

Premature Dumps in 2011

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LHC Beam Operation Workshop

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Outline

- Introduction
- Data extraction
- Dump statistics by mode
- Dump causes
- Dumps in STABLE BEAMS
- Summary

Introduction

- Every dump generating PM data is assessed by shift crew using PM Online tool.
- All beam dump characteristics are collected and stored in the PM Database.
- Dumps at 3.5 TeV are systematically reanalyzed by MPS experts.
(M. Zerlauth, R. Schmidt, J. Wenninger)
- Analysis of PM data for p+ run:
 - 19/02 (first beam) – 30/10/2011 (last dump)
 - $I_{B1} > 1e12$ and $I_{B2} > 1e12$ (exclude probes, MPS tests)

PM Online Tool

The screenshot displays the PM PLAYBACK PRO GUI interface. At the top, the window title is "PM PLAYBACK PRO GUI" and the menu bar includes "File", "Basket", "Session", and "Help". The current session is identified as "GLOBAL : GPM1 : 30.10.2011 17:10:36 (1319991036516295250)". A green status bar at the top of the main content area indicates "Final analysis is finished".

The interface is divided into several sections:

- Session confirmation**: Includes tabs for "Modules graph" and "Results". A row of buttons lists various analysis modules: BCT, B/BQBQ ISA, BIC/EVENT_SEQ, BIC/IPOC, BLM/BLMLHC, BLM/COLL_HIERARCHY, BLM/DIAMOND, BLM/LOSSES, BPM/ORBIT, FGC/DATA_RED, LHC Collimator, PIC/IPOC, and PM event data viewer.
- Dump context**: A table of event parameters:

Event timestamp:	2011.10.30 17:10:36 CET
Fill number:	2267
Acc mode:	PROTON PHYSICS
Beam mode:	BEAM DUMP
Energy:	3499920 MeV
Intensity B1:	19286 e ¹⁰ charges
Intensity B2:	19524 e ¹⁰ charges
SMP flags:	PRESENT, MOVEABLE / PRESENT, MOVEABLE
BSTAR 1/2/5/8:	1.0 / 10.0 / 1.0 / 3.0 m
- Event sequence**:

Event category:	PROTECTION_DUMP
Event classification:	MULTIPLE_SYSTEM_DUMP
Event sequence:	First USR_PERMIT change: Ch 4-Operator Buttons: A T -> F on CIB.CCR.LHC.B2
Triggered BIC inputs:	Ch 4-Operator Buttons(LHC.B2), Ch 4-Operator Buttons(LHC.B1), Ch 2-LBDS-b2 (TSU)(R6.B2), Ch 4-BLM_UNM(L6.B2), Ch 4-BLM_UNM(L6.B1), Ch 11-BLM_MSK(L6.B2), Ch 11-BLM_MSK(L6.B1), Ch 2-LBDS-b1 (TSU)(L6.B1), Ch 8-B PMs L&R syst.'A' (R6.B1), Ch 10-BPMs L&R syst.'B' (L6.B1), Ch 10-BPMs L&R syst.'B' (L6.B2), Ch 8-BPMs L&R syst.'A' (R6.B2), Ch 3-LBDS-b2 (PLC)(R6.B2), Ch 3-LBDS-b1 (PLC)(L6.B1)
SCEvents:	No power converter events found
- Machine protection features**:

Event description:	BIC_IPOC analysis finished with warnings.				
Highest beam losses:	BLMEI.04L6.B1E10_TCD SA.4L6.B1 BLMEI.04R6.B2I10_TCD SA.4R6.B2 BLMEI.04R6.B1E10_TCD QA.B4R6.B1				
Magnet quenches:	No magnet quenches found				
nQPS triggers:	No nQPS events found				
BIC IPOC:	✓	FMCM ISA:	✓	PIC IPOC:	✓
XPOC B1:	✓	XPOC B2:	✓		
Safe for injection ?:	✓	PM Overall:	✓		
- Comments**: A dialog box for session confirmation. It includes fields for "User:" and "Advised actions:". Below these, a red instruction reads: "Input your comment and confirmation parameters for session confirmation:". There are dropdown menus for "Beam Losses:", "Loss type:", "Orbit Changes:", and "Classification:". A large text area is provided for comments. At the bottom of the dialog are three buttons: "Confirm", "Discard", and "Release SIS".

At the bottom of the GUI, a status bar shows the time "21:53:48" and the message "New analysis session progress: Final analysis is finished". A green bar at the very bottom indicates the connection status: "21:53:47 - Connected to [GLOBAL] 1319991036516295250 session."

