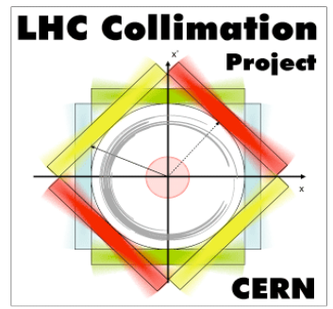
OP workshop on LHC integration and machine checkout
November 8th-9th, 2007
CERN, Geneva, Switzerland

The LHC Collimation System

S. Redaelli, AB-OP

Based on discussions with

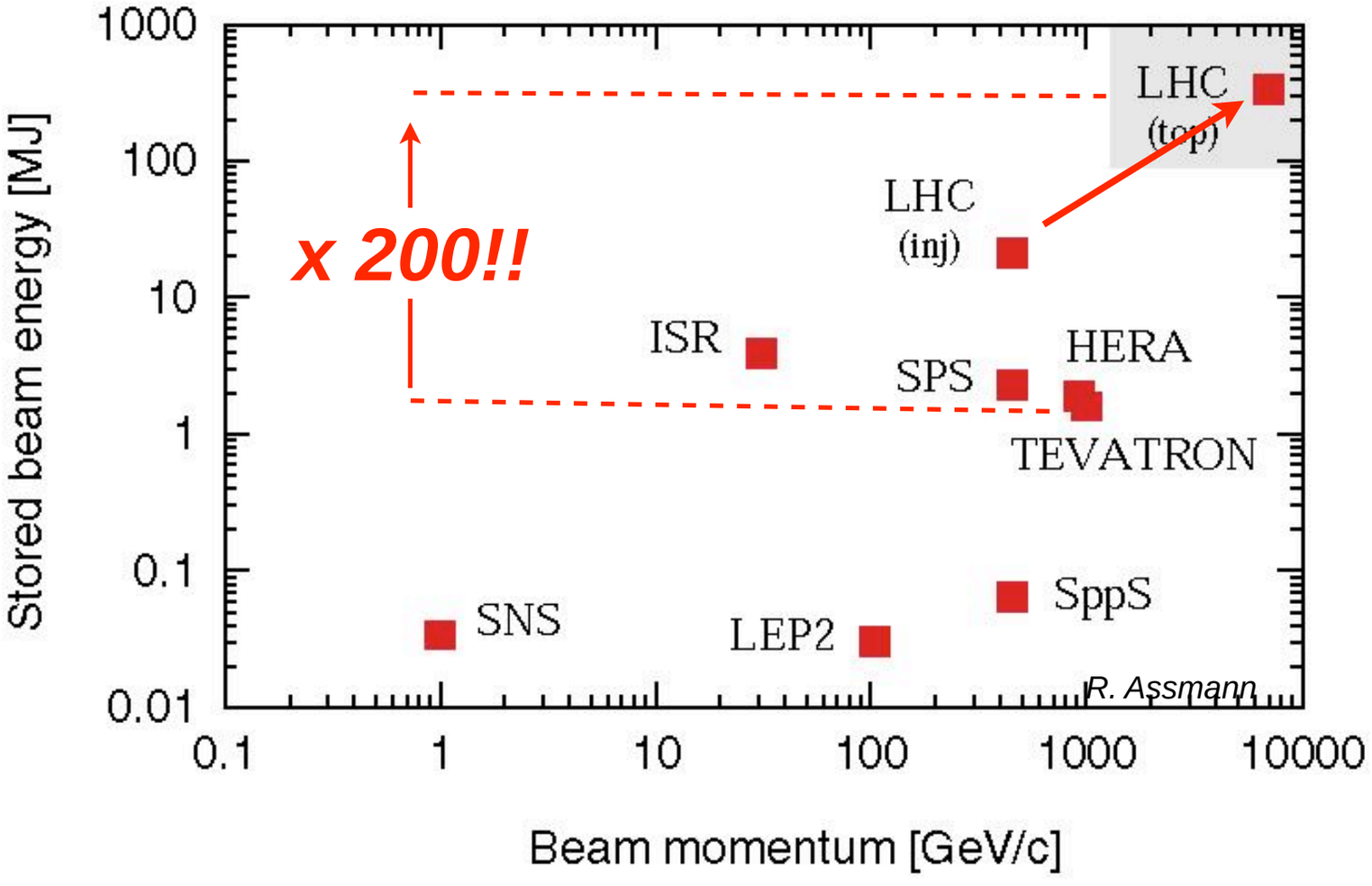
R. Assmann, M. Jonker and T. Weiler



Outline

- **Introduction**
- **LHC collimation system**
  - Layout, design and people
  - Controls and operational challenges
  - Tools available
- **Commissioning without beam**
  - Plans for commissioning without beam
  - Deliverables of cold checkout
  - Contributions from OP
- **Interfaces to other systems**
- **Conclusions**

Introduction



E_b = 7 TeV - I_b = 3.4x10^{14}

Stored energy	**~ 2 x 360 MJ**
Quench limit	~ 10 mJ / cm^3
Damage (metal)	~ 50 kJ / mm^2

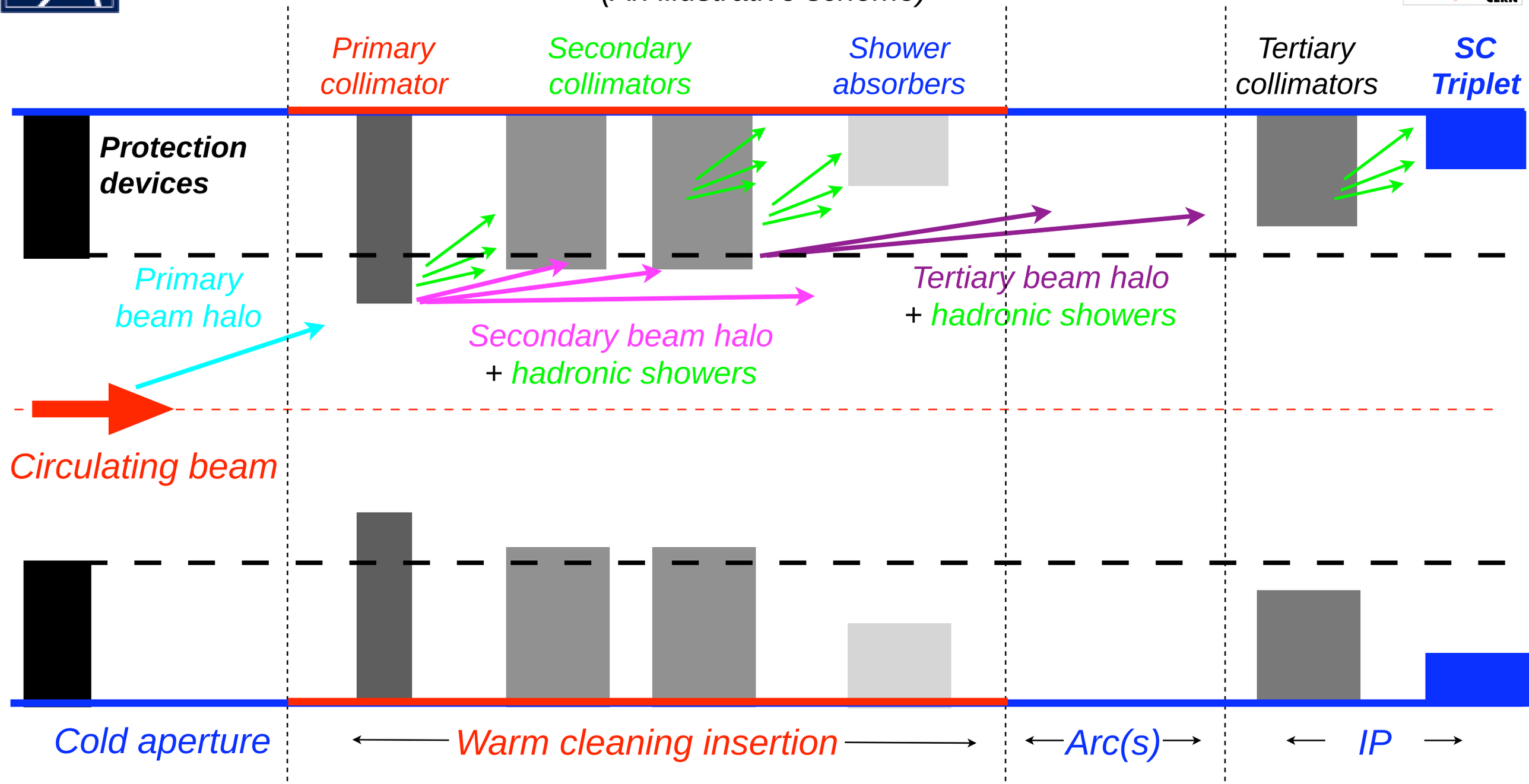
LHC enters in a ***new territory*** for handling ultra-intense beams in a super-conducting environment!

Correspondingly, a powerful **collimation system** will be needed.

- *Control losses 1000 time better than the state-of-the-art!*
- *Need collimation at all machine states: injection, ramp, squeeze, physics*
- *Important role of collimation system for machine protection*

Multi-stage collimation at the LHC

(An illustrative scheme)



Large and distributed system...

