*MPP meeting*

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*CERN, Geneva, CH*

# Collimation system: summary of changes and re-commissoning in the EYETS2016

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***for the Collimation Project Team***

# Outline

- Introduction
- New hardware for 2017
- Tests without beam
- Beam test plans
- Conclusions

# Introduction

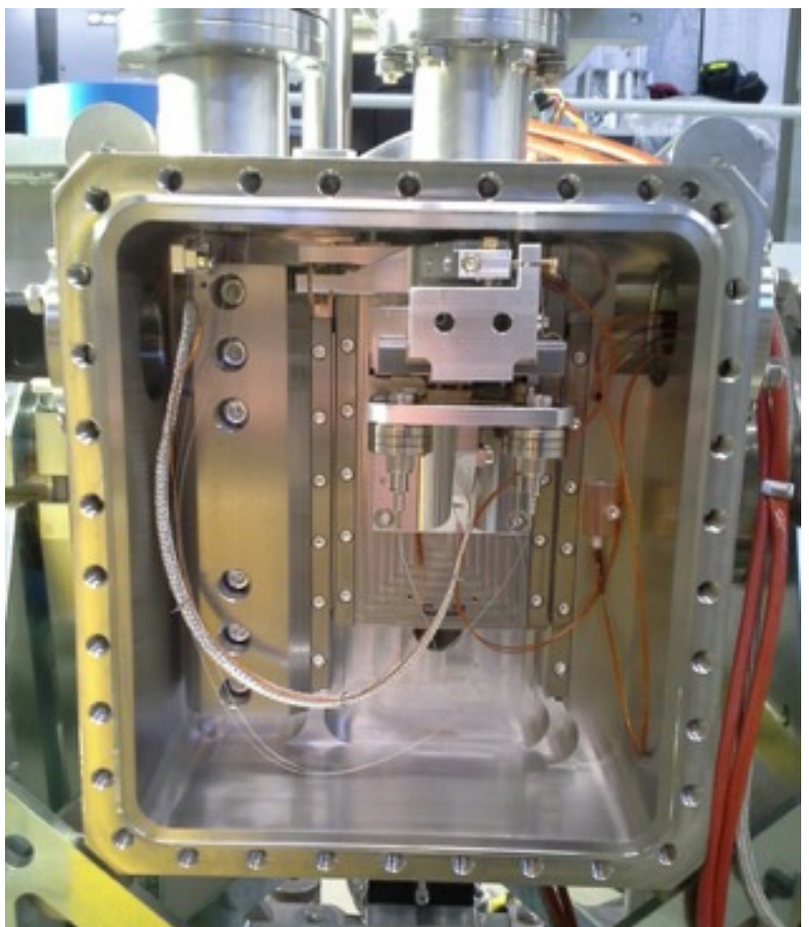
In the EYETS2016, we succeed to install **6 new collimator devices**:

- *1 primary collimator with BPMs (TCPP) ↦ standard commissioning*
- *1 low-impedance prototype (TCSPM) in IR7*
- *2 crystal collimator primaries (TCPC) in IR7, beam 2*
- *2 wire collimators for long-range beam-beam (TCTPW)*

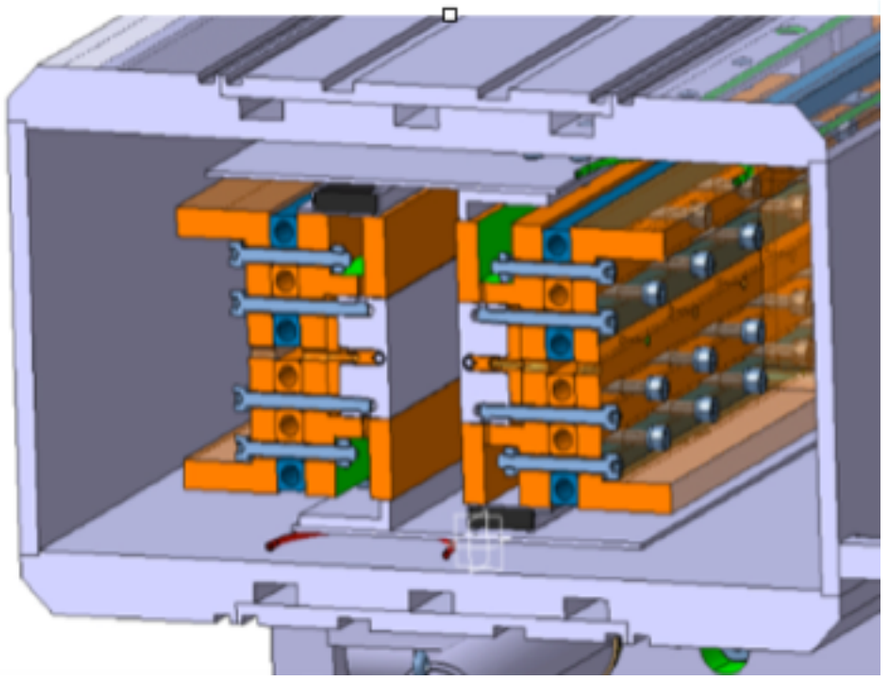
Exciting beam tests ahead and, like usual, safety comes first!

TCSPM jaw

Crystal goniometer (TCPC)



TCTPW cross section



# Collimation ECRs in 2016

- Doc. 1705737 v.1.0, **LHC-TC-EC-0005 v.1.0** (link)

  *Installation of a primary collimator with orbit pickups (TCPP) replacing a TCP*

- Doc. 1705738 v.1.0, **LHC-TC-EC-0006 v.1.0** (link)

  *Installation of a low-impedance secondary collimator (TCSPM) in IR7*

- Doc. 1705791 v.1.0, **LHC-TC-EC-0007 v.1.0** (link)

