

# Elettra & Fermi status report

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on behalf of the Elettra CS group and SPE group

## Energy price surge & budget rigidity

- 2024 cost of energy forecast: in budget
- but gas price rising again
- reduced beam-time, about 60% of usual beam-time delivered/planned
- long shutdowns
- higher workload on technical teams, taking advantage of the longer shutdowns

- shutdown foreseen July 2025
- keep accelerator building
- complete accelerator refurbishing, subsystems already started
- keep some existing beamlines/end-stations
- core design of magnets, injection etc. frozen
- design of plants and buildings frozen
- Digital Twin development in collaboration with ESRF
  - simulated control system + accelerator model
  - programming environment for developing and testing
- challenges:
  - size: ~1200 power supplies, ~100 fast BPMs
  - long/uncertain purchase times, short assembly times
  - manpower

## Control system highlights

- real-time feed-forward and feed-back loops run on Linux
- multi-core, large memory server class machines
- hard real-time by hardware partitioning and CPU isolation
- 100 Gb and 10 Gb ethernet
- software architecture exploiting DPDK framework
- feedback loops running at > 50 KHz repetition rate
- can acquire a single BPM at 1 MHz rate
- can acquire the whole orbit (~100 BPM) at 10 KHz repetition rate
- cumbia graphics library for GUIs
- ...and, of course, Tango

