BLM layout around Crystal Collimators

B.Salvachua, E.Effinger, S.Morales, C.Zamantzas

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Marian Gonzalez

Crystal collimators in IP7

- **Replacement of the 2 existing crystal collimators in IP7 during LS2**
- **1 crystal per plane and beam**
  - **TCPCV.A6R7.B2 - replacement**
  - TCPCH.A5R7.B2
  - TCPCH.A4L7.B1
  - **TCPCV.A6L7.B1 - replacement**

- **Review of Beam Loss Detection equipment around Crystals in view of an operational system**

References SmartTeam:
- R771/C4->C7R7-1701 INTEG LS2 : ST0882826_01
- R74 / C4 C5 C6 C7L7-1701 INT LS2 : ST0882956_01

Additional Information

- **Proposal discussed at WP15 HL-LHC Integration:**
  - https://indico.cern.ch/event/1014314/
  - Integration Study of TCPC Crystal collimation at IR7, M.Gonzalez
  - BLM layout proposal for crystal collimation at IR7, B.Salvachua
- **Integration details followed up at the ICL meeting:**
  - https://indico.cern.ch/event/1012496/
  - Point 7 – new BLM pour Collimateurs Crystal, M.Gonzalez

BLM configuration on the LHC crystals

We have contacted the Collimation Team to understand which detectors were used during Run 2 to measure the losses at the crystal locations.

For protons:

Crystal	BLM name
TCPCH.A4L7.B1 (B1H)	BLMEI.04L7.B1E10_TCSM.D4L7.B1
TCPCV.A6L7.B1 (B1V)	BLMEI.06L7.B2I10_TCSM.6L7.B2
TCPCH.A5R7.B2 (B2H)	BLMTI.05R7.B2I10_TCPC.A5R7.B2
TCPCV.A6R7.B2 (B2V)	BLMEI.06R7.B1E10_TCSM.6R7.B1

There is a BLM associated to this crystal, BLMTI.06R7.B1I10_TCPC.A6R7.B2 but not clear signal was measured.

For analysis of angular scans with ions:

Crystal	BLM name
TCPCH.A4L7.B1 (B1H)	BLMEI.04L7.B2I10_TCSM.A4L7.B2
TCPCV.A6L7.B1 (B1V)	BLMEI.05L7.B1E10_TCSM.A5L7.B1
TCPCH.A5R7.B2 (B2H)	BLMEI.05R7.B1E10_TCSM.A5R7.B1
TCPCV.A6R7.B2 (B2V)	BLMEI.05R7.B2I10_TCSM.B5R7.B2

For ions is normal that further downstream detectors are more sensitive to collimation losses.

We have inspected the crystal location and will propose a new configuration of the BLM detectors.

TCPCH.A4L7.B1

Pre-LS2 configuration:
BLMTS.04L7.B1E10_TCSG.D4L7.B1 BLMTS.A4L7 19918.24 m
BLMTI.04L7.B1E10_TCSG.D4L7.B1 BLMTI.A4L7 19918.37 m
Crystal TCPCH.A4L7.B1
BLMES.04L7.B1E10_TCSM.D4L7.B1 BLMES.K4L7 19920.24 m
BLMEI.04L7.B1E10_TCSM.D4L7.B1 BLMEI.O4L7 19920.37 m

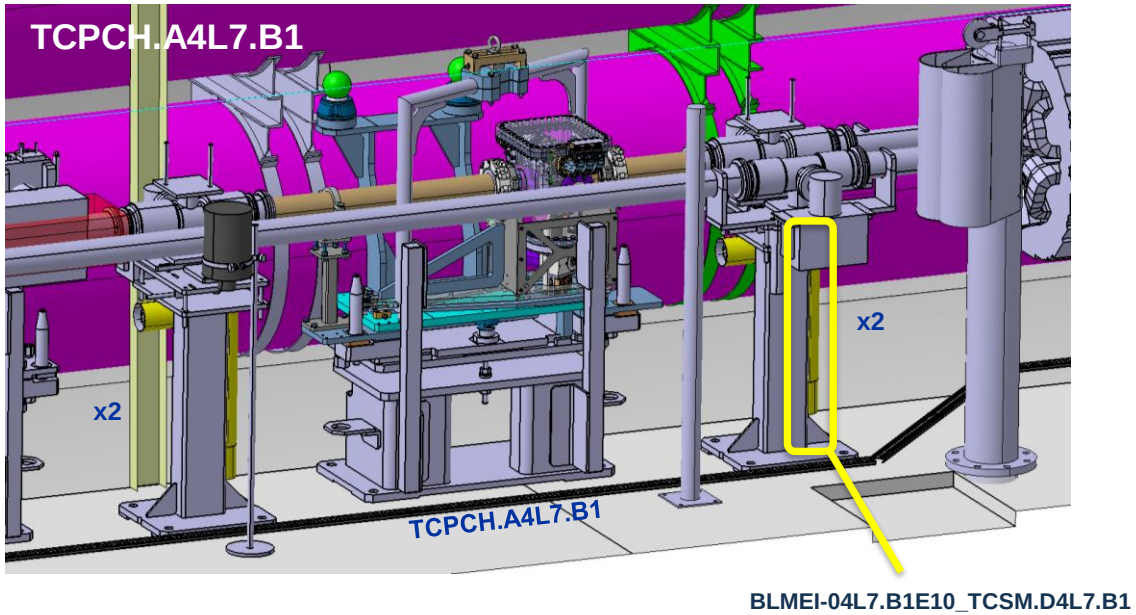
Crystal DCUM: 19919.4989 m

This crystal was installed in the TCSM.D4L7.B1 slot.