Classification & Assessment by OP

LHC Post Mortem Database

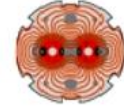
[Post Mortem Homepage](#)

[The PM System](#)

[Meetings](#)



LHC Post Mortem
Homepage



Post Mortem Database - Data Browser

User: MALBERT [Help](#)

[Logout](#)

DB Query

Global PM events Powering PM events Global statistics Fill Statistics MPS Statistics SEU Failure Count Events Data Analysis Data Raw Data

- Saved Report = "RAMP"
- Beam Mode = 'STABLE BEAMS'
- Dump Classification != 'Programmed Dump'
- Event Timestamp < 31-OCT-11
- Event Timestamp >= 19-FEB-11
- Intensity B1 [1e10] > 10
- Intensity B2 [1e10] > 10
- Mps Dump Cause is null
- Seu Dump = 'Confirmed'

- Select Columns
- Filter
- Rows Per Page
- Format
- Save Report
- Reset
- Download

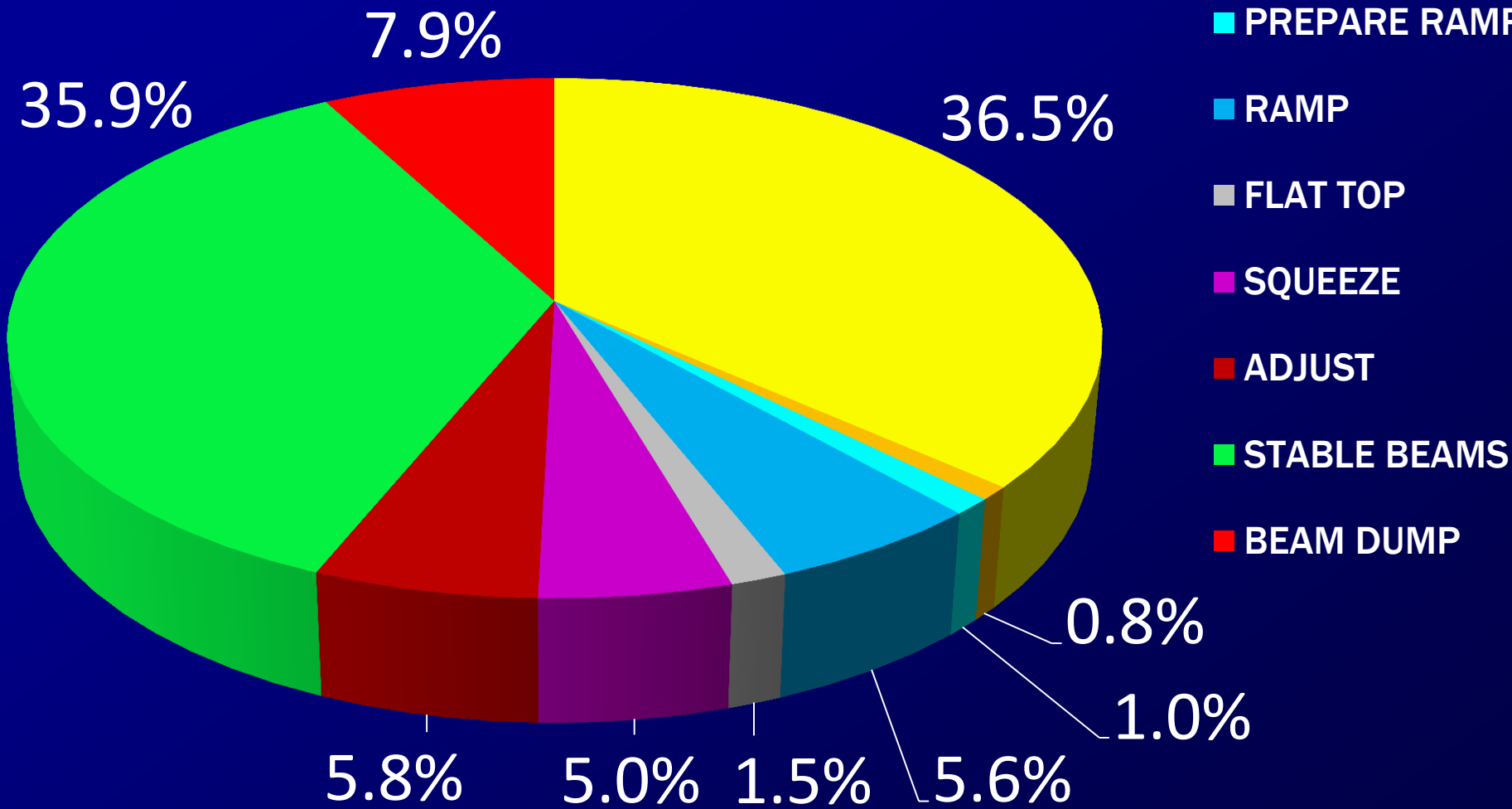
Query builder,
Reports &
Data download

Event Timestamp	Event Category	Accelerator Mode	Beam Mode	B...	Stable Beams [hours]	Fill Luminosity [nb^-1]	Mps Expert Comment	Event Classification
14-MAR-11 07.19.03.515135 AM	PROTECTION_DUMP	PROTON PHYSICS	STABLE BEAMS	3500160	1615	2.1	10.437 -	MULTIPLE_SYSTEM_DUMP
