# Ensuring Smooth Controls Upgrades during Operation

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# Coordinated deployment of controls changes across CERN Accelerator Complex

**Lessons from experience :**

- Following controls software deployment during a machine stop, numerous hours of LHC beam operation were compromised due to non-backward compatible changes, insufficient communication, inadequate pre-deployment testing.

**'Smooth Upgrades', a formal procedure and approval process :**

- Created to coordinate the deployment of a large set of controls changes developed by many independent developers in a short time window.

- While ensuring minimal impact on beams (no downtime nor degraded conditions).

- And preserving the operational interface to accelerator components.

**This talk presents the Smooth Upgrades procedure.**

# Scope & Boundary Conditions

**A CERN-wide scope :**

- All software changes related to beam operation controls.

**Three significant dimensions :**

I. 12 accelerators

II. Controls components :
- 1,200 software device classes (100,000 instances)
- 1,000 GUI applications used by operation team

III. 11 controls development units, across 4 departments in CERN Accelerator & Technology Sector.

**Deployment of changes authorized only during Technical Stops (TS) :**

- Official time slots with no beam.
- 1 or 2 TS per year, Limited duration: 8-12 hours.

**TS are not 'real' stops: several facilities operate and require operational controls during the entire TS.**
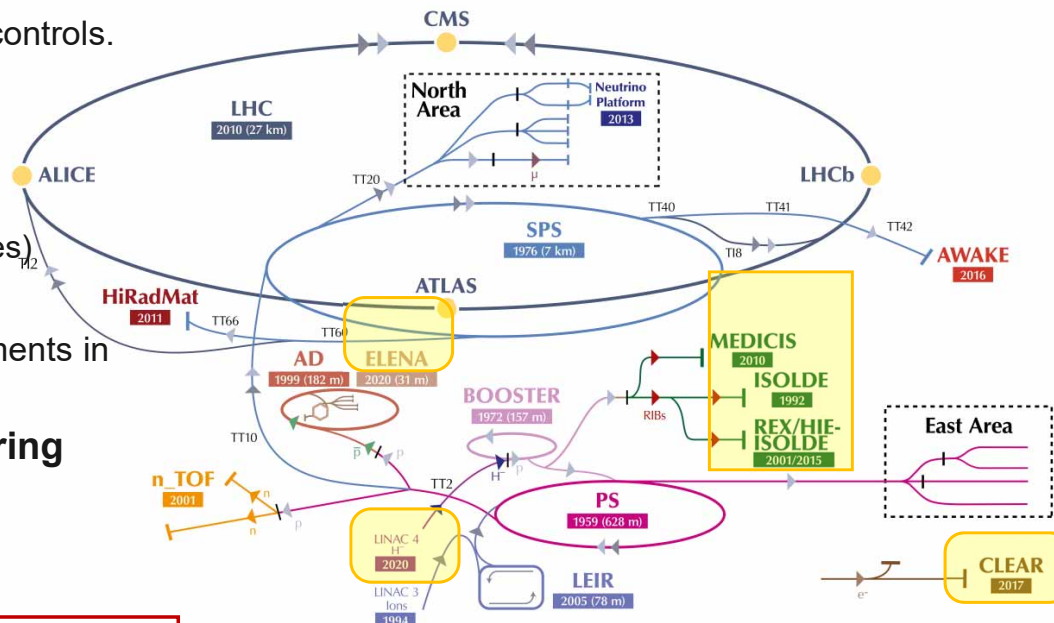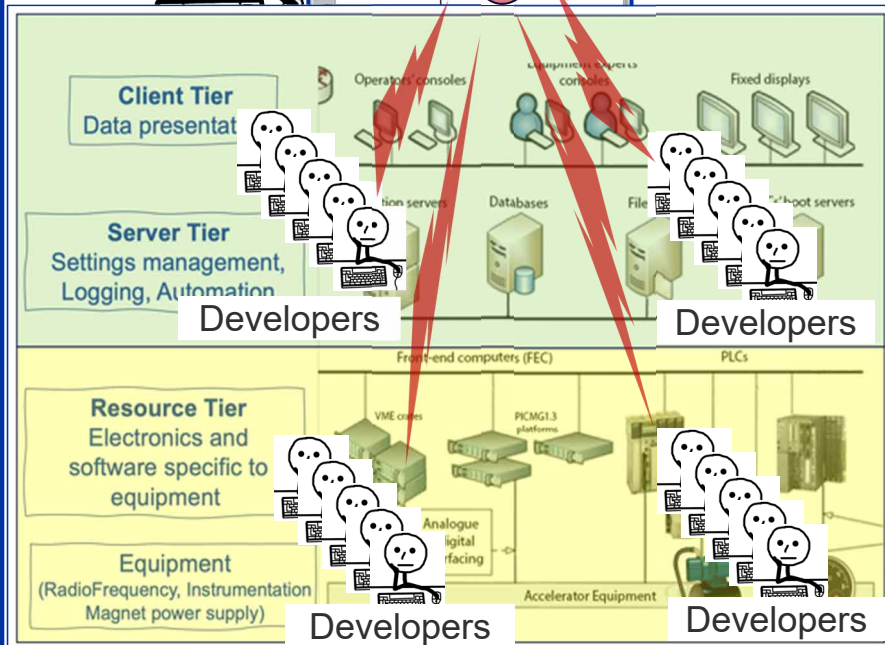
# Scope & Boundary Conditions
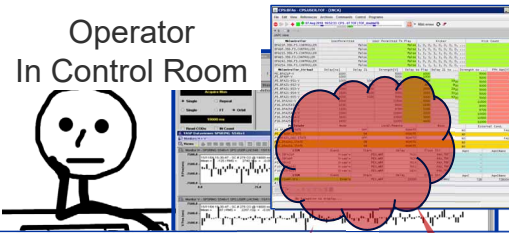