control system  
central server cluster

general purpose  
control system servers

TANGO control  
system framework



n x 100-Gbit eth links



100-Gbit eth switch stack

100-Gbit+ capable fiber optic network

SA 1

SA 2

SA 3

SA 4

SA 12



10-Gbit eth switch stack

1-10Gbit eth link



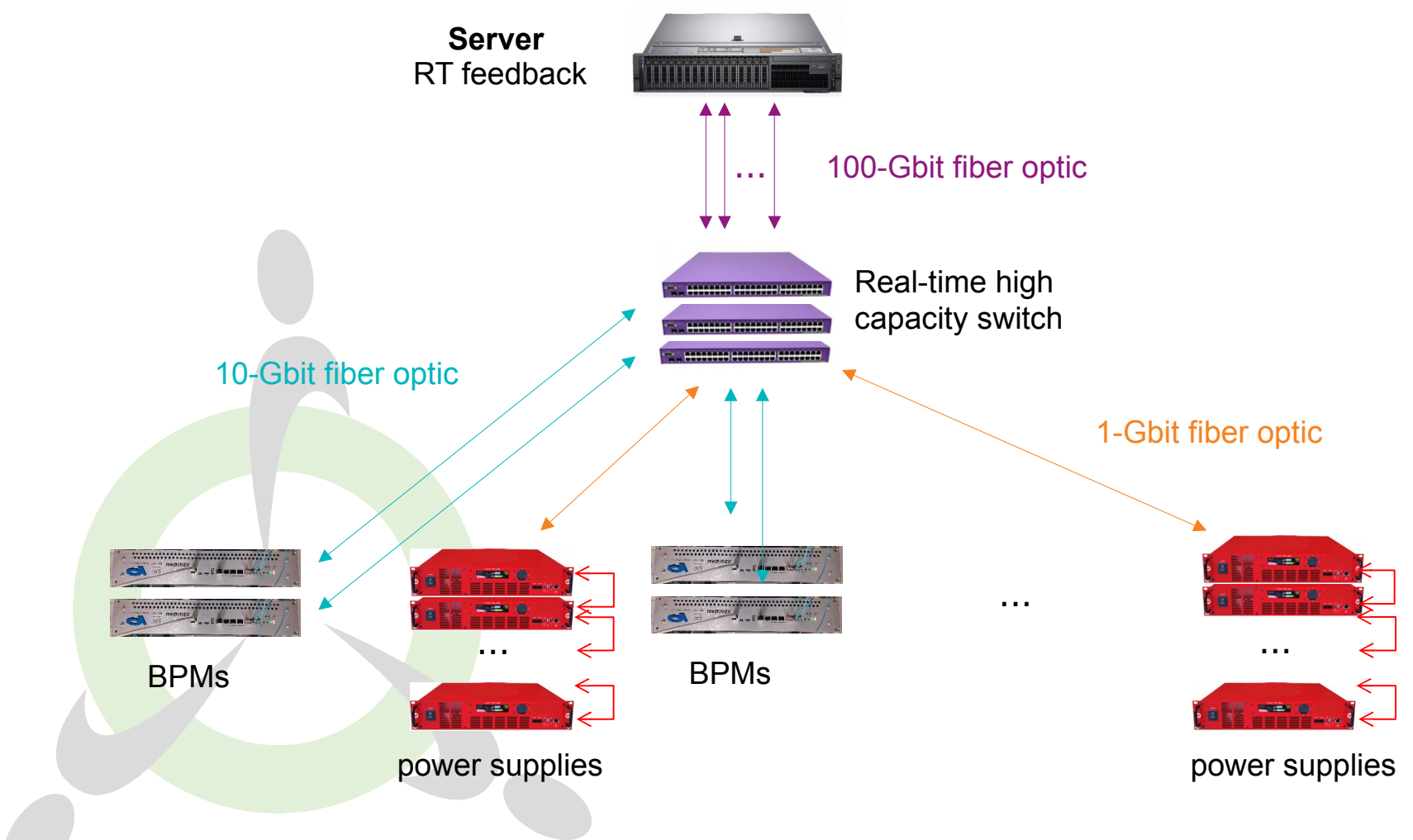
embedded systems



power supplies



SS RF amplifiers



## Operating systems

- Linux Debian 12 for workstations
- Linux Voltumna for servers
  - *Voltumna is a in-house maintained variant of Yocto Linux*
  - *used also in Fermi*

## Tango control system

- C++ and python device servers
- C++, python, and MATLAB Tango bindings for client software
- cumbia (Qt +Tango) framework for C++ graphic control panels
- PyQt for python graphic panels

Gold Members



DPDK

DATA PLANE DEVELOPMENT KIT

arm



MARVELL



ZTE

- **DPDK** is a network stack bypass technique
- Application running in userspace on *CPU* isolated cores without interacting with *Linux*, **coding in C**
- Initially used by telco companies (**latency < 20μs**)
- Available in cloud solutions by hyperscalers as:
  - Microsoft Azure
  - Amazon AWS
  - Google Cloud

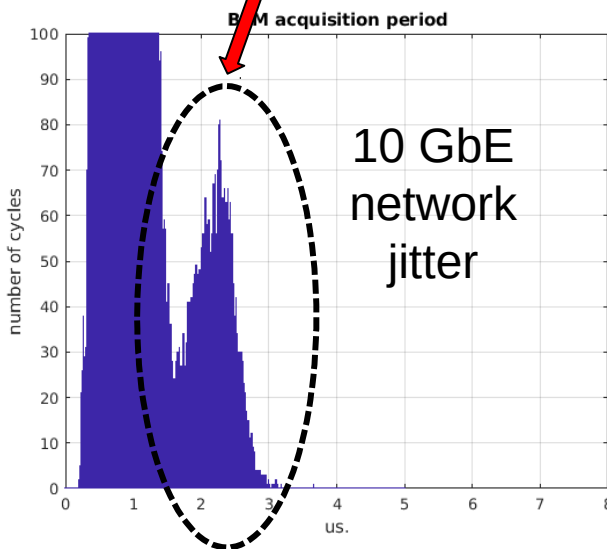
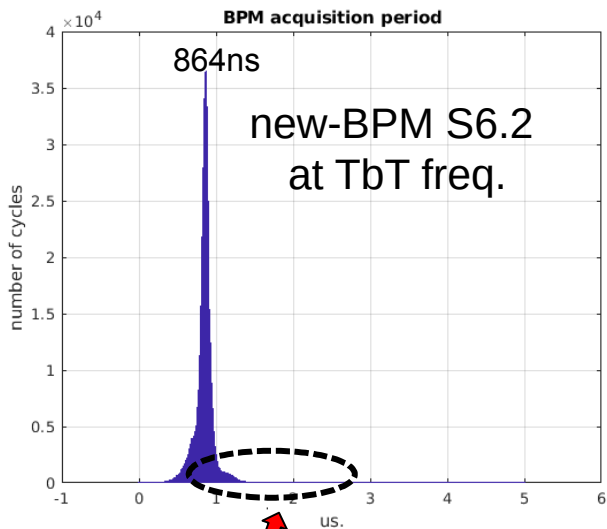
**1 CPU core** manages up to **9 Million** packets per second (9 Mpps) on a **10 GbE** nic

