QRL Sector Tests– Cryogenics

What are the tests for?

The tests are done in order to verify the conformity of the QRL with the specifications stipulated in the technical specification LHC-QRL-CI-0001.

OK => deliver *Certificate of Provisional Acceptance*

Problems => Repair & restart

What are the QRL tests not intended for?

The QRL tests are not aimed at validating other LHC systems

⇨ As long as schedule is not compromised OK

Schedule

- The tests run from late 2003 until early 2006.
- No parallel tests of QRL sectors are foreseen
- Electrical crates need to be removed before magnet installation
- QRL is on the LHC critical path

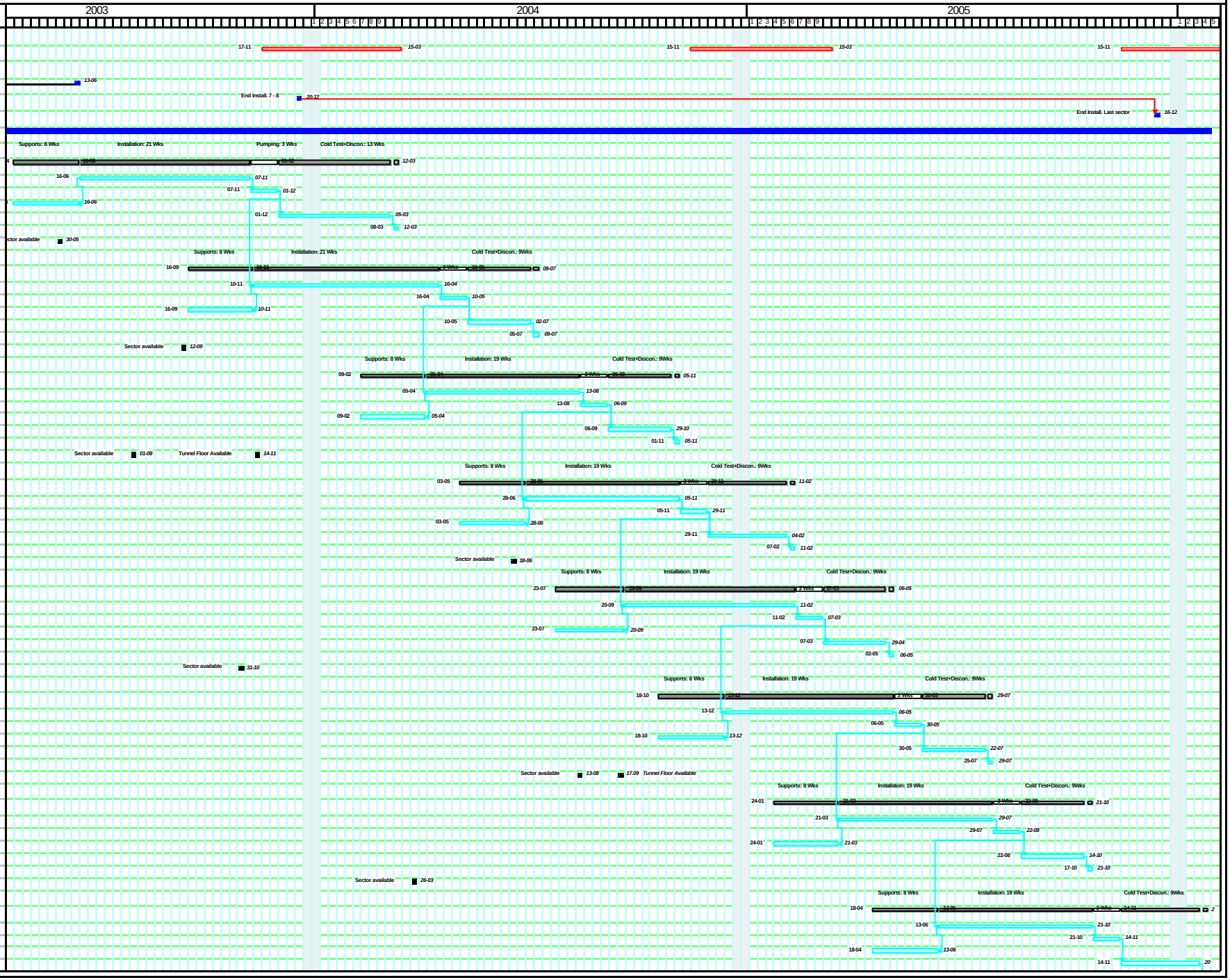
Roger GIRARDOT

Révision du 20.02.02
Edition du Wed 27-03-02

LHC CRYO : QRL Installation-Schedule

MARS 2002

CAUTION: CERN CALENDAR WITH 2 WEEKS CLOSED END OF EACH YEAR



Roger GIRARDOT

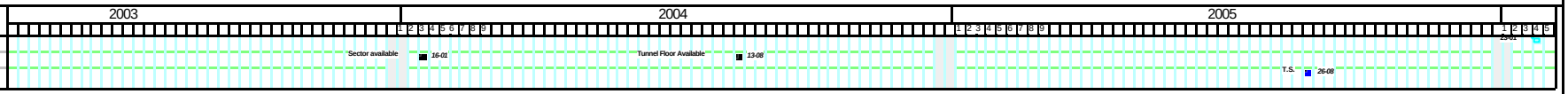
Révision du 20.02.02
Edition du Wed 27-03-02

