From the detection of a magnet quench to the beam dump

- We have discussed now the quench mechanisms, quench detection and their time constants
  - e.g. beam loss causes the magnet to quench
  - the voltage builds up and exceeds the threshold of the quench detector
  - the quench detector detects the voltage after some time
  - the QPS system fires quench heaters or triggers the energy extraction
  - at the same time, the PIC is informed
  - the heaters become efficient
  - the voltage exceeds the diode voltage, current starts to bypass magnet

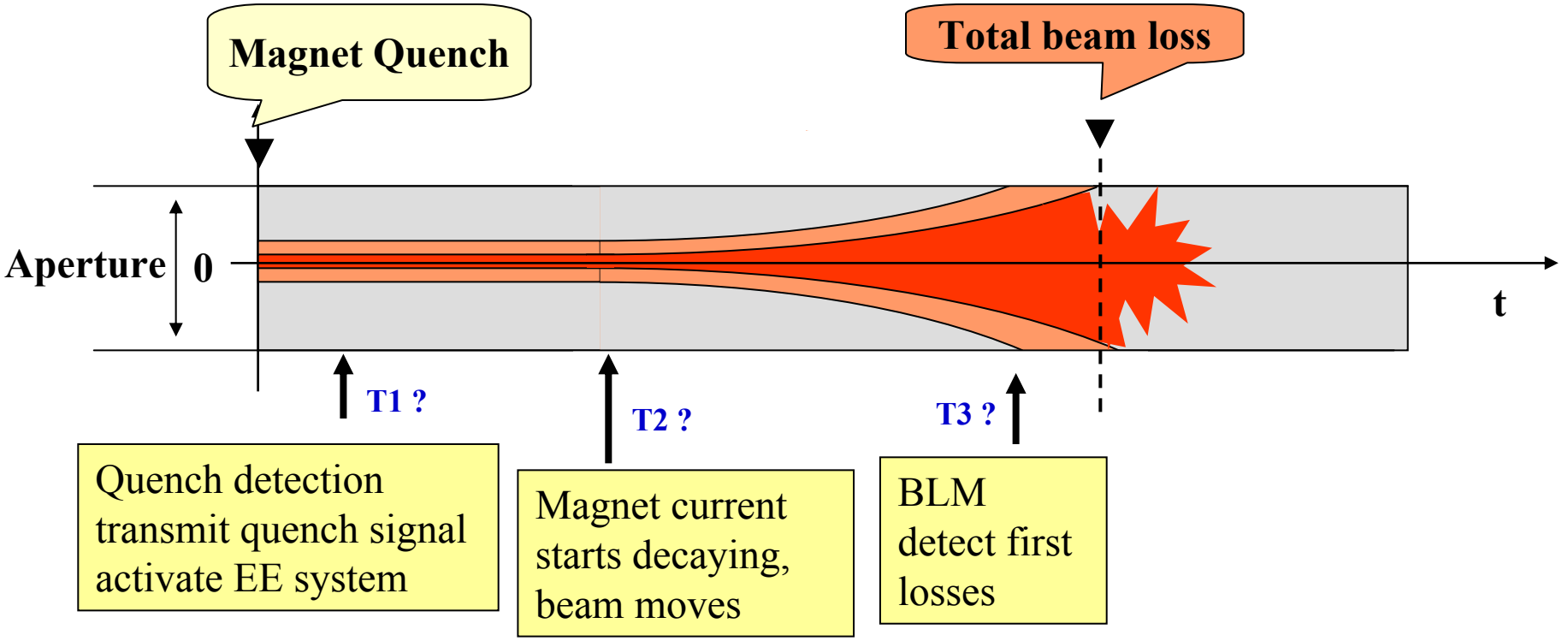
previous talks

- Remains: How long will it take from the issued quench signal to the actual completion of the beam dump
  - PIC processes the quench signal and sends a dump request to the BIC
  - the BIC sends a dump request to the beam dumping system
  - the energy extraction switch opens, and the current in the circuit decays
  - the voltage exceeds the diode voltage, and the current starts to bypass the magnet

