



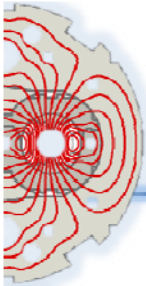
# Safety during powering



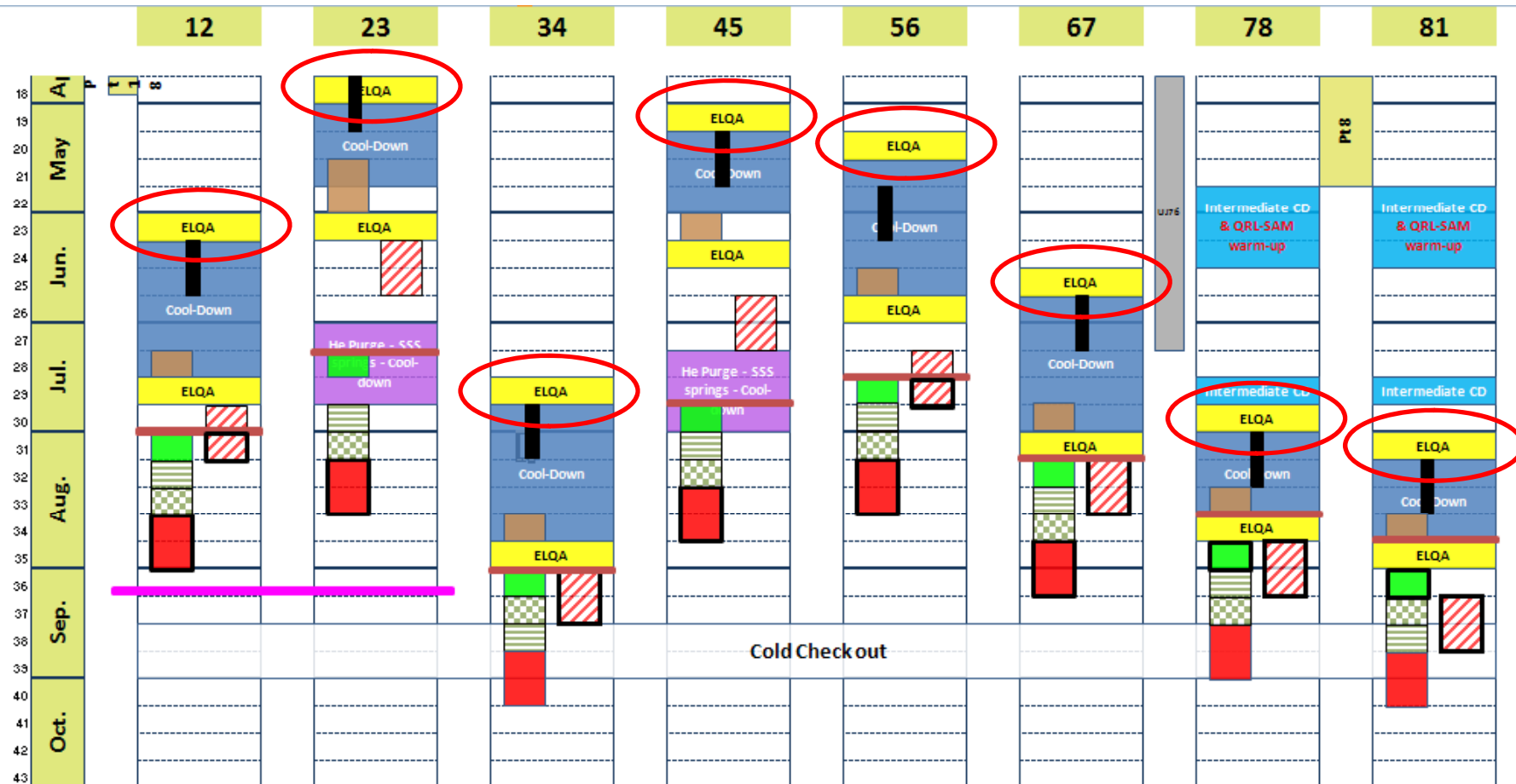
## How to ensure safety during powering? (ENFORCING the RULES)

- Powering phase I at low current: How to ensure that the current does not exceed the “safe” value?
- Powering phase II: How can we be sure that nobody is in when we power?
- Underground access during powering phase I and II for interventions: How to ensure that we do not power a circuit during such intervention (such as with the PIC)?
- Underground access during commissioning of the powering system? Is it required? (EE switches, cut water, triplet...)
- Hardware commissioning using the access system
- Set the rules for access, different modes, transition from shutdown to commissioning/operation

