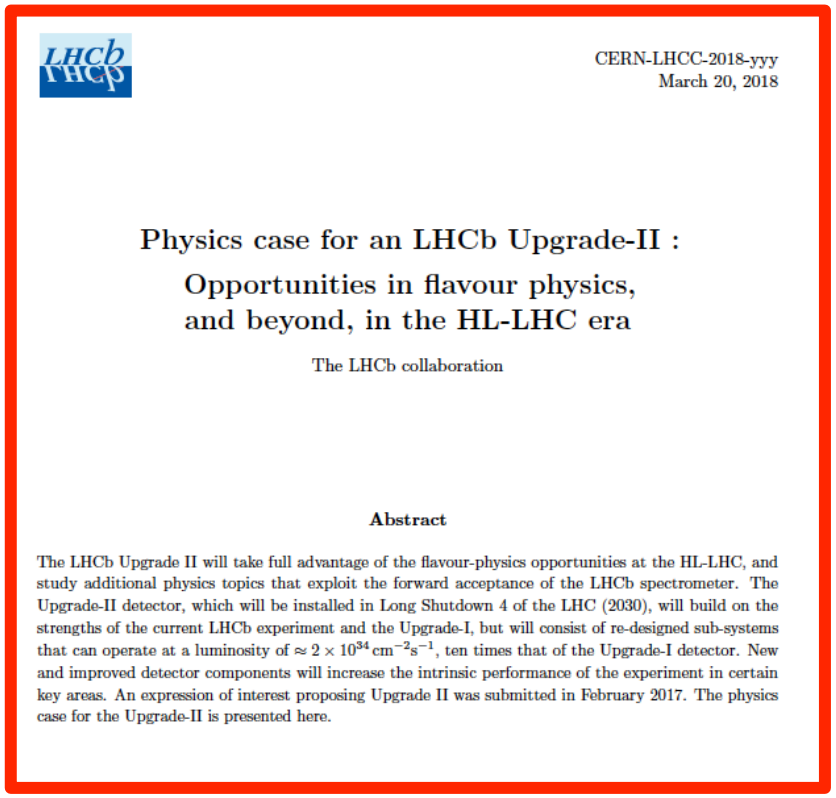
MANCHESTER 1824
The University of Manchester

Faster, Higher, Stronger: LHCb Upgrade 1b/II Workshop



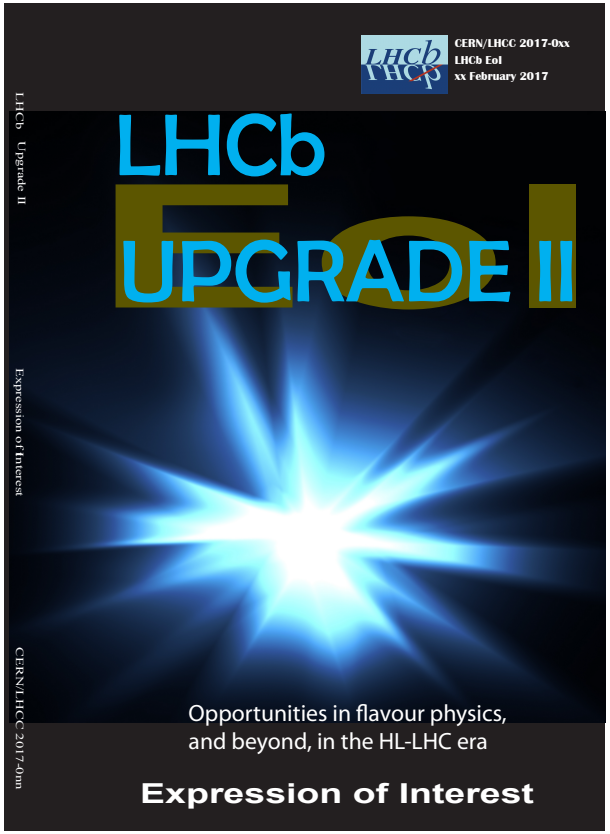
CERN-LHCC-2018-yyy
March 20, 2018

Physics case for an LHCb Upgrade-II :
Opportunities in flavour physics,
and beyond, in the HL-LHC era

The LHCb collaboration

Abstract

The LHCb Upgrade II will take full advantage of the flavour-physics opportunities at the HL-LHC, and study additional physics topics that exploit the forward acceptance of the LHCb spectrometer. The Upgrade-II detector, which will be installed in Long Shutdown 4 of the LHC (2030), will build on the strengths of the current LHCb experiment and the Upgrade-I, but will consist of re-designed sub-systems that can operate at a luminosity of $\approx 2 \times 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$, ten times that of the Upgrade-I detector. New and improved detector components will increase the intrinsic performance of the experiment in certain key areas. An expression of interest proposing Upgrade II was submitted in February 2017. The physics case for the Upgrade-II is presented here.



3rd Workshop on Upgrade II

2018

Faster, Higher, Stronger: Candidate Cities

Vs

3rd Workshop on Upgrade II

Pleased to announce that Annecy jumped through the **hoops** and won !

