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the **Large Hadron Collider** project

LHC Project Document No.
LHC-LJ-EC-0003

EDMS Document No.
507947

Engineering Change requested by (Name & Div./Grp.) :
R. Assmann AB/ABP, C. Fischer AB/BDI, D. Macina TS/LEA

Date: 2004-11-25

Engineering Change Order – Class I

Integration of Tertiary Collimators, Beam-Beam Rate Monitors and Space Reservation for a Calorimeter in the Experimental LSS's

Brief description of the proposed change(s) :

It is proposed (1) to integrate tertiary collimators into the layout of all four experimental insertions, (2) to reserve space in between the vacuum chambers in IR2 and IR8 for beam-beam rate monitors and (3) to reserve space for a small experimental calorimeter in IR8.

Equipment concerned :	***Drawings concerned :***	***Documents concerned :***
BRAN, TCT, XFCAL, BPTX, VCTY, X2ZDC, XRP1	**LHCLSX__0001- LHCLSX__0004** **LHCLSX__0009- LHCLSX__0010** **LHCLSX__0015- LHCLSX__0016** **LHCLSXG_0001** **LHCLSXG_0003**	**LHC-B-ES-0007 rev 1.1** **LHC-X2ZDC-EC-0001**

PE in charge of the item :	***PE in charge of parent item in PBS :***
C. Boccard AB/BDI, E. Bravin AB/BDI, M. Gallio PH/UAI, B. Jeanneret AB/ABP, M. Oriunno PH/TOT, C. Rathjen AT/VAC	**S. Chemli TS/IC** **R. Ostojic AT/MEL**

Decision of the Project Engineer :

- ☐ Rejected.
- ☐ Accepted by Project Engineer, no impact on other items.
  Actions identified by Project Engineer
- ☑ Accepted by Project Engineer, but impact on other items.
  Comments from other Project Engineers required
  Final decision & actions by Project Management

Date of Approval : 2004-11-25

Decision of the PLO for Class I changes :

- ☐ Not requested.
- ☐ Rejected.
- ☑ Accepted by the Project Leader Office.
  Actions identified by Project Leader Office

Date of Approval : 2004-11-25

Actions to be undertaken :

Modify the drawings and Equipment codes concerned to reflect the changes described in this ECR.

Date of Completion : 2004-11-25

Visa of QA Officer :

Note : when approved, an ***Engineering Change Request*** *becomes an* ***Engineering Change Order/Notification****.*

1. DETAILED DESCRIPTION

1.1 TERTIARY COLLIMATORS (TCT) IN IR1, IR2, IR5, IR8 **by R. Assmann, V. Kain**

The overall design of the LHC collimation system has recently been optimized for robustness, cleaning efficiency and protection [1]. It is proposed to put tertiary collimators (TCT's) around the interaction points of the LHC in order to protect the super-conducting triplets against energy deposition of the beam halo (cleaning functionality) or possibly mis-kicked beam (machine protection functionality). The horizontal and vertical TCT collimators are fully movable and can be empirically placed at the settings that optimize the machine and physics conditions in terms of halo cleaning, background and protection. The tertiary collimators would be put to about the same aperture as the super-conducting triplets. The beam loss that is encountered with the new layout in the tertiary collimators would otherwise occur in the triplet. It should be noticed that, due to the use of metallic jaw material, the larger gaps and the limited number of tertiary collimators, the contribution to the overall machine resistive impedance is not important (an increase of a few % in the worst case). On the contrary, the use of tertiary collimators might allow to open the gaps of the secondary collimators at 7 TeV with an important overall gain in machine impedance (trade-off in cleaning efficiency between secondary and tertiary collimators).

1.1.1 NUMBER OF REQUIRED TCT'S

The aperture of the triplets must be protected in both horizontal and vertical planes against the beams entering the experimental insertion (incoming beams). Then vertical and horizontal TCT's are required for each incoming beam in each experimental. A total of **16 TCT collimators** were included into the LHC layout.

The **TCT's in IR8 (LHC-b) are considered as optional** and will not be installed for 2007. LHC-b has a nominal value for β^* of 10m (instead of 0.5 m at the other insertions, taking into account that IP2 will run with 0.5 m for ion collisions). The IR8 triplet will then not become an aperture limitation and no additional protection by TCT's is required. Only for early physics a smaller β^* of 1m is foreseen and operation without a TCT should impose no problems. In case that the operational scenario for IR8 is changed such that TCT's are required, then the TCT's can be added into the proposed space reservations.

1.1.2 LOCATIONS

Several constraints (in addition to maximum compatibility with the existing layout) were taken into account for placing the tertiary collimators:

1. Minimal phase advance between the TCT's and the super-conducting triplets, in order to produce an optimal shadow.

2. Placement of horizontal TCT's at a location of sufficient beam-beam separation, such that two opposite jaws can be placed for the incoming beam.

3. For the high luminosity experiments it is preferred to put TCT's at a location further away from the IP, such that showers originating from the TCT's are more diluted at the experimental detectors.

