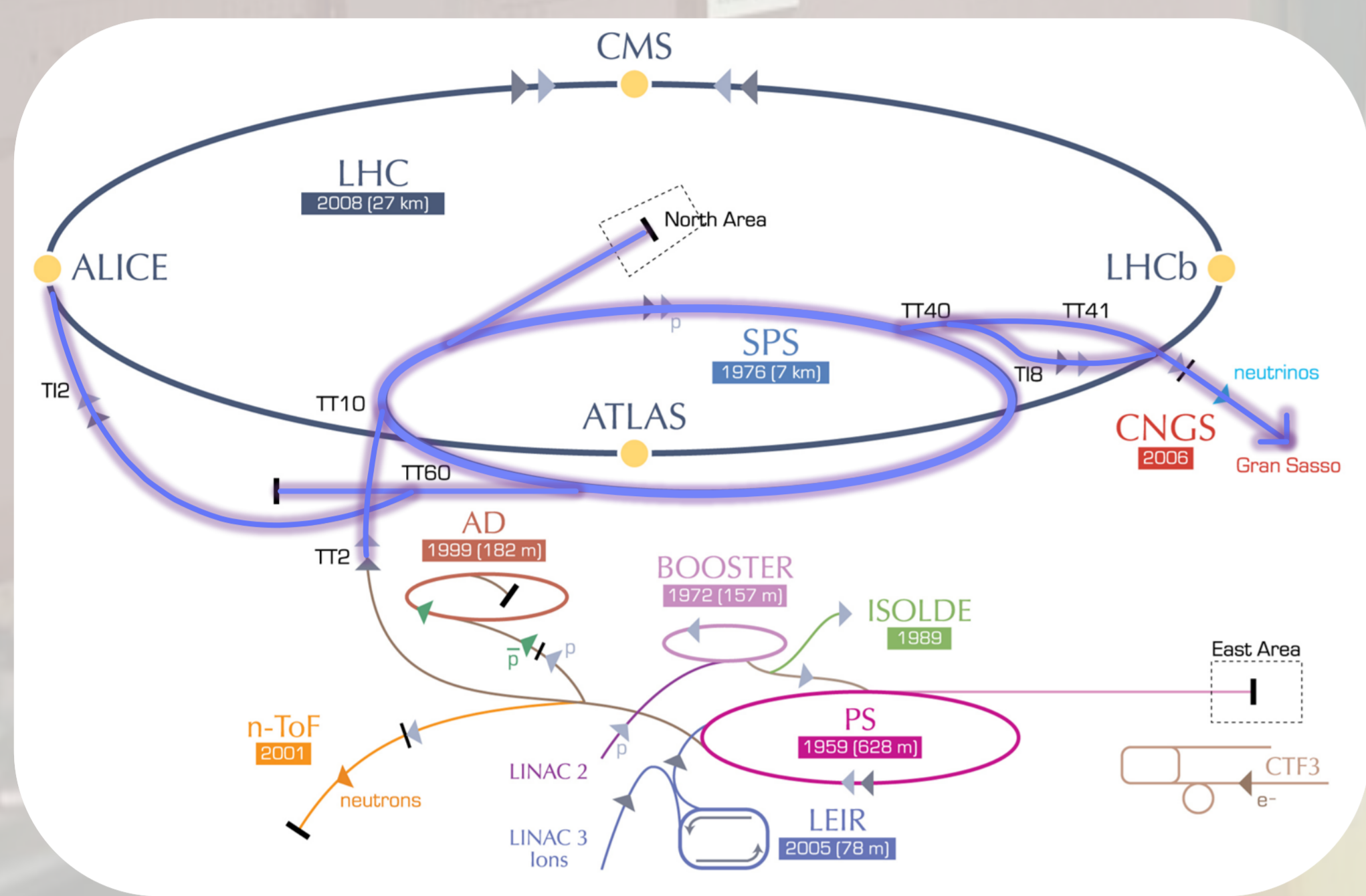


Abstract

The Super Proton Synchrotron is the main injector for the Large Hadron Collider (LHC). The 7 km SPS accelerates particles from 14 to 450 GeV. The deployment of the new Function Generator Controller allowed the development of an energy saving system optimising the magnetic cycle by pulsing only when needed. The FGC framework in the SPS will simplify operation and add more flexibility, reliability and availability. This system will be the new standard across the accelerator complex.

