Elettra & Fermi status report

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on behalf of the Elettra CS group and SPE group

Status: Operation of light sources

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Energy price surge & budget rigidity

- reduced beam-time, about 60% of usual beam-time delivered
- long shutdowns
- higher workload on technical teams, taking advantage of the longer shutdowns:

Elettra

- installation of RF solid state amplifiers
- ion pumps power supplies replacement

FERMI

- new linac accelerating sections, higher energy, lower wakefields
- FEL1-EEHG improvements

Status: Elettra 2.0 project progress

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- shutdown foreseen March 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 in final review (MAC July 2023)
- Digital Twin development in collaboration with ESRF
  - simulated control system + accelerator model
  - programming environment for developing and testing
- machine physics and operator user interfaces
  - first release ready by the end of 2023
- challenges:
  - size: ~1200 power supplies, ~100 fast BPMs
  - long/uncertain purchase times, short assembly times
  - manpower

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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

Status: Elettra 2.0 control network

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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

...

Status: Elettra 2.0 real-time network

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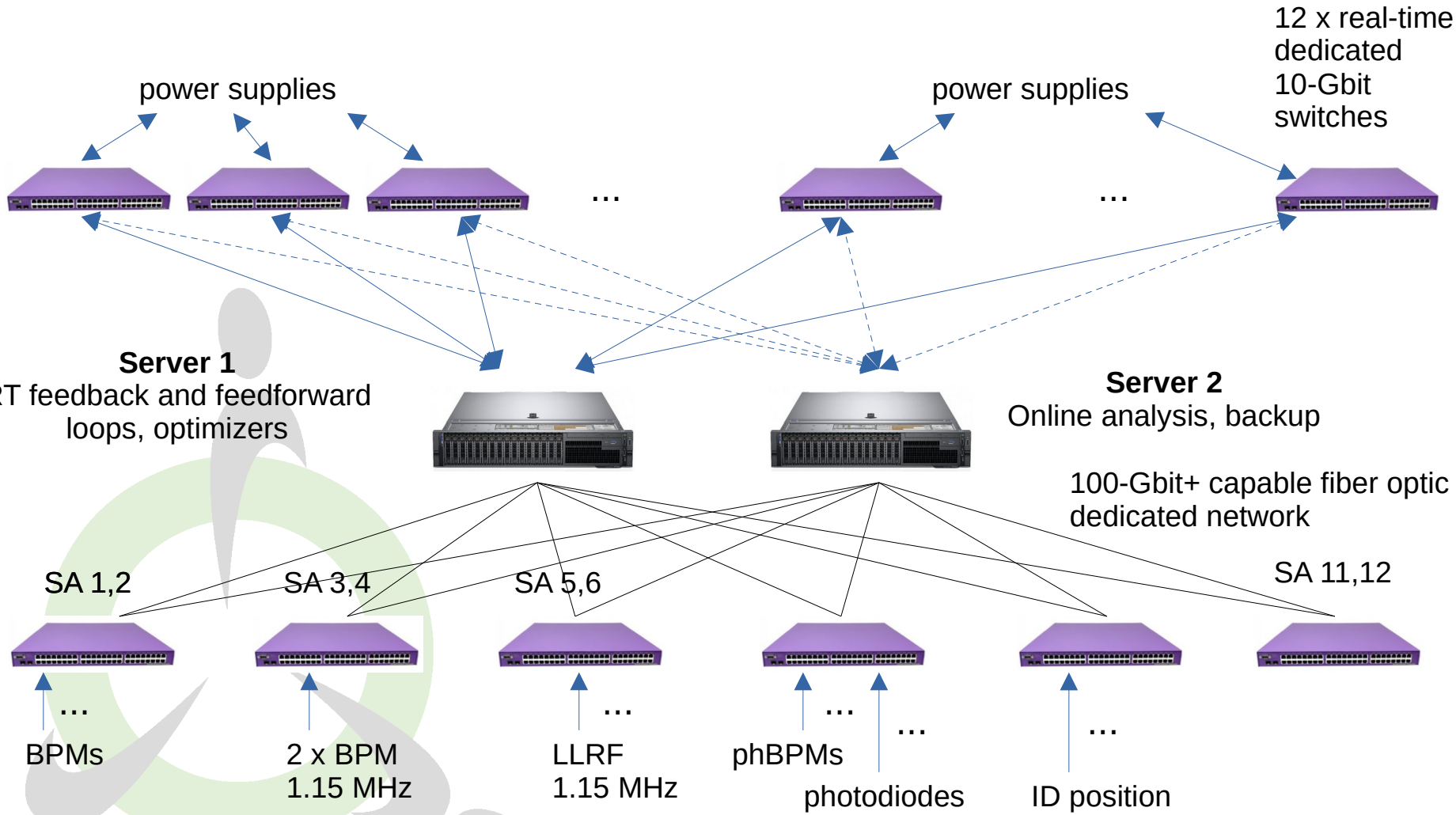

