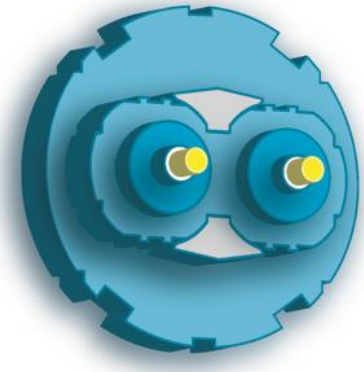


High Luminosity LHC

Radiation aspects at LHC Point 7

Cristina Adorisio and Stefan Roesler
(CERN - DGS/RP)

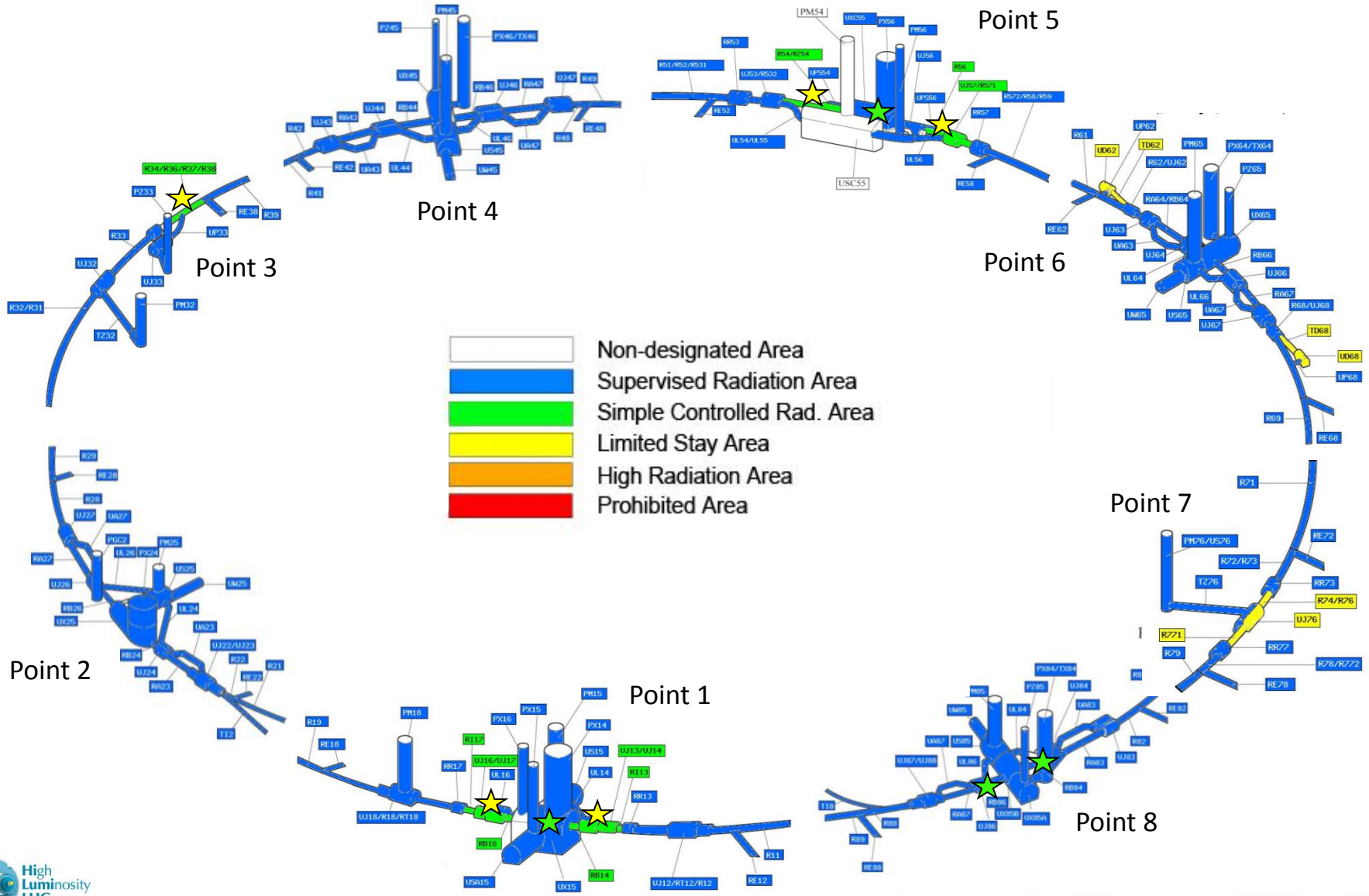
The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Outline

- LHC during LS1
  - Radiological classification evolution
  - LSS7 and LSS3 radiological measurements
- Dose rate outlook
  - Operational scenarios
  - Evolution until HiLumi era
    - LSS7
    - Point 1 and 5 inner triplet regions
- Summary and Conclusions

