Planning the ADT experiments

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ADT MODES

The Transverse Damper (ADT) allows to create fast losses in the timescale of several LHC turns. Therefore, it can be used for UFO-like losses investigations.

There are three methods of exciting the beam:

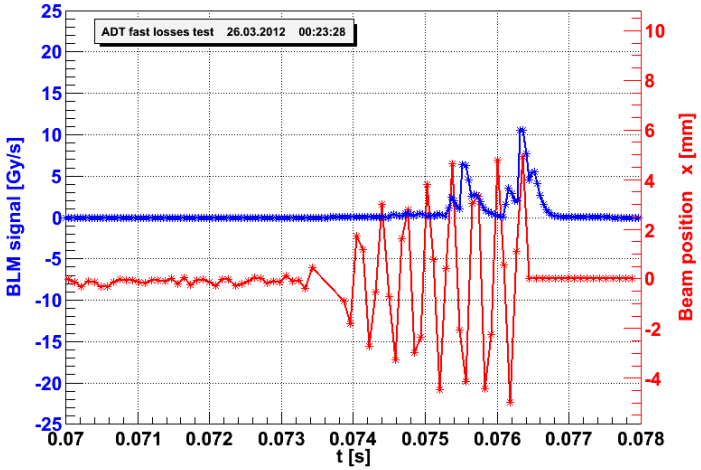
1) Coherent excitation (used for injection/abort gap cleaning)

2) White noise excitation (used for controlled emittance blow-up)

3) Feedback sign flip (typically this is a failure mode)

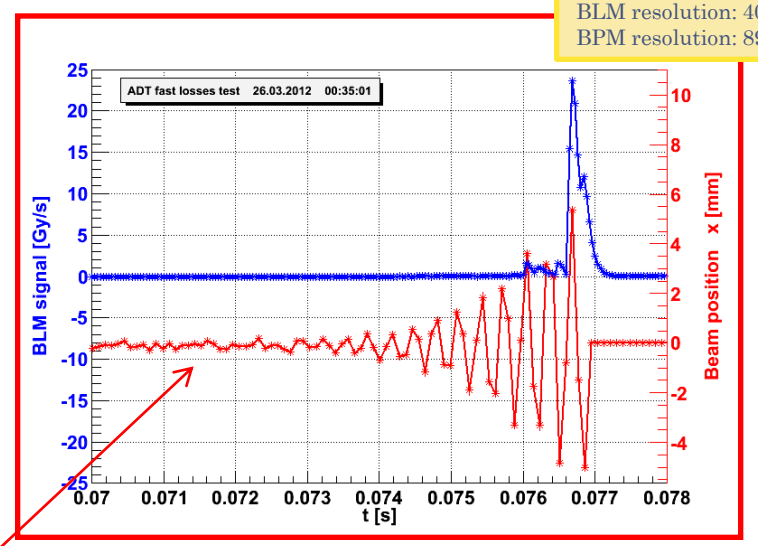
The most convenient mode for the fast losses studies

ADT Fast Losses Test (26TH March 2012)



