LHCb Upgrade II next steps

Matteo Palutan

(INFN-Frascati)

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FTDR published!

CDS link

https://cds.cern.ch/record/2776420/

Huge achievement by the collaboration after many years of effort

LHCC review started September 2021, concluded in March 2022

From LHCC review report

Detector Cost

High-level review

- A thorough cost review was not conducted as part of the review, but cost estimates were discussed system-by-system at a relatively coarse level. The cost estimates were found to be credible and reasonable given the current level of maturity of the technical design.
  - It is noted that the estimates are largely based on extrapolations from existing systems (within and outside of LHCb).
  - Technological advances, achievable with significant R&D, have the potential to create opportunities for cost reductions.

Detector	Baseline (kCHF)
VELO	14800
UT	8900
Magnet Stations	2300
MT-SciFi	22400
MT-CMOS	19500
RICH	15600
TORCH	9900
ECAL	34800
Muon	7100
RTA	17400
Online	8900
Infrastructure	13500
Total	175100

LHCC recommendations

LHCb Upgrade II Framework TDR Review

Main observations and recommendations

- The **LHCC notes** that the physics case was previously endorsed by the LHCC in 2018.
- The **LHCC recommends** that LHCb continue the R&D necessary to complete technical design reports on the proposed schedule, noting that technological advances may generate opportunities to reduce costs relative to the extrapolations from existing systems and technologies included in the current cost estimate.
- The **LHCC recommends** the continued investigation of descoping and other cost-saving possibilities. Given the possible tight installation schedule, designs of all subsystems should include the possibility for phased and staged installation.
- The **LHCC notes** that the increase of necessary computing resources will require significant advances in the computing model and in offline reconstruction algorithms, which in turn requires a strong team engaged for a long time. The LHCC encourages LHCb to strengthen the computing team.
- The **LHCC notes** that, beyond financial resources to cover the CORE cost of the ambitious upgrade, it is essential that the personnel for R&D, production and installation is available on top of the personnel needed to operate and maintain the current detector, and to carry out LS3 activities and commissioning of new detectors to be installed at that point, as well as data analysis. The planning of personnel resources should be monitored as the project moves forward, and concrete, defensible plans should be established at the time of the writing of TDRs.

LHCC recommendations

The Way Forward

LHCC perspective

- The **LHCC recommends** that a well-defined process to establish the financial envelope prior to the preparation of TDRs be set up and notes that close coordination with funding agencies will likely be required in this process.

- A well-defined procedure for the approval process of these upgrades will be very useful to guide the process towards the preparation, review and approval of TDRs and beyond.
  The LHCC will develop a proposal, inspired by the document defining the Phase II review and approval process (CERN-LHCC-2015-007 - “LHC Experiments Phase-II Upgrades Approval Process”), to be discussed at the coming LHCC meeting in May/June 2022.

Special RRB meeting with Funding Agencies last Friday June 24th

The Upgrade II approval process

Step 1, Part 1

Letter of Intent

From RRB discussion

- The experiments will provide an overall description of the intended upgrade programme in the form of a Letter of Intent (LoI) or similar. This documentation will contain conceptual designs for the global detector system, as well as for all elements of the upgrade, and will include:
  - Physics motivation and performance.
  - Detailed description of each element of the upgrade.
  - Plan and schedule for remaining R&D, prototyping etc.
  - Plans for technology selection, where applicable.
  - Current estimates of approximate total CORE project costs, and schedule, in the appropriate detail to complete this step of the review.
- LHCb has fulfilled this step with the submission of
  - Upgrade II Expression of Interest (LHCC 2017-003, 2017)
  - Physics Case for Upgrade II (LHCC 2018-027, 2018)
  - Upgrade II Framework TDR (CERN-LHCC-2021-012, 2021)
    - Contains some elements foreseen for Step 1, Part 2 (see next slide)

All very favorably reviewed by LHCC.

DONE!