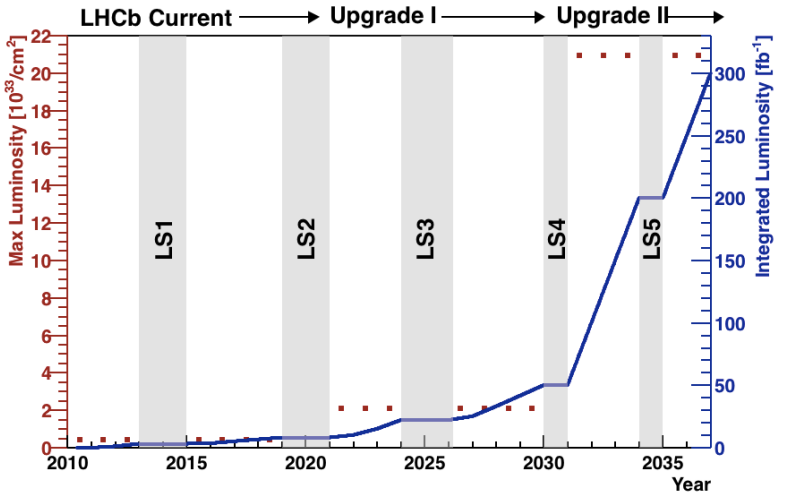
LHCb Timeline

- LHC Run-I (2010-2013)
- LHC Run-II (2015-2018)
  - Trigger computing increased.
- LHC Run-III, Run-IV (2021-2023, 2026-2029)
  - Major 'New' Experiment: **LHCb Upgrade [I(a), I(b)]**
  - L = 2×10^{33} $cm^{-2}s^{-1}$, integrated $50 fb^{-1}$
- LHC Run-V (2031-)
  - Major 'New' Experiment

