Elettra Sincrotrone Trieste

Elettra
Sincrotrone
Trieste

TANGO

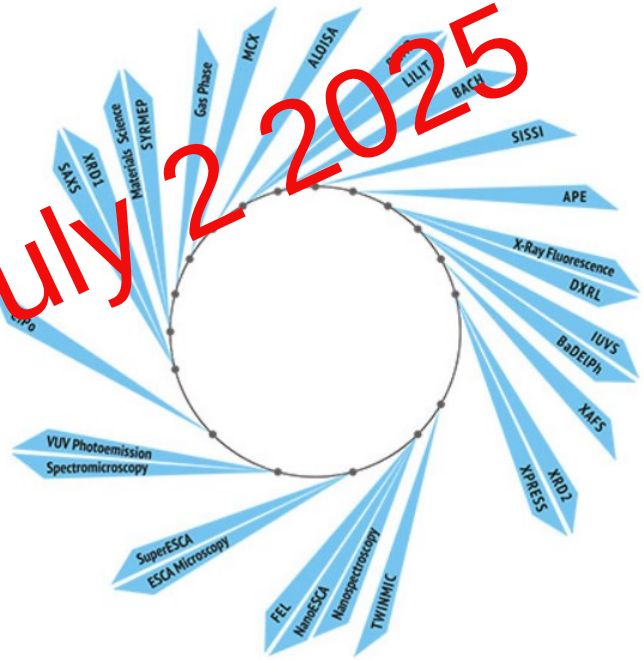
# Elettra 2.0 status update

Elettra
Sincrotrone
Trieste

# Elettra


- 2/2.4 GeV 3rd generation light source, operating Oct 1993
- 2.0 GeV (75% of user time), 2.4 GeV (25% of user time)
- 300 mA at 2.0 GeV (lifetime 26 h), 140 mA at 2.4 GeV (lifetime 40 h)
- top-up: 1 mA every 6 min at 2.0 GeV, 1 mA every 20 min at 2.4 GeV
- filling pattern: single, few, multi. Typical: multibunch filled at 95% (864 ns) and hybrid (multibunch with a single bunch in the dark gap)

| | |
|---|---|
| 1.1L | TwinMic |
| 1.2L | Nanospectroscopy |
| 1.2L | NanoESCA |
| 1.2R | FEL |
| 2.2L | ESCA Microscopy |
| 2.2R | SuperESCA |
| 3.2L | Spectromicroscopy |
| 3.2R | VUV Photoemission |
| 4.2 | CiPo |
| 5.2L | SAXS |
| 5.2R | XRD1 |
| 6.1L | Materials Science |
| 6.1R | SYRMEP |
| 6.2R | GasPhase |

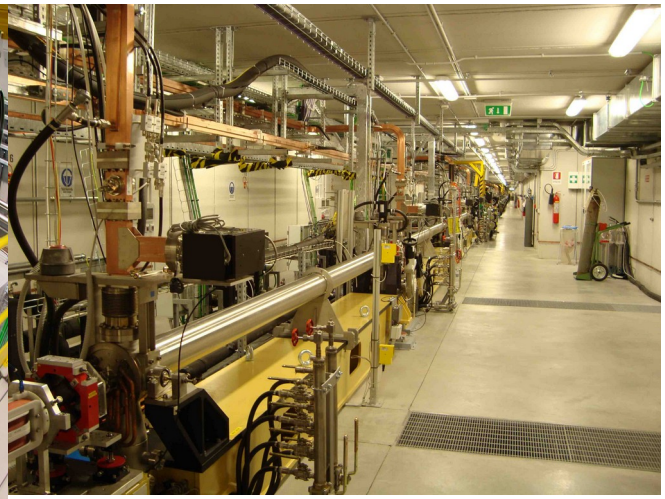



| | |
|---|---|
| MCX | 7.1 |
| ALOISA | 7.2 |
| BEAR | 8.1L |
| LILIT | 8.1R |
| BACH | 8.2 |
| SISSI | 9.1 |
| APE | 9.2 |
| XRF | 10.1L |
| DXRL | 10.1R |
| IUVS | 10.2L |
| BaDElPh | 10.2R |
| XAFS | 11.1R |
| XRD2 | 11.2C |
| Xpress | 11.2R |