Based on various studies a location close to the D2 magnets was identified as the optimal position for TCT's. From Figure 1 it is seen that the phase advance error from D2 to the super-conducting triplet is acceptable for small β^*. The two beams are well separated at the D2 and an already existing collimator design with two jaws can be used.

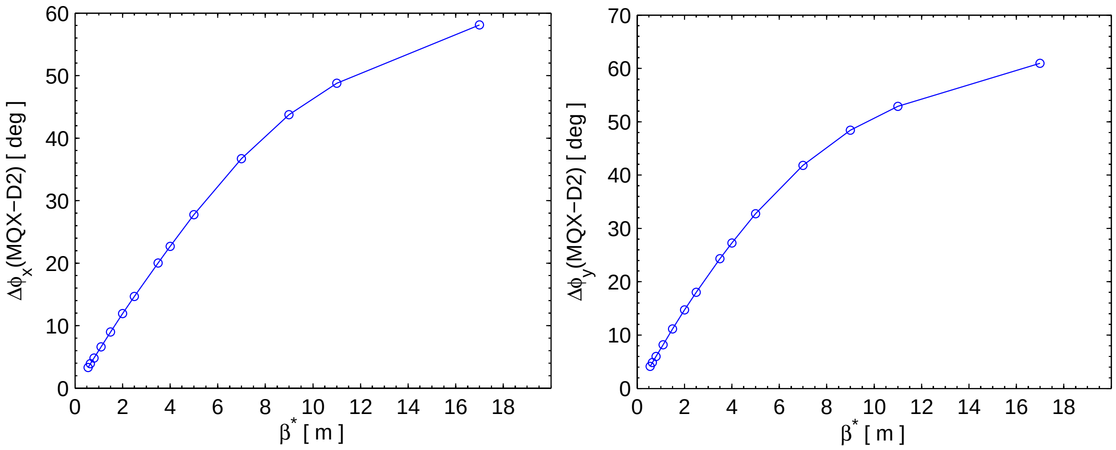

Figure 1 Horizontal (left) and vertical (right) phase advance from D2 to the super-conducting triplet, shown as a function of the beta value in the interaction point [2].

Due to equipment interference the vertical TCT's in IR2 and IR8 could not be placed at the D2 location. In IR2 and IR8 the vertical TCT's were therefore put close to D1, still guaranteeing good protection and cleaning. A new collimator design with two beams in a single collimator tank is required for the D1 location.

The following layout has been established for the different experimental insertions:

- **IR1 and IR5:** Both horizontal and vertical TCT's are put close to the D2 magnet. The cleaning and protection of ATLAS and CMS is therefore identical.

- **IR2 and IR8:** The horizontal TCT's are put close to the D2 magnets. Due to space constraints, the vertical TCT's are put close to the D1 magnets.

Please see Table 1 with the detailed positions for the new TCT's. For completeness the modified locations for the TCLP's (absorbers for physics debris) are listed as well.

Table 1: TCT positions in the various experimental insertions. The reservations for the TCT's go from the tunnel floor to take into account the collimator supports.

Insertion	Collimator	Acting on beam	Location (distance from IP) [m]	Number of beams in tank
1 (and 5)	TCLP.4L1.B2 [1]	2	-(150.47-148.99)	1
	TCTH.4L1.B1	1	-(148.26-146.78)	1
	TCTV.4L1.B1	1	-(146.58-145.10)	1
	TCTV.4R1.B2	2	145.10 - 146.58	1
	TCTH.4R1.B2	2	146.78 - 148.26	1
	TCLP.4R1.B1 [1]	1	148.99 - 150.47	1
2 (and 8)	TCTH.4L2.B1	1	-(118.688-117.208)	1
	TCTV.4L2.B1	1	-(74.23-72.75)	2
	TCTV.4R2.B2	2	72.75-74.23	2
	TCTH.4R2.B2	2	117.208-118.688	1

[1] For the TCLP.4 reservation in IR5 please see Section 4.

1.1.3 DESIGN OF THE TCT'S AT D2

The design of the TCT collimators at the D2 location is derived from the TCS (secondary collimator) design [3] as shown in Figure 2. The outer dimensions of the tank are identical to the TCS design and are summarize shortly:

- o Length: 1.480 m
- o Width (horizontal TCT): 0.266 m
- o Height (horizontal TCT): 0.168 m

For the vertical orientation the width and height must be inter-changed. The dimensions listed above were used for the integration of the TCT collimator tanks at D2. The required length in the layout took into account the need for additional vacuum interconnect and pumping units.