LHC CRYO : QRL Installation-Schedule

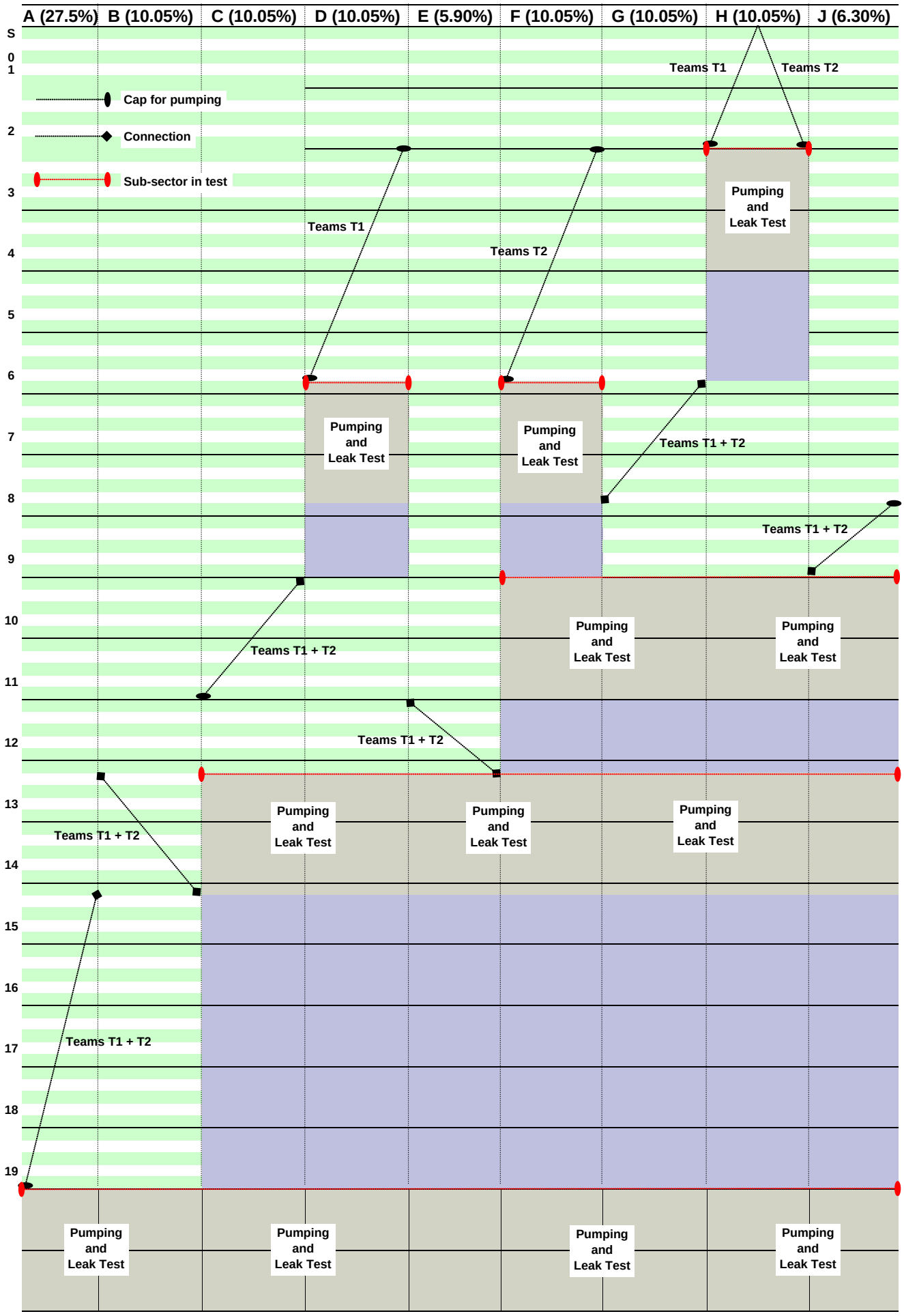
MARS 2002

CAUTION: CERN CALENDAR WITH 2 WEEKS CLOSED END OF EACH YEAR

ID	Task Name
124	*Disconnecting QUI*
125	*Sector available*
128	Technical Specification: 28 August



Scenario:19 weeks installation with 2 teams (2 x 8h00)



QRL Sector Tests– Cryogenics

Reception Tests

After installation of each QRL sector reception tests will be done to:

- Verify correct operation of components (sensors, actuators)
- Verify mechanical characteristics
- Asses overall behavior at cryogenic conditions
- Measure the thermal performance

QRL Sector Tests– Cryogenics

Test Procedure

- After assembly of the QRL (sub) sector, the insulation is pumped out and both leak & pressure tests are performed.
- "Magnets" are replaced by "test Boxes" housing interconnecting pipes.
- Test 1: Circulation of cold helium only in the main headers (pipes)
- Test 2: Circulation along headers & interconnection pipes in "test Boxes".

Process Characteristics

- Cryogenic equipment is extremely **slow**
- Measurement of thermal properties is **even slower**, static conditions are required.
  => accuracy of instrumentation is the issue
- No disturbances due to circulating particles beam, eddy currents,…….
  => No very complex dynamics => Control shall be much simpler than for the LHC