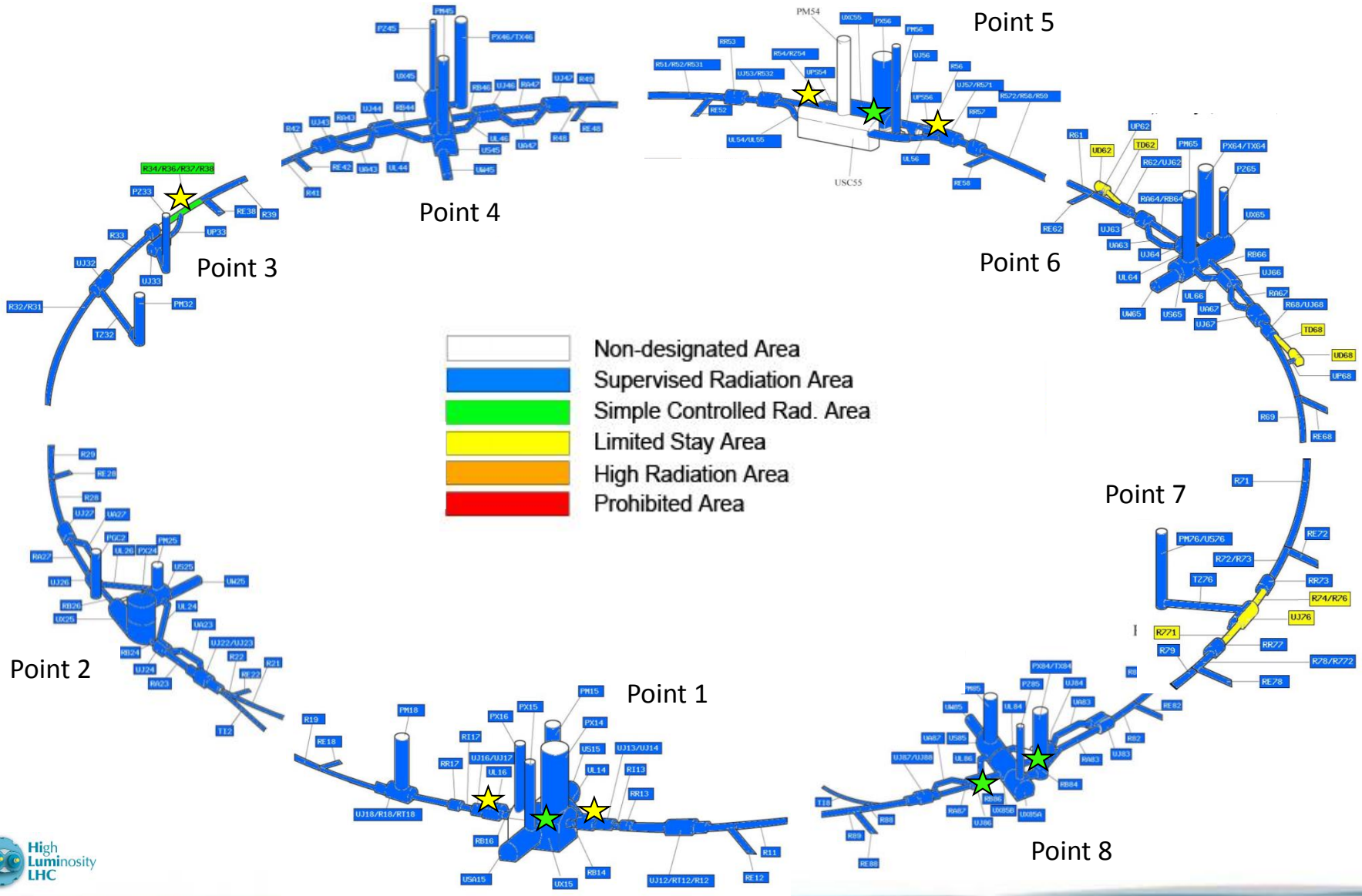
LHC during LS1

December 2012



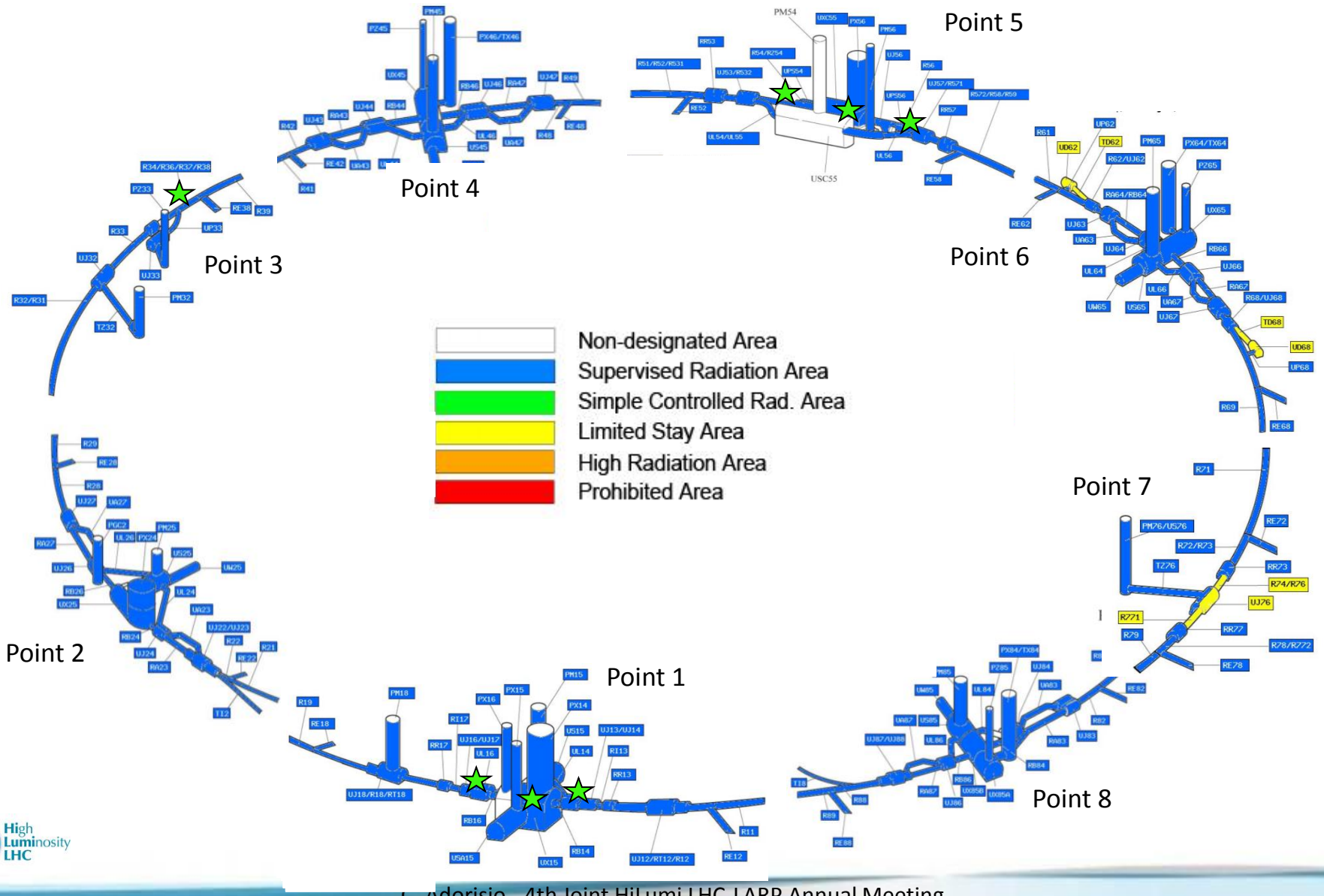
LHC during LS1

February 2013



LHC during LS1

December 2013

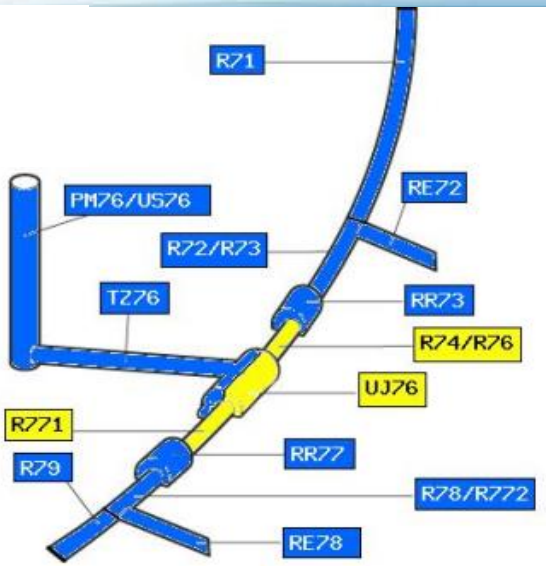


LHC IR7

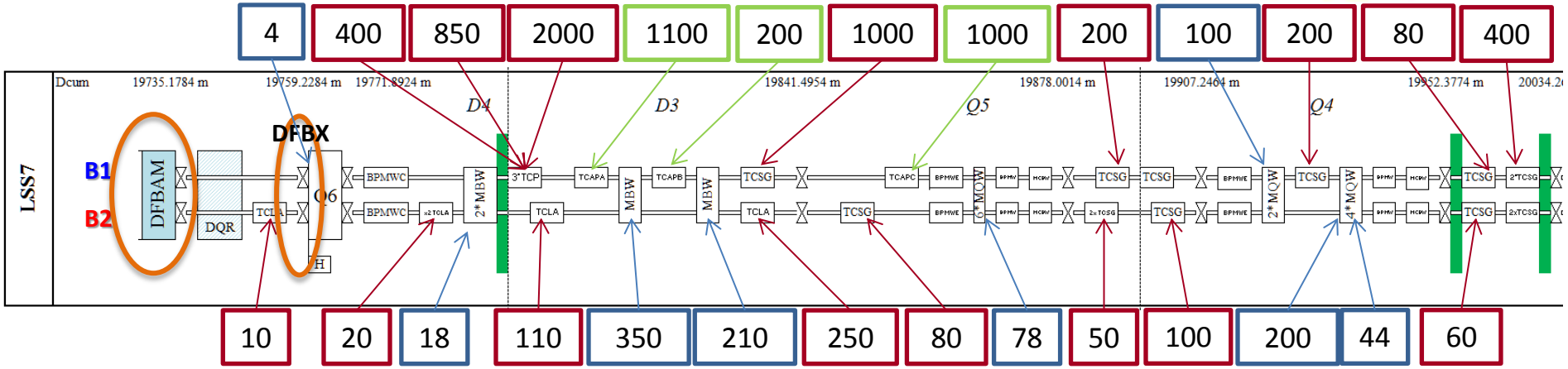
during LS1

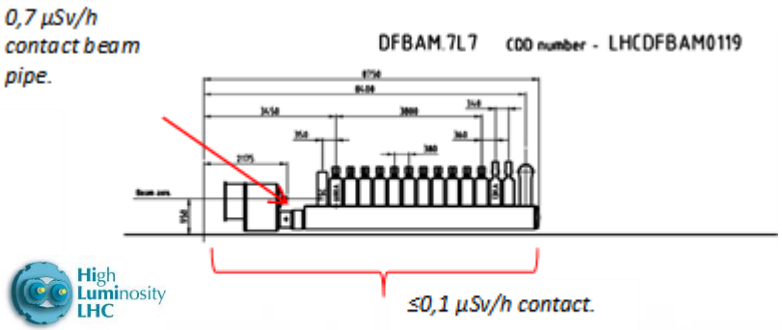
Ambient dose equivalent rates in µSv/h at 40cm
measured on Dec 20, 2012
(last "good" fill on Dec 5, i.e. cooling time >1week)

Non-designated Area
Supervised Radiation Area
Simple Controlled Rad. Area
Limited Stay Area
High Radiation Area
Prohibited Area