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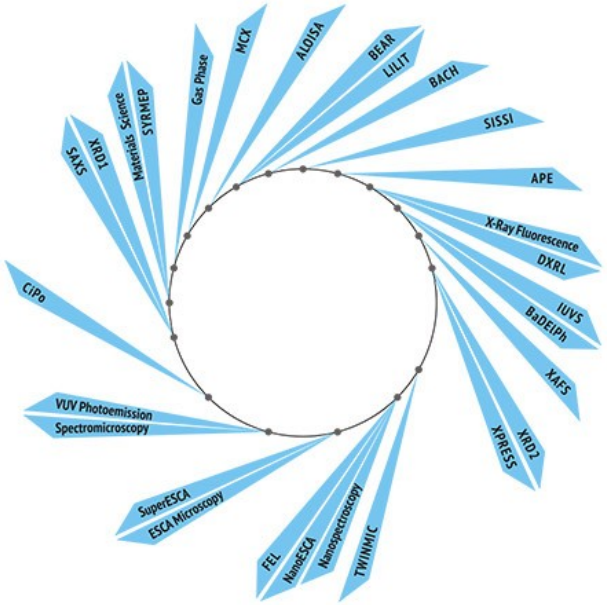
ELETTRA end-stations

- **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

Status: Fermi

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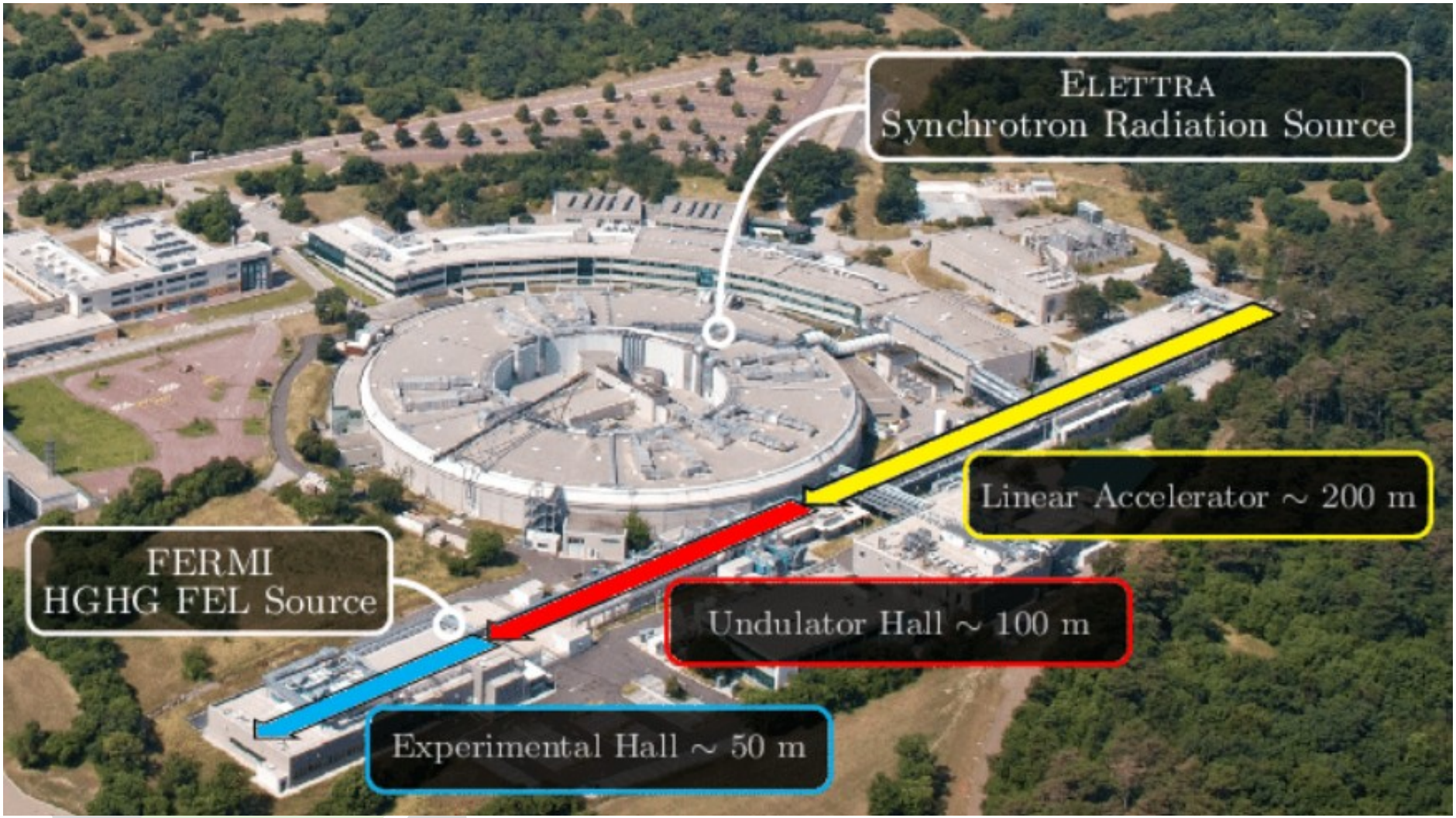