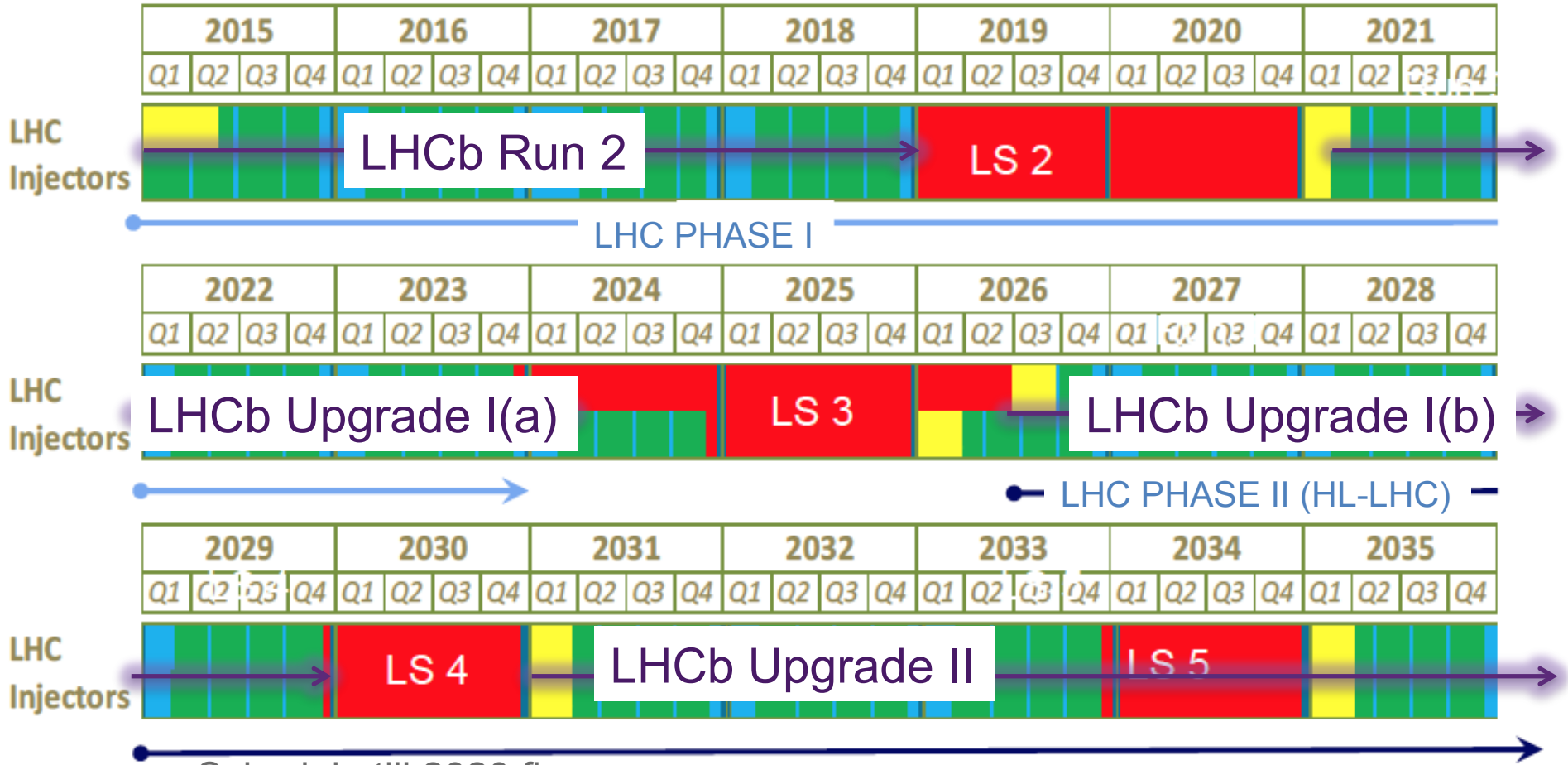
LHCb Upgrade II

L = 2×10^{34} $cm^{-2}s^{-1}$, integrated $300 fb^{-1}$

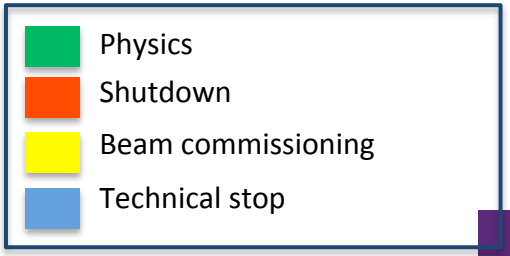
– May be only general heavy flavour expt on this timescale



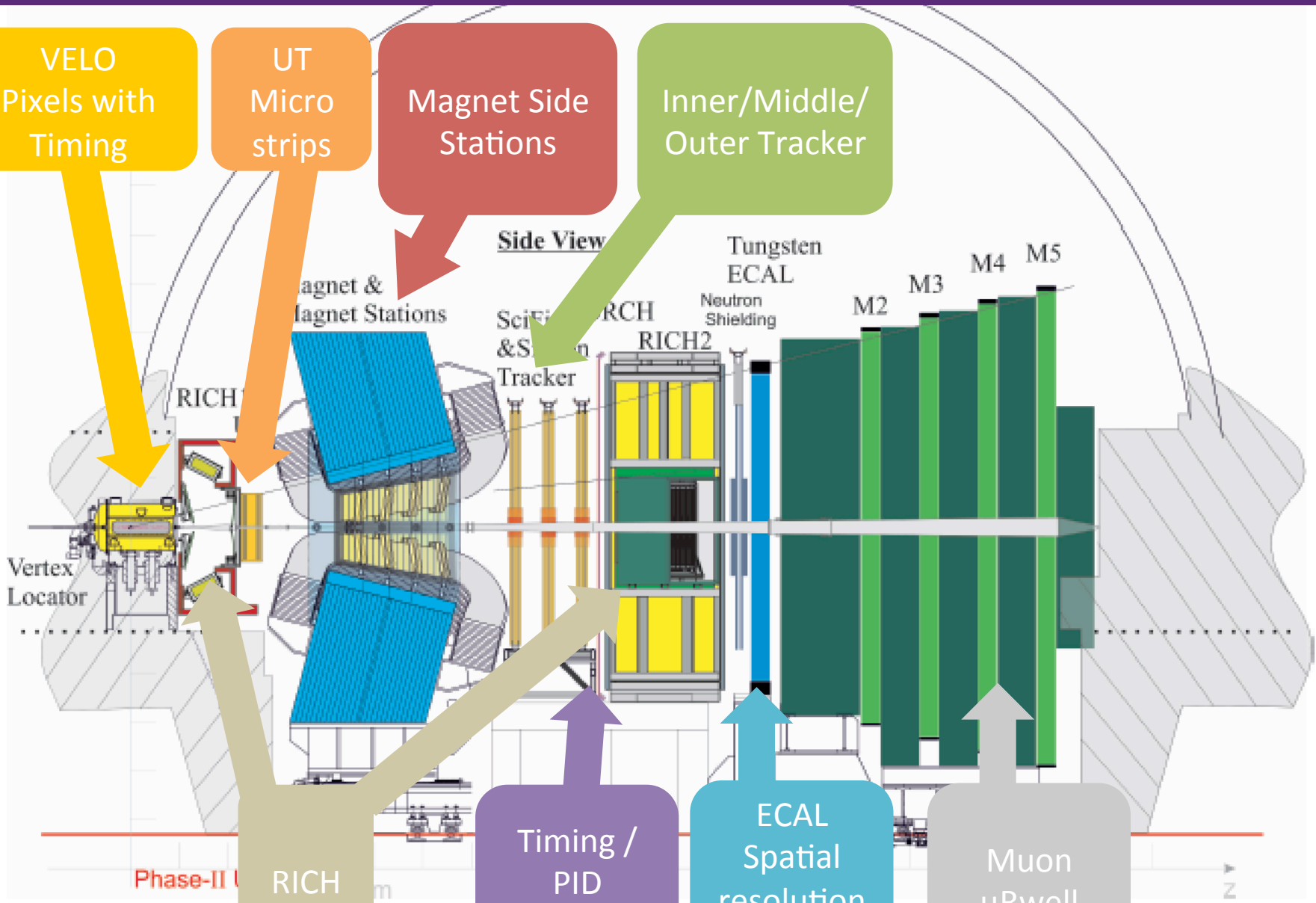
LHC Schedule & LHCb



- Schedule till 2020 firm
- GPD main upgrades (phase II) scheduled for LS3
- HL-LHC upgrade in LS3
- **Belle II finishes ~ 2025**



