FGC3 Integration in PSB/PS

MSWG meeting

November 26th 2013

FGC3 Software Classes

- The FGC3 is the current power converter controller developed by CERN TE-EPC, based on the FGC2 used in the LHC

- Two different software classes will run on the FGC3:
  - Class 61 – For continuously regulated converters
  - Class 62 – For capacitor discharge converters

- Class 61 was created by porting the FGC2 POPS controller class in 2011 and was commissioned in 2012/13 in the PSB.

- Class 62 is being written now for pulsed converters in Linac4 – first tests with a real pulsed converter are planned before Christmas and full deployment is planned for the operational stop in April 2014.

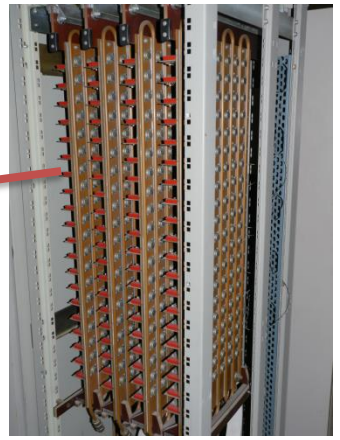
FGC3s in PSB

- 32 ACAPULCO power converters controlled by FGC3s running Class 61 were commissioned during the 2012-2013 run.

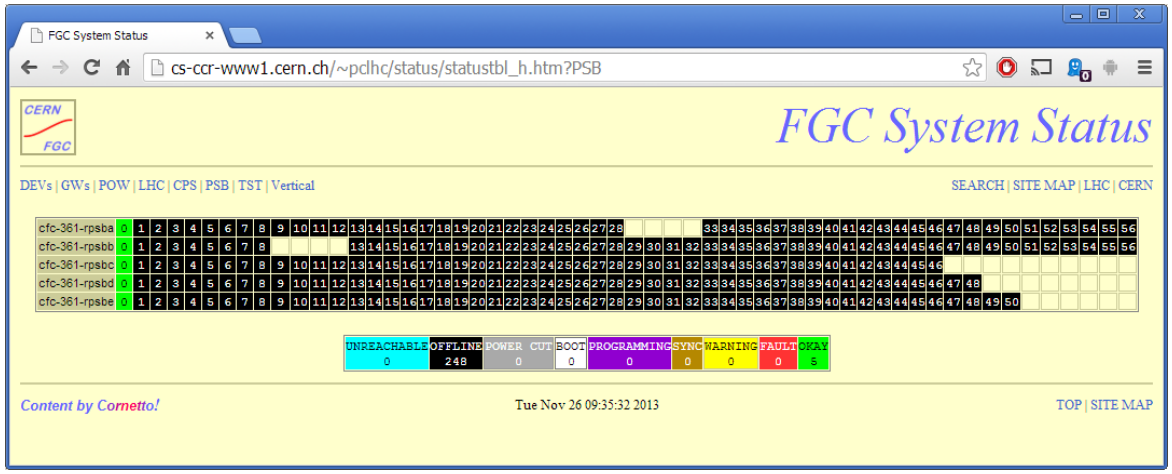
- Each ring has 26 dipole corrector circuits, but only 32 of the 104 circuits can be powered at one time.
- All 104 circuits were tested – some for the first time ever – and 37 were found to be inverted.
- Commissioning meetings followed the progress: http://cern.ch/proj-fgc/static/Platforms/FGC3/Commissioning.htm

FGC3s in PSB

- During LS1, the 145 old multipole corrector power converters have been removed and 82 new ACAPULCO converters have been installed.



- The 140 multipole circuits will be commissioned in the beginning of 2014.
- All five FGC_Ether gateways were installed in 2010/11 and have been running since then.
- An FGC device has been defined for every circuit.



