Hardware Solutions

For Motion Control at the ESRF

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Motion Control at the ESRF

Different actuators

- Stepper motors (~5000 axes)
- Brushless and DC (brushed) motors (~30 axes)
- Piezo-electric actuators (~100)
- Piezo-motors (~30, but growing)

Different Position Sensors

- Incremental encoders, optical or interferometers
- Absolute encoders (different protocols: SSI, BISS, EnDat, ...)
- Sensors with analogue output
    - Capacitive sensors
    - Strain gauges
    - LVDT sensors

What are the specific needs?

Continous Scan Generalisation

- Hardware synchronisation of positioning devices and detectors (fly scans)

Advanced functionalities

- Multiaxes, synchronised movements
- Parametric, complex trajectories (coordinated motions, N dimensions)
- Movements triggered by external hardware signals
  - Shutters
  - Hardware synchronised motion sequences
- Closed loop with exotic sensors

Hardware solutions at the ESRF

The ESRF strategy: Define a set of standard control components

Specialised
- Well defined functionality
- Not invade/usurp other element's functions

Flexible
- Easy to interface with the other devices

Adaptable
- Functionally rich, able to cope with a myriad of requirements

High performance
- Dedicated specialised components can achieve higher performance

Hardware Solutions at the ESRF

Piezo-electric actuators control

PI controller family E-500

- High voltage Amplifier
- Servo controller modules (analog regulation)
- Accepts strain gage sensors
- A communications module can be added in old installations, giving access to output triggers, programmable trajectories…

PI family E-700

- High performance (digital servo controller)
- Intelligent communications module
- Output triggers, trajectories programmable
- Control of PI piezo-motors through a common command set
- Only capacitive sensors

Some ESRF developments

V2F100

- Analogue voltage to high frequency converter
- Two independent input channels
- 100 MHz full scale output
- SSI-encoded output
  - The analogue input voltage can be seen as an absolute encoder (SSI protocol).

MUSST : Syncronisation / Triggering unit

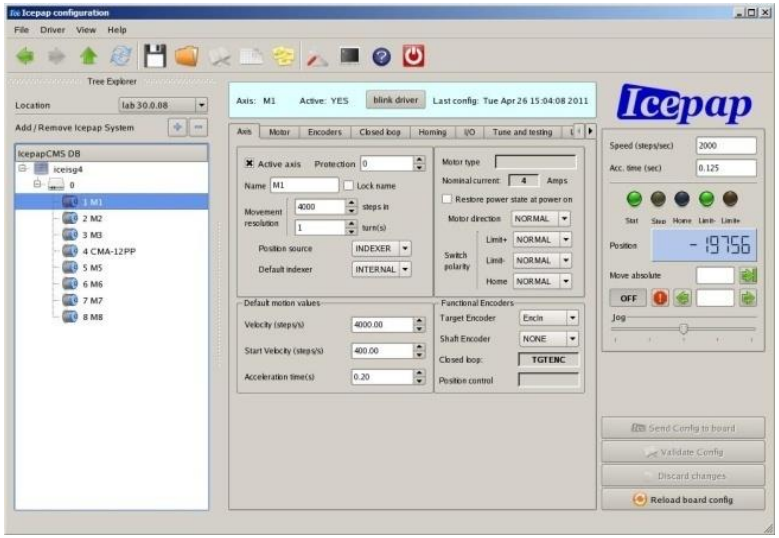
Can be operated also as a data acquisition unit.

- 6 main input channels (counters, incremental and absolute SSI encoders, analog signals, …).
- A fast internal programmable sequencer (FPGA based)
- External or internal events can be combined to generate trigger sequences

The IcePAP motion control system

An ESRF/ALBA development collaboration
The motor control standard for ESRF and ALBA

- 3000 drivers manufactured and installed at the ESRF
- 2500 drivers to be manufactured in the next 3 years



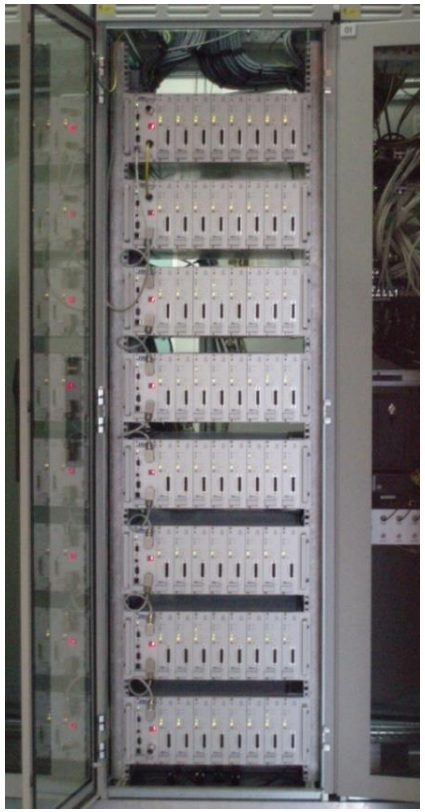
Adapted to the ESRF basic needs

With one single equipment, most of the motors at ESRF can be driven.