**Acknowledgments:** B.Bellesia - M.Gruwe - M.Pojer - L.Ponce - R.Shmidt - A.Vergara - M.Zerllauth



# From SD to HWC

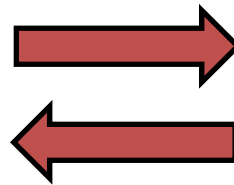


# EIQA and cool-down

EIQA



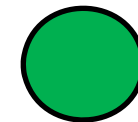
Cool-down + He filling



UAs

**GENERAL**

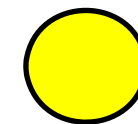
+ signalization

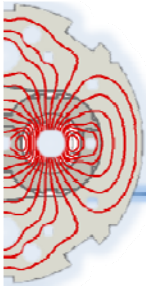


**TUNNEL**

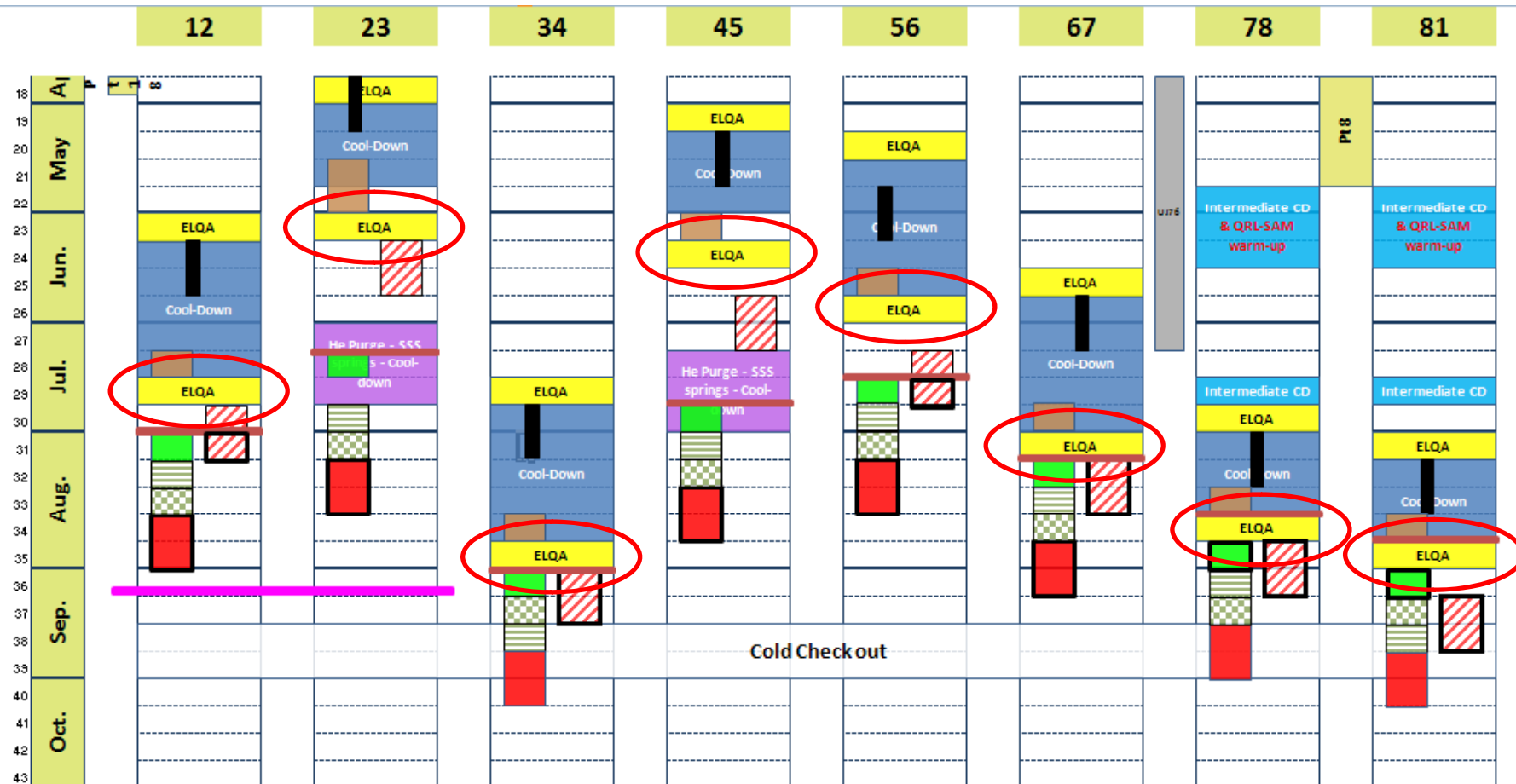
**RESTRICTED**

no patrol





# Powering test



# Powering test – Old rules



**After September 19<sup>th</sup>**

## **THE RULE:**

- **Access restrictions for any circuit at any current (only RB, RQD/F and some IPQs were powered):**
  - **No one in the tunnel and underground areas of the sector**
  - **In case of incident, helium might flow into adjacent sector: no one in the adjacent experiments or sectors**