collimator | absorber | magnet





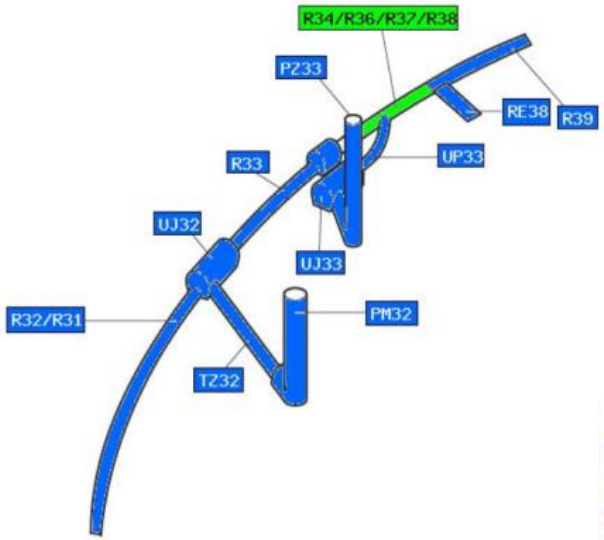
High Luminosity LHC

LHC IR3

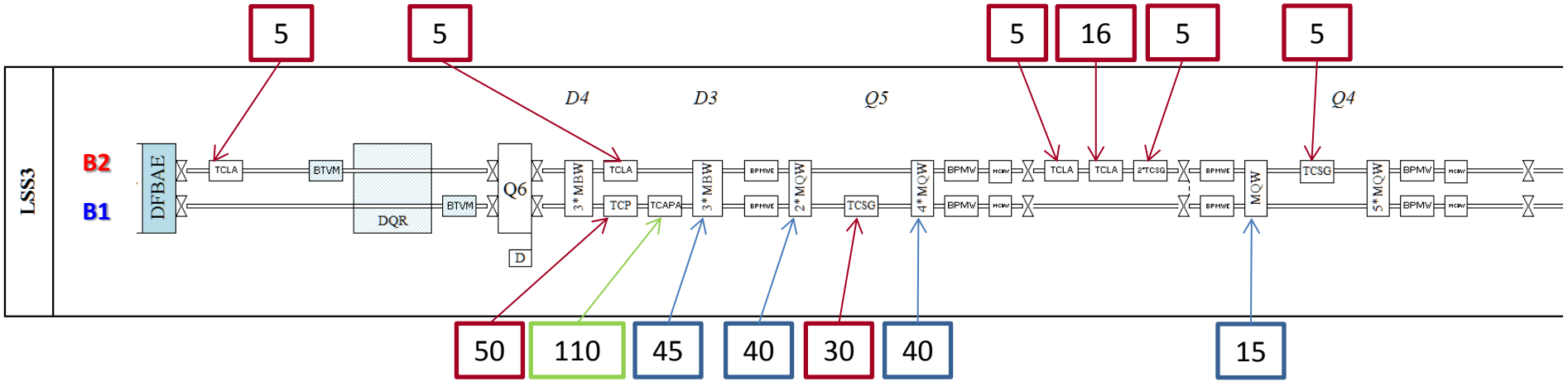
during LS1

Ambient dose equivalent rates in µSv/h at 40cm
measured on Dec 20, 2012
(last "good" fill on Dec 5, i.e. cooling time >1week)

Non-designated Area
Supervised Radiation Area
Simple Controlled Rad. Area
Limited Stay Area
High Radiation Area
Prohibited Area



collimator | absorber | magnet



Ambient dose equivalent rates are 10-40 times lower than in IR7 (reflecting the sharing)

Operational scenarios

Nominal scenario

Shutdown	Year of LHC Operation	Instantaneous luminosity [$cm^{-2}s^{-1}$]	Integrated Luminosity [fb^{-1}]
	2012	8.00E+33	30
LS1			
	2016	1.45E+34	35
	2017	1.65E+34	50
	2018	1.75E+34	50
LS2			
	2020	2.00E+34	25
	2021	2.00E+34	60
	2022	2.00E+34	60
LS3			
	2026	5.00E+34	250
	2027	5.00E+34	250
	2028	5.00E+34	250
LS4			
	2030	5.00E+34	250
	2031	5.00E+34	250
	2032	5.00E+34	250
LS5			
	2034	5.00E+34	250
	2035	5.00E+34	250
	2036	5.00E+34	250
LS6			
	2038	5.00E+34	250
	2039	5.00E+34	250

Total integrated luminosity up to LS3: 310 fb^{-1}

Total integrated luminosity 3060 fb^{-1}

Ultimate scenario

Shutdown	Year of LHC Operation	Instantaneous luminosity [$cm^{-2}s^{-1}$]	Integrated luminosity [fb^{-1}]
LS3			
	2026	7.50E+34	300
	2027	7.50E+34	300
	2028	7.50E+34	300
LS4			
	2030	7.50E+34	300
	2031	7.50E+34	300
	2032	7.50E+34	300
LS5			
	2034	7.50E+34	300
	2035	7.50E+34	300
	2036	7.50E+34	300
LS6			
	2038	7.50E+34	300
	2039	7.50E+34	300
	2040	7.50E+34	300

Total integrated luminosity 3910 fb^{-1}

Generic study

Geometry

"Generic collimator" (length: 120 cm)

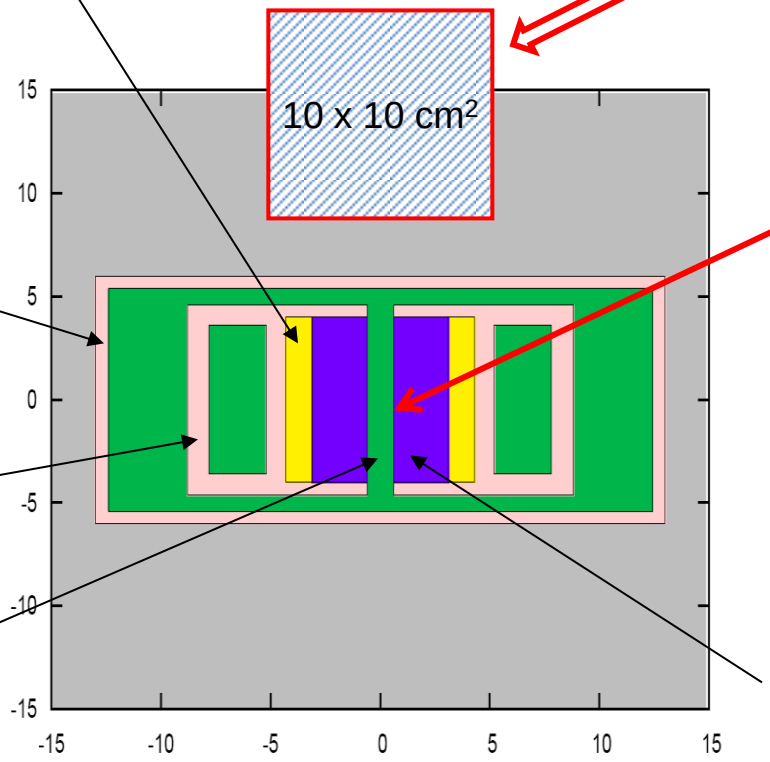
Scoring of ambient dose equivalent rate at different cooling times

Cooling system
Copper (scaled density)
15 x 80 mm^2

Tank
Stainless Steel
Thickness: 6 mm

Structure
Stainless Steel
Thickness: 6/10 mm

Gap
Full width: 12mm



Jaws
graphite/copper/tungsten
25 x 80 mm^2

Generic study

Derived scaling parameter

Evolution of residual dose equivalent rates

(for areas where activation is related to the beam intensity, *e.g.*, IR3/7)

x/LS1	LS2	LS3	LSx_{HL} Nominal	LSx_{HL} Ultimate
One week cooling	4.0	4.4	17	23
One month cooling	4.0	4.5	17	23
Four months cooling	4.0	4.8	20	25
One year cooling	4.8	5.9	26	32

Graphite jaws

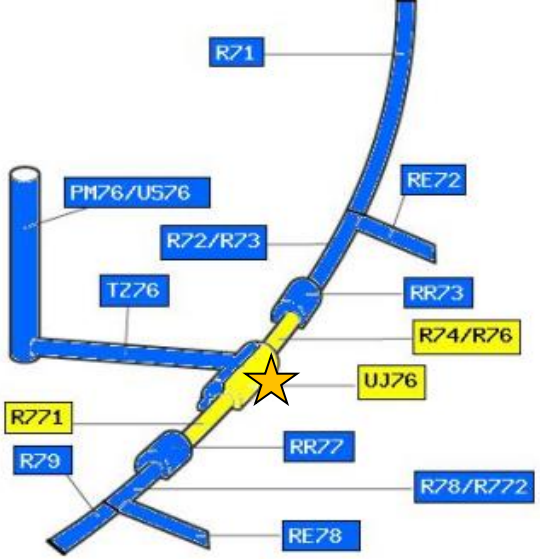
Cooling time	Scaling factor
1 week	2.0
1 month	1.0
4 months	0.4
1 year	0.2

Future situation

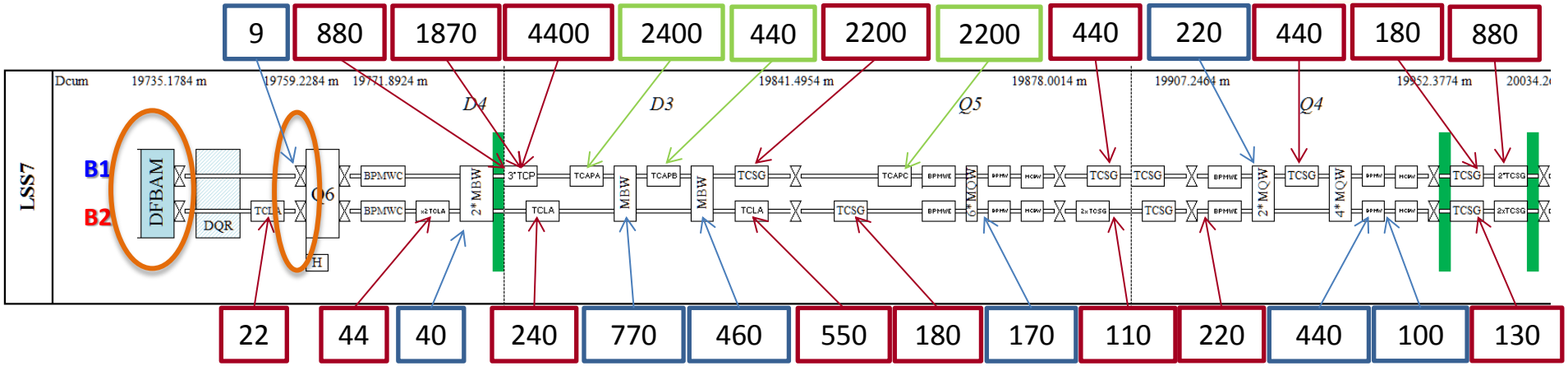
IR7 – LS3, 1 month of cooling time

Ambient dose equivalent rates in µSv/h at 40cm
measurements scaled using generic study scaling factor:
4.4 (LS1 → LS3 1 week c.t) * 0.5 (1 week → 1 month c.t.)