**4 CPU cores** manage up to **116 Mpps** on a **100 GbE** nic

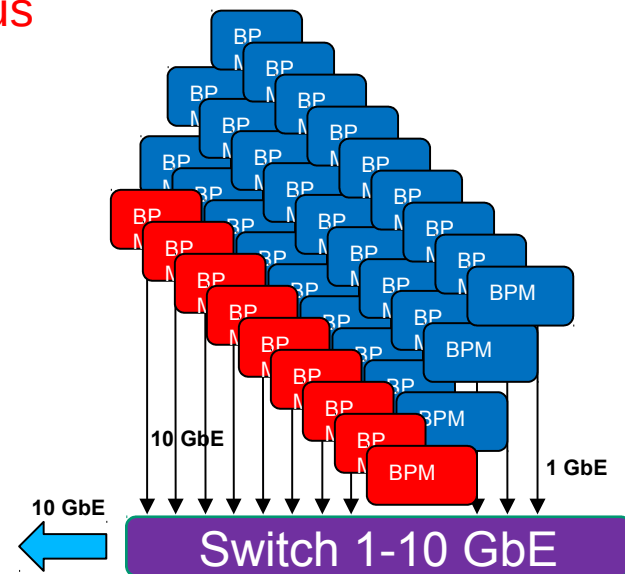
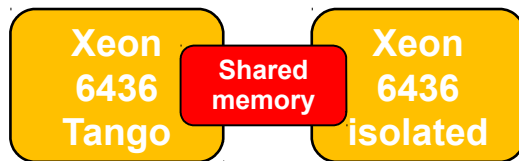
standard payload

[https://fast.dpdk.org/doc/perf/DPDK\\_23\\_03\\_Intel\\_NIC\\_performance\\_report.pdf](https://fast.dpdk.org/doc/perf/DPDK_23_03_Intel_NIC_performance_report.pdf)





- Actual tests:
- 8 new-BPMs at 1.15 MHz + 24 Libera at 10 kHz over one 10 GbE link (sectors 5,6,7) -> main server
- main server acquiring 9.5 Mpss, no pkt loss 99.8% pkts processed in less than 1  $\mu$ s
- worst case 3.5  $\mu$ s



100 GbE mandatory for Elettra 2.0

PLC based system

2.8k digital inputs: *magnet coil thermo switches, vacuum gauges, limit switches...*

1.6k digital outputs: *power supplies, valves, shutters, device enable contacts...*

1k K type thermocouples: *on vacuum chamber, photon absorbers, BPMs...*

24 4-20mA analog inputs: *cooling water pressure gauges*

More than 10 times the I/O points the Elettra MPS

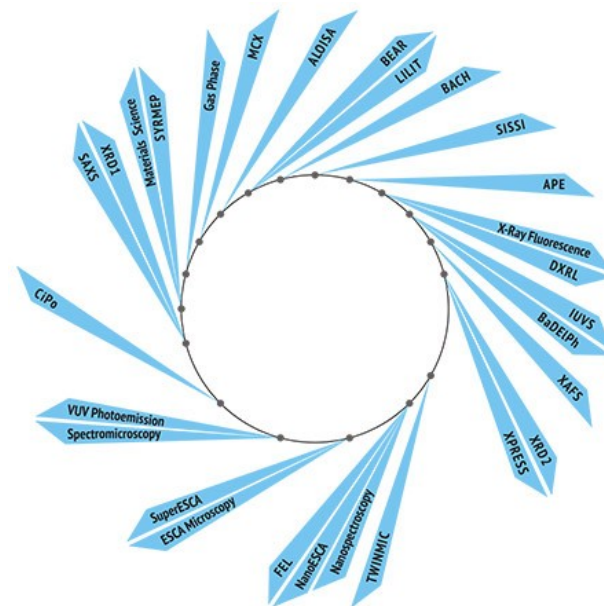
Remote I/O nodes with input and output modules