  - **Sectors that were not concerned could be accessed**

## **MEANS TO ENFORCE THE RULE:**

- **Tunnel and underground areas in closed mode with patrol**
- **Adjacent sectors in closed mode with patrol**
- **Adjacent experiments in closed mode with patrol**



**This mode of operation was very constraining**

# Powering test – Old rules



Before September 19<sup>th</sup>

## Below 1 kA

### THE RULE:

- Access to tunnel and UAs allowed only to people involved in powering tests
- No restriction for experiments
- No restriction for adjacent sectors

### MEANS TO ENFORCE:

- Tunnel in restricted mode with patrol 
- UAs - UJs in general mode 
- Experiments access left to exp.

## Above 1 kA

### THE RULE:

- No access to the tunnel
- Access to UAs – UJs allowed only to people involved in powering tests
- No restriction for experiments
- No restriction for adjacent sectors

### MEANS TO ENFORCE:

- Tunnel in closed with patrol 
- UAs - UJs in general mode 
- Experiments access left to exp.



# Powering test – Old rules



**Before September 19<sup>th</sup>**

This mode of operation was not too constraining during  
powering tests



We want to retain this principle but...

...improve it in the light of what happened on Sept. 19<sup>th</sup>!!



# Powering test – New rules

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## PHASE I



- LOW CURRENT phase
- Underground areas and tunnel accessible for people involved in powering tests
- Similar to “Below 1 kA” phase

## PHASE II



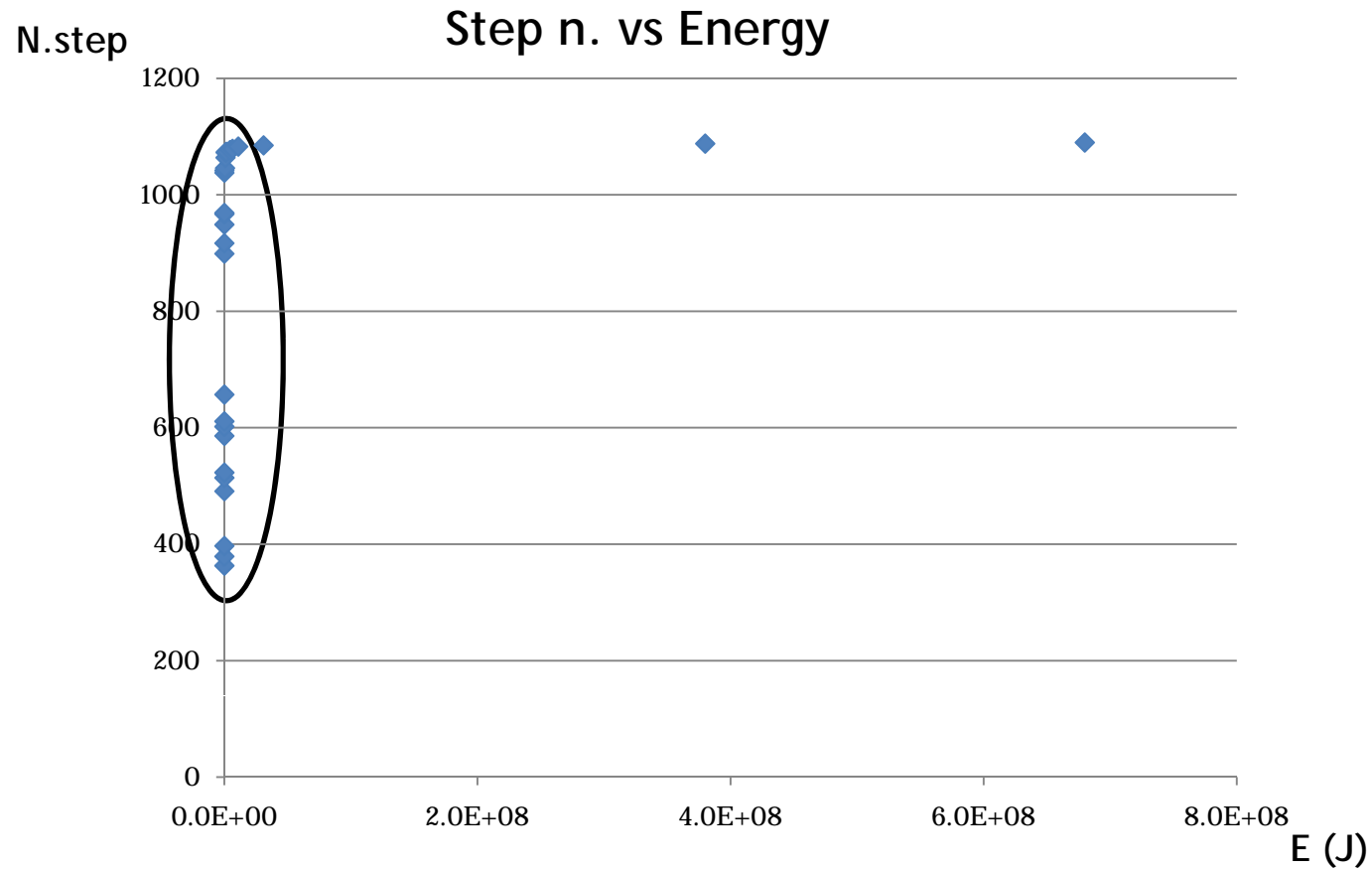
- HIGH CURRENT phase
- No access for anybody (restrictions to be defined)
- Similar to “Above 1 kA” phase but more constraining