15-MAR-11 04.53.58.909384 AM	PROTECTION_DUMP	PROTON PHYSICS	STABLE BEAMS	3500160	1617	2.91	14.645 -	SINGLE_SYSTEM_DUMP
18-MAR-11 11.35.11.968775 PM	PROTECTION_DUMP	PROTON PHYSICS	STABLE BEAMS	3500040	1635	0	0 RF interlock, but caused by problem with FGC that got two many event at the same time. The function was not correctly executed, this confused the RF system that tripped and requested a beam dump. The dump cause is classified as PC (since the FGCs are under the responsibility of EPC)	SINGLE_SYSTEM_DUMP
20-MAR-11 05.49.56.671554 AM	PROTECTION_DUMP	PROTON PHYSICS	STABLE BEAMS	3500160	1638	7.08	1321.144 S81: Cryogenics lost for MSR8	MULTIPLE_SYSTEM_DUMP
23-MAR-11 09.32.07.094983 AM	PROTECTION_DUMP	PROTON PHYSICS	STABLE BEAMS	3500040	1646	.228	0 RQTL11.R6B1 got a water fault due to a faulty interconnection piece, PIC reaction times OK.	MULTIPLE_SYSTEM_DUMP

All beam dumps by mode

Total: 482

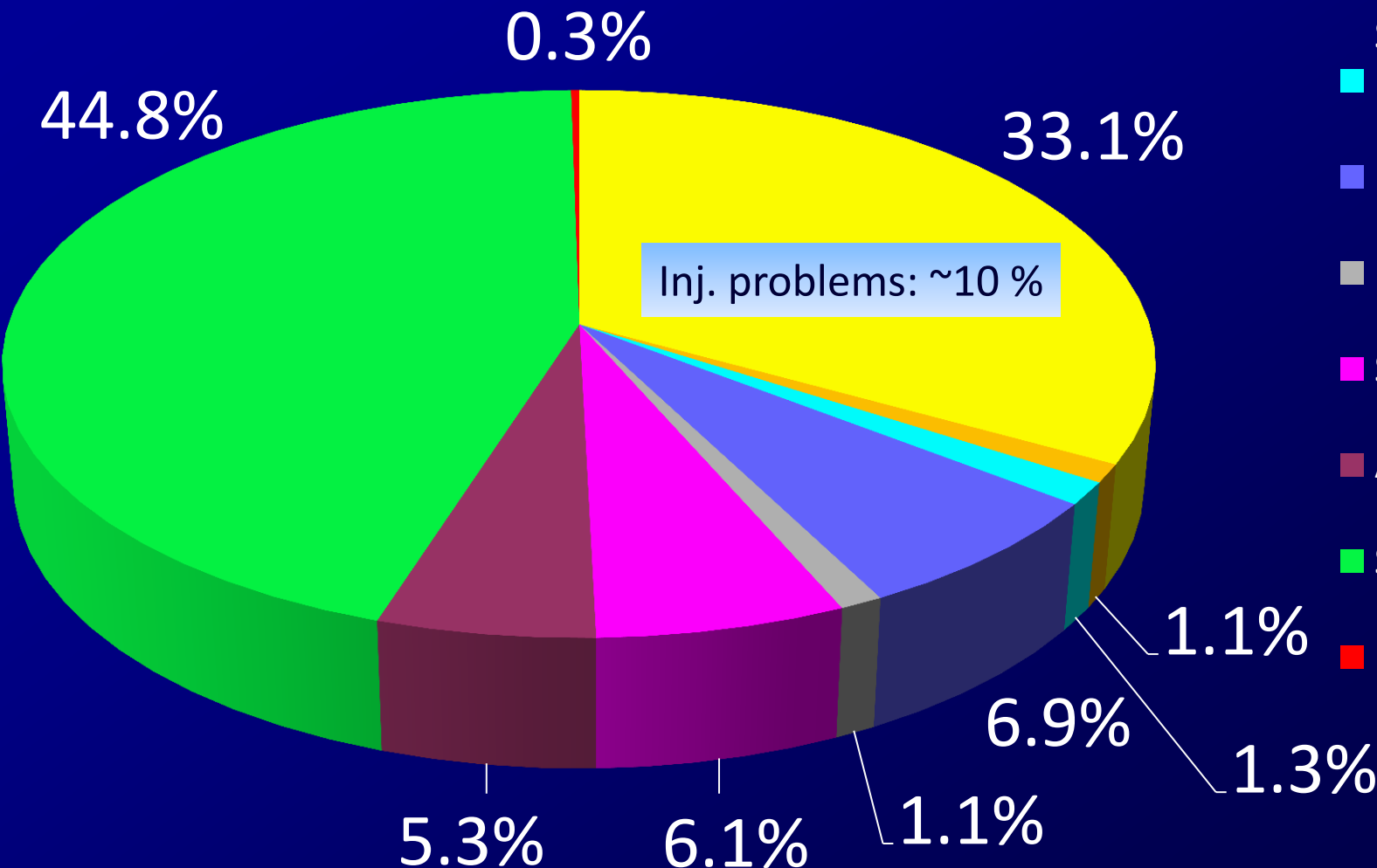
- INJECTION
- PHYSICS BEAM
- INJECTION SETUP BEAM
- PREPARE RAMP
- RAMP
- FLAT TOP
- SQUEEZE
- ADJUST
- STABLE BEAMS
- BEAM DUMP



Non-programmed dumps by mode

Total: 375 (78%)