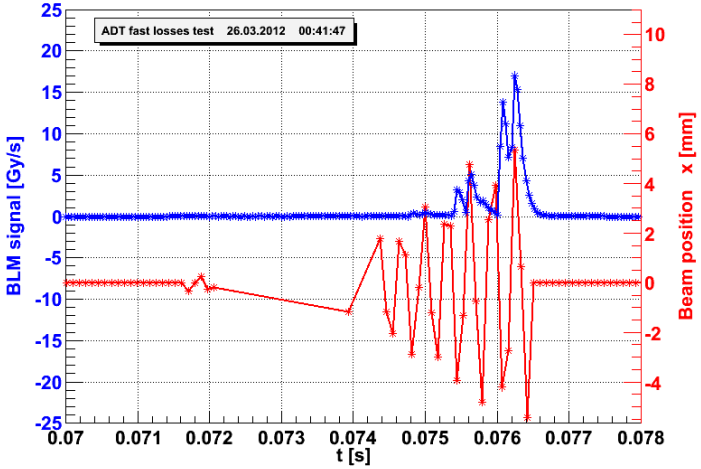
Method 1: Coherent excitation

BLM resolution: 40 µs
BPM resolution: 89 µs



Method 3: Feedback sign flip, max gain

The most regular increase of the oscillations

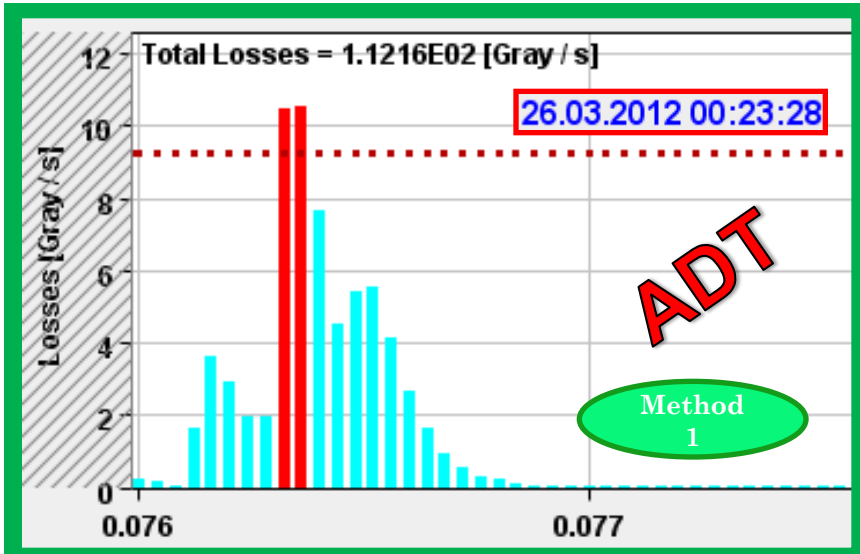


Method 3: Feedback sign flip, decreased gain

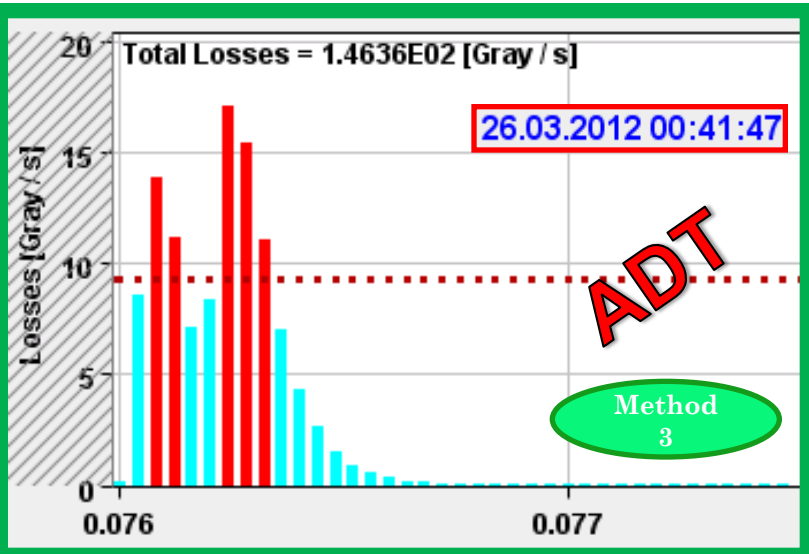
The higher the gain is, the faster the oscillation amplitude increases

Energy: 450 GeV
Beam: 2
Plane: horizontal

ADT Fast Losses Test vs UFOs



BLMEI.06R7.B2I10_TCP.B6R7.B2



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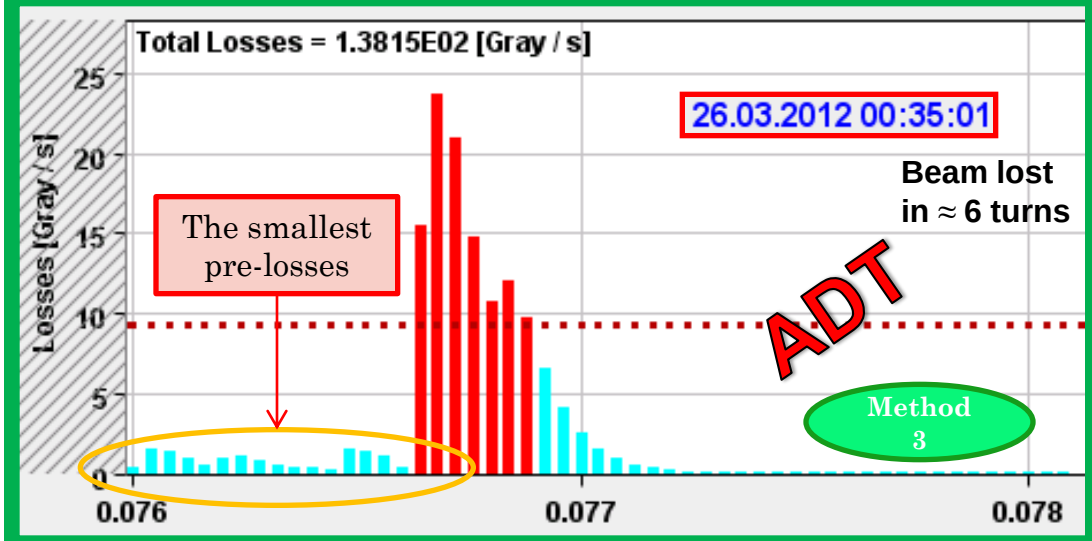

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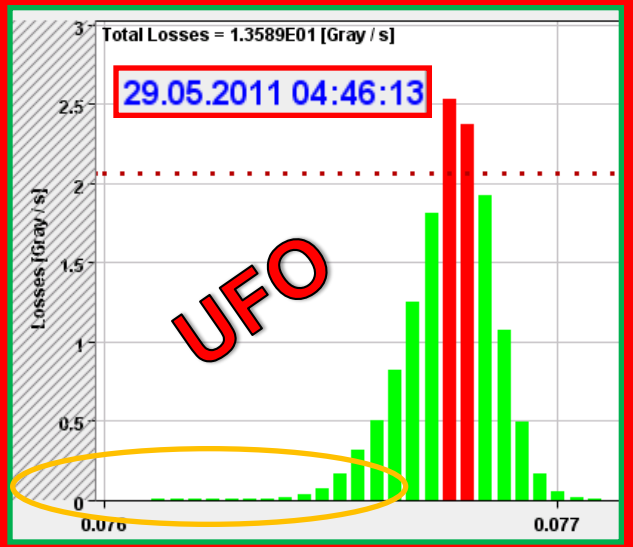


BLMQI.28L8.B1E10_MQ

ADT FAST LOSSES TEST AT 450 GEV FOR UFO STUDIES

A.Priebe, T.Baer, D.Valuch

Aims of the experiment

1) Recreate the conditions of fast (~ 1ms) proton beam losses which are the most similar to the Quench Test

2) Study the use of the ADT system as a tool for loss induction

3) Check the impact of phase advance between transverse dampers and collimators on:

   - Excitation efficiency
   - Loss time structure
   - Loss efficiency

ADT FAST LOSSES TEST AT 450 GEV FOR UFO STUDIES

Strategy

A.Priebe, T.Baer, D.Valuch

1) Finding the critical loss location

a) Change a position of TCP collimator jaw
b) Set up the excitation in appropriate plane with ADT feedback loop sign swap method and apply a small gain
c) Inject one probe bunch
d) Observe what is and where the highest signal of BLM occurs
e) Decrease BLM monitor factor depending on a value of losses

2) Ultimate data acquisition

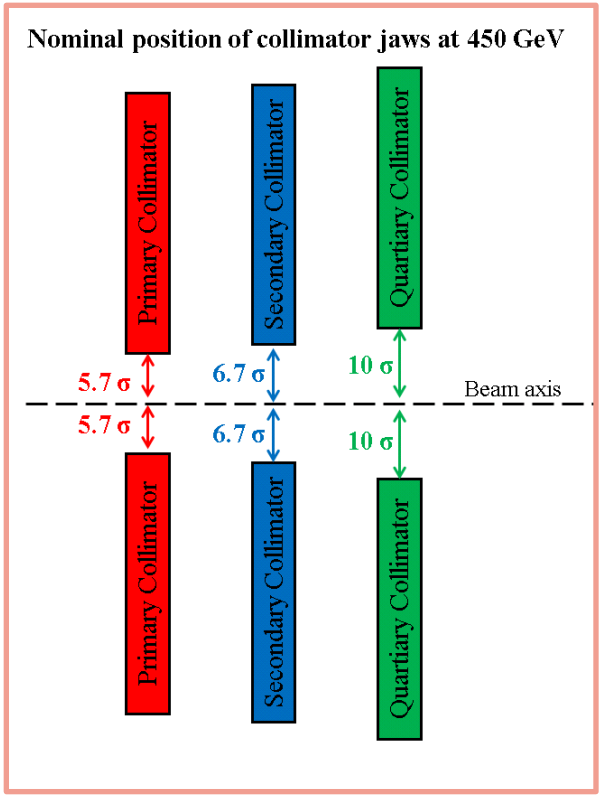
a) Set the excitation in the appropriate plane at maximum gain
b) Change feedback sign
c) Inject a probe beam
d) Collect PM data

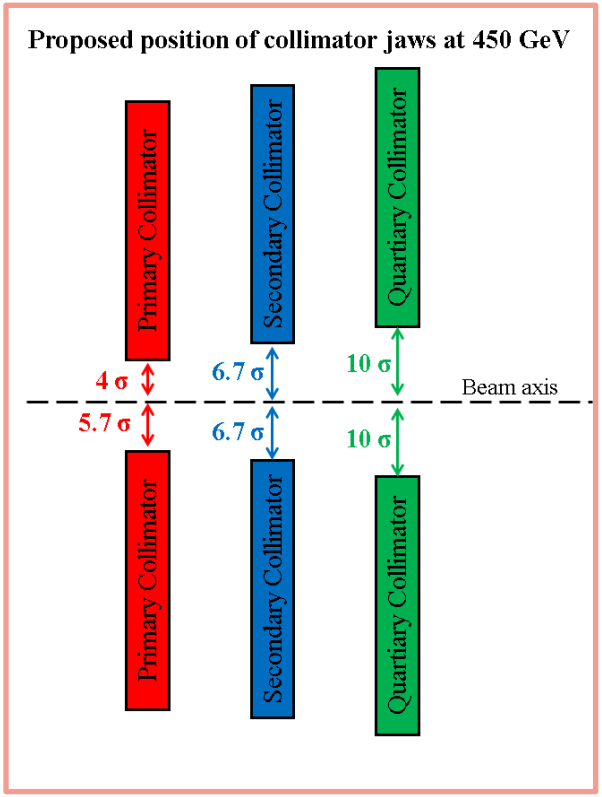
3) Return to the nominal settings

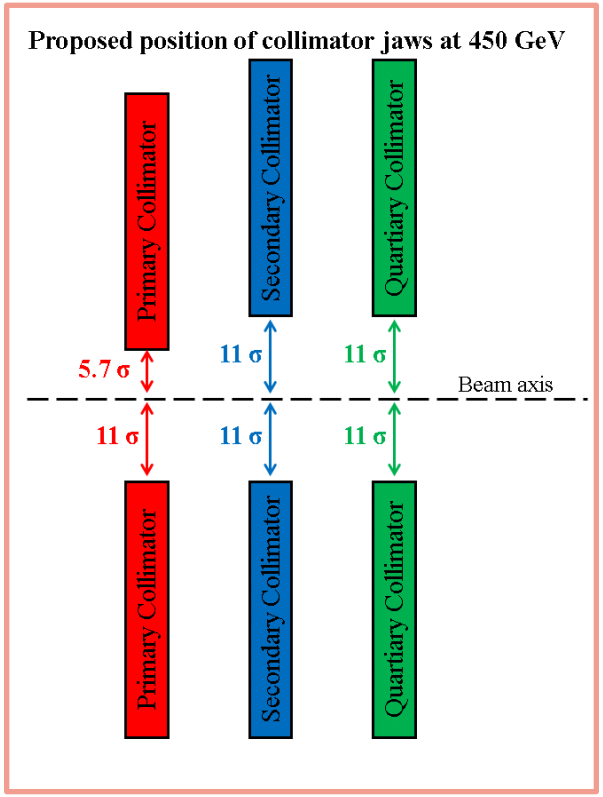
a) Move back a position of collimator jaws to the nominal conditions (responsibility of the collimators team)
b) Change the BLM monitor factor to 1.0 (responsibility of the BLM team)

Steps 1 – 3 repeated for each beam and each plane

POSITION OF COLLIMATORS AT 450 GEV







Asymmetric position of TCP jaws

Losses only on one side of an aperture (for Quench Test purpose)