=> Programming shall be straightforward

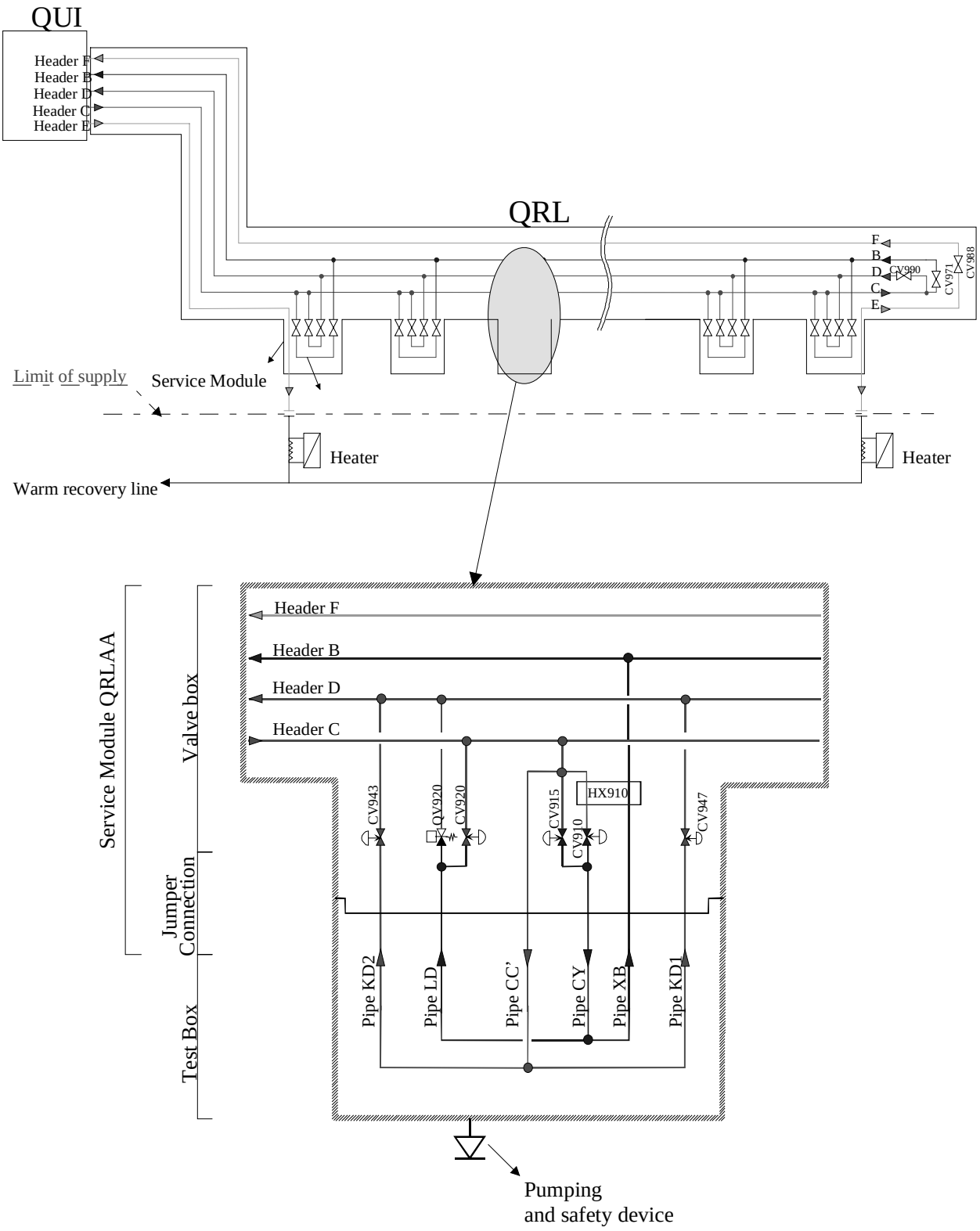


Figure 12-1: Typical base frame flow-scheme of a QRL Sector

QRL Sector Tests– Cryogenics

Requirements for tests

- Access to tunnel already 8 weeks before installation
- Utilities: electrical power, compressed “air”, …
- Adjacent cryogenic refrigeration
- Control Infrastructure: Ethernet network, “piquet” calls
- Vacuum in full operational status
- Cables
    - WorldFIP (digital)
    - alcove ⇔ QRL Service Module (SM)
    - QRL SM ⇔ Local electronics
- Cryogenic (industrial) control equipment in operational status
- World FIP equipment for signal readout
- Wireless communications for safety & mobile SCADA

QRL Sector Tests– Cryogenics

Open Issues

- Position of controllers (Alcoves or local control room) ⇔ network reliability vs equipment reliability
- Valve positioner not yet chosen, it can be of either “smart” or “analog pneumatic” type
- LHC type electronic cards will not be on ready until mid-2004
  => Use (fabricate) prototypes for missing parts
  => Shuffle IO crates to QRL sector under test
  <= Evacuation of electronics imposed by installation of cryo-magnets

Conclusions

Schedule is tight and all “LHC solutions” will not be ready for the first QRL reception test, but fallback solutions are (already) available.