Easy to maintain
- Simple installation and maintenance
- Standard cabling
- No micro-code to load

A rich set of configuration parameters
- fully software configurable
- Need of a configuration tool -> icepapcms

A high quality system with low production cost
- 500 €/axis
- high performance: high resolution, closed loop, homing
- reliable

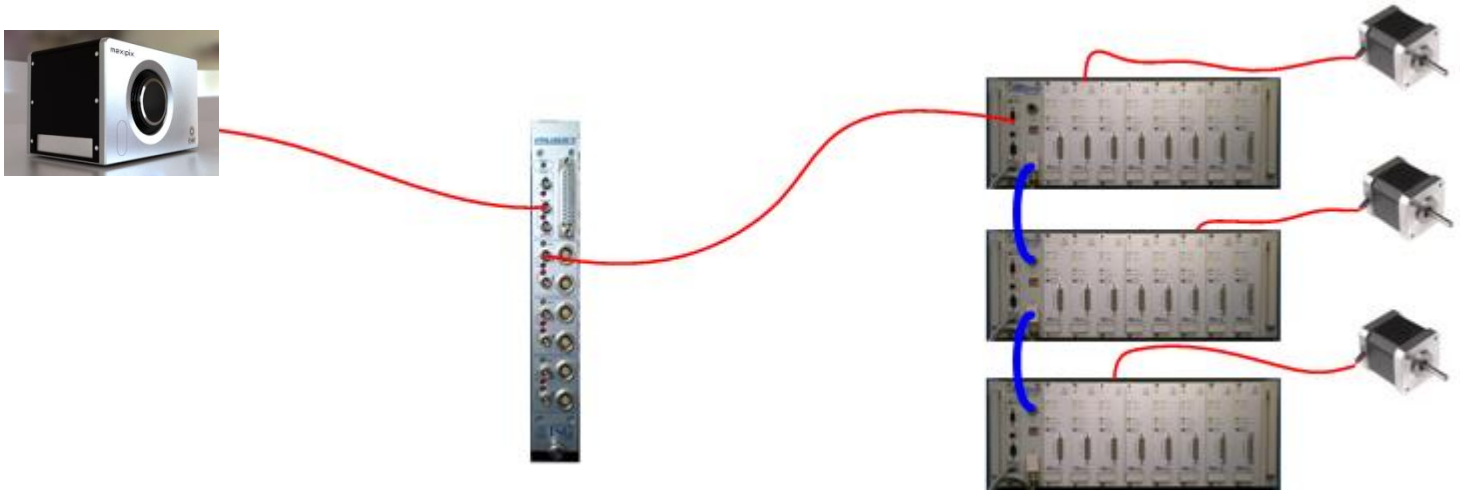


➔ All the needs for single axis control are fulfilled

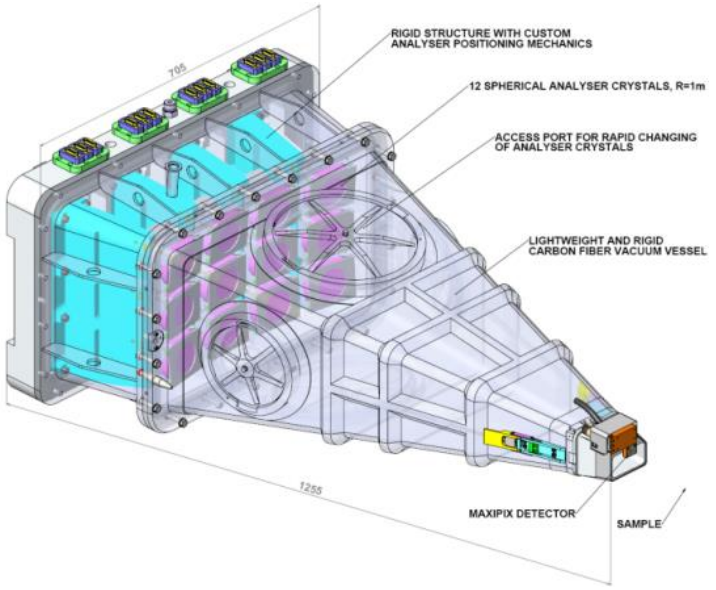
Multiaxes and synchronisation capabilities

Up to 128 axes in a single system

- Synchronised actions inside a system
- Synchronisation among different systems is possible
- Output position signal multiplexer for detector synchronisation



IcePAP Example Applications: ID20 (UPBL6) Raman Spectrometer



- 6 x 12 x 3 = 216 stepper motors to position the analyser crystals
- All the axes are moved simultaneously for fast alignment

Easy to interface with other elements in the experiment

Interface to external power drivers

Easy and standard interface with

- Other motor power drivers: brushless (i.e. Aerotech, Etel, …)
- Piezomotor controllers (i.e. SmarAct)

Electronic cam:

A synchronisation output pulse in each driver

➔ Detector synchronisation without external synchronisation hardware (no MUSST needed!)

New functionalities under development

Movements triggered by hardware

- Motion triggered on external signals
- Sequences driven by an external signal

Parametric, multiaxes trajectories

DC and brushless motors control & enhanced power control strategies

Advanced diagnostics and tests

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