The Upgrade II approval process

Step 1, Part 2

Scoping Document

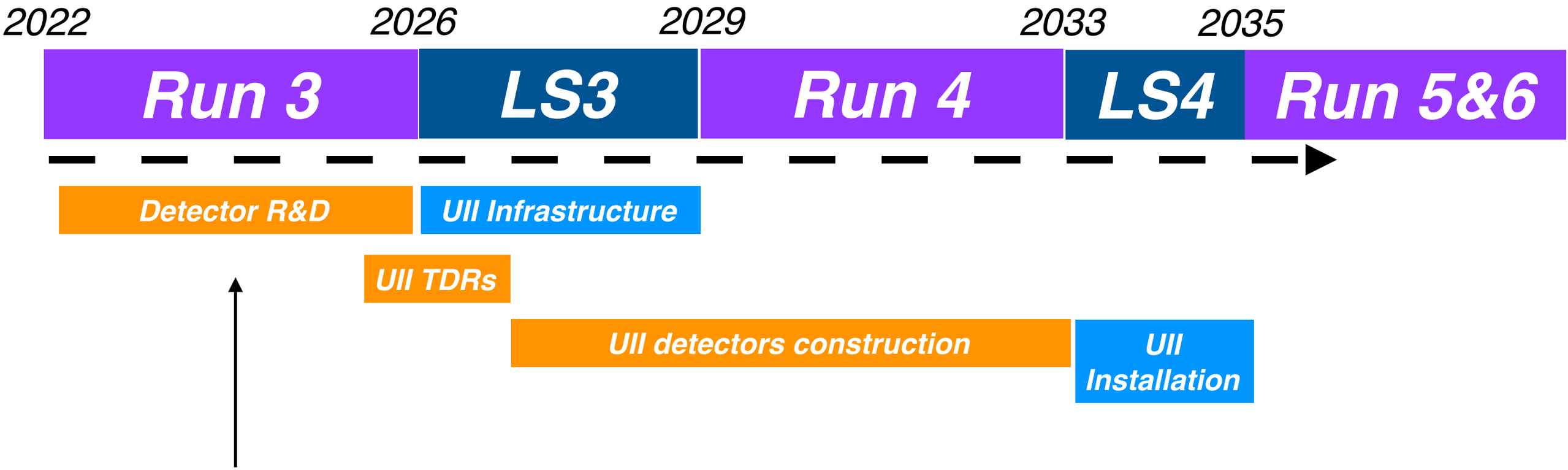
NEXT STEP

- The initial documents of Step 1.1 will be supplemented by a Scoping Document (SD).
  Requires the establishment of plausible cost scenarios to be defined in close exchange between the relevant stakeholders (Funding Agencies, CERN management, experiments, review bodies).
  Starting point: The scope defined in the initial documents.
- The SD will include:
  - Detector scoping options matched to the established cost ranges of the Phase IIb upgrade program, with estimates of cost, person power and the needed funding profile, as well as expected M&O costs.
  - An overview of the R&D, construction and installation schedules. Demonstration of sufficient schedule contingency with respect to a full installation of the upgrades in LS4 is essential.
  - Information on the availability of the required appropriate human resources, technical infrastructure and laboratory capacity in the collaboration to carry out the project with sufficient contingency.
  - A preliminary top-level project management plan setting out the project organisation, key milestones (including project phases and review strategy), deliverables, and risk analysis.
  - A list of expected Technical Design Reports (TDRs) and an overall plan with milestones and schedule for producing them.
  - An analysis of the impact of different scenarios on the physics performance.

Timeline depends on us, 1-2 years is a reasonable time range

the sooner the better to speed-up the approval process

Timeline for Upgrade II



SCOPING document

Rilevante per il MUON project:

- *al livello dello SCOPING document si possono mantenere ancora piu' opzioni, ma se ci sono cambiamenti rilevanti rispetto al FTDR vanno descritti*
- *eventuali aumenti di costo (possibili per il MUON) vanno ben giustificati (il richiamo generale e' per una riduzione dei costi)*

Impressioni dall'RRB

Durante la tavola rotonda, le FAs hanno espresso il loro punto di vista sull'Upgrade II

- *LHCb/UK ha vinto una gara e ha gia' ottenuto un finanziamento di ~60MEUR (inclusi staff) per il progetto*
- *Il CERN ha espresso l'intenzione di finanziare l'Upgrade II secondo il fair share (~12%, equivalenti a ~20MEUR su 175)*
- *l'INFN ha espresso interesse, e ha indicato ~2 anni come un periodo giusto per arrivare a una decisione. Chris ha mostrato il ferro di Opera al CERN come il primo mattone dell'Upgrade II… la cosa e' stata apprezzata*
- *le altre nazioni anche hanno espresso interesse, con situazioni varie per quanto riguarda le tempistiche*

