HL-LHC BLM layout proposal for IP1 & IP5

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Valuable contributions from R.Calaga, E.Effinger, N.Joannon, A.Lechner, F.P.Nicoletti, F.X.Nuiry, J.Oliveira, F.Sanchez Galan, G.Girardot, C.Zamantzas

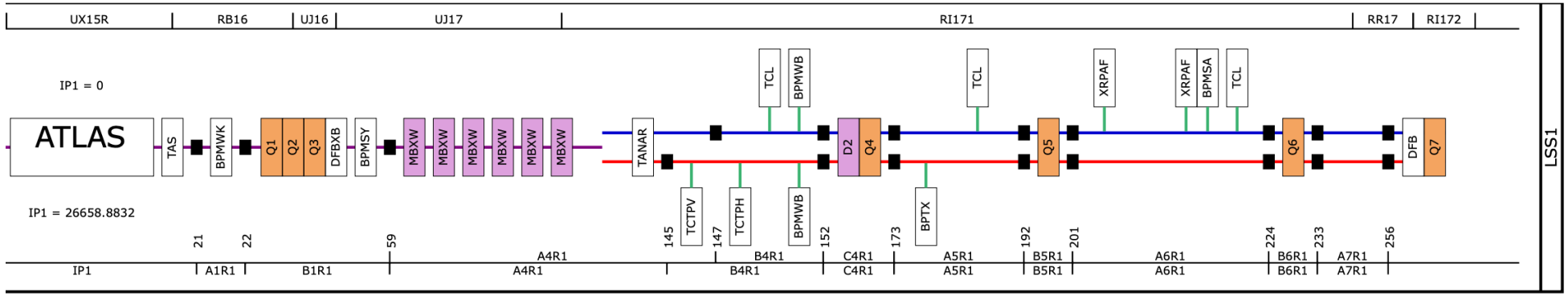
27 May 2024 - BLMTWG #99 BLM Thresholds Working Group

Introduction

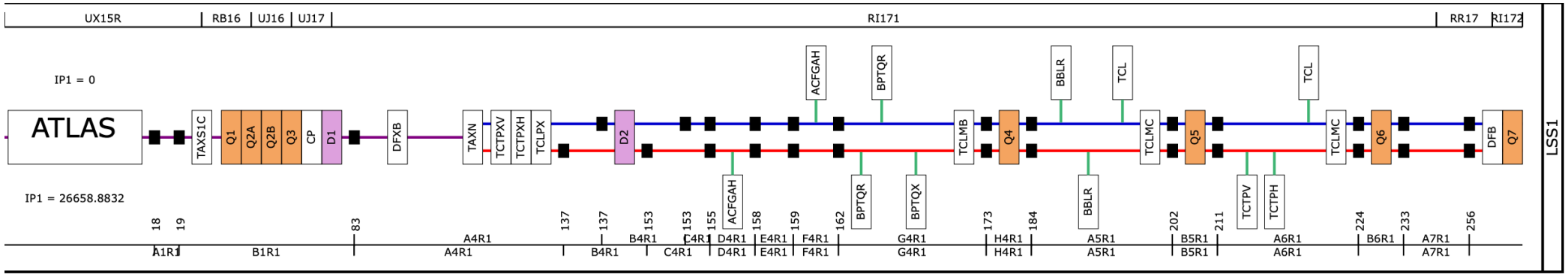
Several upgrades for HL-LHC with the goal of increase the integrated luminosity by a factor of 10 beyond the LHC design values (250 fb-1/year for 12 years)

- Cell1 to Cell3 will be completely renovated
- Cell4 to Cell6 new recabling, new elements and displacement of present elements

LHC today



HL-LHC



Figures from https://accelerator-synoptics.web.cern.ch (the distances in the figure are not to scale)

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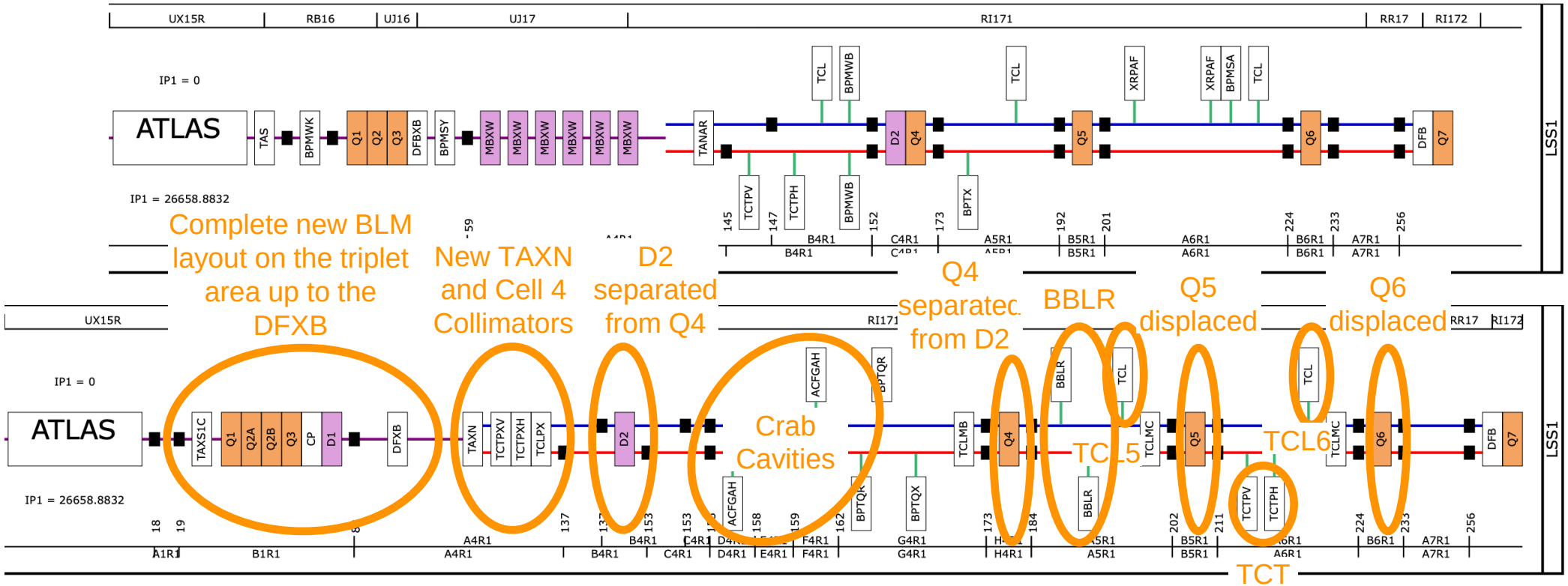
HL-LHC



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BLM layout for IP1/IP5

Cell 1 to Cell 3:

- New layout for Cell 1 to Cell 3 for the renovation of the triplet area

Cell 4:

- New TAXN
- New TCTPXH, TCTPXV and TCL4
- D2 which is separated from Q4
- Crab-Cavities
- Q4 which is separated from D2
- BBLR (between Cell4 and Cell 5)

Cell 5:

- TCL5
- Q5 displaced

Cell 6:

- TCTPV, TCTPH
- TCL6
- Q6 displaced

Triplets BLM layout (Cell 1 - Cell 3)

Integration started long time ago ~ 2020

- HL-LHC WP15 Integration meeting: https://indico.cern.ch/event/968283/ with the estimation of number of BLM monitors in that area to go through the cabling request.
- Several discussions since then but integration was not finalised.
- Most material is in BI-BL cernbox folder until formalised into ECR

  CERNBox/eos/project/be-bi-bl/BLM/BLMLHC_LS3_HL

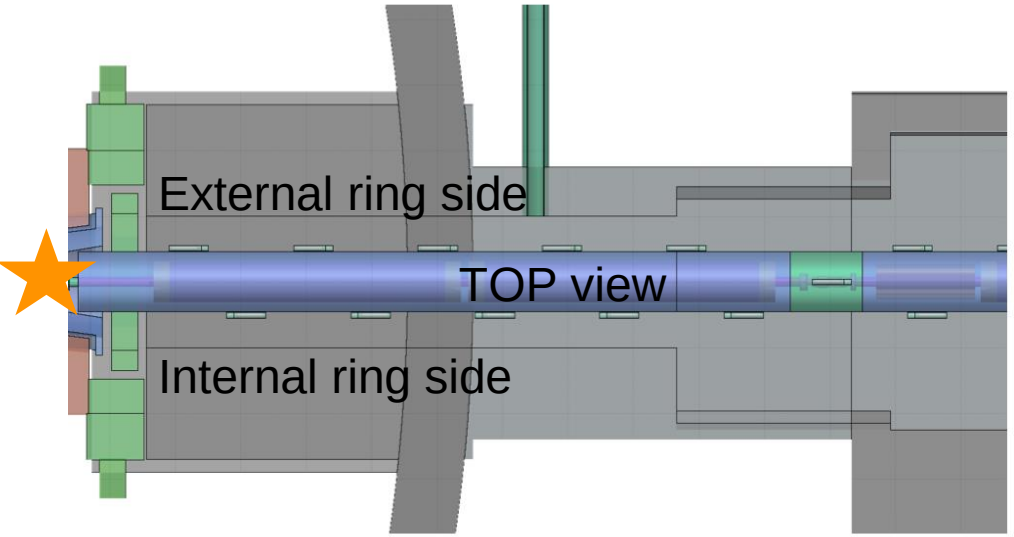
Expected beam loss contribution on the triplets:

