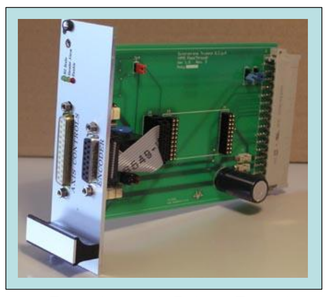
YAMS: a Stepper Motor Controller for the FERMI@Elettra Free Electron Laser

AUTHORS **A. Abrami, M. De Marco, M. Lonza, D. Vittor.**
Affiliations Sincrotrone Trieste, Trieste, Italy.

ICALEPCS 2011

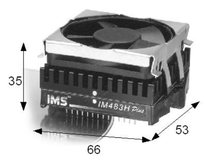
New projects, like FERMI@Elettra, demand for standardization of systems in order to cut development and maintenance costs. The various motion control applications foreseen in this project required a specific controller able to flexibly adapt to any need while maintaining a common interface to the control system to minimize software development efforts. These reasons led us to design and build "Yet Another Motor Subrack", YAMS, a 3U chassis containing a commercial stepper motor controller, up to eight motor drivers and all the necessary auxiliary systems. The motors can be controlled locally by means of an operator panel or remotely through an Ethernet interface and a dedicated Tango device server.

2 Phase Stepper Motor Driver			
Card Name	**IM481H**	**IM483H**	**IM805H**
IMS hybrid	IM481H	IM483H	IM805H
Motor current (peak)	0.2– 2.1 A	0.5 – 4.2 A	1 – 7.1 A



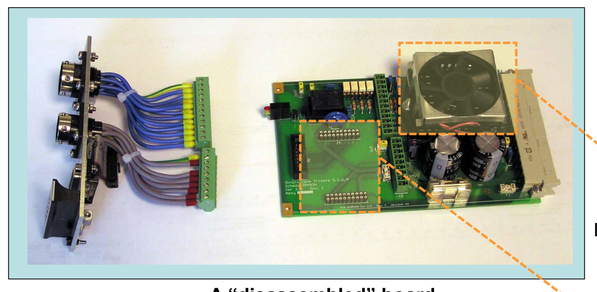
Passthrough Driver Board

IM481H Driver Board



IM483H & IM805H Hybrids

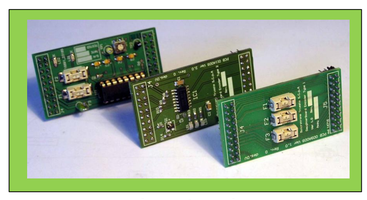
IM483H & IM805H Driver Board



A "disassembled" board

Motor Driver Boards

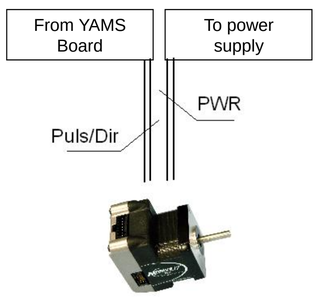
These boards are designed in the DIN41494 Eurocard standard, each carrying the electronics necessary to cope with different motor type and power. From the point of view of the core controller the connecting bus is the same, being its main feature the pulse/direction interface. The power section of the board is realized using the IMxxxH hybrid family produced by IMS (now "Schneider Electric Motion USA").



Encoders Boards

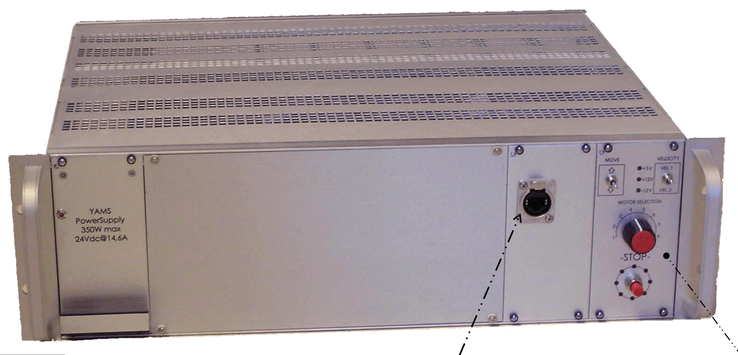
Passthrough Board

Besides the driver board that actually may power a stepper motor, a "versatile board" was designed called "Passthrough". This board is equipped with two connectors. One of them carries the motor, switches and brake signals: this is not directly connectable to the phases of a motor, a power stage with the pulse/direction interface must be interposed (for instance motors with power electronic integrated). The other connector is exactly the same sub D encoder connector of the other boards, and, in fact, this board has the same "encoder conditioning philosophy" and may host the same range of encoder daughter boards.