The Phase I LHC collimation system

Multi-stage halo cleaning

Two warm cleaning insertions

IR3: Betatron cleaning

- 1 primary (H) → TCP [C]
- 4 secondary (H,S) → TCS [C]
- 4 shower abs. (H,V) → TCLA [W]

IR7: Betatron cleaning

- 3 primary (H,V,S)
- 11 secondary (H,V,S)
- 5 shower abs. (H,V)
- 3 beam scrapers (H,V,S)

Local cleaning at triplets

- 8 tertiary (2 per IP)→ TCT [W]

Physics debris absorbers [Cu]

- 2 TCLP's (IP1/IP5)

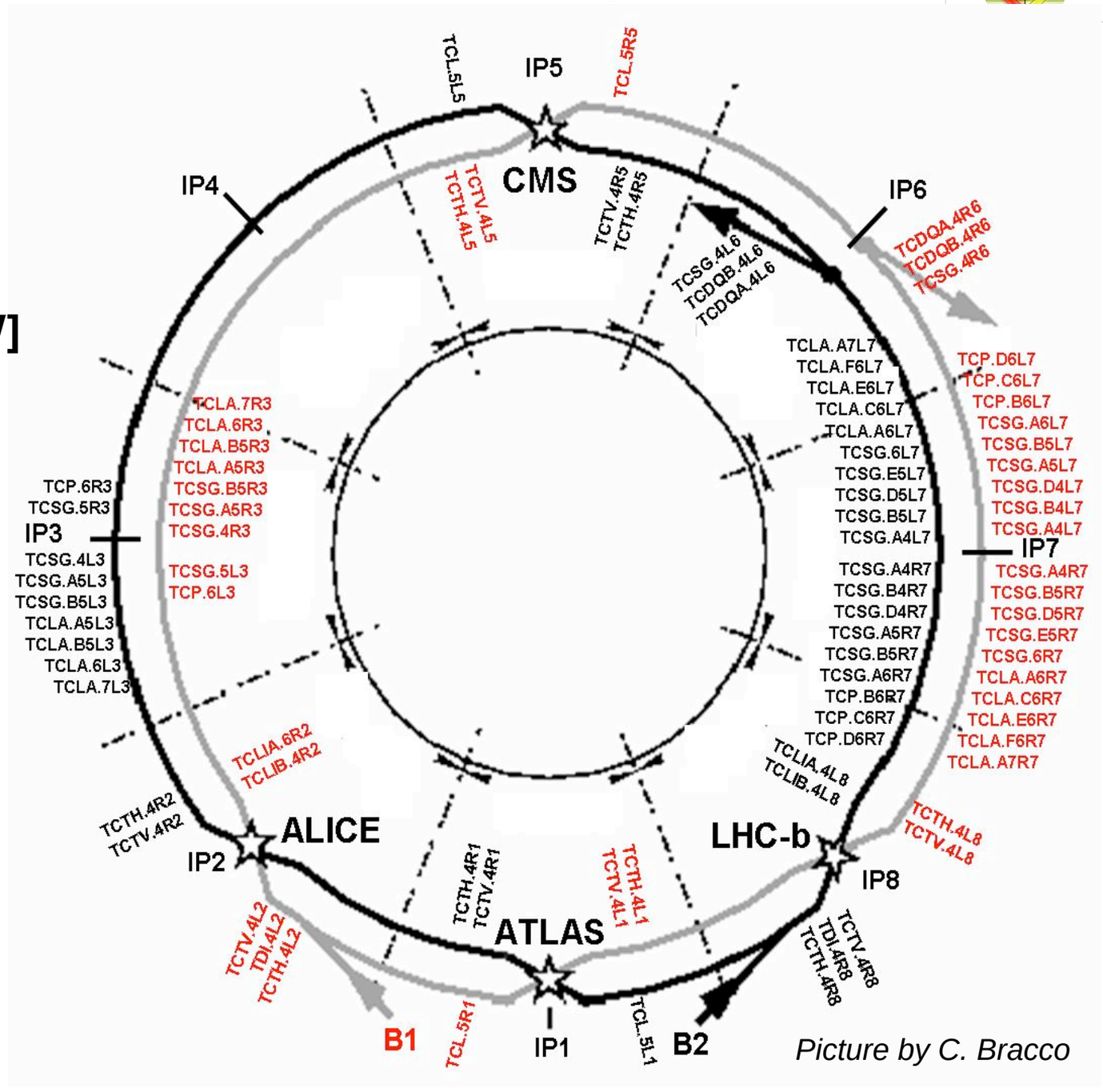
Protection (injection/dump)

- 10 elements →TCLI/TCDQ [C]

Transfer lines

- 13 collimators → TCDI [C]

Passive absorbers for warm magnets



Picture by C. Bracco

*41 movable **ring** collimators per beam!*

Present system status and plans

*Detailed documentation in a recent note by Ralph: ECR **LHC-TC-EC-0001-00-10***

In the tunnel, as of today:			
	Ring:	IR7 (TCP's, TCSG's)	18
		IR6 (TCSG's)	2
		IR5 (TCT's)	3
		IR8 (TCT's)	2
	TL's:	TI8	6
		TI2	5
		Total	***36***

Expected for first run to 7 TeV: 71*

*(Nominal Phase I system: **98**)*

** Rely on production schedules of CERCA and TS workshop*
After the crisis, fully on track for the moment!

⇒ No expected performance limitations for first physics run (Stage A)

⇒ For checkout matters, no differences from the final system...

System commissioning: People

(inside mandate of the LHC collimation project)

System commissioning:	R. Assmann, T .Weiler	AB-ABP
	S. Redaelli	AB-OP
	M. Jonker, *M. Sobczak*	AB-CO
	R. Losito, A. Masi + team	AB-ATB (low-level)
	O. Aberle, R. Chamizo, Y. Kadi + team	AB-ATB (hardware)

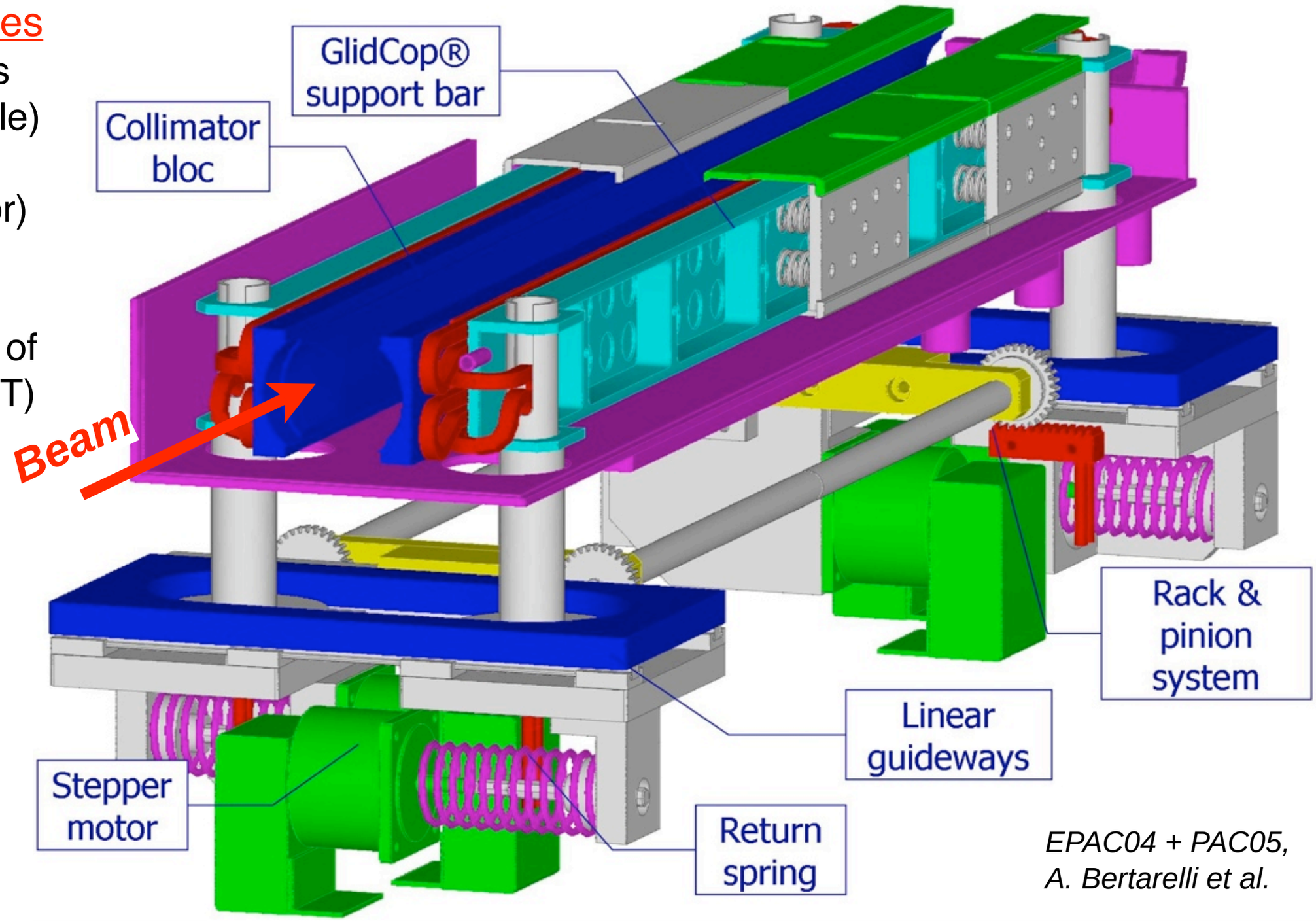
Special functionalities	Injection team, Dump team,	(with beam only)
(protection, physics,...)	Ion collimation team, TOTEM, ...	

Several project internal **meetings** to drive the various activities (Collimation project steering, Collimation Working Group, Controls, ...). *Links given in OP-wiki for documentation*.

