LHCb Upgrade

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On behalf of LHCb TC team

LS2 DAYS
29-30 SEPTEMBER 2015

http://indico.cern.ch/event/436424/

LHCb Upgrade parameters

Luminosity

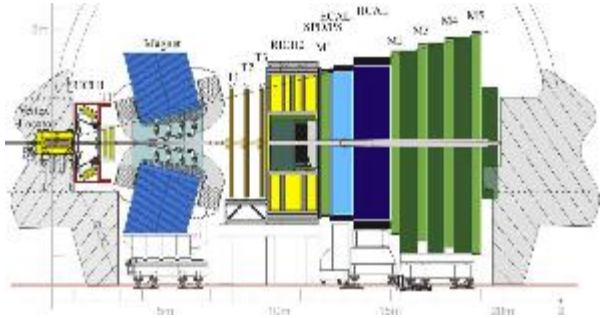
Run2 **4 x 10^{32} cm^{-2} s^{-1}** (2 x nominal)

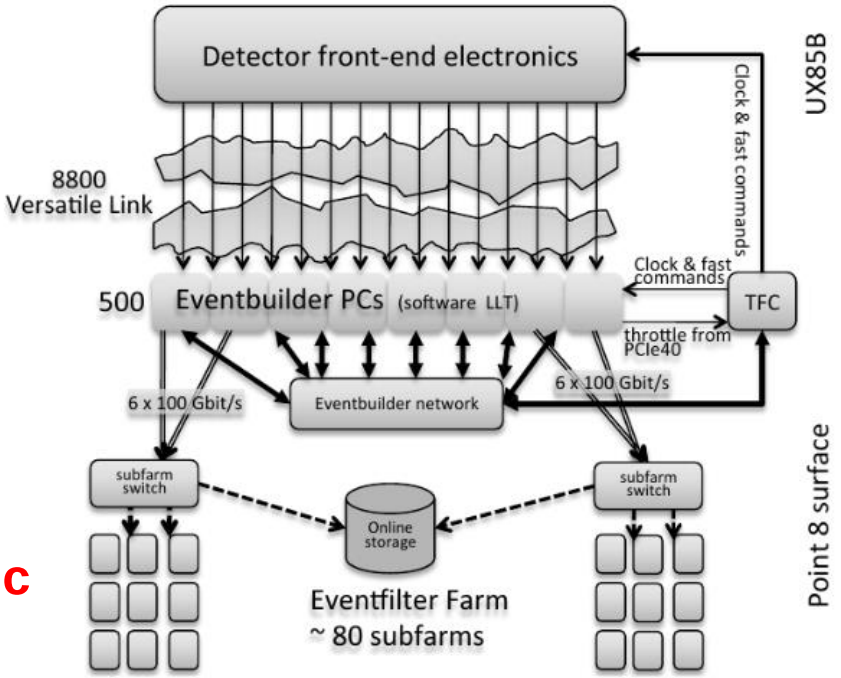
Upgrade: **2 x 10^{33} cm^{-2} s^{-1}** Run

Read-out

Run 2 **1 MHz**

Upgrade **40 MHz**

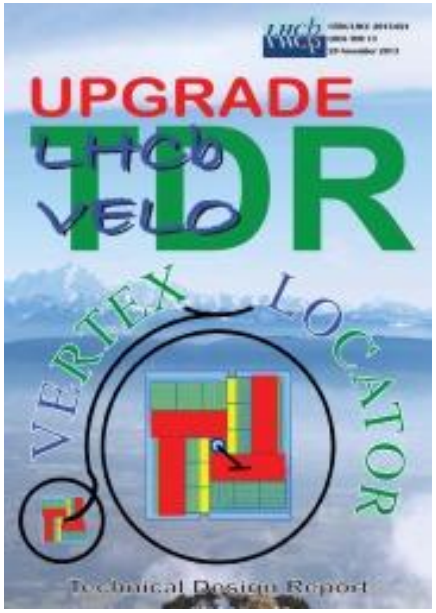


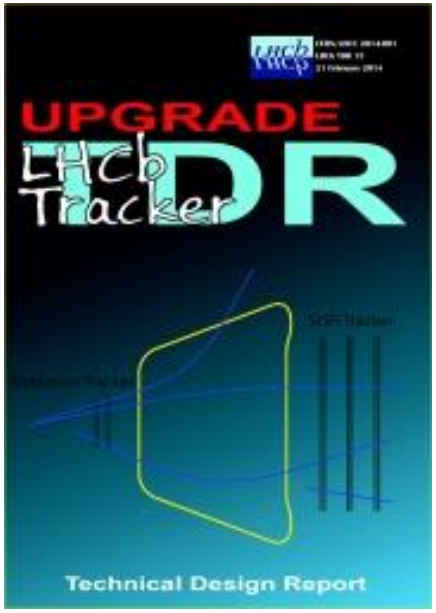


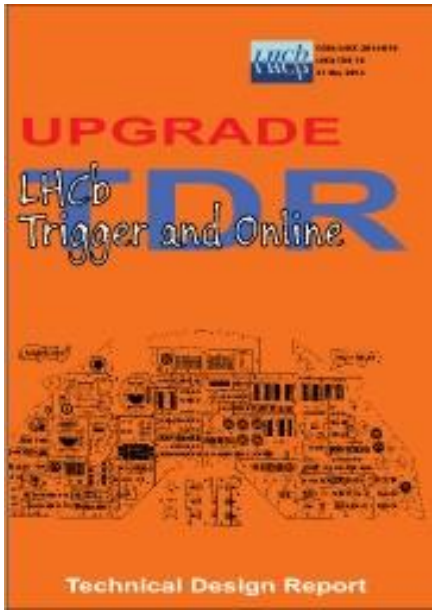
The LHCb upgrade in short:

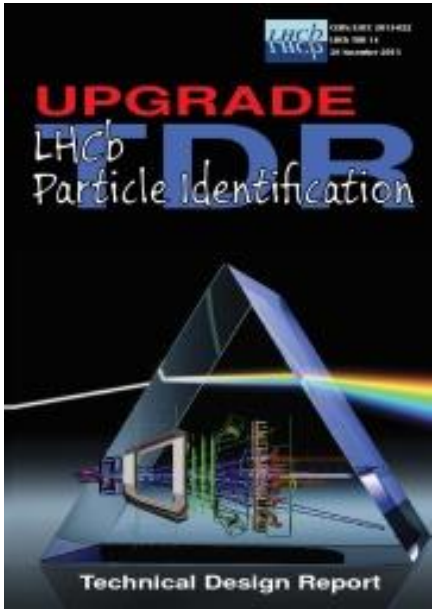
1. **Replace all detectors which cannot stand the rate (occupancy) and the corresponding infrastructure**
2. **Replace all Read-Out Electronic**
3. **New Data Center**

