The TOTEM Interlock Strategy and Implementation
Contexts of RP Operation: The Beam Modes

- **NO BEAM**
  - RP operation allowed

- **ADJUST request**
  - Handshake signal exchange → extract RPs

All other modes:
- RPs must be out,
- otherwise:
  - USER_PERMIT = FALSE
  - INJECTION_PERMIT = FALSE
1. **NO_BEAM:**
RP operation possible.
Injection prevented by USER_PERMIT1 = FALSE when not all RPs are at end switch.

2. **STABLE_BEAM:**
Normal mode for RP operation.

RP positions measured by LVDT; limits received from LSA collimation database via FESA. → in PXI: comparison at 50 Hz

If out of limits:
- level 1 (warning limit): warning to DCS and CCC; extraction
- level 2 (critical limit): alarm; emergency extraction;
  
  USER_PERMIT1 = FALSE → beam dump
  
When not all RPs are at end switch: INJECTION_PERMIT = FALSE

During data taking: manual movement inhibit to prevent undesired manual RP movements
But: extraction in emergency situations always possible! (SW → motors; HW → springs)
A Closer Look at the Relevant Beam Modes (2)

3. **UNSTABLE_BEAM:**
   No normal RP operation.
   If not all RPs are at end switch:
   - no interlock action \((\text{DEVICE\_ALLOWED} = \text{STABLE\_BEAM} \lor \text{UNSTABLE\_BEAM})\)
   - but automatic RP extraction with motors

   Exception: special RP/collimator position calibration runs requested by collimation group
   → manual OVERRIDE signal to prevent automatic RP extraction

4. **Switching to ADJUST Mode:**
   To be preceded by handshake via DIP protocol (ADJUST request → ready for ADJUST)
   to allow for RP extraction.

   Switching without RP extraction would lead to beam dump via USER_PERMIT1.
Interlock Block Diagramme

IN MOTOR CONTROL RACK

- Home Switch 1
- Home Switch 12
- LVDT 1
- LVDT 12
- FESA
- GMT (SMP)
- TOTEM Operator

IN S2E11 (TRIGGER/DAQ) RACK

- DAQTR 1
- DAQTR 4
- DAQTR DOWN
- DAQTR_OUT 1
- DAQTR_OUT 12
- DAQTR_OUT 4
- DAQTR DOWN

Motor Control

- CIBF 1
- CIBU 1
- CIBF 2
- IN CMS INTERLOCK RACK S1E08

Symbols:
- AND
- OR
- COMPARE
- LIMITS
- X 12
- DEVICE_ALLOWED
- OVERRIDE 1
- STABLE_BEAM
- INJECTION_PERMIT
- USER_PERMIT1
- USER_PERMIT2
- MACHINE FLAGS
- TOTEM INTERLOCK CARD
- ALL_RP_OUT
- BACK_HOME
- TOTEM_OPERATOR OVERRIDE 1
- STABLE_BEAM
CIBU2: second interlock box allowing to dump the beam based on RP information not related to the position: e.g. count rates, vacuum deterioration

- These conditions can usually be adequately addressed by RP extraction without beam dump.
- Reasonable dump thresholds need RP running experience.
  Particular example: RP detector count rates must be compared with BLM information

⇒ In the first running season: no dump possibility implemented.
  Later implementation only if needed
• Logics part fully programmable (PLD)

• Inputs:
  - from 24 RP end switches
  - from PXI, motor control:
    - results of comparison between LVDT position data and limits from LSA DB
    - 4 spares
  - machine flags:
    - DEVICE_ALLOWED
    - STABLE_BEAM
    - SAFE_BEAM 1 and 2 (presently unused)
    - POST_MORTEM trigger (not yet used)
    - IMMINENT_BEAM_ABORT (hardware signal presently unused; also received via DIP → used for handshake)
    - 2 spares
  - from TOTEM operator / DAQ:
    - 2 OVERRIDE signals
    - 2 spares

• Outputs:
  - USER_PERMIT signals for CIBU1 and 2, each for beam 1 and 2
  - INJECTION_PERMIT signals for CIBF1 and 2
  - copies of all input and output signals for information to the motor control
  - 10 spares
Status and Planning

• Interlock card in production: to be finished by 4 May
• mounting components: + 1 week → 11 May
• lab tests and PLD programming: + 2 weeks → 25 May
• interlock commissioning and tests: to be discussed with machine