CERN's Accelerator Complex



	SPS Users	Injection energy	Flat top energy	Extraction type
P R O T O N	North Area (Fixed Target)	14 GeV	80 to 450 GeV	Slow extraction
	LHC (Pilot, 25ns, 50ns, 75ns, 150ns, 200ns)	26 GeV	450 GeV	Fast extraction
	CNGS (Cern Neutrino to Gran Sasso)	14 to 26 GeV	400 GeV	Fast extraction
	Hiradmat (High Radiation to Materials)	26 GeV	440 GeV	Fast extraction
	MD pulsed (Machine Development)	14 to 26 GeV	80 to 450 GeV	No extraction
	MD coastable	26 GeV	26 to 270 GeV	No extraction
I O N	North Area (Fixed Target)	17.07 GeV	27 to 450 GeV	Slow extraction
	LHC (Pilot, 200ns)	17.07 GeV	450 GeV	Fast extraction
	MD Pulsed (Machine Development)	17.07 GeV	80 to 450 GeV	No extraction
	MD coastable	17.07 GeV	17.07 to 270 GeV	No extraction

SPS Dynamic Economy

Triggered automatically by the level of the beam intensity.

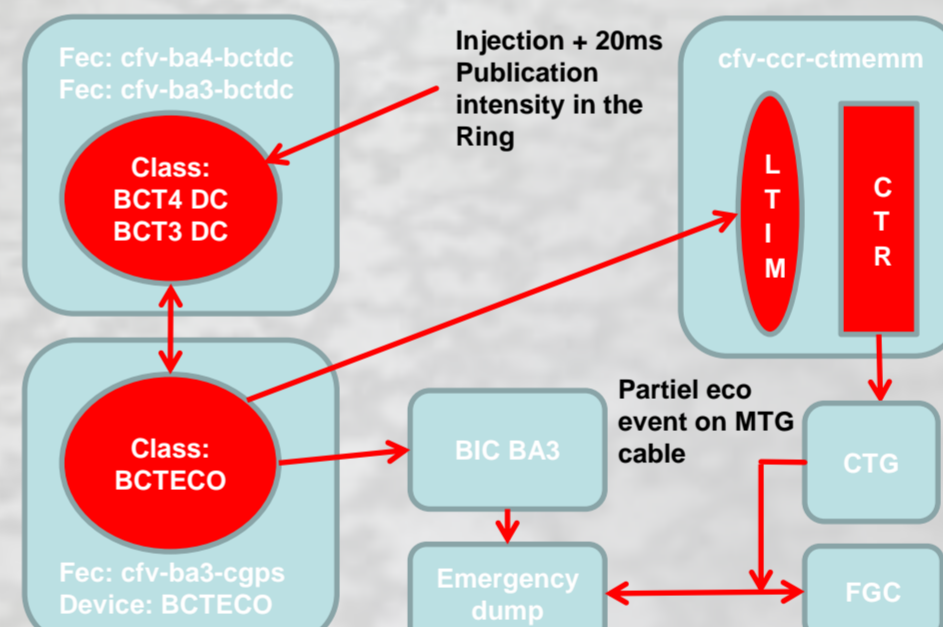
- Main Dipole Power Supplies stay at injection energy.
- All ring circuits stay at minimum current.
- All transfer line circuits except injection line (TT10) stay at minimum current because the next beam injection on the same cycle passes through TT10 to go to the injection dump.
- The scraper will not execute its cycle.
- We can force the pulse manually for verification purposes.



Fast Beam Detection

- BCT3, BCT4 (Beam current transformer) will:
 - Publish intensity in the ring at 20 ms after injection.
- BCTECO (Economy server) will:
 - Subscribe and compare the value with a threshold set for each cycle.
 - If Value < threshold.
 - Open the loop of the Beam Interlock Controller (firing emergency dump).
 - Triggers the LOCAL TIMING which in one turn triggers the economy event generation in the cable.
 - Closed the loop of the Beam Interlock Controller at the end of the cycle.
- On this timing event
 - The emergency dump is fired a second time for redundancy.
 - All FGC crates switch to partial economy.