Collimator design

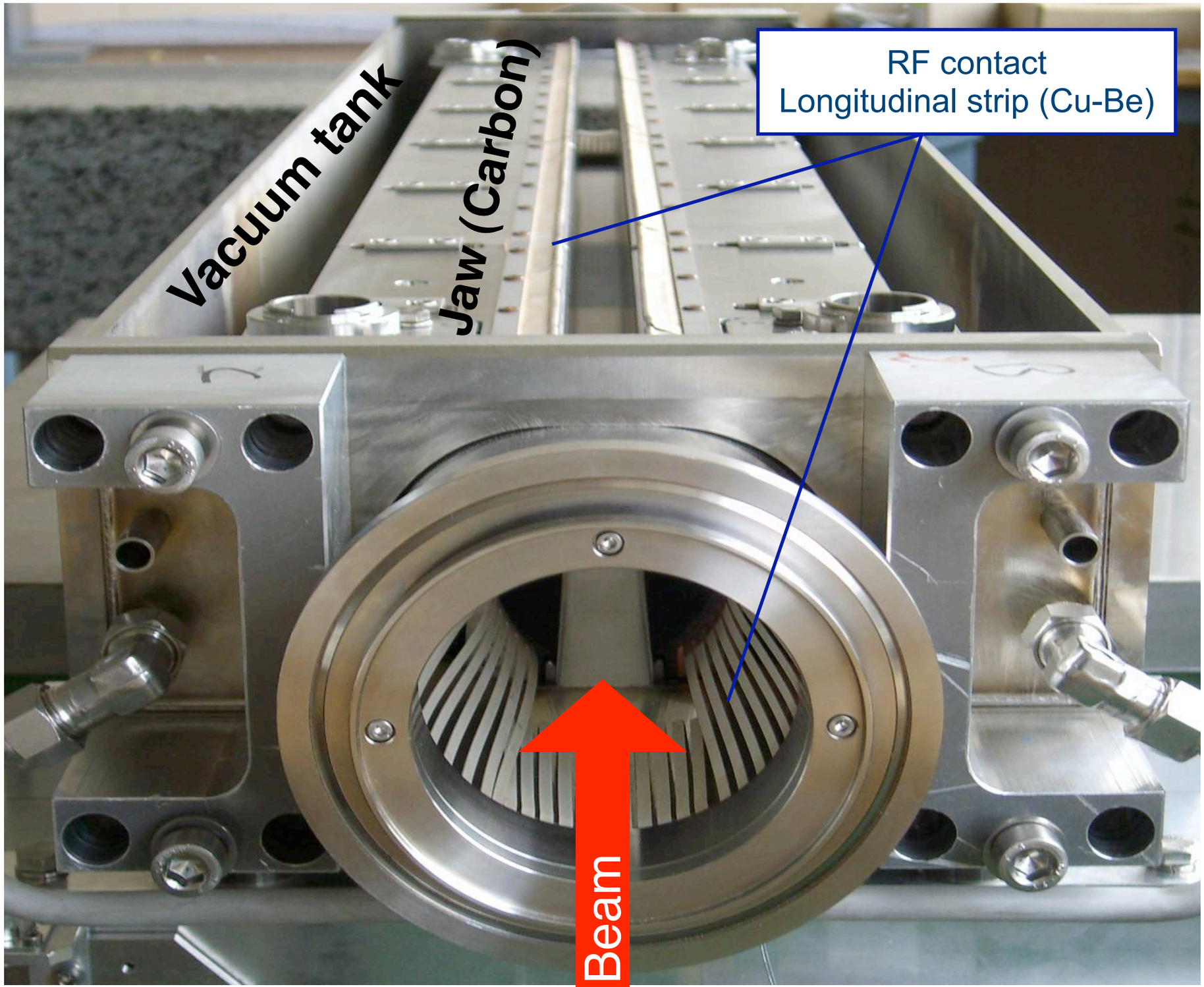
Main design features

- Two jaws, 4 motors (position and angle)
- Concept of spare surface (5th motor)
- Different azimuthal angles (H,V,S)
- External reference of jaw position (LVDT)
- Auto-retraction
- RF fingers
- Jaw cooling

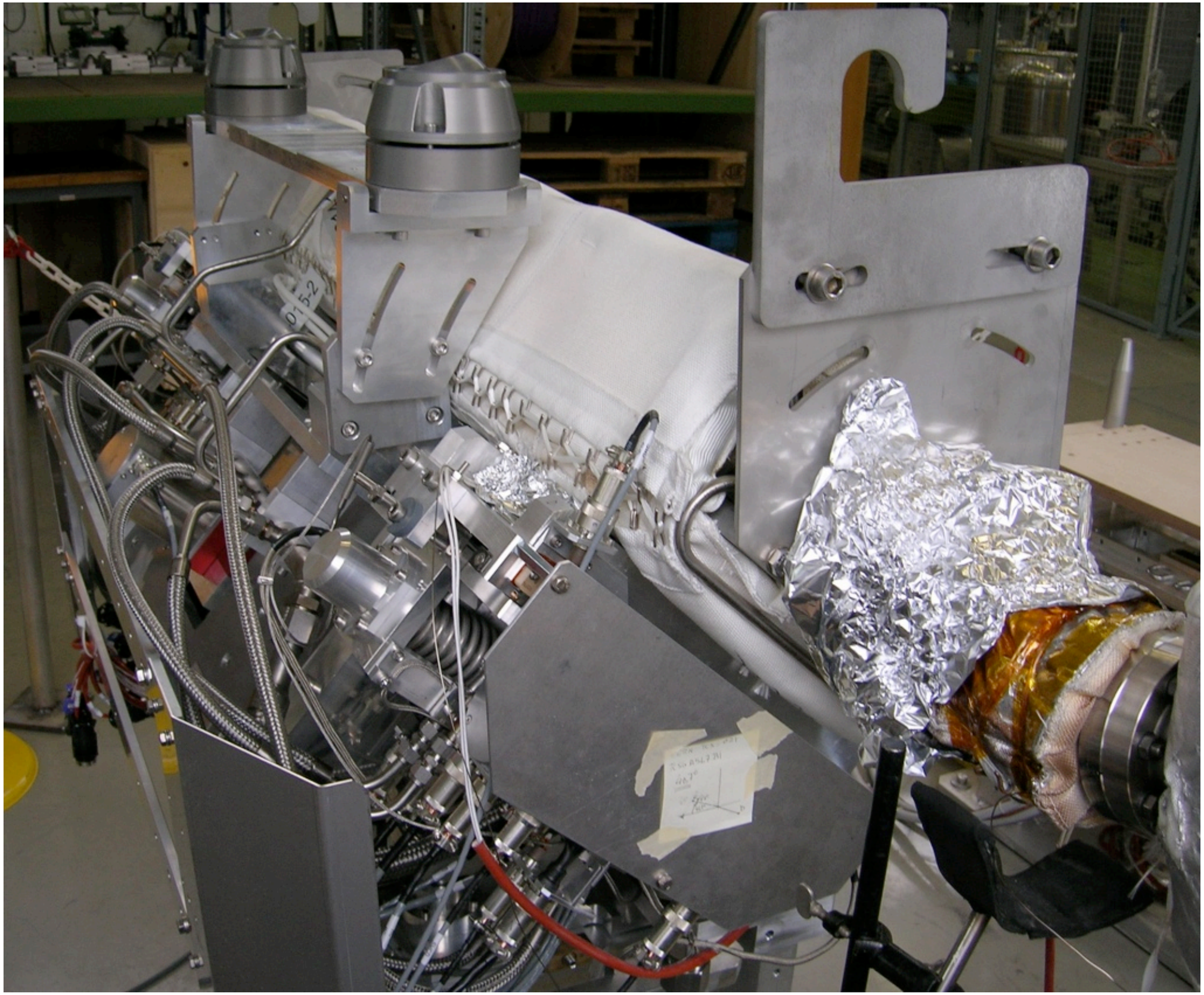


EPAC04 + PAC05, A. Bertarelli et al.