Further readings





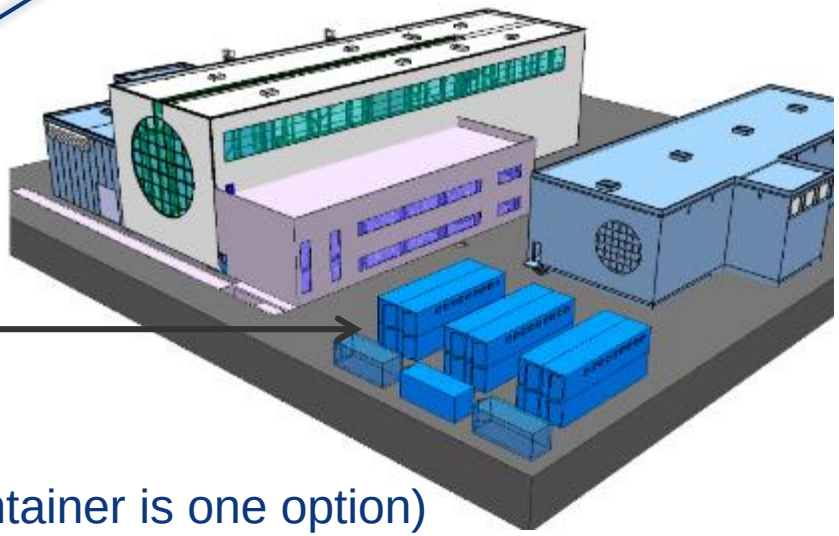




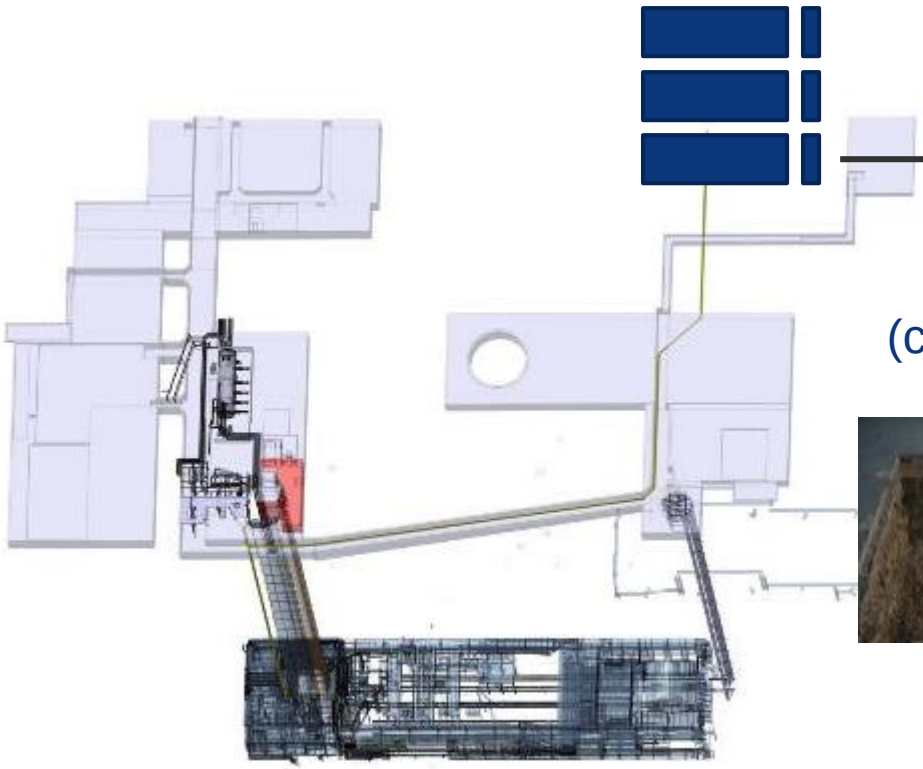
LHCb Upgrade: Surface

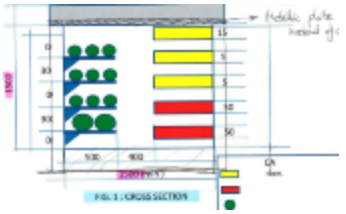
- New Data Center
- Pull 17000 x 300m fibres from UX to Surface
- New data centre 2MW IT power
- New technical galleries

Not constrained by LHC schedule

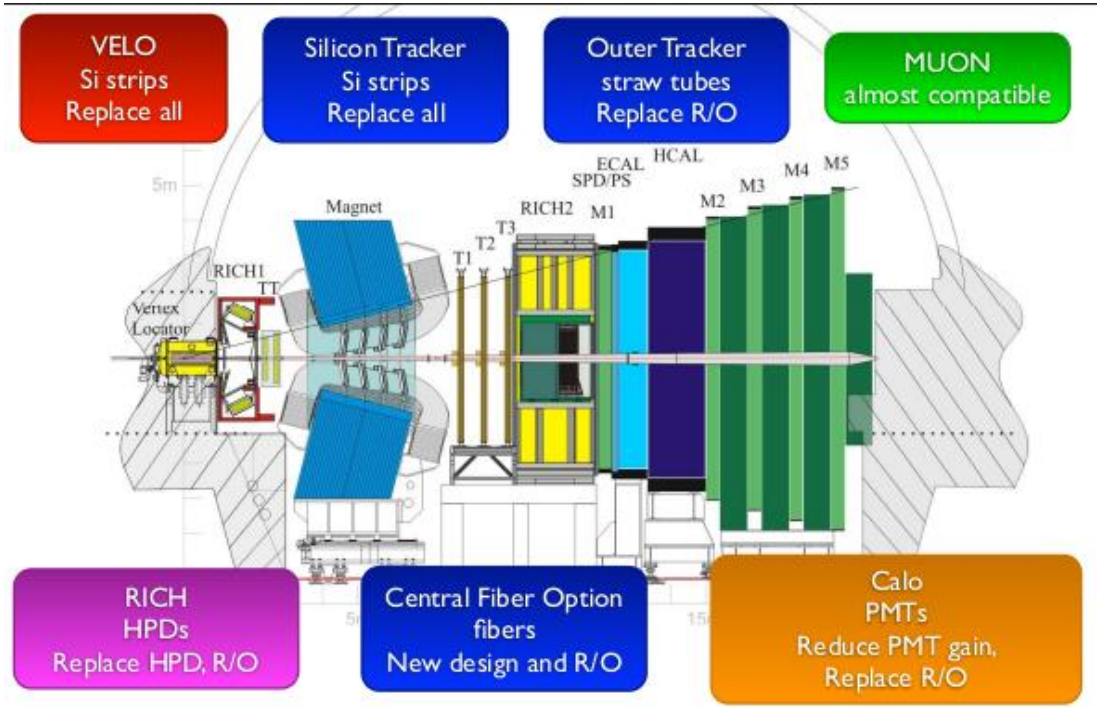


(container is one option)