**Wide scope** of changes + stringent boundary conditions

⬇

**High risk** to alter the operational interface when deploying a controls change.

⬇

Need of a standardized approach to coordinate controls changes across all accelerators and teams.

# Pilars of Smooth Upgrades (SU)

1. **Organization**

2. **Workflow**

3. **Software supporting the SU process**

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1. **Organization**
   - **A team of about 40 individuals:** **20** coming from the core controls units, **10** from units developing equipment-specifc controls and **8** from operation team.
   - Operating under the guidance of **the SU Coordinator.**

2. **Workflow**

3. **Software supporting the SU process**
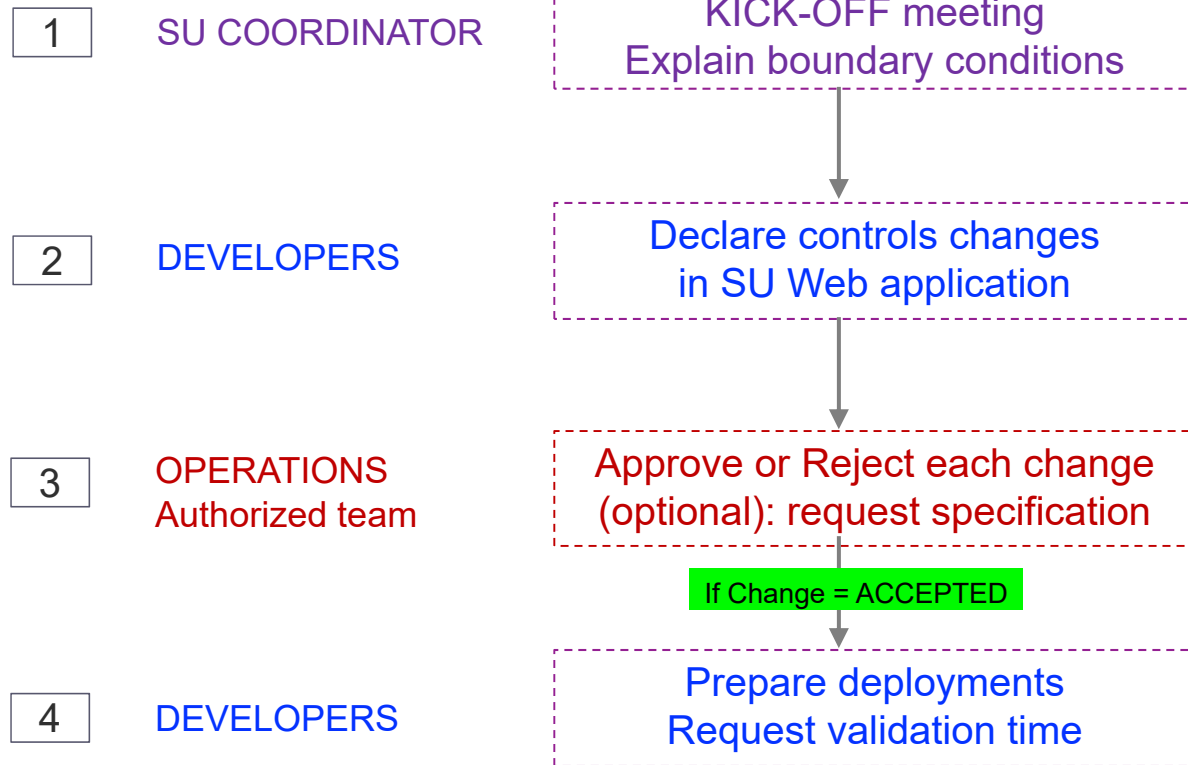
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3. **Software supporting the SU process**

# Workflow

**1**  SU COORDINATOR

KICK-OFF meeting
Explain boundary conditions

**2**  DEVELOPERS

Declare controls changes
in SU Web application

**3**  OPERATIONS
Authorized team

Approve or Reject each change
(optional): request specification

If Change = ACCEPTED

**4**  DEVELOPERS

Prepare deployments
Request validation time

# Workflow - 2

**5**  SU COORDINATOR

DEPLOYMENT LAUNCH meeting
Finalize list, deployment sequence

2 weeks before
Technical Stop

List of changes FROZEN

**6**  DEVELOPERS

Deploy controls changes
Inform operation team

During
Technical Stop

Deployment = SUCCESS

Deployment = FAILURE

**7**  SU COORDINATOR

DEBRIEFING Meeting
Analyse issues, improvements

<1 week after
Technical Stop

# Pilars of Smooth Upgrades (SU)

1. **Organization**
   - Team = 40 individuals, 20 coming from 3 core controls groups, 10 from equipment groups, and 8 from operation team
   - Team operates under the guidance of the SU Coordinator.

2. **Workflow**

3. **Software supporting the SU process**

# Software supporting the SU process

**A user-friendly web-based application.**

**Facilitating the SU process along the lifecycle of a controls change :**

- Declaration -> Approval -> Deployment.



EDIT view
Exhaustive description of each control change

Title: FGC_63 PSB BSW circuits: restore ILC regulation error warning threshold

Group: SY-EPC

Accelerators: PSB

Needed by: 2023-06-20 08:00

Event name: ITS1-2023

Responsible: Quentin Andrew King, Raul Murillo Garcia

CCR EDMS Status: Not required

CCR EDMS ID:

Approval Body: OP

FESA/FGC change requiring modifications on high level SW: No

People involved: Quentin Andrew King, Todor Todorcevic

Comment: No API change, but restoring a lost functionality - allow the regulation error warning threshold to be reactivated. It has to be off at the moment. 1 hour at the end of the TS with machine closed needed for validation without beam.