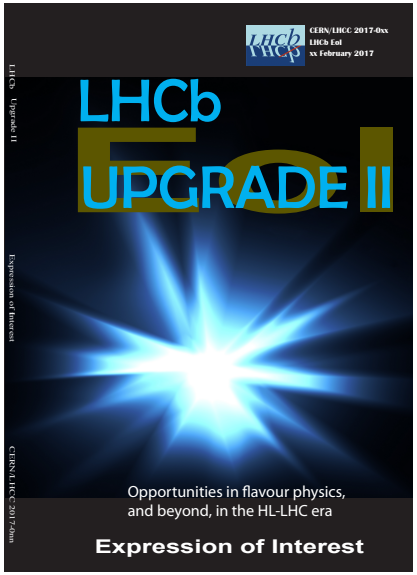
Upgrade II Detector



LHCC response to EOI

From LHCC minutes: May 2017

- The **LHCC notes** the submission of the EoI for LHCb upgrades beyond Phase-I, and **encourages** LHCb to pursue the physics studies and collaboration with the LHC experts to motivate these upgrades with a solid physics case, taking into account the expected results from LHCb Phase-I and Belle II, and establish feasible running conditions that do not interfere with other LHC experiments. The **LHCC urges** the LHCb management to ensure that these activities have no impact on the on-going Phase-I upgrades, which must take priority.



Interpret as:

- Physics case document required
  - Emphasis of this meeting
- Increase interaction with LHC accelerator experts from LHCb Eric Thomas
  - Talk: Riccardo de Maria
  - Attending: Beniamino Di Girolamo

LHCb Upgrade II Timeline

Run 4 Run 5

Year 0 2 4 6 8 10 12 14

1 3 5 7 9 11 13

2017 2018 2020 2023 2026 2031

Physics Case

HL-LHC

NEW!

Upgrade II Technical Design Report

Upgrade 1b PID Technical Design Report

Upgrade 1b Tracking Technical Design Report

Upgrade II Detector TDRs

In addition:
European Strategy Meeting
Is key

European Strategy for Particle Physics 2019/2020

- Please ensure that your LHCb Institute is engaged in your national processes to provide input to the Strategy Process
- The outcome of this strategy will be critical to the approval of the LHCb Upgrade II.

Deadline for input: 18 December 2018
Open Symposium: May 2019
Strategy Drafting Session: January 2020
CERN Council update: by May 2020

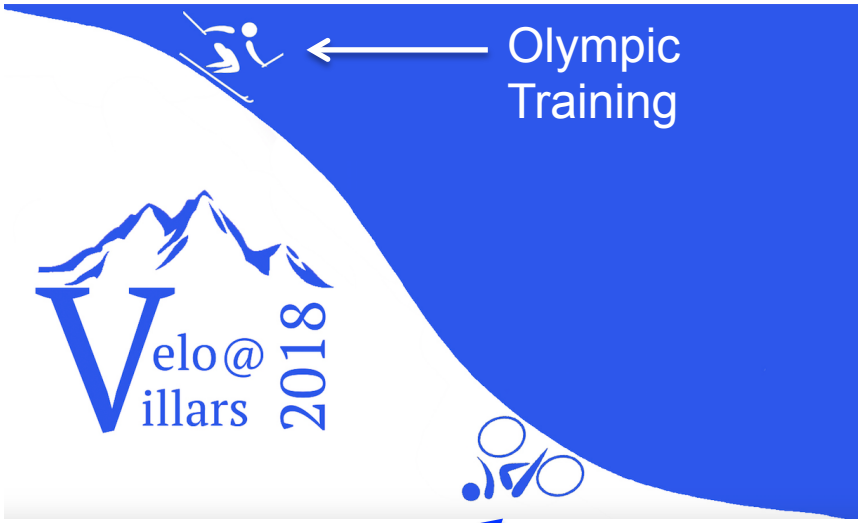
Primary central LHCb submission through CERN yellow book
Main LHCb contact: Mika Vesterinen

Detector Meetings: VELO

- **Dedicated retreat held**

Introduction and aims of workshop	*Paula Collins*	
Villars-sur-Ollon	14:30 - 14:45	
VELO Upgrade II brainstorm	*Martin Van Beuzekom*	
Villars-sur-Ollon	14:45 - 15:15	
RF foil constraints and prospects	*Massimiliano Ferro-Luzzi*	
Villars-sur-Ollon	15:15 - 15:35	
Coffee Break I		
Villars-sur-Ollon	15:35 - 15:55	
CMOS detectors with fast timing	*Eva Vilella Figueras et al.*	
Villars-sur-Ollon	15:55 - 16:20	
HVCMOS for extreme environments	*Gianluigi Casse*	
Villars-sur-Ollon	16:20 - 16:45	
Timing layers, 4 Dimension and 5 Dimension Tracking detectors	*Nicolo Cartiglia*	
Villars-sur-Ollon	16:45 - 17:10	
Fast timing ASICs	*Michael Campbell*	
Villars-sur-Ollon	17:10 - 17:35	
Fast timing ASICs	*Vladimir Gromov*	
Villars-sur-Ollon	17:35 - 18:00	
Coffee Break II		
Villars-sur-Ollon	18:00 - 18:20	
DAQ limitations and challenges	*Karol Hennessy*	
Villars-sur-Ollon	18:20 - 18:45	
Moving data with fibres	*Jan Troska*	
Villars-sur-Ollon	18:45 - 19:10	
FPGA Compute Acceleration Tests for the LHCb Upgrade	*Christian Faerber*	
Villars-sur-Ollon	19:10 - 19:35	
Challenges of a many-core implementation for VeloPix	*Daniel Hugo Campora Perez*	
Villars-sur-Ollon	19:35 - 20:00	