* S. Redaelli, "Status of collimation commissioning with beam", LHC Machine Committee meeting, 04.04.2012

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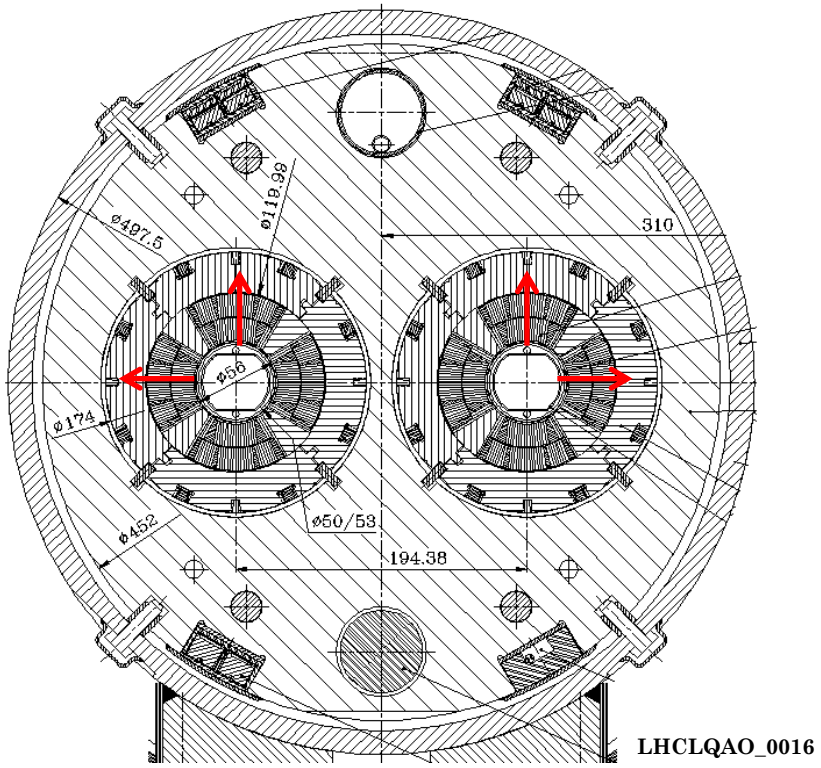
Beam parameters

1) Beam intensity: 10^{10} protons (pilot bunch)
2) Beam energy: 450 GeV
3) Beam orientation:
    a) Beam 1, horizontal
    b) Beam 1, vertical
    c) Beam 2, horizontal
    d) Beam 2, vertical



Losses

Losses should appear on the outside of the coldmass

a) Vertical plane – E_{dep} on an upper collimator jaw
b) Horizontal plane (beam 1) – E_{dep} on an external collimator jaw
c) Horizontal plane (beam 2) – E_{dep} on an internal collimator jaw

The LHC arc half-cell location for autumn QT is not determined yet. Thus, all four scenarios of beam losses must be studied.

INVESTIGATIONS OF PHASE ADVANCE IMPACT

No.	Element	μ_x [2π]	μ_y [2π]
1	TCP.C6L7.B1	47.18	43.57
2	TCP.D6L7.B1	47.18	43.57
3	TCP.C6R7.B2	48.01	44.35
4	TCP.D6R7.B2	48.01	44.35
5	ADTKH.A5L4.B1	24.16	22.26
6	ADTKV.A5R4.B1	24.20	22.32
7	ADTKH.A5R4.B2	24.16	22.46
8	ADTKV.A5L4.B2	24.11	22.43

Tune:
$Q_x = 64.28$
$Q_y = 59.31$

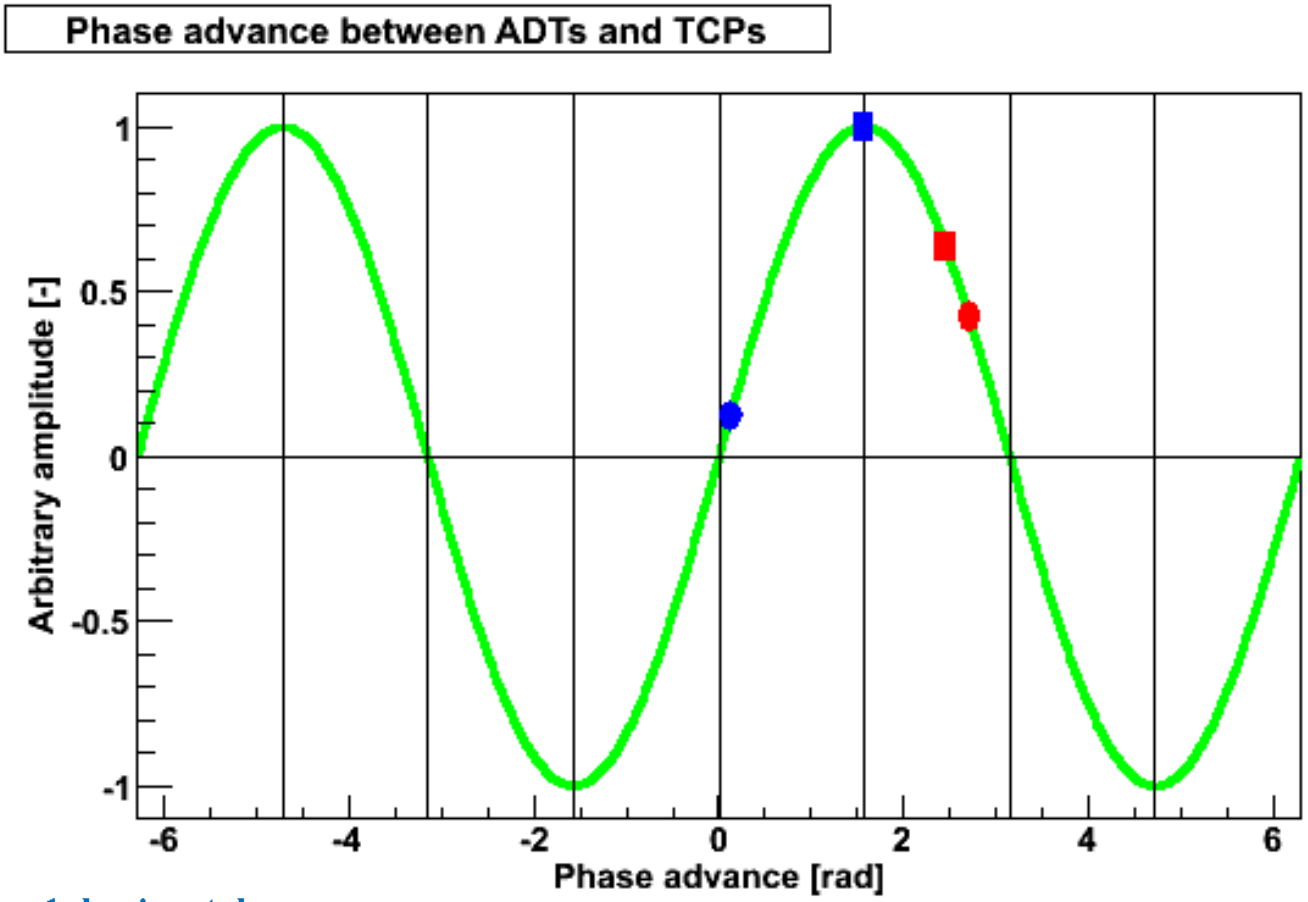
Phase advances between collimators and transverse dampers were calculated:

a) For beam 1 $\Delta\mu_{ADT \rightarrow TCP} = \mu_{TCP} - \mu_{ADT}$ (1)

b) For beam 2 $\Delta\mu_{ADT \rightarrow TCP} = \mu_{ADT} + (Q - \mu_{TCp})$ (2)

Beam	Element	Horizontal [2π]	Vertical [2π]	Horizontal [deg]	Vertical [deg]
1	ADT → TCP	23.02	21.25	7.2	90.0
2	ADT → TCP	40.43	37.39	154.8	140.4

INVESTIGATIONS OF PHASE ADVANCE IMPACT



- Beam 1, horizontal
- Beam 2, horizontal
- Beam 1, vertical
- Beam 2, vertical

PROPOSED QUENCH TEST LOCATIONS

Phase advances between MQ and ADT :

No.	MQ	φ_x [deg]	φ_y [deg]	Focusing plane	MQ	φ_x [deg]	φ_y [deg]
1	MQ.20R5.B1	**21.6**	**158.4**	Vertical	MQ.20R5.B2	72.0	270.0
2	MQ.12L6.B2	**165.6**	**136.8**	Horizontal	MQ.11L6.B1	334.8	338.4
3	MQ.19L6.B2	**136.8**	**79.2**	Vertical	MQ.19L6.B1	316.8	345.6
4	MQ.27L6.B2	**158.4**	**72.0**	Vertical	MQ.27L6.B1	295.2	356.4

Constraints : $\varphi_x > 0°$, $\varphi_y > 0°$

a) horizontal plane:

$\varphi_x = (7.2 \pm 20.0)°$ or $\varphi_x = (154.8 \pm 20.0)°$

b) vertical plane:

$\varphi_y = (90.0 \pm 20.0)°$ or $\varphi_y = (140.4 \pm 20.0)°$

Beam	Element	Horizontal [2π]	Vertical [2π]	Horizontal [deg]	Vertical [deg]
1	ADT → TCP	23.02	21.25	7.2	90.0
2	ADT → TCP	40.43	37.39	154.8	140.4

Assumptions: Beam 1 and Beam 2 should behave the same in distinguished planes.
Planes considered independently from each other.

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Potential risks

1) There is some finite probability that a bunch can miss the primary collimators (TCP), depending on the phase advance between the ADT and the TCP.
2) Particles can be stopped on one of the downstream collimators inducing a secondary particle shower.
3) In the worst case 1-2 magnets can quench with the probe beam at injection energy.
4) In order to minimize the risk we will start with the beam excitations at low gain and see if the losses occur in the location different from the expected one.
5) If the signal is high on the other collimators, we could retract them to a parking position.

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But …

1) During the ADT fast losses test with symmetrical position of collimator jaws (26th March 2010) no significant losses appeared along the ring beside Octant 7 (TCLA.B6R7.B1).

2) Phase space coverage plots show that without TCP, the phase space is well-covered by other collimators (except TCDQ) and losses with these intensities shouldn't be a problem. (T.Baer)

3) During "Quench Margin at Injection" (ATS-Note-2011-067 MD) there was no quench with $3 \cdot 10^{10}$ protons at 450 GeV lost on TCLIB.

Summary and Conclusions

1. ADT can induce fast losses with a timescale of UFOs but with different temporal distribution.
2. ADT feedback sign flip method has turned out to be the most convenient for fast losses studies.
3. Asymmetrical position of collimator jaws will provide losses only on one side of the aperture (→ QT with 3-corrector bump scenario).
4. Two configurations of collimators were proposed.
5. Phase advance might be crucial for the decision of QT location.
6. Presented MD plan is a part of preparation for the Quench Test (if given). ADT fast losses test with nominal energy (4 TeV) will be planned separately.