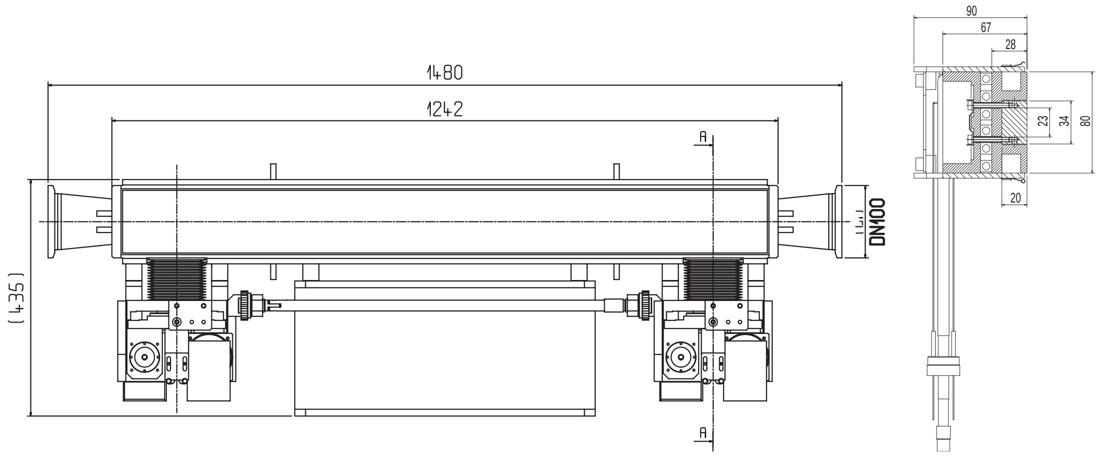

Figure 2 Drawing of the TCS tank (left) and possible Cu/W jaw layout (right) for the TCT collimators at the D2 location [3].

The main difference between the TCS and the TCT designs concerns the jaw assembly. For the TCT's it is foreseen to use a copper jaw mounted on a cooling plate, possibly with a tungsten inlet. A possible scheme for a Cu/W jaw is illustrated in Figure 2. Once the new layout is approved, detailed showering studies will be performed and the material in the active part of the TCT jaw (copper or tungsten) will be decided based on the results.

1.1.4 DESIGN OF THE TCT'S AT D1

The TCT collimators at D1 are in design similar to the recently approved TCLI's at the D1 location [4]. Both types of collimators must accommodate two beams in the same vacuum tank with one beam only being collimated. A technical design remains to be developed for the D1 location. The same longitudinal space as for the TCS design is allocated.

1.1.5 INFRASTRUCTURE FOR TCT COLLIMATORS

The TCT collimators in the experimental insertions require the following infrastructure (compare LHC-LJ-EC-0002):

1. Connection to the demineralised water circuit (27°C inlet temperature).
2. Power and signal cables. Per collimator we require the following cabling: 2×NG28, 1×NG18, 1×NE26, 4×NE18, 1×NE6, 8×NE4 and 1×CKR50. As two TCT's are proposed for each side of the insertion, twice the number of listed cables must be included.
3. It is estimated that 1 electronics rack is required per interaction point, depending on the final decisions on collimator control. This rack would include power supplies and control for all TCT, TCLP and TCLI collimators in a given insertion.

1.2 BRAN IN IR2 AND IR8

by C. Fischer

For the measurement of the interaction rate in IR2 and IR8, 4 beam-beam rate monitors **(BRAN)**, 2 per IR, are needed. They are located on the left side and on the right side of each IP at the point where the common vacuum chamber starts to split into two different channels.
The rate monitors are incorporated within a 300 mm long and 94 mm wide block, inserted in between the two vacuum chamber channels. Hence they are not part of the LHC machine vacuum system. For the purpose of the instrument, the interception of the neutral particles arising from the pp interactions, the monitors need to be placed just after the single vacuum chamber splits in two separate chambers at each side of the IR' s. The width of the devices (94mm) requires sufficient space between the two beam pipes.

In collaboration with AT-VAC, (C. Rathjen), a solution has been found by placing the monitors in between the two tubes of the recombination vacuum chamber, where a larger distance between the two beam pipes can be obtained. It is agreed with AT-VAC to have a region of at least 0.3 m where the beam pipes will leave a clear distance of 100 mm (minus 3x2 mm for all manufacturing and alignment tolerances and the bake-out system), as seen in the case of IR2 right on Figure 3, (courtesy of C. Rathjen).

Interference issues with ALICE ZDC's might require the installation of the BRAN monitors on movable supports that allow their lowering below the machine plane during heavy ion runs. Therefore, the reservation must be made down to the floor to incorporate the necessary space for these supports.

The same longitudinal reservation of 0.3 m is also needed on each side and at these locations in IP8 for beam-beam rate monitors. However, due to the possible request for the installation of an experimental calorimeter at the same location, see Section 1.3, the reservation must be extended longitudinally from 0.3 m to 0.9 m and includes again the space down to the floor. The detailed positions from the IP are listed in Table 2.

Table 2: Positions for the BRAN and the calorimeter

	Name	Position from IP2/IP8 (m)
IR2	BRAN.4L2	-113.119 -> -112.819
	BRAN.4R2	112.819 -> 113.119
IR8	BRAN.4L8 and XFCAL.L8	-114.258 -> -113.358
	BRAN.4R8 and XFCAL.R8	113.358 -> 114.258

1.3 EXPERIMENTAL CALORIMETER

by D. Macina

The possibility of installing a small calorimeter in IR8 on both sides with respect to the IP can be taken into account simply by enlarging the longitudinal space reserved for the BRAN from 0.3 m to 0.9 m (see Table 2). The sharing of this space with the BRAN is described in Section 6.