- INJECTION
- PHYSICS BEAM
- INJECTION
- SETUP BEAM
- PREPARE RAMP
- RAMP
- FLAT TOP
- SQUEEZE
- ADJUST
- STABLE BEAMS
- BEAM DUMP



Beam dump causes

$E \geq 3.49 \text{ TeV}$

$I_{B1} > 1e12$

$I_{B2} > 1e12$

■ Beam dumps in STABLE BEAMS
 ■ Beam dumps without MDs
 ■ Beam dumps with MDs

169

263

272

Beam monitoring (impact on beam)

Orbit, BPM, Beam Loss, Collimator adjustments, BCM, Feedbacks

42%

Failure in MPS System

LBDS, PIC, BLM, BIC, SIS

71%

Operator (EOF)

10%

Equipment failure (no impact on beam)

79%

0 100 200 300

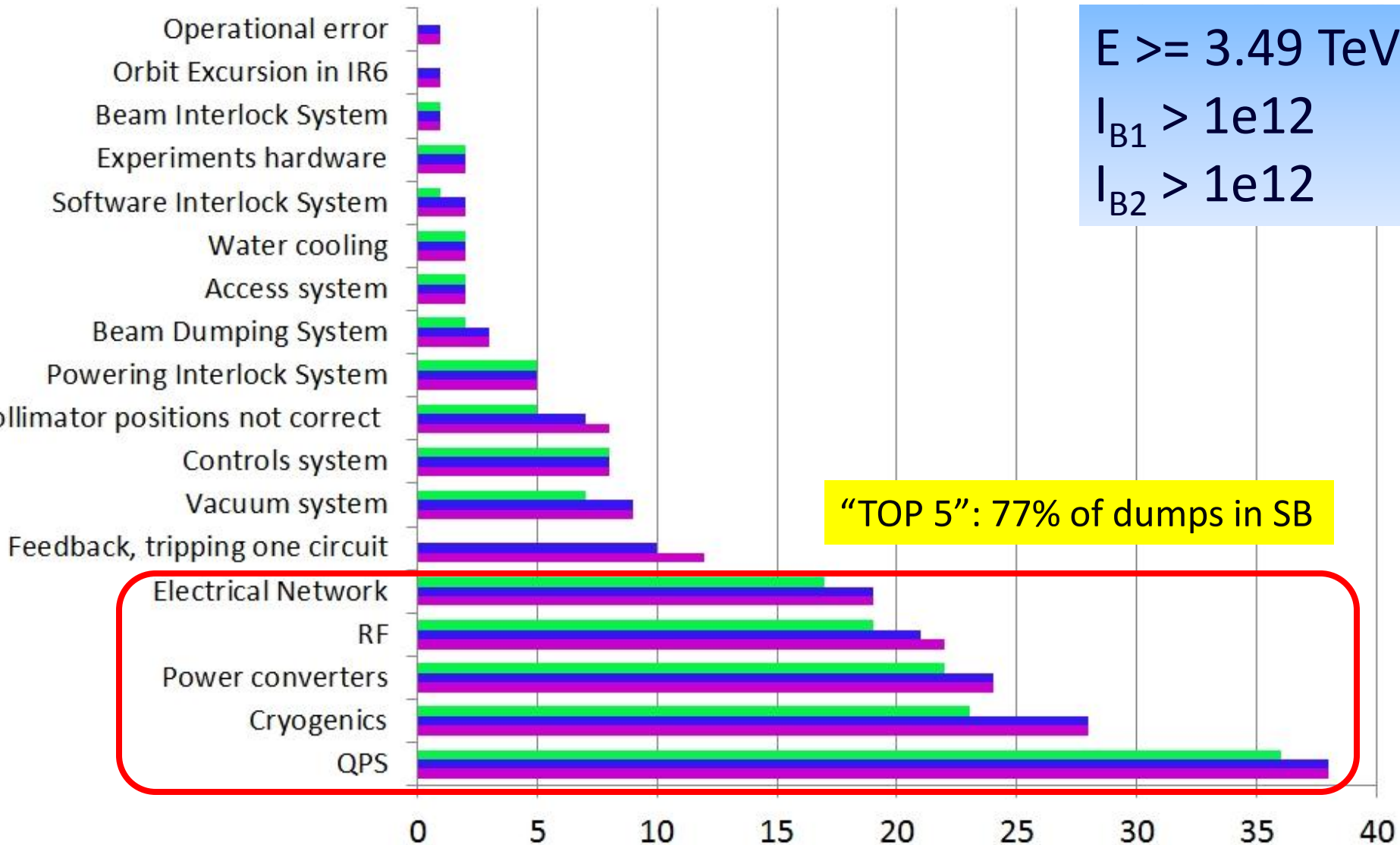
Beam dump causes by equipment

■ Beam dumps in STABLE BEAMS ■ Beam dumps without MDs ■ Beam dumps with MDs