Pending actions from PSB FGC3 commissioning

Actions pending since last meeting in April:

- Review of INCA re-subscription logic following excessive polling by INCA to re-subscribe to offline FGCs following ring change. **Action: GK, SP**
- Investigate subscription issues between INCA and FGC3s.
  - Ensure that the FGC subscription table is reset when a gateway is restarted. **(QK)**
  - Investigate why some signals are marked as disconnected following the restart of a gateway. **(GK, SP)**
- Review all cause/consequence and actions for FGC3 alarms and find out from the LASER team how to include USER information about an alarm. **Action: QK, SP, JLS**
- Add DIRECT and BLOCKING states to STATE.PC state machine **– DONE**
- Add REF.CCV as a non-volatile property **– DONE**
- Review how to hide unused circuits in OASIS viewer **– in progress**
- Implement the pre-function policy PPM property and add it to INCA and the knob **– in progress – not required for PSB**
- Define an approach to handle non-PPM cycling converters **– DONE**
- Agree a way for the operations team to identify the cause of an interlock, to reset it if possible or take an appropriate action to resolve the problem. **Action: Pierre Dahlen, RS.**
- Include a step in the circuit reconfiguration procedure to test the connection with the WIC when present. **Action: Serge, Pierre Dahlen - Delay till 2014**

FGC3 in PS

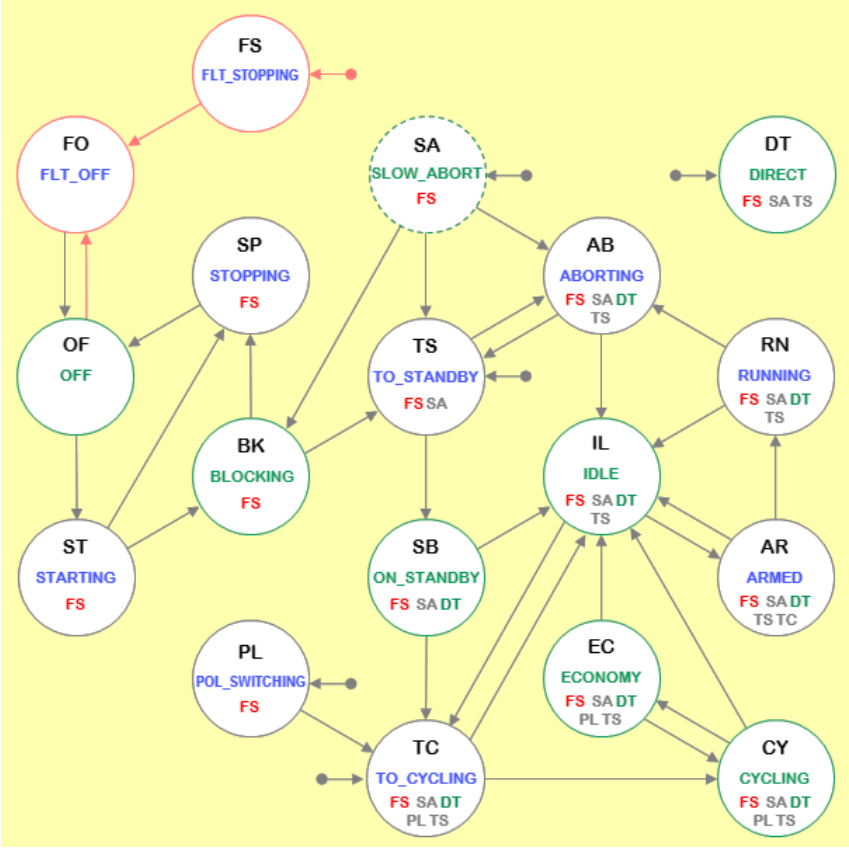
- During LS1, only 4 new FGC3-based systems will be installed in the PS using the new CANCUN converters (these are updated ACAPULCOs with higher voltage-loop bandwidth)
- These 4 new systems are for resonance compensation

- For the moment, the only other FGCs in the PS are the FGC2s that run the old MPS (rotating machine) and the new POPS.
- The POPS controls will ultimately be migrated to FGC3 to benefit from the increased network bandwidth (FGC_Ether is much faster than WorldFIP) and logging memory.
- This upgrade will be in LS2 or LS3.

