LHC Study Working Group
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Collimation MDs for the LHC Run II

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Other inputs: W. Scandale, impedance team, aperture team…

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Collimation MD requests for 2015

- Beta*-reach: IR7 Collimation hierarchy limit and impedance [β*-reach] [Impedance]
- Beta*-reach: Collimation with tighter TCTs [β*-reach]
- Beta*-reach: IR aperture measurement at small beta [β*-reach]
- Special collimator settings for reduced impedance [Impedance] [β*-reach]
- IR2 aperture measurements at 6.5 TeV [β*-reach]
- Characterization of embedded BPM collimators [OP efficiency] [β*-reach] [Exploring safety limits]
- Off-momentum tail scraping for passive abort gap cleaning [OP efficiency]
- Improved BLM-based collimator alignment [OP efficiency]
- Improved off-momentum loss maps [OP efficiency]
- Active halo control [HL-LHC] [OP efficiency]
- Crystal collimation [HL-LHC]
- Collimator quench test for protons at 6.5 TeV [Exploring safety limits] [HL-LHC] [OP efficiency]
- Collimation quench tests for ions at 6.5 Z TeV [Exploring safety limits] [HL-LHC] [OP efficiency]
- Scans of physics debris collimators [Exploring safety limits]
- Beam tail population measurements using collimator scans [Exploring safety limits] [HL-LHC]
- Continuous loss maps during energy ramp and squeeze [Exploring safety limits]