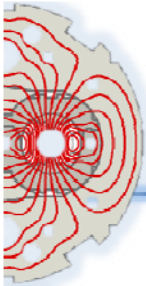


# Powering test – New rules



What can we gain with this approach?

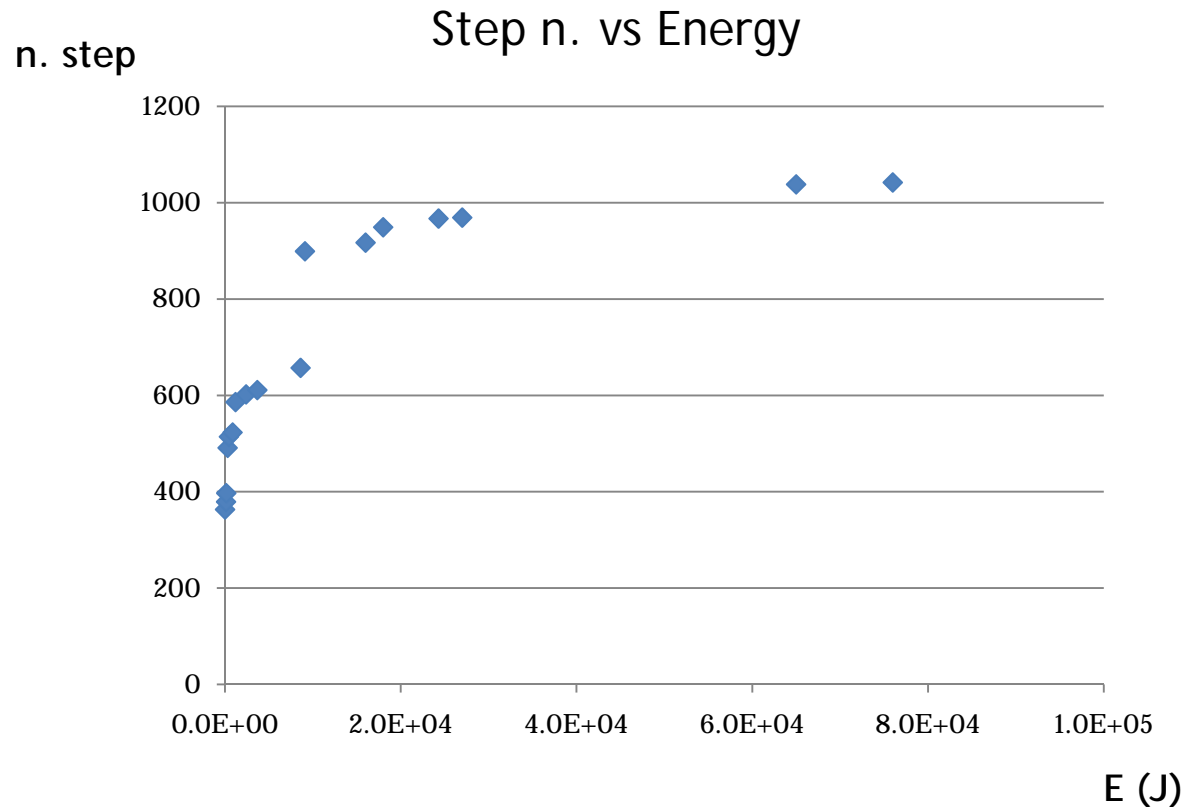




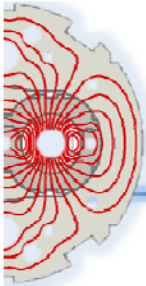
# Powering test – New rules



What can we gain with this approach?



Last test steps are much longer, but most of problems normally found at the beginning



# Powering test – New rules



## Phase I - Low current powering tests

Current limited to a value to be defined, with negligible risk of massive helium release

### Access conditions (the rule)

Only people with “test-related” activities allowed in

- Tests may continue

### Means to enforce rules

Current limitation:

- Hardware limitation on current for RB and RQD/F power converters
- Software current limitation on the other converters

Access control:

- All doors closed and emergency handles rearmed
- Whole tunnel area patrolled
- Tunnel in restricted access mode ●



# Powering test – New rules



## Phase I - Low current powering tests

### How to deal with ACCESS REQUESTS...

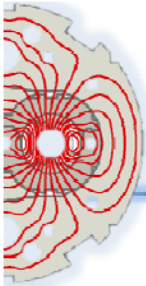
#### Access for “test-related” interventions

People with “test-related” activities allowed in

- Tests may continue
- ADI system for approval of activities and access requests

#### Access for non “test-related” interventions

- Scheduled when no powering, if possible (see Boris)
- If really needed
  - stop powering
  - lock with global PIC
- Access maintained in restricted mode



# Powering test – New rules

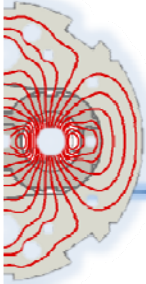


## Phase I - Low current powering tests

### How to deal with EXCEPTIONS...

#### Loss of safe conditions (external door open or forced)

- Abort the ongoing tests. How?
  - Interlock
  - alarms
- Close and rearm doors
- Patrol area
- Restart powering tests



# Powering test – New rules



## Phase II - High current powering tests

HW current limitation removed - massive helium release CANNOT be fully excluded

### Access conditions (the rule)

No one is allowed in the underground areas (experiments?)

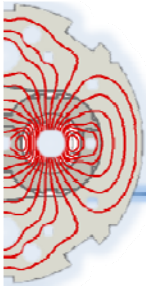
### Means to enforce rules

Access control:

- All doors closed and emergency handles rearmed
- Whole area patrolled
- Closed access mode ●

It is required to define a matrix showing what areas need to be closed and patrolled  
(Adjacent tunnel? Service areas? Experiments?)

What is accessible during powering phase II with current in the magnets, possibly with  
the main dipoles at full current?