this talk

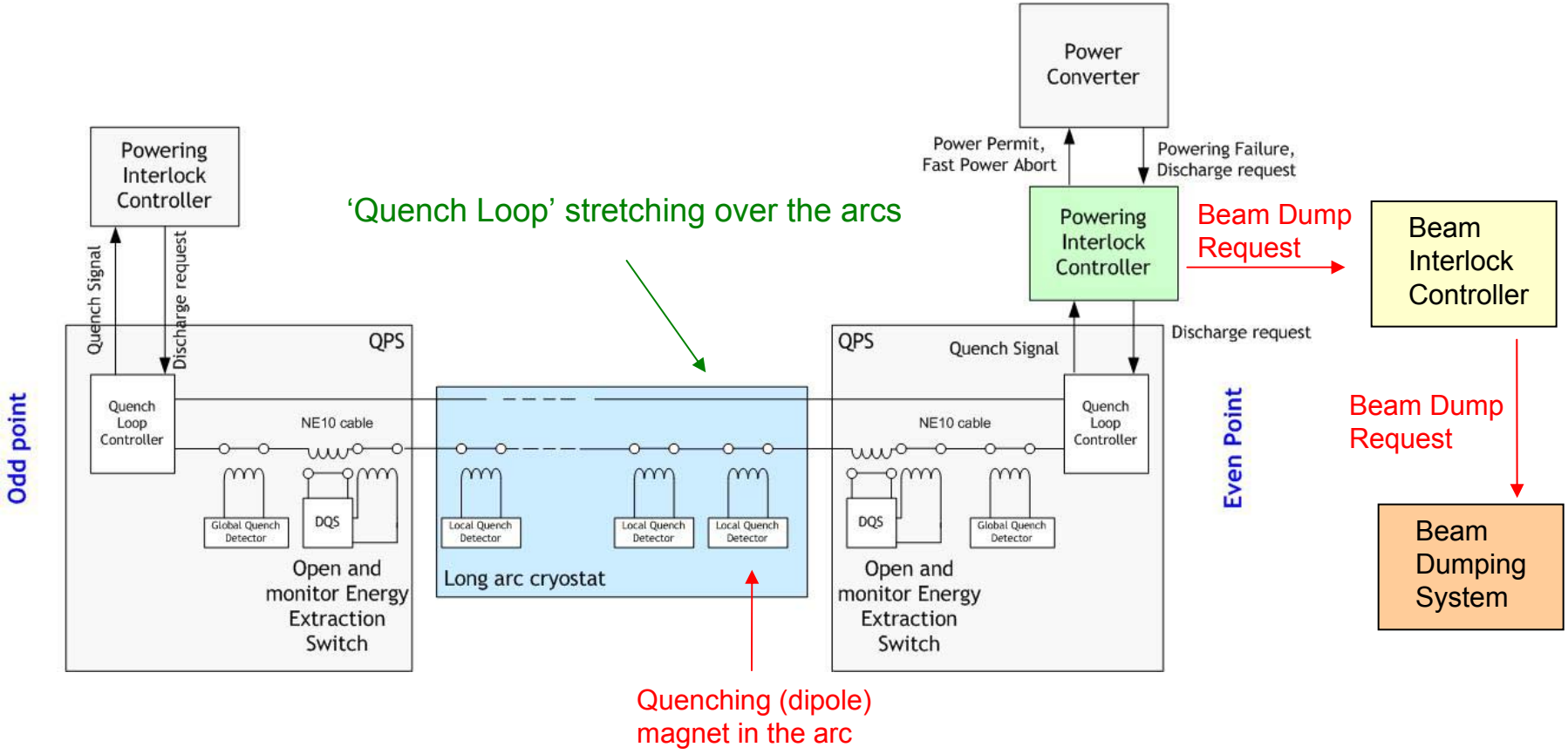
- Beam is to be dumped before the current in the magnet starts to decay (from this point on the beams are deviated)

- The Powering Interlock Controller is the only system sending (direct) beam dump request after powering failures
  - But, is it fast enough?
  - 'Secondary' protection with collimators, BLM (possibly BPM / beam lifetime)



