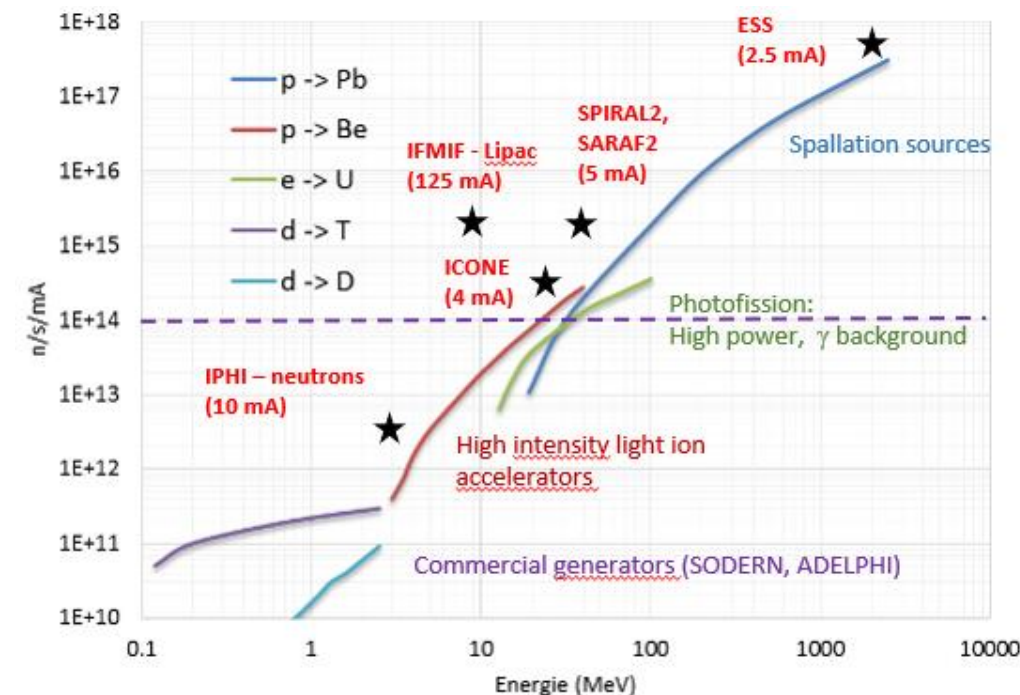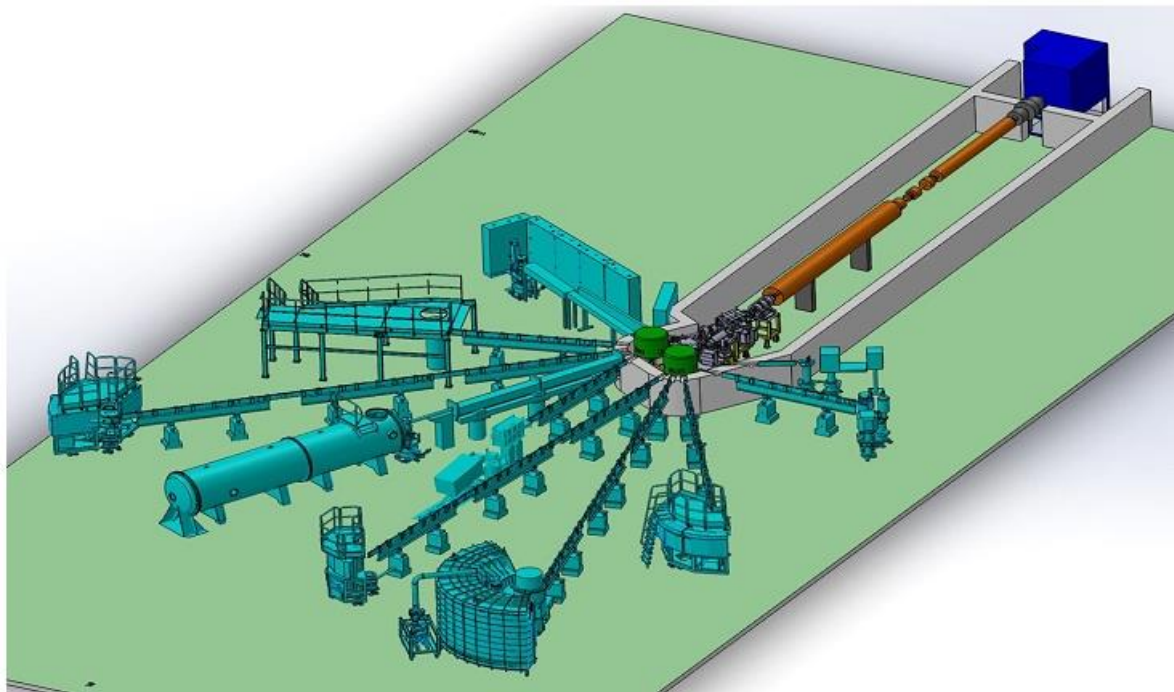# Introduction to the software and hardware platforms for the Pre-Project of the ICONE Accelerator

