I. Béjar Alonso

9th Meeting of the HL-LHC Parameter and Layout Committee

Participants: Austin Ball, Isabel Bejar Alonso, Oliver Bruning ,Helmut Burkhardt, Rama Calaga, Samy Chemli, Ricardo Di Maria, Paolo Ferracin, Rhodri Jones, Roberto Kersevan, Herve Prin, Stefano Redaelli, Lucio Rossi, Jan Uythoven, Damiel Wolmann

Excused: Gianluigi Arduini, Amalia Ballarino, Paolo Fessia, Ezio Todesco, Markus Zerlauth

The slides of all presentations can be found on the website and Indico pages of the PLC:

HL-LHC PLC homepage: https://espace.cern.ch/HiLumi/PLC/default.aspx

Indico link: https://indico.cern.ch/event/315418/

O. Brunning opened the meeting by approving the minutes of the previous meeting.

Crab cavity integration in the layout (longitudinal space requirements) with the new baseline of 4 cavities per beam and side of the IP – (R. Calaga - slides)

R. Calaga presents the new Baseline for the crab cavities that integrate 4 cavities per beam with 3.4MV/cavity. For several reasons it has been identified that the SPS-type cryomodule, containing 2 cavities for the same beam, is the best option also for the HL-LHC (mechanical, alignment, modularity, use for the crab kissing scheme,…). There are presently 3 concurrent designs for the cryomodule, the longest being 3.1m long. This value is the one that has been taken in consideration for the integration studies. This option replaces the previous baseline. R. de Maria confirms that this option is already considered as the baseline for WP2.

Action: The new Layout will be approved in next PLC. All WPL are asked to check that there is no objection from their side.

R. Calaga explains that the present space requirements are not linked to the RF cryomodules themselves but to the other RF systems (power amplifiers, wave guides,…). In the past, it had been considered the possibility to use the RR caverns but the time delay for the control system seemed not acceptable. Today we know that this scenario can work from the controls point of view, but becomes unacceptable because of the difficulties for routing the RF guides and the high radiation levels in the zone. It is impossible to have radiation hard low RF electronics.

The preferred option would be a layout similar to the one in P4 with a bypass tunnel, but the current configurations in P1 and P5 cannot offer this option.

The second option studied (that will be presented by P.Fessia in a future meeting) includes new underground caverns on both sides of the IP for RF and Cryogenic equipment.

L. Rossi comments that the quality of the space required by the cryogenic group is not the same as the one required by the RF group.

R. Calaga confirms that in any case there is not enough space in the RR for all the equipment and the shielding that will be required.

The third option is to drill from the surface cores for the coaxial guides and put the low RF in surface. The 80 m deep distance is acceptable. Such studies were already done in the past for the superconducting link.

A. Ball points out different technical problems that could be linked to the civil works (including possible pollution, environmental studies, ground water frozen for the excavation) and the proximity to the border of the CERN land. R. Calaga indicates that the building could be very low to reduce the visual impact. L. Rossi confirms that this was already considered for the surface buildings of the superconducting links.

ACTION: To pursue the study of the option including vertical cores. To be done by the integration team.

ACTION: Plan a presentation at the TC comparing the three different options. (Enlarging of the RR, new caverns and vertical cores)

New optics V2.0 including impact of the flat beam operation and ATS optics on the protection efficiency of the TAN and the possibility of having a movable TAN (R. de Maria - slides)

R. De Maria enumerates the past layout versions and the main changes between versions.

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He passed through the main changes of the HLLHCV1.1, motivated by the progress in the definition and integration of the equipment, energy deposition studies and experience from beam operation. One key difference between the V1.0 and the V1.1 Layout are different diameters for the TAS absorber.

TAS aperture

Layout	Element	Target[1] [σ]	Aperture estimate + imperfections [σ]	Sensitivity[2] [σ/mm]
V1.0	TAS r=30 mm	≥12	12.82	0.57
V1.1	TAS r=28.5 mm	≥12	12.00	
	TAS r= 27 mm	≥12	11.10	
	Q1	≥12	13.64	0.31
	Q2-Q3	≥12	10.97	0.21

L. Rossi asks to reduce the TAS aperture radius to 27 mm unless there are strong objections.

Several issues are raised such as failure scenarios, synchronous dump, reduced aperture margins, etc. It is confirmed by A. Ball that the TAS is movable but not during operation.