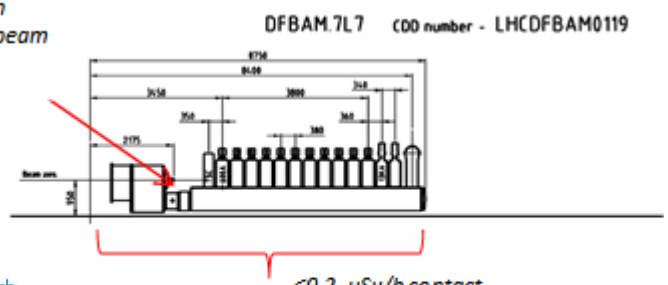
Non-designated Area
Supervised Radiation Area
Simple Controlled Rad. Area
Limited Stay Area
High Radiation Area
Prohibited Area



collimator | absorber | magnet



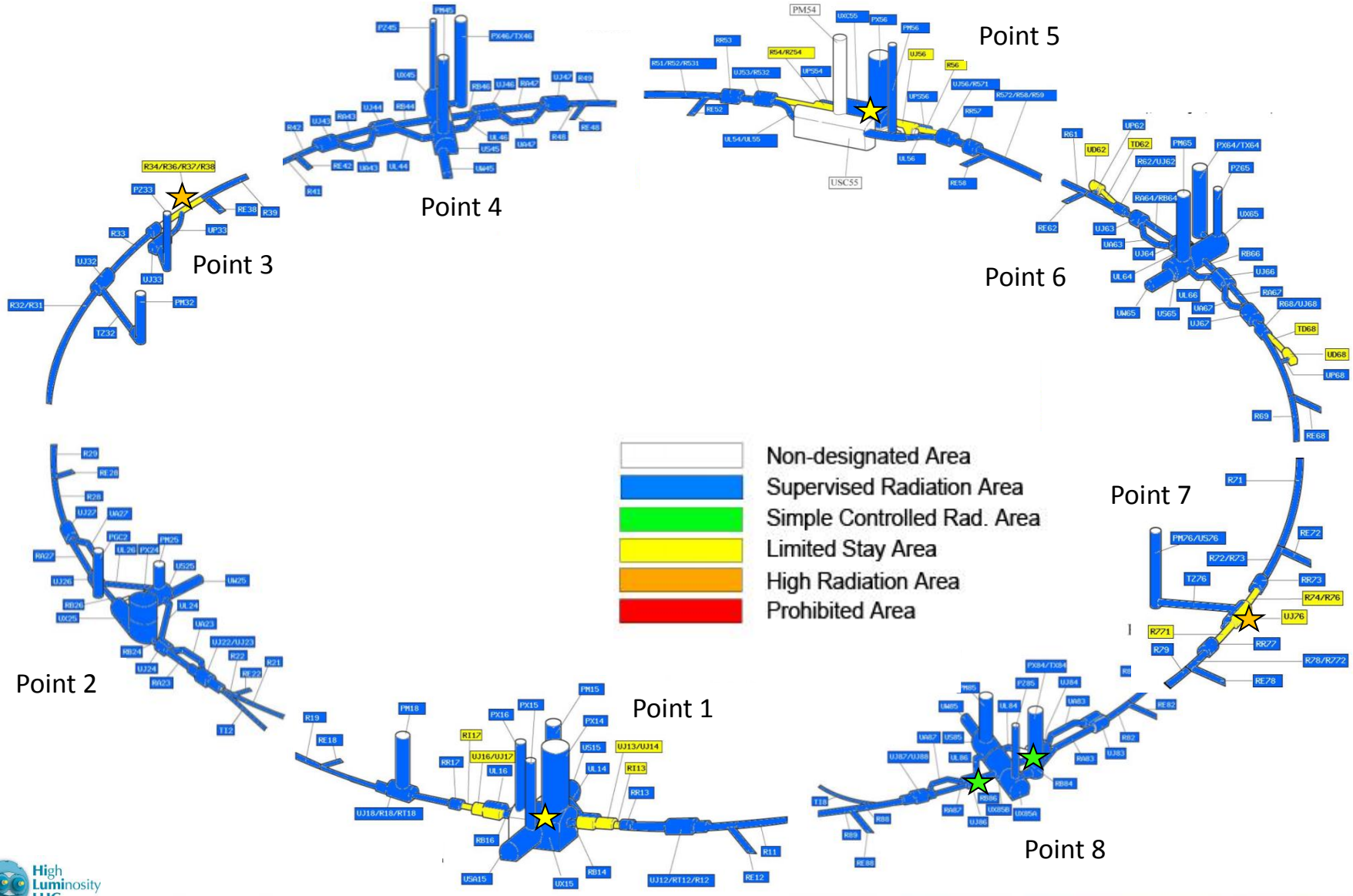
1,5 µSv/h contact beam pipe.



Radiological classification:
Limited Stay Area with some hot points

Future situation

IR7 – LS3, 1 month of cooling time

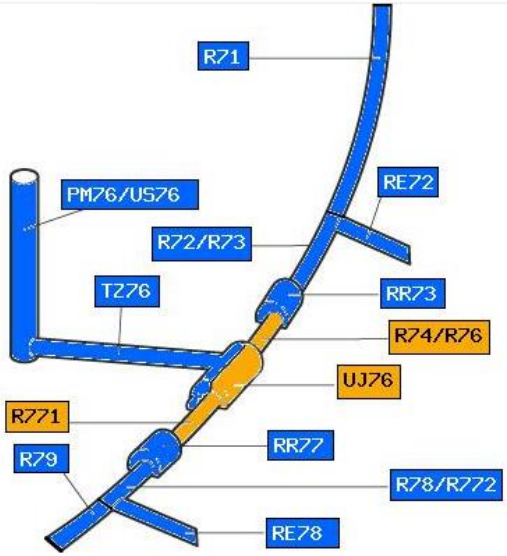


Future situation

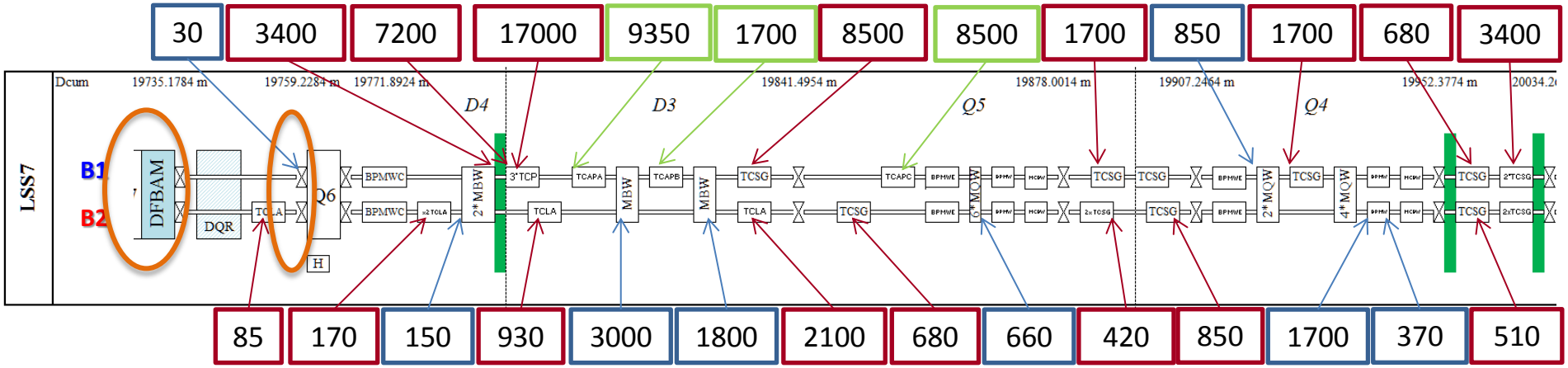
IR7 – LSx_{HL} nominal, 1 month of cooling time

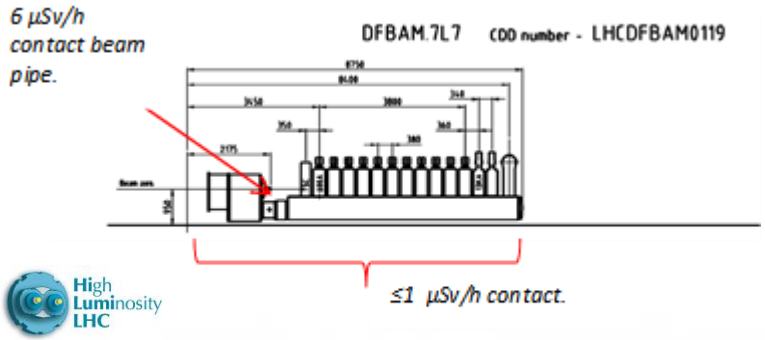
Ambient dose equivalent rates in µSv/h at 40cm
measurements scaled using generic study scaling factor:
17 (LS1 → $LSx_{HLnominal}$ 1 week c.t) * 0.5 (1 week → 1 month c.t.)

