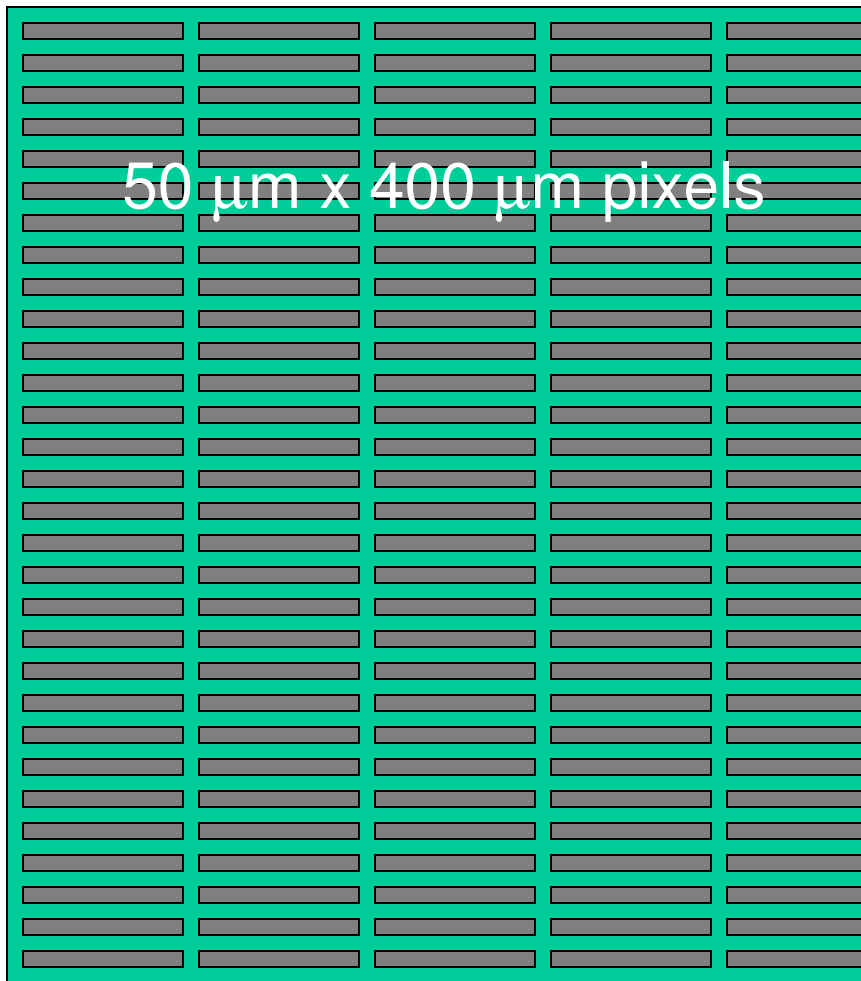
- **Phase I:** 2014 or later
  - Luminosity:  $2 \times 10^{32} \rightarrow 10^{33}$
  - Eliminate L0: readout 1 MHz  $\rightarrow$  40 MHz for all detectors:
    - Replace FE of most detectors (except for MU & very front part of ECAL & HCAL)
    - Since the readout chips integrated with sensors must replace:
      - all silicon detectors: VELO, IT, TT
      - RICH photo-detectors
    - Minimal changes in detector layout
- **Phase II:** 2018 or later
  - Luminosity:  $2(-5) \times 10^{33}$
  - Possibly major detector changes:
    - eliminate RICH1, replace its functionality with new Super-RICH
    - Fiber tracker in OT (and IT?)
- Have to consider a possibility of the two phases merging into one-step upgrade

## VELO

- See Paula Collins' talk at Jan 20, Upgrade Leader Meeting (also weekly VELO upgrade meetings)
  - “big enthusiasm within the group to make the sensor choice pixel based”:
    - Making 40 MHz strip modules may be even more challenging project
    - Radiation hardness
    - Interest from VELO institutes. Synergy with world pixel effort.
- A lot of detailed pixel detector design/technology questions (including RF foil):
  - Will need to be settled by the participating institutions
  - Initial iterations likely to be based on simplified or stand-alone simulations
- Emerging detector design will need to be integrated with **LHCb MC/reconstruction software for upgraded LHCb detector**:
  - **Impact on physics performance** (fine tuning of the design, TDR)
  - **Triggering** (CPU time at high luminosities is likely a non-trivial issue in spite of progress done by Marcin Kucharczyk, Victor Coco & Sheldon Stone)