Alexis Gaget

CEA / IRFU (Saclay)

# ICONE : an accelerator-driven neutron source

- **ICONE an HICANS** (High Current Accelerator-based Neutron Sources)
- **High current (current peak ~80mA) - Low energy accelerator – 25 Mev**
  - Compact
  - Reduced cost
  - Great operational flexibility
  - There is no production of high-energy secondary particles (fast neutrons and gamma rays)

(ICONE stands for Installation COmpacte de NEutrons in french or Innovative COmpact NEutron facility in english)

ICONE : an accelerator-driven neutron source
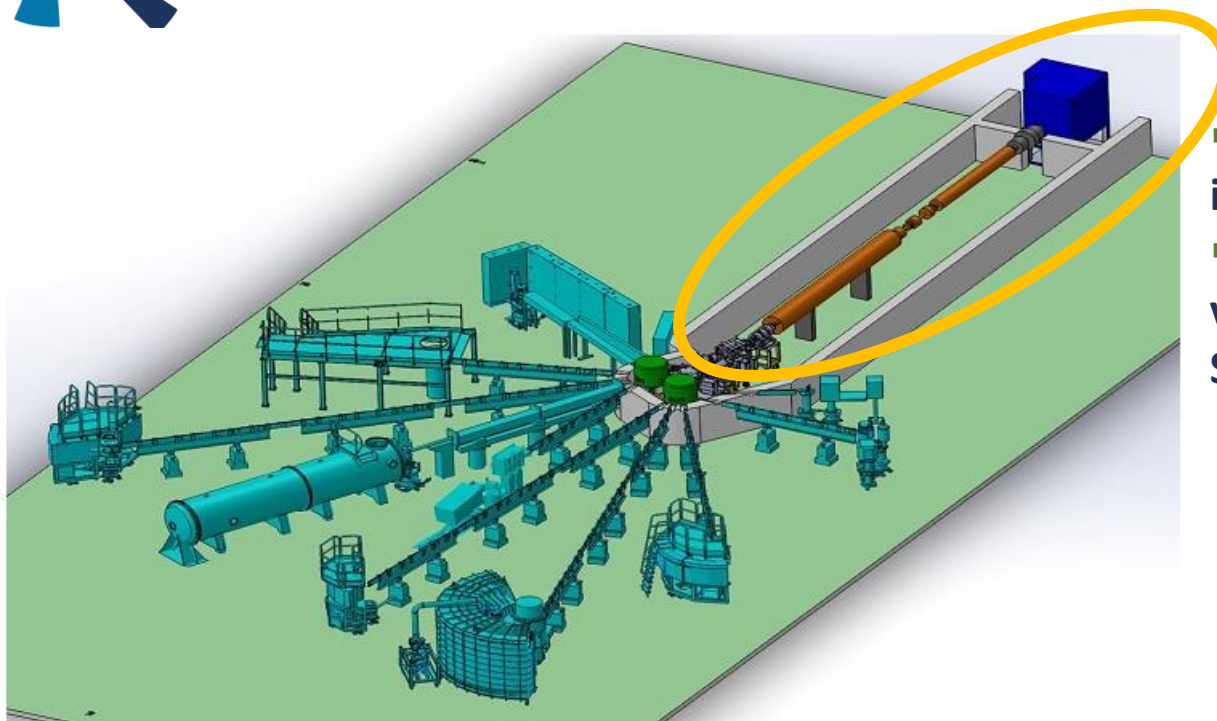
- **CEA IRFU is in charge of the development of the LINAC and its control system.**
- **The design is Based on our extensive experience with various accelerators such as SPIRAL2, ESS, IPHI upgrade, and SARAF**