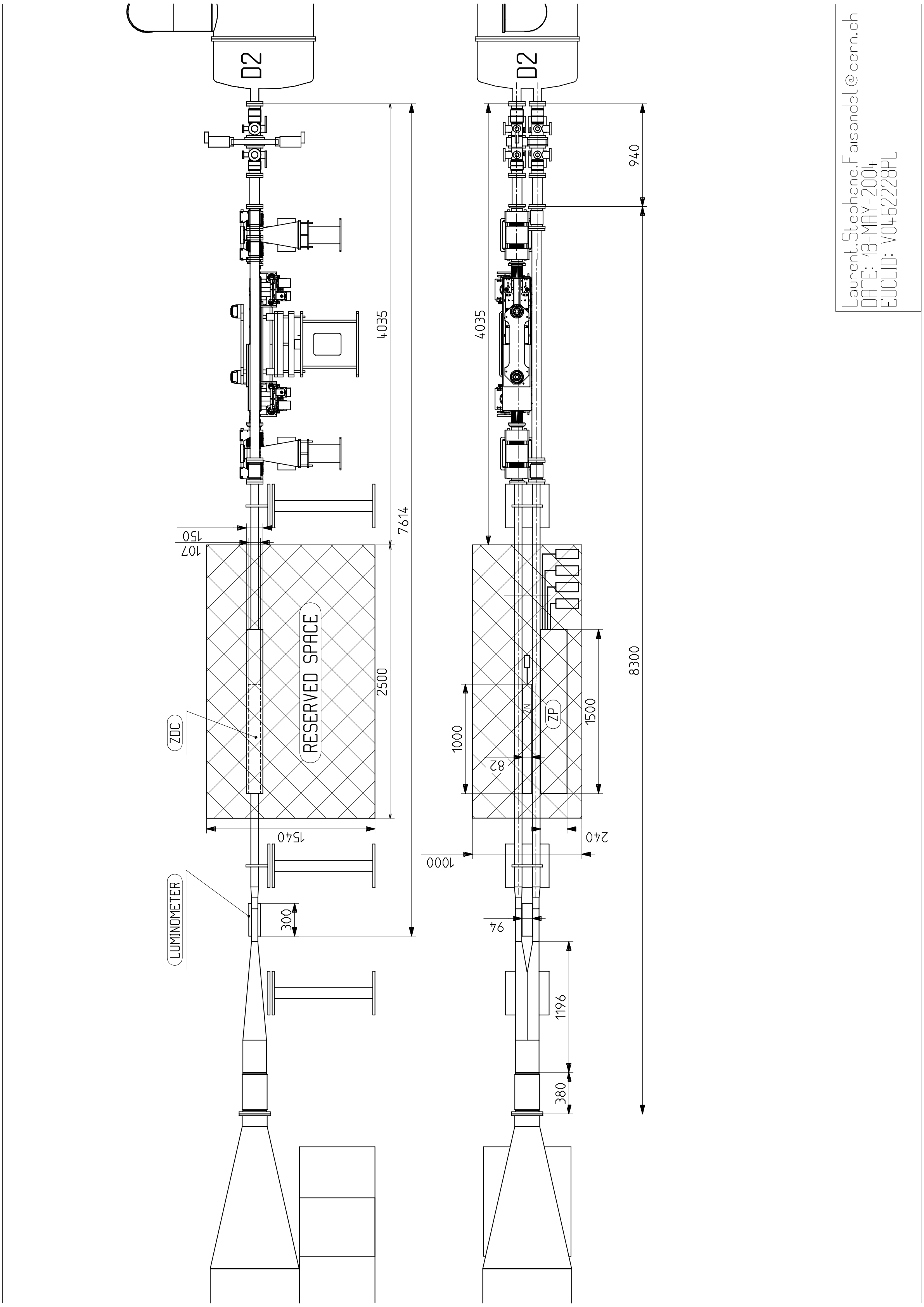

Figure 3: Beam-beam rate monitor (BRAN), XZDC and TCT integration in IR2 R (IR2 L symmetrical; supports not detailed).

1.4 RECOMBINATION CHAMBER

by C. Rathjen

The recombination chamber continues after the two skewed cones (similar to TAN chamber geometry) into two straight tubes (see Figure 3). The length of these tubes is 400 mm for IR2 and 1000 mm for IR 8. These two tubes represent the internal aperture bottleneck of the chamber for the converging beams. A clearance of 3 mm on each side to the 94 mm BRAN is at the moment foreseen. It can be increased to 4.5 mm for a tubes of 1.5 mm wall thickness. The optimal value will be a compromise between bakeout requirements and fabrication tolerances.

Table 3: Positions straight tubes of recombination chamber

	Name	Position from IP2/IP8 (m)
IR2	VCTYB.4L2.C	-113.169 -> -112.769
	VCTYB.4R2.C	112.769 -> 113.169
IR8	VCTYA.4L8.C	-114.308 -> -113.308
	VCTYA.4R8.C	113.308 -> 114.308

1.5 BPTX POSITIONS

by C. Rathjen

The BPTX positions are changed in all experimental insertions (see Section 4). The new positions can be found in Table 4. The BPTX are now located direct to the sector valve assembly at the Q4's. The length of the BPTX is 285 mm instead of the formerly quoted 500 mm in the LHC functional layout data base. The BPTX positions at Point 1 and 5 avoid interferences with the Q4 DSL link feeding according to the actual link design. If the DSL link design will change in the future, the BPTX supports will probably have to be redesigned accordingly (see Figure 4) or the BPTX has to move further away from Q4. It should be noticed that according to the actual space reservation, the BSRT and BWS supports may also interfere with the DSL link at Point 5. However these devices are not in the baseline yet and therefore eventual integration problems will be addressed in the future once the decision to install them is taken.

