Equipment for testing of larger structures - system test

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Equipment for system test

- Assumption that the device to test is equipped with temporary or “real” boards to connect type-1 cables

- Data transmission:
  - Short twinax from PP0 to Optobox (shortest production length to keep ”tuning” to GBCR, no extra production) → more details to be followed-up with planning of Su Dong
  - Optoboards v1 up to 3 per sub-system
  - Mount and cooling for Optoboards to be prepared (liquid cooling at 10°C)
  - Fibers to Felix servers: in SR1 50 m fibres, for sites shorter fibres (length to be seen), 2 MPO24 OM3 per Optobox fibres not required to be radiation hard, fibre shuffling box
  - Power cable: 9-12 V, Optobox motherboard with two FEAST DC-DC converters (mostlikely not yet BPol12), alternatively temporary readout of temperature sensors required. FEAST used as two stages 10 V → 2.5 V. Powering of 10 V with lab power supply (TBC)

Equipment as pre-production items from various WBS

- DAQ FW/SW
  - FELIX v712 Phase-I boards (2 in Liverpool) further ones getting tested and available in Summer 2020. Server PC ordered
    - However server and boards can't stay longer than 3 years outside of CERN , otherwise VAT has to be paid by institutes (mostlikely anyway the case for non-EU sites)
  - DAQ/DCS FW/SW: "ready for system test", via WBS 2.1.11 (Joern Grosse-Knetter) to be prepared. Effort needed to get it operational!
  - "Shopping list for readout by Joern Grosse-Knetter https://indico.cern.ch/event/871587/contributions/3675876/attachments/1971656/3280022/RD53A_readout_schedule.pdf

Equipment as pre-production items from various WBS

- Powering:
  - ~~Power supplies from pre-production, via WBS 2.1.8~~ Market survey not progressing well
    → power supplies most likely to be purchased by groups
    - Survey on what PSU do you already have: https://forms.gle/Ear5UTSKdh7eVj4F9

  - In Sites: Place on dummy PP0 for power molex connectors – thick cable with banana plugs to PSUs, place PSUs next to setups. On LV/HV boards use short type-1 power cables with banana plugs to PSUs?
  - In SR1: Place on dummy PP0 for power molex connectors cables to dummy PP1 (molex to molex), then cable to PSUs in rack room (setup in radiation lab)s

  → Details on availability of cables to be discussed

- DCS/Interlock
  - DCS controller emulator on FPGA – flat ribbon cable (IDC connector with 4xn Module lines)
  - DCS Units: custom-made units based on PLC → development ongoing in Liverpool and by N. Pacifico (CERN)
  - In addition monitoring via DCS via FELIX to monitor module ADC temperatures
  - Monitoring of temperatures and voltage drops via MOPS. Development of software started

Further equipment

- Environmental chamber (parts in the chamber in SR1)
  - Thermally insulated and light-tight enclosure to mount and protect prototype
  - Cables with electrical rating: 8 A, up to 700 V bias voltage
  - Dew point well below operation temperature (dew point sensors from Vaisala)
  - Flushed with nitrogen or dry air
  - (Camera, microscope for optical inspection)
  - Motorized stage for source scans
  - Door switches
  - Sensors for humidity, temperature (on module, in box), dry-out, dew point, light (use of same sensors will make use in interlock easier)

Equipment in SR1

For testing of new prototype with RD53A

- LV need max. 2 V, 6 A per FE
- Power supply with min. 24 V per channel (~30 V)

- Specific LV current source under development by Bonn and Wuppertal with WIENER. If functional, additional ones can be purchased for setup
- Power supply for HV: re-use ISEG
- Power supply for DCS controller: re-use MPOD
- Power supply for Optoboards: max. 15V, 3A – use MPOD