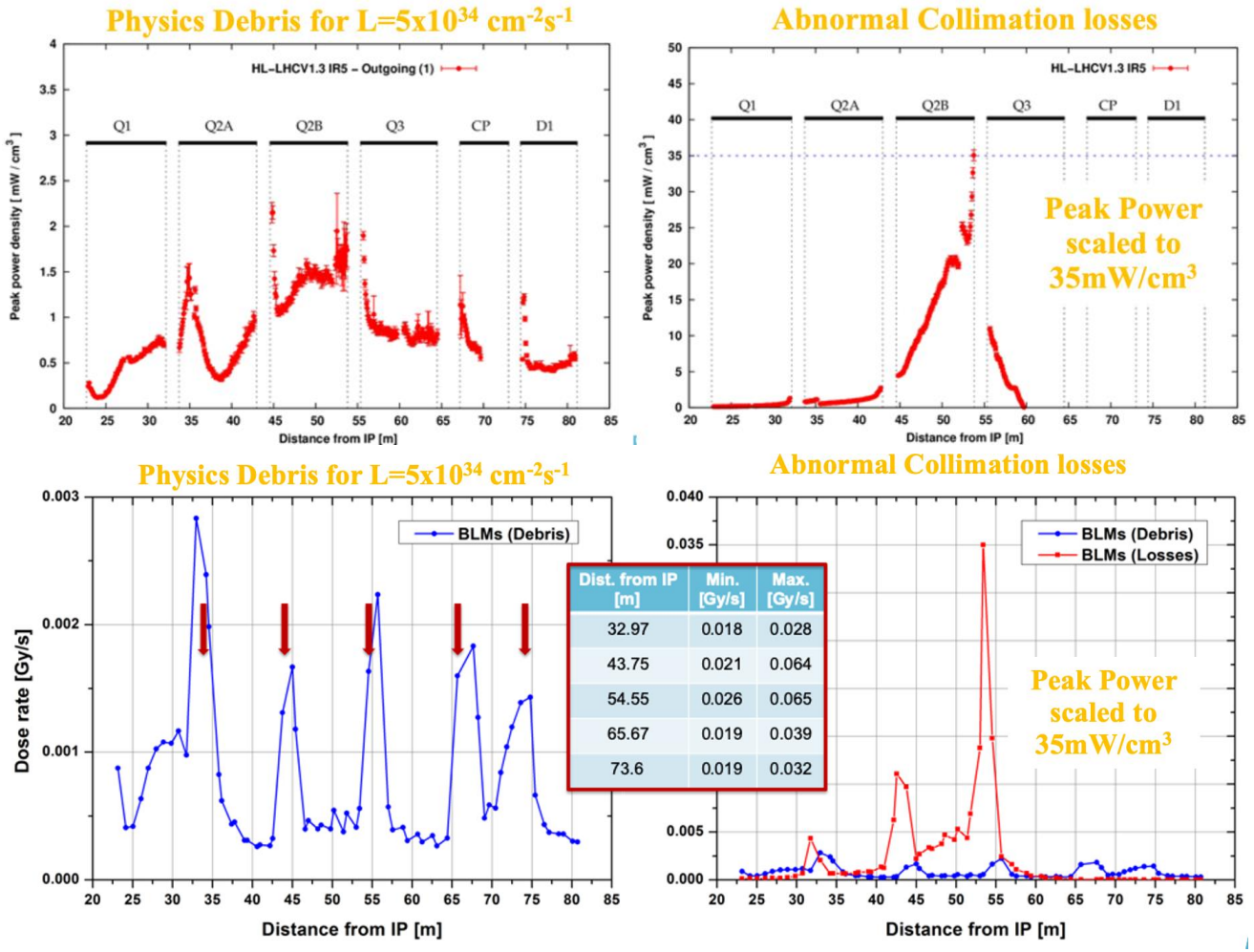
- Two beam loss contributions:

  physics debris + abnormal collimation losses (accidental loss scenario)
- Difficult to disentangle from these two contributions as the BLM detectors will measure both.

Recap of beam loss simulations

- Tracking simulations of beam losses in the HL-LHC triplet, Ye Zou (HL-LHC WP13)
- BLM response simulations for the HL-LHC triplet, Andrea Tsinganis (HL-LHC WP13) using layout optics HL-LHC v1.3, 255 μrad half crossing angle, β*=20cm.





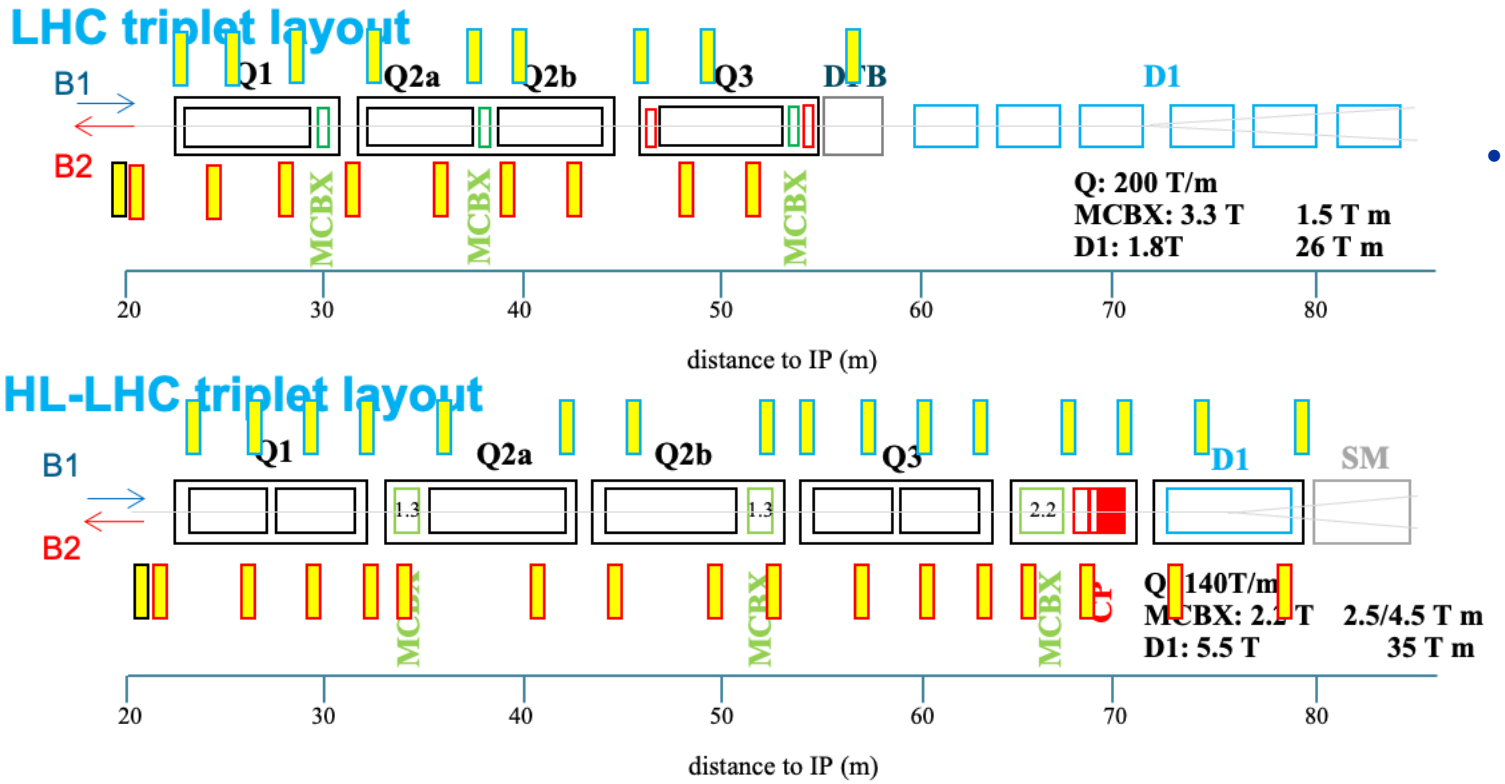
Dist. from IP [m]	Min. [Gy/s]	Max. [Gy/s]
32.97	0.018	0.028
43.75	0.021	0.064
54.55	0.026	0.065
65.67	0.019	0.039
73.6	0.019	0.032

Similar signal for Internal or External BLM
BLM on top of the interconnect has more signal due to less shielding

Initial BLM detectors proposal

BLM detectors in LHC triplet:

- 2 detectors/beam/quadrupole with additional monitors for the DFB
- No monitors installed in the warm D1
- Total of **19 detectors between 20-90 m from IP**



HL-LHC triplet (2020):

- 2 detectors/beam/quadrupole including super-conducting D1 and CP
- Total of 33 detectors between 20-90 m from IP:
  - 8 BLM at Q1/Q2/Q3
  - 4 BLM at D1 and 4 BLM at CP
  - 1 BLM BPMSW @ 21 m
- Additional monitors in selected locations read-out by the R&D rad-hard read-out with ASIC.

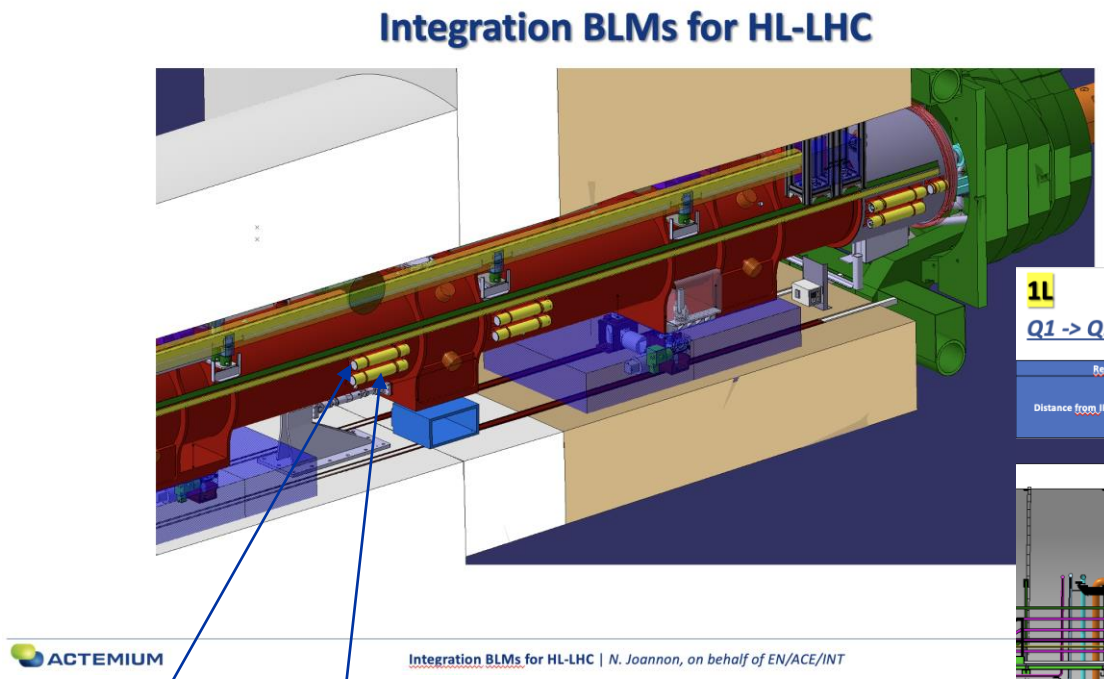
See next talk by C.Zamantas

Update on 2024:

- *Avoid External side of the ring - difficult/impossible of access for maintenance and irradiation test.*
- *Reduce number of detectors with the standard read-out —> lose redundancy*
- *Add 1 detector at EACH location with the new ASIC read-out —> gain redundancy*