The BLM associated to the empty slot (TCSM.D4L7.B1) should be the re-assigned to the crystal.
BLMEI -> BLMTI

Proposal:
- **No change in layout**
- **Update DB with correct name**

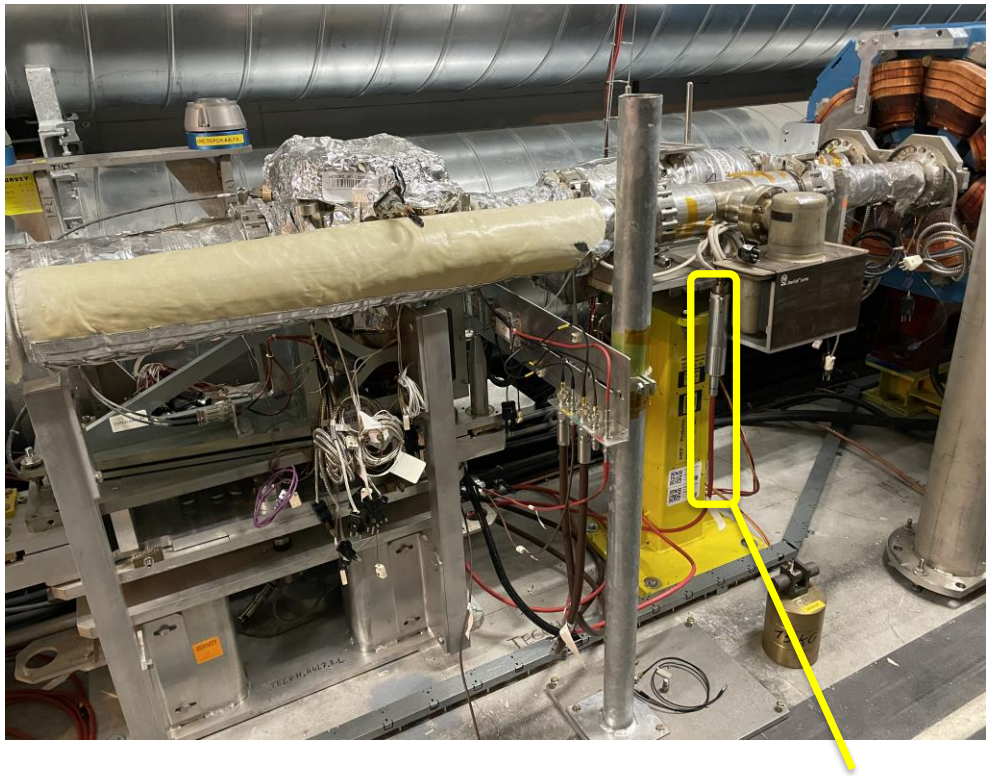
Beam 1



Proposal (update on DB only):
BLMES.04L7.B1E10_TCSM.D4L7.B1 -> BLMTS.04L7.B1E10_TCPCH.A4L7.B1
BLMEI.04L7.B1E10_TCSM.D4L7.B1 -> BLMTI.04L7.B1E10_TCPCH.A4L7.B1

Inspection of TCPCH.A4L7.B1

Beam 1



BLMEI-04L7.B1E10_TCSM.D4L7.B1 is downstream the TCPCH.A4L7.B1

Proposal (update on DB only):
BLMES.04L7.B1E10_TCSM.D4L7.B1 -> BLMTS.04L7.B1E10_TCPCH.A4L7.B1
BLMEI.04L7.B1E10_TCSM.D4L7.B1 -> BLMTI.04L7.B1E10_TCPCH.A4L7.B1

Video close-up:
https://cernbox.cern.ch/index.php/s/VVbbimlPKxtcFdD

TCPCV.A6L7.B1

Pre-LS2 configuration:

BLMTS.06L7.B2I10_TCLA.A6L7.B2	*BLMTS.H6L7*	*19839.24 m*
BLMTI.06L7.B2I10_TCLA.A6L7.B2	*BLMTI.H6L7*	*19839.37 m*
Crystal TCPCV.A6L7.B1		
BLMES.06L7.B2I10_TCSM.6L7.B2	*BLMES.V6L7*	*19844.30 m*
BLMEI.06L7.B2I10_TCSM.6L7.B2	*BLMEI.V6L7*	*19844.43 m*