First current source prototype from WIENER

- Cable rated to 8 A for powering to be selected/purchased/re-used
- FELIX: 3 SWRODs with 100Gbit network, up to 3 FELIX v712 boards
- Fibres to be purchased 2 MPO24 OM3 fibres from one optobox to FELIX board, fibre-shuffling to be seen (ongoing qualification task)
- Optoboards from sub-systems foreseen, liquid cooling at 10°C with chiller or C6F14
- SR1 TTC crate and scintillators (currently not in use)

- Pulse generator for low power mode (not available yet)

- Interlock matrix crate (from IBL, later from pre-production) (new qualification task)
- CO_2 cooling plant (1.4 kW at -30°C)

Comments on testing

Aim to validate with a loaded local support (RD53A)

- Assembly and loading of loaded local supports, integration of services and required accuracy
- Type-0 services
- SP-chain operation on local support
- Readout tests, data rate test with realistic services on local supports (as much as available regarding type-1)
- Thermal performance with realistic modules (power consumption, non-homogenity)
- Grounding & shielding behaviour

➢ Perform all required tests for the module FDR, on-detector services FDR and loaded local support FDR → Required results to be further discussed with related coordinators

➢ Collect failure modes and durations of testing to give input for QC in production

➢ Use of production database to compare to results from module testing

- Anything else?

System testing: Tests 1

- **Readout for multi-modules**
  - **Multi-module readout**: FELIX based
  - **Tuning of FE**: standard, to minimum threshold
  - **Variation of HV:** modules without HV, ramping tests, several lines per chain
  - **Module cross talk:** modules close to each other, tests with type-0 services
  - **Reduction of noise**: optimization of grounding, impact of noisy modules
  - **Impact of misconfigured readout** on modules
  - External trigger and running with TTC/LTI
  - Double-trigger, high trigger rate and close trigger tests
  - Bandwidth and data processing test
  - Recording of full data stream
  - Frequency and amplitude sweeps to be performed and impact on modules assessed using previous readout tests and tuning
  - Robustness to noise: Tests with high leakage current - ‘lights on' test to emulate irradiated modules
  - Test with high noise: Varying of sensor bias and/or direct manipulation of global gain (Vthin param) → increases noise occupancy → potential oscillation of SP?

- **Data transmission**
  - **Data transmission with realistic chain on local support**
  - **Tuning of lpGBT, phase-tuning**
  - Verification of high speed readout (1.28 Gbit/s from FEs)
  - **(CMD forwarding) not in services foreseen**
  - **Uplink sharing?**

- **DCS**
  - **Test of DCS controller**: DCS controller
  - **DCS monitoring via FELIX**
  - **Interference between** all the different elements that are now tightly coupled on the local supports? (MOPS, GBCR, different sensors, other SP chains)

System testing: Tests 2

- **Powering**
  - **Serial powering tests on multi-modules**: monitoring of currents, impact from off-mode of HV power supplies for different operation modes (LV on/off, HV on/off, etc.)
  - **Tuning of resistors:** Test of transients of coupling capacitors with long chain for readout and DCS controller
  - **Noise injection test:** tests with noisy tuned modules performed, double trigger noise tests, injection of magnetic field, injection of RF
  - Measure: Module I-V curve
  - Measure: current balancing on the module, or local (=regulator) current overhead

- **Grounding and shielding**
  - Understand protection of shielding, HV tests, variation of scheme (several HV lines per SP chain)
  - Noise insertion tests with RF energy injections
  - Decoupling of modules from cooling pipe/structure (AC/DC)
  - Electrical break?

- **Welding test???**

- **Magnetic field**
  - Test of fully loaded local support in magnetic field?