Integration of cell 1 - cell 3

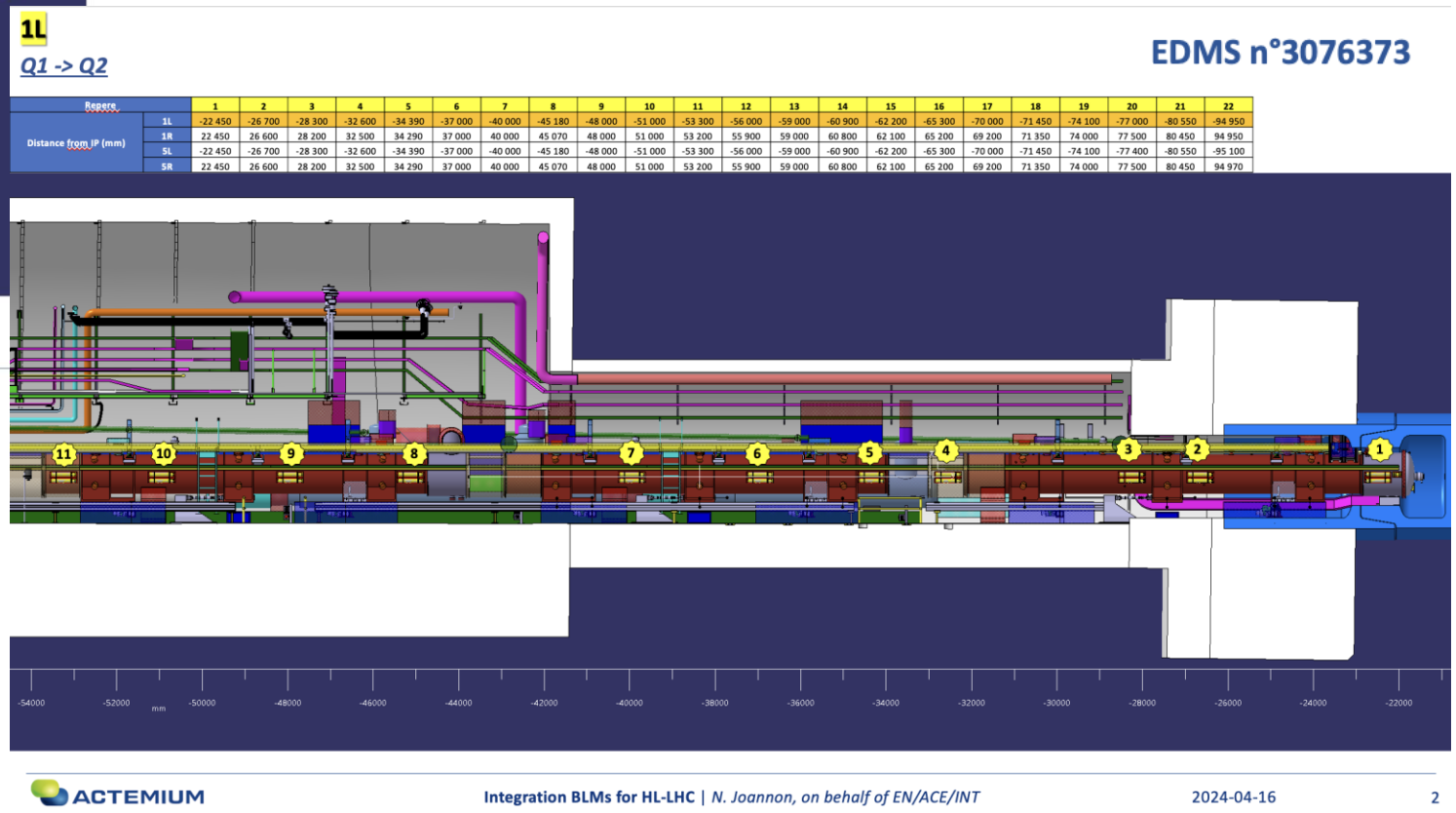
N. Joannon EN/ACE/INT



All proposed cell1-3 locations have been discussed and analysed. A complete the integration study has been done. Few modifications need to be checked.

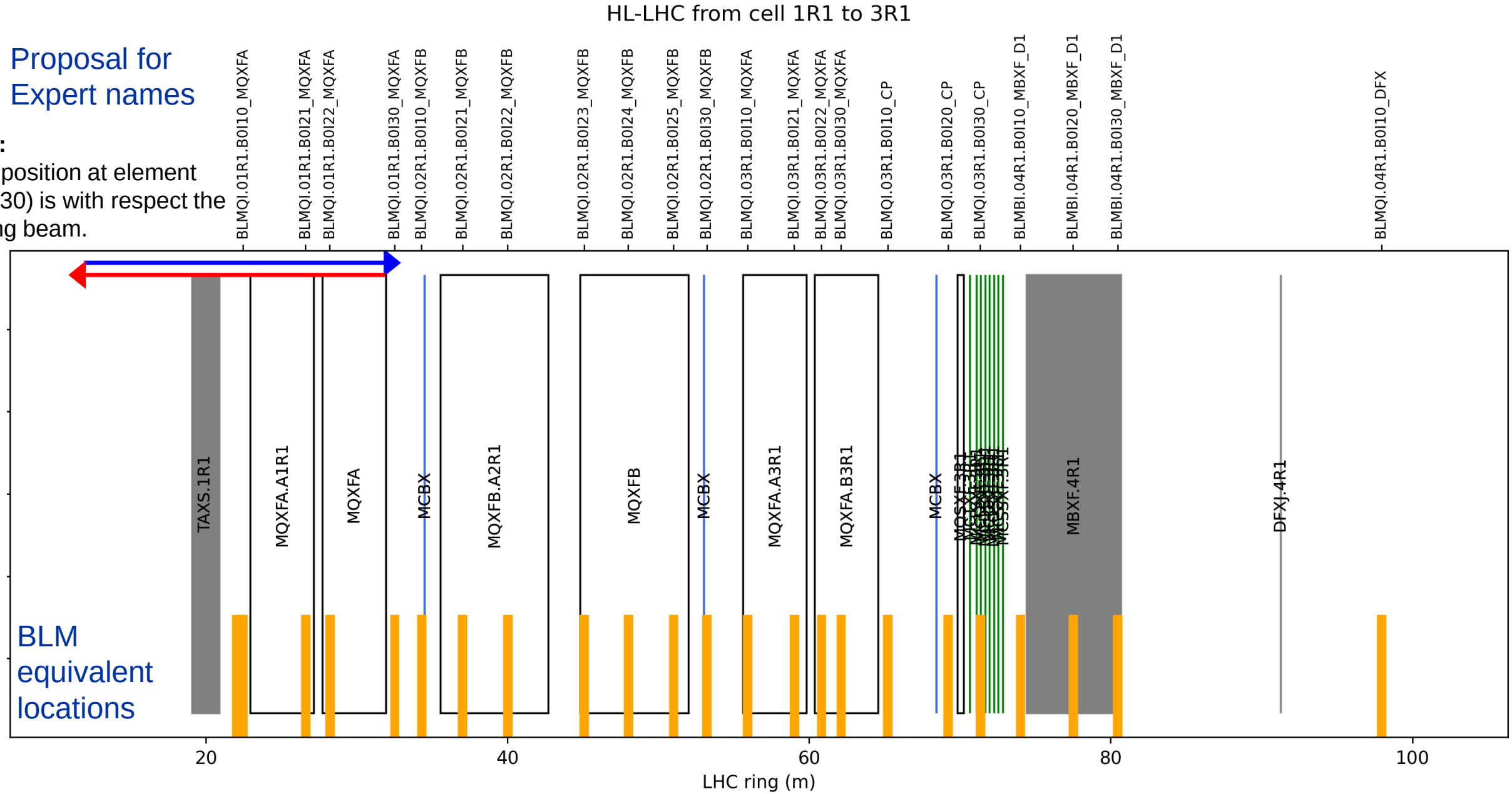
1 BLM read by standard BLM electronics (no change wrt LHC)

1 BLM read by new rad-hard electronics.



Proposal for Expert names

Notice:
B0 but position at element (10,20,30) is with respect the outgoing beam.



Corrections to this layout proposal

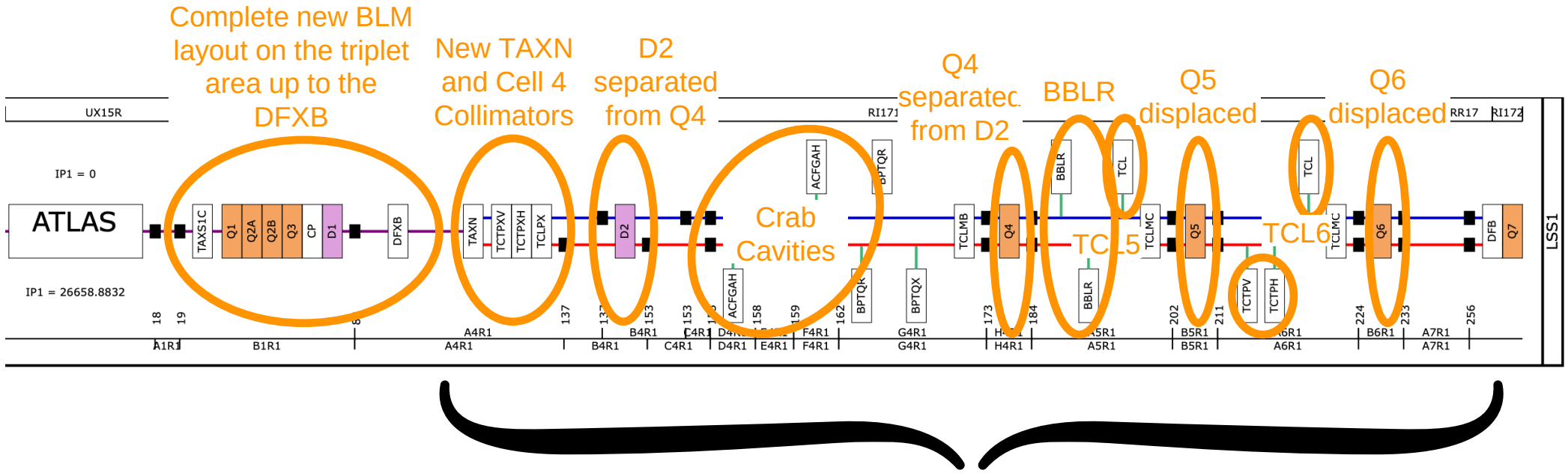
Small modifications to be assed with integration (equivalent for all IP1/IP5 L/R):

- Q3 BLMQI.03R1.B0I21_MQFA to be displaced -1 m
- Q3 BLMQI.03R1.B0I30_MQFXA (should be at the end, currently at the middle) to be displaced + 2m
- CP the 3 BLMs 10,20,30 to be displaced + 2 m
- D1 BLMBI.04R1.B0I10_MBXF_D1 to be displaced + 1 m

Please have a look for additional changes and do not hesitate to send us feedback
Both on position and naming