$E \geq 3.49 \text{ TeV}$

$I_{B1} > 1e12$

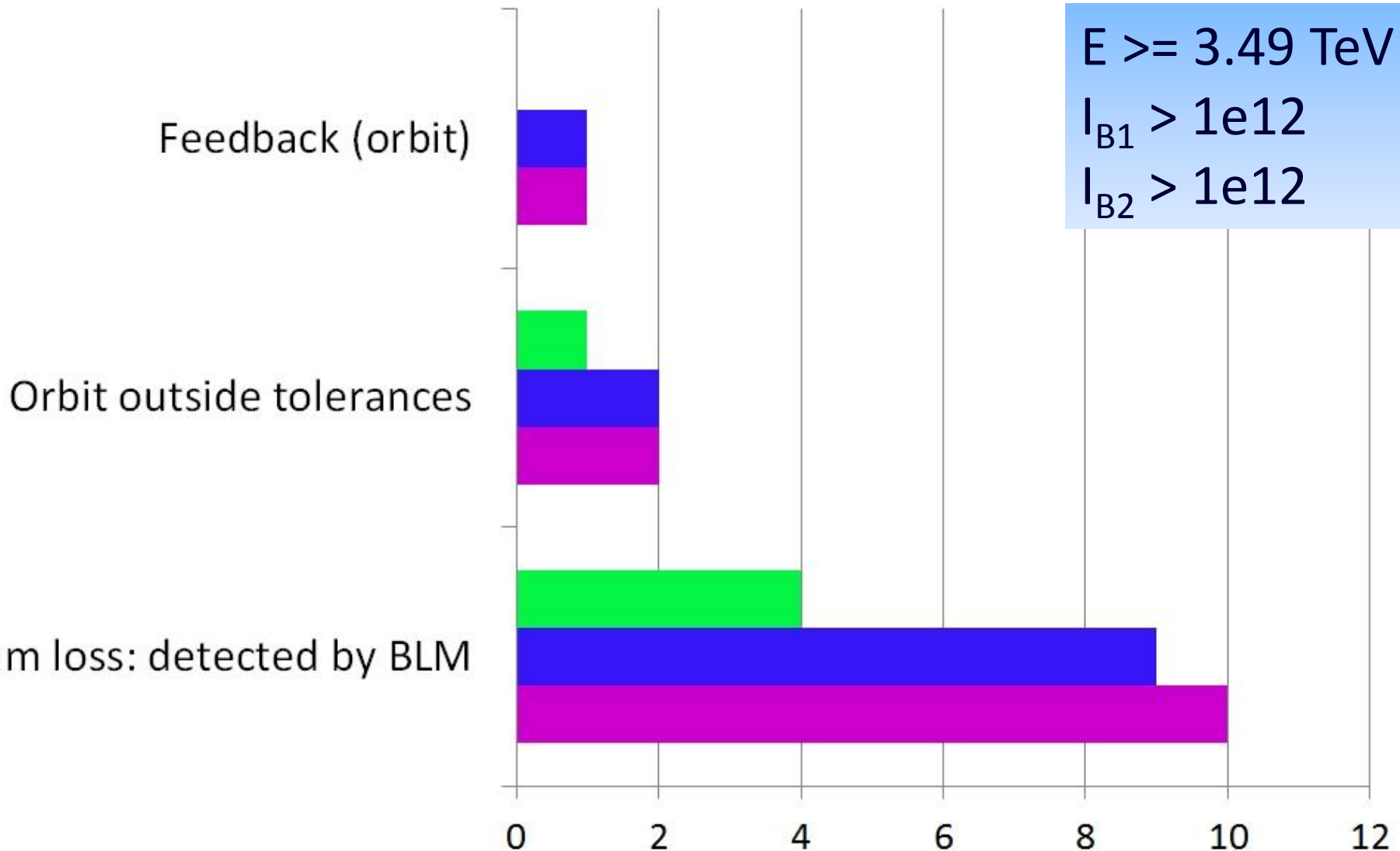
$I_{B2} > 1e12$



“TOP 5”: 77% of dumps in SB

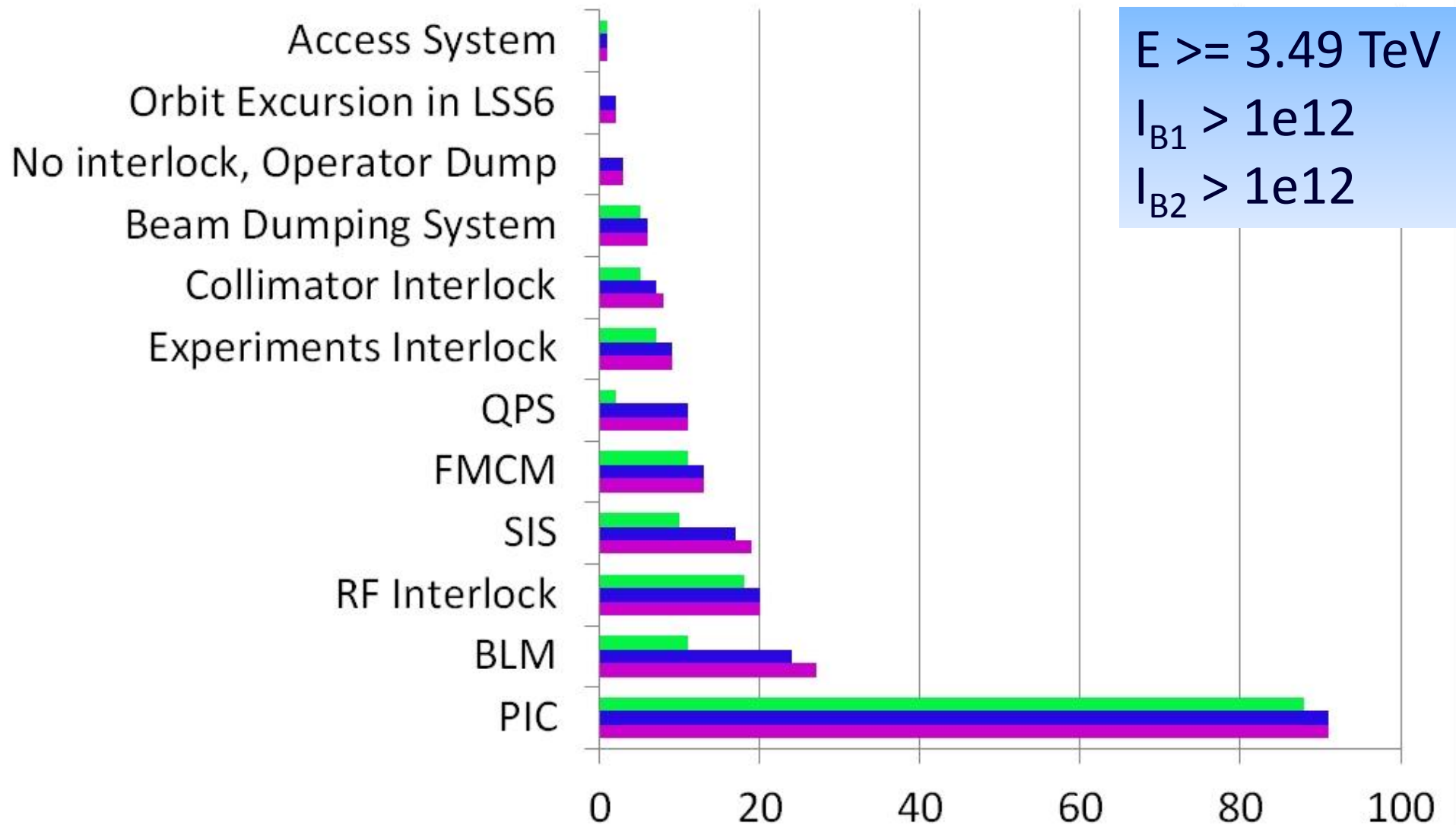
Beam dump causes by beam monitoring

■ Beam dumps in STABLE BEAMS ■ Beam dumps without MDs ■ Beam dumps with MDs



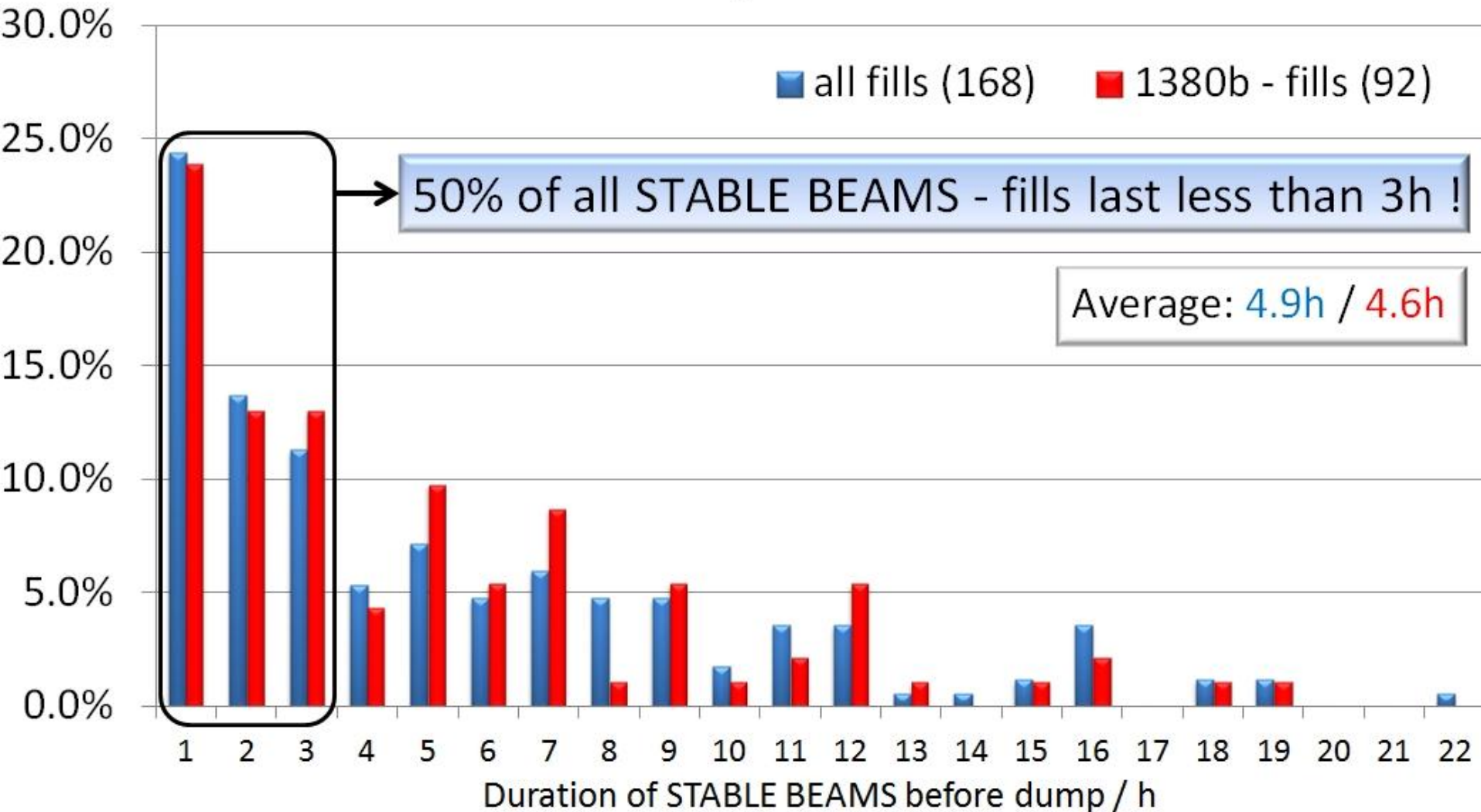
Systems which saved us...