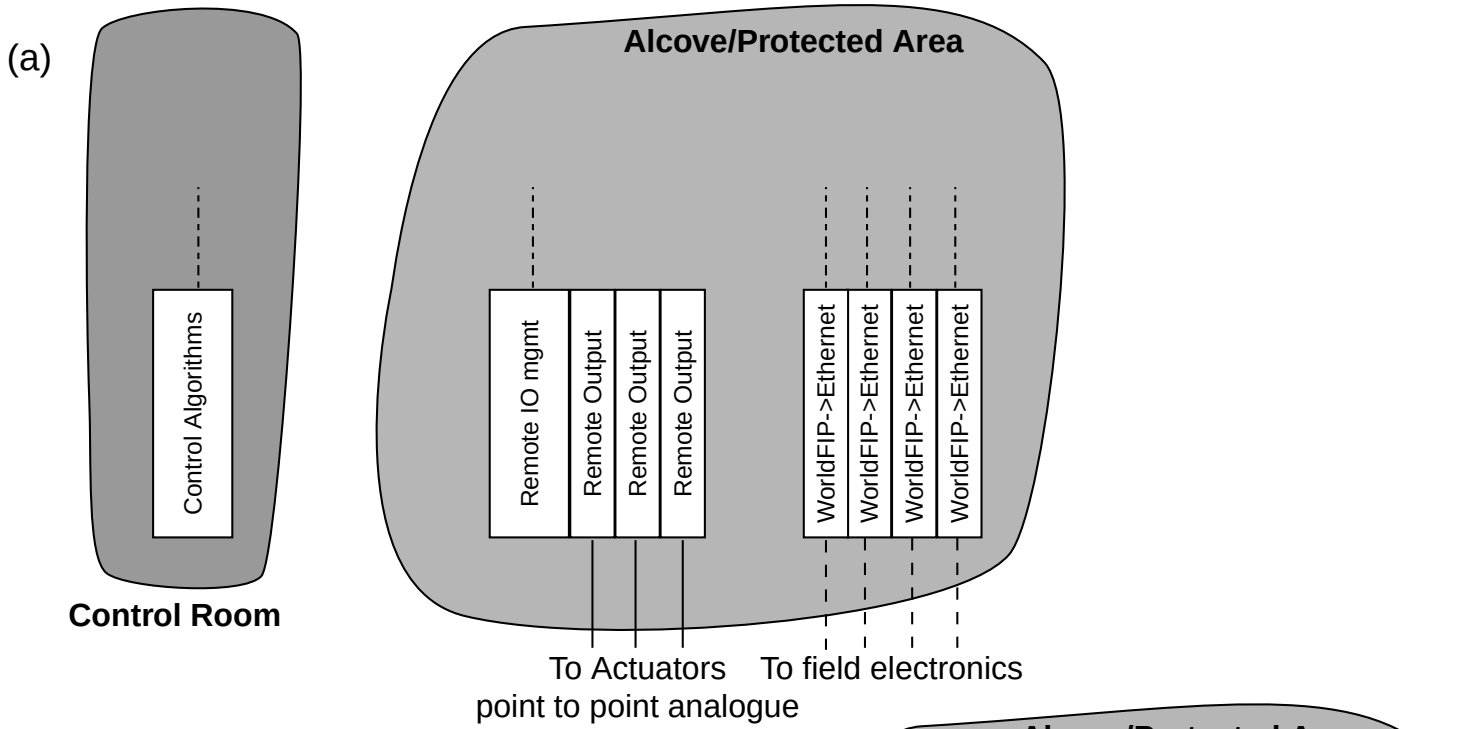
"Field Network" for tunnel cryogenics

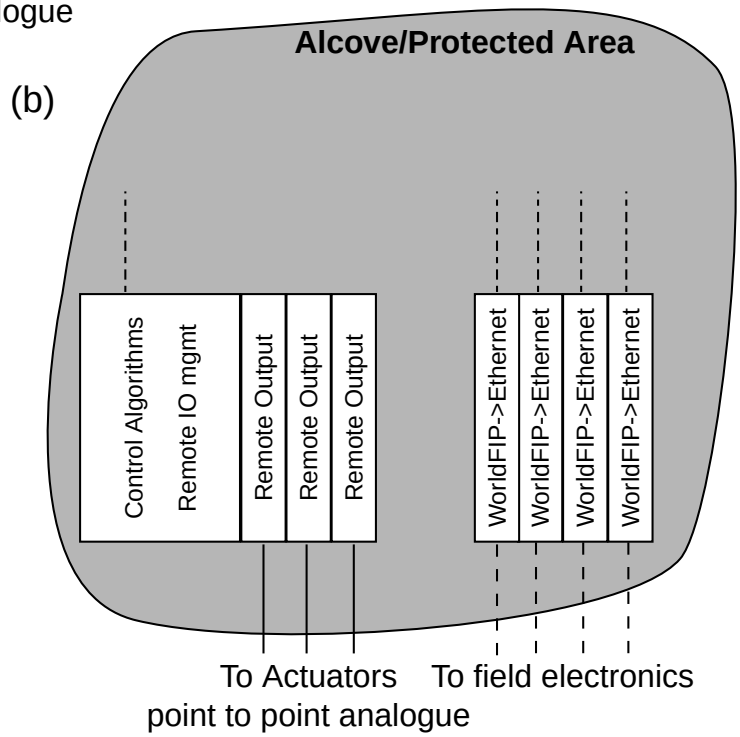
For Cryogenics the control system is highly distributed:
- WorldFIP and analogue wires are used to exchange information with the field (tunnel),
- Ethernet is used for exchanging information with "WorldFIP interfaces",
  "Schneider remote IO" and "Schneider controllers".

The closed control loop algorithms are calculated in the controllers.
Case (a): Ethernet must be available during all phases concerning installation, commissioning & operation of cryogenic equipment.
Case (b): Ethernet availability is required only locally. Wide area Ethernet still required for SCADA or data server applications.

Note that it is not completely ruled out that one day WorldFIP interfaces may be integrated directly onto the PLC backplane.