Cell 4 - Cell 6

HL-LHC



Let’s now propose the layout for the rest of the LSS

TAXN

F.Sanchez Galan

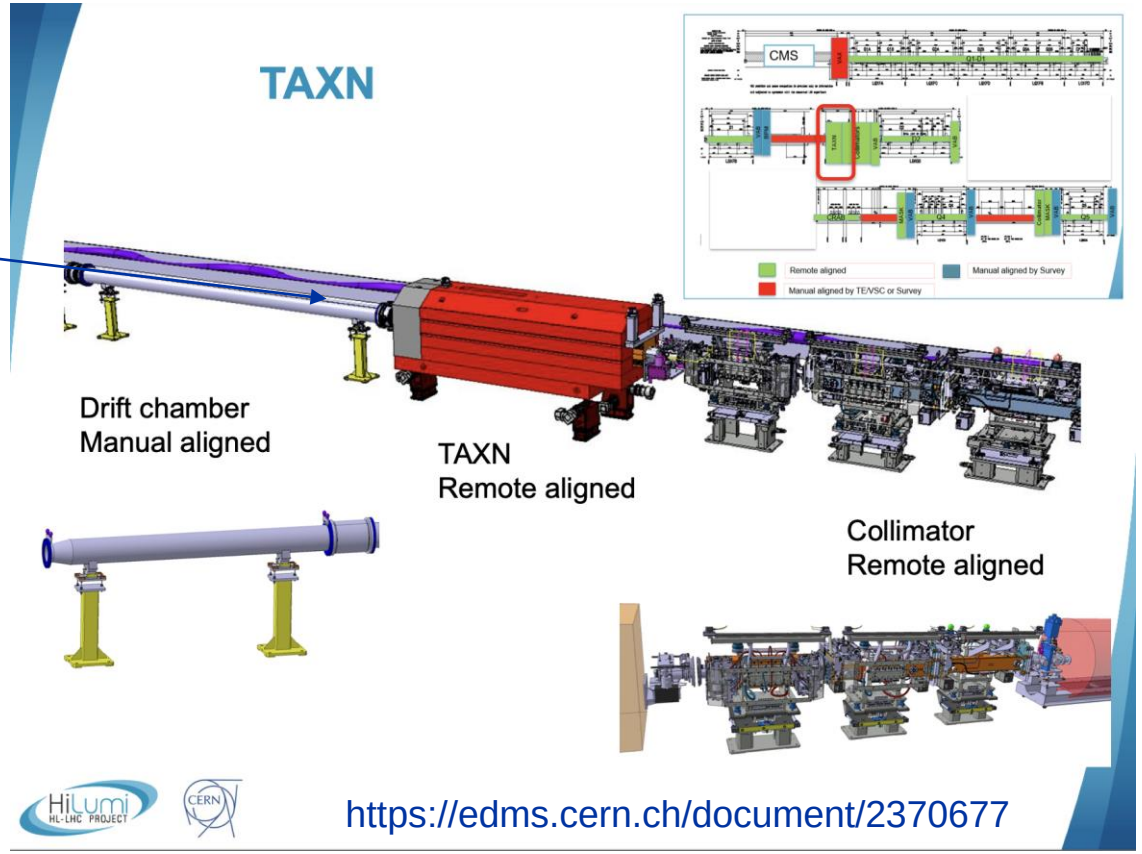
Holding the recombination chamber and several detectors (ZDC ad BRAN)

Proposal to add 1 BLM for the TAXN (towards the IP), similarly to the present configuration.

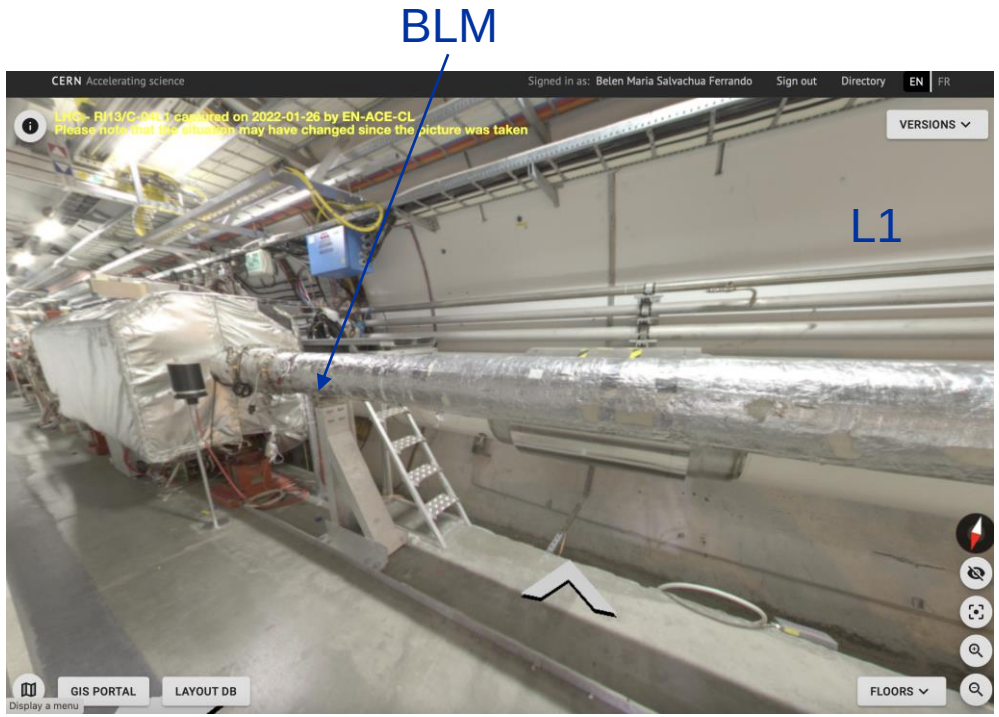
Integration not done yet, but there is space, we just need to avoid the reserved space on the side and the removal/installation of the TAXN.

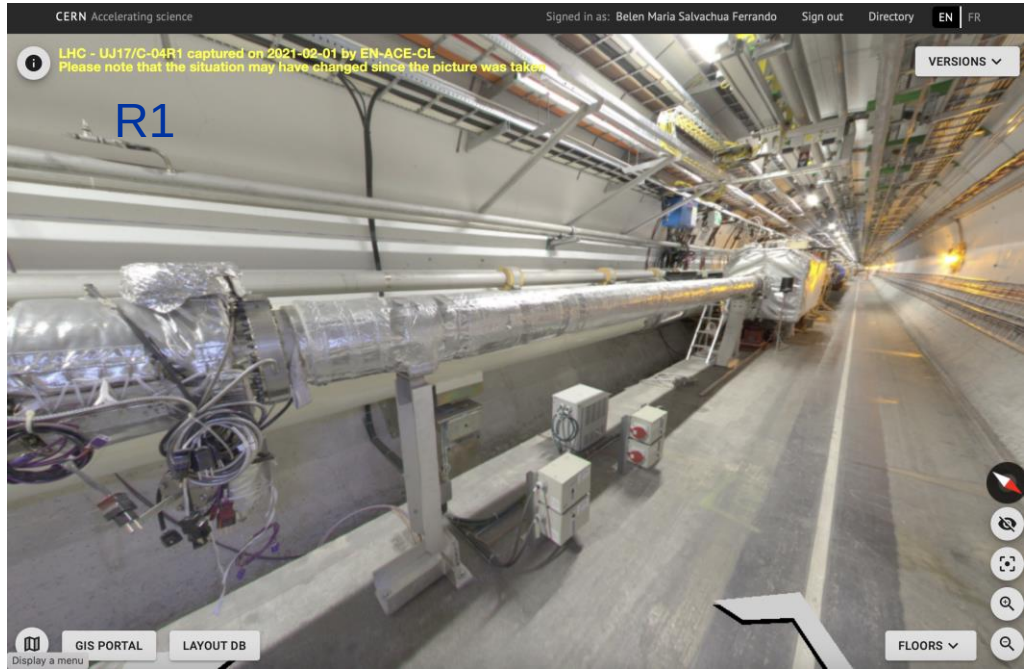
Installation could be done with the standard BLM support.

We do not install another BLM after the TAXN because cell 4 collimators are right after (TCT BLM between collimator and TAXN)



TAXN


BLM
CERN Accelerating science
Signed in as: Belen Maria Salvachua Ferrando
Sign out
Directory
EN
FR
VERSIONS
L1
GIS PORTAL
LAYOUT DB
FLOORS
Display a menu


CERN Accelerating science
Signed in as: Belen Maria Salvachua Ferrando
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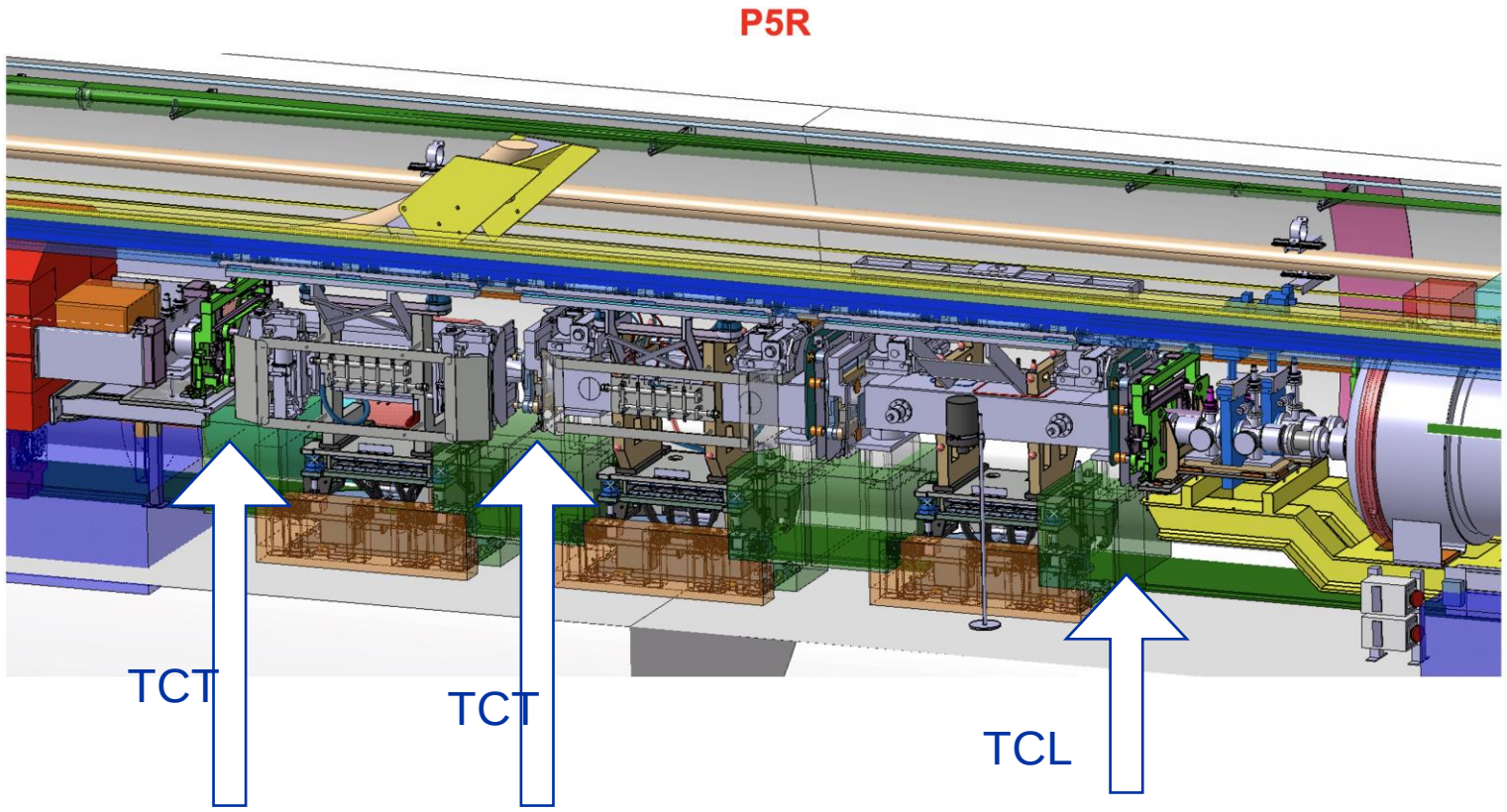
Directory
EN
FR
LHC - UJ17/C-04R1 captured on 2021-02-01 by EN-ACE-CL
Please note that the situation may have changed since the picture was taken
VERSIONS
R1
GIS PORTAL
LAYOUT DB
FLOORS
Display a menu