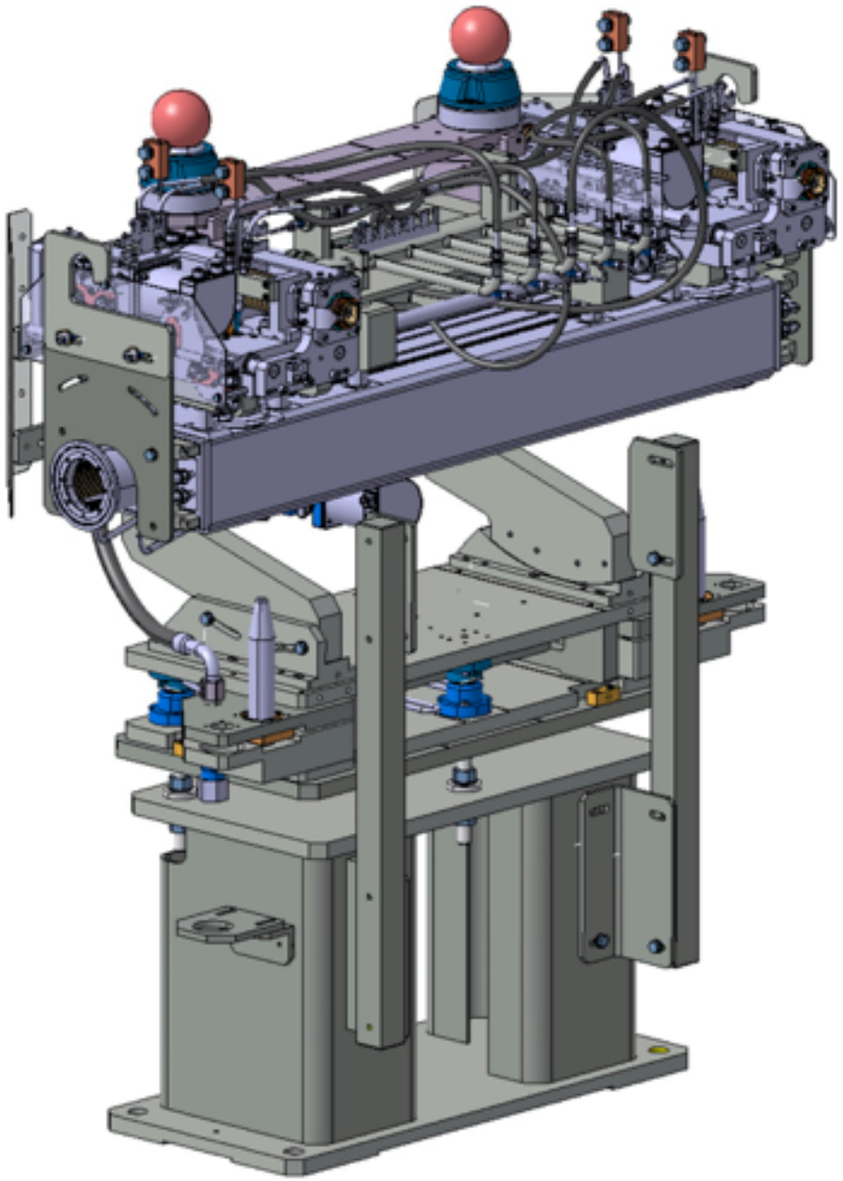
  *Installation of two wire collimators in IP5 for Long Range Beam-Beam compensation*

- Doc. 1714148 v.1.0, **LHC-TC-EC-0008 v.1.0** (link)

  *Installation in IR7 of Primary Crystal Collimators (TCPC) on Beam 2*

- Various presentations at CWG / ColUSM meetings

# Primary collimator with BPMs



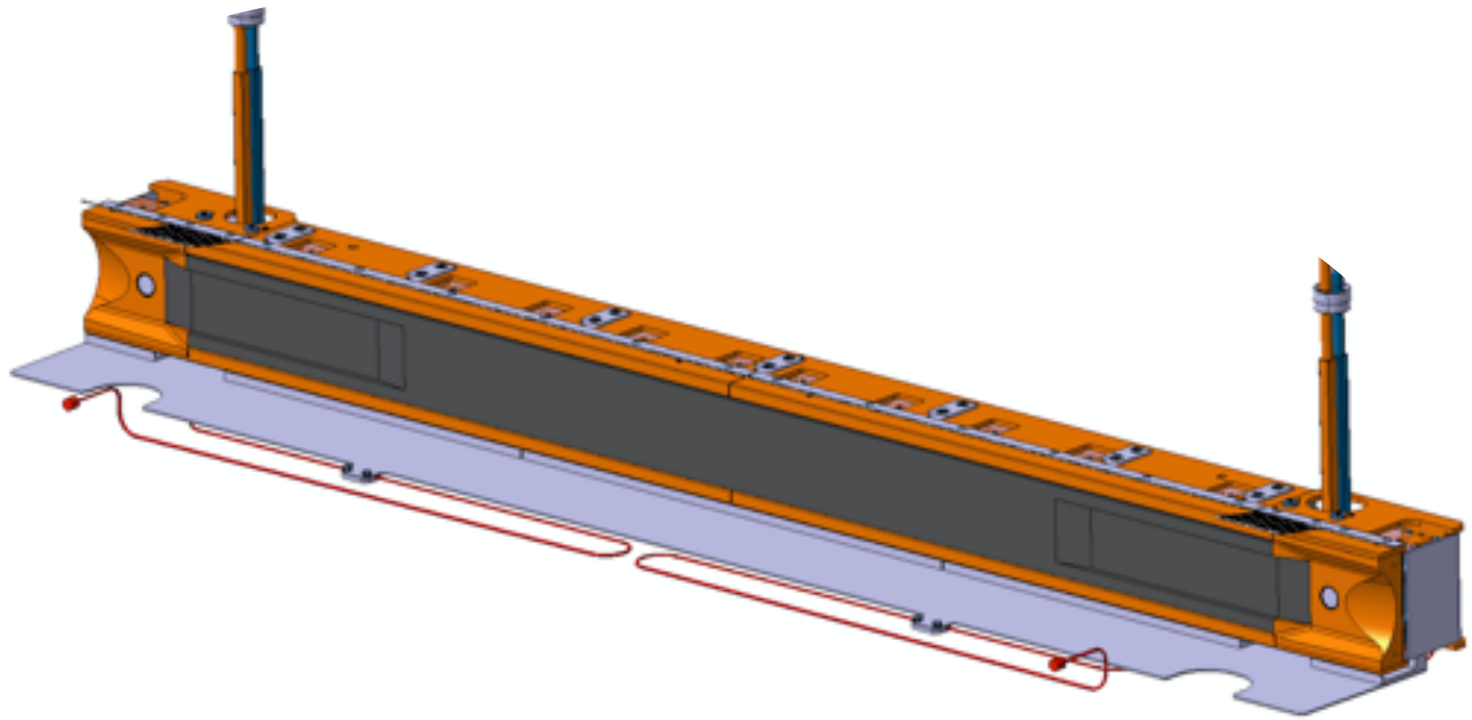
L. Gentini, MME

Adds BPMs to carbon-based TCP.

Built as a spare to replace a TCP that has cooling problems in Run I.

Replaces the TCP.C6L7.B1 (H).

An operational collimator to be fully commissioned!