How are the network connections routed?



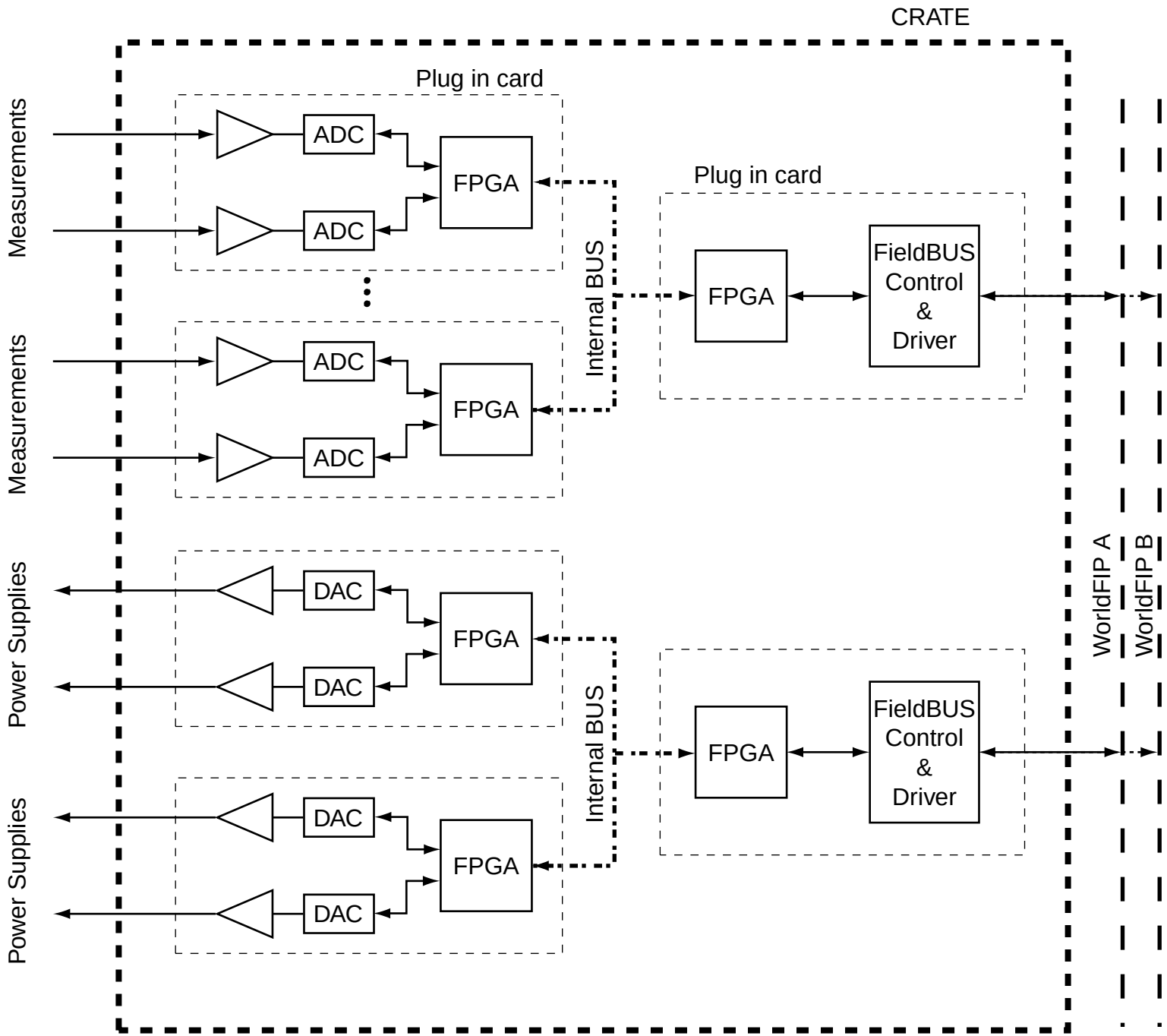


Ethernet

WorldFIP

Analogue

LHC Cryogenic crate for tunnel



Crate Capacity
FIP Addresses: 4
Measured values: 30
Variable Power Supply: 8

FileldBus Control & Driver:
- MicroFIP C131
- MicroControlled Mode operation

FPGA:
- Microprocessor emulation
- RT Data Processing
- Digital IC Communication mgmt.
- Digital IO (to/from field)
- Neighbour Reset