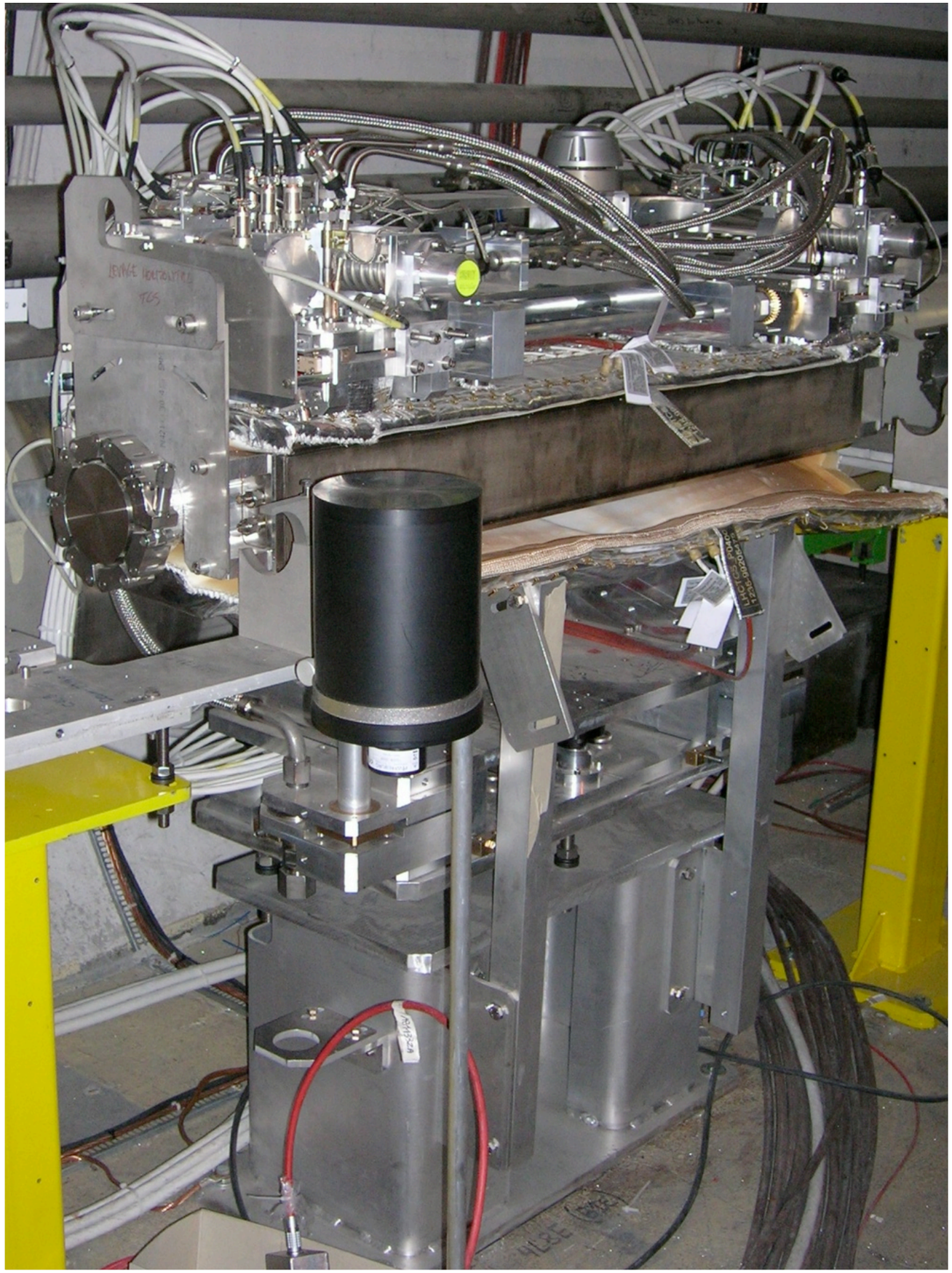
Real collimators



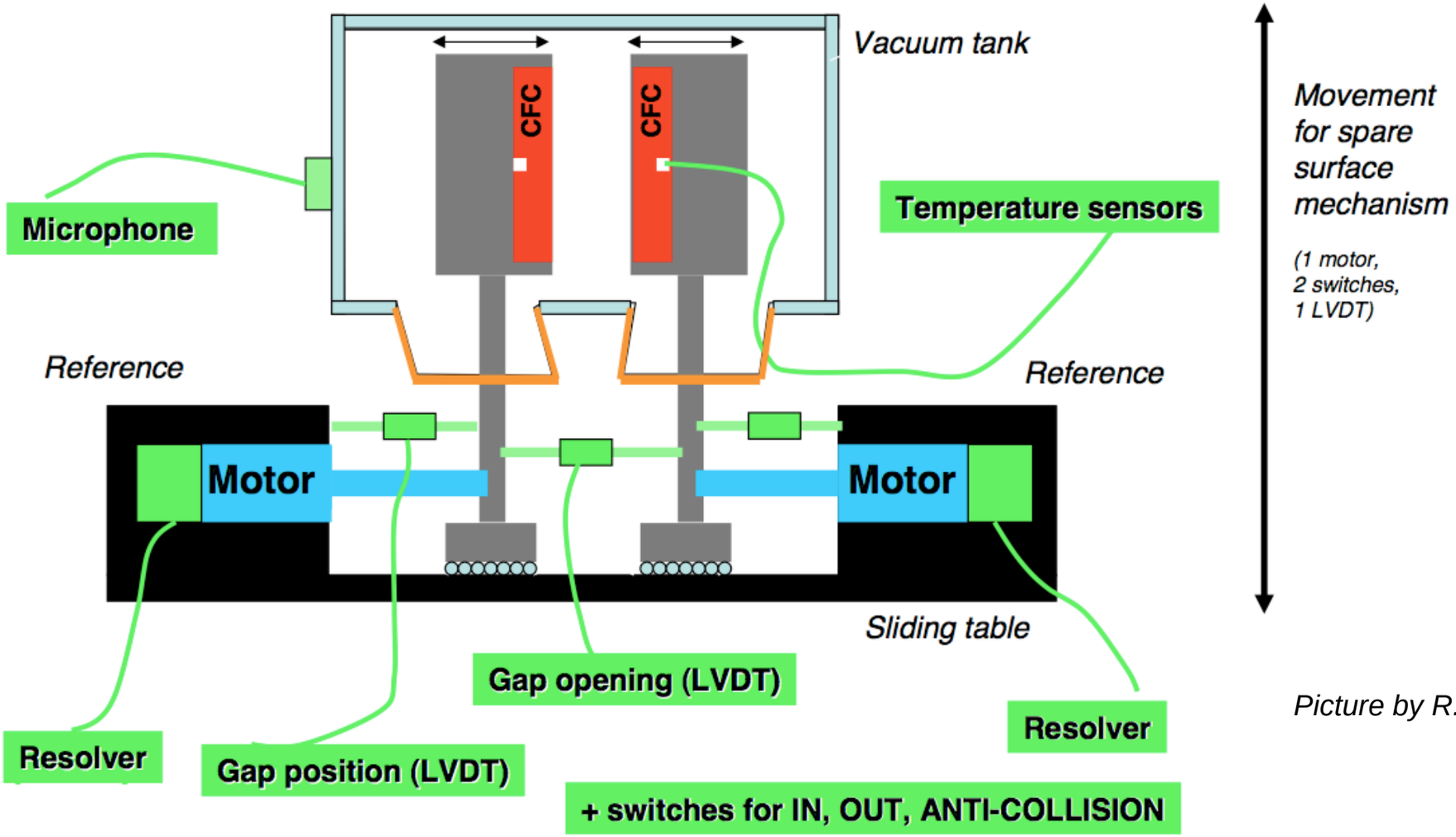
Real collimators



Real collimators



Controls challenge - settings/survey



Picture by R. Assmann

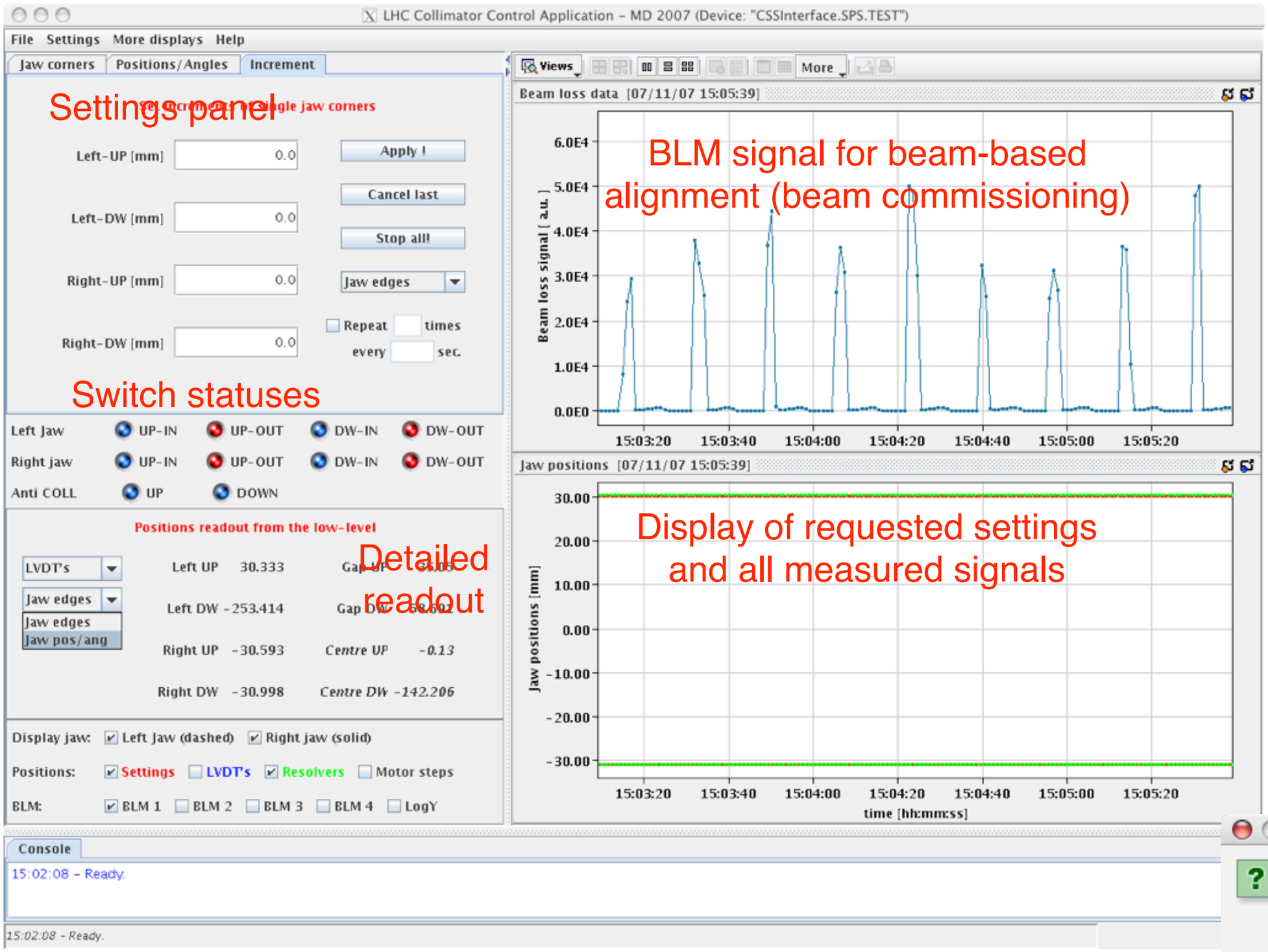
~400 degrees of freedom

Settings: 2 jaws → 4 motor positions; 1 motor for tank position.

Survey: 7 position measurements (4 corners + 2 gaps + tank)
4 motor resolvers
5 temperature sensors (1 per jaw corner + water temperature)
10 switch statuses (full-in, full-out, anti-collision)

Dump thresholds (functions+discrete): 6 x 2 jaw positions/gaps; some gap values vs. energy and beta* factor; 5 temperatures; switch statuses vs. machine mode.

Tools available from the CCC



Tools **adequate** for the HWC commissioning of collimators.

Will include routines for HWC procedures, if needed

Additional displays for temperature, transient beam loss are available

Additional expert tools access directly low-level controls (e.g. calibration)

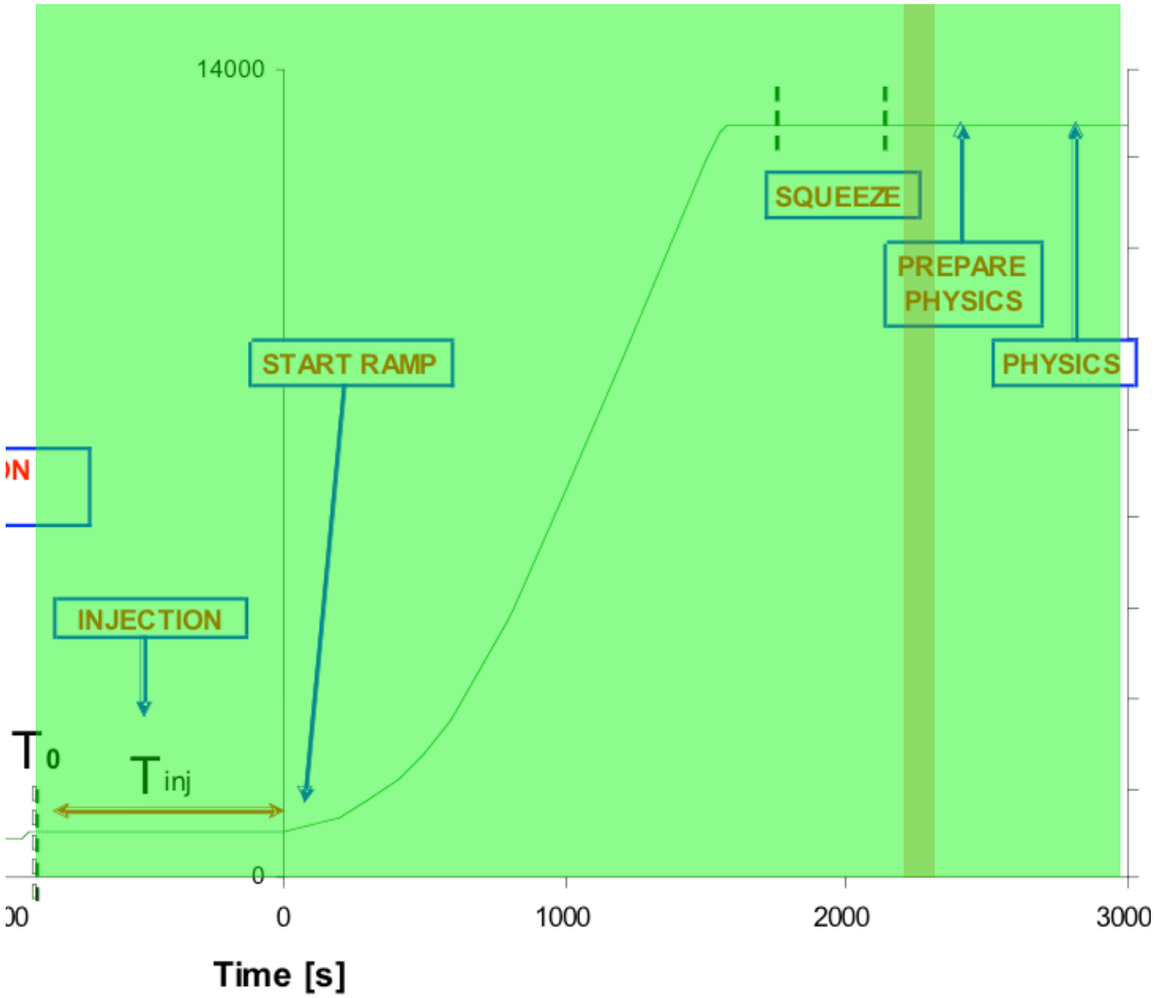
Software specs: LCH-TCT-ES-0001-00-20 (2006)