Crystal DCUM: 19843.6189 m

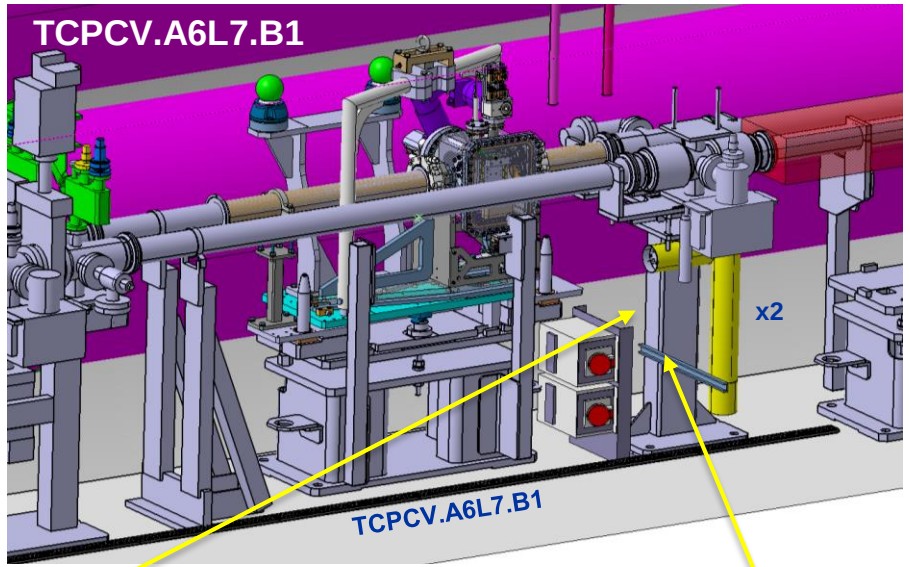
There isn't a BLM for the crystal, only for the TCSM Internal B2.

Collimation was using as measurements the BLM from the other beam.

Proposal:

- **Update installation**

Beam 1

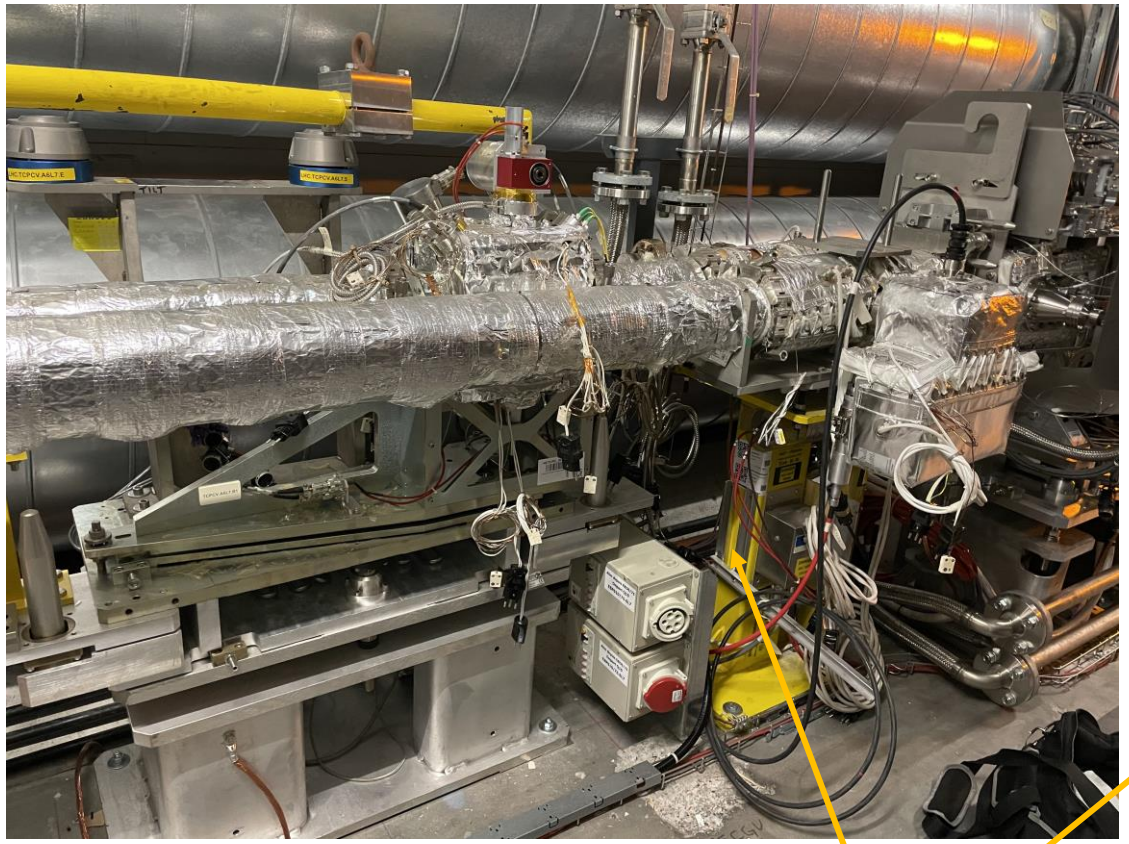


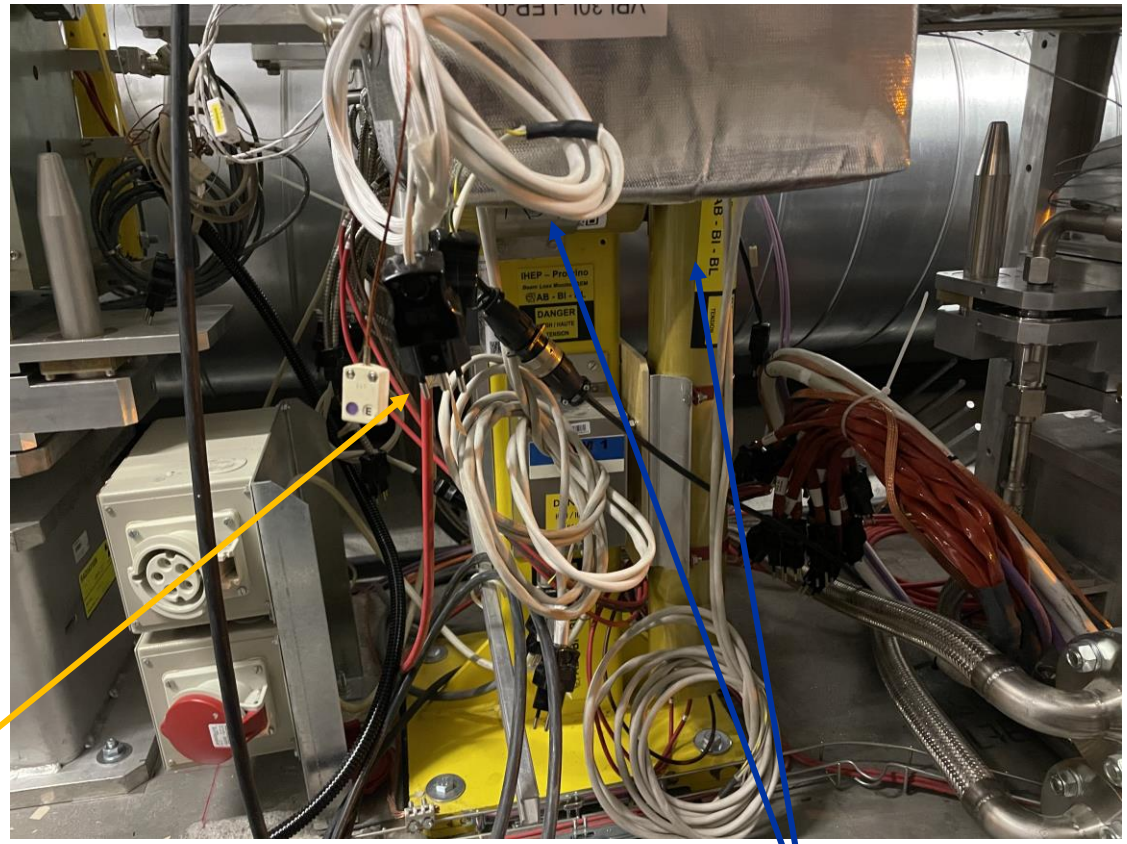
Metallic bars agreed by E.Page to be removed

Proposal:
Install an additional external BLM right next toTCSM.6L7.B2 BLM

Inspection of TCPCV.A6L7.B1

Beam 1





BLM IC and LIC
for TCSM.6L7.B2

Proposal:
Install an additional external BLM right next toTCSM.6L7.B2 BLM.
Only one Ionization Chamber. We can use the spare channel from the warm magnet (removed in LS2)