S.Redaelli commented that the proposed TAS aperture is not compatible with the agreed collimator setting baseline for the beta* cases of 15cm. Potential drawbacks are higher loss rates close to the experiments. The impact on machine protection in case of asynchronous dumps must also be addressed. S.Redaelli commented that we clearly aim at a tighter collimator hierarchy, that will free aperture for smaller TAS, but at this stage he proposes to stick to the agreed baseline.

Action: WP8 to study the different scenarios in order to evaluate if the reduced TAS aperture of 27mm is acceptable. Considering the limited resourced the presentation of the study is set not before end 2014.

Decision: The working hypothesis will be a TAS radius of 27 mm until a revision is requested by the WP8 analysis.

S.Redaelli commented that one of our HiLumi parters is studying the minimum protection aperture in the IRs: we expect results after summer if all goes well.

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D1 update

Layout	Length [m]	Field [T]	Integral [Tm]	Load line
V1.0	6.7	5.2	35	70%
V1.1	6.3	5.6	35	75%

For the TAN-Q4 region the main changes are the shift of the Q4 towards the arc, 2+2 cavities instead of 3 crab cavities, extending the crossing scheme to the crab cavity area, introducing one design for orbit correctors close to D2 and Q4, move TCT on non IP side of D2 and move TAN towards the D2.

S. Redaelli suggests moving the TCT in front of the Q4 instead. R. De Maria indicates that both possibilities are acceptable. S. Redaelli confirms that they will study this possibility considering the different scenarios.

TAN optimization

The TAN optimization takes in consideration the input from WP10 and the constraints from WP12. R. De Maria encourages the study of the integration of the masks in the cold masses. L. Rossi requests that there is a presentation of the Vacuum strategy in the Technical committee.

Action: Schedule a presentation on the vacuum layout strategy

Regarding the optimization of the TAN to the optics it is stated that it could be very interesting to have a movable TAN as it is impossible to optimize at the same time for flat and round optics.

To the question of L. Rossi on which optics is the baseline, O. Bruning states that flat beams is the back up scenario in case of problems with the implementation of the crab cavities. The use of Flat optics implies the use of the LRBB wire compensator and could be an intermediate case until the crab cavities become fully operational.

R. De Maria states that with a cross angle of 18 σ it could be possible to have a vertical-vertical crossing. O. Bruning asks to study it in detail to obtain a more precise value and to have the option not to use only the horizontal-vertical scheme.

The different TAN geometries and a possible TAN modularity are discussed.

Action: WP8 to study different geometries of the TAN and a possible modularity to allow adjustments for round beam and flat beam operation during technical stops

D2 Update

Layout	Length	Field	Integral	Coil AP	CB OD/ID	BS OD/ID	BS Ogap/IGap	Shape
	m	T	Tm	mm	mm	mm	mm	
V1.0	10	3.5	35	105	_/_	_/82	_/72	Rectellipse
V1.1	9	4	35	105	_/_	_/88.5	_/82.5	Octagon

The reduction of the D2 length is under discussion and field quality validation is in progress.

The octagon shape of the beam screen is optimal for flat optics. R. Kersevan confirms that for them this is also an optimal solution.

IR orbit manipulations and orbit corrector strategies

Considering the offset allowed by the crab cavities and the operational margin it is possible to extend the crossing bump to the Q4 correctors and to share the strength between correctors in D2 and D4. This makes possible to use the same type of correctors in D2 and Q4.

R. De Maria shows the orbit corrector budget

	opt round/ opt inj	MCBX [Tm]			MCBYY [Tm]		MCBY|C [Tm]
		1	2	3	D2	Q4	
X-ing at IP	590 µrad	0.1/0.7		1.8/0.7	2.3/1.9	2.5/2.5	0.4/0.4
Sep. at IP	1.5/4.0 mm	0.1		0.2/0.7	0.2/0.4	0.0	0
Triplet Mis.	2 sigma	1.0/1.0	1.4/1.4	0.8/0.8	0.0	0	0
Offset IP (x-ing)	+/-0.5 mm	+0.3/-0.3		-0.7/+0.7	+0.2/+0.2	0.0	0
Crab cavities alignment	+/-0.5 mm ($p_{x/y}$=0)	0.2/0.2		0.4/0.4	0.3/0.3	0/0	0.4/0.3
	+/-0.2 mm delta	0/0			0.5/0.5	0.7/0.7	0.2/0.2
Arc. Imperf.	to be assessed	0			0	0	2.3-1.5