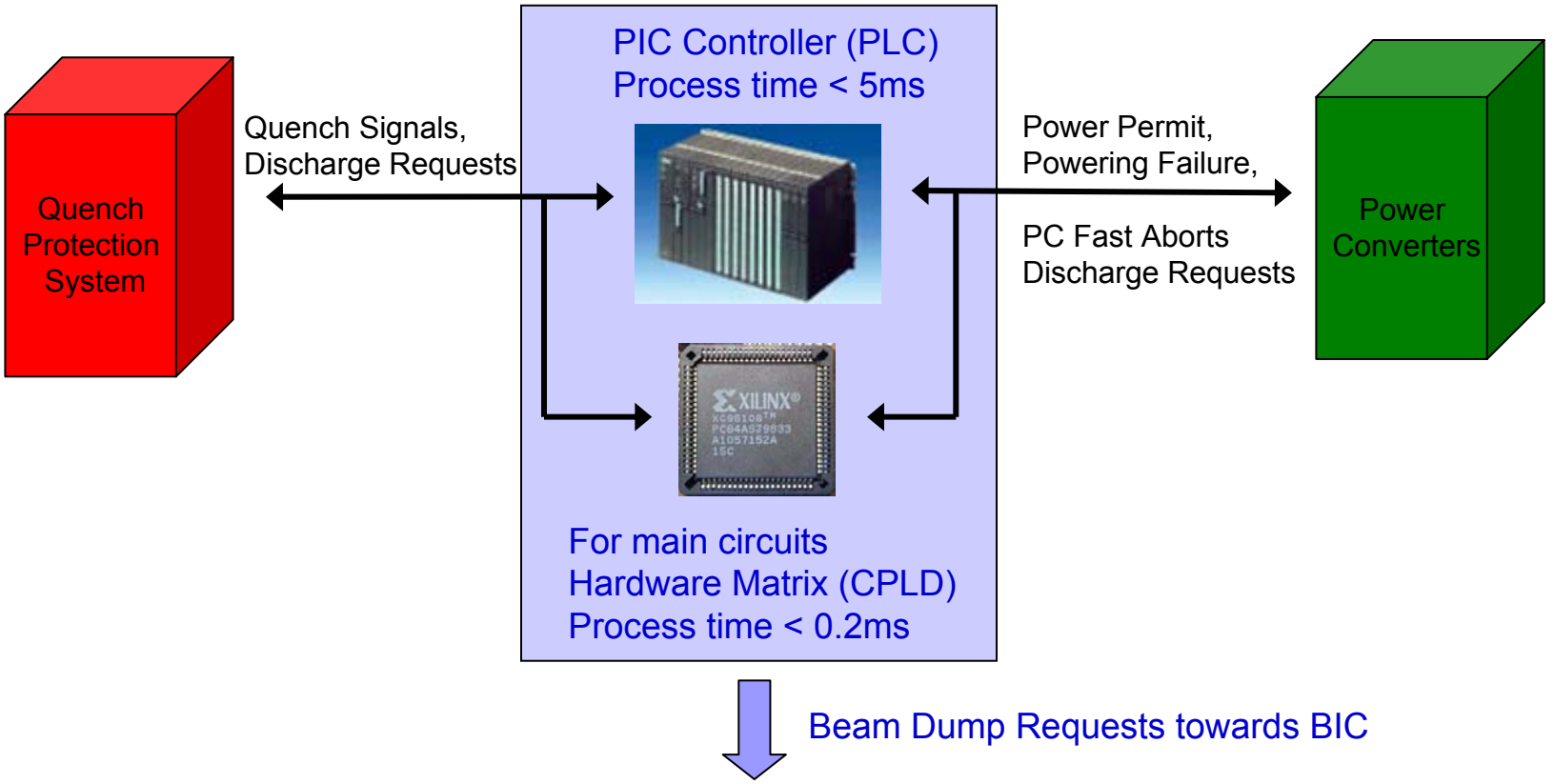
Hardware configuration and signal transmission

- Main dipole circuit as an example (largest effect on circulating beams in case of failure)