Status: Fermi layout

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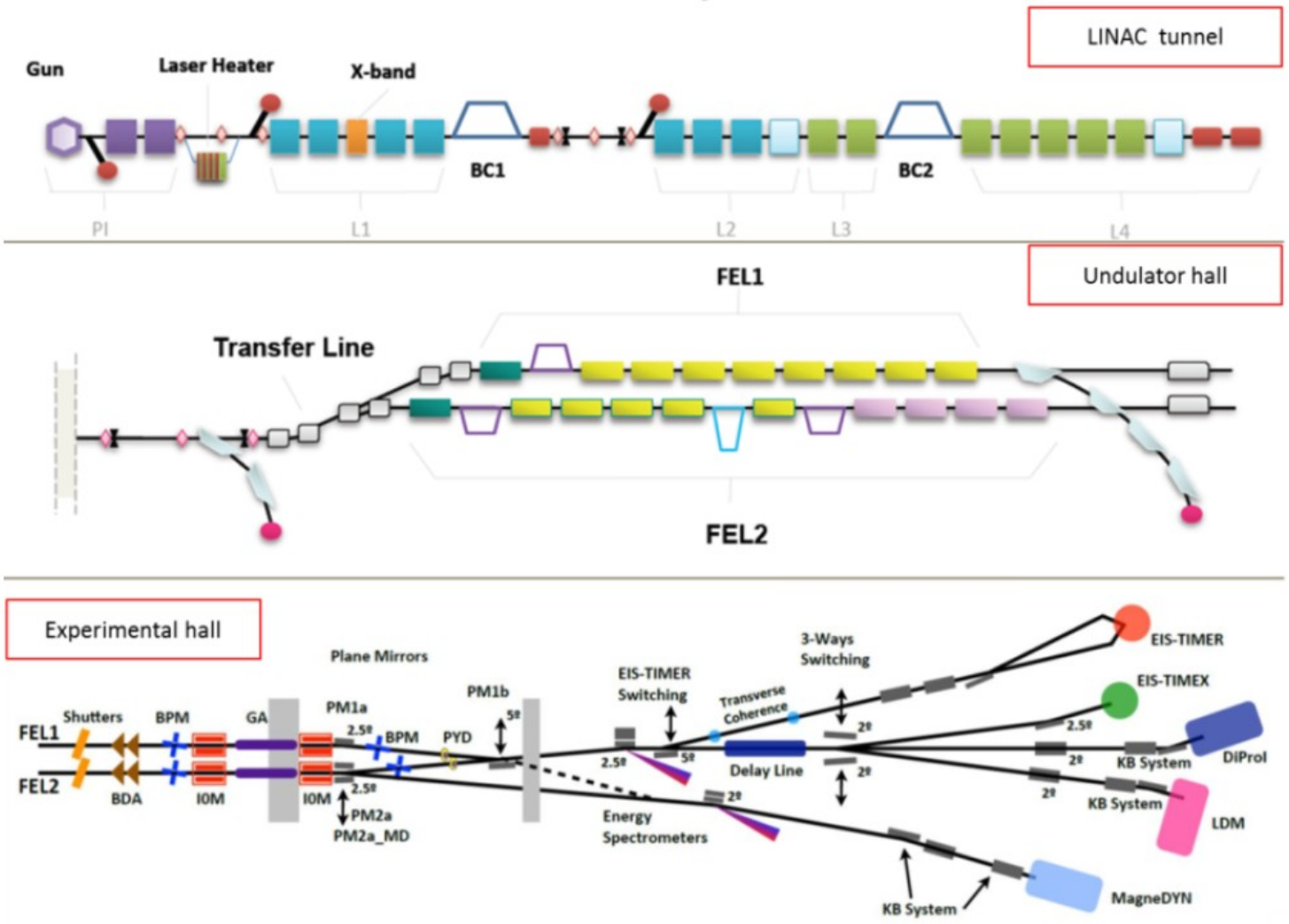