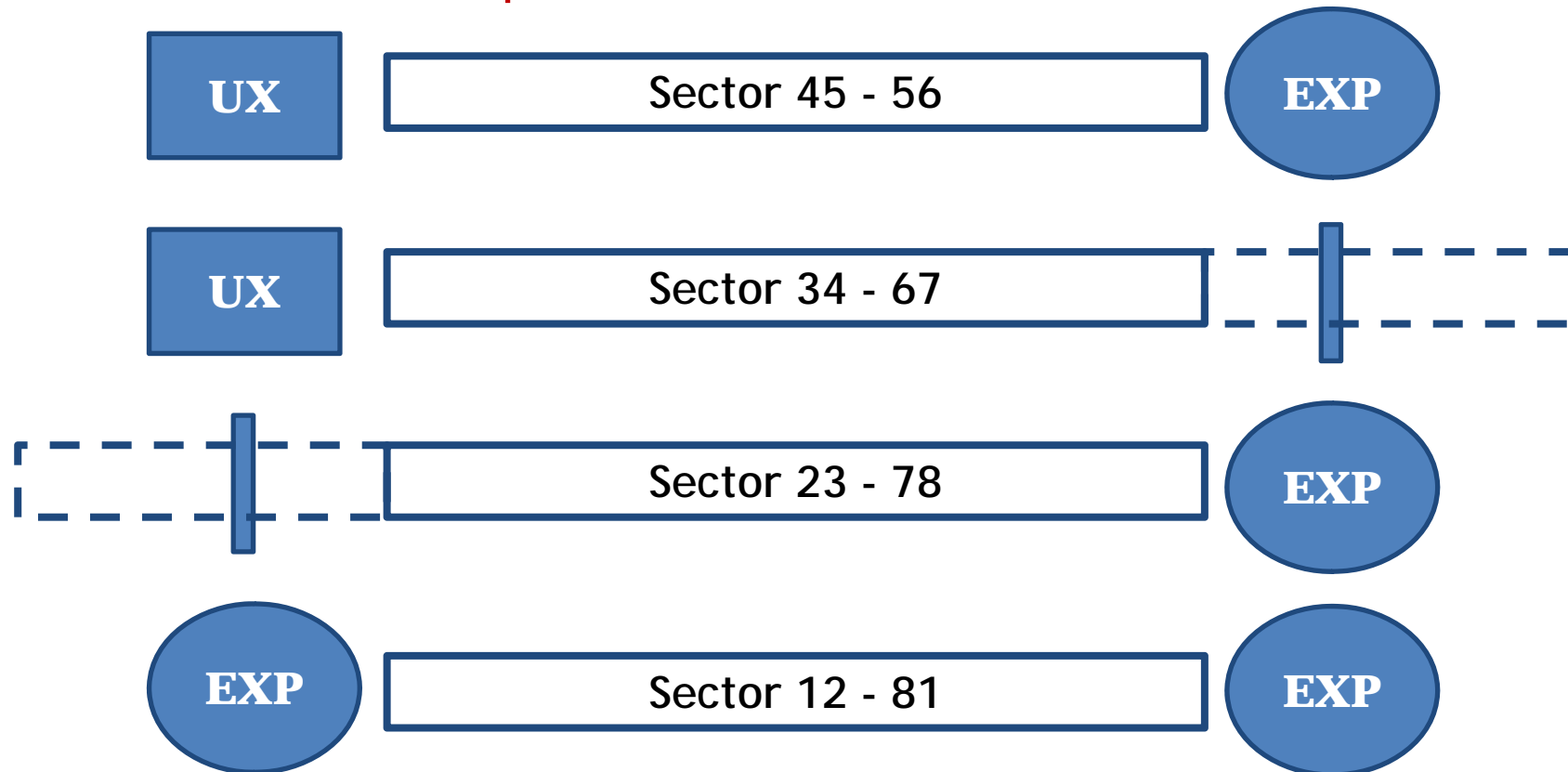


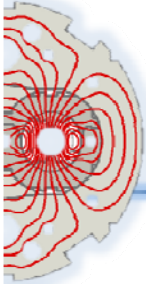
# Powering test – New rules



## Phase II - High current powering tests

All points are different but...





# Powering test – New rules



## Phase II - High current powering tests

How to deal with ACCESS REQUESTS...

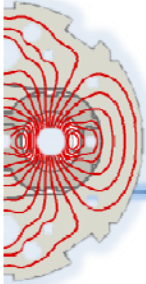
The proposal is to have a “Block all” button on the PIC to ease blocking a full sector at the same time (see Laurette’s)

With the help of this functionality the EIC must:

- Lock the whole sector
- Switch the area in restricted mode
- Authorize people in







# Powering test – New rules



## Phase II - High current powering tests

How to deal with EXCEPTIONS...

- **Access with current:**
  - EE switches discharge measurements
    - only for Sector 34 + 7 circuits in Sector 45
    - (current needed 600 A)
  - Inner Triplet - calibration of converter
    - (current needed 500 A)
  - Discharge request provoked by cutting water on the cooling system
    - discussions are ongoing on the possibility of eliminating this step or to operate the mains circuits converter at a lower current
  - Tuning of PC
  - ...

# Powering test – New rules



## Phase II - High current powering tests

How to deal with EXCEPTIONS...



**Back to phase I**

Hard procedure because:  
Setting hardware limitation requires people in the tunnel not necessarily where the intervention is done and moreover...we wouldn't apply the procedure to the team setting the interlock