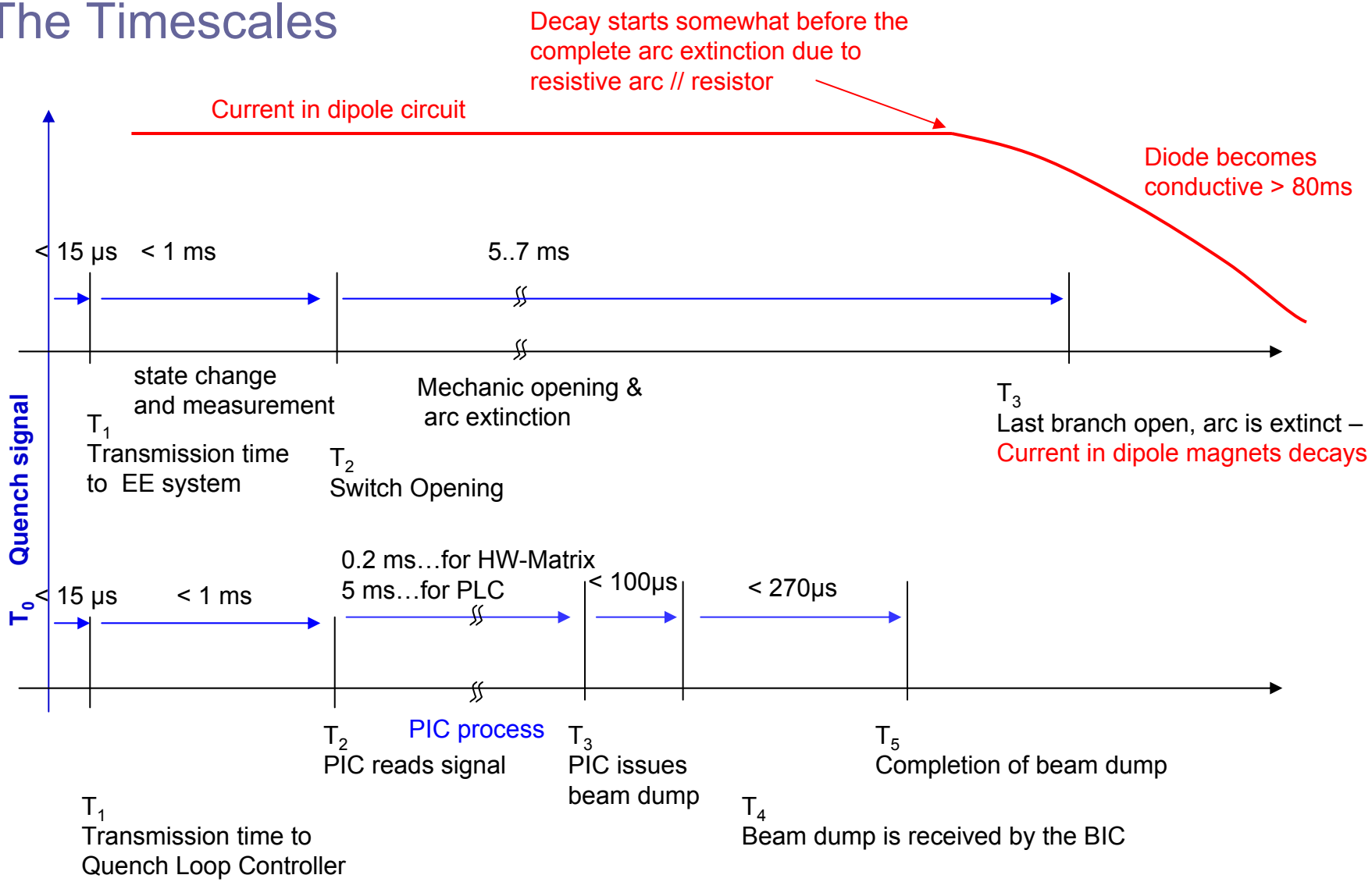


The PIC process times

- Powering Interlock Controller is based on a PLC controlled process, monitoring and controlling up to 45 electrical circuits (>200 signals) / powering subsector
  - RT process with guaranteed response time of <5 ms for critical circuits
- For time (beam) critical circuits -> configurable hardwired matrix in parallel for generation of the beam dump signal



The Timescales



Conclusions (sc magnets)

- Main dipole and main quadrupole circuits certainly most time critical due to undelayed activation of 13kA energy extraction system upon detection of a quench
  - Due to the delay in the switch opening of the 13kA energy extraction system, the beam is dumped before the current in the magnet starts decaying
  - also true in case of self triggering of EE system (internal failures or unintentional opening of a single branch)
- For all other sc magnets the time constraints are less critical
- For time critical signals (mainly main dipole and quadrupole circuits due to large effects on the circulating beams), a hardwired matrix within the PIC can be configured in parallel to the PLC process for the generation of a very fast beam dump signal
- QPS/PIC will dump the beams before BLMs see any beam losses -> redundancy for issuing the necessary beam dump but…

Still an open question…nc magnets

- What to do for normal conducting magnets?
  - Time constants in the order of seconds, thus << sc magnets
  - WIC (Warm Magnet Interlock Controller) is a slow system, BLMs are the only protection in case of PC failures
- Recent failure during SPS extraction towards TT40 – failure scenario was already known from simulations
- Fast current monitoring for critical circuits similar to HERA is proposed