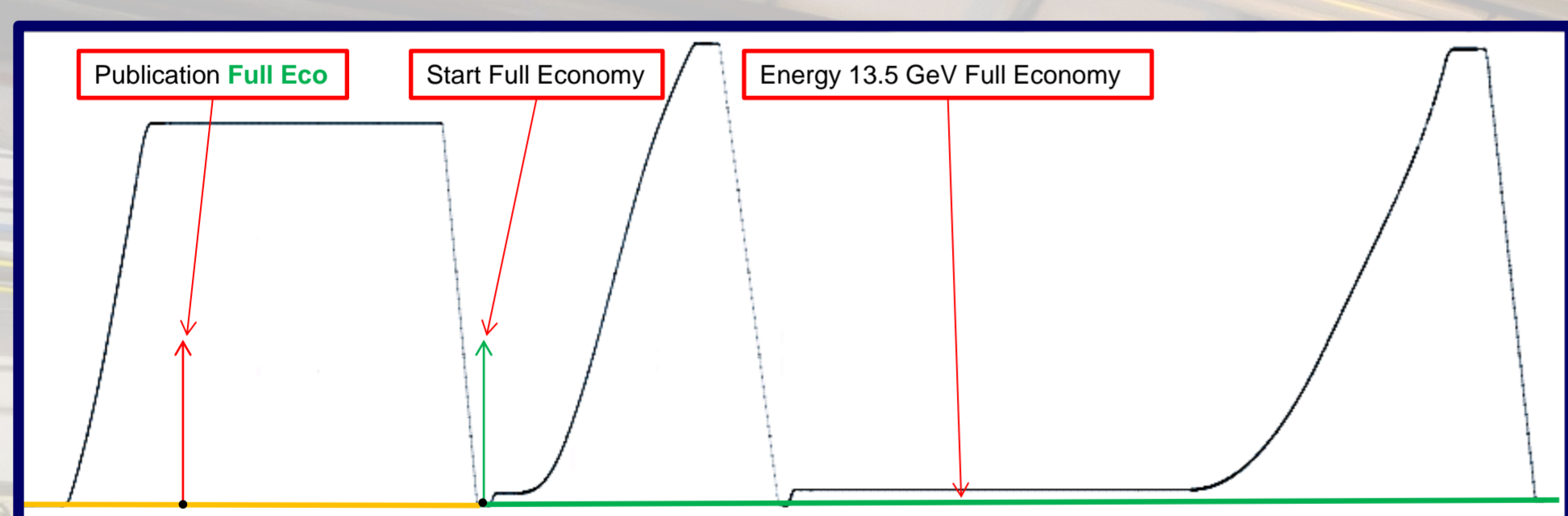
All of this must be executed in ~40 ms.



SPS Full Economy

Triggered by manual switch of external condition or a missing signal from electricity network supplier.

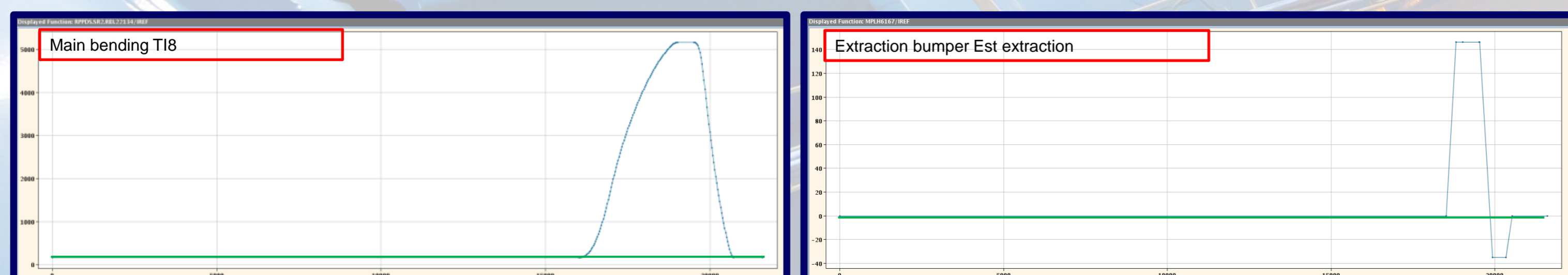
- Timing system will publish an event Full Eco in telegram.
- Main Dipole Power Supplies stay at 13.5 GeV for all cycles.
- All ring circuits stay at Imin.
- All transfer line circuits including TT10 stay at minimum current.
- 660 circuits switch on full economy.
- We can force the pulse manually for verification purposes.