Until July 2 2025

Elettra Sincrotrone Trieste

# Fermi



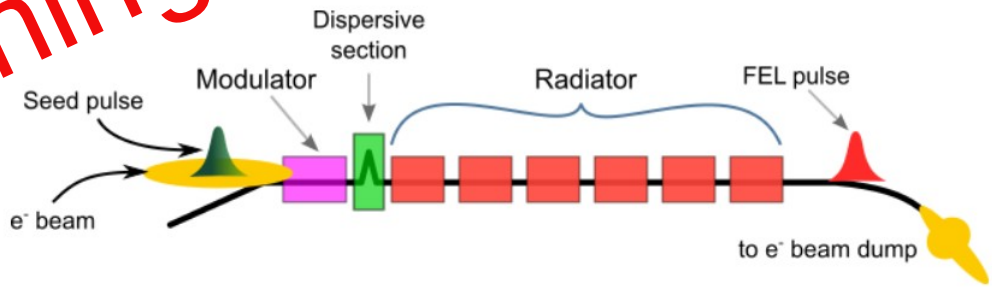
- Free Electron Laser, seeded, ultra-short, high-brilliance, XUV pulses

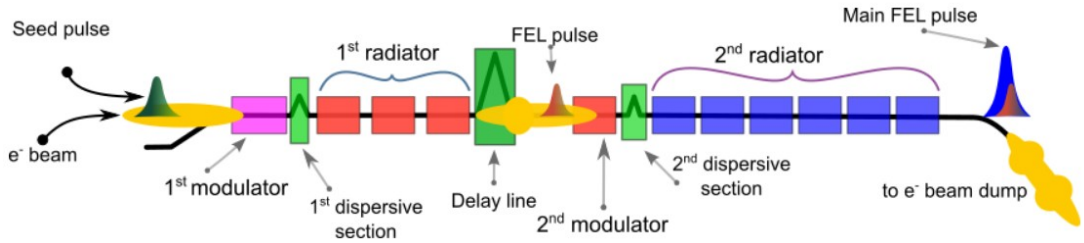
- FEL-1 - single-stage high-gain harmonic generation FEL, wavelength 100-20 nm

- FEL-2 - double-stage high-gain harmonic generation scheme, wavelength 20-4 nm

| Parameter | Units | Value |
|---|---|---|
| Repetition rate | Hz | 10 - 50 |
| Bunch charge | pC | 700 |
| Peak current | A | 700 |
| Bunch length | ps | 1.0 |
| Energy | GeV | 1.0 – 1.5 |
| Energy spread | keV | 100 |

Keep up-and-running



# Elettra 2.0

Key objectives:

- brilliance and coherence: hundredfold increase in brilliance and photon beam coherence
- nanometer scale imaging: enhanced spatial resolution will support nanotechnology research enabling the visualization and manipulation of structures at the nanometer scale→new materials
- biological and chemical science: enhanced tools for structural biology and chemistry

Storage ring upgrade:

- Low emittance ring -> reduce the present beam emittance by a factor of 50, resulting in a photon source with higher brilliance and coherence.
- Include 2 superconducting bending magnets that will enhance production of photons with energy above 60 keV

Beamline enhancements:

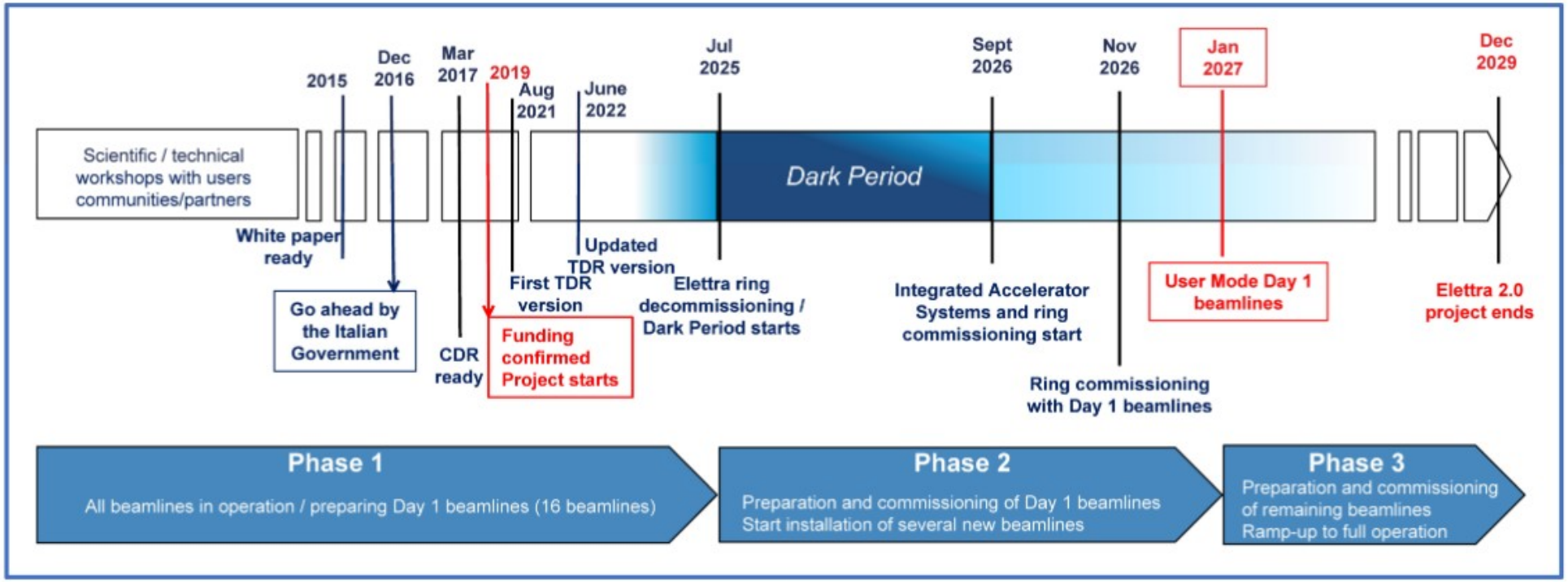
- Advanced Spectroscopy: Enhanced capabilities in X-ray absorption spectroscopy, photoemission spectroscopy, and high-resolution diffraction
- Coherent Diffraction Imaging: This technique will be expanded to provide higher-resolution 3D imaging
- Time-resolved Experiments: Enhanced ability to capture ultrafast processes

Cryogenic and Vacuum Systems:

- To support the advanced beamline capabilities, the cryogenic and vacuum systems will be overhauled

# Elettra 2.0

July 2 2025

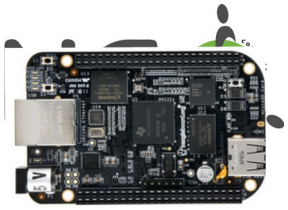


# Elettra 2.0

CS highlights

- very few VME front-end computers stay in operation!
- but we'll have small embedded systems (beaglebone) and "**large embedde systems**"
- 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, 10 Gb and 1 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** library for GUIs
- ...and, of course, Tango