Motor with integrated electronics

YAMS front view



Ethernet connection for remote controls

Front Panel Controls
- Forward/Reverse Movement
- Speed Selector
- Axis Selector
- Stop button

Function	**Value**
Mains power supply	220V
Motor power supply	24V, 350W max
Electronics power supply	5V, 50W - ±12V, 30W
Core motion controller	DMC family by Galil Inc.
Communication Interface	Ethernet 10BASE-T
Local Interface & Control	Motor, speed (1 out of 2), direction-movement selectors Stop-all-motion pushbutton Power supply leds.
Motor driver boards	up to 8

YAMS rear view

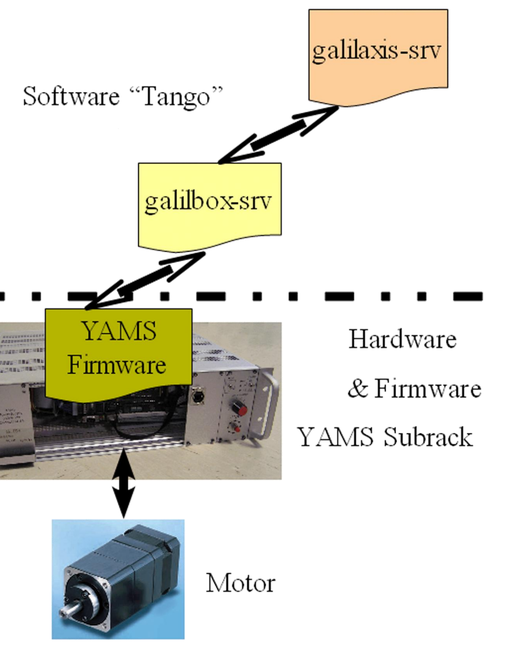
A YAMS subrack equipped with six motor driver boards is shown; blind panels are used to close the unused slots (here not shown).

Encoder Daughter Boards

The purpose of the encoder boards is to adapt and/or condition the signals coming from the encoder to the inputs accepted by the DMC controller. Up to now we have developed three types of encoder boards:

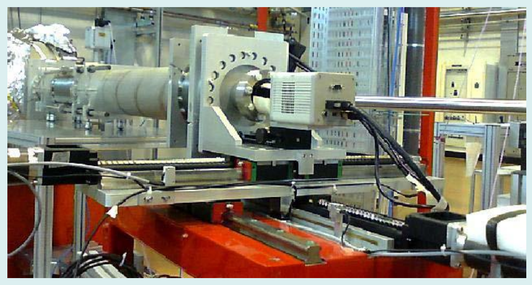
- **Type 1** encoder board: it just connects the external encoder connector to the internal signal buses. No conditioning is performed.
- **Type 2** encoder board: it converts RS422 level balanced signals from digital sin/cos encoders to unbalanced signals.
- **Type 3** encoder board: it accepts a 4-20mA analog signal and converts it to an internal voltage signal.

SOFTWARE ENVIRONMENT

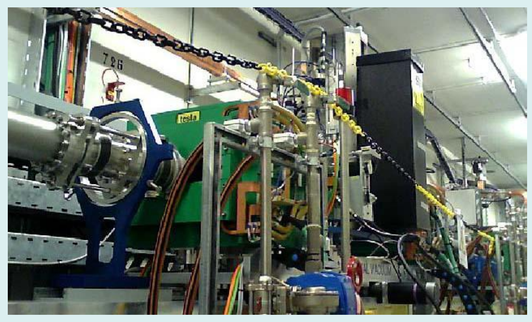


The DMC family controllers have their own communication and programming protocol and language, besides a good basic instruction set for motion control. So, if necessary, it is possible to add specific routines into the controller memory to improve the controller functionalities. These routines may be referred as "firmware".
A similar solution for motion control was also adopted by the SOLEIL synchrotron light source, participating with other partners, including Sincrotrone Trieste, to the Tango collaboration. They developed the software architecture and the first releases of the "galilbox-srv" and "galilaxis-srv" Tango device servers. As a result, the YAMS project has inherited a considerable amount of knowledge and ready to re-use code, thus reducing the overall development time.
Differences between SOLEIL and FERMI@Elettra in the modality the stepper controllers are employed, led us to modify both firmware and software from their initial releases. For instance, the FERMI@Elettra version is capable to read a potentiometric encoder, i.e. an analog sensor, and close on it the motion control loop.

FERMI INSTALLATIONS



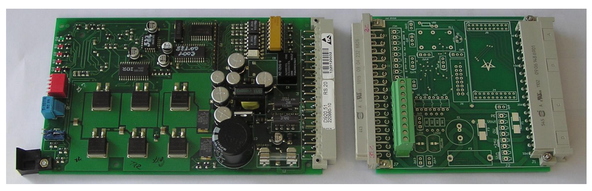
Photon spectrometer, an high precision installation.



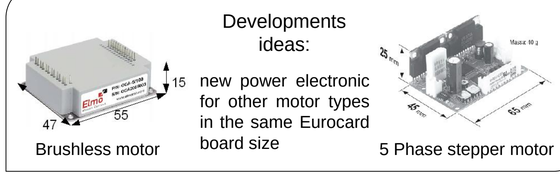
Bunch Compressor, an heavy duty installation.

DEVELOPMENT

A new driver board is under development, it will adapt the YAMS bus interface to the old "Berger-Lahr" D450 (5 phase) and D920 (3 phase) stepping motor cards, thus confirming and realizing the "retro-fit" issue for the old installations in ELETTRA.
A piezo motor driver board and a 1Vpp analog encoder daughter board will soon be designed for beamlines and experimental chambers.



D920 Berger-Lahr Power Board YAMS-Berger Adapter Board



Brushless motor

Developments ideas:

new power electronic for other motor types in the same Eurocard board size

5 Phase stepper motor

for additional information, please contact:
alessandro.abrami@elettra.trieste.it
marco.lonza@elettra.trieste.it