# Low-impedance collimator prototype

Final jaw design for HL-LHC.

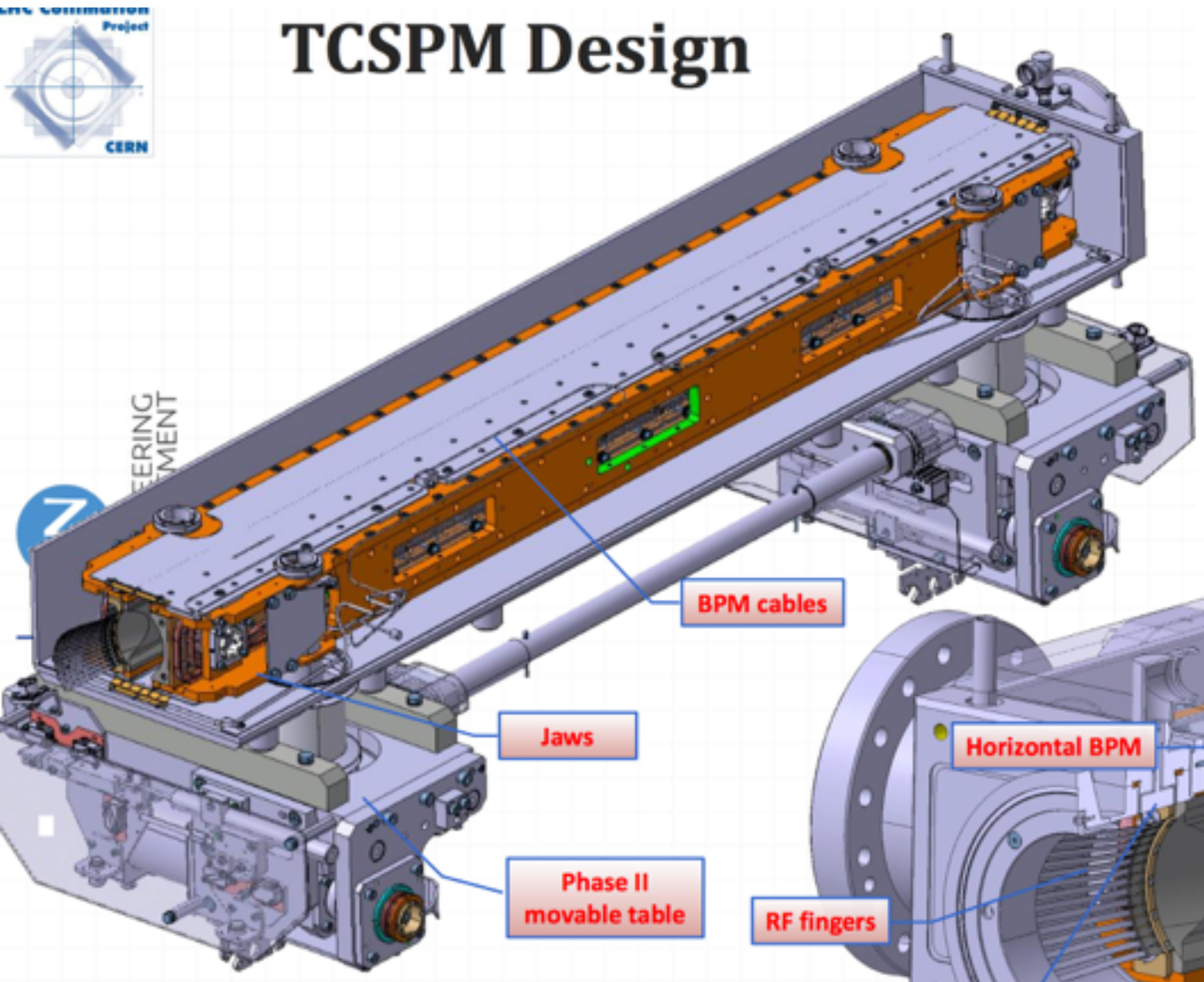
First built with advanced materials (Molybdenum-Graphite. MoGr).

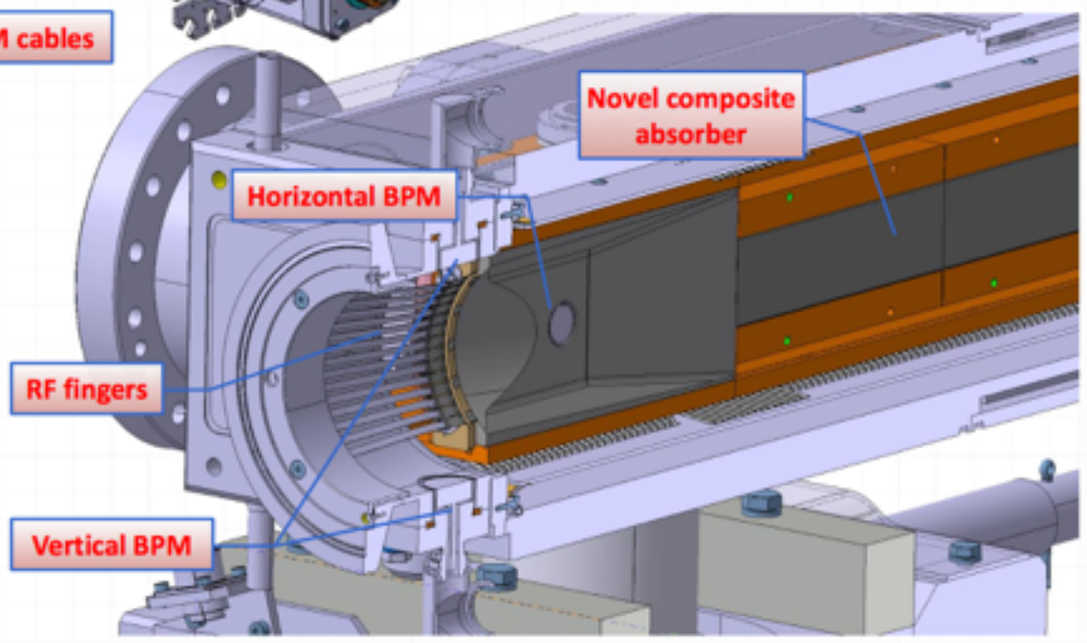
"Three-BPM" design: third BPM measures along non-collimated plane (not yet HL baseline).

Three different surfaces.

New slot:  TCSPM.D4R7.B2 (V).

2017: only used in MDs.