Nel complesso, data la situazione sembra opportuno non allungare troppo i tempi per arrivare a uno scoping document

Rapporti con la Russia

"The CERN Council met this week, and high on the agenda was a topic that deeply concerns us all: the ongoing brutal invasion of Ukraine by the Russian Federation, aided by the Republic of Belarus. Yesterday the CERN Council declared that it intends to terminate CERN's International Cooperation Agreements with Russia and Belarus at their expiration dates in 2024. However, the situation will continue to be monitored carefully and the Council stands ready to take any further decision in the light of developments in Ukraine. These measures confirm the Council's strong condemnation of the invasion, while leaving the door open for continued scientific collaboration should conditions allow in the future."

The Council reaffirmed that all decisions taken to date, along with all the actions undertaken by the Management, which have had a marked impact on the involvement of the Russian Federation and the Republic of Belarus in the scientific programme of the Organization, remain in force until further Council decision.

→ ***Non e' possibile al momento coinvolgere formalmente gli istituti russi nelle discussioni su Upgrade II***

E' ovvio che discussioni informali possono avvenire e avveranno

→ ***La preparazione dello scenario per lo scoping document non può assumere il loro contributo***

→ ***La presenza della sola Italia per il MUON e' un problema che dovremo affrontare***

Organisation for the next steps

Project leaders have been asked to appoint deputies for UII

UT: Jianchun Wang

SciFi (includes Mighty Tracker): Fred Blanc, Mathew Needham

CALO: Andreas Schopper

Muon: Wander Baldini

Online & RTA: Tommaso Colombo

Situation after last CB, to be completed

TORCH: Neville Harnew (deputy Roger Forty)

Magnet Stations: Cesar Luiz Da Silva (deputy Macin Chrzaszcz)

New R&D projects

Organisation for the next steps

Upgrade II Planning Group

Mandate for R&D Phase:

1) follow the sub-detector R&D and ensure developments are in-line with a global project optimisation

2) target an optimisation of the project in ~18-24 months time, understand the implications on detector and physics programme, prepare/ review the financial envelope

3) organise, in strict connection with URB and MemCo, the dissemination of the project reaching new groups/communities

4) follow the preparations of LS3 activities, both for infrastructure and detector, assist in preparing LS3 TDRs where appropriate, liaise with LHC

The U2PG reports to TB,URB and CB where major decisions will be taken

Organisation for the next steps

Upgrade II Planning Group

Composition for the next 2 years

Management:	Matteo Palutan (dSP, chair), Andreas Schopper (URB), Chris Parkes (SP)
Physics Performance:	Yasmine Amhis (PC), Tim Gershon
Tracking:	Marcel Merk, Paula Collins
PID:	Guy Wilkinson, Hassan Jawahery
Online:	Renaud Le Gac, Vava Gligorov
Offline:	Marco Cattaneo, Vincenzo Vagnoni
Electronics:	Ken Wyllie
Infrastructure:	Eric Thomas
New Groups:	Giovanni Passaleva