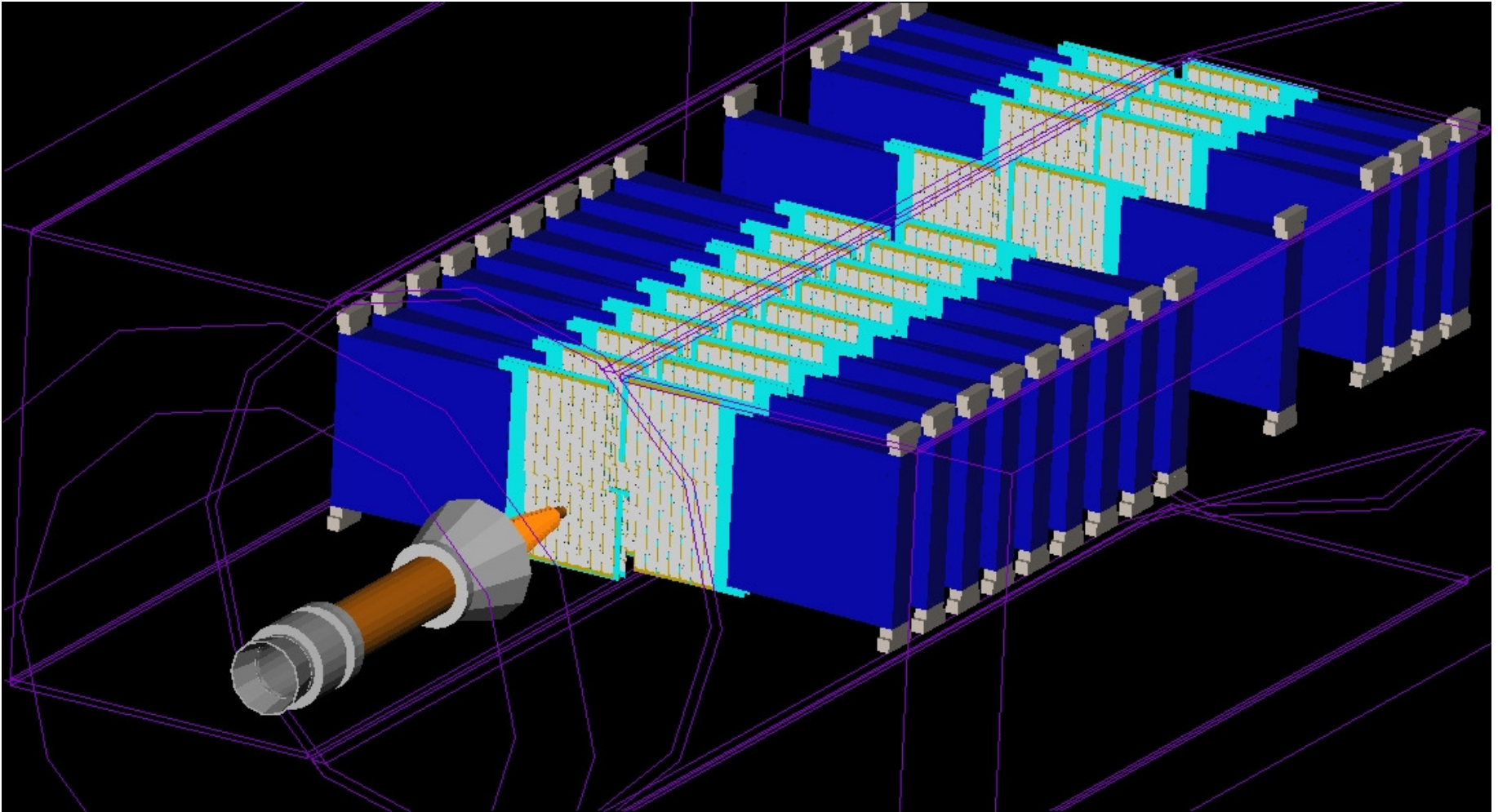
## Some recent work on FPIX chip version

- FPIX chip based design (Liverpool-Syracuse) – Marina Artuso, Themis Bowcock, Steve Blusk (see 2/3/09 VELO Upgrade Meeting talk by Steve)