Status: Fermi upgrade program

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Undergoing a series of upgrades to extend the facility spectral range to cover the water window and above, and to reduce the minimum pulse duration below the characteristic lifetime of core hole electrons of light elements.

FEL1-EEHG upgrade (Echo Enhanced Harmonic Generation)

- From HG with 1 seed laser to EEHG with 2 seed lasers
- New undulator, new magnetic chicane
- Decrease minimum wavelength from 20nm to 10nm
- 2023!

Increase Linac energy

- Ongoing collaboration with PSI to refurbish old s-band acceleration cavities with new ones with higher gradient (first cavity installed in 2022)

FERMI 2.0 upgrade

- To cover “water window” and above, after Elettra 2.0 completion (2026), CDR completed, waiting for funding

Status: Fermi control system upgrade

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Short term upgrades

- Refurbishing old Intel rackmount servers from Ubuntu 10.04/14.04 to Voltumna Linux diskless OS (Yocto based)
  (*fix system bugs and better support to hw drivers/libs*)
- Using **DPDK** for real-time communication for all new ethernet applications
  (*avoid ethernet driver patching*)
- Upgrade connections between beamlines and the main control system to 10 Gbit
  (*increase bandwidth*)

Medium term upgrades

- Move DAQ front-end from corporate cluster to control system cluster
  (*decrease latency*)

Long term upgrades

- Replace VME crates with VM and/or rackmount Edge servers
  (timing/event system distribution issue)

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As a single experiment machine

- Machine could be directly tuned by beamline scientists during experiments (e.g. wavelength change)
- Machine continuously optimized to maximize the radiation performance required by the running experiment

Feedbacks, otimization and automation

- Shot-to-shot feedbacks to keep the most critical machine parameters stable (10)
- Programmable feedback/optimization framework (MIMOFB) managed by non control system experts (physicists, operators) (15 feedbacks, 4 optimizers)
- Use of Sequencers to speed up automation (995)

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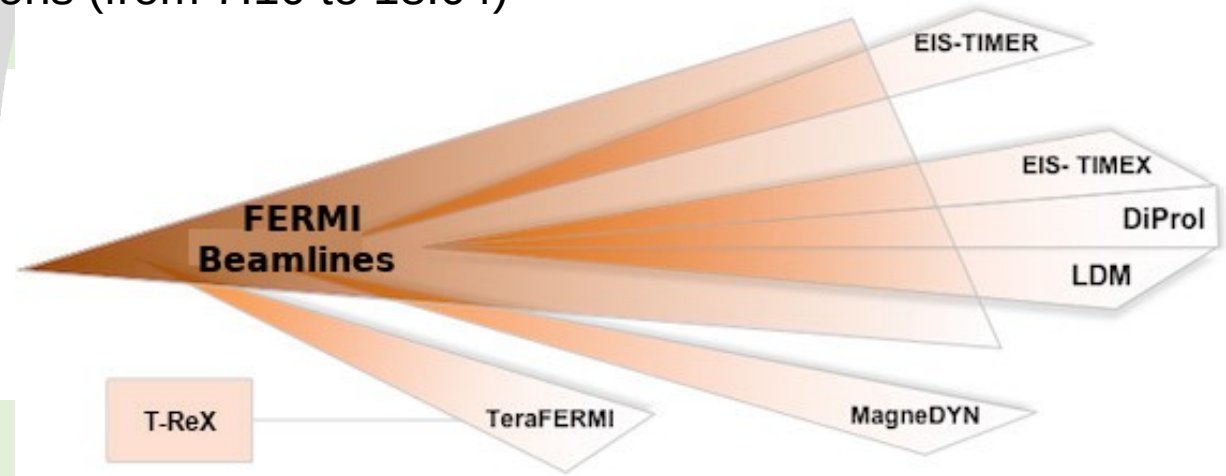
FERMI end-stations

- **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!

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