Proposal for Electrical Protection in HL-LHC undergeound areas

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Context

- The HL-LHC Underground Areas shall be accessible
  - independently of the operational status of the accelerator and the equipment(*)
  - by personnel without “Habilitation électrique”
  - Electrical Safety Awareness sufficient
- for activities in
  - monitoring and control,
  - “fine-tuning” equipment parameters,
  - standard exchange of failed components

- The equipment in the areas must be protected in an appropriate way to avoid harm to personnel

(*) exception: cool-down of the cryogenic system

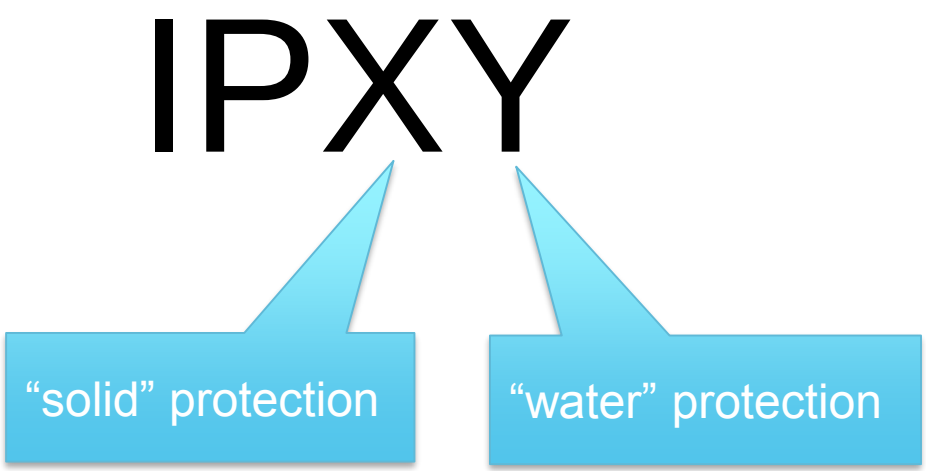
Electrical Protection

- Electrical hazards come from
  - Direct contact with electrical conductor
  - For high current: contact between conductor(s), ground and metallic objects (short circuit, high power dispersion)
  - Electric arc (in high voltage applications)

  - Indirect contact to be treated by proper ground connection of all metallic frames and casings with appropriate ground leads. Earthing positions are available in the areas

IP rating

- Against direct contact, and to protect the equipment in the enclosure against ingress, the IEC defines an Ingression Protection (IP) rating of enclosures in Standard IEC 60529 v.2.1
- Two digit classification:



Recommendation: IP Rating

- Standard electrical equipment (from manufacturer) in the HL-LHC underground shall conform to

Low Voltage	**IP2X**	**no accidental contact with finger**
High Voltage	**IP3X**	**no accidental contact with screwdriver**

- Connections between equipment must respect same level
- No change w.r.t. LHC

- Covered by French Standard NF-C18-510: if the equipment protection is IP2X / IP3X, then
  - Conductors and metallic parts are not considered “nu sous tension”
  - Manoeuvres (e.g. turn on/off) are authorised by personnel without “habilitation”

Electrical Protection against Dripping Water

- In underground areas, water may drip from overhead (condensation, overflow, leaks)
  - Option 1: specify conformity to level IPX1

  - Option 2: where required and possible (space !), case-by case solutions shall be implemented to protect the equipment and the personnel

Special Systems

- Non standard equipment:
  - designed and built at CERN or collaborating institution
  - Built-to-print by industry after CERN plans
  - No IP rating certified by manufacturer
- Examples:
  - 18 kA supplies
  - Current leads
  - RF equipment

- These systems shall undergo a dedicated risk assessment.

Recommendation: Electrical Works

- Electrical works in the HL-LHC underground areas require a lock-out of the circuits concerned and of those with which the personnel could come accidentally in contact.
  - Example: Live cables limit interventions on cable trays.

- Possibility for electrical works during accelerator operation and commissioning is limited.
- Put in place proper procedures for lock-out

Summary

- In HL-LHC underground areas:
  - Electrical Protection Index for Standard equipment
    - IP2X for low Voltage
    - IP3X for high voltage
    - In agreement with NF-C18-510
  - Protection against dripping water where required:
    - IPX1 or local water protection
  - Non-standard equipment to be specified after dedicated electrical risk assessment
  - Possibility for executing electrical works remains limited