Ion Source — LEBT — RFQ — MEBT — DTL — HEBT

80 mA   75keV   3.62 MeV   25 MeV
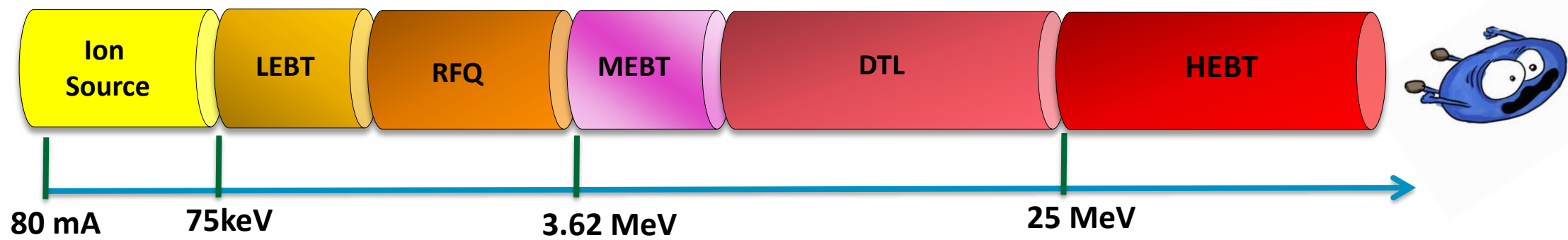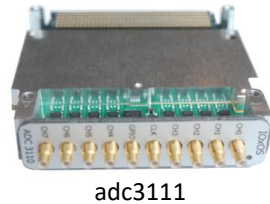
Control system hardware platform

Hardware platform (based on SARAF and IPHI upgrade)

- **Standardized platform based on SARAF and IPHI upgrade**

- Fast/Semi Fast Acquisition based MTCA.4 :
  - Crate MTCA.4 NAT NATIVE-R2 (**6 cards**) or NATIVE-R9 (**12 cards**) (mostly for profiler like Harps)

Native R2

Native R9

  - Fast Acquisition (5MSmp/s -> **250MSmp/s**) : CPU IOxOS IFC1410 & IOxOS ADC3111

adc3111

IFC1410

  - Semi Fast Acquisition (50KSmp/s -> **5MSmp/s**)
    - CPU IOxOS IFC1410 and IOxOS ADC3117 (**5MSmp/s, 20 channels**)
      - ACCT, Faraday Cup, current measurement, RF...
      - FPGA development kit available for IFC1410
    - CPU DAMC-FMC1Z7IO and RTM D-tacq acq424elf (**1MSmp/s, 32 channels**)
      - Profiler (Harps)
      - 64 channels at 1Msps up to 50Hz

ADC3117

Acq424ELF
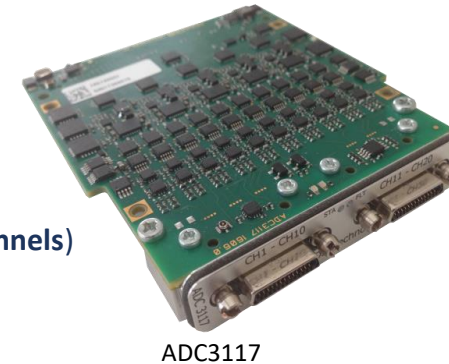
Hardware platform

- **Standardized platform**

- Remote IOs:
  - vacuum , interlocks process … : Siemens 1500 PLC & remote I/O modules (OPC UA)