Collimators - Cell 4/5/6

F-X. Nuiry



Adapting BLM support in collaboration with STI

TCTs in Cell 4 and Cell 6

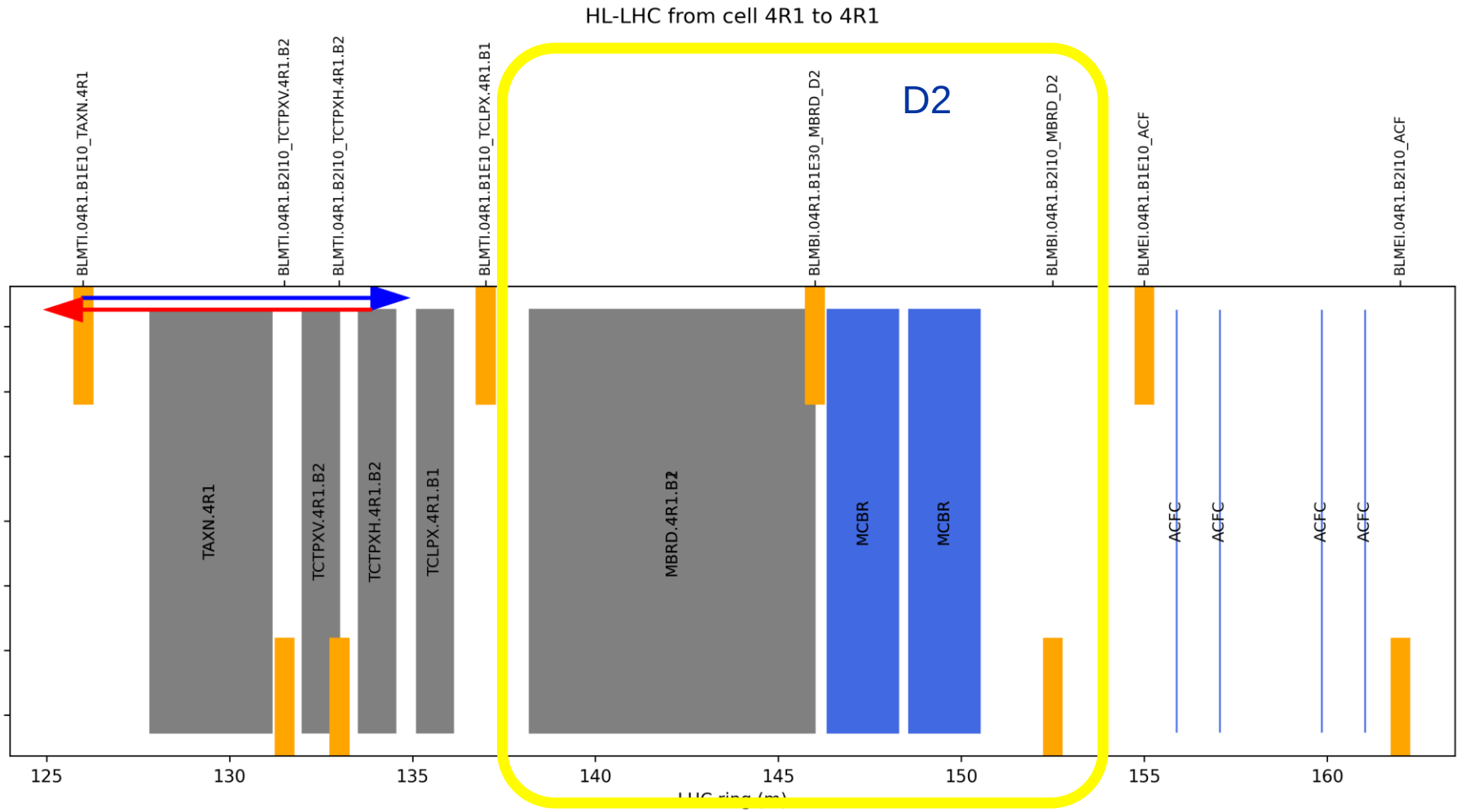
TCL4, TCL5 and TCL6

Integration needs to be finalised, work on going with STI for the supports and locations of BLMs.

Space is very tight, but we are aiming at making a more uniform configuration.

We provide today the approximate locations of the BLMs to be verified with integration WP15 (attached to the agenda)

D2 and Crab-Cavities



For HL, D2 is separated from Q4. We need certain monitoring.

Proposal

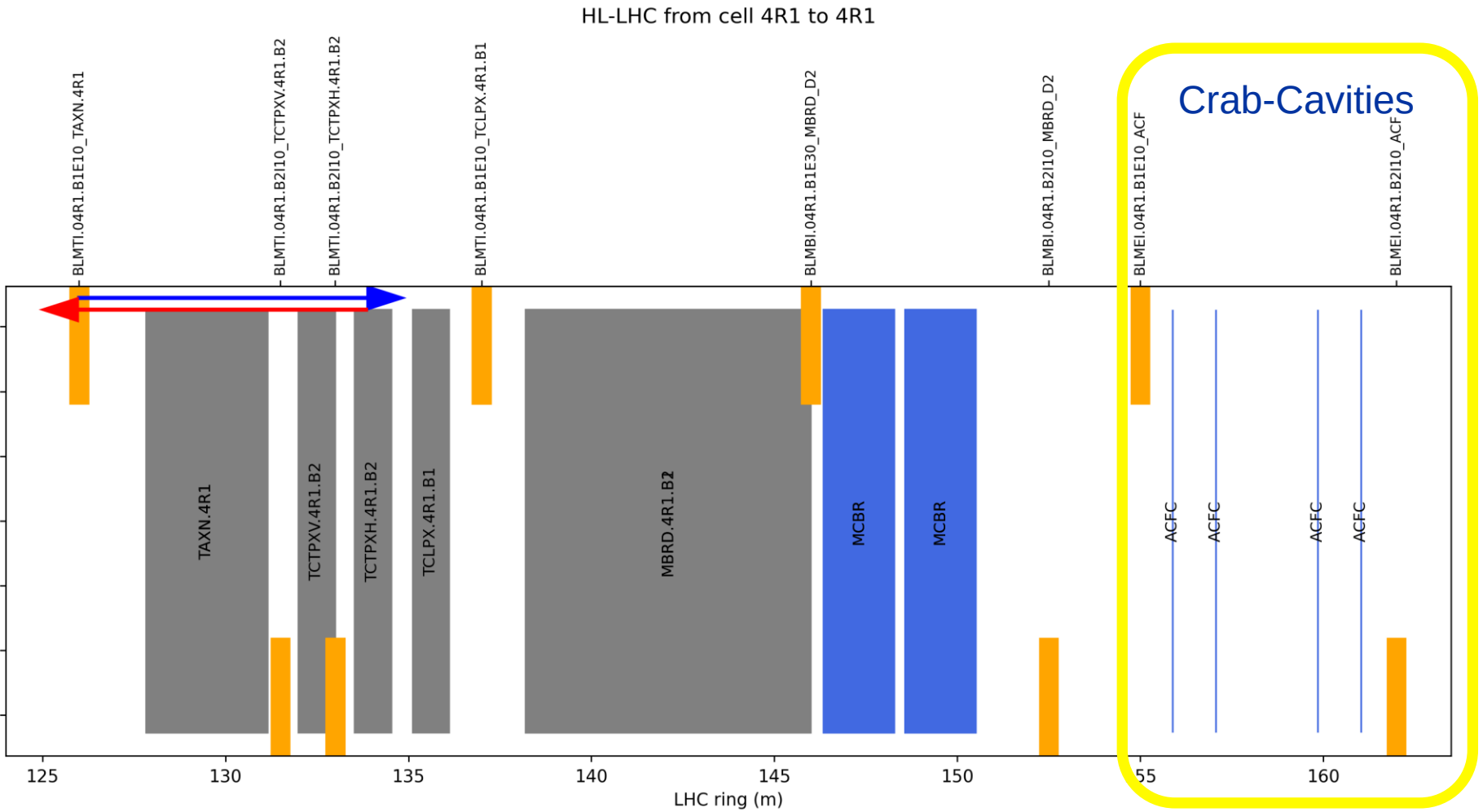
2 BLMs:

- 1 between D2 and the correctors
- 1 on the correctors side
- Already 1 BLM expected between TCL and D2

In this area, we are adding BLM external/internal in order to keep it similar to present system.