Video close-up support:
https://cernbox.cern.ch/index.php/s/aNFGkemk4t0tCJN

TCPCH.A5R7.B2

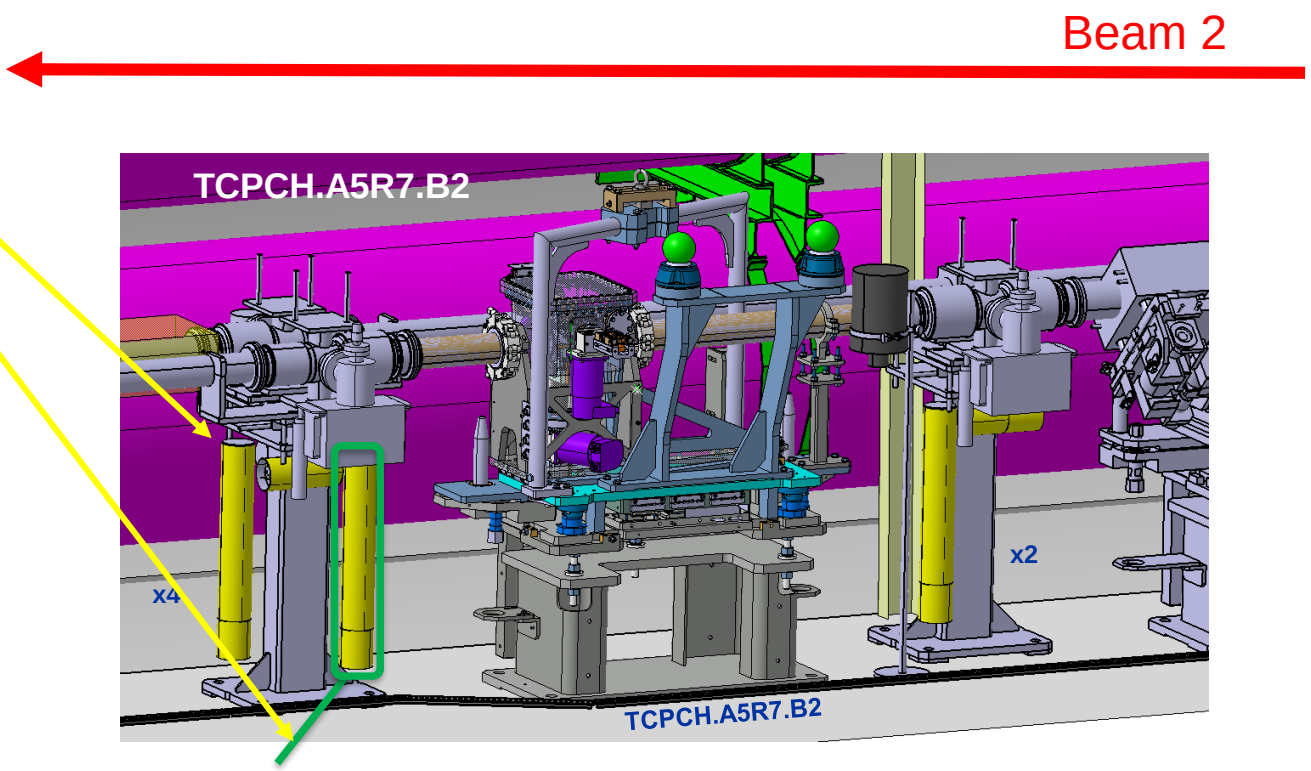
Pre-LS2 configuration:
Crystal TCPCH.A5R7.B2
BLMTI.05R7.B2I10_TCPC.A5R7.B2 BLMTI.F5R7 20089.55 m
BLMES.05R7.B1E10_TCSM.B5R7.B1 BLMES.D5R7 20089.42 m
BLMTS.05R7.B2I10_TCPC.A5R7.B2 BLMTS.F5R7 20089.42 m
BLMEI.05R7.B1E10_TCSM.B5R7.B1 BLMEI.D5R7 20089.29 m

Crystal DCUM: 20090.1559 m

BLM for TCSM.B5R7.B1 and TCPC.A5R7.B2 crystal already installed in the same support.