## GEANT4 implementation

- Victor Coco 2/10/09

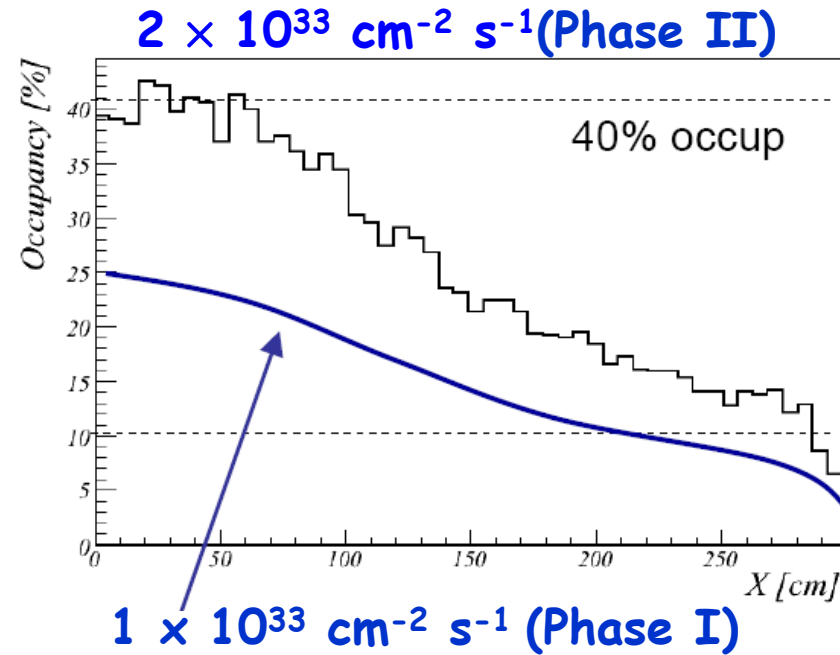
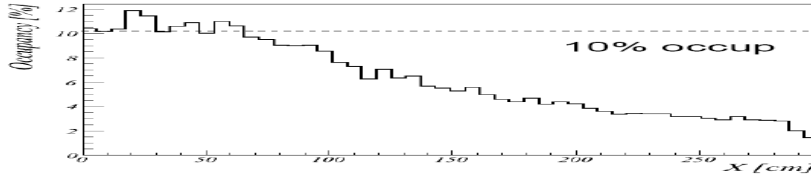


- Marcin Kucharczyk started work on pattern recognition program

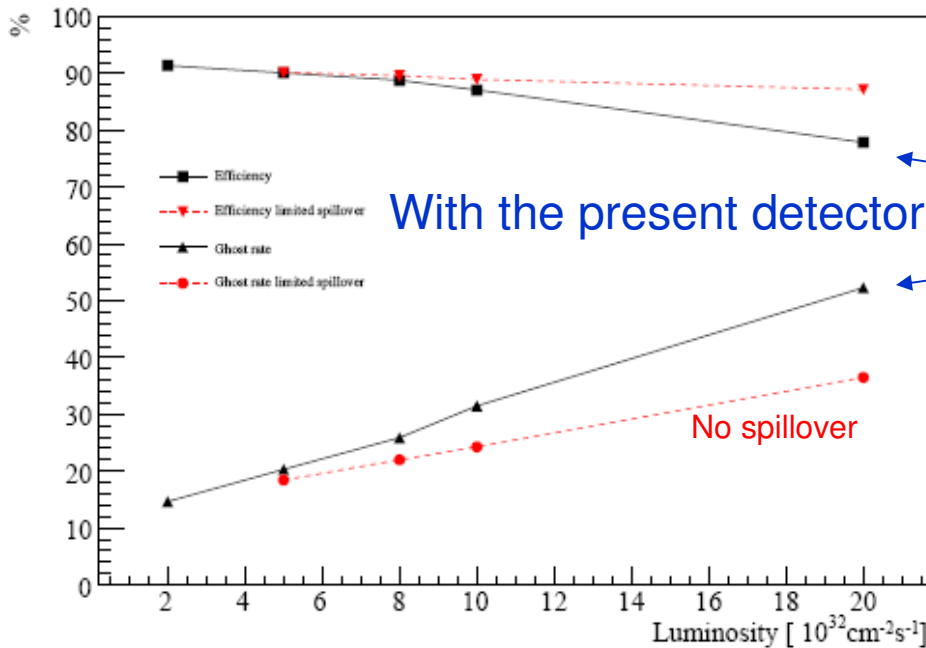
# T-stations

- Major issue: **what is tolerable occupancy in OT?** See talk by Antonio Pellegrino at 1/20/09, Upgrade Leader Meeting.

$2 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$



LHCb-2007-144 (Matt Needham)