Non-designated Area
Supervised Radiation
Simple Controlled Ra
Limited Stay Area
High Radiation Area
Prohibited Area



collimator | absorber | magnet

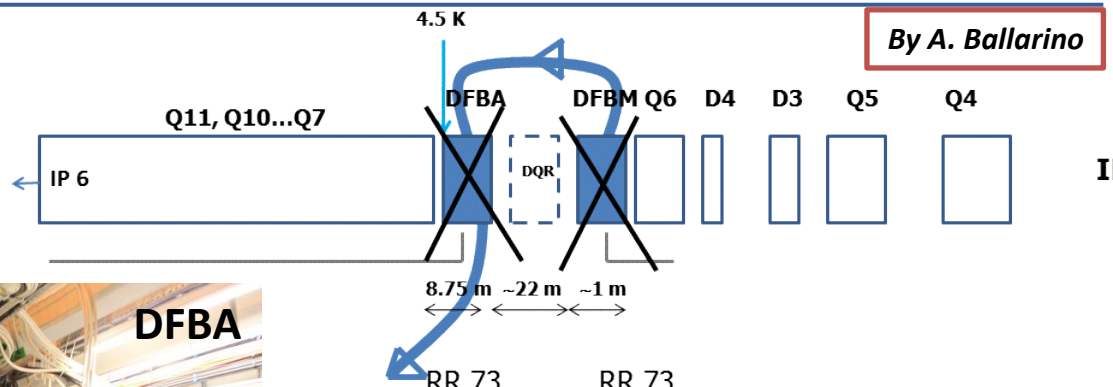


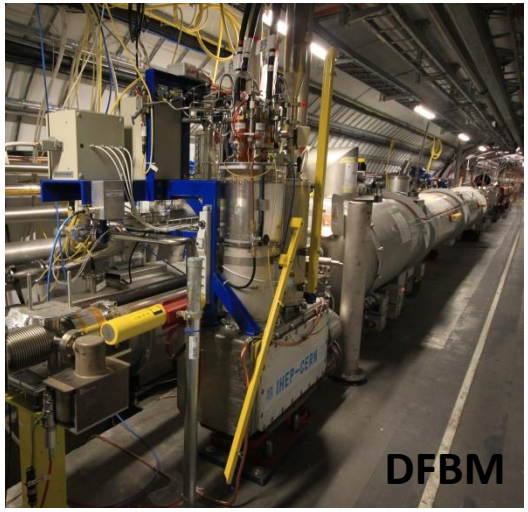


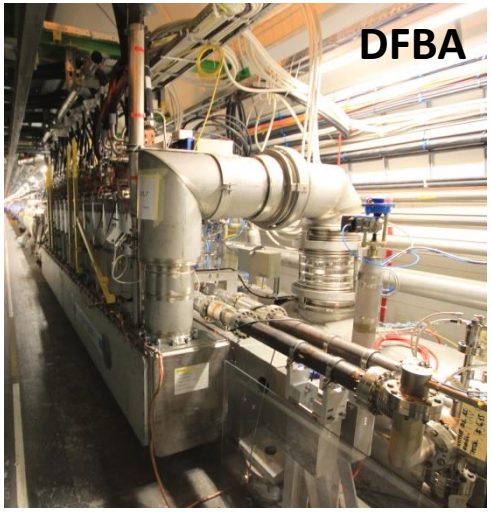
Radiological classification:
High Radiation Area

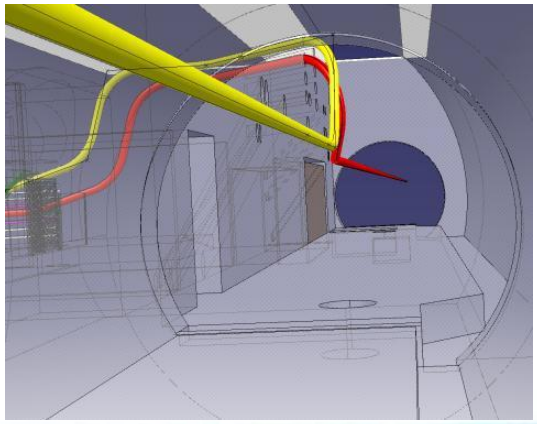
Ultimate: a factor 1.3 higher
it doesn't change the radiological classification