Important changes in FGC3 software

Power Converter State Machine

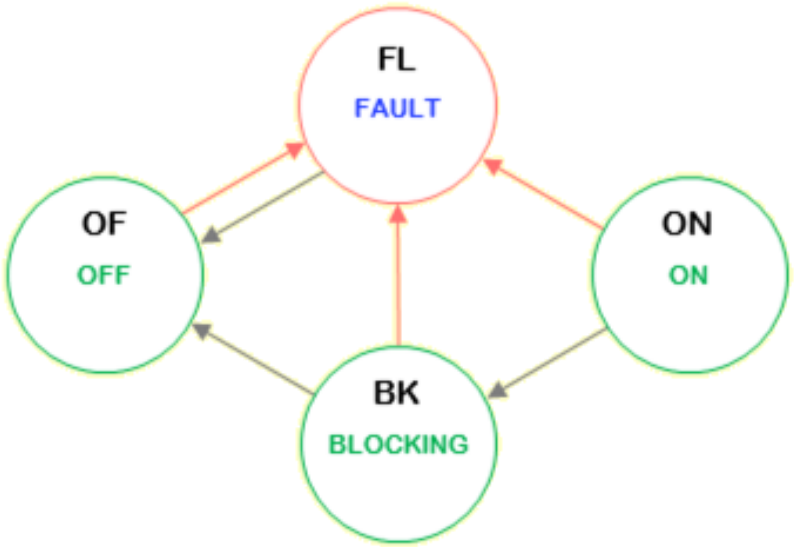
- **Three new states added**
  - BLOCKING - output stage of converter is blocked (like ON_STANDBY in the PSB now)
  - DIRECT – current reference is set in REF.CCV property
  - ECONOMY – state used in the new FGCD MUGEF for the SPS economy cycles
- **Deployment targeted for week 3 of January – must be rolled out everywhere at once.**