LHCb Upgrade: Underground



Systems to be removed

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

New systems to be installed

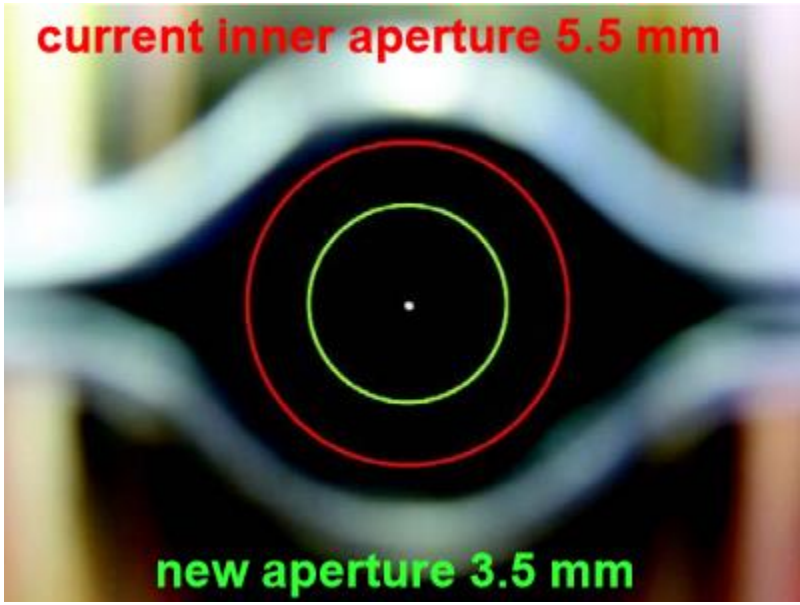
- VELO Pixel
- UT
- SciFi

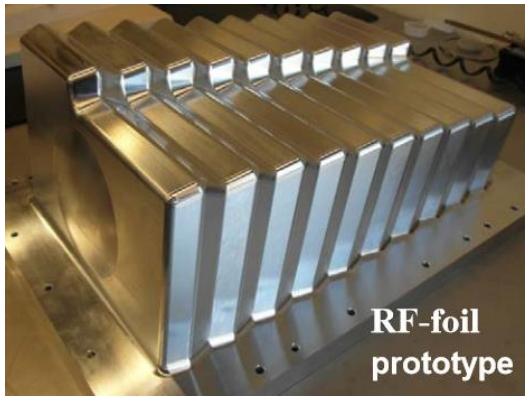
Systems to be partly modified/removed

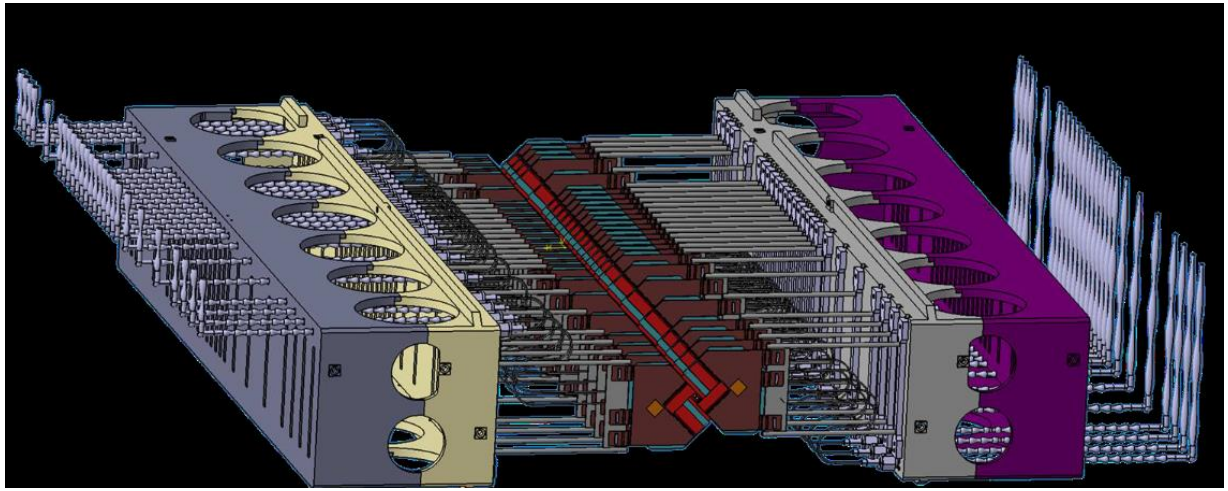
- MUON Electronics
- CALO Electronics
- RICH1 & RICH2 HPDs

VELO

- New silicon pixel sensors
- New RF foil
- New Wakefield suppressor
- New motion System
- New CO_2 cooling
- …

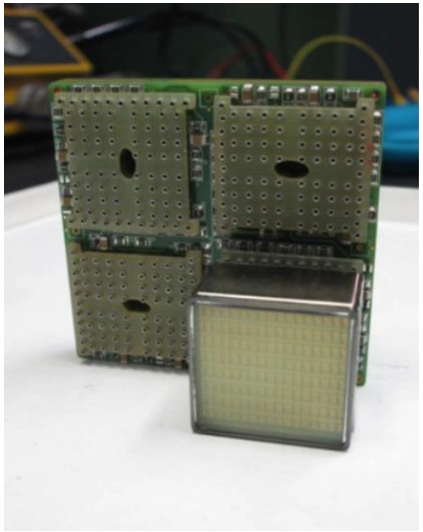


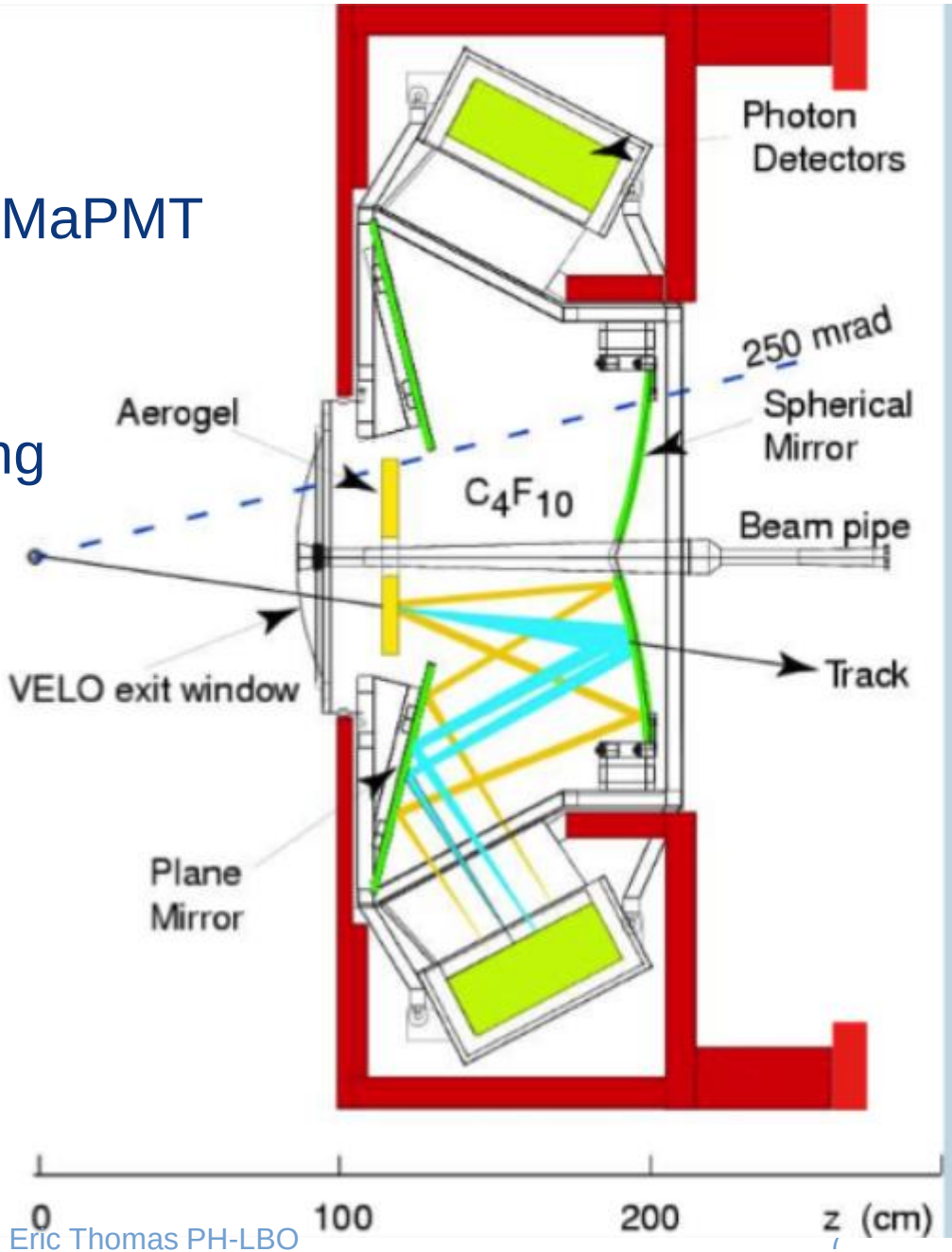




RICH1 and RICH2

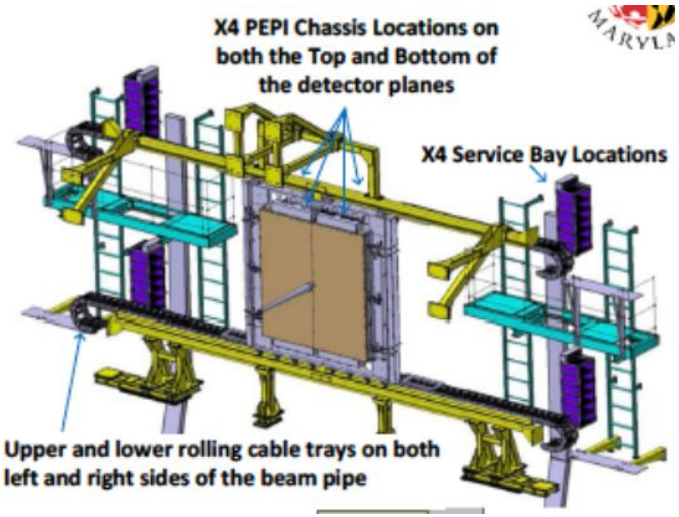
- New photon detector: 64ch MaPMT
- New optic (RICH1)
- New gas enclosure (1)
- Re-use (part) existing cooling facilities
- Modifications of shielding
- …