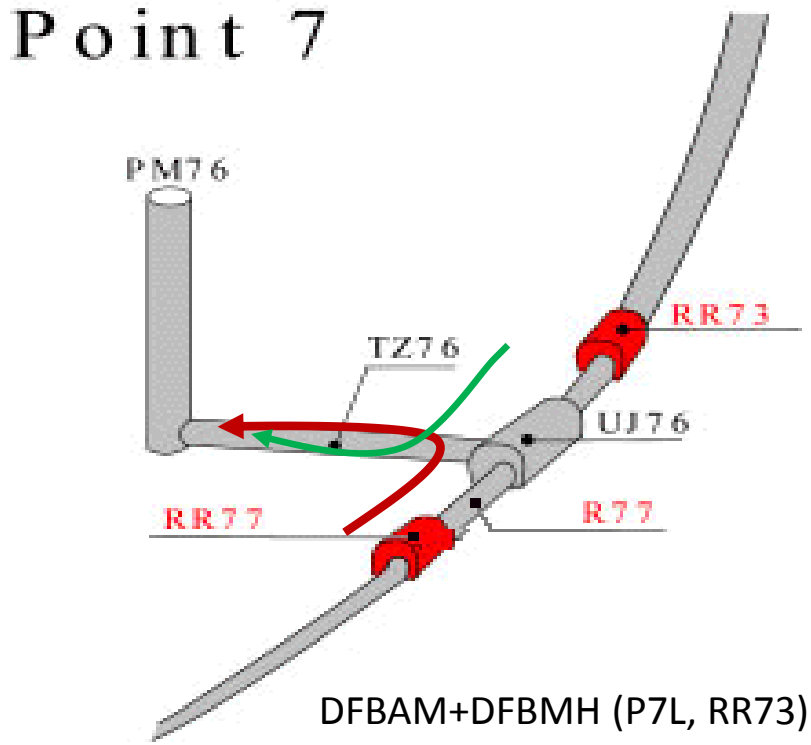
Powering at LHC Points 7









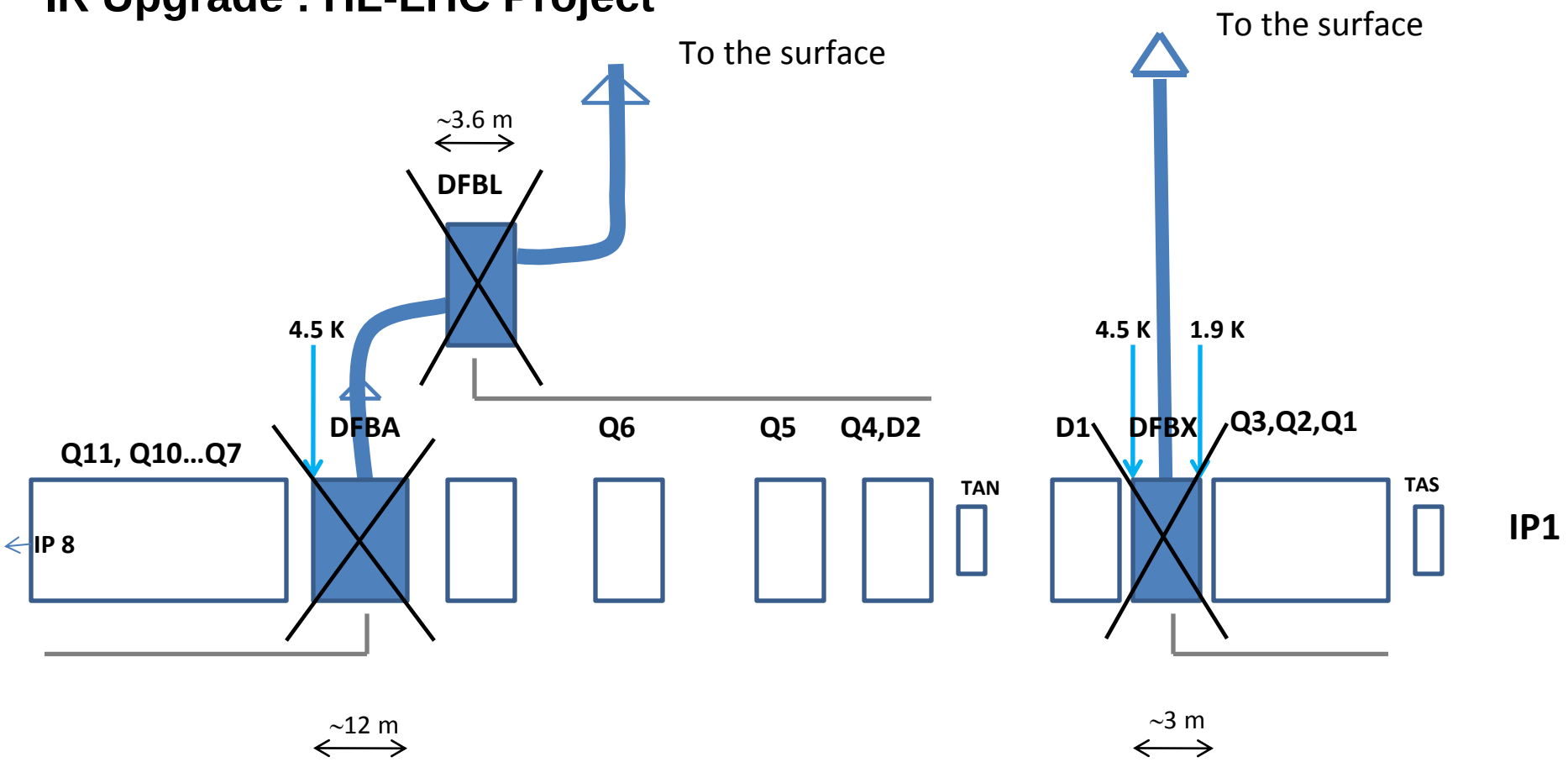


DFBAM+DFBMH (P7L, RR73)
DFBAN+DFBMH (P7R, RR77)

Powering at LHC Points 1 and 5

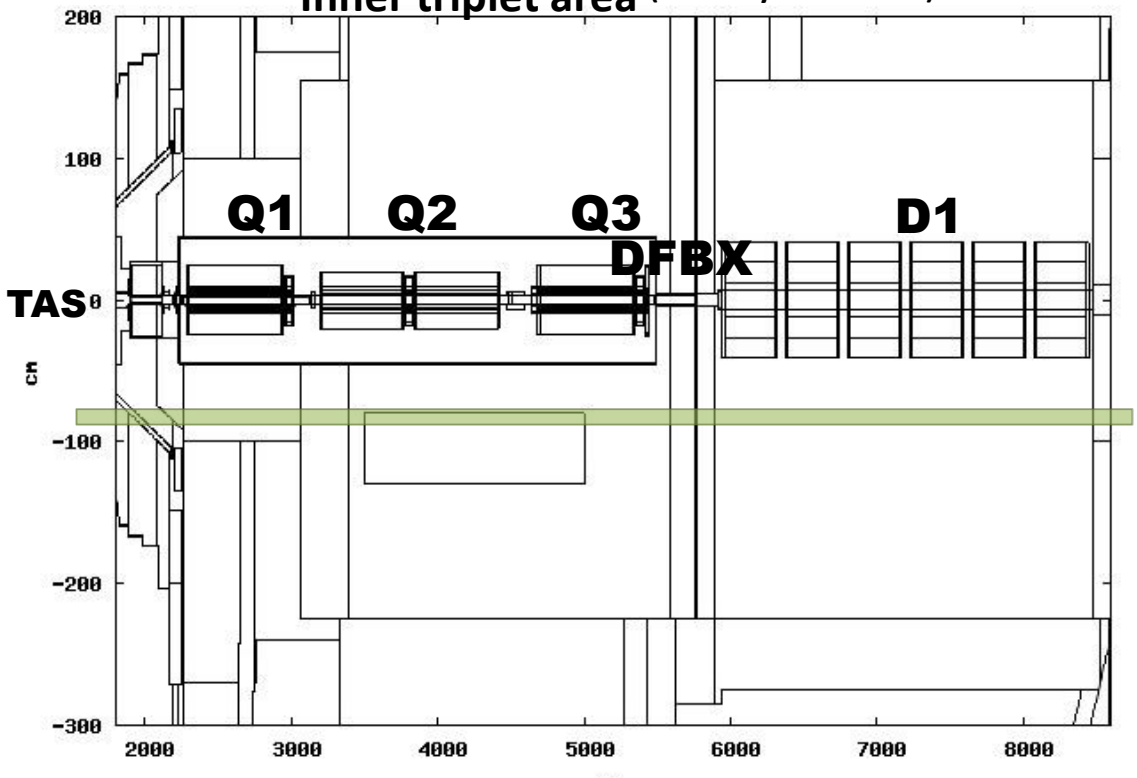
By A. Ballarino

IR Upgrade : HL-LHC Project



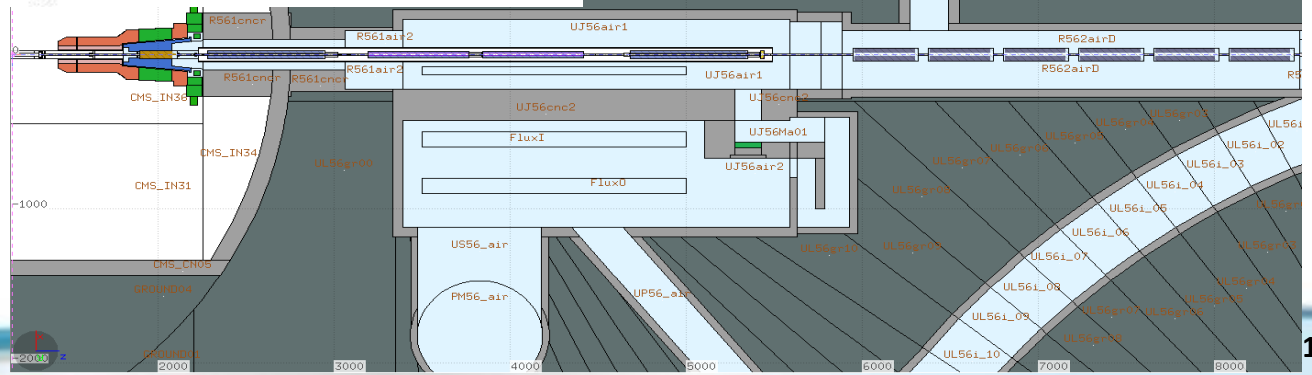
Pre HL-LHC era (LS2 and LS3)

IR5 LHC Fluka geometry
Inner triplet area (courtesy Fluka team)



Shutdown	Year of LHC Operation	Instantaneous peak luminosity (**) [cm-2s-1]	Integral luminosity in interval [fb-1]
	2012	8.00E+33	30
LS1			
	2015	1.45E+34	35
	2016	1.65E+34	50
	2017	1.75E+34	50
LS2			
	2019	2.00E+34	25
	2020	2.00E+34	60
	2021	2.00E+34	60
LS3			

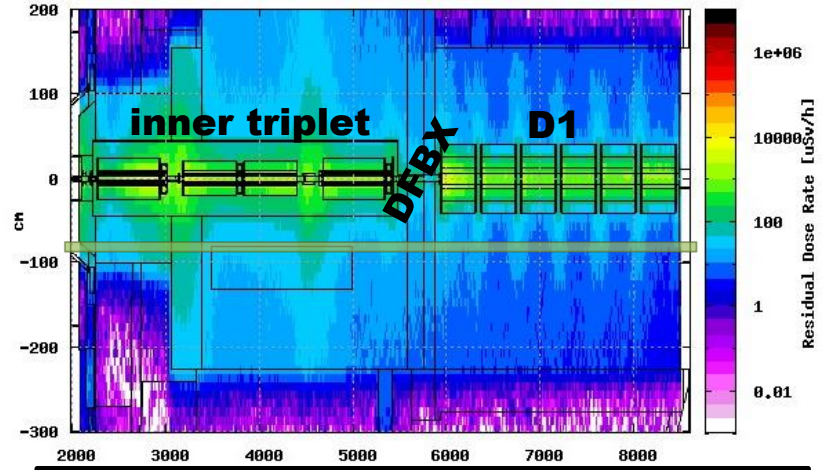
Total integrated luminosity: 310 fb^{-1}