R. Bruce, 2015.03.03

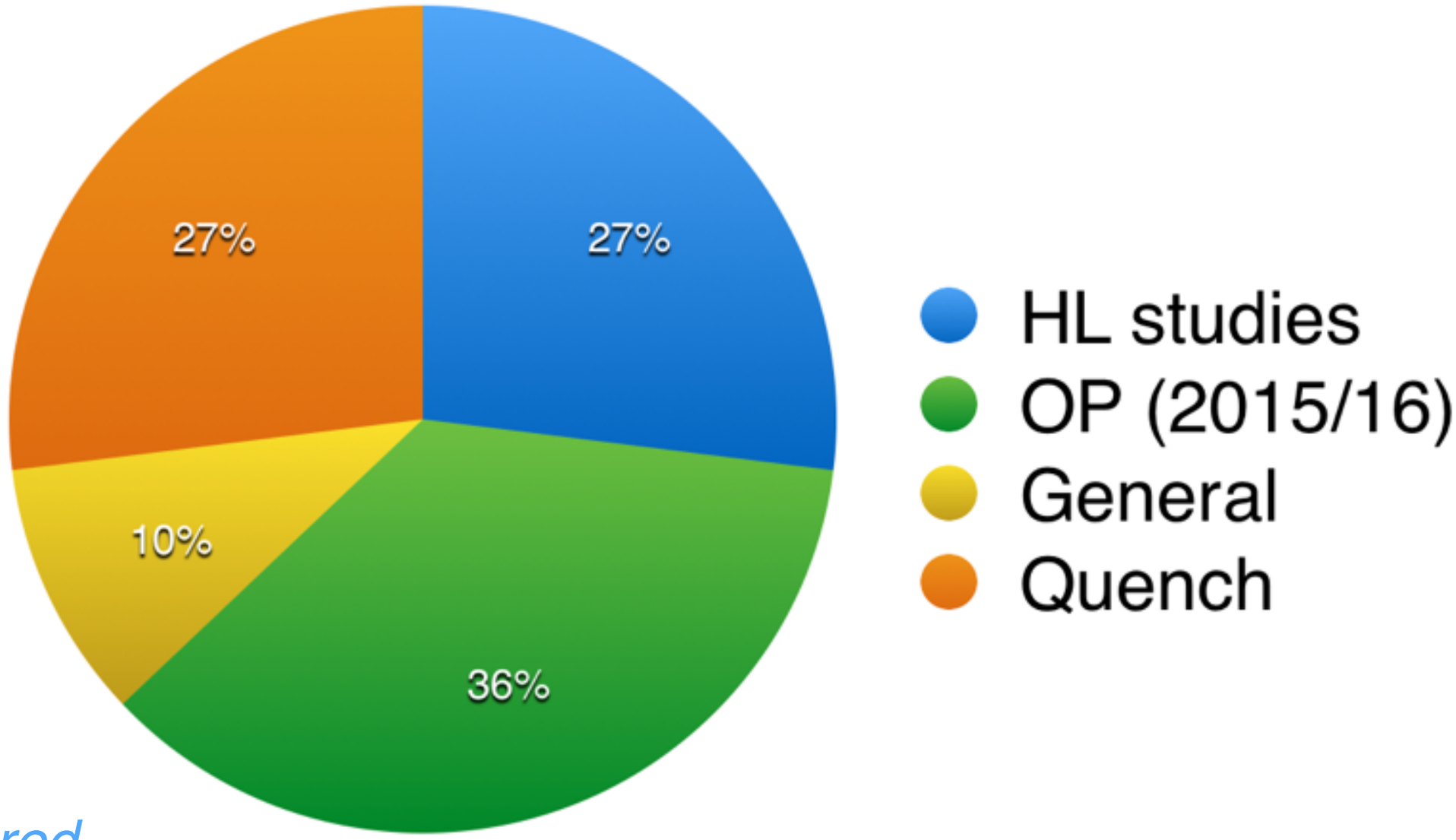
Assigned collimation MDs in 2015

MD#	user	Request	Slot	Time given	[MDNOTE]	MD Title
284	glvalent	14	1	8	CERN-ACC-NOTE-2016-0010	Beam tail population measurements using collimator scans
307	rbruce	12	1	8	CERN-ACC-NOTE-2015-0037	Beta*-reach: IR aperture measurement at small beta
310	rbruce	8	1	8	CERN-ACC-NOTE-2015-0036	Beta*-reach: Collimation with tighter TCTs
311	glvalent	8	1	8	CERN-ACC-NOTE-2015-0028	Characterization of embedded-BPM collimators
312	rbruce	24	1	*9*	CERN-ACC-NOTE-2016-0009	Active halo control
314	amereghe	8	1	8	CERN-ACC-NOTE-2016-0007	Beta*-reach: IR7 collimation hierarchy limit and impedance
333	stefano	16	2	*11*	CERN-ACC-NOTE-2015-00xx CERN-ACC-NOTE-2015-00yy	Crystal collimation
910	hgarciam	4	2	1	CERN-ACC-NOTE-2016-0011	Off-momentum loss maps with one beam (2 EoF studies)
340	belen	16	1	12	CERN-ACC-NOTE-2016-0015	Proton quench tests at top energy
	phermes	16	1	12	—	Ion quench test at 6.37 TeV
	stefano	12	1	4	—	Crystal collimation of ion beams

Thanks to Rogelio.

MDs requested but not assigned are <u>not</u> listed here.
List total allocated times.
Major fault subtracted for "floating" crystal MD for ions.
"Active halo" and "crystals": counted 7h each for the 14h given in parallel.
MD note preparation well advanced:
not all are completed by nearly final drafts available for all proton MDs.

Collimation MD's by category



Considered time figures from previous table.

Several studies: no net distinction.

Requests — “Operation / general”

The following are requested as part of the 2016 beam commissioning.
We will request as MDs what cannot be completed.

- **Continue improvements of collimation operational aspects**
  - Exploitation of BPM collimators *(should be in commissioning)*
  - Faster alignment algorithms: BLM and BPM methods
  - Faster BLM data: 50Hz-100Hz acquisitions (now: 12.5Hz).

- **Aperture measurements** *(collimation with HSS team)*

  The standard yearly aperture checks must be covered in commissioning: validation of machine configurations.
  - Symmetry of aperture in IR1: for swaping Xing angle sign.
  - Reserve slots — if needed — for checks in other IPs.

- **Continuous loss maps during ramp and squeeze**

  Part of the commissioning for the combined R&S, important for pushing the squeeze performance.

Requests — “Operation/general”

- **Collimation scans to probe transverse beam halo**

  Follow up of nice measurements at 4TeV and 6.5TeV

  Try with bunch trains (requires fast diamond detectors in IR7)

  Possible: end of fill during intensity ramp up?

- **TCL scans in IR1/5**

  Parasitic or end-of-fill as can be done in stable beams.

  Including specific checks of D2 quench limits.

- **Passive cleaning of abort gap with TCPs in IR3.**

- **Closer TCP settings and halo cuts.** new!

Requests — "β^* reach"

Clearly, our MD requests will depend on the choice for 2016!

What do we still need to study if we do not go for 40cm in 2016?

If we go to 40cm, what do we need to possibly go even below?

- ☑ **Off-momentum aperture and cleaning**
- ☑ **Collimation cleaning, fast losses (and maybe aperture checks) with flat beams**
- ☑ **Improved validation for asynchronous dumps**

  Some aspects discussed in Roderik's talk at Evian, to improve confidence on "phase advance" assumptions.

- ☑ **Study further the hierarchy limits for smaller β*:**

  See next slide about impedance

  TCT setting versus experiment backgrounds

  IP6 losses from secondary halos

Requests — "impedance"

- **Continue improving understanding of measurements with single bunches versus TCSG settings. TCSG/TCP retraction.**

  Hopefully, a lot can be done in commissioning.

  We request to repeat impedance checks towards the end of the year to quantify effects from radiation on collimator materials.

- **Empirical tests of reduced impedance through "special" secondary collimator (TCSG) settings**

  Single-jaw cleaning; impedance vs cleaning for a reduced set of TCSGs, …

- **Impedance contribution from primary collimators (TCPs)**

  Important for material choice of TCP's to be replaced in LS2 with BPMs.

  MoGR performed very well in HRM tests in 2015. Gains ~x5 in resistivity!

- ***Impedance contribution from TCT's and TCL6 at low β****

- ***IR3 impedance contribution to total budget (for HL)***

  Low-impedance collimators taken out of the baseline.

- **High priority starting in 2017: install a TCSPM (MoGR, coating) that will require dedicated MDs.**

Requests — "HL"

Quench limits

Analysis of 2015 tests is ongoing — not clear yet if we need more tests with beam in 2016.

For proton, we did not achieve the desired loss rates because of lack of time (>6h lost due to LSA software problem). Highest priority for 2016 is to reach ~1MW.

Bumps in IR7 to mitigate losses?

Active halo control

Working on the understanding of first results in 2015.

Would like to repeat a "good candidate" found in MD2 (tail losses without emittance blowup, only over short times).

Important to study also tune ripple methods from MQW, not done in 2015.

Beyond 2016: other methods for tune ripple (non-linear magnets)

Collimators with wires: effects on single-bunch halos?

Crucial: impedance studies (see previous slide)

Requests — “HL / crystals”

Very promising results in 2015, but still several open questions

- **Measurements of collimation cleaning with protons at 6.5TeV**
- **Heavy ion channeling at 6.5 TeV**

  Not possible in 2015 because of lack of time (MD lost: Pb source issue)
- **Channeling performance in dynamic machine phases (ramp and squeeze)**

  Synergy with the requested tests on continuous loss maps.
- **Improved characterisation of crystals (in particular, vertical “quasi-mosaic”)**

  Not possible in 2015 because of lack of time.
- **Tests with higher beam intensity are TBC — setup requires changes of hardware interlocks.**

  MDs more efficient if we could make tests with more pilot bunches!