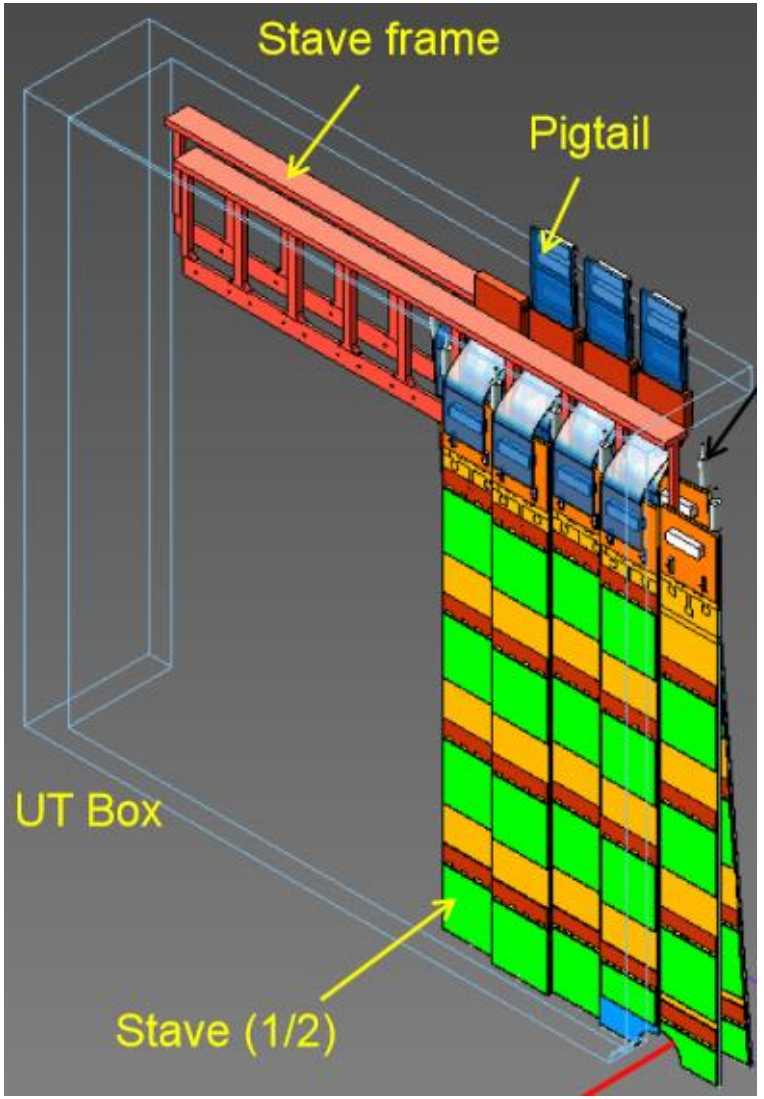




UT

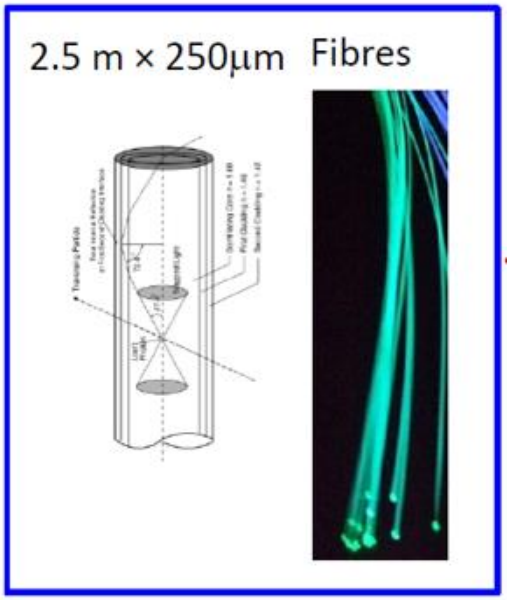
- New silicon sensors (strip)
- Less material, closer to beam pipe, read-out strip geometry adapted to particle flux
- New CO2 cooling system
- Keep only supporting rails
- …

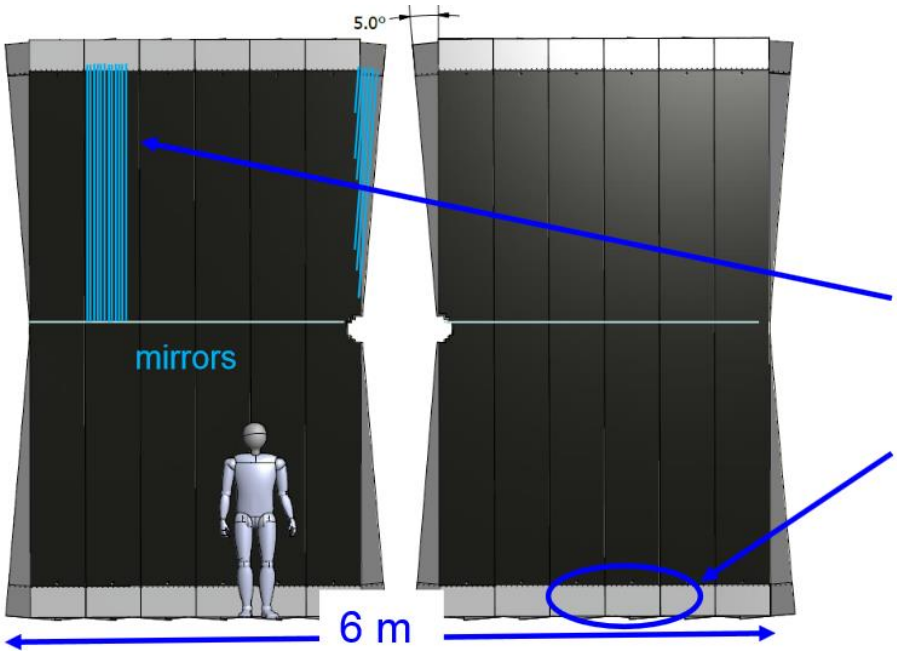


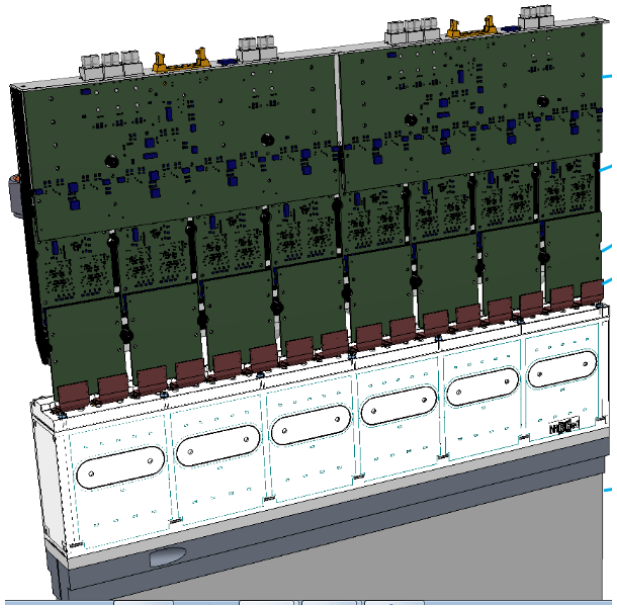


SciFi

- Scintillating fibers (12 000km)
- Read out by SiPM (-40ºC)
- New monophase cooling system

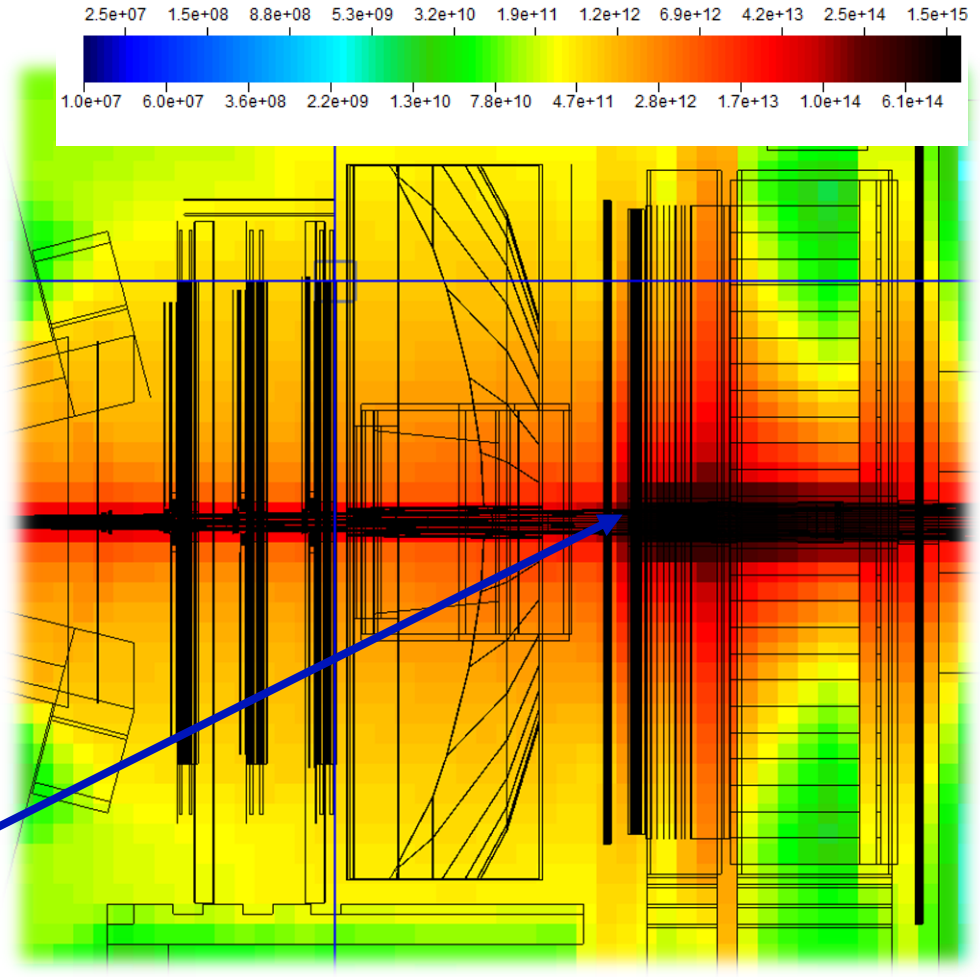






Shielding (neutron)