■ STABLE BEAMS ■ without MDs ■ including MDs



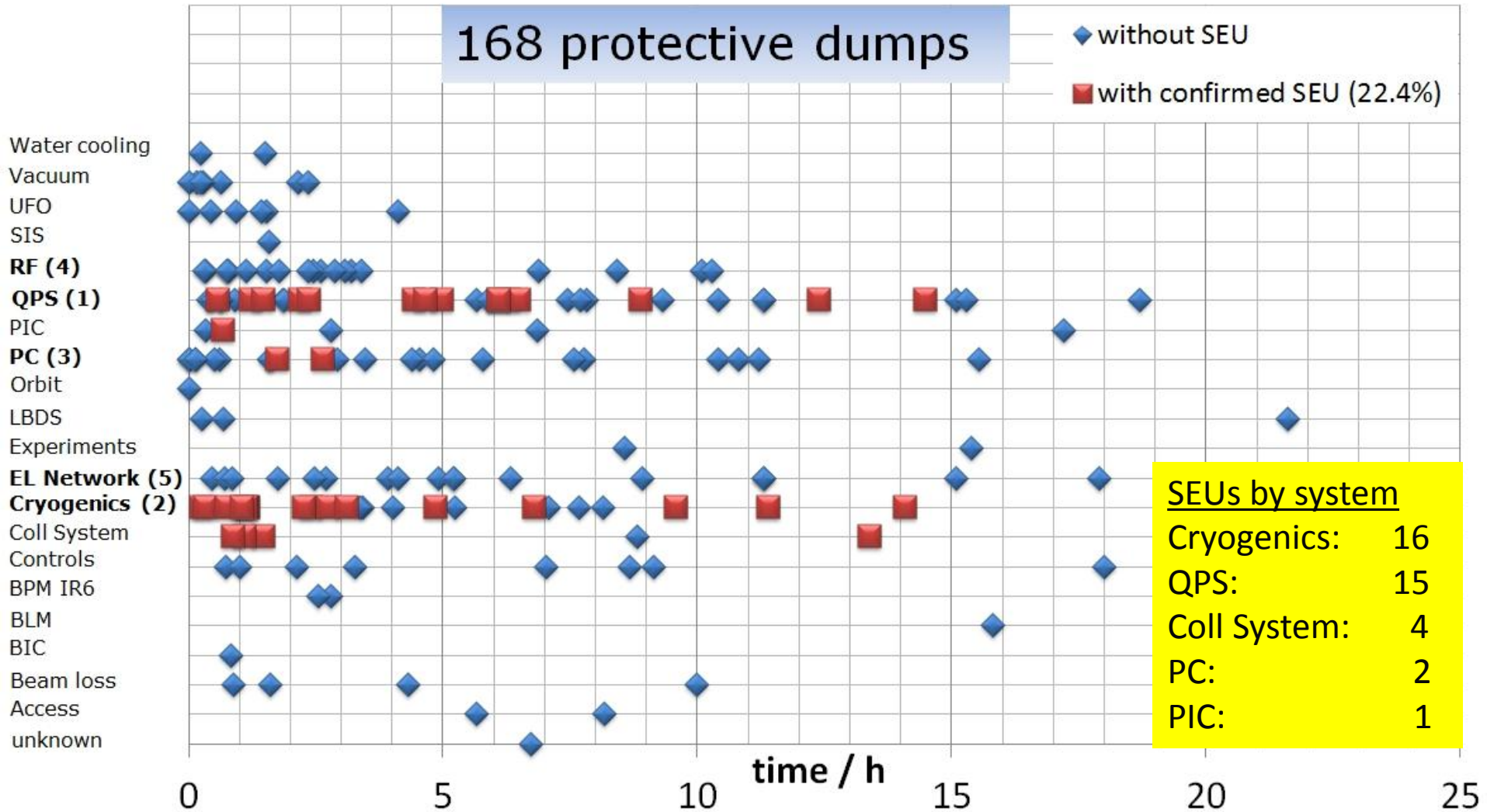
STABLE BEAMS – often short !