EDMS documents:

- A. Priebe, T. Baer, D. Valuch, "MD1-2012 ADT fast losses test at 450 GeV for UFO studies", EDMS No: 1212026 v.1

Open questions

1. How can we set collimator jaws with 4 TeV beam? Safety issues?

2. Change of all collimators positions with single button?

THANK YOU FOR YOUR ATTENTION !

QUESTIONS?

COMMENTS?

SUGGESTIONS?

BACK-UP SLIDES

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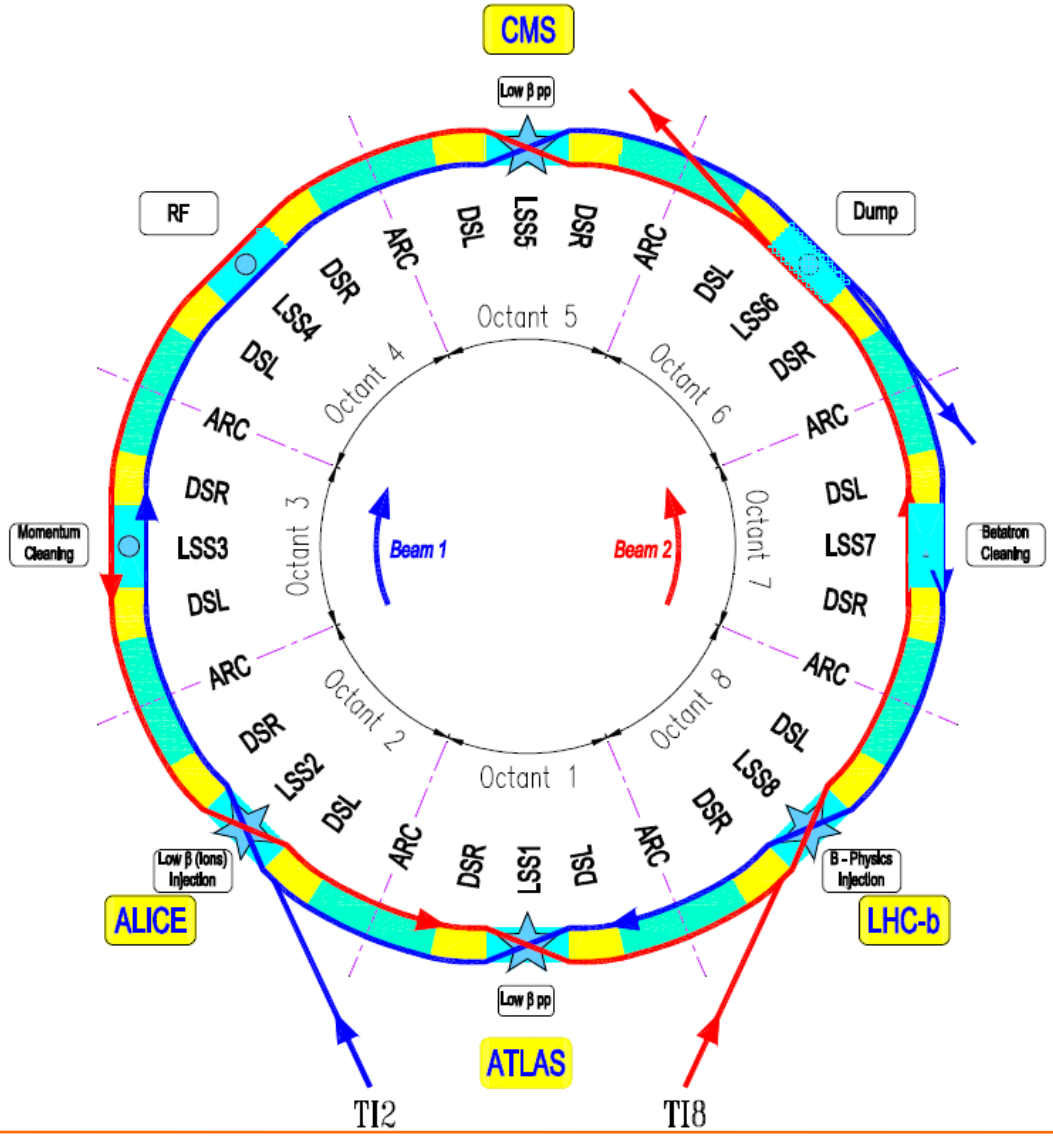
LHC elements where the changes will be implemented during the MD

No.	Beam	Plane	Collimator	ADT
1	1	Horizontal	TCP.C6L7.B1	ADTKH.A5L4.B1
2	1	Vertical	TCP.D6L7.B1	ADTKV.A5R4.B1
3	2	Horizontal	TCP.C6R7.B2	ADTKH.A5R4.B2
4	2	Vertical	TCP.D6R7.B2	ADTKV.A5L4.B2

TCP stands for Primary Collimator for Cleaning (C – horizontal collimators, D – vertical collimators) and ADT - Transverse Damper.