Prototyped with beam tests at the SPS; now extended to multi-collimator control

Operational challenges

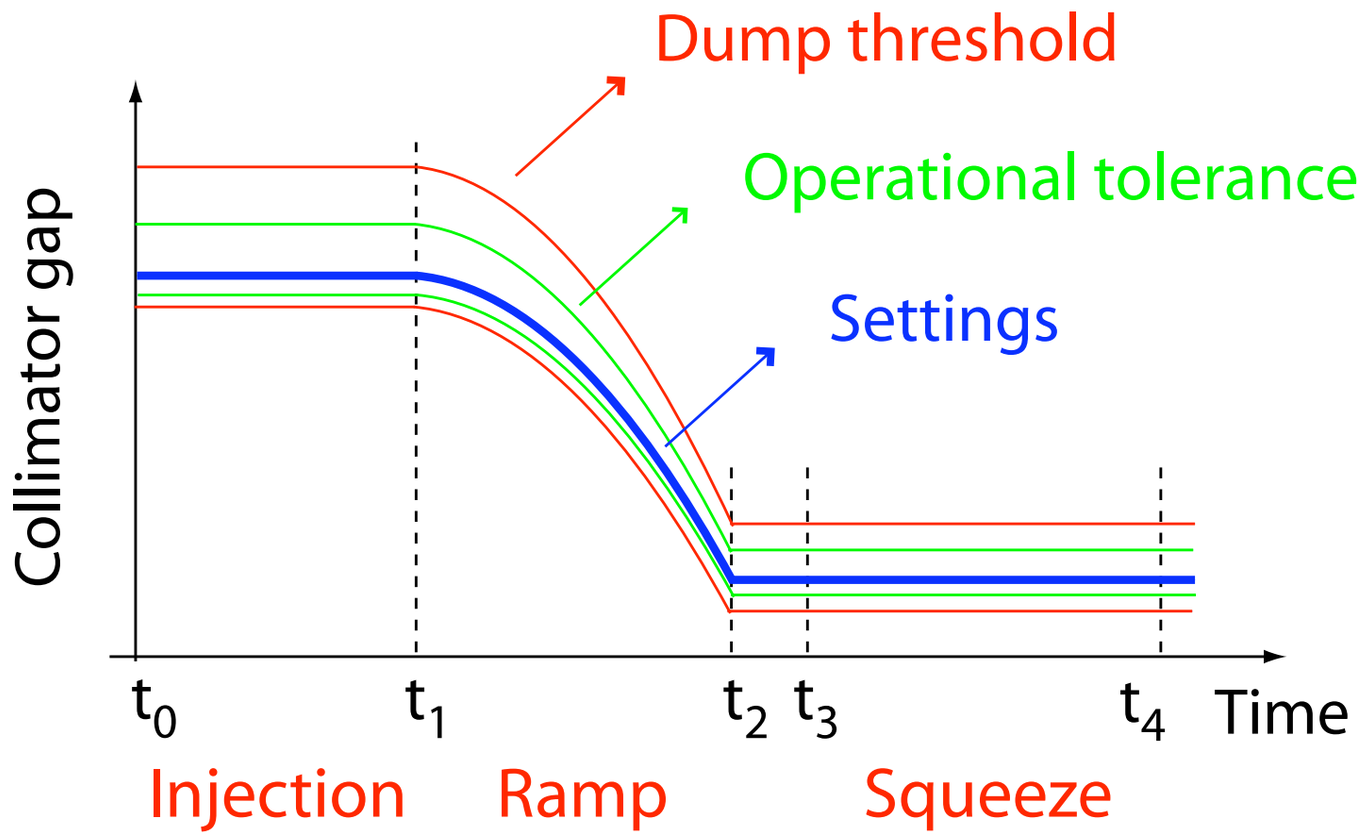
LHC

Tevatron



LHC: cleaning and protection **required** all the time: injection → 7 TeV → physics!

Example of collimator settings



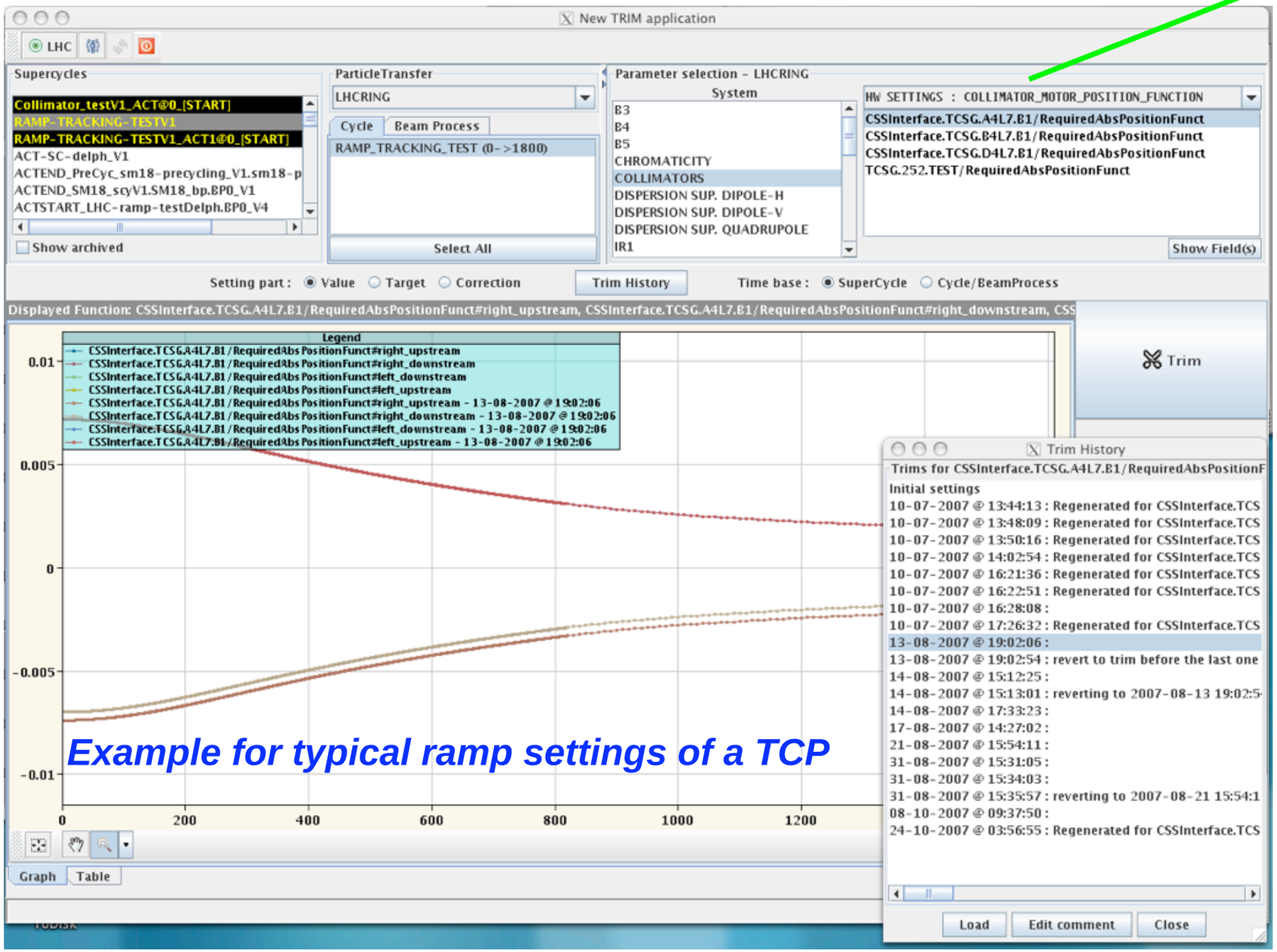
Each "critical" collimator **setting** will have **limit functions** for **dump thresholds** and **operational tolerance** windows.

Functions and "actual" settings needed!

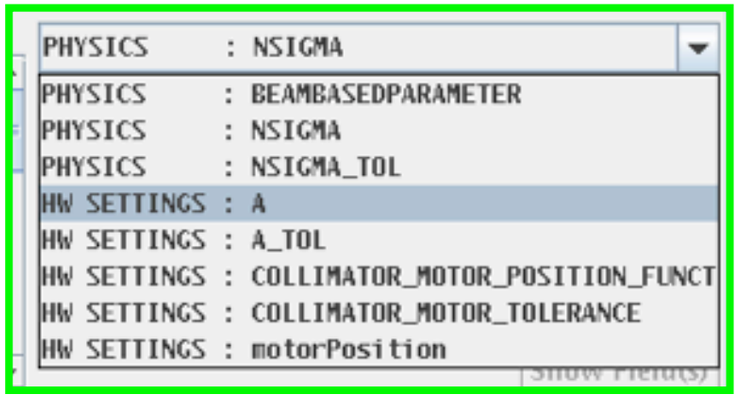
Beam safety: system detects internally faults

Redundancy: limits vs. energy, beta* factor

Tools for function-driven control



Example for typical ramp settings of a TCP



Implementation into **standard LSA tools**: TRIM, generation, makerules, ...
Dedicated application will come as needed.

Function-driven movements not yet operational from CCC

Main **challenge** for the next months.

Test stand setup in the collimator workshop, results expected by December 2007.

Thanks: Mike, Delphine, Lasse, LSA team (Greg, Wojtek Jutta, Raphael)

Tools: Web documentation for HWC

THE LHC Operation Web Site

and APPLICATION LAUNCHER

LHC Documentation and Application

LHC NEWS
- LHC installation schedule
- LHC publication @ CERN
- LHC Picture
- TI2/TI8
- Getting started before beam
- HWC Safety New!

LHC INFORMATION "ONLINE"
- LHC Pages 1
- LHC Temperature
- HWC Work advancement
- LHC Powering to Nominal test evolution New!
- Logbook LHC
- Logbook HWC : 1-2/2-3/3-4/4-5/5-6/6-7/7-8/8-1
- LHC Piquet
- LHC Planning
- Operators in CCC

DOCUMENTATION
- HWC Coordination New!
- HWC procedures
- HWC Operation WIKI
- LHC procedures
- LHC Operation WIKI

LINKS FOR OPERATORS

LHC Meetings and documents

LHC MACHINE
- Design report
- LHC Project
- Chamonix

LAYOUT, DB, MTF, EDMS, CIRCUITS
- Electrical circuits
- EDMS
- MTF
- LAYOUT DB
- Collimator DB
- Sequencer DB

LHC EXPERIMENT
- ATLAS
- ALICE
- CMS
- LHCb
- TOTEM

COMMITTEES
- ICC
- LTC
- MARIC
- LEMIC
- LHC SC
- LHC MAC
- LHCCWG

LHC Related Link

LINKS TO OTHER SITES
- Hardware Commissioning
- LHC Operation project
- LHC Operations (Mike)
- LSA Project
- AB Department
- CERN

CONTACTS
- CCC Phone
- EiC and Operators
- Operators Only
- EiC Only

OPERATION GROUP
- Operation Group Organigram
- Operation Web Site
- Machine operation schedule
- Machine Status

LHC SECTION
- LHC Section
- LHC operation schedule
- Minutes

Link to on-line collimation DB

Thanks to R. Billen (DB), D. Jacquet (DB-OP), E. Veyrunes (web)

Web repository kept up-to-date: will included all collimators installed in the LHC.