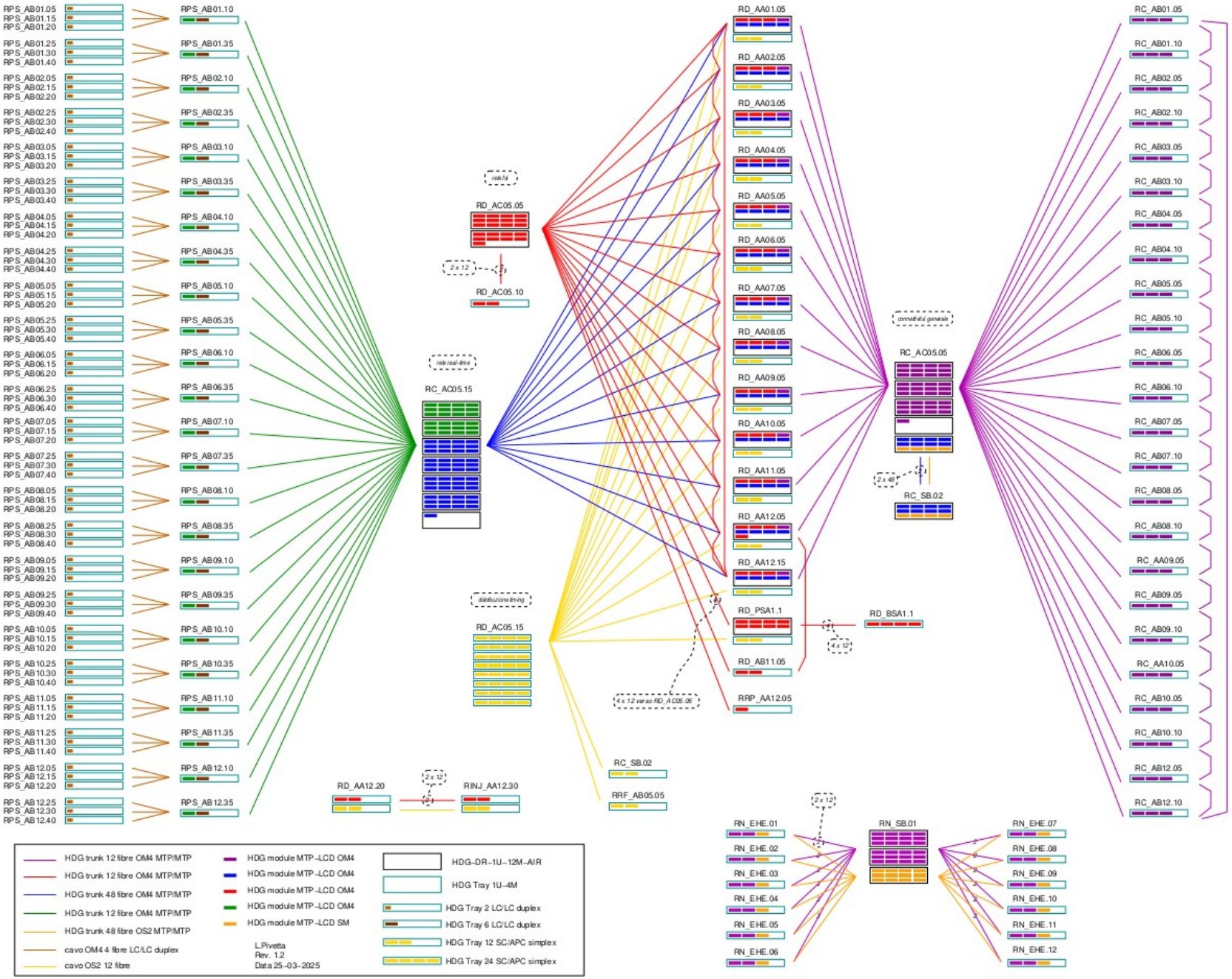
# Embedded systems



- Several generations OS, difficult to maintain, outdated compilers
- FLOP/**Voltumna**: a custom Linux distribution based on Yocto Project
- Available for:
  - BeagleBone, BeagleBoneAI
  - Artesyn MVME5100, MVME6100, MVME7100, MVME2500
  - Jetway NUC (Intel Trail-M N2930 SoC Processor)
  - Advantec PCM-3362N (PC/104+)
  - Terasic Sockit (Cortex-A9 + FPGA)
  - AAEON UP Xtreme (Intel WHL-U Core i7/i5/i3/Celeron)
  - Supermicro SSG-6039P-E1CR16 (4U, dual socket Intel Xeon)
  - Supermicro SYS-6018R, SYS-5019P, SYS-1028U (1U, single socket Intel Xeon)
  - Dell Poweredge R750
  - Supermicro SYS-510D (1U, single socket Intel Xeon D)
- + : Hardware optimizations
- + : Strict revision control
- 100+ systems deployed