D2 and Crab-Cavities

R.Calaga



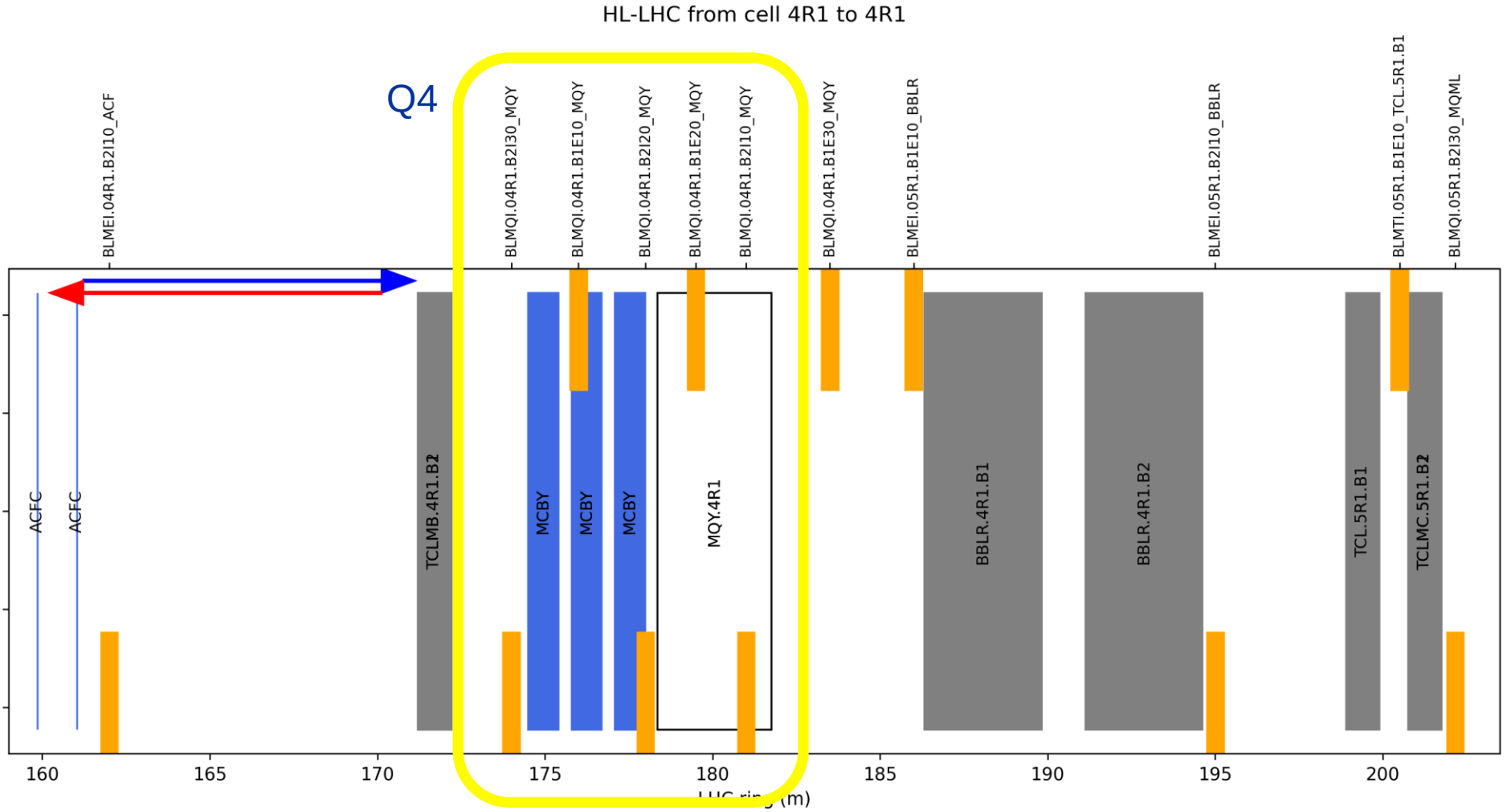
Proposal

2 BLMs

- 1 BLM upstream
- 1 BLM downstream

No installation on the side of the cavities, because there is no space, since the cryogenics go up to the transport area.