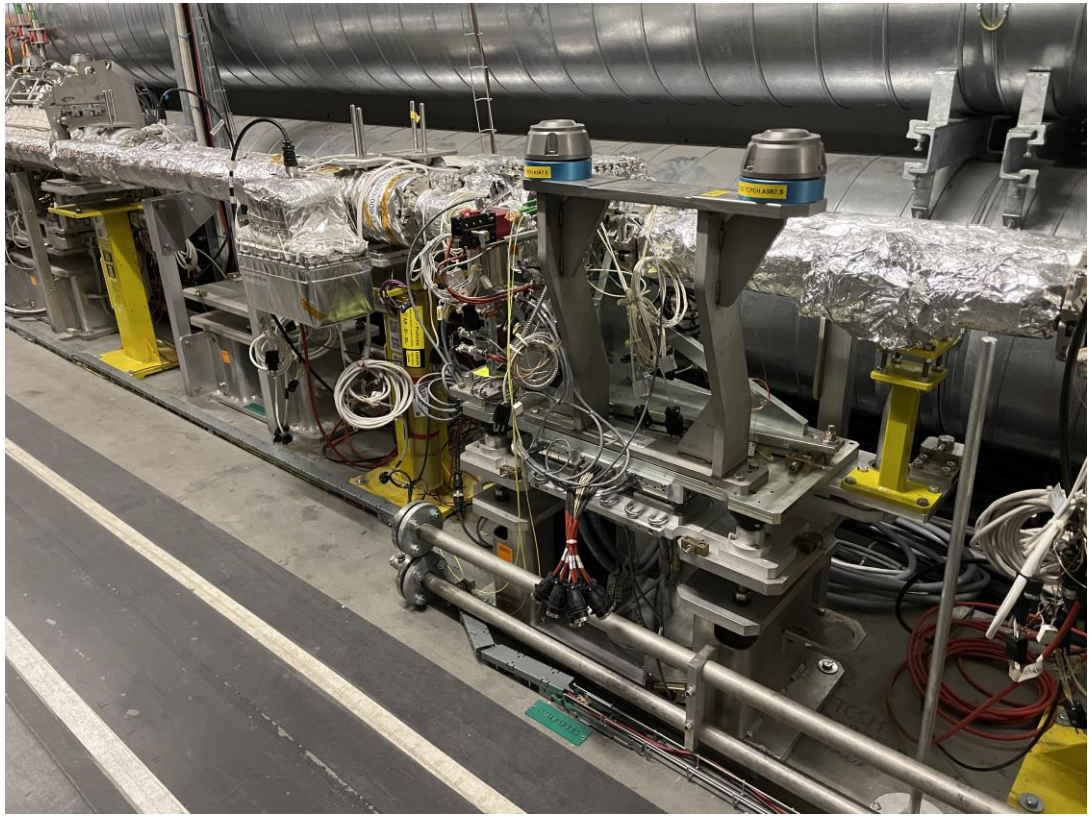
Proposal:
- **No change**

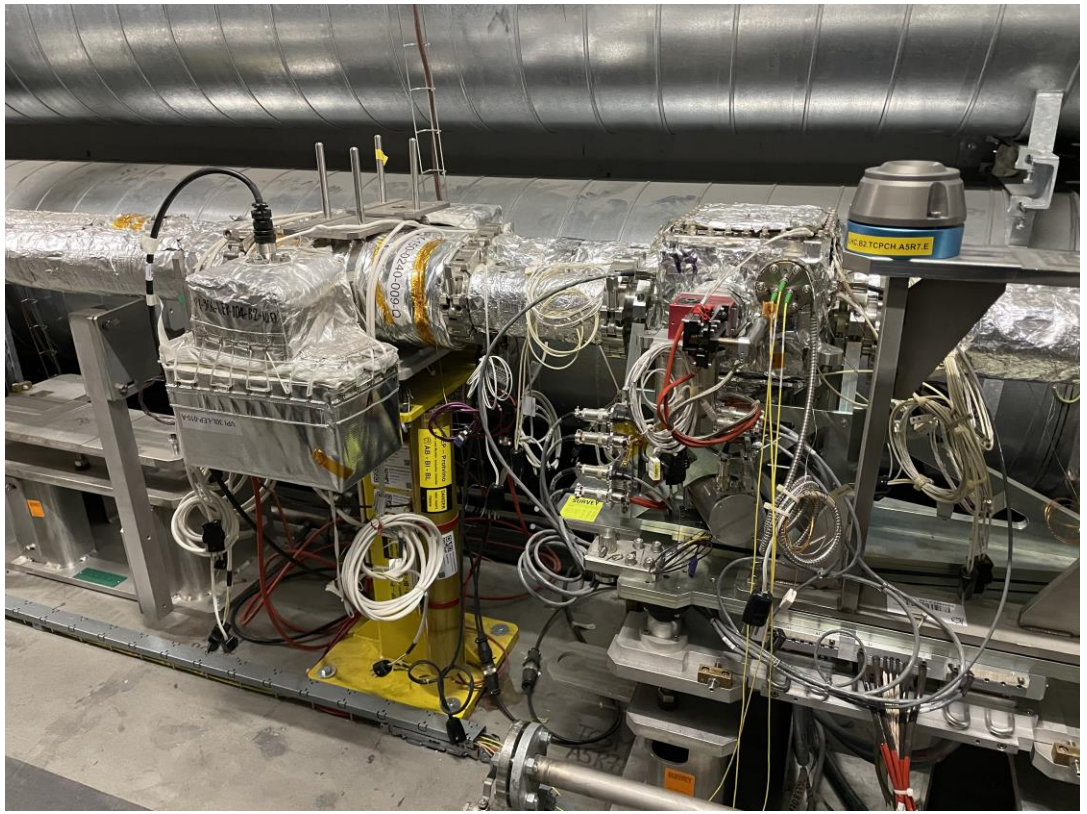
Proposal:
Nothing to be done



Inspection of TCPCH.A5R7.B2

Beam 2





Proposal:
Nothing to be done, all OK

Link to movie:
https://cernbox.cern.ch/index.php/s/54XcYtSBlK1AWnB

TCPCV.A6R7.B2

Pre-LS2 configuration:
BLMTI.06R7.B2I10_TCPC.A6R7.B2 BLMTI.K6R7 20145.20 m
Crystal TCPCV.A6R7.B2
BLMES.06R7.B1E10_TCSM.6R7.B1 BLMES.B6R7 20144.02 m
BLMEI.06R7.B1E10_TCSM.6R7.B1 BLMEI.B6R7 20143.89 m