LAYOUT

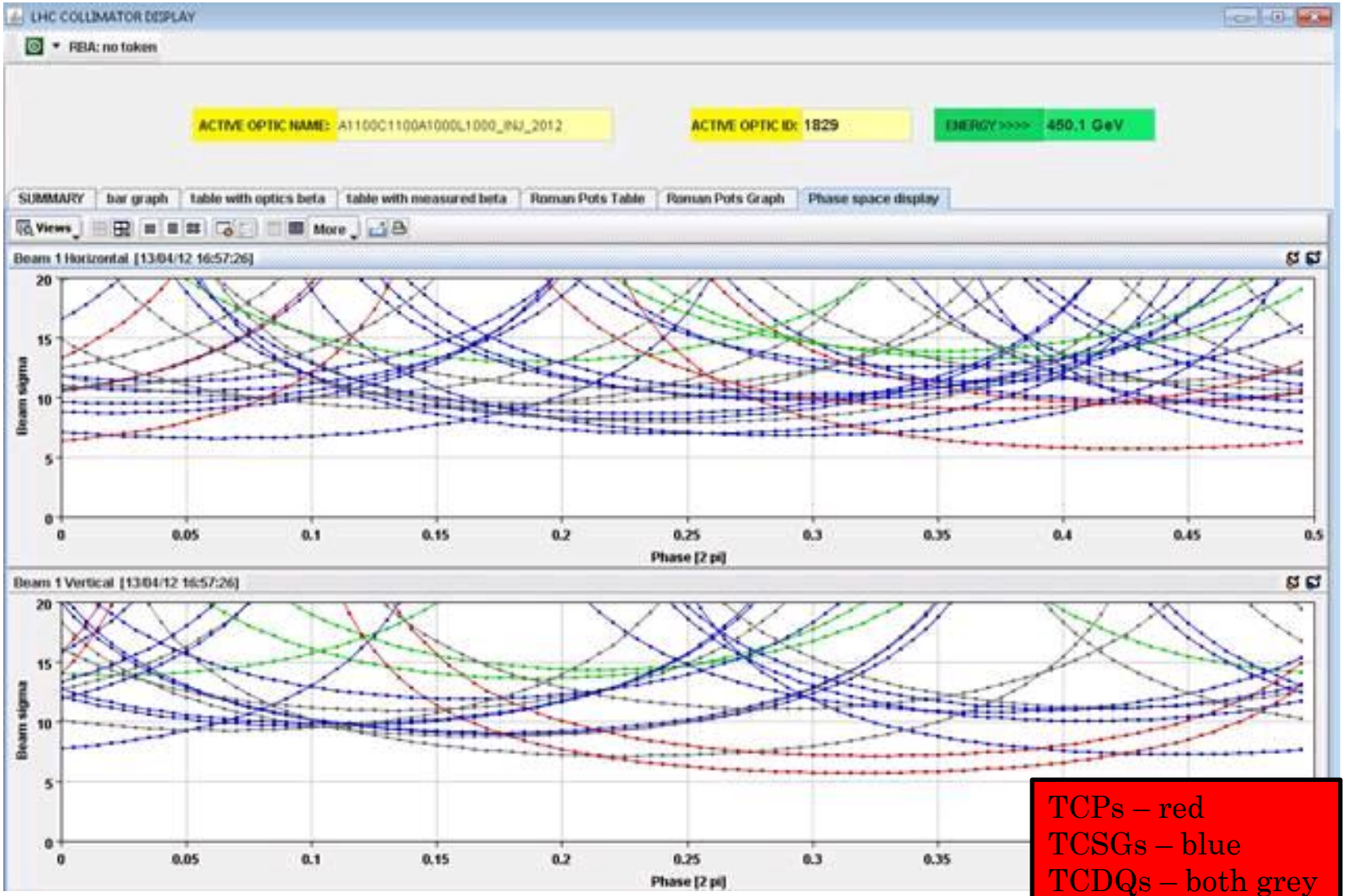
Schematic layout of the LHC. Beam 1 circulates clockwise and Beam 2 counter-clockwise.
(LHC Design Report, Chapter 3)