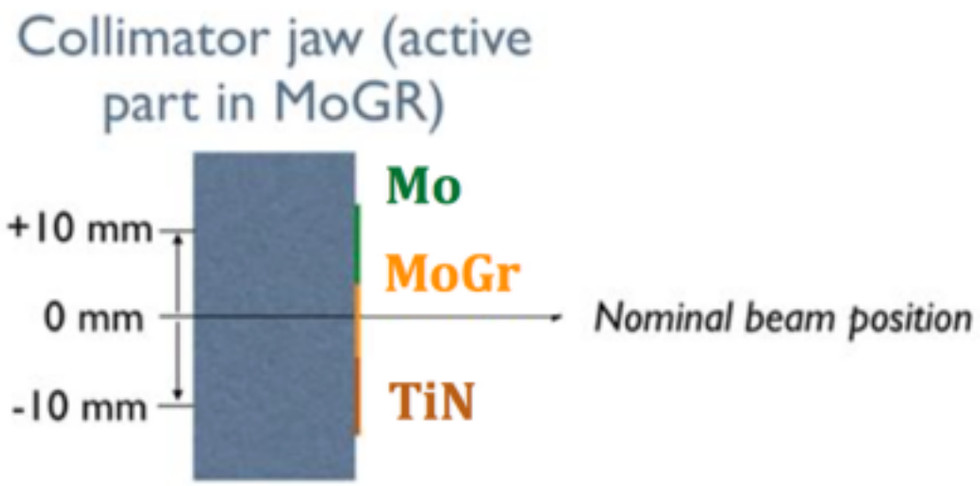


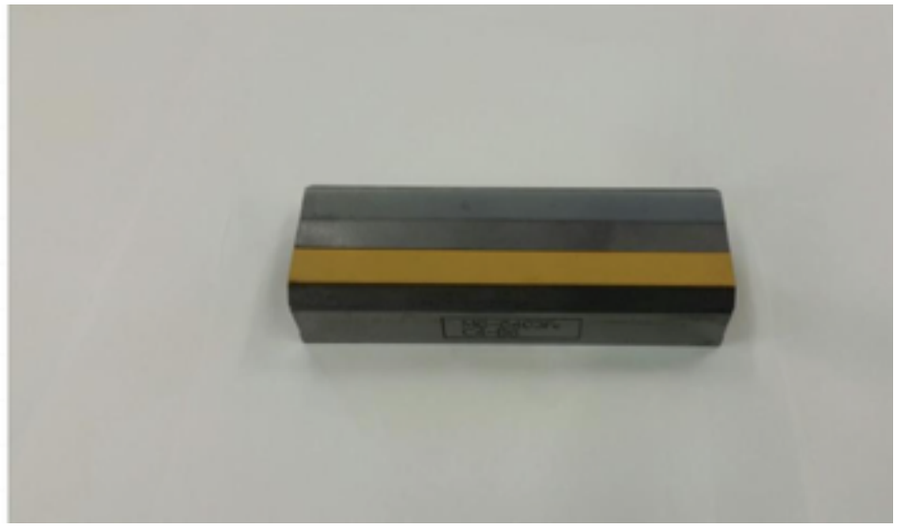



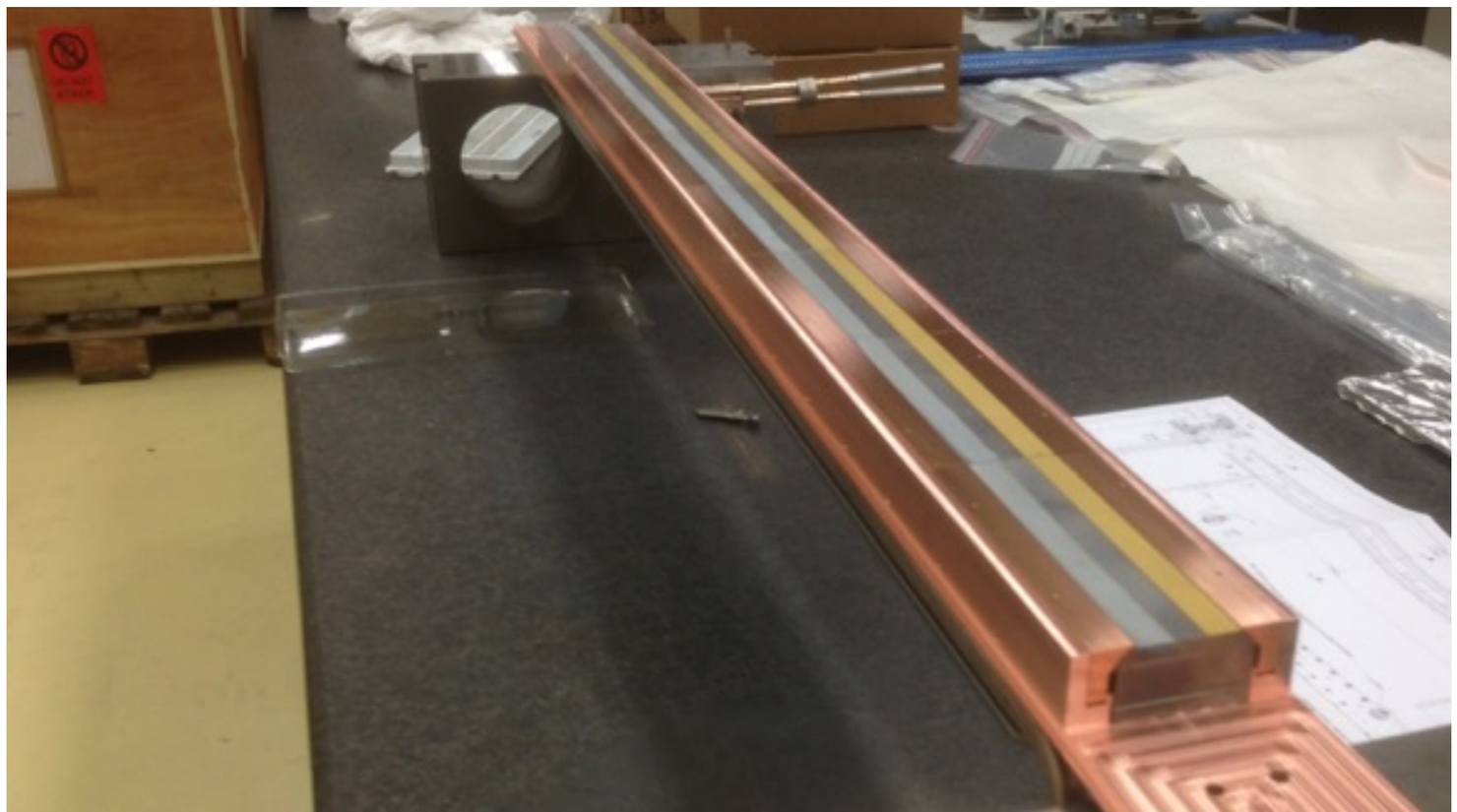

*F. Carra for MME: ColUSM, Dec. 9th, 2016*

# Low-impedance prototype jaw

Idea: Test 3 different surface resistivity values (2 coatings);
Challenging but feasible according to impedance team;
Unique opportunity to test coatings with LHC beams.