Table 4: new BPTX positions in m from IP1

Component name	S_START old	S_END old	S_START new	S_END new
_BPTX.4L1.B1	26507.8932	26508.3932	26484.0602	26484.3452
_BPTX.4R1.B2	150.99	150.99	174.538	174.823
_BPTX.4L2.B1	3212.8674	3213.3674	3186.0944	3186.3794
_BPTX.4R2.B2	3451.3084	3451.8084	3477.5414	3477.8264
_BPTX.4L5.B1	13178.2116	13178.9966	13154.6186	13154.9036
_BPTX.4R5.B2	13479.8866	13480.3866	13503.9796	13504.2646
_BPTX.4L8.B1	23195.5248	23196.3098	23169.8368	23170.1218
_BPTX.4R8.B2	23434.2958	23434.7958	23461.2838	23461.5688

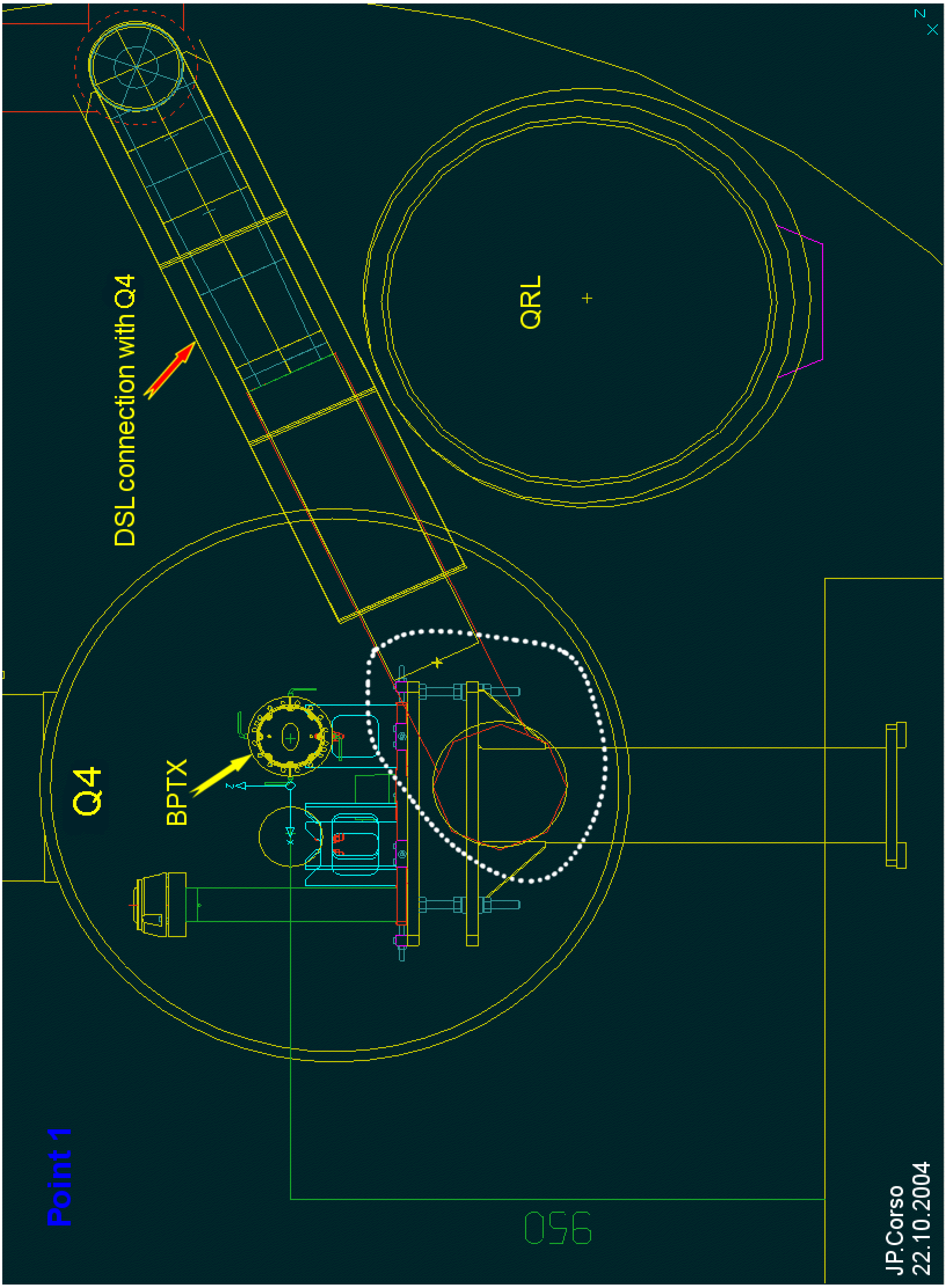

Figure 4:The picture shows the interference between the DSL link and the BPTX support in case the BPTX is placed within the first 1850 mm from Q4.