Q4 and BBLR

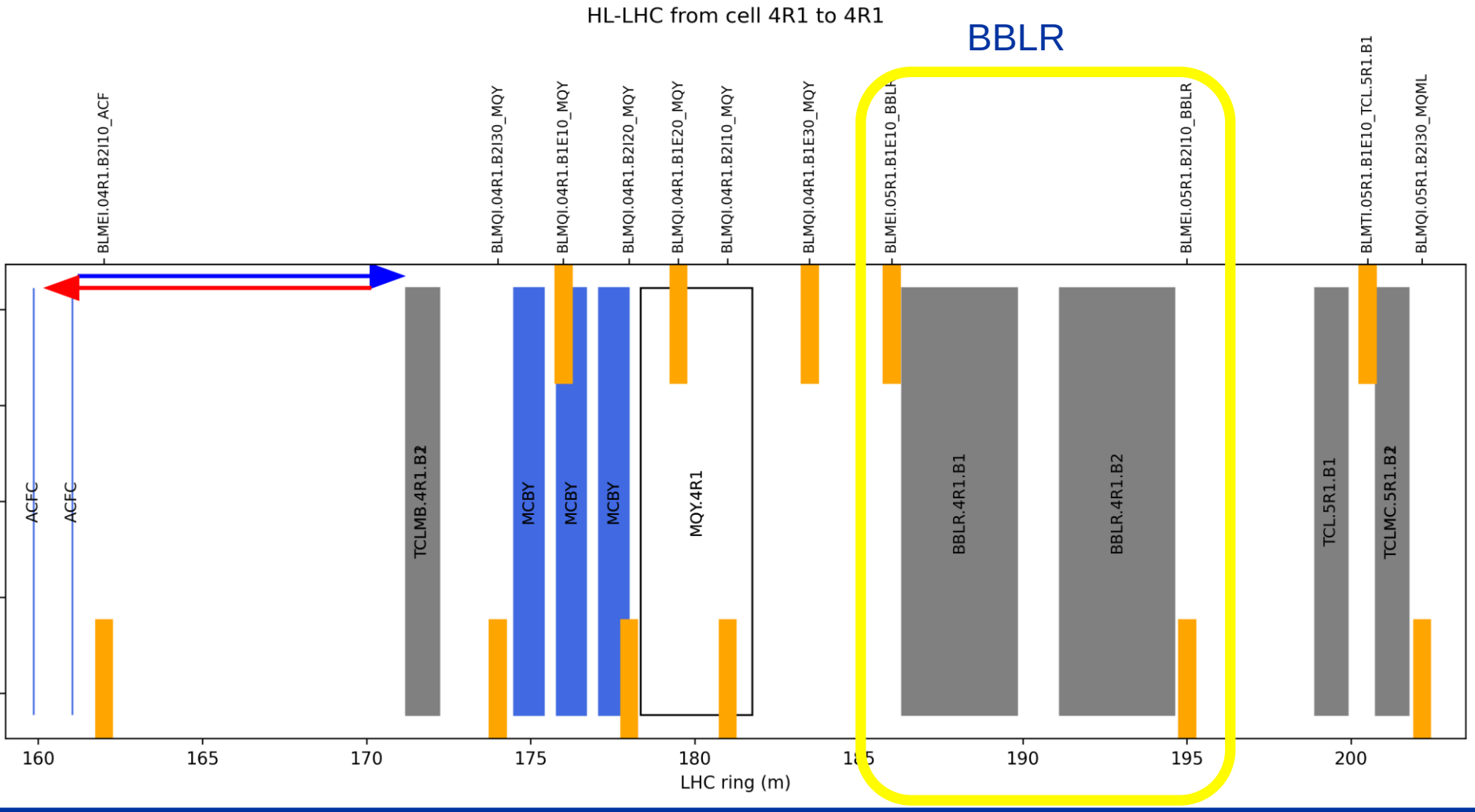


Proposal

6 BLMs

- Similarly distributed as Q5/Q6

Q4 and BBLR

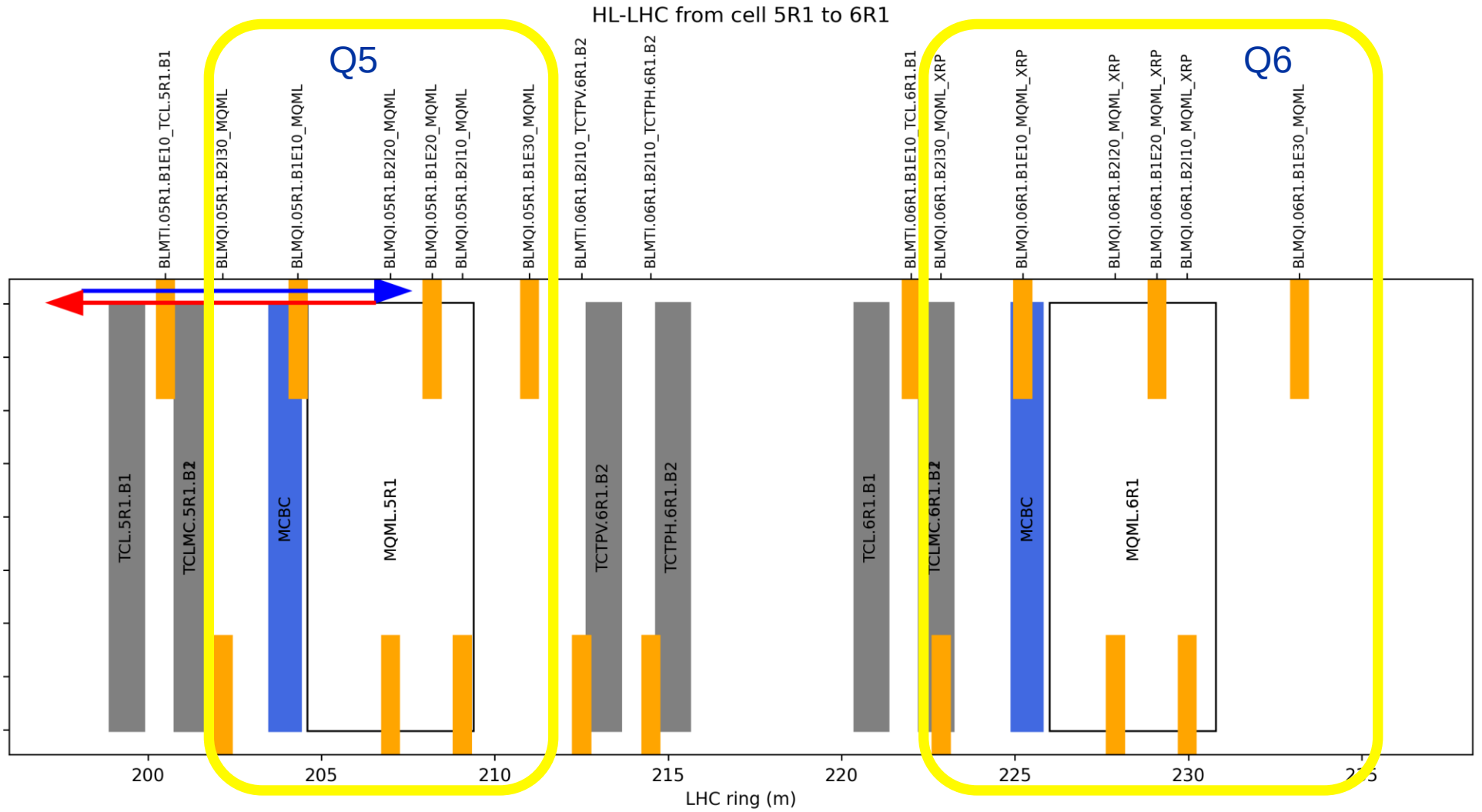


Proposal

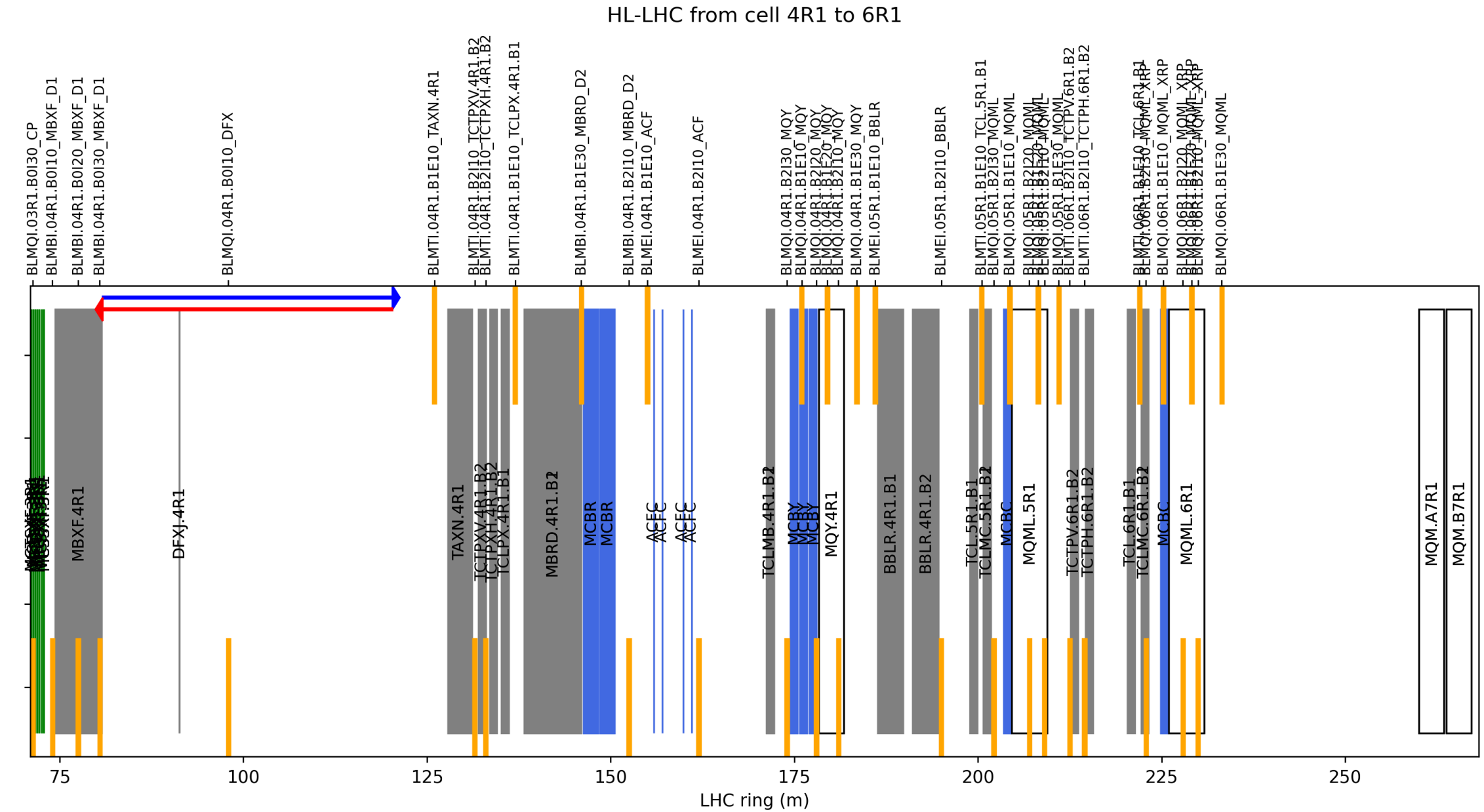
2 BLMs

- Before/After

Q5 and Q6



6 BLMs per quadrupole


HL-LHC from cell 4R1 to 6R1
BLMQI.03R1.B0I30_CP
BLMBI.04R1.B0I10_MBXF_D1
BLMBI.04R1.B0I20_MBXF_D1
BLMBI.04R1.B0I30_MBXF_D1
BLMQI.04R1.B0I10_DFX
BLMTI.04R1.B1E10_TAXN.4R1
BLMTI.04R1.B2I10_TCTPXV.4R1.B2
BLMTI.04R1.B2I10_TCTPXH.4R1.B2
BLMTI.04R1.B1E10_TCLPX.4R1.B1
BLMBI.04R1.B1E30_MBRD_D2
BLMBI.04R1.B2I10_MBRD_D2
BLMEI.04R1.B1E10_ACF
BLMEI.04R1.B2I10_ACF
BLMQI.04R1.B2I30_MQY
BLMQI.04R1.B1E10_MQY
BLMQI.04R1.B2I20_MQY
BLMQI.04R1.B1E20_MQY
BLMQI.04R1.B2I10_MQY
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BLMQI.05R1.B2I30_MQML
BLMQI.05R1.B1E10_MQML
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BLMQI.06R1.B2I20_MQML_XRP
BLMQI.06R1.B1E20_MQML_XRP
BLMQI.06R1.B2I10_MQML_XRP
BLMQI.06R1.B1E30_MQML
MBXF.4R1
DFXJ.4R1
TAXN.4R1
TCTPXV.4R1.B2
TCTPXH.4R1.B2
TCLPX.4R1.B1
MBRD.4R1.B2
MCBR
ACFC
TCLMB.4R1.B2
MCBY
MQY.4R1
BBLR.4R1.B1
BBLR.4R1.B2
TCL.5R1.B1
TCLMC.5R1.B2
MCBC
MQML.5R1
TCTPV.6R1.B2
TCTPH.6R1.B2
TCL.6R1.B1
TCLMC.6R1.B2
MQML.6R1
MQM.A7R1
MQM.B7R1
75
100
125
150
175
200
225
250
LHC ring (m)

Conclusions

Draft of all BLM layout from Cell 1 to Cell 6.

248 BLMs in total IP1 + IP5 (with additional 92 for the new ASIC read-out)

Missing only to include XRP - but for IP5 the BLMs will be integrated in the XRP support directly.

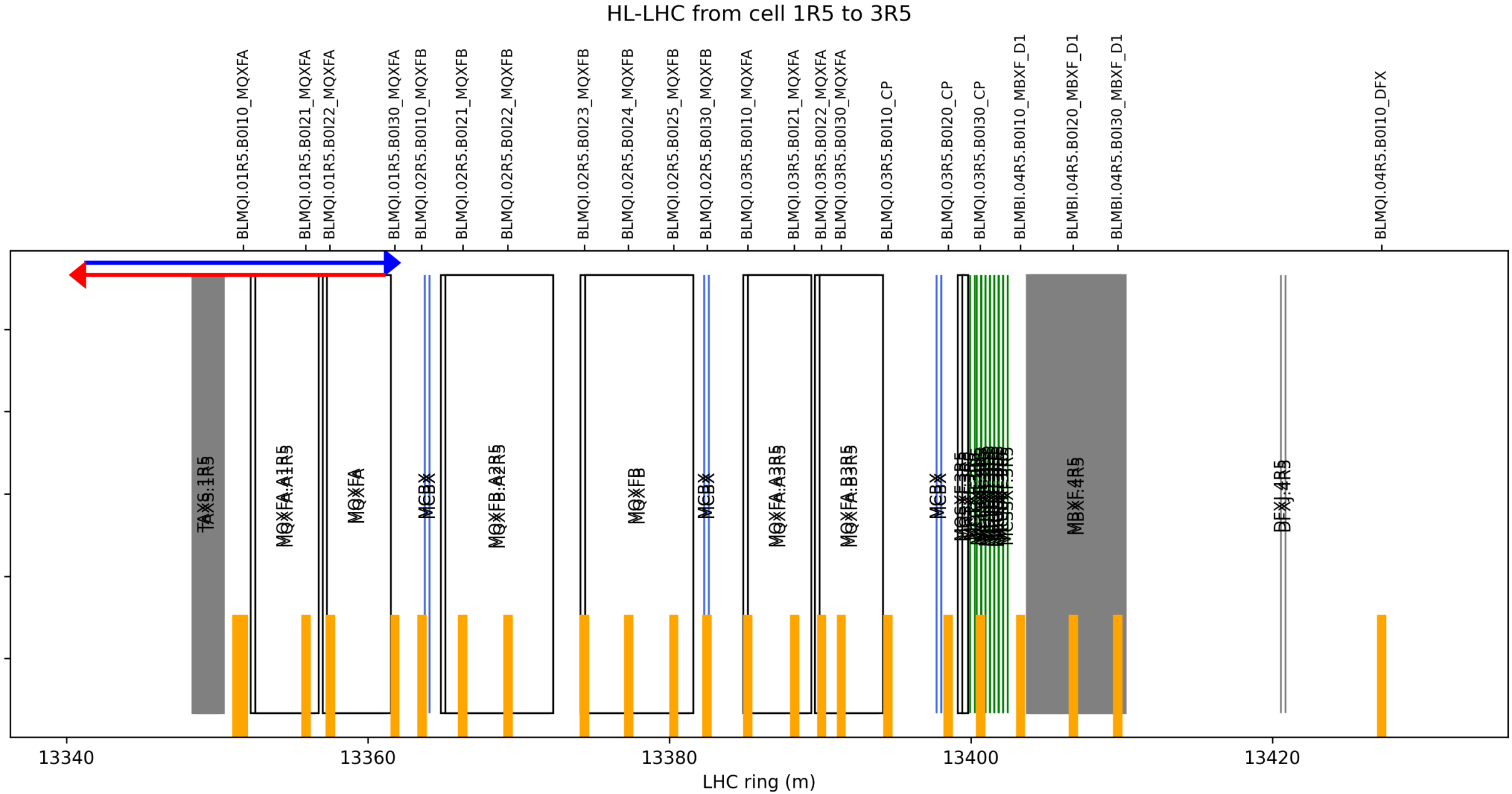
Next:

- Share the new BLM positions with integration to finalise the layout
- Integrate BLM signal and power boxes
- Integrate ASIC crates (3 per IP-side)

BACK-UP

Approximate positions Cell 1 - 3

- Approximate locations for the placement of the monitors:
  - After interconnect + middle/close to interconnect + after interconnect + before interconnect
  - Q1: 21 (IC+LIC) + 27 + 28 + 32
  - Q2: 34 + 37 + 40 + 45 + 48 + (51) + 53
  - Q3: 56 + 59 + 61 + 63
  - CP: 65 + 70 + 71.5
  - D1: 74 + 77 +80
  - IC right after D1
  - *D2 will need also BLMs*