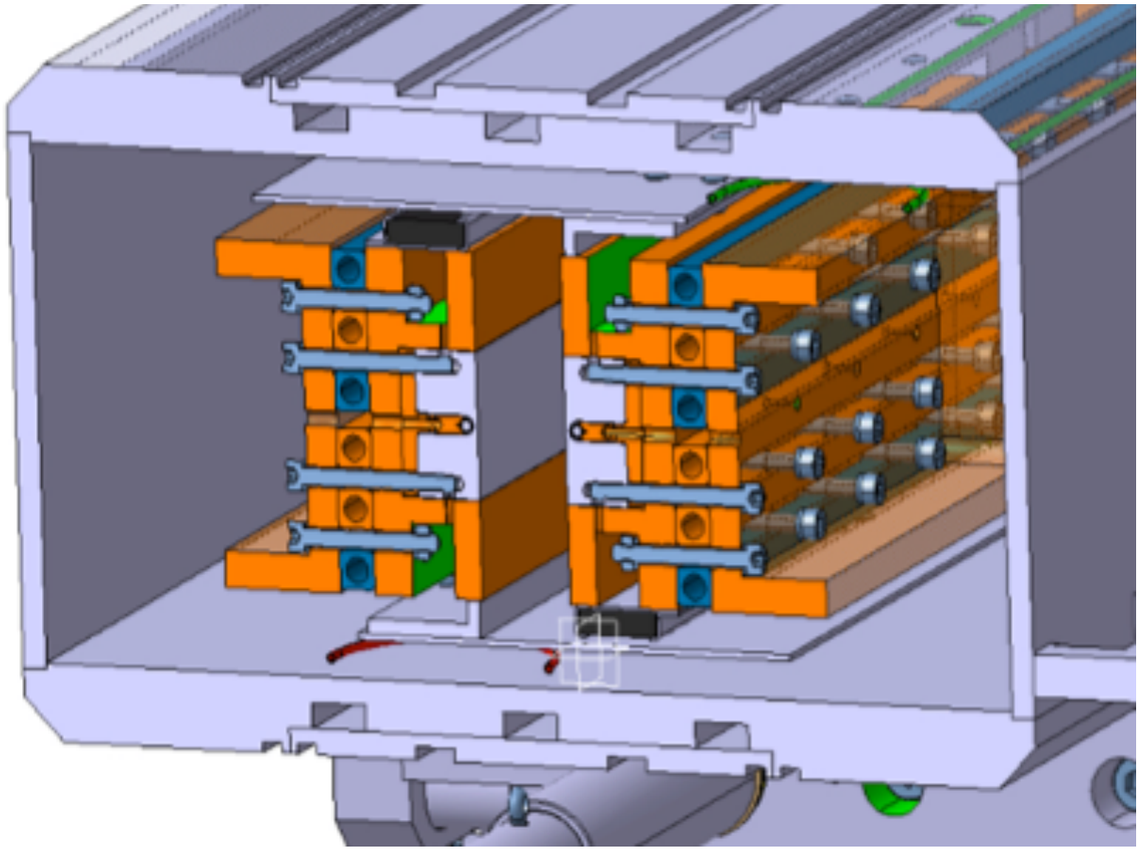


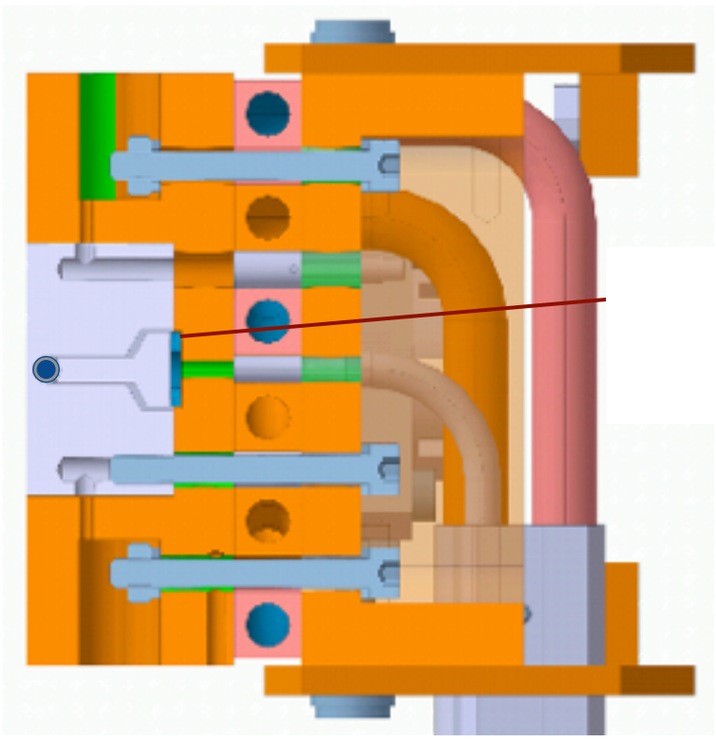





*Need to operate the 5th axis with beam!*

# Wire collimators





*Tertiary collimator with embedded wire for LRBB MDs*

In-jaw wire design for long-range beam-beam compensation study.

2 operational collimators replaced: TCTPH.4R5.B2, TCL.4L5.B2 (H).