1.6 ZDC POSITION **by C. Rathjen**

In order to integrate the horizontal TCT at IR2, the space reserved for the ALICE ZDC will have to be moved with respect to the position given in [7] (See section 4).

New ZDC positions

2.5m reserved for ZDC:	
X2ZDC:4L2	-116.398 -> -113.898
X2ZDC.4R2	113.898 -> 116.398

2. REASONS FOR CHANGE

2.1 TCT **by R. Assmann, V. Kain**

The super-conducting triplets in the experimental insertions are local aperture bottle-necks during luminosity production of the LHC. While the 7 TeV apertures in the arcs are above 30σ, the triplet apertures can be as low as 8.4σ in the nominal collision optics. Such local aperture bottlenecks will catch a large fraction of the beam halo (normal operation) and mis-kicked beam (failure cases):

1. Normal operation:The triplets are directly hit by the tertiary beam halo coming from the cleaning insertions. The triplets potentially absorb tertiary beam halo from 8.4σ to 30σ. As a result the triplet can quench or halo-generated background in the experiments can be generated. Figure 5 shows an example calculation of local losses around the LHC ring [5]. A 7 TeV beam halo impacts on the betatron collimators in IR7. A small fraction (tertiary beam halo) escapes and is lost at various aperture limitations in the ring. It is seen that indeed loss spikes occur at the super-conducting triplets in the experimental areas. The predicted losses are above the design operating conditions for the LHC (survival of a transient drop in beam lifetime to 0.2 h with nominal intensity). Tertiary collimators are required to protect the super-conducting triplets against the predicted beam loss.
2. Possible failure scenario:The TCDQ object in IR6 is designed to protect the ring against mis-kicked beam in case of an abnormal beam dump. The required settings are tight and experience shows that a full protection with these tight tolerances might not be 100% ensured during all times. In order to avoid damage to the super-conducting in case of a rare failure of the TCDQ protection, it is required to put a protection device at the super-conducting triplet. The tertiary collimators will provide the required protection. It is noted that the tertiary collimators are not expected to survive if they are hit by direct beam. They will require replacement.

The TCT's will provide an important enhancement of cleaning efficiency, will allow a control of beam-induced background and will protect the triplets against rare events of beam-induced damage.

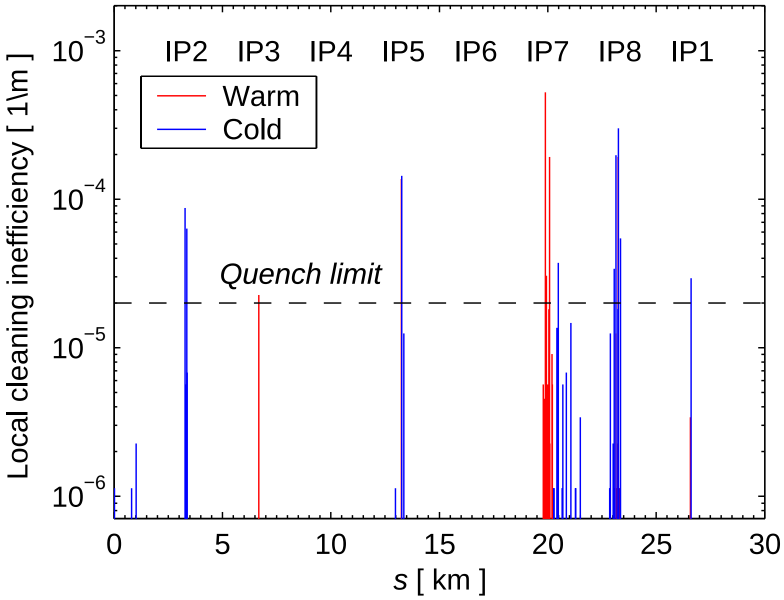

Figure 5: Example of **loss distribution** [5] around the ring for betatron cleaning. The losses are expressed in terms of local cleaning inefficiency and are directly compared to the **estimated quench limit for nominal intensity and a beam lifetime of 0.2 h (design goal)**. Note that all IR's are squeezed to nominal β^*, except IR8 where the initial β^* of 1 m is assumed.

2.2 BRAN

by C. Fischer

The proposed reservations of the BRAN monitors comply with the requests made in the corresponding functional specification [6].