Distribution of dumps in STABLE BEAMS



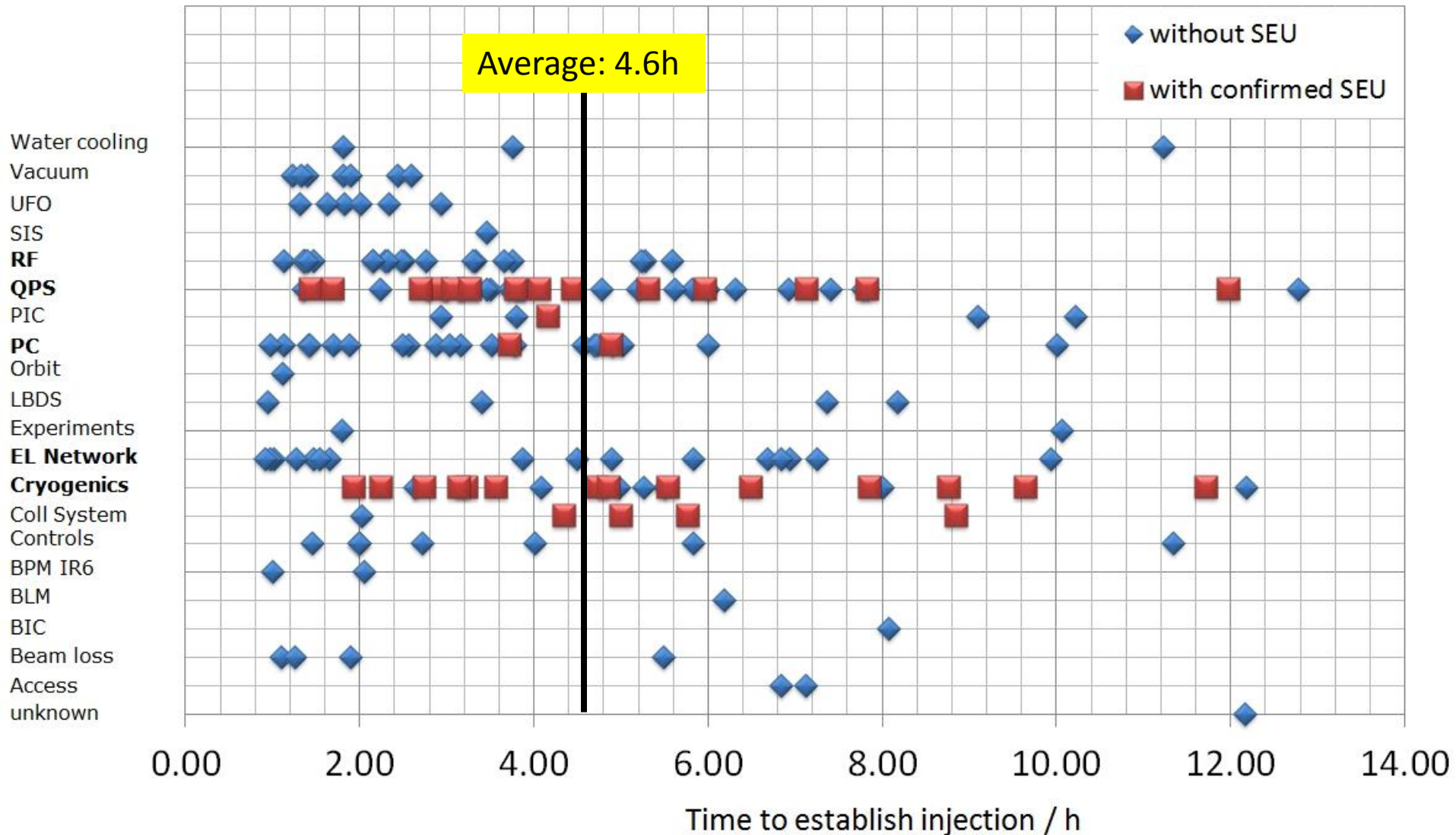
Dumps in STABLE BEAMS

Distribution of dump causes in STABLE BEAMS



Recovery after dump in SB

STABLE BEAMS - from dump to injection



Proposals for improvements

- PM Online tool should offer re-editing (correction of wrongly assessed dumps)
- Include injection scheme in PM-Database
- Do we need to add more categories for dump classification?
“Other” used for 11% of non-programmed dumps
- Should we also systematically analyse dumps at injection energy ?

Summary

- **Beam dump causes due to equipment failures clearly dominate.**
- **50% of all fills & “1380b – fills” last < 3h**
- **Average fill duration: ~5h**
- **22% of STABLE BEAMS - fills were dumped by SEU effects, mainly on cryogenics and QPS equipment**
- **The average time from a beam dump in STABLE BEAMS to the next injection is ~4.5h.**