Web documentation

LHC Collimation Project

Home of the Project for the LHC Collimation System

Top	Project Team	Notes	Collimator List	Sounds/Movies	Meetings
Links	Papers	Talks (WG)	Layout IR3/7	AB Departm.	Pictures

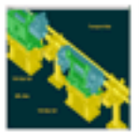
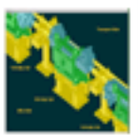
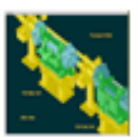
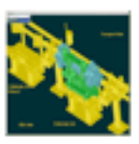
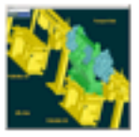
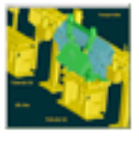
Collimator operational information

IP/BEAM	B1	B2
1	X	X
2	X	X
3	X	X
5	X	X
6	X	X
7	X	X
8	X	X
TI	X	X
ALL	X	X

Configuration file

DEVICE_NAME	MTF link	FAMILY	IP	BEAM	ANGLE	Config Angle	Jaw Orientation	Summary	Photo 252	Photo LHC	3D Layout	Last modified

Snapshot of web-DB

DEVICE_NAME	MTF link	FAMILY	IP	BEAM	ANGLE	Config Angle	Jaw Orientation	Summary	Photo 252	Photo LHC	3D Layout	Last modified
TCSG.252.TEST		TCSG	7	B1	135.0							
TCP.D6L7.B1	TCP109 Acceptance (extra)	TCP	7	B1	90.0	-90.0	D/B/C/A	xls/pdf				31/07/2007
TCP.C6L7.B1	TCP101 Acceptance (extra)	TCP	7	B1	0.0	0.0	C/A/D/B	xls/pdf				31/07/2007
TCP.B6L7.B1	TCP102 Acceptance (extra)	TCP	7	B1	127.0	-53.1	C/A/D/B	xls/pdf				01/08/2007
TCSG.A6L7.B1	TCS020 Acceptance (extra)	TCS	7	B1	141.2	-38.9	C/A/D/B	xls/pdf				01/08/2007
TCSG.B5L7.B1		TCS	7	B1	143.5							
TCSG.A5L7.B1	TCS021 Acceptance (extra)	TCS	7	B1	40.7	-139.3	D/B/C/A	xls/pdf				25/10/2007
TCSG.D4L7.B1	TCS029 Acceptance (extra)	TCS	7	B1	90.0	-90.0	D/B/C/A	xls/pdf				10/08/2007
TCSG.B4L7.B1	TCS032 Acceptance (extra)	TCS	7	B1	0.0	0.0	C/A/D/B	xls/pdf				10/08/2007

What is behind...: Database tables

File Edit Script Results View Tools Help

Query1

```
select MADX_name, ANGLE, FAMILY, JAW_LEFT_UP, JAW_LEFT_DOWN,
JAW_RIGHT_UP, JAW_RIGHT_DOWN, STOP_LEFT_UP_OUT, STOP_LEFT_UP_IN, STOP_LEFT_DOWN_OUT,
STOP_LEFT_DOWN_IN from collimator_info;
```

#	MADX_NAME	ANGLE	FAMILY	JAW_	JAW_	JAW	JAW_	STOP_A_OUT	STOP_A_IN	STOP_A_OUT	STOP_A_IN
1	TCTH.4R5.B2	0	TCTH	C	A	D	B	-30.0066941625263	6.00326475447175	-30.0066941625263	6.00326475447175
2	TCDIV.29012	90	TCDIV	B	D	A	C	-25.7317972605134	5.76275305801791	-25.7317972605134	5.76275305801791
3	TCDIH.20607	180	TCDIH	A	C	B	D	-25.7425287444619	5.58511057607411	-25.7425287444619	5.58511057607411
4	TCDIH.29050	180	TCDIH	A	C	B	D	-25.7410251869721	5.75247601777136	-25.7410251869721	5.75247601777136
5	TCDIH.29205	180	TCDIH	D	B	C	A	-25.97803638636	6.06275695577716	-25.97803638636	6.06275695577716
6	TCDIV.29234	90	TCDIV	B	D	A	C	-25.993482102623	5.97670326500856	-25.993482102623	5.97670326500856
7	TCSG.5R3.B2	0	TCS	B	D	A	C	-29.9847847218502	5.98354858197495	-29.9847847218502	5.98354858197495
8	TCSG.252.TEST	135	TCSG	D	B	C	A	-30.1137088173136	6.02989693753804	-30.1137088173136	6.02989693753804
9	TCSG.A5R7.B2	39.40021063703	TCS	D	B	C	A	-30.0025744723205	6.02923153623587	-30.0025744723205	6.02923153623587
10	TCDIV.87645	-90	TCDIV	D	B	C	A	-26.25255457	5.843151676	-26.25255457	5.843151676
11	TCSG.B4L7.B1	0	TCS	C	A	D	B	-30.004707605359	5.99232341695944	-30.004707605359	5.99232341695944
12	TCSG.D4R7.B2	-90	TCS	D	B	C	A	-30.000110580013	6.00883391849115	-30.000110580013	6.00883391849115
13	TCSG.D4L7.B1	-90	TCS	D	B	C	A	-29.9893152639636	5.98390110277465	-29.9893152639636	5.98390110277465
14	TCSG.B5L3.B2	0.800254438216	TCS	B	D	A	C	-29.9900255389444	6.0169679179833	-29.9900255389444	6.0169679179833
15	TCP.6L3.B1	0	TCP	B	D	A	C	-29.9979861403517	6.02281003059079	-29.9979861403517	6.02281003059079
16	TCSG.4R3.B1	0	TCS	B	D	A	C	-30.010883009438	6.00967458642566	-30.010883009438	6.00967458642566
17	TCDIV.87804	-90	TCDIV	D	B	C	A	-25.8185	5.932	-25.8185	5.932
18	TCDIH.88121	0	TCDIH	B	D	A	C	-26.04615302	6.086821694	-26.04615302	6.086821694
19	TCSG.A4L7.B1	.4122139237696	TCS	C	A	D	B	-29.9994209410164	6.03380997187762	-29.9994209410164	6.03380997187762
20	TCP.B6R7.B2	.4997018495379	TCP	C	A	D	B	-30.0059528491363	6.00070378576735	-30.0059528491363	6.00070378576735
21	TCSG.4L3.B2	0	TCSG	B	D	A	C	-29.9953526004488	6.0201060915818	-29.9953526004488	6.0201060915818
22	TCSG.A4R7.B2	.8988507546374	TCS	C	A	D	B	-30.0183546831154	6.00337299930464	-30.0183546831154	6.00337299930464
23	TCSG.A6R7.B2	.6971485648364	TCS	C	A	D	B	-30.0416250008385	6.01069464881458	-30.0416250008385	6.01069464881458
24	TCSG.A5R3.B1	-9.6	TCS	B	D	A	C	-30.0103212428684	6.01030563398841	-30.0103212428684	6.01030563398841
25	TCP.B6L7.B1	.0898483785227	TCP	C	A	D	B	-30.0077749588488	6.0071644795315	-30.0077749588488	6.0071644795315
26	TCSG.6R7.B1	15662015617741	TCS	C	A	D	B	-29.9897686661813	6.01081036691205	-29.9897686661813	6.01081036691205
27	TCSG.A6L7.B1	.8804950592782	TCS	C	A	D	B	-29.9881046548277	5.99176454095223	-29.9881046548277	5.99176454095223
28	TCP.6R3.B2	0	TCP	B	D	A	C	-29.99475942	6.032479307	-29.99475942	6.032479307
29	TCSG.A4R7.B1	33.70501015343	TCS	D	B	C	A	-30.004292223736	5.98068577324292	-30.004292223736	5.98068577324292
30	TCP.D6R7.B2	-90	TCP	D	B	C	A	-29.9953429176117	6.01861405152476	-29.9953429176117	6.01861405152476
31	TCP.C6R7.B2	0	TCP	C	A	D	B	-29.9923759247047	5.9933805668386	-29.9923759247047	5.9933805668386
32	TCSG.A4L7.B2	7.900207129377	TCS	D	B	C	A	-29.9967958928447	6.00071254658053	-29.9967958928447	6.00071254658053
33	TCDIV.88123	90	TCDIV	B	D	A	C	-25.93092618	6.248895266	-25.93092618	6.248895266

Done, ran 0 of 1 statements. Statement failed Script: 0.016 Secs

SQLBuilder

SELECT	*
FROM	WHERE
DISTINCT	ROWNUM < 10
AND	OR
COUNT(*)	IS NOT NULL

User Objects | All Objects | DictObjects

- USERS_TIMING_EVENTS
- VISIBLE_PROPERTIES
- VISIBLE_PROPERTY_FIELDS
- Views
  - HWC_ELECTRICAL_CIRCUITS_HIST_V
  - POWERCONVERTER_OP_INFO_V
  - STAGE_BLM_APPLIED_THRESHOLDS_V
  - STAGE_BLM_MASTER_THRESHOLDS_V
  - V_ACTUAL_HARDWARE
  - V_ACTUAL_HARDWARE_GRP_DEVICES
  - V_BEAMPROCESS_TYPES
  - V_BEAM_MODES
  - V_BLM_INFO
  - V_CIRCUIT_POWERCONVERTERS
  - V_COLL_FLATNESS
  - V_COLL_PARAMS
  - V_CRITICAL_PROPERTIES
  - V_CYCLE_TIMING_USERS
  - V_DEVICES
  - V_ELEMENTS
  - V_ELEMENTS_LOGICAL_HARDWARE
  - V_FESA_DEVICES
  - V_FESA_DEVICE_TYPES

#	Name	Type
01	MADX_NAME	VARI
02	MTF_NAME	CHAI
03	CERCA_NAME	VARI
04	DEVICE_ID	NUM
05	ANGLE	NUM
06	MATERIAL	VARI
07	LENGTH	NUM
08	BEAM	CHAI
09	FAMILY	VARI
10	IP	VARI
11	BLMI	VARI
12	BLMS	VARI
13	STOP_LEFT_UP_OUT	NUM
14	STOP_LEFT_UP_IN	NUM
15	STOP_LEFT_DOWN_OUT	NUM

*Includes all required **critical** configuration (BLM's) and calibration data and operational data*

***Merges**:*
layout information + production and CERN measurements + results of approval + nominal optics...

*Will be updated with the results of the **HWC***
(e.g.: updated calibration of switch position)

46 devices inserted in the production database as of today!
Automatic tool provided by CO-DM; consistency checks.