Important changes in FGC3 software

Power Converter State Machine

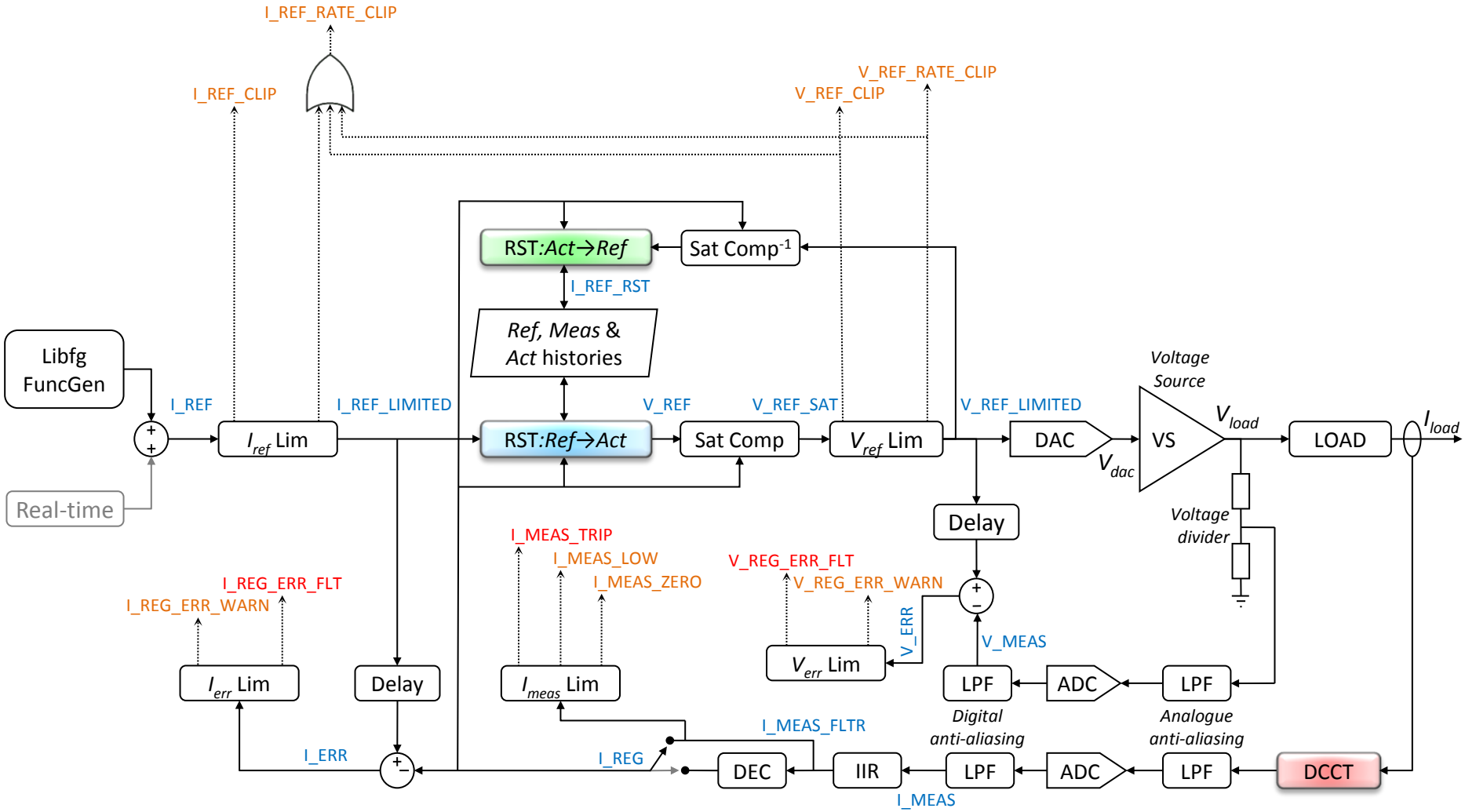
- **Simplified power converter state machine added**
  - Only three target states for MODE.PC_SIMPLIFIED :
    - OFF
    - BLOCKING
    - ON



  - Target state ON is defined using the STATE.PC_ON property. Three options are supported :
    - IDLE
    - CYCLING
    - DIRECT

In development for 2014

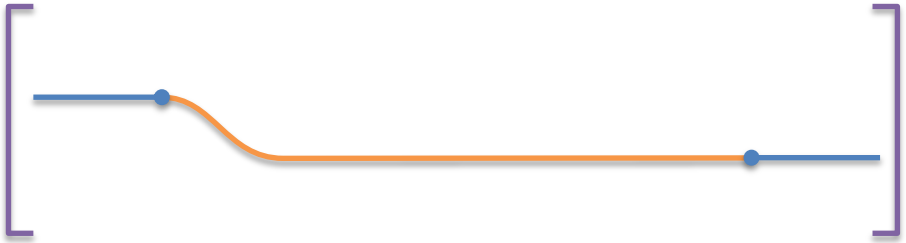
Improved regulation algorithm with better filtering - Field regulation support



In development for 2014

Pre-function policy property : REF.FUNC.PREFUNC

- **RAMP**

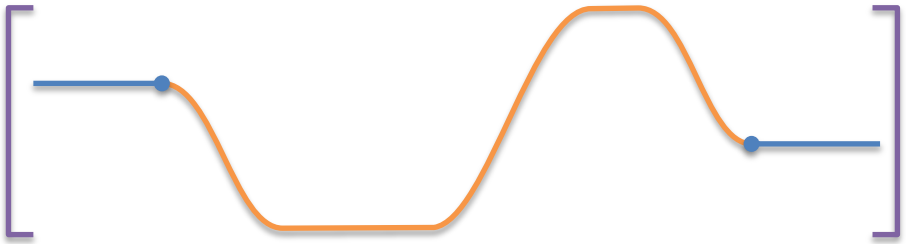


Minimise I_{rms} by ramping down early and ramping up as late as possible.