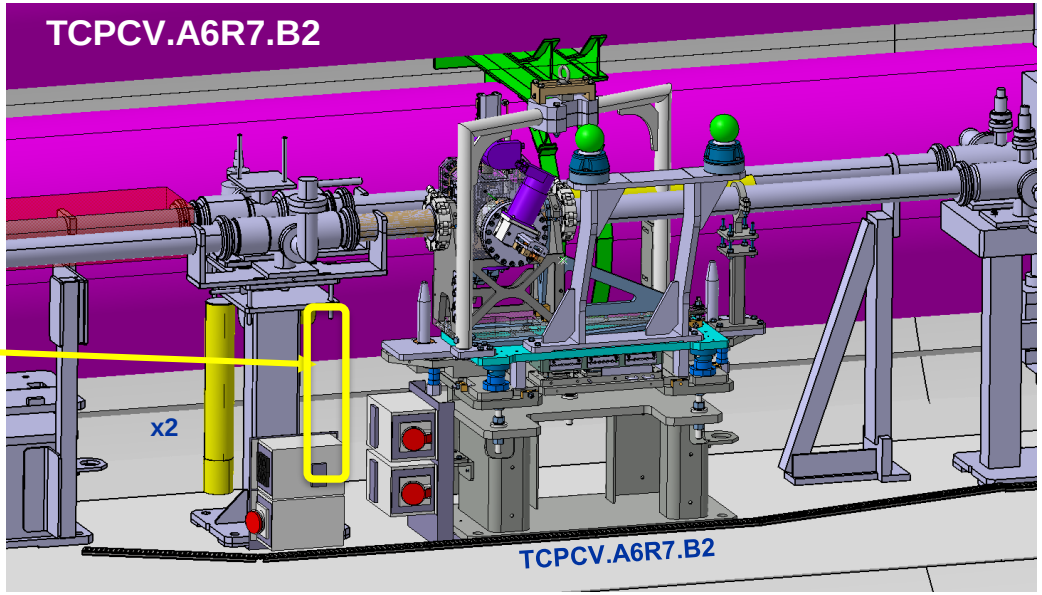
Crystal DCUM: 20144.7009 m

BLM TCPC.A6R7.B2 is upstream the crystal (confirmed with tunnel inspection)