Endorsed at June CB

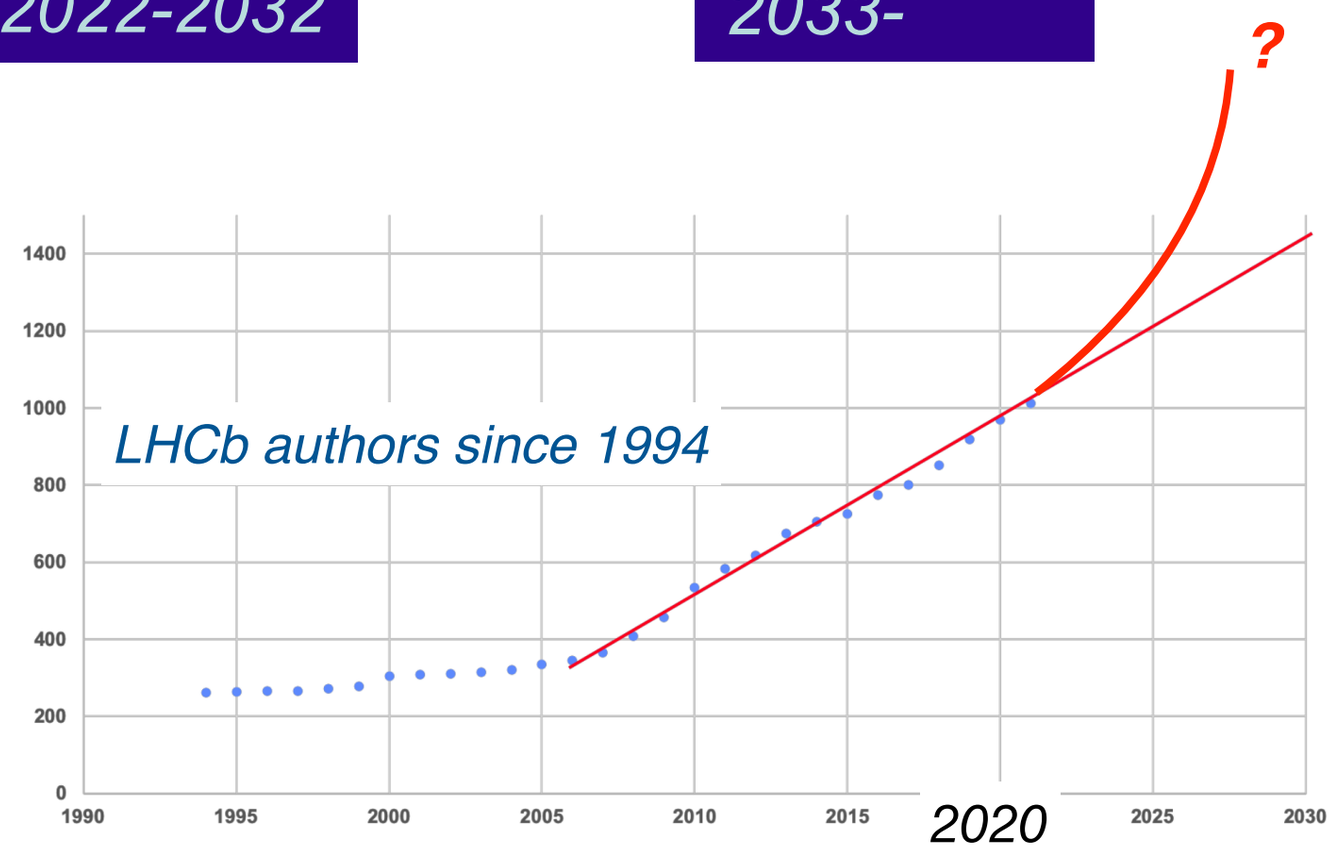
Conclusions

After the FTDR publication, the Upgrade II is now proceeding to the next steps: R&D, design optimisation, discussion with Funding Agencies