PHASE SPACE COVERAGE PLOTS

Beam 1

T.Baer

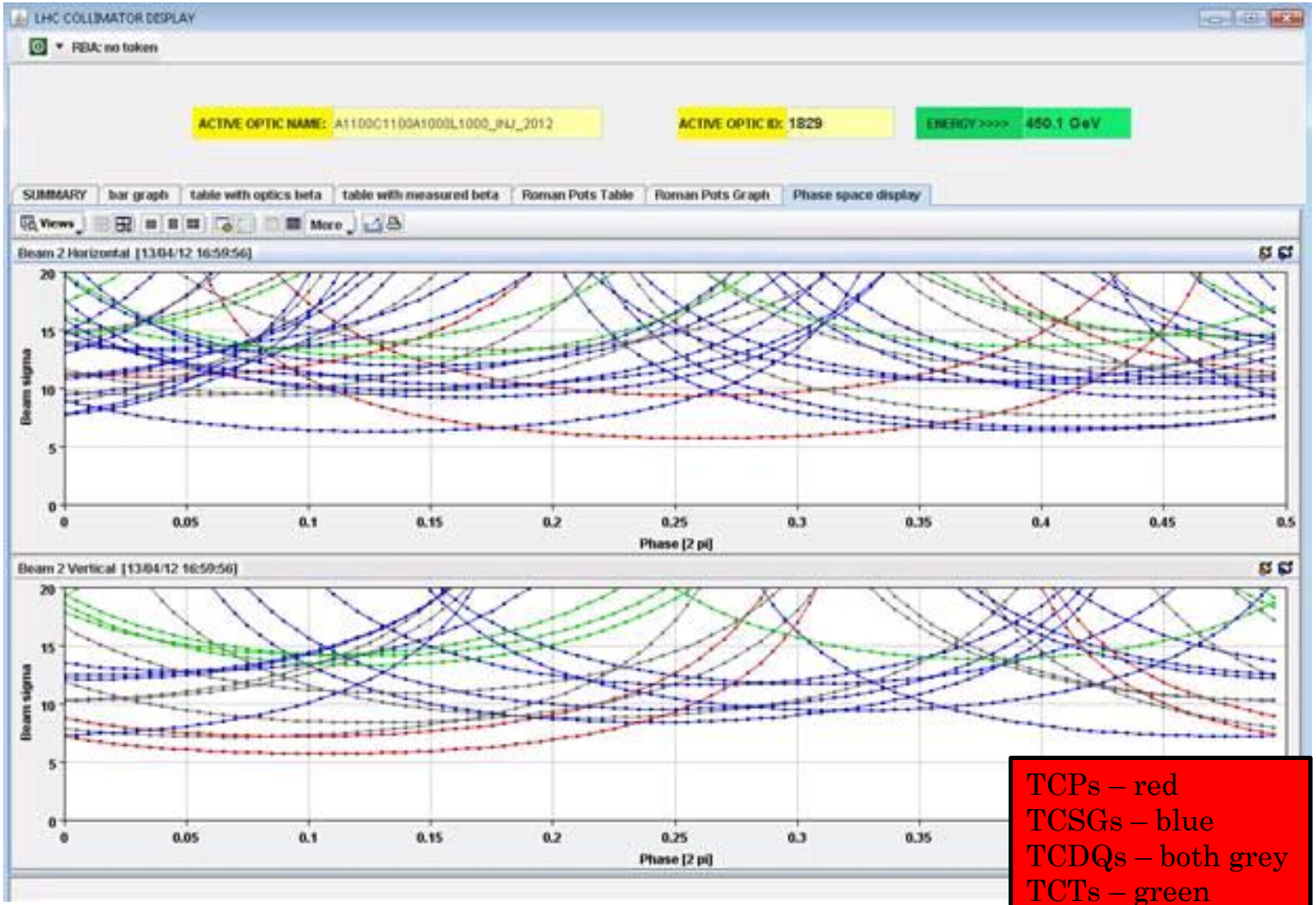


TCPs – red
TCSGs – blue
TCDQs – both grey
TCTs – green

Phase space coverage plots

Beam 2

T.Baer



TCPs – red
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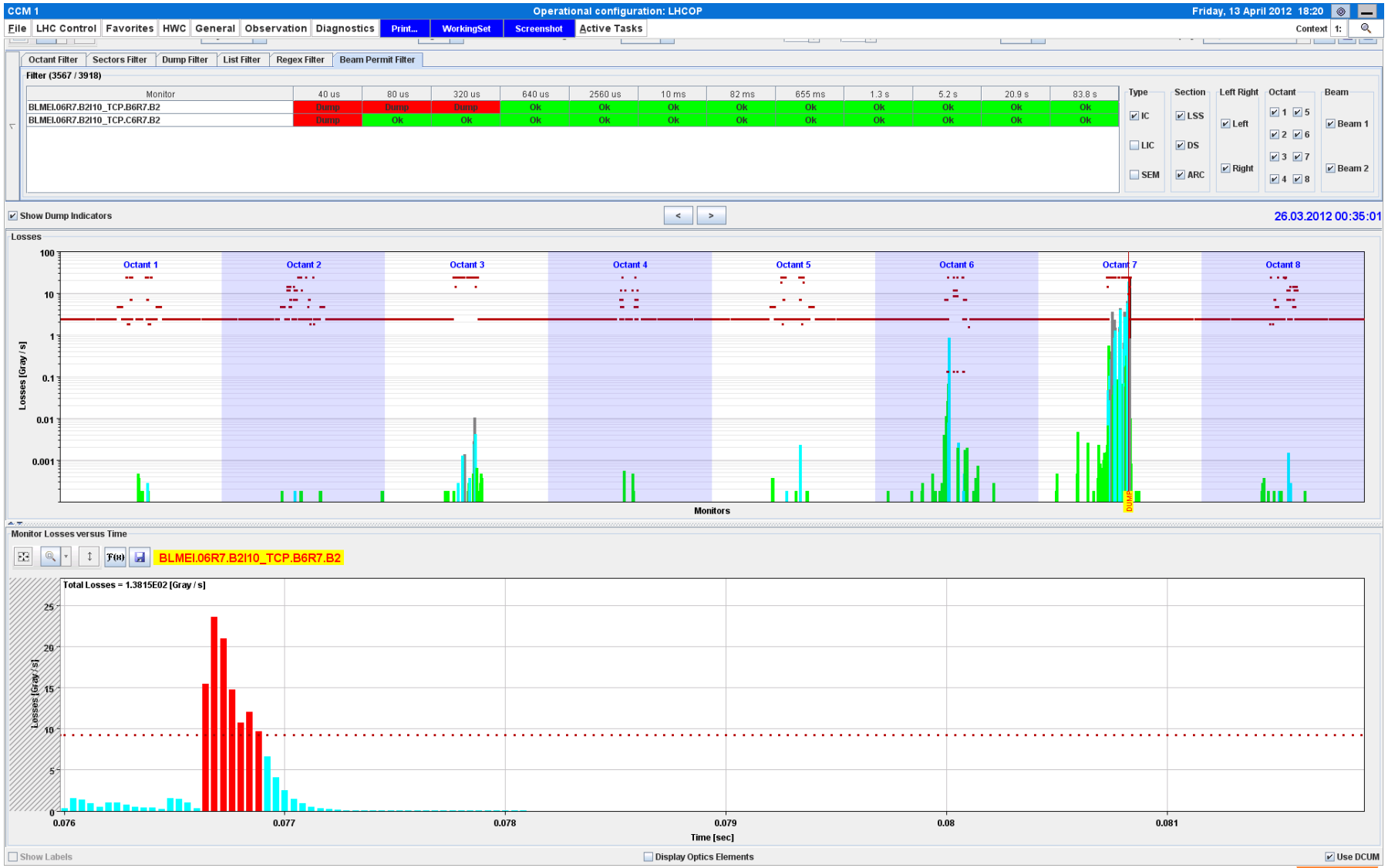
TCDQs – both grey
TCTs – green

ADT FAST LOSSES TEST, 26TH MARCH 2012



ADT FAST LOSSES TEST, 26TH MARCH 2012