Using VELO in the trigger	*Conor Fitzpatrick*	
Villars-sur-Ollon	13:00 - 13:25	
Data processing ideas	*Sebastien Ponce*	
Villars-sur-Ollon	13:25 - 13:50	
Module integration ideas	*Alessandro Mapelli*	
Villars-sur-Ollon	13:50 - 14:15	
Mechanical considerations	*Raphael Dumps*	
Villars-sur-Ollon	14:15 - 14:40	
Wrap Up	*Mark Richard James Williams*	
Villars-sur-Ollon	14:40 - 14:45	



Solving technological challenges

Detector Meetings: “5D” ECAL

- **Regular meetings underway – new ECAL collaborators**

23/2/18

14:00 → 14:10 **Introduction**
Speaker: Guy Wilkinson (University of Oxford (GB))

14:10 → 14:30 **Some remarks on calorimeter performance requirements**
Speaker: Andrei Golutvin (Imperial College London)
Ecal23Febr.pdf

14:30 → 14:45 **Physics requirements for neutral isolation - first thoughts**
Speaker: Julian Garcia Pardinas (Universidade de Santiago de Compostela (ES))
NeutralIsolation.pdf

14:45 → 15:00 **Progress on simulation studies (GEANT)**
Speaker: Markus Roehrken (CERN)
20180223_ECAL_M...

15:00 → 15:20 **Progress on simulation studies (DELPHES)**
Speaker: Adam Davis (Tsinghua University (CN))
ecal_delphes_updat...

15:20 → 15:40 **Scintillation properties and radiation hardness of the Ce-dopled, CodopedCe, Mg garnet crystal and garnet crystal fibre development**
Speaker: Etiennette Auffray Hillemanns (CERN)
GarnetpropertiesEa...

15:40 → 16:00 **Measurements of irradiated and non-irradiated GAGG crystals**
Speaker: Iouri Guz (Institute for High Energy Physics (RU))
GAGG_measureme... GAGG_measureme...

16:00 → 16:20 **Towards enhancing cluster reconstruction by Machine Learning**
Speaker: Andrey Ustyuzhanin (Yandex School of Data Analysis (RU))
TowardsCaloriemet...

16:20 → 16:30 **Preparation for the Annecy meeting**
Speaker: Guy Wilkinson (University of Oxford (GB))

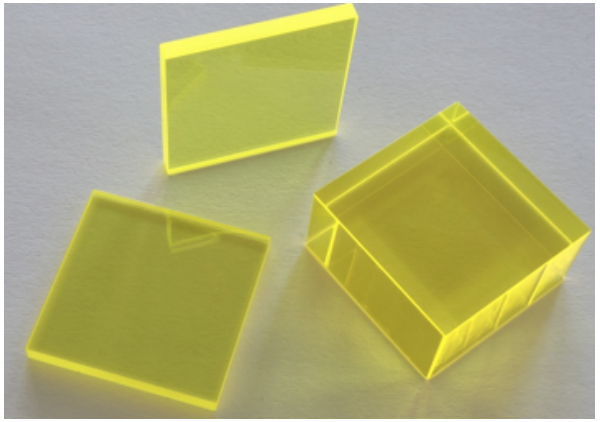
13/12/17

15:00 → 15:20 **Introduction**
Speaker: Guy Wilkinson (University of Oxford (GB))
CALO_Dec2017.pdf

15:20 → 15:40 **Simulation progress**
Speaker: Adam Davis (Tsinghua University (CN))
summary.pdf

15:40 → 16:00 **Ideas on the scintillating element of the ECAL module**
Speaker: Andrei Golutvin (Imperial College London)
CaloIdeas.pdf CERN 2017 Buzano... CERN 2017 Buzano...

16:00 → 16:20 **Possible R&D on the GAGG crystal [O. Buzanov, MISIS/FOMOS]**
Speaker: Andrei Golutvin (Imperial College London)



Impossible to GAGG !

Detector Meetings: Inner Tracker Middle Tracker

- Interest from CMOS community outside LHCb

16/3/18

13:00 → 13:20 **Introduction**
Speaker: Chris Parkes (University of Manchester (GB))
ITIntro_160318_Par... ITIntro_160318_Par...