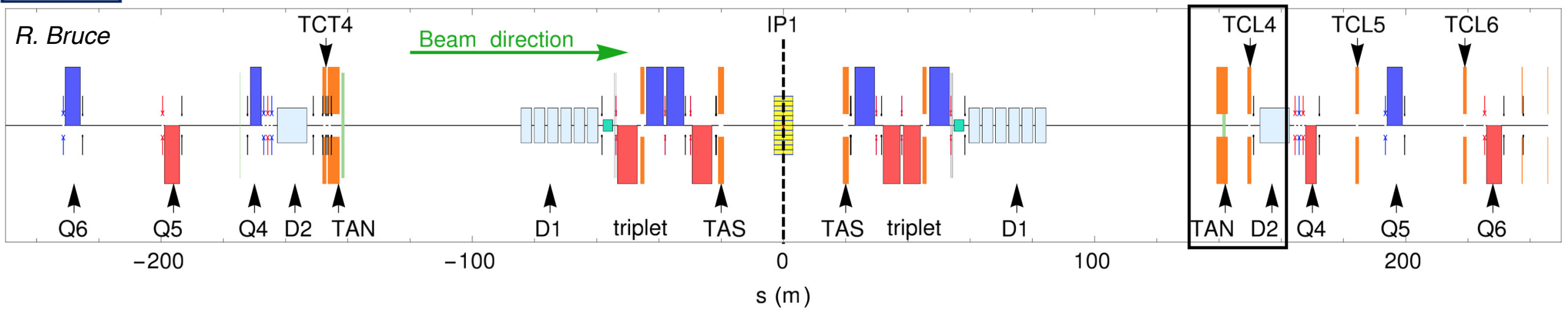
Important to ensure that standard operation at high intensity is ok.

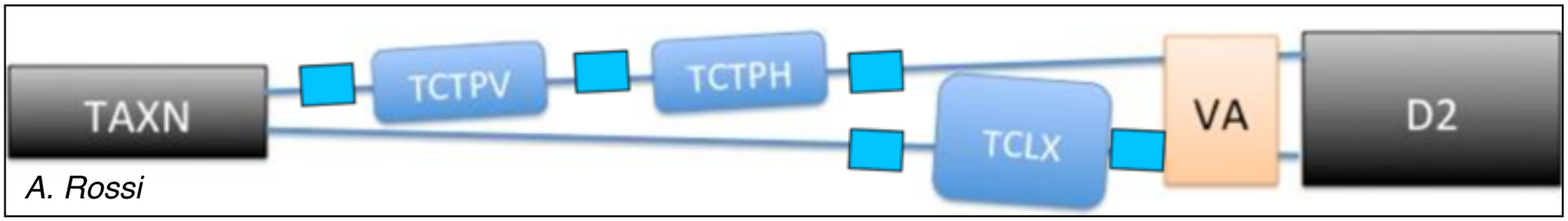
Wire current only in MDs, but the proposed “weak-strong” setup foresees high intensity on B1.

(Add BPMs to the TCL.4L5.B2).

See recent talk here by A. Rossi on wire current interlock.

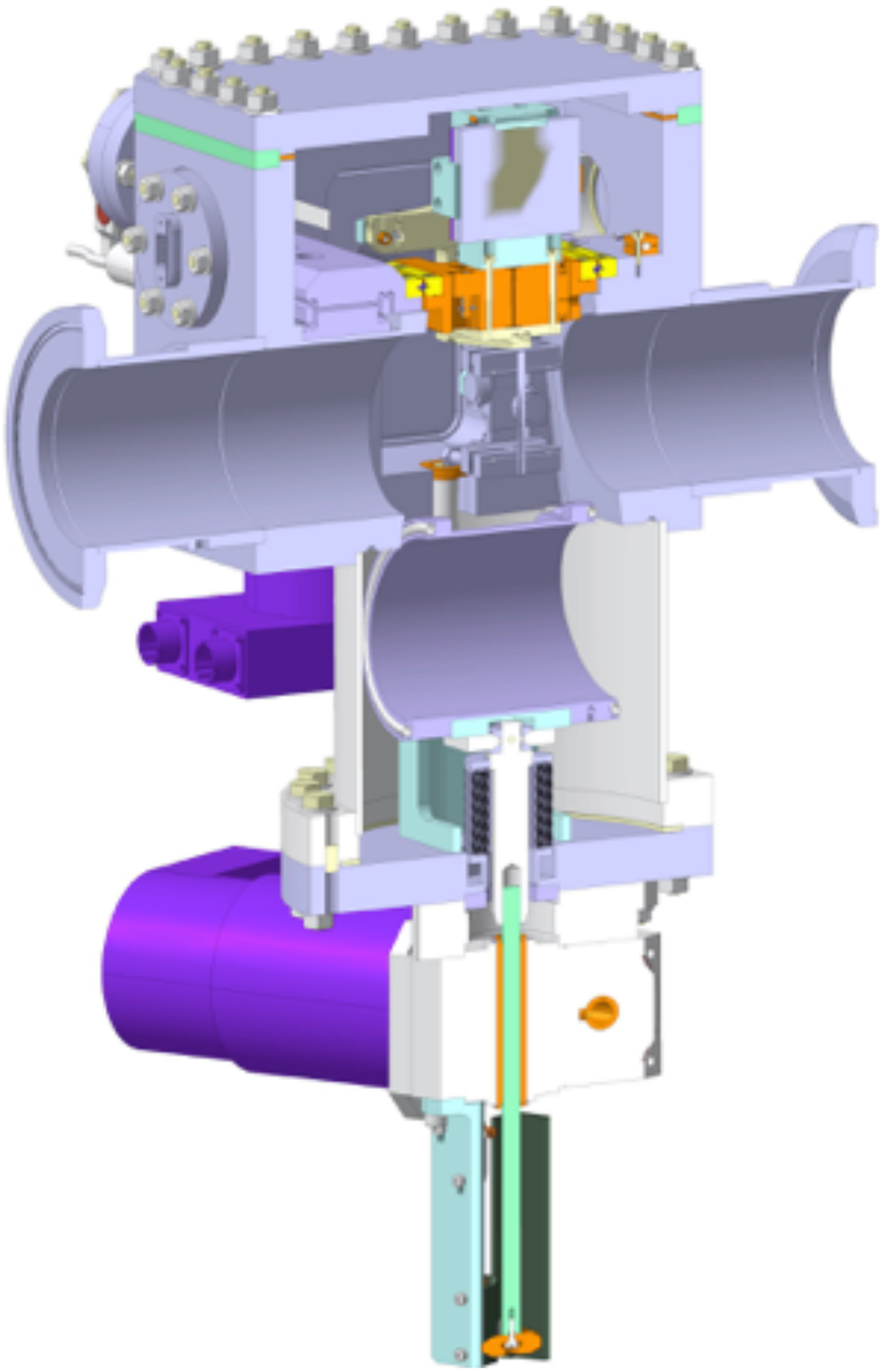
# A packed region




*Important to exclude any interference with adjacent collimators when wire is powered. Very promising results without beam, but a verification must be done with beam.*