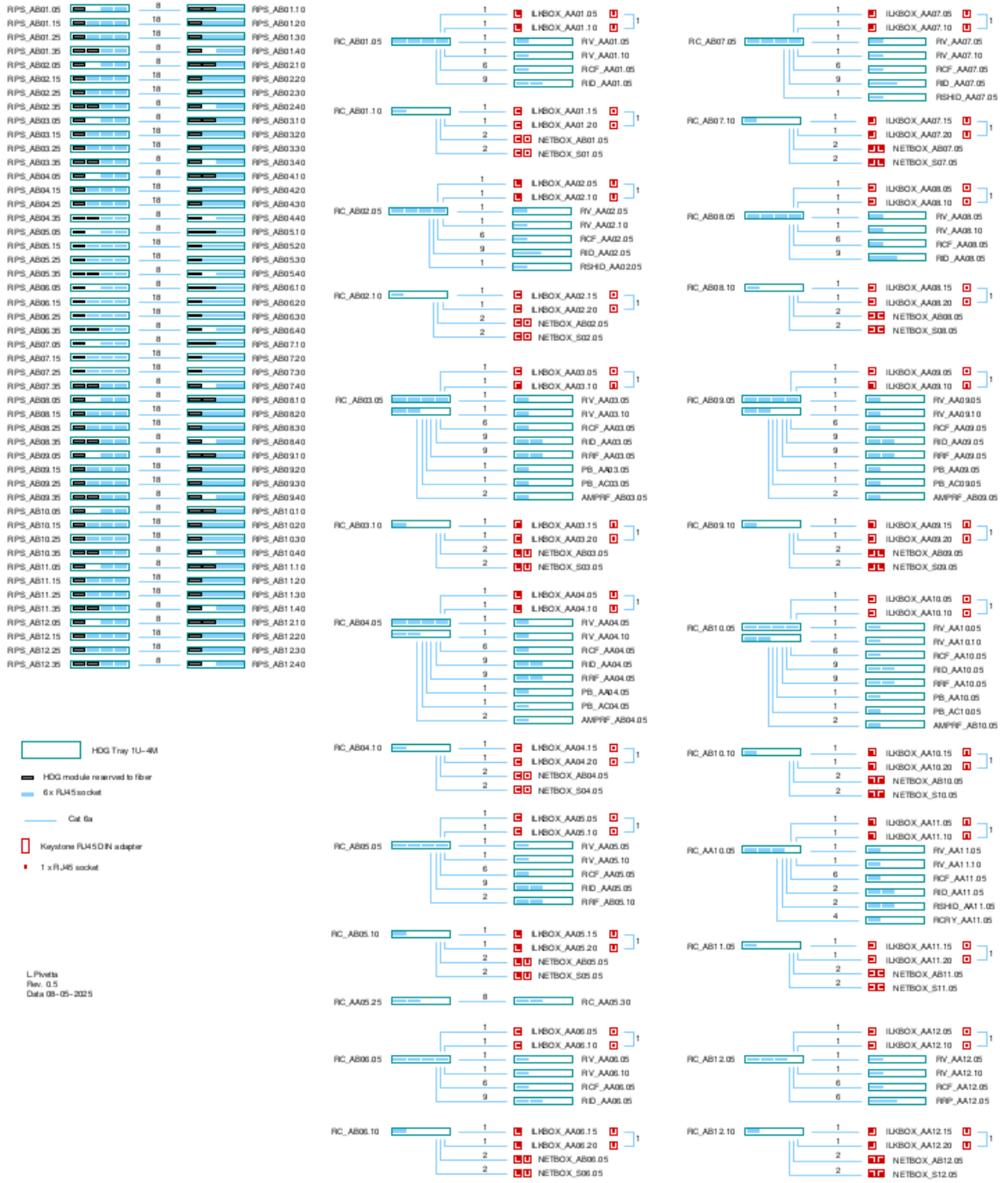
# Elettra 2.0 – fiber optics

- Multiple star topology
- OM4/OS2 FO, 100+ GB capable
- Extreme Networks core and peripheral switches
- Modular design, capable to grow with requirements
- Physical partitioning, functional partitioning
- ~100 switch foreseen
- Many VLANs



# Elettra 2.0 – copper

- cat 6a F/FTP structured cabling
- 24 RC racks to equipment
- 24 RPS isle distribution



# Elettra 2.0 controls network

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




...