Thanks to Ronny, Chris, Delphine, Mike. BLM team (Laurette).
Data are the outcome of the Collimation Production Steering approval procedure (thanks to T. Weiler, R. Chamizo, R. Losito's team ...)

Outline

- Introduction
- LHC collimation system
  - Layout, design and people
  - Controls and operational challenges
  - Tools available
- **Commissioning without beam**
  - **Plans for commissioning without beam**
  - **Deliverables of cold checkout**
  - **Contributions from OP**
- Interfaces to other systems
- Conclusions

Plans for HWC without beam

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CH-1211 Geneva 23
Switzerland

the **Large Hadron Collider** project

LHC Project Document No.
LHC-AB
CERN Div./Group or Supplier/Contractor Document No.
AB/ABP, AB/ATB
EDMS Document No.
000-2007-1234

Date: 2002-04-15

Test Procedure

COLLIMATOR FINAL ASSEMBLY AND HARDWARE COMMISSIONING FOR LHC

Page 3 of 30

Table of Contents

S. Redaelli
R. Saban
Th. Weiler

- **HWC procedures** specified (EDMS document by **T. Weiler**): cover all production phases.
- HW commissioning in preparation of beam operation **MTF structures**.
- Close collaboration: **ABP**, **ATB**, **OP**, **CO**, **HCC**

Final validation of single collimator functionalities!

MTF
Equipment Management Folder
Home | H
Search : Equip

Profile Workflow

Profile for **TC**
Description: **Collimator**

Main | Profile data | Workflow

Actions : Add step

Workflow diagram

No Workflow Diagram defined

Workflow Steps

Step	Other name	Description name
MTF013485	()	10-BS Cooling Water Infrastructure
MTF013486	()	12-BS Final Cabling and Plug-in Check
MTF013487	()	14-TE Removing Blocking of Jaws
MTF013488	()	16-TE Water Tightness - Flow Rate Adjustment
MTF013489	()	18-TE Jaw Movement and Pos. Sensor Response
MTF013490	()	20-TE Temperature Sensor Response Check
MTF013491	()	22-FS Auto-retraction Test
MTF013492	()	24-FS LVDT and Resolver Calibration
MTF013493	()	26-FS Interlock Chain Check
MTF013494	()	28-FS Communication Check
MTF013495	()	30-FSV Auto-Retraction Tests
MTF013496	()	32-FSV Measurement of Mechanical Play
MTF013497	()	34-FSV LVDT and Resolver Calibration Check
MTF014798	()	IN010. Initial alignment

Beam commissioning not discussed here.
→ *Commissioning studies in PhD of C. Bracco (May 2008)*
→ *Talk at the MAC of Dec. 2007*

Why do we need tests after installation?

Important to verify hardware functionality and ensure that remote operation is safe:

- Final sensor calibration in accelerator environment (long cables)
- Repeat measurements after transport (e.g. verify switch position)
- Are we sure that the collimators perform as in surface??

News from last Friday, Ralph's following up...

This is not the high-precision environment that we expected

Three collimators to be taken out of the tunnel for cleaning!

Heavy debris from cutting and welding found on the collimator, its mechanical system and on sensors.

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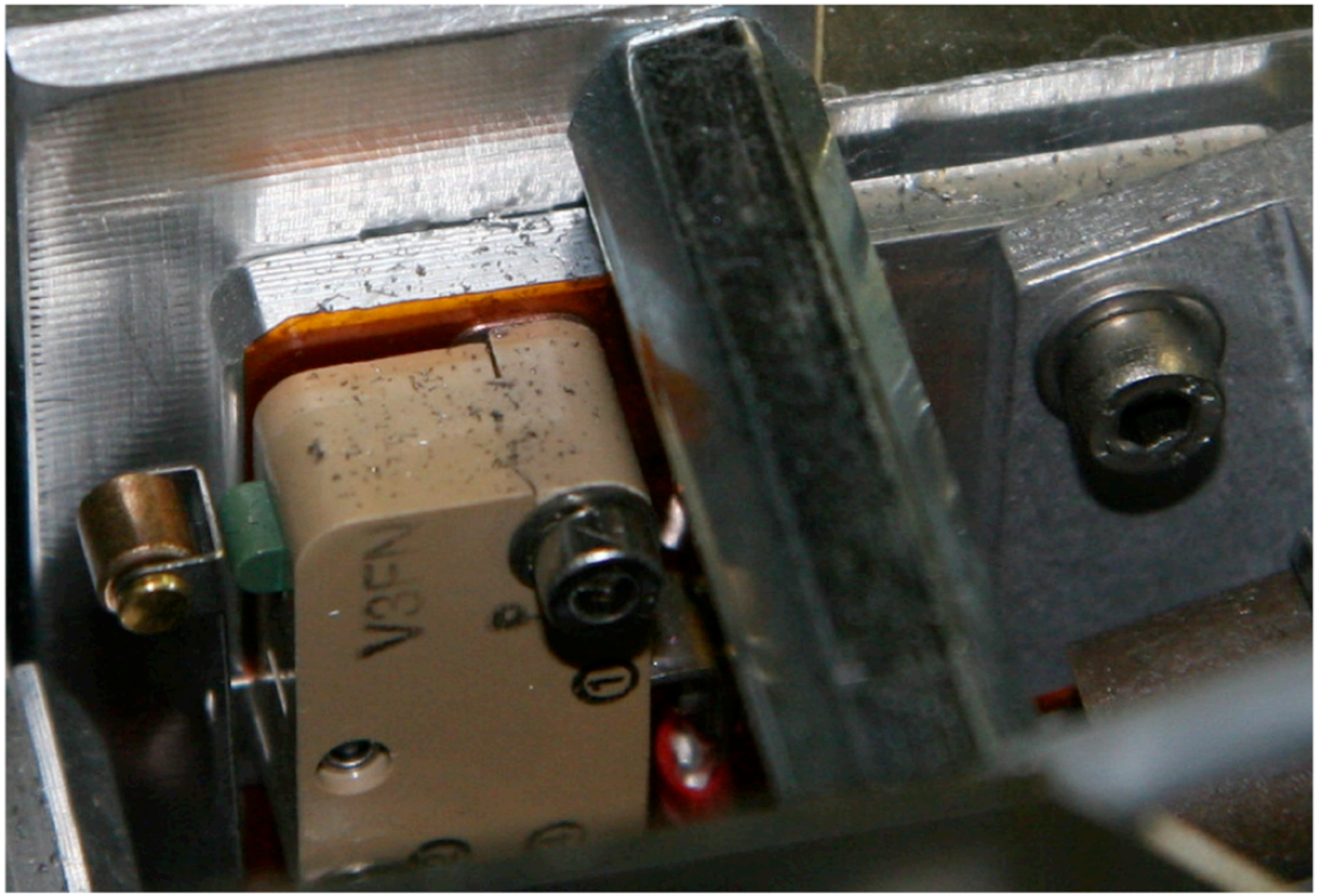

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One protection found was dirty green linen with holes. This was found partly directly on the naked collimator: high risk when being removed, if the linen gets stuck on cables, sensors, …