BLM at empty slot TCSM.6R7.B1 are just downstream the crystal

Proposal:
- **Update installation**

Beam 2

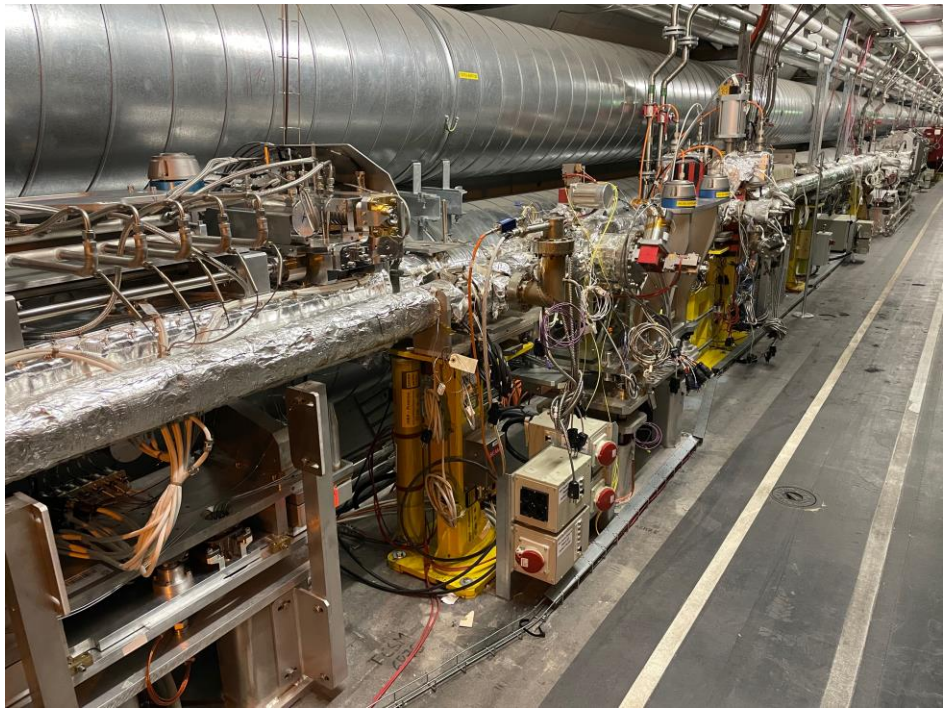


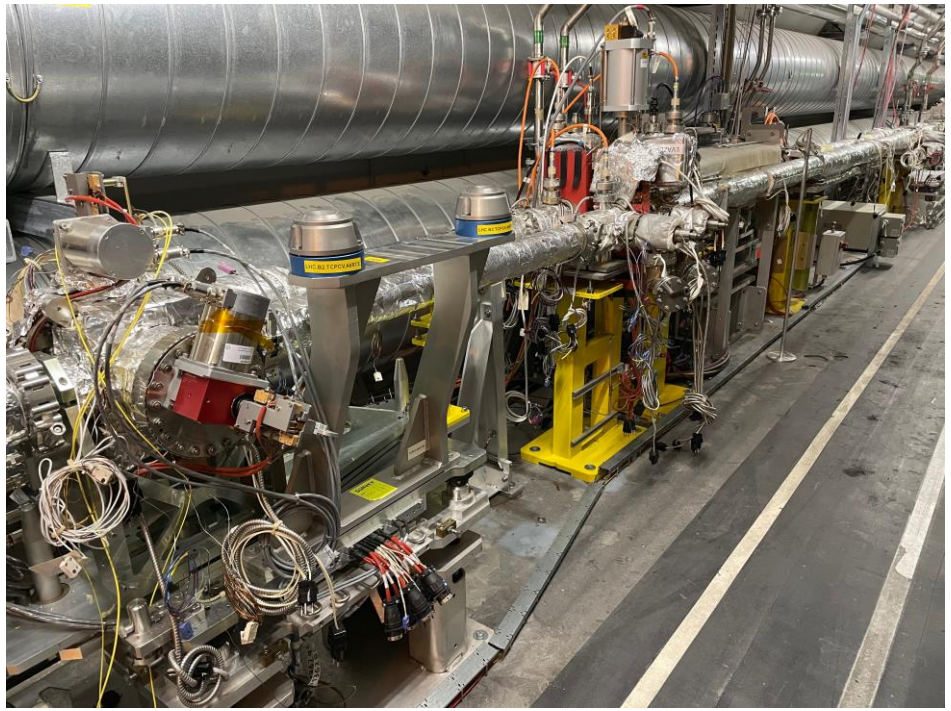
Proposal:
Displace the existing BLMTI.06R7.B2I10_TCPC.A6R7.B2 to the same support as the BLM TCSM.6R7.B1

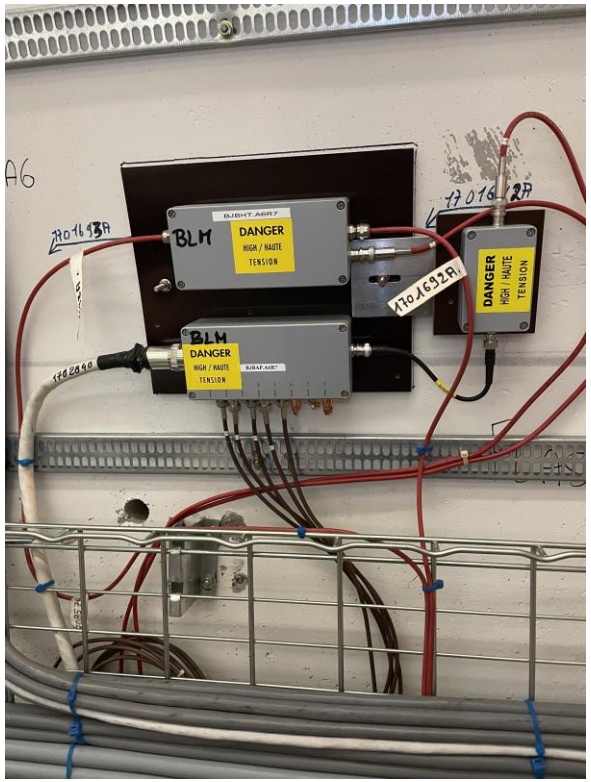
Electrical boxes will need to be displaced in order to allow alignment team to access that area

Inspection of TCPCV.A6R7.B2

Beam 2







Proposal:
Remove BLMTI.06R7.B2I10_TCPC.A6R7.B2 found at 20149 m and move it at the same support of the TCSM BLM. We verified that we have spare channels to connect the new BLM

Link to movie:
https://cernbox.cern.ch/index.php/s/Ub0oTOWUm7zdfs1

Summary of proposed changes

Crystal	Run 3	Comment
TCPCH.A4L7.B1 (B1H)	BLMTI.04L7.B1E10_TCPCH.A4L7.B1	Update of monitor names in DB. No installation change
TCPCV.A6L7.B1 (B1V)	BLMTI.06L7.B1E10_TCPCV.A6L7.B1	Installation of new Ionization chamber
TCPCH.A5R7.B2 (B2H)	BLMTI.05R7.B2I10_TCPCH.A5R7.B2	Nothing to be done
TCPCV.A6R7.B2 (B2V)	BLMTI.06R7.B2I10_TCPCV.A6R7.B2	Displacement of present ionization chamber to a new location

Layout modification for the 2 Vertical Crystal Collimators.
Database update for the rest.

With this configuration we will have a dedicated BLM detector (Ionization Chamber) for each crystal, this is needed in order to have dedicated BLM beam dump thresholds for these devices.

For the future we could study the need of installing a LIC (new design) in addition to the IC, as it is done for the collimators.