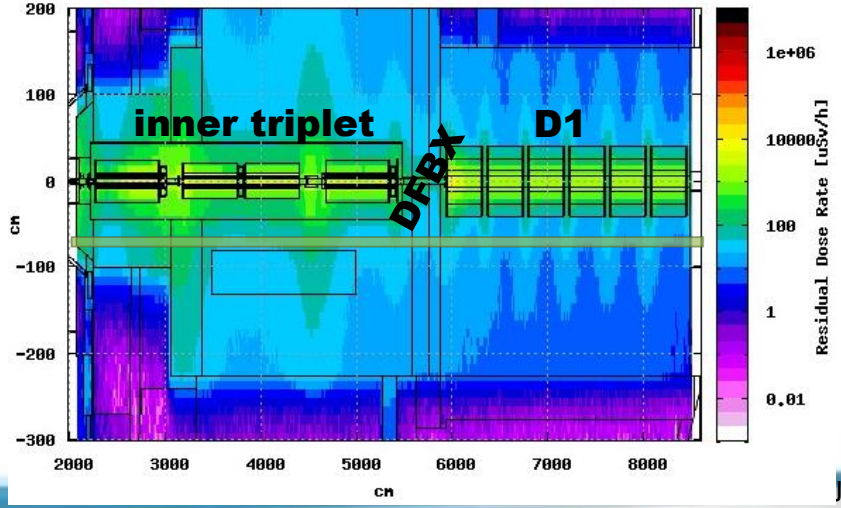
Ambient Dose Equivalent Rates

Cooling time dependence

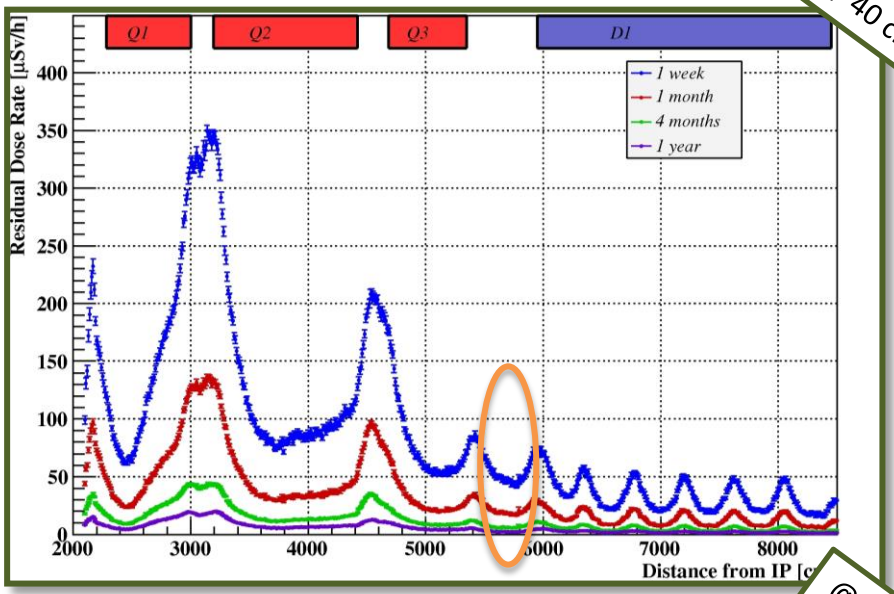
LS2 – 1 month cooling time
Total integrated luminosity 165 fb^{-1}



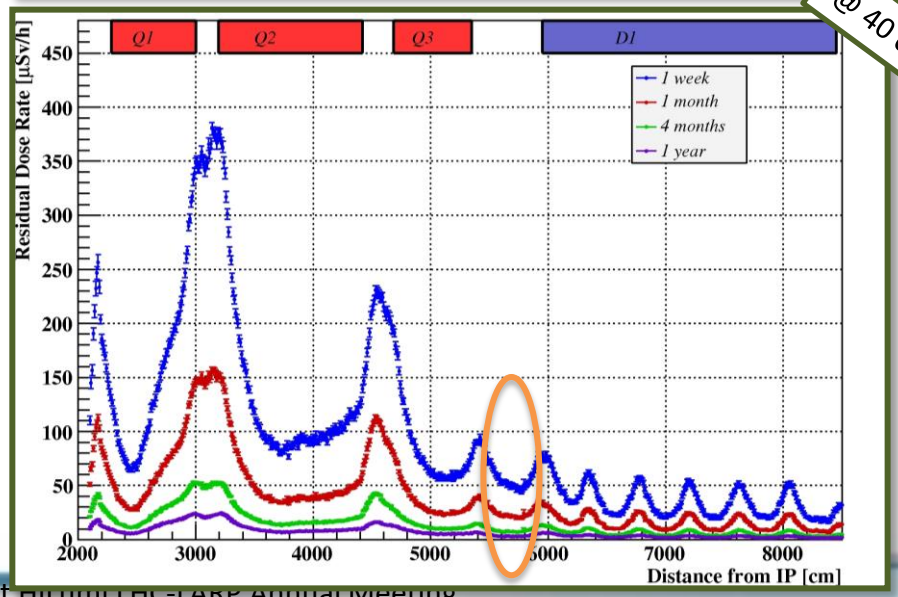
LS3 – 1 month cooling time
Total integrated luminosity 310 fb^{-1}