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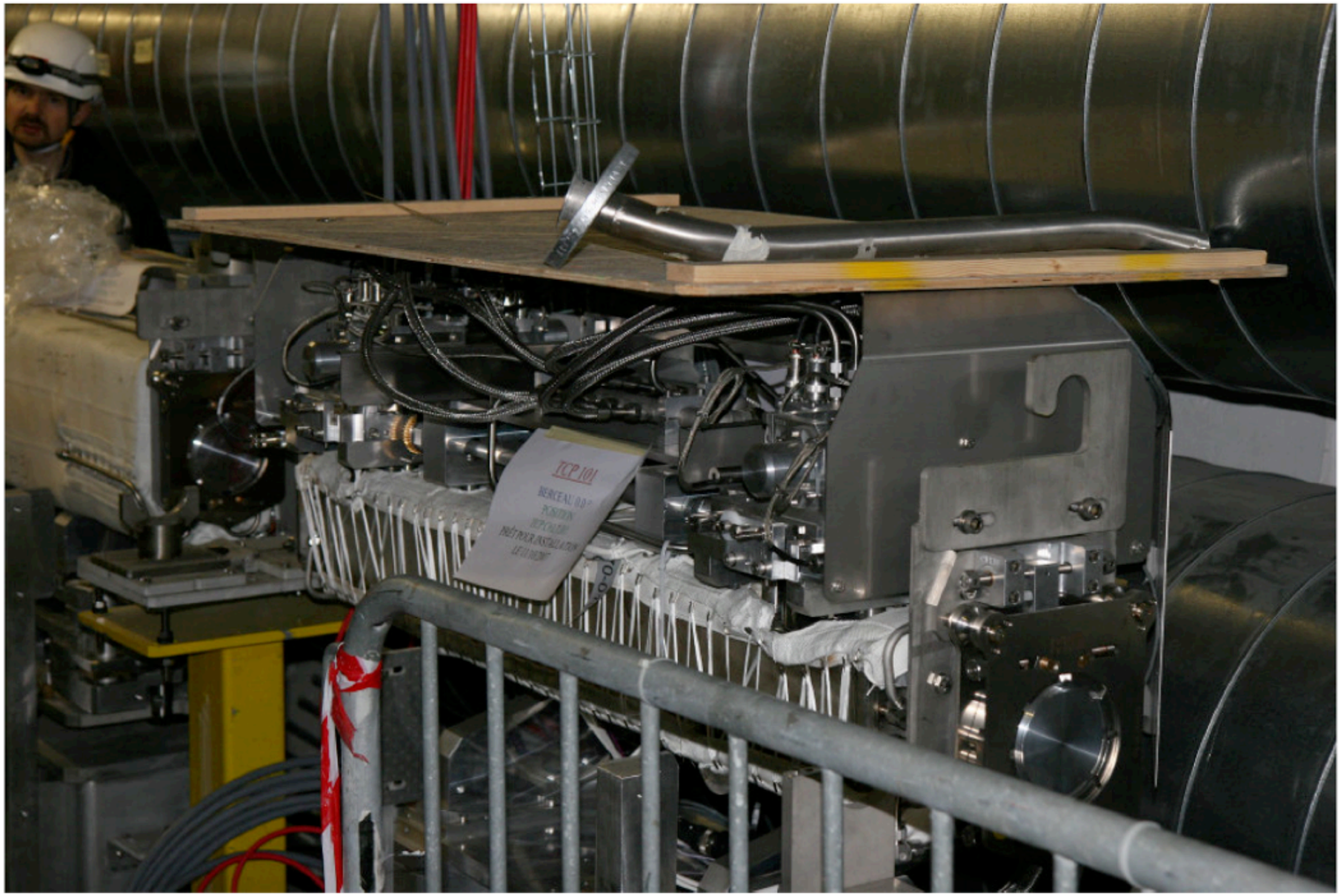
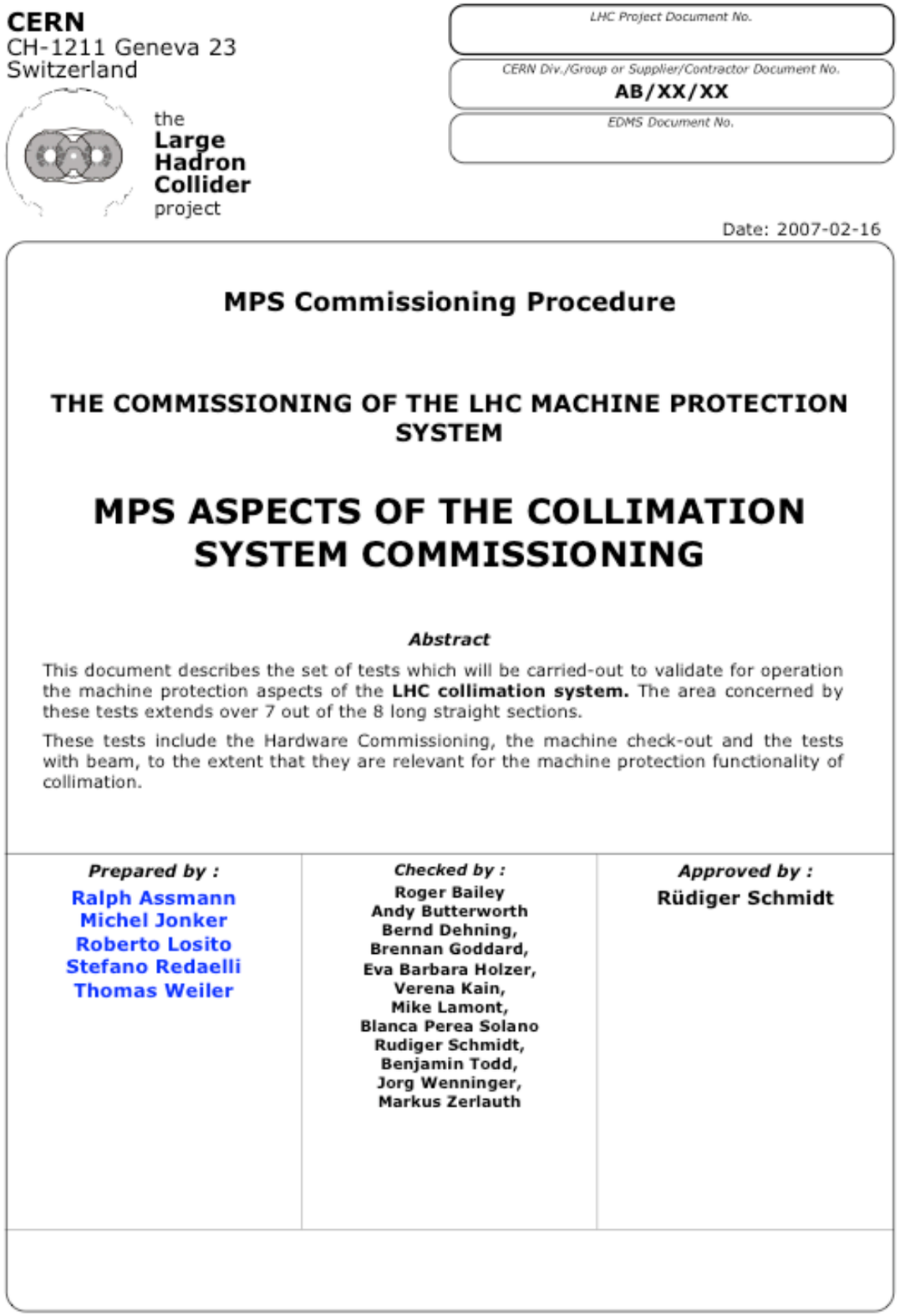


Another "solution" found was the placement of a wooden board on the collimator.

Machine protection aspects



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LHC Project Document No.

CERN Div./Group or Supplier/Contractor Document No.
AB/XX/XX

EDMS Document No.

Date: 2007-02-16

MPS Commissioning Procedure

THE COMMISSIONING OF THE LHC MACHINE PROTECTION SYSTEM

MPS ASPECTS OF THE COLLIMATION SYSTEM COMMISSIONING

Abstract

This document describes the set of tests which will be carried-out to validate for operation the machine protection aspects of the **LHC collimation system.** The area concerned by these tests extends over 7 out of the 8 long straight sections.

These tests include the Hardware Commissioning, the machine check-out and the tests with beam, to the extent that they are relevant for the machine protection functionality of collimation.

Prepared by :	*Checked by :*	*Approved by :*
Ralph Assmann **Michel Jonker** **Roberto Losito** **Stefano Redaelli** **Thomas Weiler**	**Roger Bailey** **Andy Butterworth** **Bernd Dehning,** **Brennan Goddard,** **Eva Barbara Holzer,** **Verena Kain,** **Mike Lamont,** **Blanca Perea Solano** **Rudiger Schmidt,** **Benjamin Todd,** **Jorg Wenninger,** **Markus Zerlauth**	**Rüdiger Schmidt**

Commissioning of **machine protection functionality** documented.
Discussions at the MP-SubWG

Includes commissioning of relevant safety aspects (without and with beam) and handling of critical parameters.

Complementary to HWC procedure, more focused on **global system checks**.

No details discussed here.

Deliverables for the cold checkout

Outcome of the **collimator hardware commissioning**:

- ☑ Validation of single collimator HWC, all relevant functionality
- ☑ Settings and sensor readouts (position, temperature, switches,...) verified
- ☑ Control of each collimator from CCC is declared "**safe**"
- ☑ Machine protection functionality (without beam) partially established

Cold checkout should be focused on

- ☑ **Perform global, simultaneous system checks**
  - Control an *ensemble* of collimators
  - Address timing and synchronization issue
  - Function-driven motion, "tracking" tests with other equipment
  - Establish full machine protection functionality without beam
- ☑ **Verify interfaces to other accelerator systems**
  - Beam loss monitors: configuration/acquisition of distributed system
  - Sequencer driven commands, machine modes
- ☑ **Management/validation of measurement data**
  - Verify logging of distributed systems (big data sets!)
  - Consistency and sanity checks; global system status

Contribution expected from OP

- ☑ Top-level control, LSA implementation
- ☑ Check of system interfaces
- ☑ Participation to HWC, definition of procedures
- ☑ Preparation of operational and configuration data
- ☑ Database maintenance
- ☑ Web documentation (production phase)

People: Stefano, Delphine (OP data, LSA parameter space),

Eric (web, soon software!).

All under Mike's blessing, obviously.

More contribution expected for checkout tests from CCC, when the system will be operational (e.g. procedure for global system checks)

Interfaces to others systems

	Application	XPOC	Analog Acquisition	Alarms	Software Interlocks	Critical Settings	Post Mortem	Timing
INJECTION KICKERS	☑	X	X	X		X	X	X
BEAM DUMP	☑	X	X	X		X	X	X
POWER CONVERTERS				X	X		X	X
COLLIMATORS	☑			X	X	X	X	X
RF	☑☑		X	X	X		X	X
LFB	☑		X	X		X	X	X
TFB	☑		X	X			X	X
MAGNETS				X			X	
MKQA				X	X		X	X
WARM MAGNETS				X	X		X	X
RADIATION MONITORS				X			X	
SPECTROMETERS				X	X		X	

Interfaces - cont'd

☑ *Post-mortem* / logging

1 Hz logging sufficient (synchr. to machine)
Consistency checks and analysis tools to be developed
TI2 as test-bed: 3 collimator x several days (seems promising)

☑ Timing

Essential! LSA will have to drive the hardware through machine timing
Settings + thresholds need to be synchronized and driven coherently

☑ Critical settings

Limit functions in the LSA + FESA level ready for tests
Implementation of MCS functionality to be discussed
Detailed MP procedures are (will be) available

☑ Alarms

List of relevant failure needs to be prepared (map the internal failures)

☑ Software interlock

Failures are mostly detected internally
→ Test that collimator beam permit (HW) is removed
Orbit interlocking at specific location (experience will tell...)

Conclusions

- ☑ **Collimation system installation in good shape**
  - We need to be ready to handle the full Phase I system!
- ☑ **Hardware commissioning without beam** (within coll. proj. mandate)
  - Deliverable: collimator HW safe for operation from CCC
  - Procedures are available - *will be detailed further, as required*
  - Software tools basically available - *good feedback from TI2 tests*
  - Required function driven motion still to be demonstrated
- ☑ **Scope for the checkout - what we need for beam startup?**
  - System fully operational; synchronized functions
  - Machine protection functionality fully established (scope of Stage A)
  - Reliable interfaces to distributed BLM system!
- ☑ **Significant contributions from OP**
  - So far: involvement in HWC + software issues
  - Expected to grow during checkout - collimator experts still driving tests

References: links in OP wiki

Relevant References for the Collimation system

Papers on the collimator layout:

1. Concept of multi-stage cleaning in the LHC Blue book, Vol. 1, Ch. 18
2. Detailed layout of the LHC collimation system layout (Phase I + slot allocations for subsequent phases)
    1. ECO for the final IR3 and IR7 layout (LHC-LJ-EC-0002), also listed in the LHC Collimation Project page
    2. ECO for Tertiary Collimators (TCT)
    3. ECO for Active absorbers
    4. ECO for Passive absorbers

System performance; system staging versus LHC performance:

1. G. Robert-Demolaize's PhD thesis CERN-THESIS-2006-069
2. Ralph at Chamonix 2006
3. Various presentations at the LHC collimation working group meeting (LCWG)

Procedures:

1. Hardware commissioning procedures (EDMS commissioning procedure)
2. System for the first year of operation (ECR LHC-TC-EC-0001)
3. Machine protection commissioning link
4. System commissioning during Stage A: talks at the LHCCWG (1, 2)

Specs of various controls levels

1. Top level: LHC-TCT-ES-0001-10-00
2. Middle level: under publication
3. Low level: under publication

Recent presentations:

1. Recent overview of the Phase I collimation: Stefano at HB2006
2. Readyness for the first year of operation: Ralph at the MAC

Web pages

1. LHC collimation Project
2. LHC collimation working group
3. Web documentation of the system with details of each device
4. MTF HWC for the LHC collimators