13:20 → 13:30 **Discussion**

13:30 → 13:50 **HVCMOS Technology options**
Speakers: Ivan Peric (KIT - Karlsruhe Institute of Technology (DE)), Ivan Peric (Ruprecht-Karls-Universitaet Heidelberg (DE)), Technology (DE))
TechnologyOptions.... TechnologyOptions....

13:50 → 14:00 **Discussion**

14:00 → 14:20 **HVCMOS chip design experience**
Speakers: Eva Vilella Figueras (University of Liverpool (GB)), Eva Vilella Figueras
2018_Vilella_U2_up...

14:20 → 14:30 **Discussion**

14:30 → 14:50 **Mechanics, Services concepts from Sci-Fi and ST experience**
Speaker: Fred Blanc (EPFL - Ecole Polytechnique Federale Lausanne (CH))
20180316_IT_SciFi_...

14:50 → 15:00 **Discussion**

15:00 → 15:20 **Mu3e performance, testing and assembly experience**
Speaker: Dirk Wiedner (Ruprecht Karls Universitaet Heidelberg (DE))
Mu3e_performance,... Mu3e_performance,...

15:20 → 15:50 **Discussion**
close.pdf close.pptx

T&A 12/12/18

16:45 → 17:05 **VELO**
Speaker: Mark Richard James Williams (University of Manchester (GB))
TAmeeting_FutureV...

17:05 → 17:25 **Upgrade phase II**
Speaker: Matthew David Needham (University of Edinburgh (GB))
U2Tracking.pdf U2Tracking.pptx

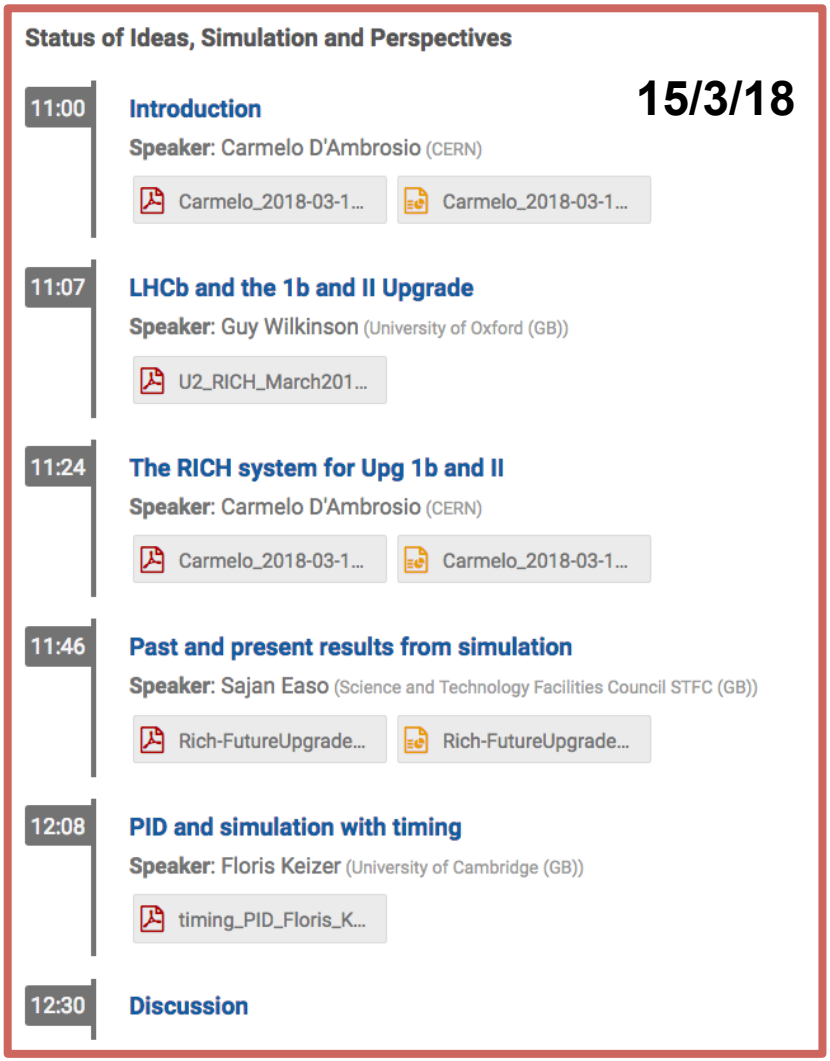
17:25 → 17:45 **Occupancies studies for the T stations**
Speaker: Gregory Max Ciezarek (CERN)
TStationOccupanci...

17:45 → 18:05 **FPGA tracking: Status of the Downstream Tracker for Upgrade-Ib**
Speaker: Giovanni Punzi (Universita & INFN Pisa (IT))
Downstream_UP1B-...

- Regular Meetings on Magnet Side Stations been running for ~ 2 years

Detector Meetings: RICH /TORCH

- **Marathon meeting**



Status of Ideas, Simulation and Perspectives

15/3/18

11:00 **Introduction**
Speaker: Carmelo D'Ambrosio (CERN)
Carmelo_2018-03-1... Carmelo_2018-03-1...