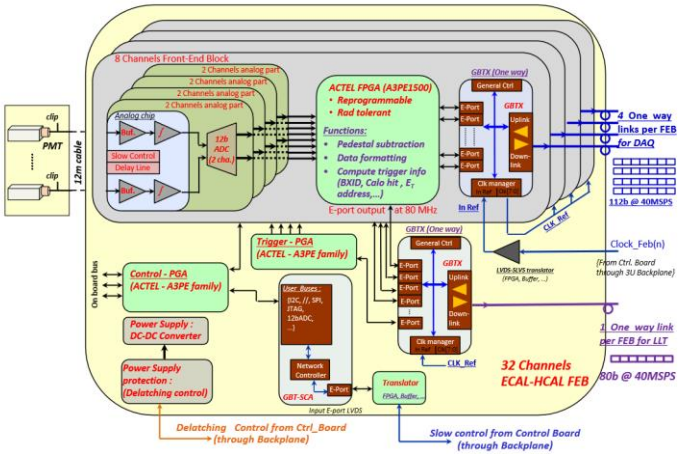
- Silicon Photomultipliers are not immune against radiation
- Shielding will be required.
- Concept, design and integration being studied!
- Structure to be built!

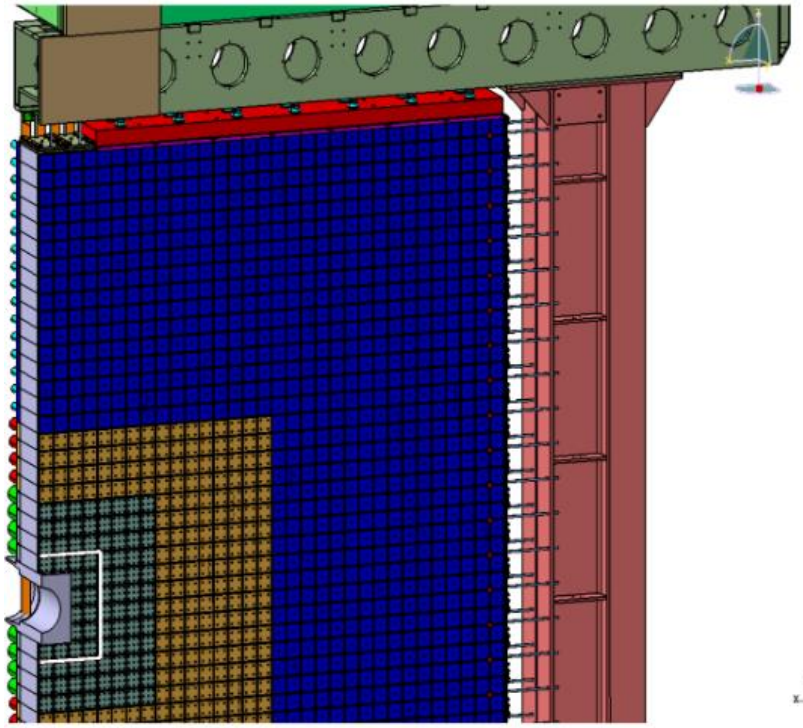


1MeV neutron equivalent fluence: Absolute Values
2x5cm + 10cm PE
(maximum thickness)

CALORIMETERS

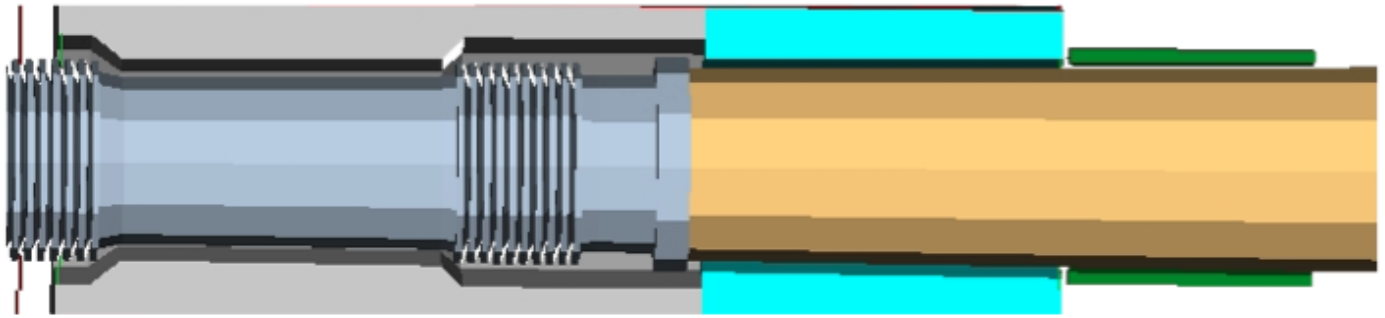
- Replace only few innermost modules (ECAL) (may be shifted to LS3)
- Add shielding (HCAL)
- New R/O electronics





M2-M5

- Production of New chambers
- Remove R/O electronic and cables
- Install new R/O electronic chain
- Additional shielding and modification of the beam pipe plugs (could be anticipated yets, eyets)



HCAL beam plug

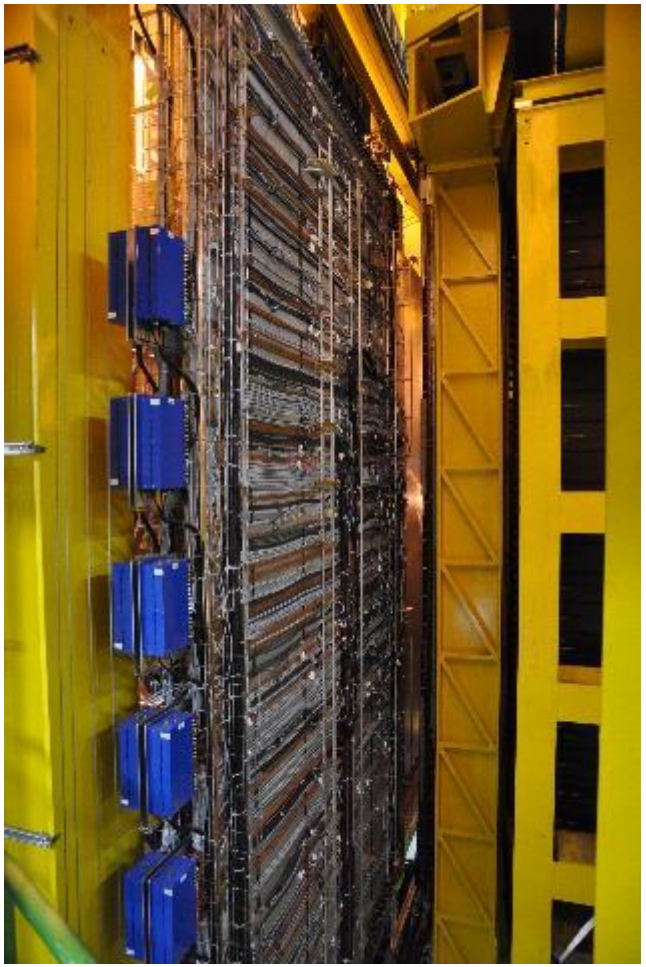
M2 plug

Vacuum Chamber

- Remove and re-install vacuum chamber
- Access structures and platforms to be installed
- In Addition wrt LS1: Section1, Wakefield suppressor, RF foil, and bake-out.
- Constraints from VELO, RICH1, and UT
- Tight planning and correlation