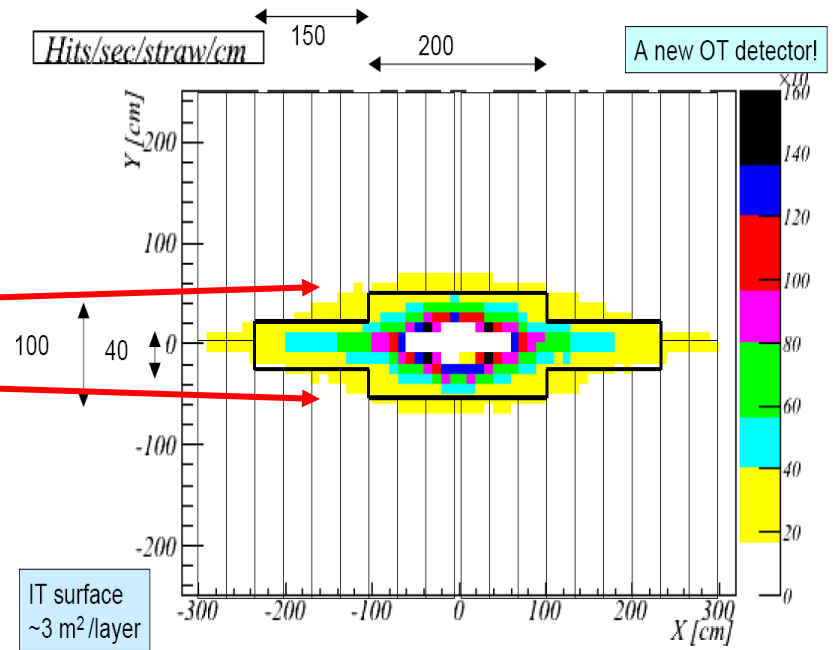
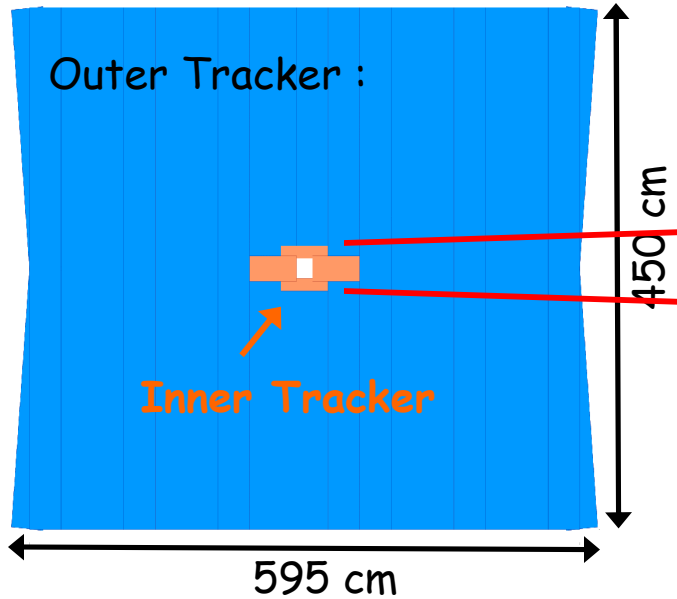


- o "weak" efficiency dependency
- o "strong" ghost dependency

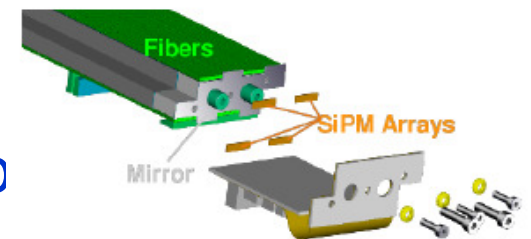
- **Impact on:**
  - Physics performance?
  - Trigger timing?
- There is also a concern about radiation hardness of present OT modules

## T-stations

- OT/IT boundary?



- If try to keep OT occupancies at present level:
  - IT size explodes
  - Must rebuild OT modules to smaller size
- Optimal compromise boundary?  
Corresponding IT design?
- Replacing OT (& IT?) with fiber tracker is also under considerations





## TT

- See talk by Matt Needham at 1/20/09, Upgrade Leader Meeting for detailed design issues.
- Does it need to be Trigger Tracker, Ks detector or both?
- If RICH1 is not there in Phase-II:
  - Does magnet move closer to VELO to make more space for Super-RICH?
    - Impact on TT position and size
    - If not, more TT stations closer to VELO?

## Priorities

- No doubt doing physics with the existing LHCb detector is the first priority
  - Without success of the present program, upgrade is unlikely
  - Important lessons to be learned from the data:
    - e.g. OT occupancies and aging
    - Triggering – real life vs MC
- However, unless you plan to retire or move on to a different experiment in ~2014 **we must press the upgrade program now:**
  - Phase-I timeline is very tough
  - After we get the first collision data it will be even more difficult to focus on the upgrade
  - If there is no future in LHCb the member institutes will have to divert their resources to other future efforts soon
  - Don't be surprised in a premature end to the present LHCb program becomes luminosity upgrade plan for CMS & ATLAS if we don't have viable upgrade program

## Role of tracking group ???

- Physics and trigger consequences of increased occupancies in OT
- Help extending present tracking code (pattern recognition, track fit) from  $R/\phi$  strips to  $x/y$  pixels in vertex detector
- Help setting up software framework for studies of upgraded LHCb detector (centralized special geometry and software releases)
- Provide regular forum for discussion of tracking related upgrade studies