 - Non-critical slow acquisitions: Beckhoff (OPC UA) : EK9160 & remote I/O modules
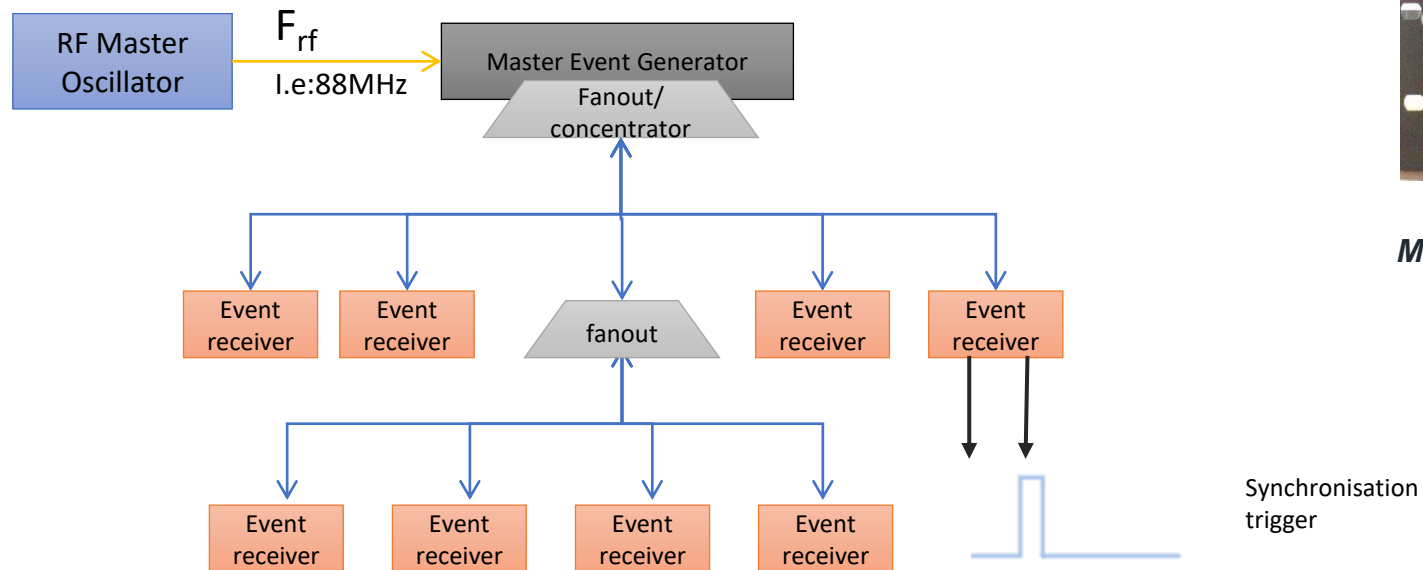

Thanks to THE Ralph and THE Dirk for the OPC UA driver

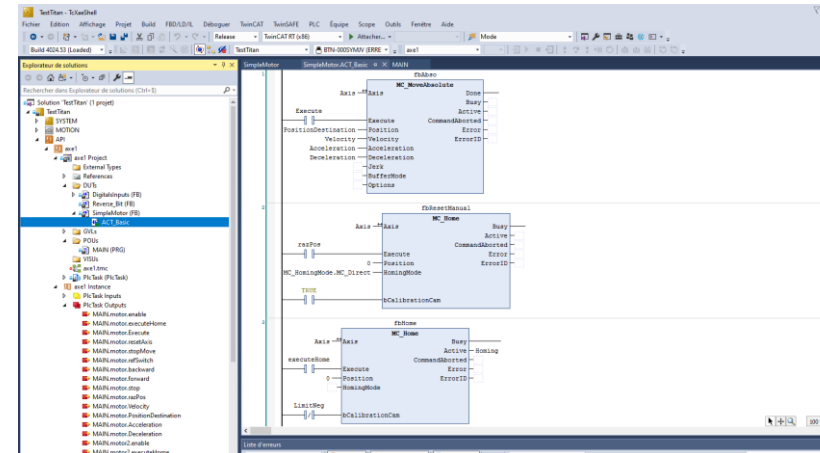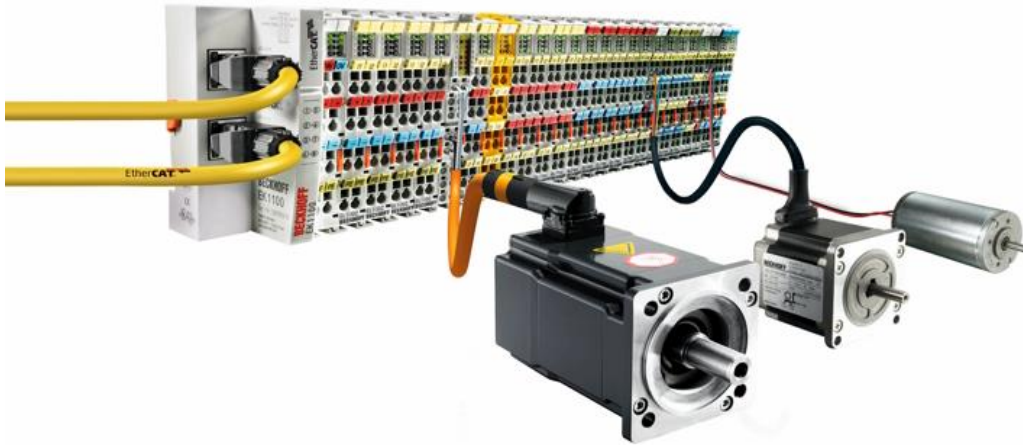# Hardware platform