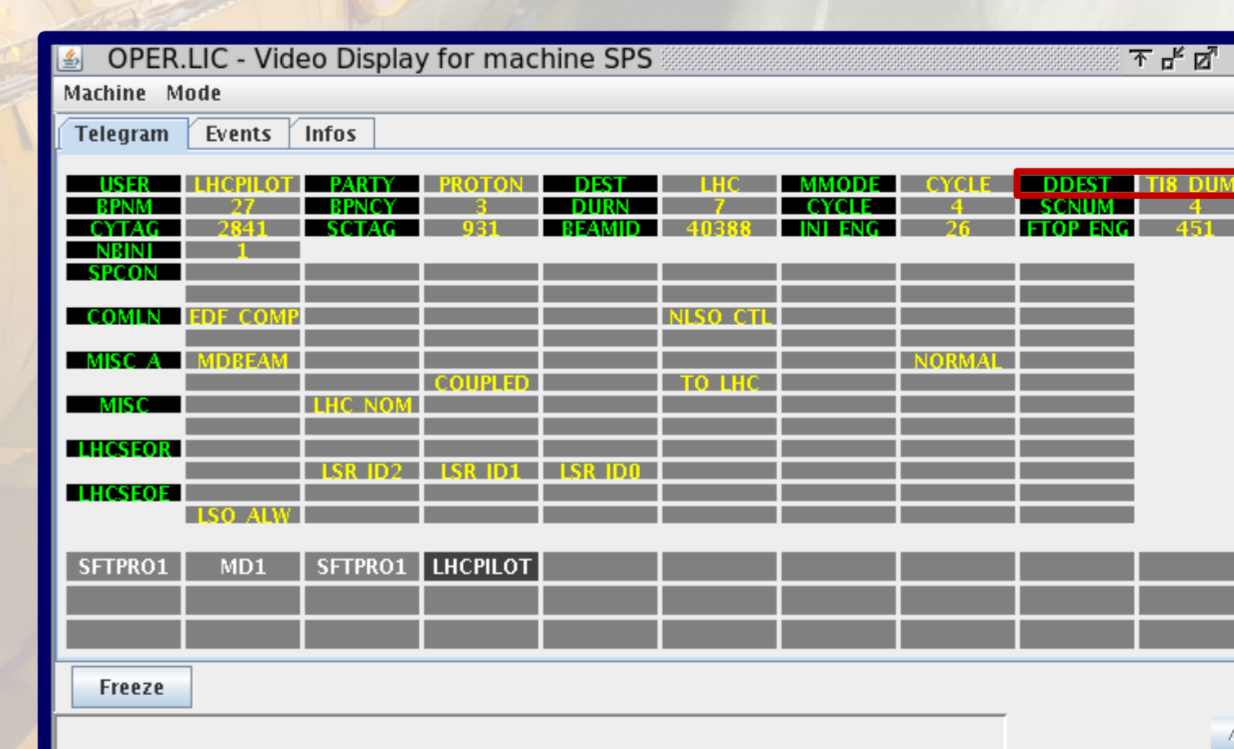
Full Economy Control

Transfer Line Dynamic Destination Economy

- Transfer LHC B2.
 - East extraction bumpers, TT40 and T18 will pulse only on dynamic destination T18_DUMP, LHC_B2.
- Transfer LHC B1.
 - West extraction bumpers, TT60 and T12 will pulse only on dynamic destination T12_DUMP, LHC_B1.
- Transfer Hiradmat.
 - West extraction bumpers, TT60 and TT66 will pulse only on dynamic destination Hiradmat.
- Overriding will be possible to test the lines.



Dynamic Destination Economy Triggered



With these three modes of economy not only do we gain an electrical energy saving but also we solicit the transformers, the power converters, the magnets and the vacuum chambers inside the dipoles only when beam is present in the machine. We therefore increase the life span of each element of the machine and in turn the reliability and availability of the SPS complex as a whole.