- **MIN**

Minimise I_{rms} even more by ramping down to I_{min} immediately and up to new function as late as possible.

- **MINMAX**



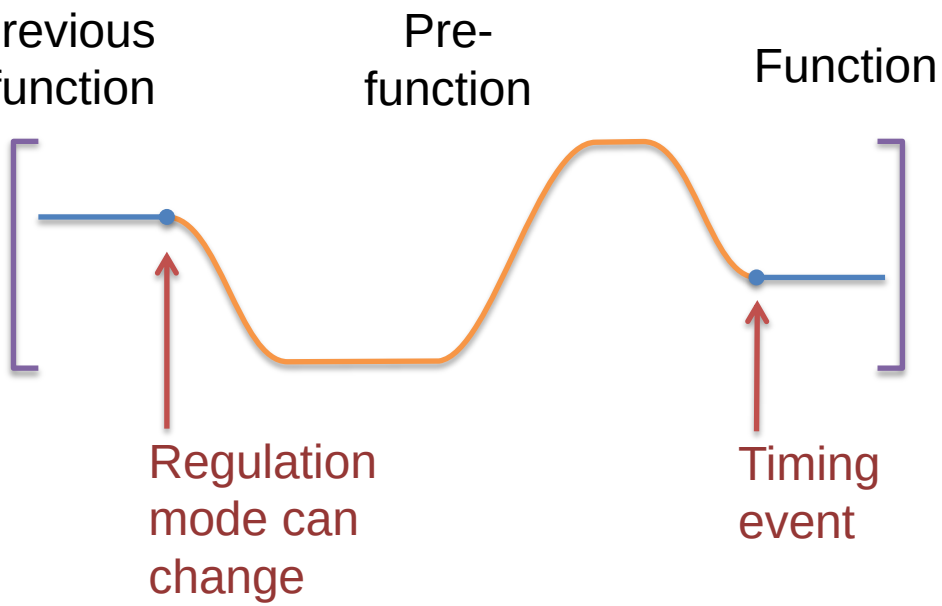
Minimise I_{rms} and field reproducibility by always descending to new function.

In development for 2014

Pre-function policy property : REF.FUNC.PREFUNC

- Each reference function will combine a pre-function segment and a function
- Each reference has a regulation mode (field, current, voltage) – field measurement is expensive so it is only available when it is really needed
- The regulation mode can change at the start of the pre-function segment
- The pre-function segment is not controllable with a capacitor discharge converter