# Beam 2 crystals

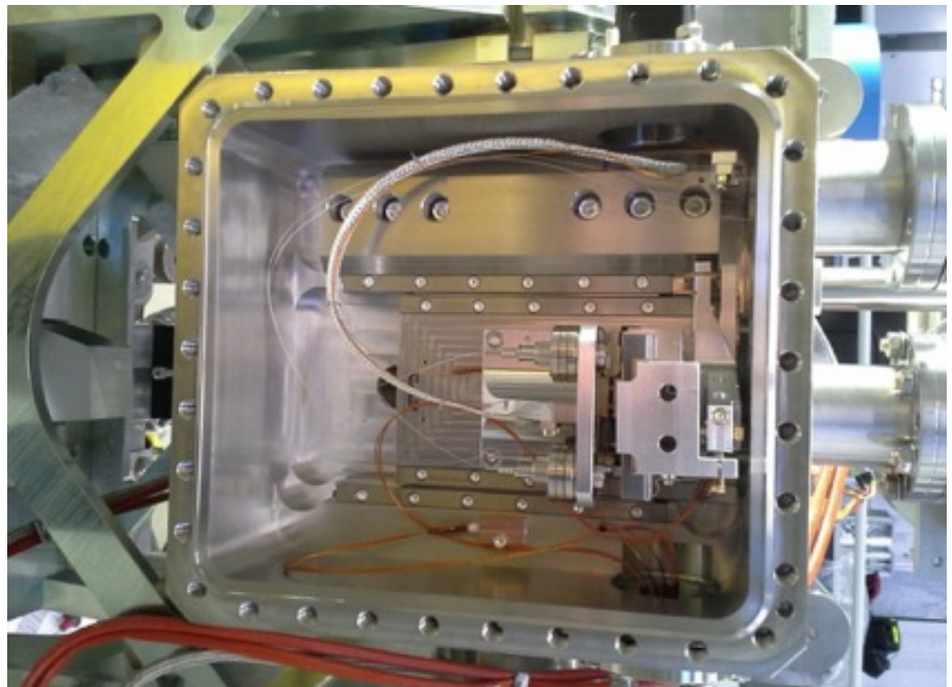


Improved hardware: better bending angles and goniometer controls, now bake-able (new piezos).

Two new devices on B2, kept B1 ones.

Machine protection logic remains the same as for B1: transparent for high-intensity runs.

Used only in MDs, no high intensity tests planned for 2017 at this stage (requires controls update).



# For reference

New crystals :

"TCPCH.A5R7.B2" 20090.16

"TCPCV.A6R7.B2" 20144.70

Low-impedance collimator:

"TCSPM.D4R7.B2” 20069.59

Primary with pickups:

"TCP.C6L7.B1” 19791.48

Collimators with wires:

"TCTPH.4R2.B2” 3451.32

"TCL.4L5.B2” 13180.06

*(From 2017 sequence — Thanks R. de Maria)*

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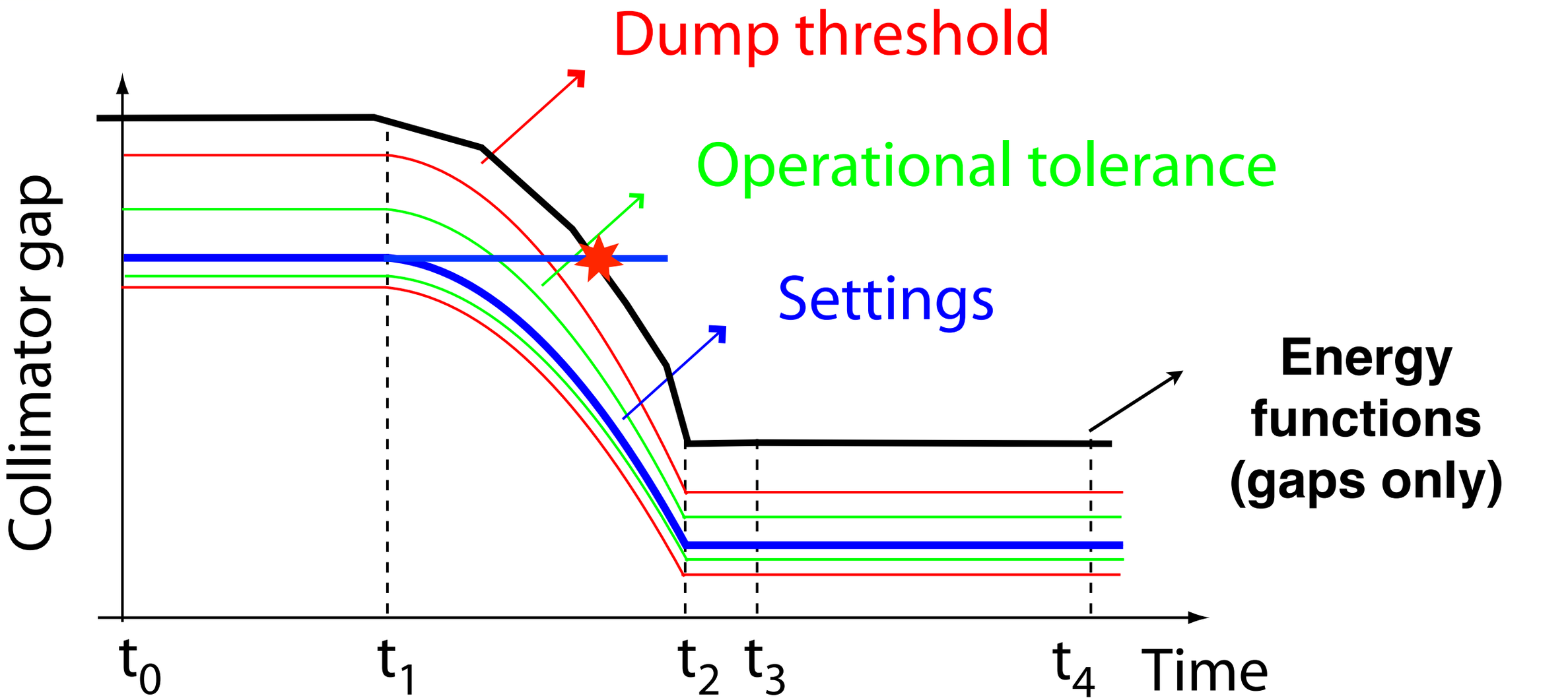
# Recap.: collimator interlocks




- Two regimes: discrete ("actual") and time-functions *(internal clock at 100 Hz )*
- **Inner** and **outer thresholds** as a function of **time** for each motor **axis** (4 functions per collimator). Triggered by timing event (e.g. start of
  *"Double protection" → BIC loop broken AND jaw stopp*
- Redundancy: **maximum allowed gap versus** (4 per collimator: IN/OUT)
  *Beams dumped if a collimator does not*
- Redundancy: **max. and min. allowed gap** (4 per collimator: IN/OUT)
  *Beams dumped if a collimator does not s squeeze function.*

**Tested by an automatic sequence for each collimator.**

# New interlock 2017 — BPMs in SIS

Various discussions at CWG/MPP meetings + ad hoc meeting (Collimation, MP, BI, OP): *https://indico.cern.ch/event/614105/*

Agreed to implement it for the intensity ramp up.