Large objects to dismantle

- M1

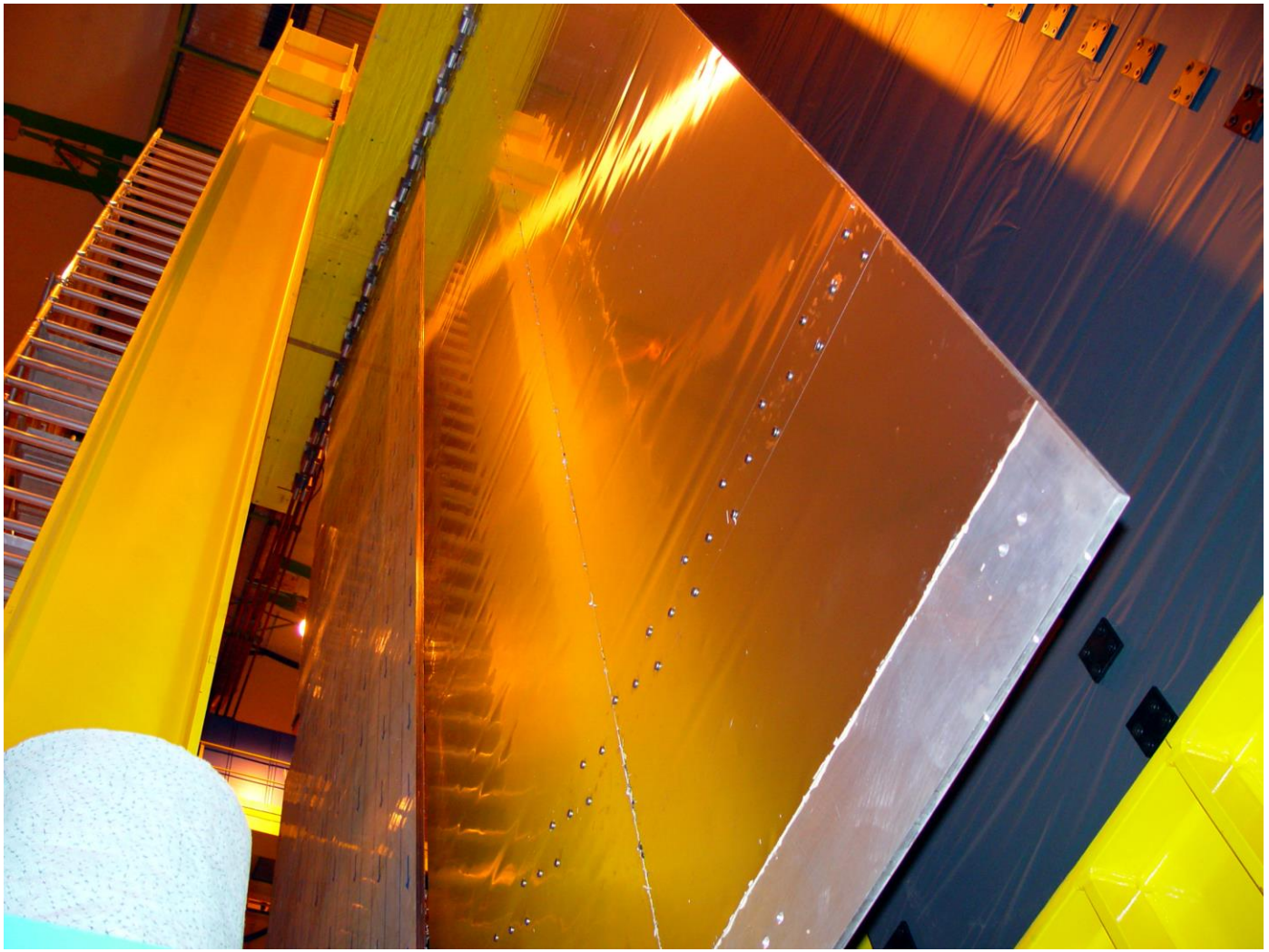


Large objects to dismantle

- PS/SPD

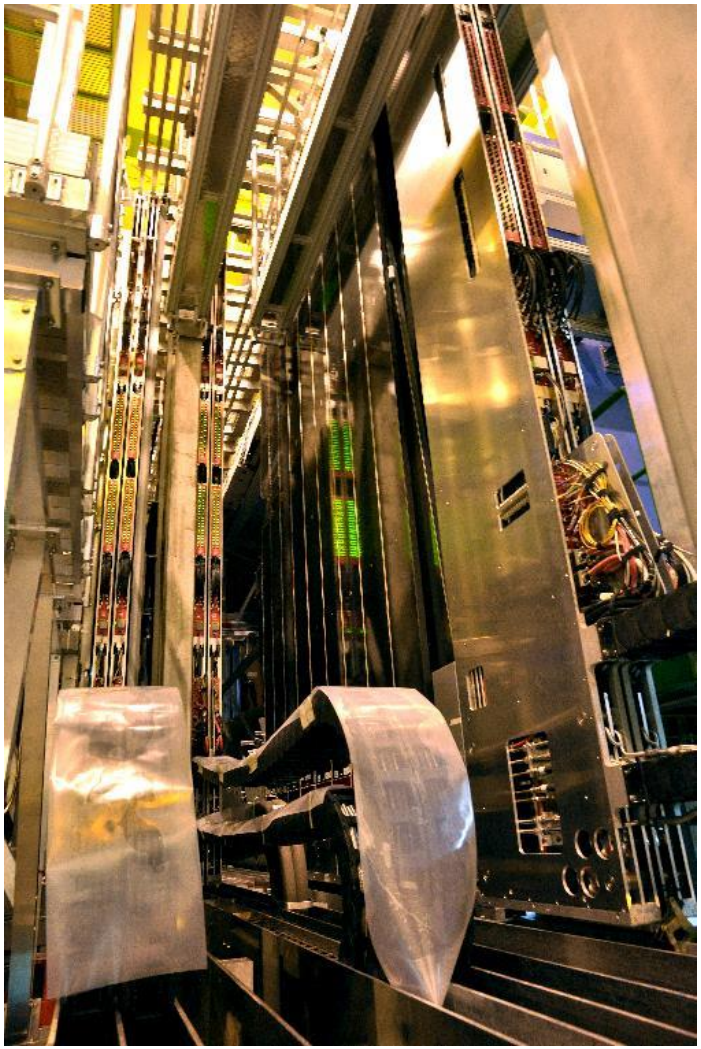
Large objects to dismantle

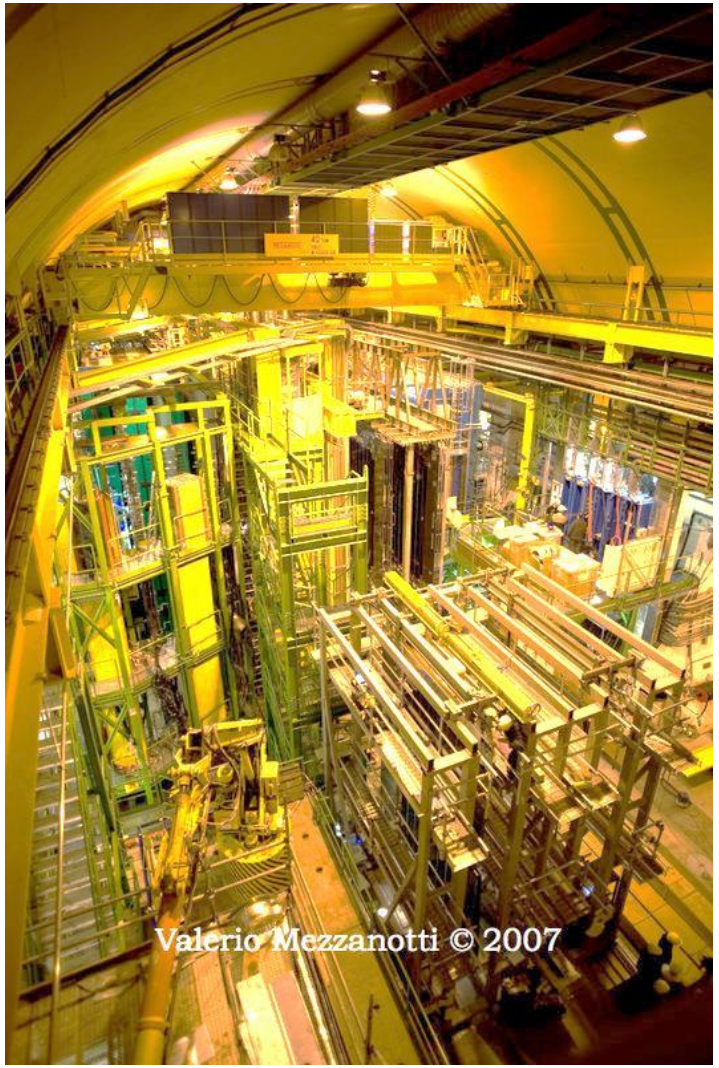
- Lead



Large objects to dismantle