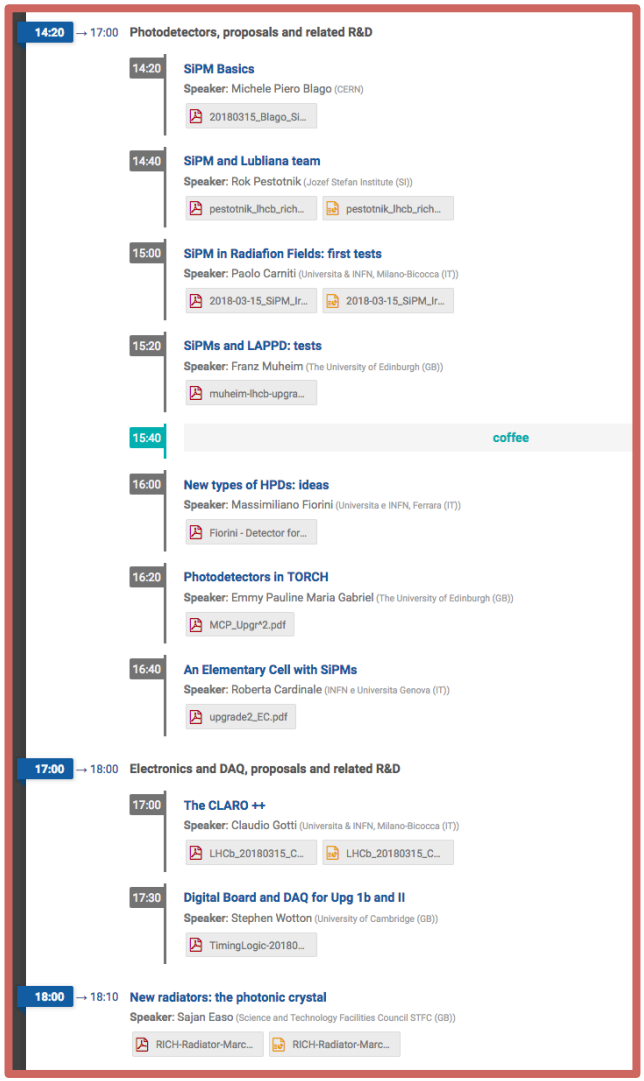
11:07 **LHCb and the 1b and II Upgrade**
Speaker: Guy Wilkinson (University of Oxford (GB))
U2_RICH_March201...

11:24 **The RICH system for Upg 1b and II**
Speaker: Carmelo D'Ambrosio (CERN)
Carmelo_2018-03-1... Carmelo_2018-03-1...

11:46 **Past and present results from simulation**
Speaker: Sajan Easo (Science and Technology Facilities Council STFC (GB))
Rich-FutureUpgrade... Rich-FutureUpgrade...

12:08 **PID and simulation with timing**
Speaker: Floris Keizer (University of Cambridge (GB))
timing_PID_Floris_K...

12:30 **Discussion**



14:20 → 17:00 **Photodetectors, proposals and related R&D**

14:20 **SiPM Basics**
Speaker: Michele Piero Blago (CERN)
20180315_Blago_Si...

14:40 **SiPM and Lubliana team**
Speaker: Rok Pestotnik (Jozef Stefan Institute (SI))
pestotnik_lhcb_rich... pestotnik_lhcb_rich...

15:00 **SiPM in Radiafion Fields: first tests**
Speaker: Paolo Carniti (Universita & INFN, Milano-Bicocca (IT))
2018-03-15_SiPM_Ir... 2018-03-15_SiPM_Ir...

15:20 **SiPMs and LAPPD: tests**
Speaker: Franz Muheim (The University of Edinburgh (GB))
muheim-lhcb-upgra...

15:40 coffee

16:00 **New types of HPDs: ideas**
Speaker: Massimiliano Fiorini (Universita e INFN, Ferrara (IT))
Fiorini - Detector for...

16:20 **Photodetectors in TORCH**
Speaker: Emmy Pauline Maria Gabriel (The University of Edinburgh (GB))
MCP_Upgr*2.pdf

16:40 **An Elementary Cell with SiPMs**
Speaker: Roberta Cardinale (INFN e Universita Genova (IT))
upgrade2_EC.pdf

17:00 → 18:00 **Electronics and DAQ, proposals and related R&D**

17:00 **The CLARO ++**
Speaker: Claudio Gotti (Universita & INFN, Milano-Bicocca (IT))
LHCb_20180315_C... LHCb_20180315_C...

17:30 **Digital Board and DAQ for Upg 1b and II**
Speaker: Stephen Wotton (University of Cambridge (GB))
TimingLogic-20180...

18:00 → 18:10 **New radiators: the photonic crystal**
Speaker: Sajan Easo (Science and Technology Facilities Council STFC (GB))
RICH-Radiator-Marc... RICH-Radiator-Marc...

- **Long running and advanced R&D on TORCH concept**

Detector Proposals: Sci-Fi & Muons

- **Sci-Fi additional fibre purchase & mat production approved**
- **LHCb Technical Board 12/10/18**

If we order another 1000 km we could produce fibres mats for additional 24 modules as a possible replacement option for the inner modules.