Sum		1.6/1.4	2.0/1.8	2.3/2.6	3.3/2.9	3.2/3.2	1.0/0.9
Nominal Str.		2.5	2.5	4.5	3.5	3.5	3.3[1)]-2.5

It is possible to perform an optimization shifting the IP position and re-sharing the strength. We are within the specification but with no much margin in particular for the MCBYY

ACTION R. Di Maria to cross check that the correctors will operate at 1.9 K and to verify with WP3 and S. Chemli the values for all correctors

Q4-Q5 types in IR1 and IR5

V1.1 relies on: existing 3xMCBY+MQY in Q4 being separated by D2, replacing heat exchangers to allow 1.9 K cooling, move it to Q5 position, train MQY to 200 T/m.

As an alternative, it is possible to change the design of MQYY to a lower current version but this implies building 8 additional MQYYs (extra cost of 10 MCHF) + spares and 1 extra year.

The solution is compatible also with other optics solutions, which would bring many benefits in terms of conditions at crab cavities thanks to the larger aperture in Q5.

Q5 Type in IR6 (needed for ATS)

The V1.1 includes two MQY. MQY spares are available.

R. Di Maria recapitulates the main changes

Element	IR	Type		Length [m]		Nom. Field [T or T/m]	
		V1.0	V1.1	V1.0	V1.1	V1.0	V1.1
Q1/3a/b	15	MQXF		4		140	
Q2a/b	15	MQXFL		6.8		140	
D1	15	MBXA		6.7	6.3	5.2	5.6
D2	15	MBRD			9	3.5	4
Q4	15	MQYY		3.5		120	
Q5	15	MQYL	MQY@1.9K	4.8	3.4	160	200
Q5	6	MQYL	2xMQY	4.8	2x3.4	160	160

And the aperture model

Element	Coil ap. [mm]	Sep. [mm]		Shape		BS inner specs [mm] (radius, half-gap)	
		V1	V2	V1	V2	V1	V2
TAS	n/a	n/a		Circle		30	
Q1	150	n/a		Octagon		53, 49	
Q2-Q3 to	150	n/a		Octagon		63, 59	
TAN	n/a	144	(1)	Ellipse	Circle	42, 36	(1)
MASK D2	n/a		175		Octagon		(1)
D2	105	186	188	RE	Octagon	41,36	44 ,42
MCBYY	100	194	194		Octagon		41,39
Crab	84	194		Circle		42	
Q4	90	194		Rectellipse		37, 32	
MASK Q5	n/a		194		RE		30, 26
Q5	70	194		Rectellipse			30, 26

(1) Pending vacuum valve locations

ACTION: Values for TAN and MASK D2 are accepted as baseline but missing the valves positioning. Information to be provided by WP12.

R. De Maria enumerates the open points for V1.1.

- Masks integration and vacuum layout to be finalised.
- IT and D2 beam screen design to be discussed and finalised.
- MQY at 1.9 K to be demonstrated and selection of best MQYs among spares.
- Validation of aperture margins and collimator settings.
- BPMs in the triplet area to be studied (number, aperture, performance)

And some remarks:

- Active alignment costly for corrector strength but beam base alignment.
- Decision on MQYY design is awaited: it will provide flexibility for future design.
- If the BBLR is included in the baseline specifications should be provided and the integration studied.
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ACTION: In one year time present at a TC the V1.1 versus the alternative for the Q4-Q5 types.

ACTION: Check with H. Schmickler and Y. Papaphilippou the position of the BBLR and reserve the space (adapted to the technical solution). Study the option considering round beams.

AOB (all)

R. Jones request that is confirmed that all the experiments in the tunnel area (e.g. ALFA) will be gone for the HL-LHC period and asks if this could be confirmed at a coordination meeting.

Next meeting on 23th of June 2014.