Key implementation choices for SIS logic:

- Dump if both BPMs in one collimator are out of tolerance for 6 s = 3 samples of SIS acquisition.
- Dump after 1 minute = 30 samples if both acquisition stop or if data are not valid.
- Continue with interlock logic on remaining channel if 1 acq. ok.

New developments required:

- Post-mortem to be implemented by BI
- Add collimator gap subscription in BI class (presently in collimator class).

Suggest a joint CWG/MPP before the end of May to make the point.

# 2017 strategy — without beam

Remarks:

- Several new hardware types, but no fundamental differences of core MP implementations of the system.
- Collimator wire interlocks under BE/BI responsibility (A. Rossi)
- New collimator TCSPM has the same interlock implementation as al other collimators.

Propose to apply standard “re-commissioning” strategy after YETS:

- Execute MP sequences for all new devices;
- and where connections/configurations have changed;
- and for 1 collimator per FEC + 1 collimator per config type
  *(1, 2 or 3 collimators per CPU pairs PRS/MCD have different configs)*
- Repeat for one FEC the “status interlock” checks.
- Crystals B2: standard interlock check that no beam allowed when replacement chamber gets moved OUT.
- Script for temperature interlock check: all collimators.

# New requirements with beam

The commissioning requirements are very similar to those of last year in terms of alignments, settings preparation, etc.:

- Usual alignments with reference machine at injection, FT, end of squeeze and collision.
- Loss maps table will be provided accordingly.
- No fundamental changes of operational modes.

We request to repeat the detailed BPM calibration sequences for all BPM collimators ↦ optimum setup in prep. to SIS implementation.

Require 1-2 shifts in commissioning for dedicated tests with the new wire collimators (see next page).

Standard SIS checks with beam needed — usual checks by BE/OP.

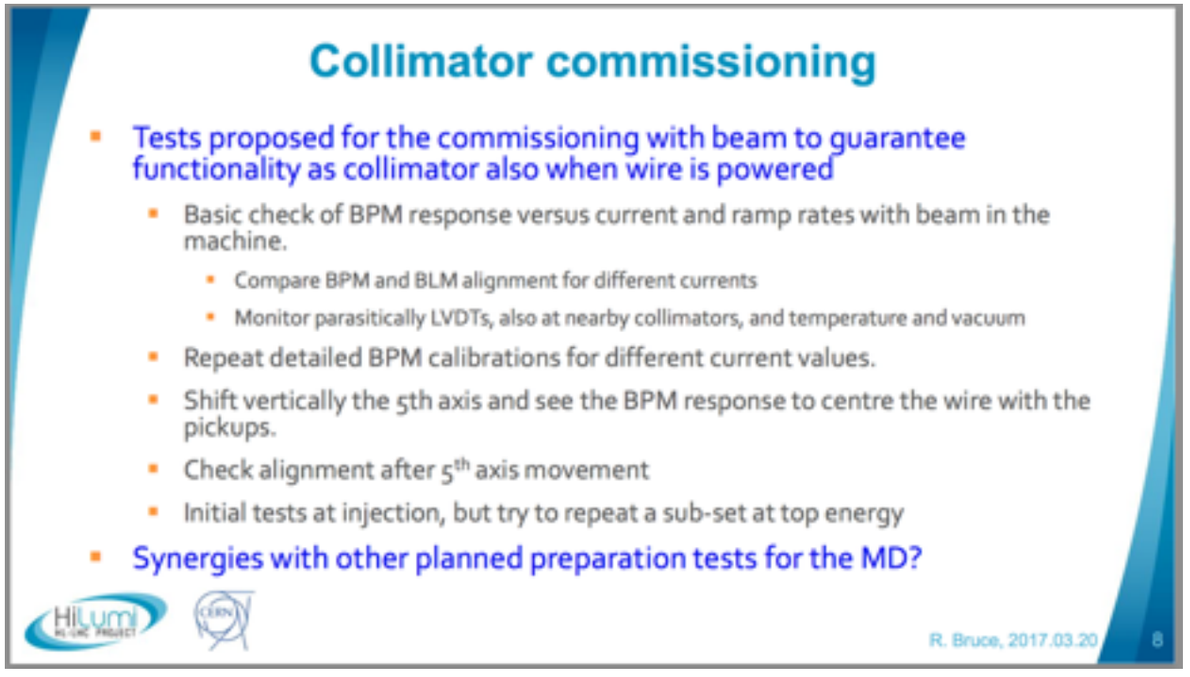
# Beam tests with wire collimators

Ensure standard functionality of new collimators with wire:

- *Check alignment after 5th axis movements*
  *(parasitic checks of vertical wire centring w.r. to BPMs)*
- *Basic check of BPM response versus current and ramp rates with both beams in the machine.*
- *Compare BPM and BLM alignment for different currents*
- *Monitor parasitically LVDTs, also at nearby collimators, and temperature and vacuum (DONE without beam: no issue expected!)*
- *Repeat detailed BPM calibrations for different current values, for all TCTP's in IR5 (4 collimators) when 2 wire collimators powered.*
- *Initial tests at injection, but ideally try to repeat a sub-set at top energy*

Synergy possible with other planned single-beam tests, but a minimum set of tests must be done independently of MD needs.

*More details in RB's talk at a recent BBLR meeting: https://indico.cern.ch/event/615088*



# Conclusions

- Presented collimation changes in EYETS2016
  - *TCP with BPMs, low impedance prototype, wire collimators, 2 new crystals*
  - *Several new devices that we are looking forward to test with beam!*
- No fundamental changes of basic MP implementations
  - *NEW: SIS on BPM finally becoming operational.*
  - *Wire interlock strategy presented here by BE/BI.*
  - *Full position interlocks also for MD devices like TCSPM.*
- Preparation without beam similar to 2016
  - *Tests progressing well. Plan a review at the CWG eetin of May 8th.*
  - *Plan to complete MP sequences in the week of Apr. 24th.*
- We will need special care for the new wire collimators, to guarantee that everything is in order for high intensity
  - *Requested 1-2 shifts in commissioning, independently of MD program.*