HL-LHC from cell 1R5 to 3R5
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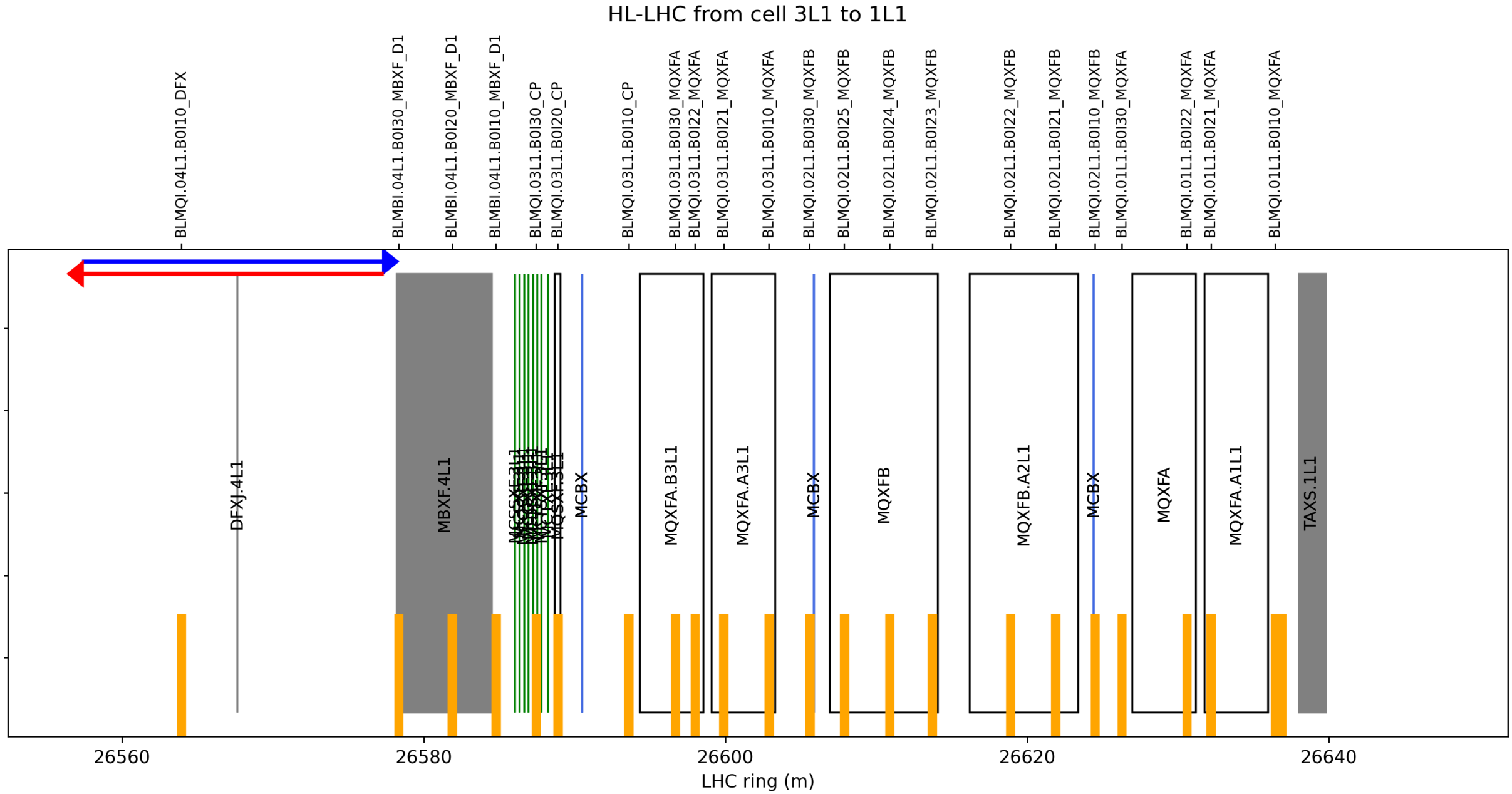
BLMQI.01R5.B0I21_MQXFA
BLMQI.01R5.B0I22_MQXFA
BLMQI.01R5.B0I30_MQXFA
BLMQI.02R5.B0I10_MQXFB
BLMQI.02R5.B0I21_MQXFB
BLMQI.02R5.B0I22_MQXFB
BLMQI.02R5.B0I23_MQXFB
BLMQI.02R5.B0I24_MQXFB
BLMQI.02R5.B0I25_MQXFB
BLMQI.02R5.B0I30_MQXFB
BLMQI.03R5.B0I10_MQXFA
BLMQI.03R5.B0I21_MQXFA
BLMQI.03R5.B0I22_MQXFA
BLMQI.03R5.B0I30_MQXFA
BLMQI.03R5.B0I10_CP
BLMQI.03R5.B0I20_CP
BLMQI.03R5.B0I30_CP
BLMBI.04R5.B0I10_MBXF_D1
BLMBI.04R5.B0I20_MBXF_D1
BLMBI.04R5.B0I30_MBXF_D1
BLMQI.04R5.B0I10_DFX
13340
13360
13380
13400
13420
LHC ring (m)


HL-LHC from cell 3L1 to 1L1
BLMQI.04L1.B0I10_DFX
BLMBI.04L1.B0I30_MBXF_D1
BLMBI.04L1.B0I20_MBXF_D1
BLMBI.04L1.B0I10_MBXF_D1
BLMQI.03L1.B0I30_CP
BLMQI.03L1.B0I20_CP
BLMQI.03L1.B0I10_CP
BLMQI.03L1.B0I30_MQXFA
BLMQI.03L1.B0I22_MQXFA
BLMQI.03L1.B0I21_MQXFA
BLMQI.03L1.B0I10_MQXFA
BLMQI.02L1.B0I30_MQXFB
BLMQI.02L1.B0I25_MQXFB
BLMQI.02L1.B0I24_MQXFB
BLMQI.02L1.B0I23_MQXFB
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BLMQI.02L1.B0I10_MQXFB
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MBXF.4L1
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MQXFA.A3L1
MCBX
MQXFB
MQXFB.A2L1
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26600
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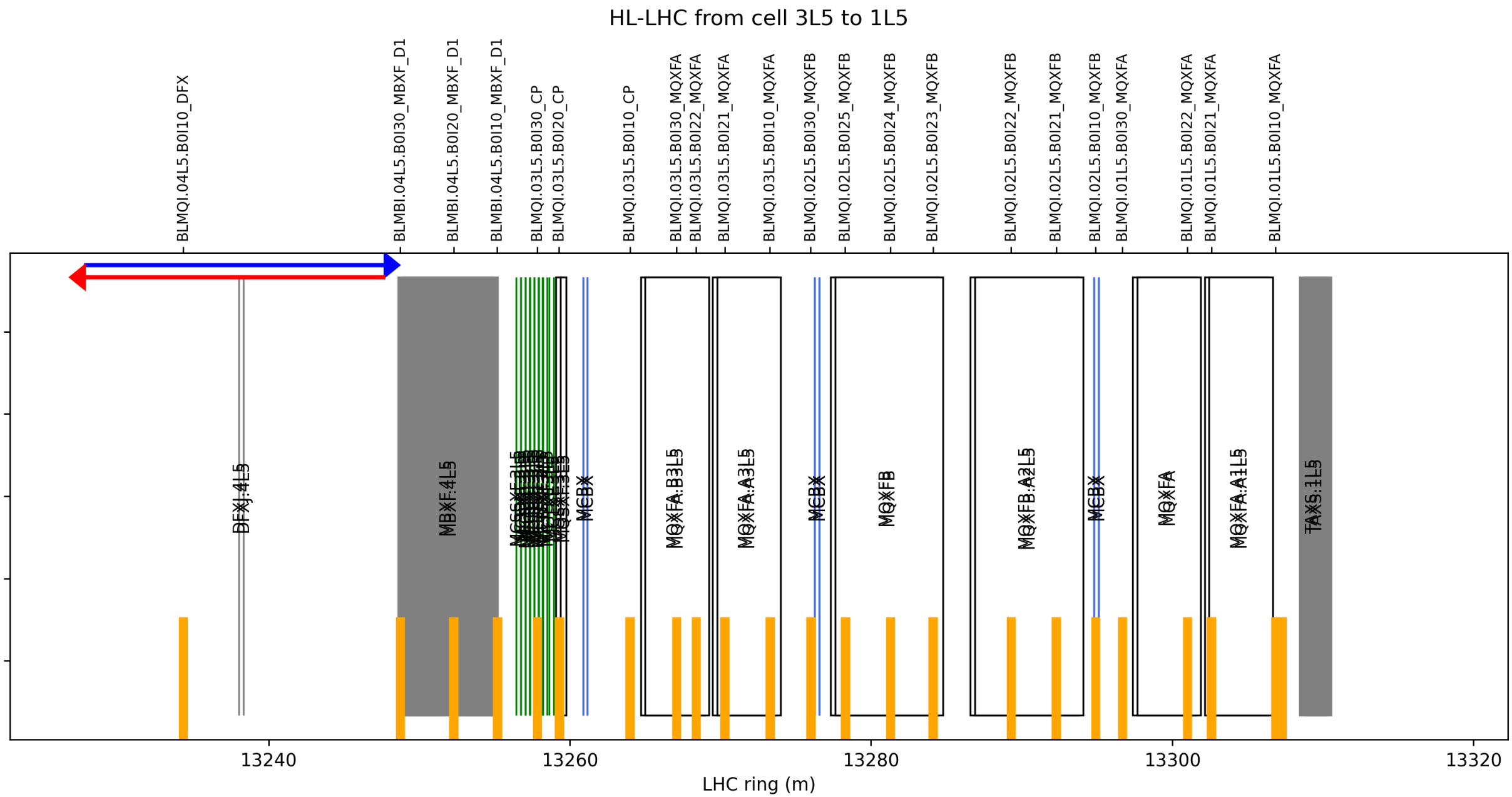
26640
LHC ring (m)


HL-LHC from cell 3L5 to 1L5
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BLMBI.04L5.B0I30_MBXF_D1
BLMBI.04L5.B0I20_MBXF_D1
BLMBI.04L5.B0I10_MBXF_D1
BLMQI.03L5.B0I30_CP
BLMQI.03L5.B0I20_CP
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BLMQI.03L5.B0I21_MQXFA
BLMQI.03L5.B0I10_MQXFA
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BLMQI.02L5.B0I23_MQXFB
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BLMQI.02L5.B0I21_MQXFB
BLMQI.02L5.B0I10_MQXFB
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13240
13260
13280
13300
13320
LHC ring (m)