JIRA URL: https://issues.cern.ch/browse/EPCCCS-9613

IMPACT URL: https://impact.cern.ch/impact/secure/?place=editActivity:212718

Functional Specification EDMS ID:

Validation Slot: Yes

Deployment Status: Deployed

# Software supporting the SU process

**A user-friendly web-based application.**

**Facilitating the SU process along the lifecycle of** ~~a~~ **controls change :**

- Declaration -> Approval -> Deployment.

<mark>LIST view</mark>
List of ALL changes
for one stop

**Also <u>enforcing</u> the SU rules :**

- Changes requiring approval remain RED until approved.

| Title | CCR EDMS Stat... 1↑ | Deployment St... |
|-------|---------------------|------------------|
| SFH10 Interlock acquisition encoding ... | Not discussed | Cancelled/P |
| ALPS IQC modification | Not discussed | |
| Migration from BQSB to BQBBQ for inje... | Not required | Deploy |
| ADHORN KiTS/KiTR(Kick Fast Control S... | Not required | Deploy |
| UCAP Upgrade 2021 YETS | Not required | Deploy |
| UCAP version of SPS Larger concentrator | Not required | Cancelled/P |
| CavityLoops update | Not required | Deploy |

Deployed

**LHC Schedule 2023**
Version 1.0 was approved at the Research Board of 7 December 2022

SU Web application showing Controls changes for this Technical Stop
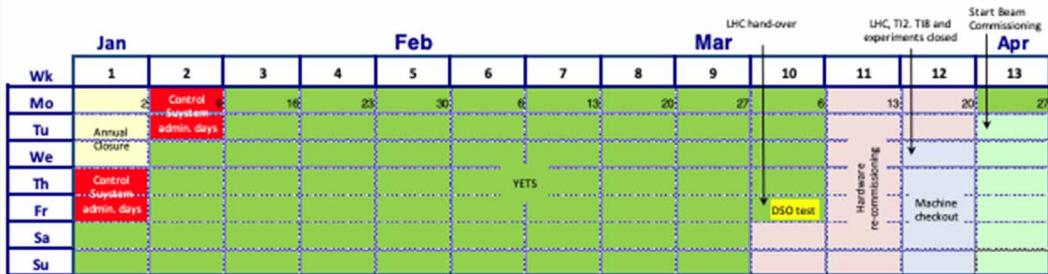
Technical Stop

# Integrated with CERN collaborative tools :

- Example: link with accelerator schedule to show all changes planned for a specific TS.

# Recent evolution

**The SU scope was extended in 2022 along two directions :**

1. **Formal approach to oversee software interface alterations of devices running on low level computers.**
   - Crucial role in the seamless deployment process and integration within the operational tool set.
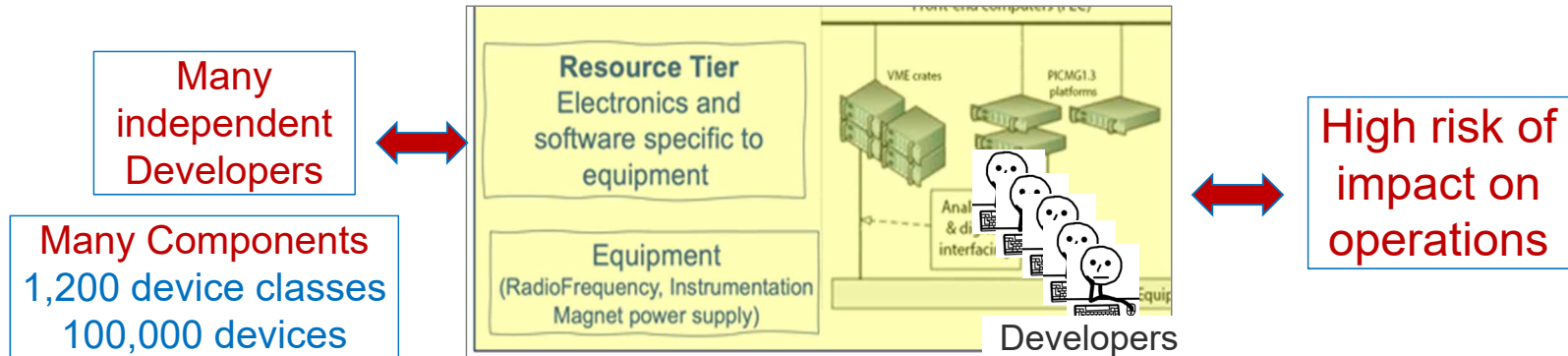
# Recent evolution -1