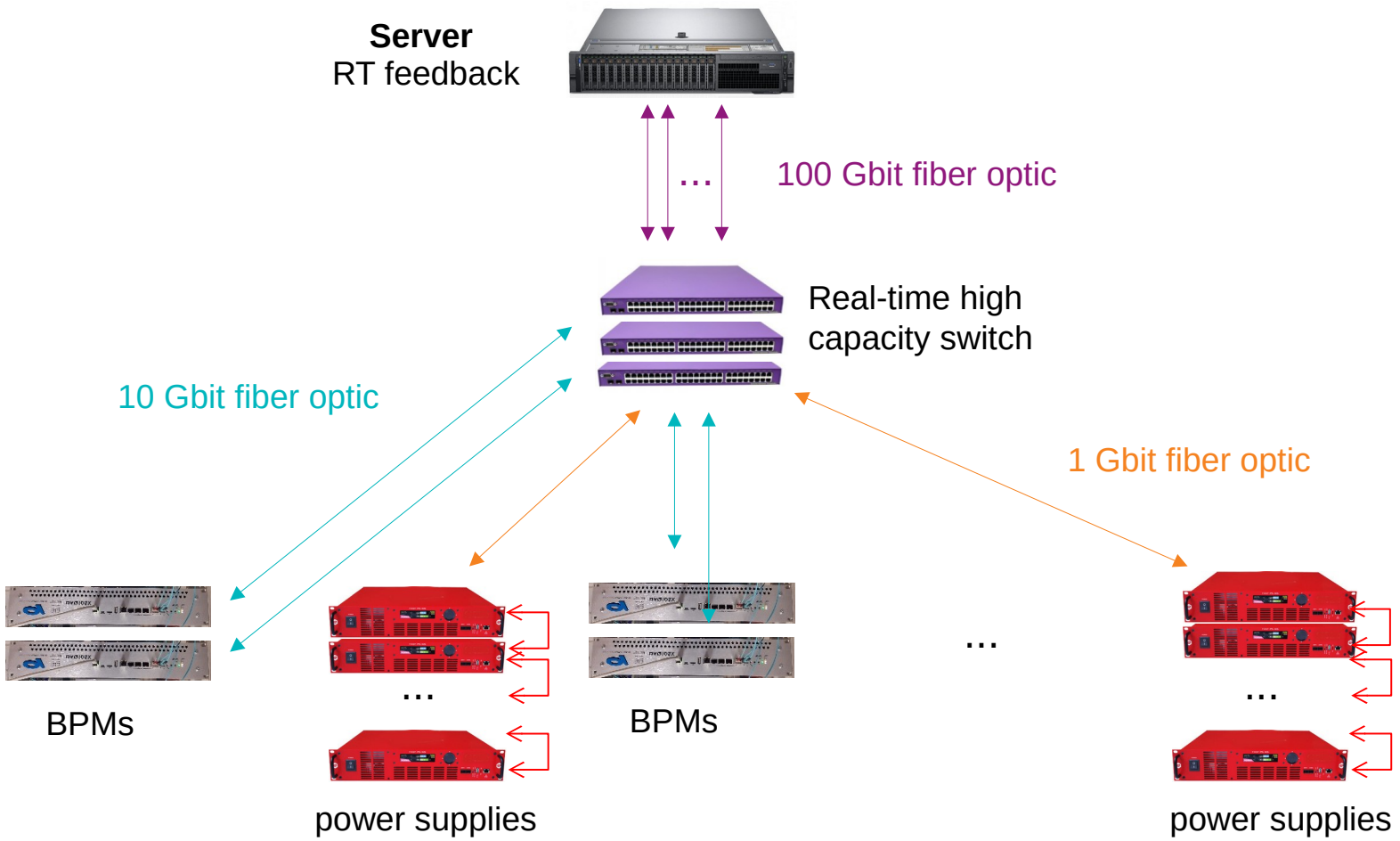
...

embedded systems

power supplies

SS RF amplifiers

# Elettra 2.0 real-time network



# Elettra 2.0 – real-time processing

- Intel + Linux Foundation support
- framework for receiving, sending and processing packets and for assigning memory and CPU resources to real-time applications
- reserve some HW resources (NIC, CPU core…) to RT application(s)
  - configure the Environment Abstraction Layer (EAL) to enable access
  - application code runs full speed on reserved core(s)
  - optimized lock-less ring buffers and inter-process communication libraries