- 48 hosted in wall boxes for equipment in the tunnel
- 24 hosted in racks for equipment in the service area
- 4 Master nodes handling logic

Dedicated fieldbus (profinet)

# ELETTRA end-stations

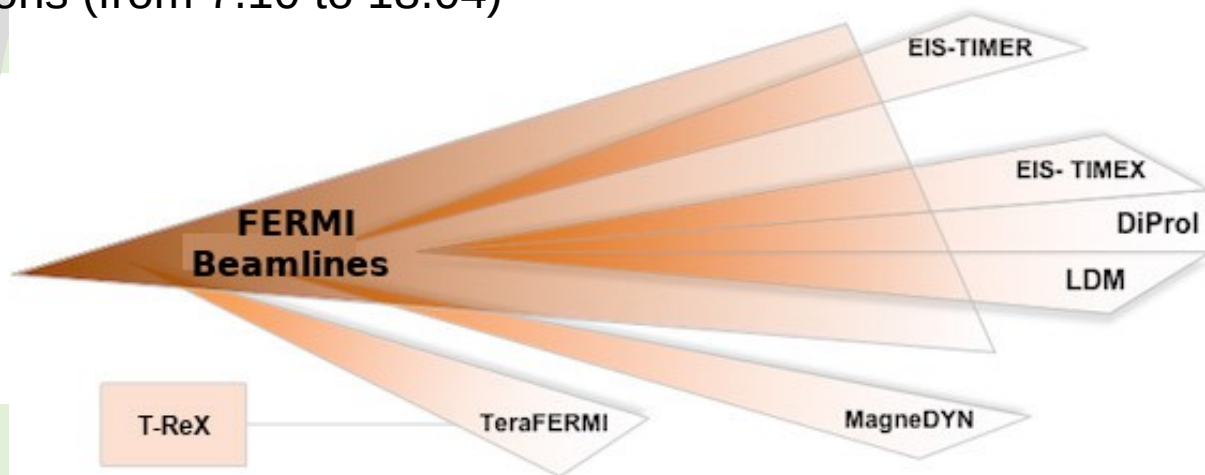
- **11** over **25** end-stations using Tango
- Latest standard Tango 9.3.4 on Ubuntu 18.04
- **Python** preferred for Servers and GUIs (taurus)
- Beamline Programs interaction via Tango bindings (Java, IDL) or generic-tcp-srv (ASCII TCP)
- Typical setup: a virtual server (net/serial instrumentation) + desktop



Twinmic	Ubuntu 18.04	9.3.x	YES
Nanospectroscopy	Ubuntu 18.04	9.3.x	(Java)
EscaMicroscopy	Ubuntu 18.04	9.3.x	(IDL)
X-Ray Diffraction 1	Ubuntu 18.04	9.3.x	YES
Syrmep	Ubuntu 18.04	9.3.x	YES
XRF	Ubuntu 18.04	9.3.x	YES
XAFS	Ubuntu 18.04	9.3.x	(LabView)
DXRL	Ubuntu 16.04	9.2.5	YES
MCX	CentOS 6	8.1.2	(PyQt)
X-Ray Diffraction 2	CentOS 6	8.1.2	YES
Xpress	CentOS 6	8.1.2	YES

## FERMI end-stations

- **7 end-stations** using Tango for control, DAQ and GUIs
- Latest standard Tango 9.3.4 on Ubuntu 18.04
- **Python** preferred for Servers and GUIs (taurus)
- Typical setup: a virtual server, 2 or more rack mount PCs + 2 or more desktops
- Due to physical rack mount machine => multiple Ubuntu distributions (from 7.10 to 18.04)



Thank-you!