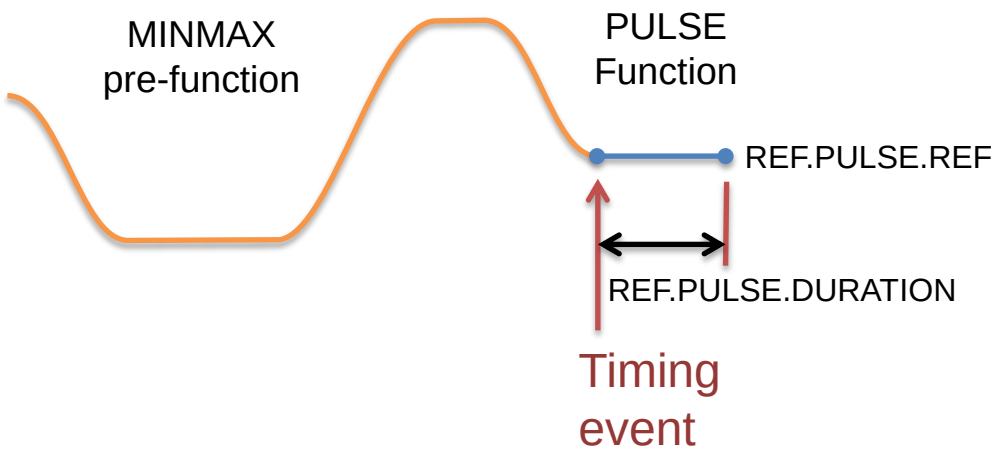
- **MINMAX**



In development for 2014

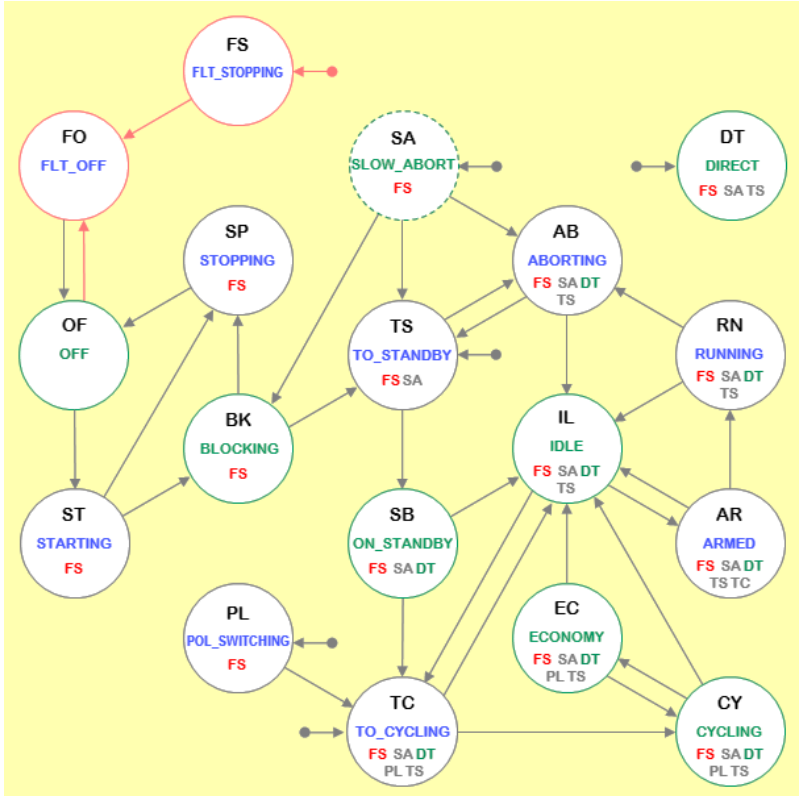
New reference function: REF.PULSE

- The simplest of all reference functions – for transfer lines
- It is the only function supported by capacitor discharge converters
- Two PPM properties:
  - REF.PULSE.REF
  - REF.PULSE.DURATION
- One non-PPM property:
  - REF.EVENT_CYC = CYCLE_START or INJECTION, or EJECTION



In development for 2014

- FGC software supports CYCLING/NON-CYCLING and PPM/NON-PPM devices:
  - DEVICE.CYC ENABLED/DISABLED
  - DEVICE.PPM ENABLED/DISABLED
- Support for CYCLING NON-PPM devices is needed in Linac4
- This is awkward for the FGCs because the upper-level control system does not discriminate between “ALL USERS” and “NO USER” – we get the same cycle selector.
- So the FGC3 must share the same memory slot for settings for these two cases
- So when switching from CYCLING to IDLE there is a conflict
- Not a serious problem with the PS/PSB but this transition is used in COAST in the SPS



Summary

- The FGC3 hardware has enormous potential to support improved features for converter control, especially improved diagnostics.

- We are still very early in the software development process, but we have a solid foundation from the 2012/13 commissioning in the PSB
- Operation in 2014 will depend on the FGC3s for the multipole corrector circuits which are essential (unlike the dipole correctors), but the FGC3s will be ready.

Thanks to TE-EPC LPC, CCS and CCE sections.