@ 40 cm

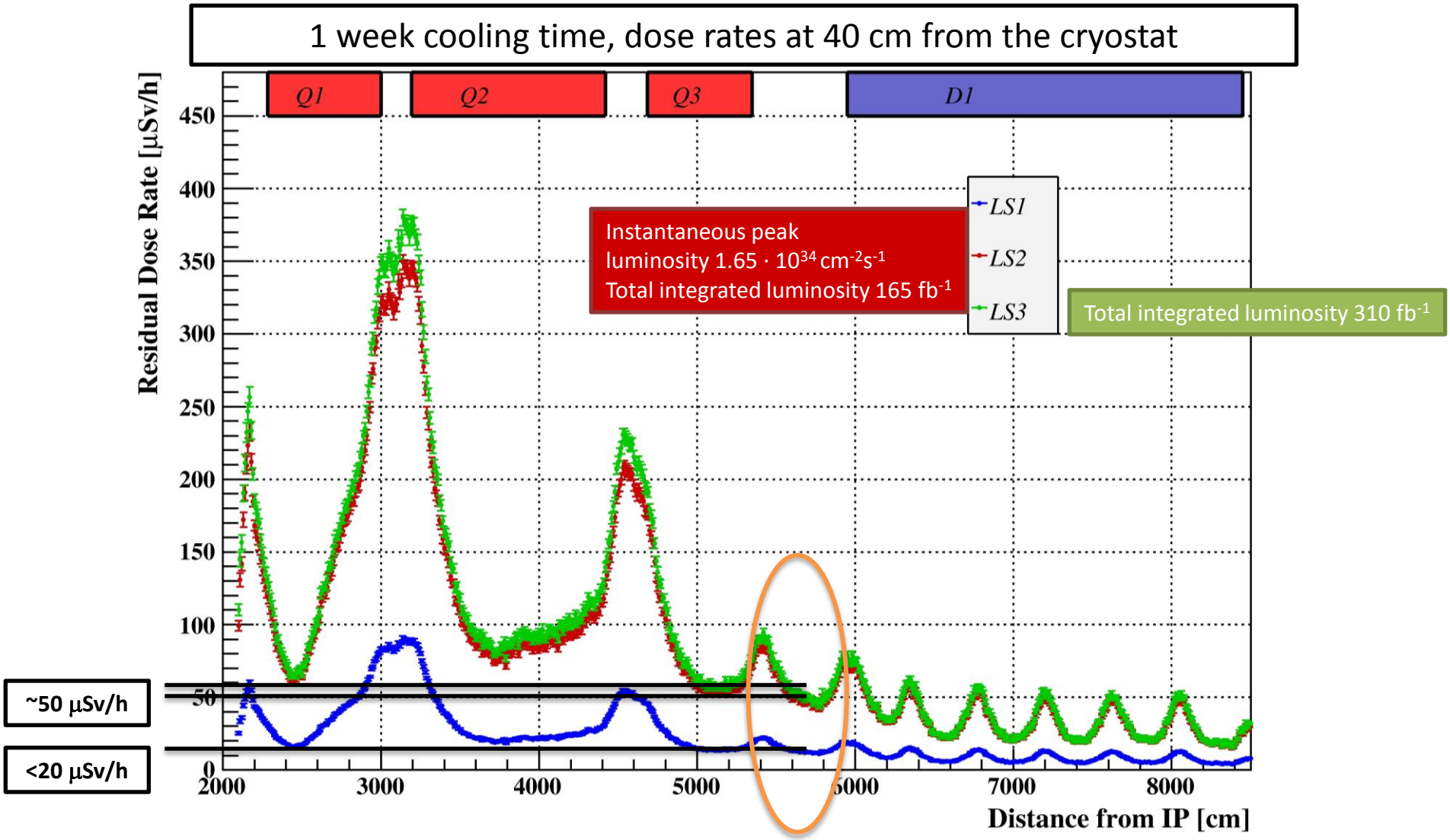


@ 40 cm



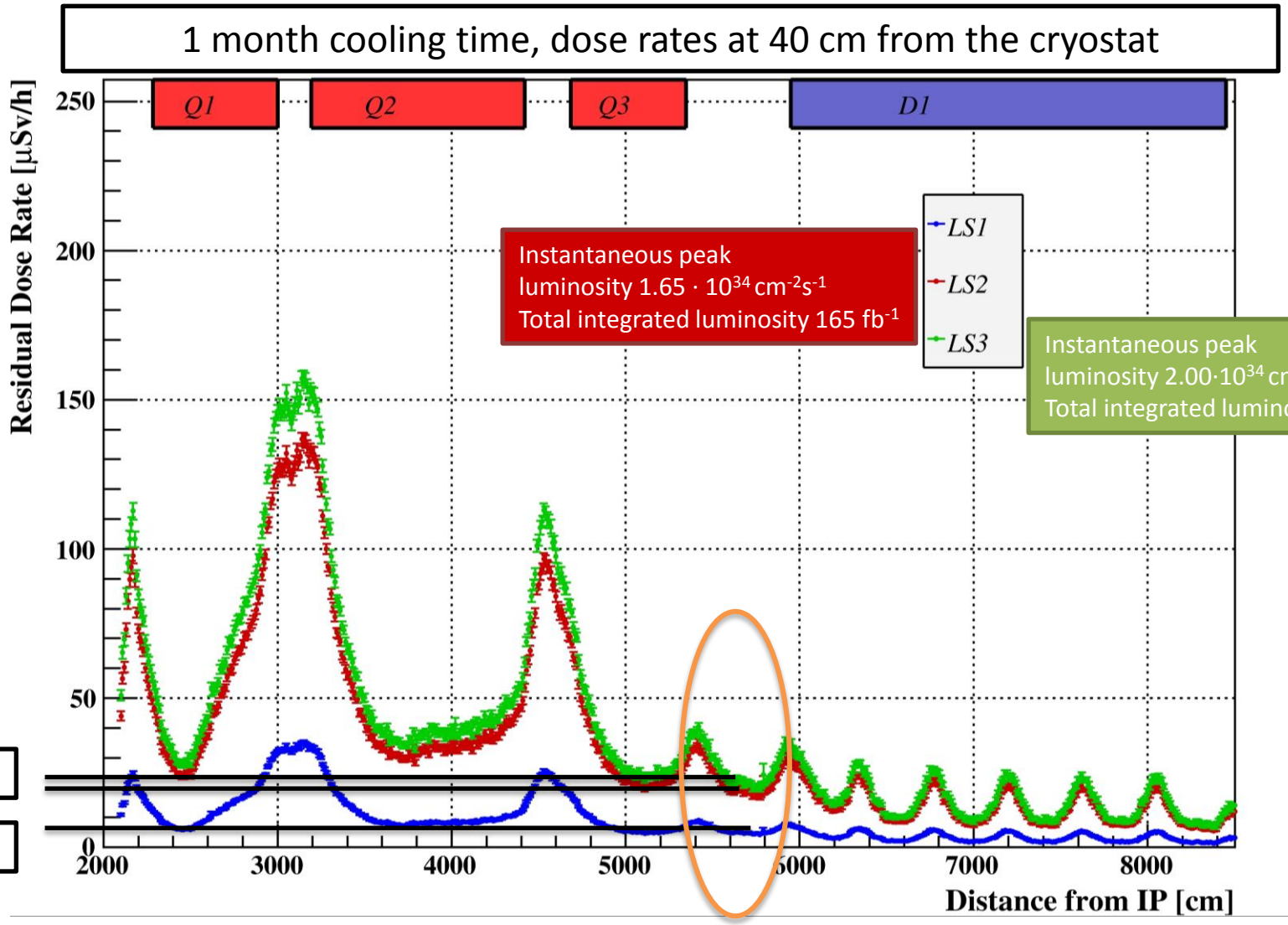
Ambient Dose Equivalent Rates

Time evolution



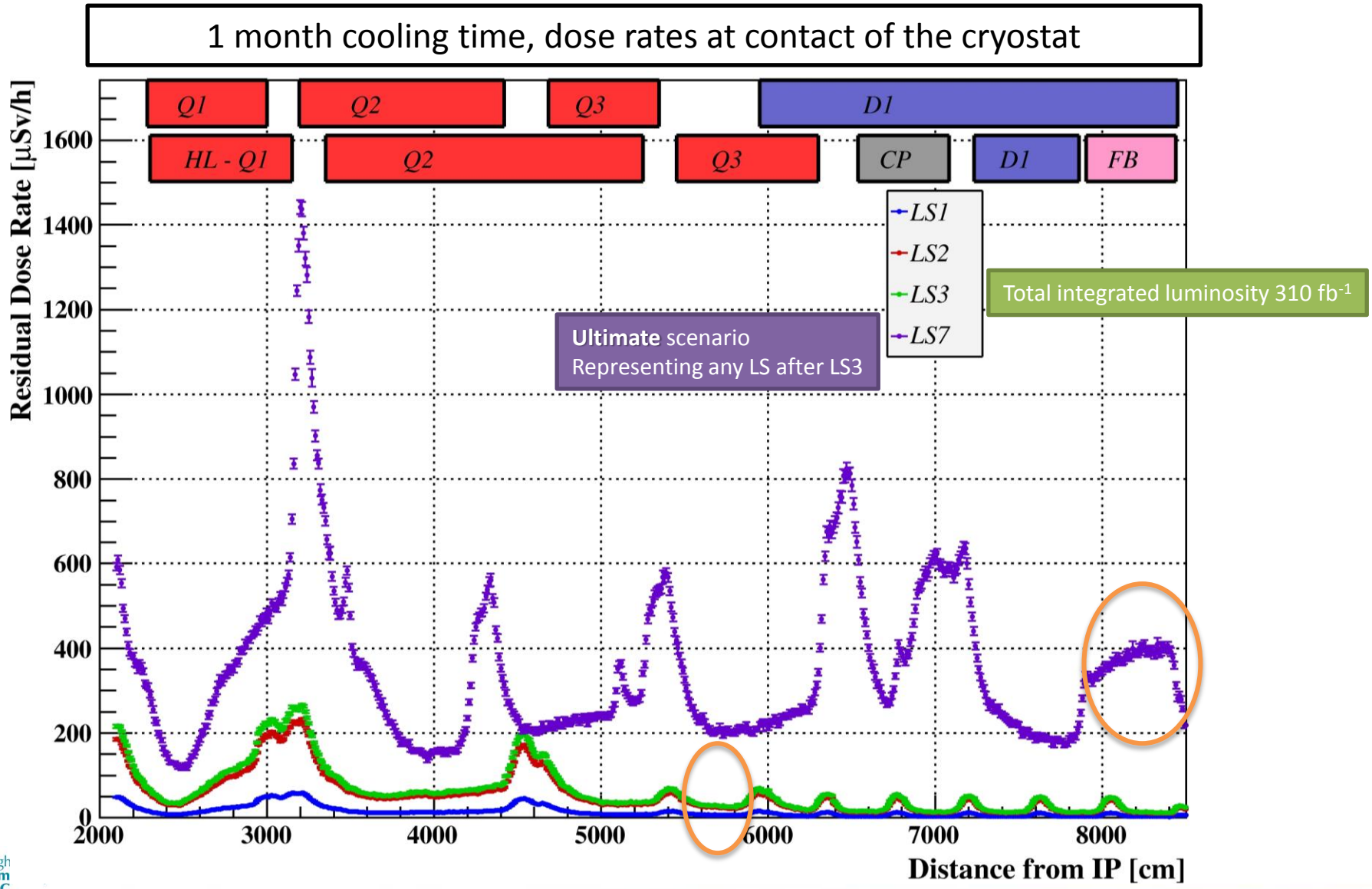
Ambient Dose Equivalent Rates

Time evolution



Ambient Dose Equivalent Rates

Time evolution



Summary and Conclusions 1/2

- **Point 7**
  - Future estimations are done on the basis of RP survey measurements and scaling factors derived from simulation (assuming *no changes* in the collimation settings)
  - Dose rates and activation at the locations of the DFBA and DFBM are expected to be comparably low with respect to the collimation region
  - In view of the installation of the Super Conducting Link passing through the LSS7, evaluation of detailed Work and Dose Planning is needed to optimize the intervention
    - Temporary shielding
    - Schedule the work at the same time of the replacement of the collimators

Summary and Conclusions 2/2

- **Point 1 and 5** (equivalent from a radiological point of view)
  - DFBX in the inner triplet area (Limited Stay area in LS3)
  - DFBA and DFBL are far from the interaction region, thus residual dose rates are expected to be very low (during LS1 at background level)
  - For the removal of the DFBX and the installation of the SC links the evaluation of detailed Work and Dose Plannings is needed to optimize the interventions (working and passaging through activated area (inner triplet area) and activated equipment (e.g. TCL collimators, TAN))

Thank You
for your attention!

EDMS.
1437532