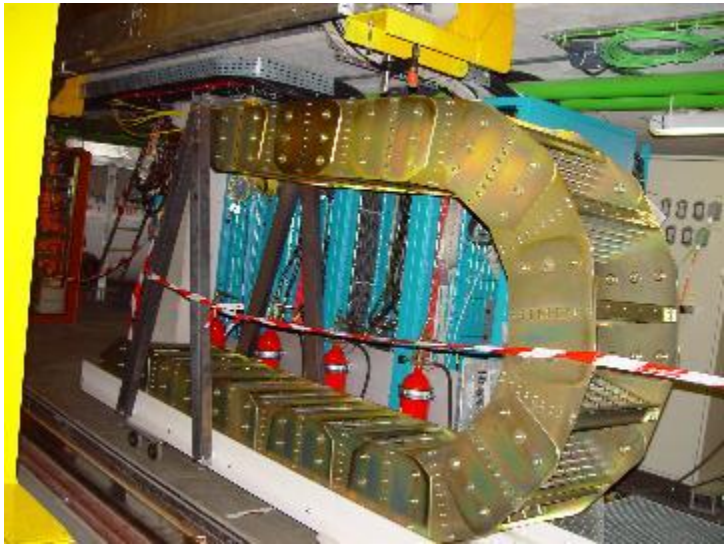
- OT





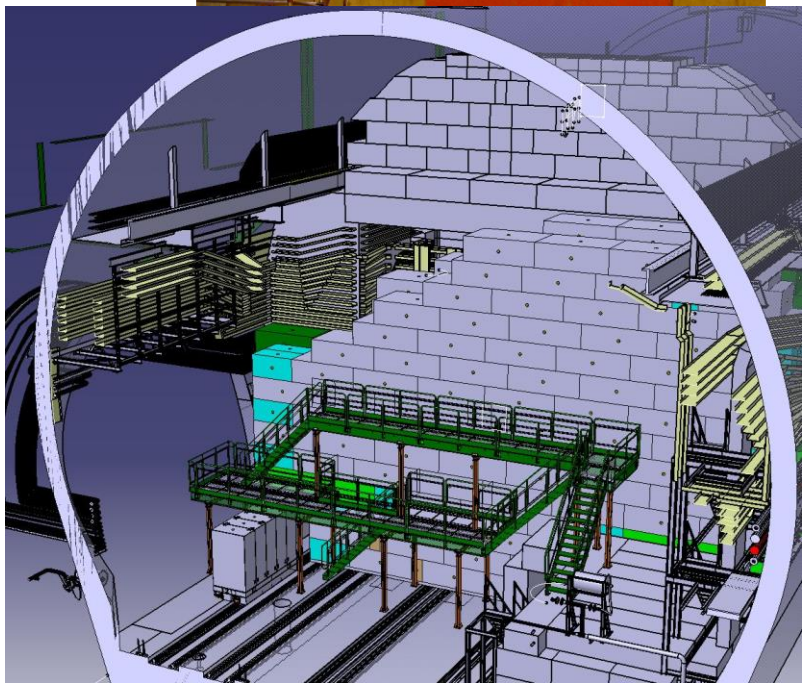
Large objects to dismantle

- Services

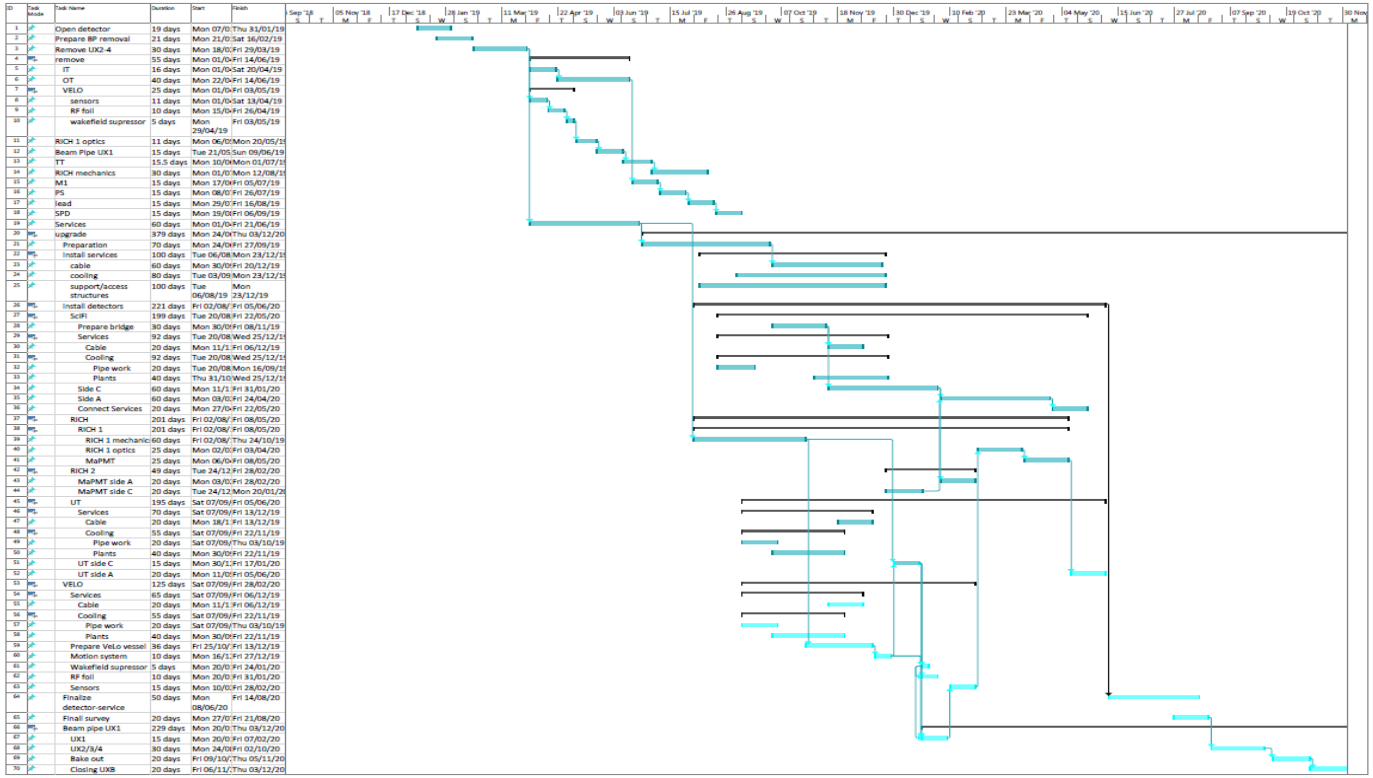


Shielding wall

- Dismantle ~33%
- For passage od detector services
- Issue : dust, logistic and storage of blocs