2.3 EXPERIMENTAL CALORIMETER

by D. Macina

The zone between the two beam pipes of the recombination chambers located in the four experimental LSS is highly interesting from the physics point of view since it gives access to the (neutral) particles produced in the primary interactions and emitted at a very small angle with respect to the beam (very forward region). In the LSS1 and LSS5 the recombination chambers are located inside the TAN absorbers which have been equipped with removable copper bars in order to host instrumentation if required. In the LSS2 the recombination chamber will host both the ALICE ZDCs [7] and, according to this ECR, the machine beam-beam rate monitors (BRAN). Finally in the LSS8 the recombination chamber will host, according to this ECR, the BRAN. In addition it would be wise to foresee the integration an experimental calorimeter like in the other LSS. In particular, the LHCf Collaboration has already proposed to install a calorimeter in this zone either in the LSS1 or in the LSS8 [8]. The LHCC has encouraged the LHCf Collaboration to continue the development of their experimental design with a view to submitting a Technical Design Report by the end of 2004 [9].The extra space reservation of 600 mm in the longitudinal coordinate and 94 mm in the transverse one will allow a future calorimeter integration without any change in the LHC vacuum layout which may become difficult and costly in the near future. The impact of this reservation on the vacuum chamber design and on the BRAN is explained in detail in Sections 4 and 6 respectively.

3. IMPACT ON COST, SCHEDULE & PERFORMANCE

3.1 TCT

by R. Assmann

The TCT's will have no impact on the LHC schedule.

The TCT's have been included into the preliminary budget for the LHC collimation project at the end of 2003. The detailed budget discussions will be handled through the LHC collimation project.

The performance reach and the protection of the collider are significantly improved with the new tertiary collimators. The behaviour of halo-induced beam loss around the experimental insertions will be studied in detail, once the layout with tertiary collimators has been fixed.

3.2 BRAN

by C. Fischer

The beam-beam rate monitors are included in the LHC beam instrumentation baseline. Their cost is endorsed by the US LARP collaboration.

3.3 EXPERIMENTAL CALORIMETER

by D. Macina

None.

4. IMPACT ON OTHER ITEMS

by Christian Rathjen

The reservation for the beam-beam rate monitors **(BRAN)** necessitates a change of the design of the recombination chambers in IR8. The fabrication costs of the chamber will not change significantly. The design of the recombination chamber in IR2 already foresees space for the BRAN. The lateral gap of the BRAN to the chamber of only 3 mm requires tight manufacturing and alignment tolerances. Due to the tight tolerances and the small beam stay clear distance, the recombination chamber has to be aligned from the survey group. If moveable BRANs are required, possible collisions have to be considered in the design as well.

The bakeout system cannot have insulation towards the BRAN. A reflective screen is proposed instead. Bakeout systems for IR2 and IR8 have to be studied and tested since no standard components can be used. At least two man weeks for an engineer and two man weeks for a technician have to be accounted in order to design and test the system. A man week in the workshop is required for the installation of the system.

The TCLP next to the sector valve assemblies obstruct the access to the vacuum instrumentation on the external beam line considerably. Interventions and maintenance has to be studied.

by D. Macina

The integration of the TCT's downstream the recombination chamber has no interference with the existing equipment in IR1 and IR8. This does not apply to IR2 and IR5:

IR2

At IR2 the integration of the horizontal TCT requires a displacement of the recombination chamber and, consequently, of the ALICE ZN and ZP, of about 2 m towards the IP. This may vary the acceptance of the ALICE detectors. Even if at a first sight the variation looks negligible, the ALICE Collaboration needs to check carefully the new location. It is assumed, of course, that the space available between the beam pipes and the amount of material in front of the detectors remain unchanged.

Finally the additional dose due to the presence of the TCT in the zone should not limit the access to the ZN and ZP which may be required for repair and maintenance once or twice per year. In case the measured dose at the TCT is too high, the best compromise between machine protection and TCT opening should be found in collaboration with ALICE.

IR5

The integration of the TCT at IR5 has a strong impact on the design of the TOTEM XRP1 station. However, during a joint meeting among CMS, TOTEM and the Collimation Project Group held on July 30th 2004 it has been decided that priority should be given to the maximum protection and cleaning enhancement at IR5 as done in IR1. This requires the integration of both the vertical and horizontal TCT downstream the TAN. In order to have the possibility to achieve it, it has been agreed that the XRP1 will occupy the space reserved for the TCLP.D2 which, according to the latest calculation, it is not required for luminosities smaller than $5x10^{33}$ [10]. It is clear that, as soon as the machine operation requires the presence of the TCLP, the XRP1 will have to be removed and placed at a different location. Though a big effort has been put in the optimization of the layout in IR5 to fulfil the agreement mentioned above, the resulting proposal implies an important reduction of the space reserved for the XRP1. The maximum space left to integrate the XRP1 is 2.73 m. Not all of this length can probably be used for TOTEM since no bellows modules are included and an infringement with the flange of the TCTH collimator on the other beam line has to be resolved. Detailed design studies are required to determine the real length available.

In order to minimize the displacement of the recombination chamber at IR2 and to maximize the space available for the XRP1 at IR5, it has been proposed to move the BPTX further away from the IP downstream the D2/Q4 cryostat. In order to standardize the LSS layout as much as possible, it has been suggested to displace the BPTX in all four experimental insertions. This proposal has been presented to the experiments in the LEADE meeting held on September 6th 2004 and unanimously accepted.