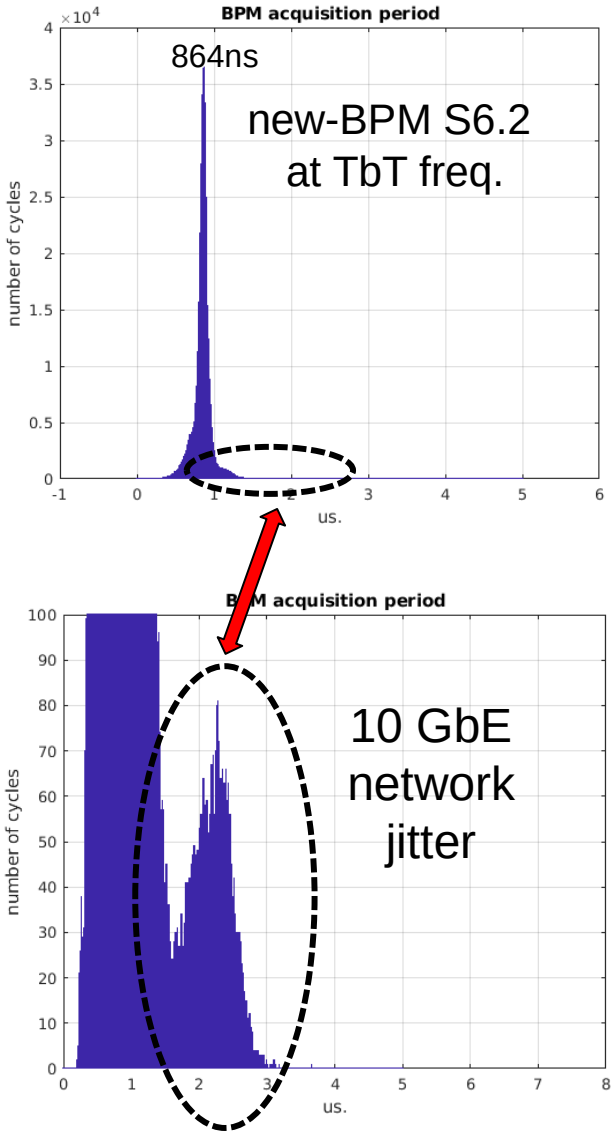
DPDK
DATA PLANE DEVELOPMENT KIT

Gold Members

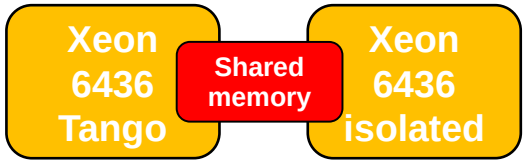
Coding in C

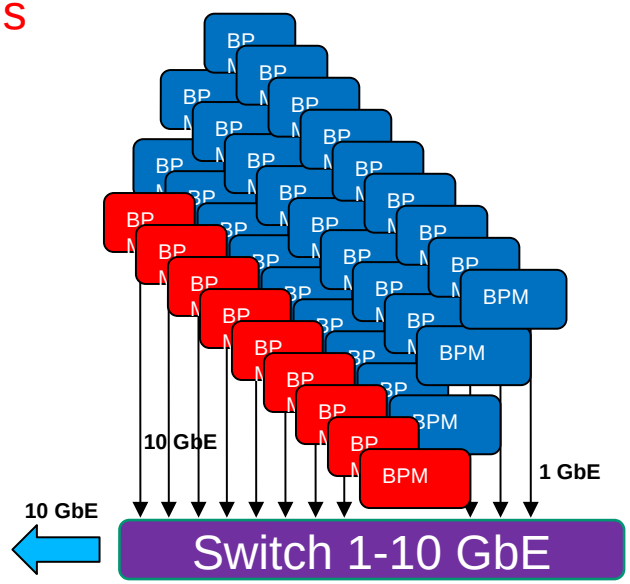
1 CPU core manages up to 9 Million packets per second (9 Mpps) on a 10 GbE nic
4 CPU cores manage up to 116 Mpps on a 100 GbE nic

# Elettra 2.0 – real-time processing




- 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 µs
- worst case 3.5 µs




100 GbE mandatory for Elettra 2.0

# Elettra 2.0 OS

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


www.elettra.eu