## Typical issues :

- **SW upgrades arrive too late with respect to machine commissioning**
  - Need to allocate adequate time for integration in high-level SW (GUI).

- **SW interface changes are not discussed at early stage with operation team.**
  - Need to establish an early approval process by operation teams.

## Implementation :

**At creation of SW device class, a mini project is launched.**

- Setting intermediate milestones.
- Describing the list of all high level SW to be adapted.

**Reusing existing SU process and webapp + new features.**

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**Reusing existing SU process and webapp + new features.**

Title:  Collimators Device Class upgrade

Group:  BE-CSS

Accelerators:  CPS

Needed by:  2023-09-21 00:00

Event name:  LHC: TS 2

Responsible:  Marine Gourber-Pace

CCR EDMS Status:  Not discussed

CCR EDMS ID:

Approval Body:  OP

FESA/FGC change requiring modifications on high level SW:  Yes

SW requiring modifications:  LSA/INCA,Other Services

Specify Other Service(s):  asadasda

Date for integration in GUI:  2023-08-31 00:00

Date for pre-validation bef 2023-09-05 00:00

OP Contacts:

People involved:

Comment:

JIRA URL:  https://issues.cern.ch/browse/APS-10108

IMPACT URL:  https://impact.cern.ch/impact/secure/?place=editActivity:215456

Functional Specification EDMS ID:

Validation Slot:  Yes

Deployment Status:  Deployed

In Production since early 2023
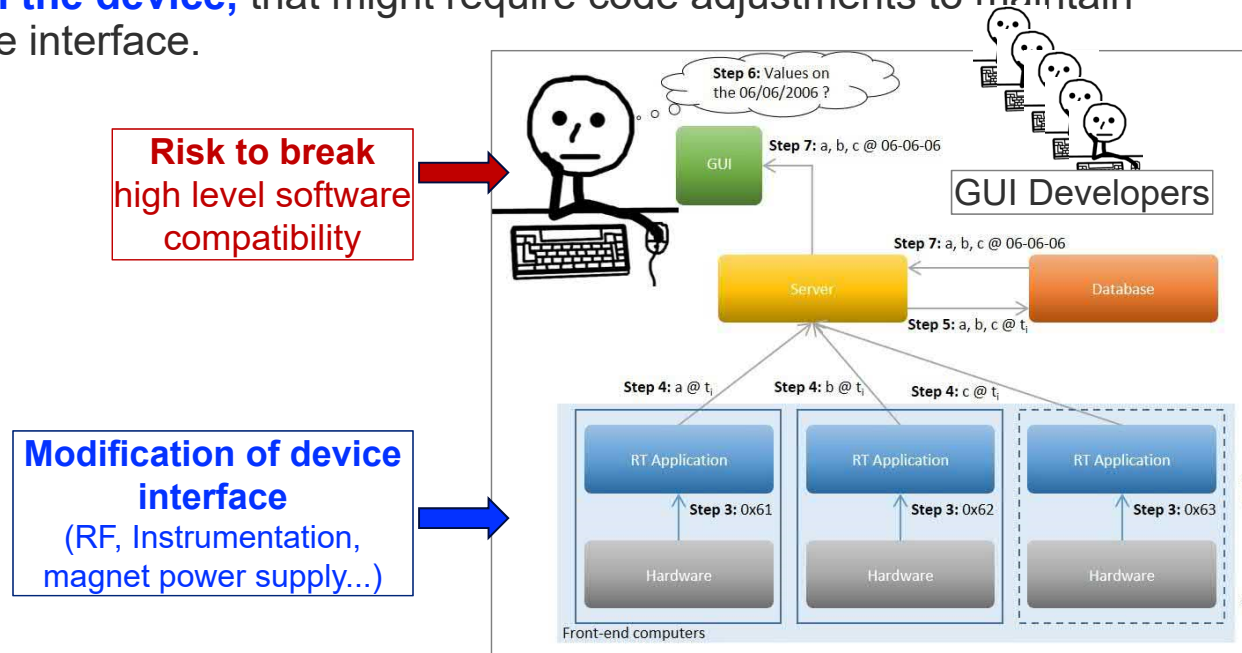
# Recent evolution -2