The SciFi groups are ready/willing to produce the additional fibre mats. If we want additional spares we should produce them immediately.

The SciFi ask the Technical Board to support the following strategy:

- to order the additional 1000 km of fibres now
- to produce fibre mats directly after we have finished the standard production

Ulrich Uwer

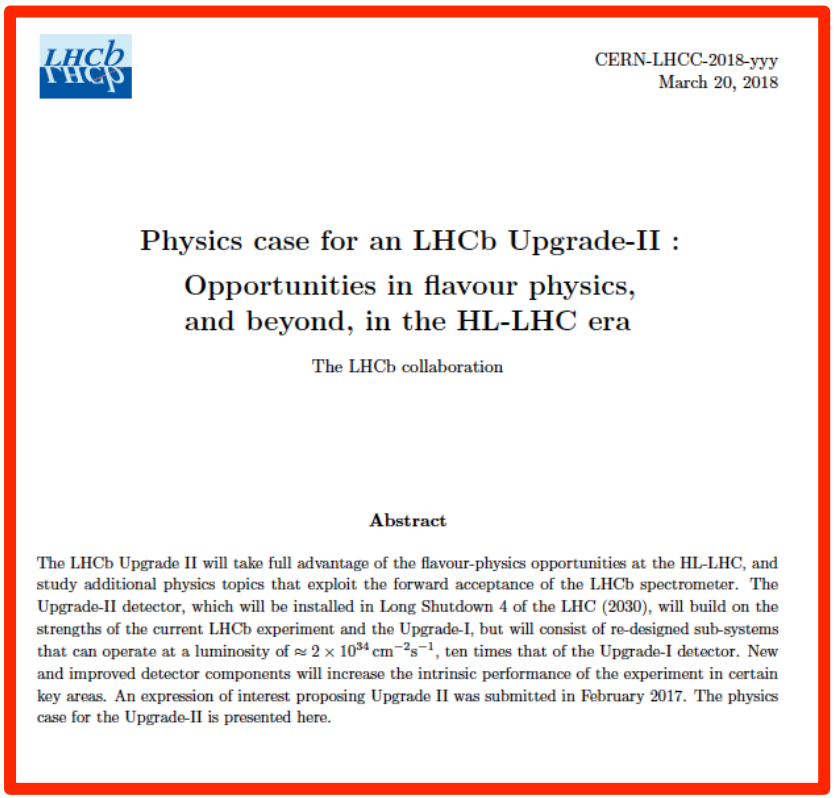
- **MWPC replacement in muon inner regions for LS3 or before**
- **LHCb Technical Board 6/3/18**

ENGINEERING CHANGE REQUEST/NOTICE

Pad chambers for Muon detector consolidation

To be filled by the requestor			
LHCb Project / System **Muon**	**EDMS No: 1912064**	**Created :** 28/02/2018	**Page : 1 of 4**
		Modified :	**Ver. No.** 1
Engineering Change requested by : M. Palutan		**Responsible Person** : M. Palutan	

Physics Case Document



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- Timeline: (Vincenzo)
  - First draft of each sub-section released by March 20 (to be circulated for the Annecy workshop)
  - Comments by the main editors within March 31
  - Second iteration for each sub-section to be released by April 15
  - Final editing by the main editors within April 30
  - Presentation to the collaboration at a special meeting on the week commencing April 30
  - Final refinements and submission to the LHCC in the week May 7.

Enthusiasm is clear ! An editing **Marathon**…..

European Strategy for Particle Physics 2019/2020

- Please ensure that your LHCb Institute is engaged in your national processes to provide input to the Strategy Process
- The outcome of this strategy will be critical to the approval of the LHCb Upgrade II.

Deadline for input: 18 December 2018
Open Symposium: May 2019
Strategy Drafting Session: January 2020
CERN Council update: by May 2020

Primary central LHCb submission through CERN yellow book
Main LHCb contact: Mika Vesterinen

Technical Associates: Olympic Athletes of LHCb

- Option for new groups to join to work on R&D
  - Do not work on physics or sign papers
  - Approved at CB in September 2017

- Potentially a useful mechanism to attract new groups for Upgrade Ib/II

- Can apply for full / associate membership subsequently

Final Message:

Discussion in your Institute / Country

- We are aware discussions are starting on the area(s) your institutes plan to contribute to.
  - Particular emphasis on the Upgrade Ib Concepts
- PID: 5D-ECAL(**x**,t,E), TORCH/RICH, Muons
- Tracking: Inner Tracker & Sci-Fi, Magnet Side Stations, FPGA based tracking
- Giovanni & I are happy to discuss with you as you formulate your plans.

Faster, Higher, Stronger: LHCb Upgrade II

- Thanks to our hosts ! A meeting in line with the Olympic motto:
- Faster: Please keep to time in your talks
- Higher: Performance enhancing coffee
- Stronger: we don't finish till > 18:30…

Annecy 2018
CANDIDATE CITY

- Very pleased to have a number of non-LHCb members attending

- We look forward to an interesting couple of days of updates on:
  - Machine studies
  - Detector Concepts
  - **Theoretical & Experimental input on Physics Case**

LHCb

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Backup