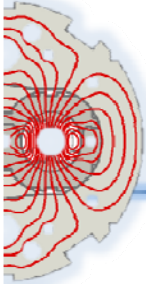


**PIC "Block" button**



**Software limitation**

**Interlock**



# Powering test – New rules



## Phase II - High current powering tests

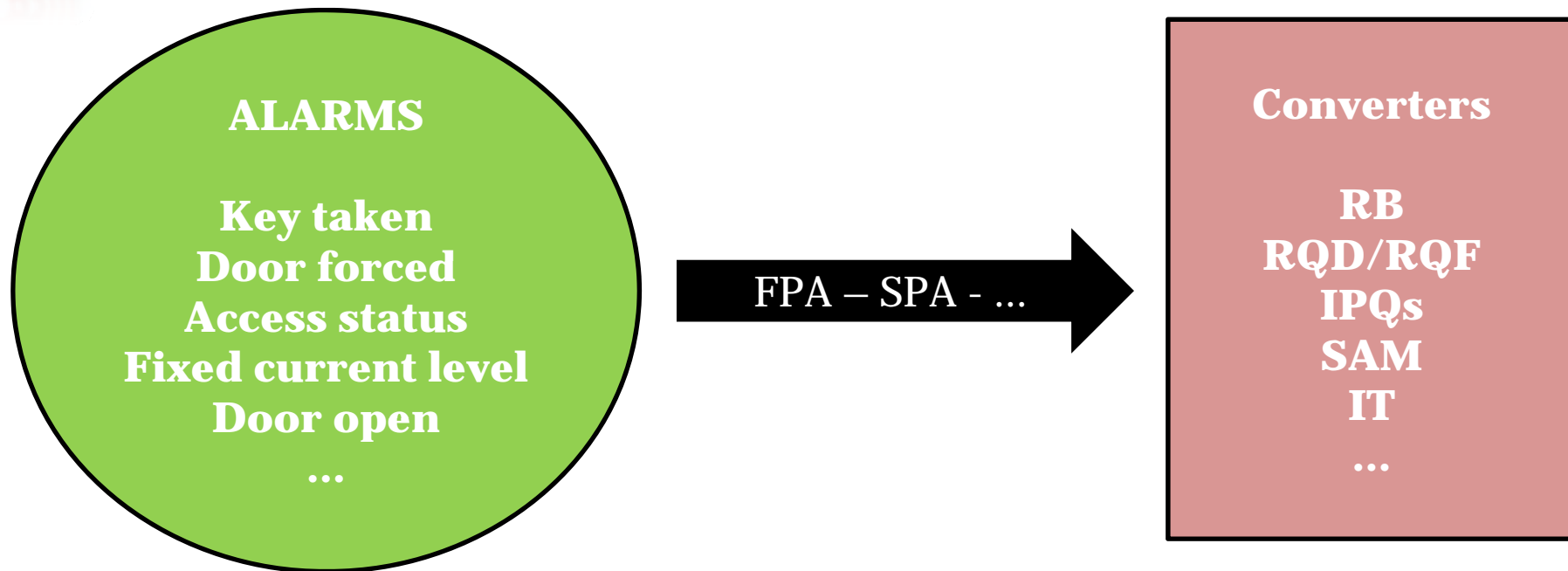
How to deal with EXCEPTIONS...

- **Access with current:**
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  - Tuning of PC
  - ...
- **Loss of safe conditions - INTERLOCK?**

# Powering test – New rules

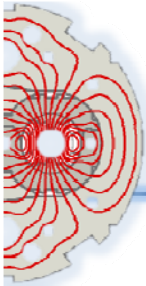


## Interlock



Details of the interlock should be defined, then the interlock has to be Implemented and tested