5. CHANGE CLASS

Class I

6. COMMENTS (COMPULSORY) **by E. Bravin**

The integration of the BRAN monitors in IR2 has been discussed with AT-VAC and the ALICE experiment. ALICE is going to install in the same region a zero degree calorimeter (ZDC) which may be incompatible with the BRAN depending on the technology used for the later. A solution has been reached and consists in having a remote controlled positioning device for the BRAN monitors allowing their retraction from the neutral particles path during heavy ion runs, only condition in which the ZDC’s will be used. A similar integration problem has been identified in IR8 where the LHC-f experiment, at the moment not yet approved, is planning to intercept the same neutral particles. In this case too an agreement has been found by placing the BRAN monitor behind the eventual LHC-f monitor.

No analysis of the impact of the TCT's on the BRAN monitors as been performed yet. The secondary particles generated in the TCT's by impinging protons could be a source of background in the BRAN monitors and make the measurement of the luminosity in IR2 (and eventually IR8) difficult or even impossible. In IR1 and IR5 the TAN should provide a sufficient shielding from these secondary particles. A study of the impact of the tertiary collimators is suggested.

7. COMMENTS **by C. Fischer**

If the transverse tolerances with the beam tubes are tight, and if the BRAN monitors are positioned remotely, they might have to share the same supporting structure as the vacuum chambers to account for ground motion effects.

8. COMMENTS **by C. Rathjen**

The ECR is accepted with the following remark: the integration of the TCTs and TCLPs between the TAN and D2 represent the best "compromise" known today. The few meters in front of D2 at IR1, IR2 and IR5 become the most crowded areas in the long straight section. Based on this proposal detailed design studies are now necessary on several components: special quick release bellows modules for the collimators (no space for proposed solutions for the cleaning insertions),TCT (infringement with other beam line: only 1 mm clearance to adjacent chamber if TCS tanks are used, no standard chamber and bakeout possible, infringement with flanges), compressed roman pots (loss of at least 1.5 m in length), sector valve assembly of D2 (no access to roughing valve on external beam line). Ideally the design studies should also include radioactive doses to address not only the mechanical aspect of the integration but also interventions and maintenance.

9. COMMENTS **by M. Gallio, A. Morsch**

A proper evaluation of the changes in the physics performance of the ZDC due to the ZDC displacement cannot be done without the knowledge of the parameters of the LHC optics and of all the apertures of the various collimators and the vacuum chambers from D1 to D2. According to the present simulation, the displacement of the ZDC produces a decrease of the acceptance of the ZDC for spectator protons of ~5%. Preliminary studies show that this percentage can be reduced if the flange at the end of the transition cone of the vacuum chamber before the recombination chamber (trousers) can be removed. Moreover the acceptance increases if one could displace the horizontal beam at IP2 of ~0.6 mm toward the external part of the LHC ring. Therefore we accept the ECR with the condition that:

- in a few months we could have more information about the apertures and the thickness of all the objects between D1 and D2 in order to properly estimate the impact of the proposed changes:
- a strong effort should be done to remove the flange and to reduce to a minimum the thickness of the support of the beam pipe immediately upstream of the ZDC.

10. COMMENTS **by K. Eggert, M. Oriunno**

The space available for the Roman Pot station XRP1has been considerably reduced with respect to the ECR LHC-XRP1-EC-0001. This implies a new design for the Roman Pot station at this location. Detailed design and integration studies are needed. TOTEM can accept the space quoted in the document (~2.5 m) but any further reduction could create problems in the performances of the experiment

11. COMMENTS **by J.B. Jeanneret**

Once the corresponding layout will be stabilised, a systematic review of the transverse geometry will be necessary for several of the elements which will be moved or added according to this document

12. COMMENTS (IF ANY) **by PLO appropriate Committees**

13. REFERENCES

[1] R. Assmann et al, “An Improved Collimation System for the LHC”. LHC-Project-Report-773 (2004).

[2] S. Fartoukh, S. Redaelli, et al, “Phase Advance Variation During the Beta Squeeze”. To be published.

[3] A. Bertarelli et al, “The Mechanical Design for the LHC Collimators”. LHC-Project-Report-786 (2004).

[4] B. Goddard and V. Kain, “New Layout of Injection Protection Elements around IP2 and IP8”. Engineering Change Order LHC-T-EC-0001 rev 1.0 (EDMS No: 494246).

[5] R. Assmann, E. Holzer, J.B. Jeanneret, V. Kain, S. Redaelli, G. Robert-Demolaize, J. Wenninger. “Expected Performance and Beam-Based Optimization of the LHC Collimation System”. LHC-Project-Report-758 (2004).

[6] R. Assmann et al, “On the Measurement of the Relative Luminosity at the LHC”, Functional Specification, LHC-B-ES-0007 rev1.1, EDMS No. 347396.

[7] L. Leistam, D. Macina, “Change of Space for the Alice ZDCs at IR2”, EDMS No 459357, LHC-X2ZDC-EC-0001.

[8] O. Adriani et al, “Measurement of Photons and Neutral Pions in the Very Forward Region of LHC”, LHCC 2003-057 / I-012 Rev. 2.

[9] E. Tsesmelis, Minutes of the 70th LHCC Meeting, CERN/LHCC 2004-016.

[10] Memorandum sent by I Baichev and J.B. Jeanneret to the LEB chairman on 15th June 2004.