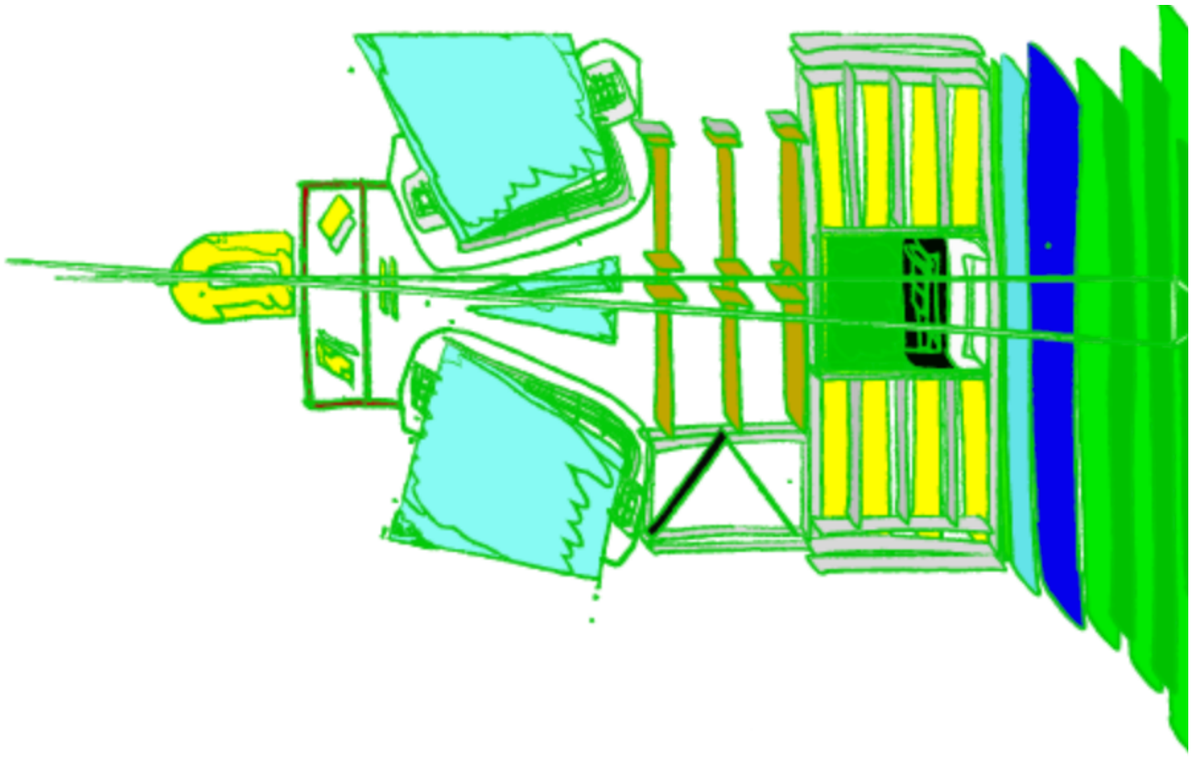
We need to carefully balance and prioritise btw the different activities…

Physics results	***Constructed: now commission!***	***It's taking shape!***
Original	*Upgrade I*	*Upgrade II*
2009-2018	*2022-2032*	*2033-*

…and of course we need many new collaborators!!



2023: its time for a new UII workshop!



"Vth Workshop on LHCb Upgrade II"

RELOADED

29-31 March 2023 in Barcelona (really, not virtually!)

Many thanks to Eugeni and Barcelona team for taking the challenge a 2nd time!

Final confirmation in a couple of weeks

SPARES

Directions for downscoping

Consequences of downscoping are being studied, effect are driven by physics or technology, a few examples below

system	what	cost reduction	impact/comments
RTA	reduce peak luminosity to 1.0×10^{34}	8 MCHF	reduce integrated lumi by ~15% , equivalent to one year of data taking, significant risk at this stage of the project
ECAL	single readout on outer region => reduce readout ch. by ~30%	13 MCHF	significant degradation in detector performance is expected, impact on physics under evaluation; effect on electrons (*i.e.* LFU studies) particularly important
TORCH	reduce coverage by 1/3	3.5 CHF	acceptance on low momentum particles reduced by ~25%, degradation on particle identification, with effect especially on flavour tagging, to be estimated
MT-CMOS	reduce CMOS pixel area by 40%	7 MCHF	this is possible if scintillating fibres with better radiation hardness properties become available to complement the pixels; reduction in tracking performances under study

The above preliminary numbers are given to illustrate the expected size of effects

We need to evaluate the impact on the physics programme, and to make best possible use of R&D on technology

We're ready to take the challenge of discussing the size of the project in terms of physics opportunities vs collaboration strength vs funds availability

Preparation of infrastructure during LS3

Based on the present experience, 2 years is the bare minimum to install the new LHCb detector during LS4

This is assuming that the intervention on the LHC cryogenic equipment is performed at LS3, otherwise a significant interference should be accounted for

A longer LS3 beneficial for LHCb only if it makes possible the intervention on the LHC cryogenic equipment

Preparation work on LHCb infrastructure for UII also planned:

- *Additional shielding for Muon detector in place of HCAL*
- *New platforms for ECAL FE electronics*
- *Refurbishment of underground infrastructure for UII online system*
- *Power distribution*
- *Safety systems*
- *Assembly buildings*

Muon shielding