- **Standardized platform**

- Timing System: Micro Research Finland (MRF) on MTCA.4
  - Event Generator Master and Fanout/concentrator : MTCA EVM 300
  - Event Receiver : MTCA EVR 300U

MTCA EVR300U

Crate NAT R2

MTCA EVM300

Synchronisation trigger
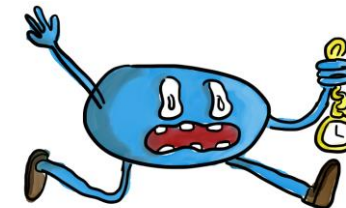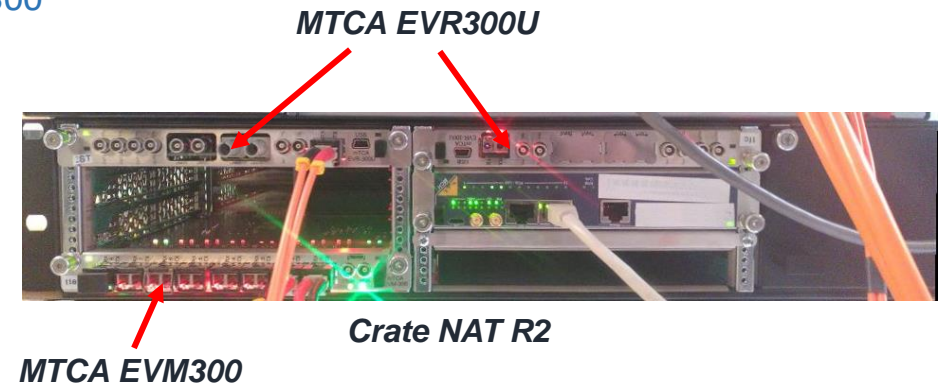
Hardware platform

- **Standardized platform**

- Motorization: Beckhoff (the whole chain: CPU,Driver, wires, motors and development environment TwinCAT)
  - IPC Beckhoff CX5110-9020+ Driver ServoMotor EL7221-9014 + Motor AL8121-0F21
  - IPC C6930 + driver AX5201 + Motor AL8011

Control system software platform

Software platform

- **EPICS V7**

- **PVAccess protocol**

- **Phoebus (CEA is a collaborator now)**
  - **Phoebus-alarm**
  - **Phoebus save-and-restore**
  - **Phoebus Olog**
  - **ChannelFinder**

- **Archive appliance**

- **Custom made software:**
  - **Gengiscan (Genius Generic Scan):** purpose is to run a "scanning procedure" (or "scan")
  - **ssh-monitor: monitor devices through ssh and CA (soon PVA ?)**
  - **…**

Software platform

- **EPNix is an EPICS development and deployment framework**
  - **Based on Nix. Nix is a package manager and deployment tool for producing reproducible and reliable software, with a very active online community (including one at CEA/IRFU).**
  - **Decentralized production architecture. The development environment heavily relies on our git instance.**
  - **Highly reproducible and easily reversible.**

Software platform

- **EPNix packages the standard EPICS support modules:**
  - **Asyn**
  - **mrfioc2**
  - **opcua**
  - **Streamdevice**
  - **Etc...**

- **EPNix also packages other EPICS-related tools, such as procServ, Phoebus, and so on. You can build them by using Nix, while having a strong guarantee that they work as-is.**
  - **Existing Packages :**
    - Phoebus (and its services such as Alarm, save-and-restore etc..)
    - Archive appliance
    - Ca-gateway
    - ChannelFinderService
    - Etc ...