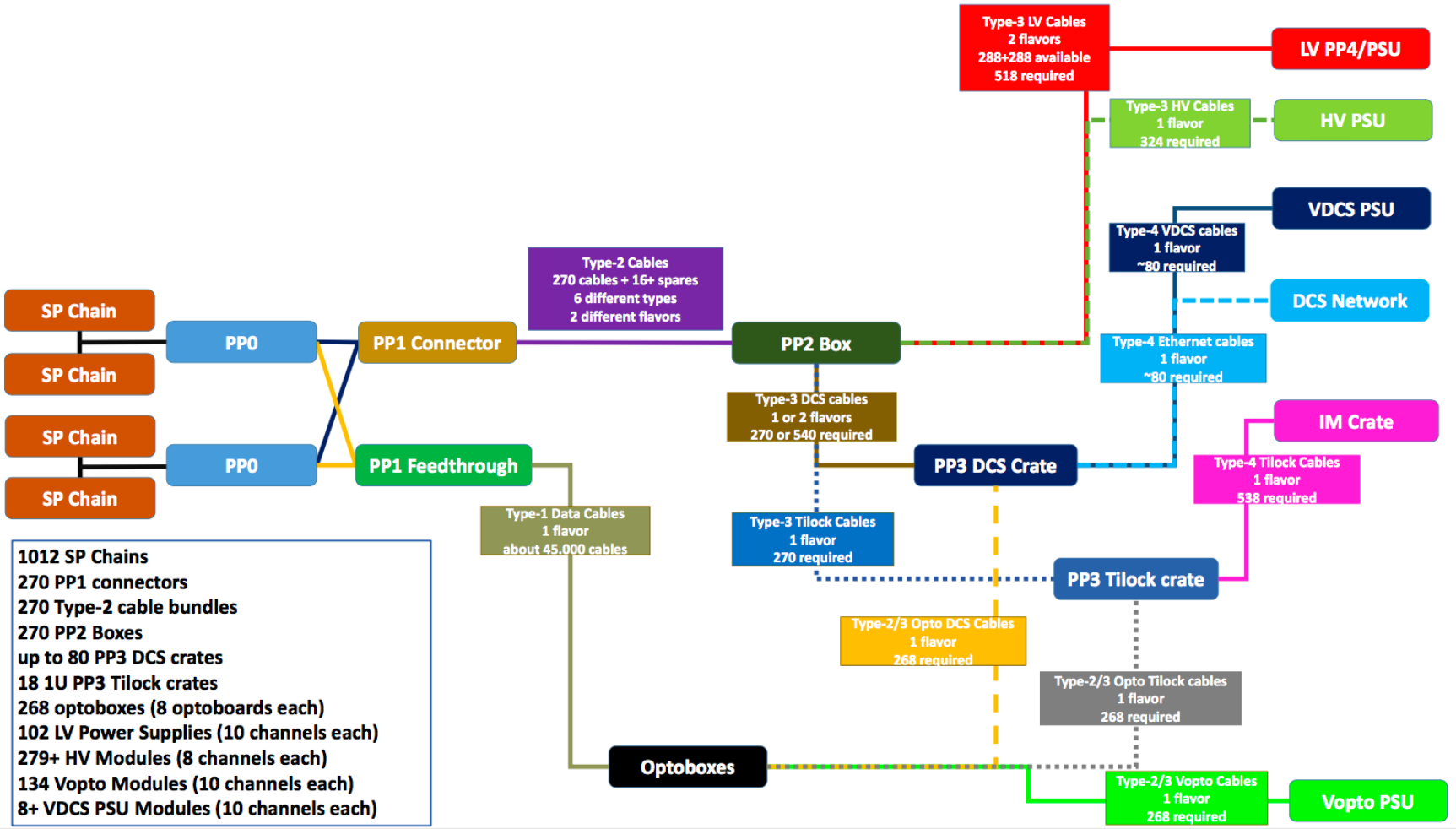
System testing: Tests 3

- **External Trigger**
  - Run with TTC crate
- **Cooling**
  - Run at different temperatures, preferably at operation temperature
  - Long-term test of chain
- **Source Tests**
  - Comparison source tests and noise runs

Discussion of tests in system test started two years ago on:
https://docs.google.com/document/d/1jmDvE_2tNZs-DXdRHX1j5ayfZ_TYyT6_3A_t328xf3g/edit

SPARE

Pixel Services



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