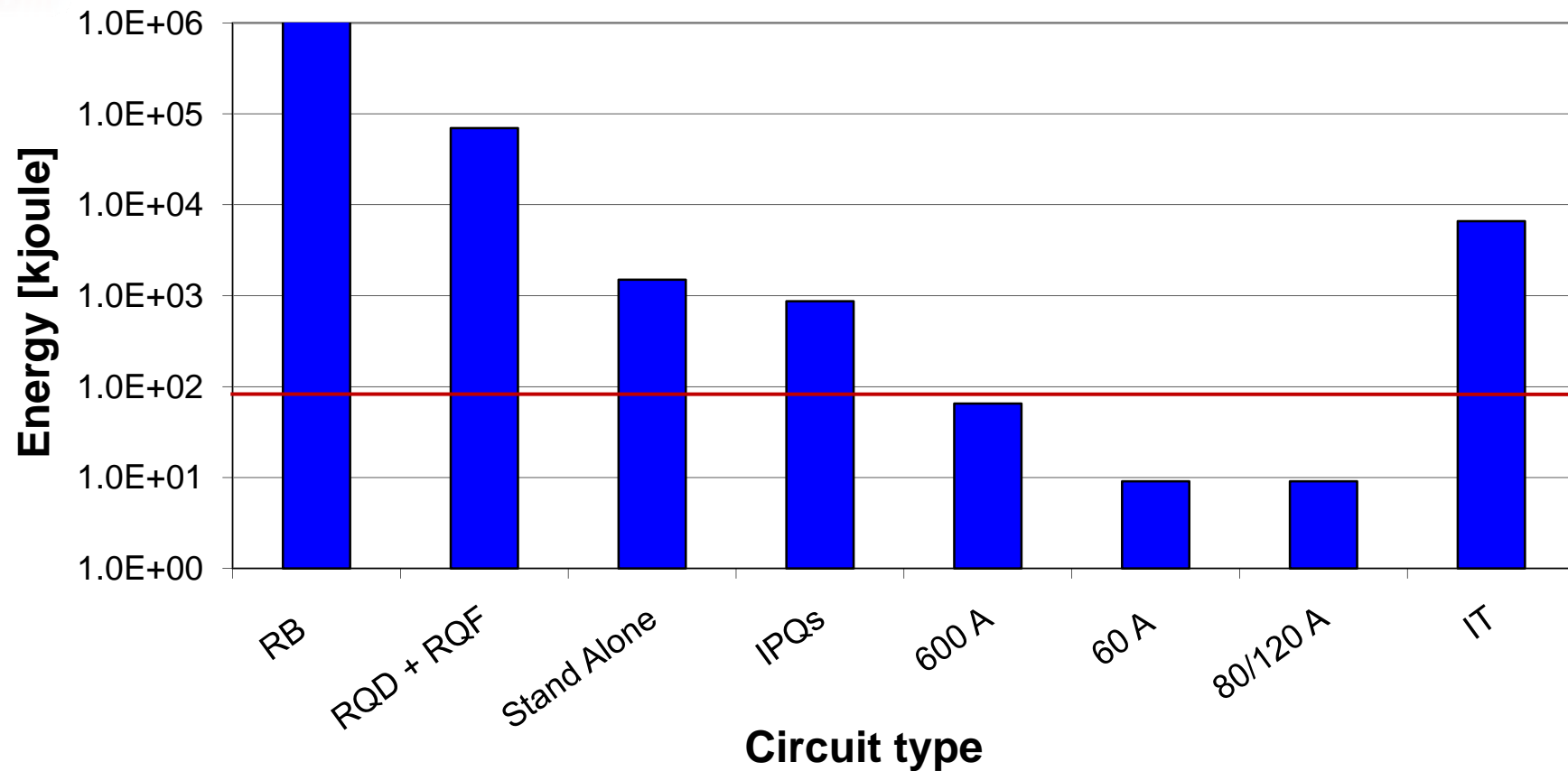
**The more complicated the interlock, the larger the number of tests!!!**

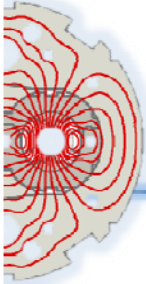


# Powering test – New rules

PHASE I-PHASE II Setting a limit...

Energy in the circuit types (high energy operation)

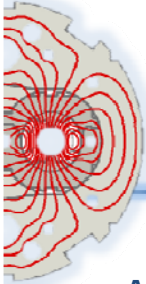




# Powering test – New rules

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- **60 A orbit correctors:**
    - Powered locally
    - Energy stored in the circuit about 10 kJoule
    - Independent circuits - they can be powered at the same time
  - **80 - 120 A correctors**
    - Powered locally
    - Energy stored in the circuit about 20-40 kJoule
  - **600A correctors @ 200A**
    - Maximum energy stored in the circuit about 8.6 kJoule
    - Discharge time very short (order of one second)
- Risk to have a massive helium release during operation of the magnet at nominal current (200 A) is negligible**
- **Still to be decided what to do with the other circuits...**
-



# Conclusions



As soon as the powering tests start (PC "*deconsigne*") the relevant areas must be patrolled

- "Phase I - Phase II" approach accepted by the safety task force, but limit has to be set and some important points are still pending:
  - **Procedure for testing circuits with people required in the tunnel during phase II** (interlock, PIC superblock, SW/HW limitation??,...)
  - **What has to be done for assuring safety in case of loss of safe conditions in Phase II** (interlock, tests aborting, driving down the converters??)
  - **INTERLOCK:**
    - Is it really needed?
    - Which alarms have to be connected to which converters?
    - Which kind of signal should be sent? What is safe?
    - Which tests are needed to validate the functionality?

**Limit of current between PHASE I and PHASE II for any circuit type should be decided on the base of the studies ongoing. The results must be documented in an Engineering Specification to be approved**