Planning - preliminary



ID	Task Mode	Task Name	Duration	Start	Finish
1		Open detector	19 days	Mon 07/01	Thu 31/01/19
2		Prepare RP removal	21 days	Mon 21/01	Sat 16/02/19
3		Remove UX2-4	30 days	Mon 18/02	Fri 29/03/19
4		remove	55 days	Mon 01/04	Fri 14/06/19
5		IT	16 days	Mon 01/04	Sat 20/04/19
6		OT	40 days	Mon 22/04	Fri 14/06/19
7		VELO	25 days	Mon 01/04	Fri 03/05/19
8		sensors	11 days	Mon 01/04	Sat 13/04/19
9		RF foil	10 days	Mon 15/04	Fri 26/04/19
10		wakefield supressor	5 days	Mon 29/04/19	Fri 03/05/19
11		RICH 1 optics	11 days	Mon 06/07	Mon 20/05/19
12		Beam Pipe UX1	15 days	Tue 21/05	Sun 09/06/19
13		TT	15.5 days	Mon 10/06	Mon 01/07/19
14		RICH mechanics	30 days	Mon 01/07	Mon 12/08/19
15		M1	15 days	Mon 17/06	Fri 05/07/19
16		PS	15 days	Mon 08/07	Fri 26/07/19
17		lead	15 days	Mon 29/07	Fri 16/08/19
18		SPD	15 days	Mon 19/08	Fri 06/09/19
19		Services	60 days	Mon 01/04	Fri 21/06/19
20		upgrade	379 days	Mon 24/04	Thu 03/12/20
21		Preparation	70 days	Mon 24/04	Fri 27/09/19
22		Install services	100 days	Tue 06/08	Mon 23/12/19
23		cable	60 days	Mon 30/09	Fri 20/12/19
24		cooling	80 days	Tue 03/09	Mon 23/12/19
25		support/access structures	100 days	Tue 06/08/19	Mon 23/12/19
26		Install detectors	221 days	Fri 02/08	Fri 05/06/20
27		SciFi	199 days	Tue 20/08	Fri 22/05/20
28		Prepare bridge	30 days	Mon 30/09	Fri 08/11/19
29		Services	92 days	Tue 20/08	Wed 25/12/19
30		Cable	20 days	Mon 11/11	Fri 06/12/19
31		Cooling	92 days	Tue 20/08	Wed 25/12/19
32		Pipe work	20 days	Tue 20/08	Mon 16/09/19
33		Plants	40 days	Thu 31/10	Wed 25/12/19
34		Side C	60 days	Mon 11/11	Fri 31/01/20
35		Side A	60 days	Mon 09/03	Fri 24/04/20
36		Connect Services	20 days	Mon 27/04	Fri 22/05/20
37		RICH	201 days	Fri 02/08	Fri 08/05/20
38		RICH 1	201 days	Fri 02/08	Fri 08/05/20
39		RICH 1 mechanic	60 days	Fri 02/08	Thu 24/10/19
40		RICH 1 optics	25 days	Mon 02/09	Fri 03/04/20
41		MaPMT	25 days	Mon 06/04	Fri 08/05/20
42		RICH 2	49 days	Tue 24/12	Fri 28/02/20
43		MaPMT side A	20 days	Mon 03/02	Fri 28/02/20
44		MaPMT side C	20 days	Tue 24/12	Mon 20/01/20
45		UT	195 days	Sat 07/09	Fri 05/06/20
46		Services	70 days	Sat 07/09	Fri 13/12/19
47		Cable	20 days	Mon 18/11	Fri 13/12/19
48		Cooling	55 days	Sat 07/09	Fri 22/11/19
49		Pipe work	20 days	Sat 07/09	Thu 03/10/19
50		Plants	40 days	Mon 30/09	Fri 22/11/19
51		UT side C	15 days	Mon 30/12	Fri 17/01/20
52		UT side A	20 days	Mon 11/05	Fri 05/06/20
53		VELO	125 days	Sat 07/09	Fri 28/02/20
54		Services	65 days	Sat 07/09	Fri 06/12/19
55		Cable	20 days	Mon 11/11	Fri 06/12/19
56		Cooling	55 days	Sat 07/09	Fri 22/11/19
57		Pipe work	20 days	Sat 07/09	Thu 03/10/19
58		Plants	40 days	Mon 30/09	Fri 22/11/19
59		Prepare VeLo vessel	36 days	Fri 25/10	Fri 13/12/19
60		Motion system	10 days	Mon 16/12	Fri 27/12/19
61		Wakefield supressor	5 days	Mon 20/01	Fri 24/01/20
62		RF foil	10 days	Mon 20/01	Fri 31/01/20
63		Sensors	15 days	Mon 10/02	Fri 28/02/20
64		Finalize detector-service	50 days	Mon 08/06/20	Fri 14/08/20
65		Finall survey	20 days	Mon 27/07	Fri 21/08/20
66		Beam pipe UX1	229 days	Mon 20/01	Thu 03/12/20
67		UX1	15 days	Mon 20/01	Fri 07/02/20
68		UX2/3/4	30 days	Mon 24/08	Fri 02/10/20
69		Bake out	20 days	Fri 09/10	Thu 05/11/20
70		Closing UX8	20 days	Fri 06/11	Thu 03/12/20

- The planning is tight and not much room is left for contingencies
- There are several internal dependencies and the main sequence is unlikely to evolve much

Interfaces and support from CERN groups

EN-EL 1/2 Power distribution

- Power for DATA CENTER (→ before LS2)
  - Primary power supply, 18kV transformer
  - Power distribution for Computing (2MW)
  - Power for services (cooling, ventilation, building …)
- Power for new equipment's (e.g. cooling plants)
- Modification/consolidation of existing installation wherever required.

EN-EL 2/2 Optical Fibers

- 17k fibers through PM (access and collaboration with Cryo)
- Installation: two options (trunk cables – blowing)
- All supports in place (LS1 – thanks to EN-MEF/EL)

- Provider of cables to be defined
- EN has forwarded a much lower bid than before
- LHCb expects in-kind contribution from institute
- Both fibre types meet specification.
- Cost and administration to be defined.

EN-CV 1/5 Detector Cooling

For VELO-UT

- CO2 2 phases
- Two independent cooling plant systems
- Should be redundant (back-up each other during maintenance, tech problems)
- To be supplied by PH-DT / LHCb – requirements to be issued soon.

➢ Primary cooling: air and mixed or chilled water (may be anticipated to EYETS)

EN-CV 2/5 Detector Cooling

RICH1 and RICH2

- C6F14 monophase >11C
- Power: may exceed the current RICH1+2 (8kW) by ~30% (TBC)
- Baseline: keep existing system and transfer lines (see edms 1327542)

- ➢ Modify existing plants to cope with new specification
- ➢ Upgrade/consolidation to run until LS4 and beyond
- ➢ Consider Greenhouse friendly alternative to C6F14

EN-CV 3/5 Detector Cooling

SciFi - SiPM

C_6F_{14} monophase, -50ºC

- New plant & transfer lines
- Greenhouse friendly alternative should be considered

SciFi – FE Electronics

Technology Demineralized H_20

- Power: probably significantly (50%) above the current OT/SPD plant
- Baseline: adapt existing OT/SPD plant, keep the transfer lines (TBC)
- Upgrade/consolidation wherever needed to run > 2030

EN-CV 4/5 PC FARM

Technology still to be decided

Quickly evolving field

- Main options identified until today:
  - Direct Liquid Cooling (DLC)
  - Natural free cooling (NFC)
  - Water Cooled Heat Exchanger Doors (WCD)
  - …

➢Primary cooling / air conditioning shall be supplied

EN-CV 5/5 Ventilation UX85

- Pressure differential cascade found acceptable for run2 running conditions

- Increase to Lumi ~2 10^{33} Hz cm^{-2}

➢ Pressure differentials shall comply to HSE/RP requirements (does the current ‘derogation’ still holds?)

EN-HE HANDLING

- Handling for dismantling and installation of detectors, associated services, access platforms and support structures.
- Transport from UX to storage space
- Handling for dismantling and re-installation of shielding wall
- Transport of the concrete block.
- Handling for SiPM shielding wall installation
- Crane operators, cherry picker driver

EN-MEF-SU SURVEY

- Consulting during R&D phase (ongoing)
- Survey during the assembly phase
- Sporadic survey before and during installation
- Survey of most systems after installation

EN-MEF-COL SAFETY COORDINATORS

The LS2 safety risk factors:

- Heavy handling
- Co-activities
- Users, contractors,
- Tight schedule

LHCb needs on site Safety Coordinator

- Provide VIC
- attending meetings - aware of activities
- Providing advice to users, contractors, and Staff

HSE-RP RADIOPROTECTION

- LHCb is providing personnel for low risk and low duty task (RPE and RPA).

- Additional support will be needed, mostly during the dismantling phase (high flow of outgoing material)
  - Clearance and sorting of outgoing material
  - Risk assessment for destructive work

GS STORAGE - LOGISTICS

- Detectors parts will be recuperated, stored, or become (radioactive) waste.
- Some may return to institute
- Final fine dis-assembling will not take place in the pit

➢Need storage space for large detector parts, with some components being radioactive (min 200m^2)

➢Need protected storage space for concrete blocks (100m^2)

GS Civil Engineering

- Civil Engineering for new data center
  - Preparation for the housing of PC farm
  - Technical galleries from SCX to PC FARM
  - Technical galleries from Transformers to PC farm

SYMMARY

- LHCb will have a major upgrade in LS2
- The planning is tight and sequences must be respected.
- Resources and support from CERN technical department are needed
- In addition to high level of technical support LHCb relies on commitment and flexibility of all stakeholders

Thank you for your attention!