**The SU scope was extended in 2022 along two directions :**

2. **Online monitoring of operational device changes**
   - **Driver:** SU process relies on a <u>static</u> declaration of changes, therefore is not fully immune to human mistakes (overlooked dependencies, insufficient validation of changes,…), with potential bad impact on operation.

# Recent evolution -2

**Aim : identify online <u>deployed</u> modifications on the device interface AND the linked high level software interacting with the device,** that might require code adjustments to maintain compatibility with the new device interface.



**Risk to break** high level software compatibility

**Modification of device interface** (RF, Instrumentation, magnet power supply...)

# Recent evolution -2

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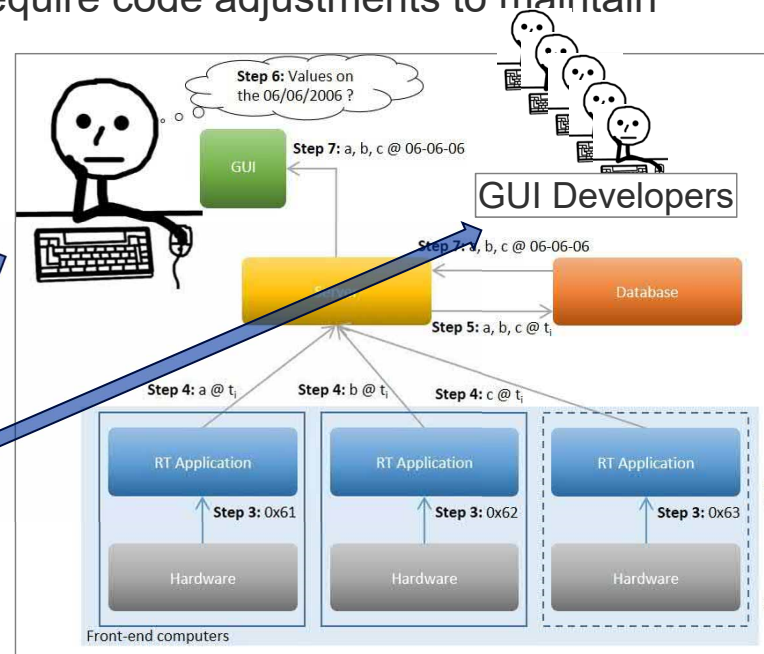
**Implementation : Automated email notifications :**

1. **To the operations team**

- To warn about potential broken interface.

2. **To developers of GUI driving the device**

- To trigger early adaptation of application's code.

# Summary

- **Smooth Upgrades, a key contributor to the stability of controls for beam operation.**

- **Key points**
  - Standardized approach, endorsed by the beam controls developers community at CERN
  - Essential cross-team coordination.
  - Efficient and integrated set of tools to support this process.
  - Continuous effort to refine the process based on feedback gathered following Technical Stop.

- **Outlook**
  - The coordination of SW interface changes for devices running on low level computers remains critical for a seamless deployment process.
  - It is the focal point concentrating current efforts, to combine a comprehensive pre-deployment description of changes together with a monitoring of the changes that have been deployed.