Already available EPICS modules: https://epics-extensions.github.io/EPNix/
(and for more questions, Rémi is in the room)

Software platform

- Short example with the archiver-appliance

```
{

  # After importing 🔷 EPNix , you can do:
  services.archiver-appliance = {
    enable = true;

    stores.lts.location = "/data/lts";
    stores.mts.location = "/data/mts";
    stores.sts.size = "20g";

    openFirewall = true;
  };
}
```

Machine Protection System

- Machine Protection System at SARAF (A. Gaget):
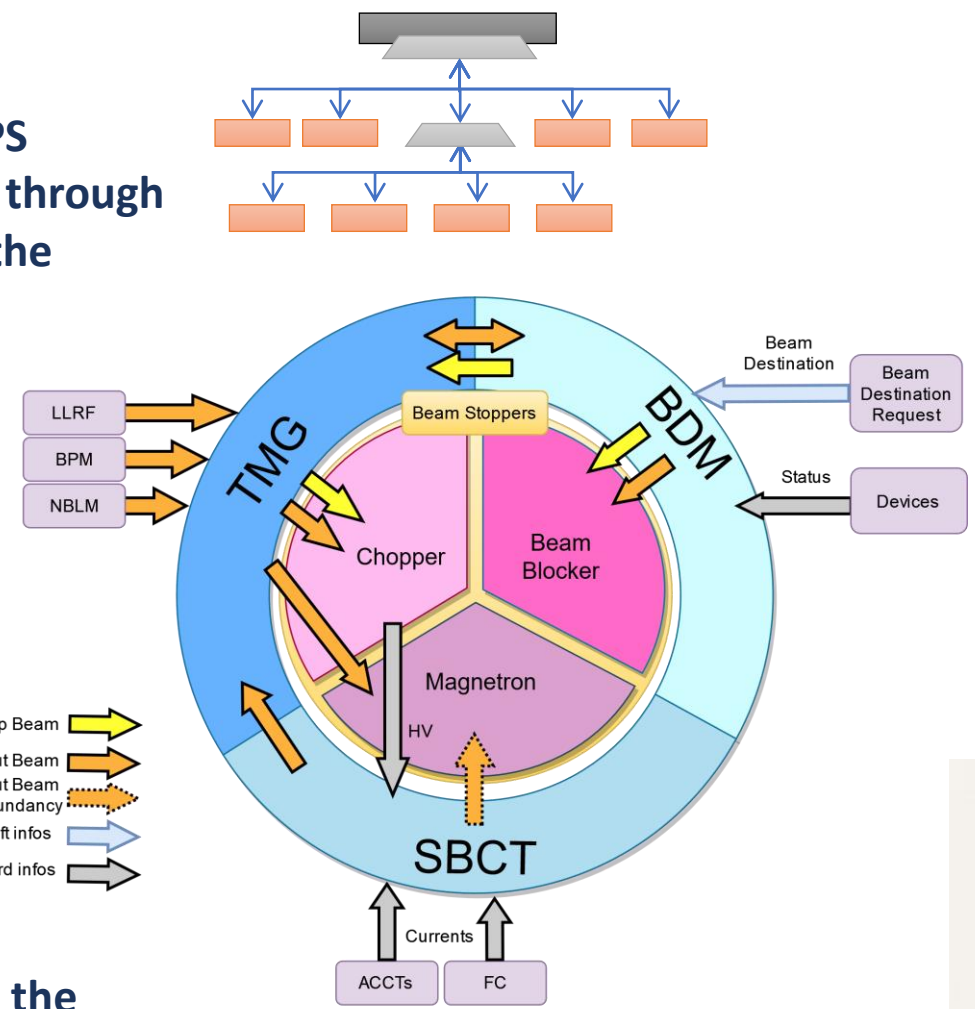https://accelconf.web.cern.ch/icalepcs2023/posters/thpdp102_poster.pdf
- MRF Timing System Design at SARAF (A. Gaget):
https://accelconf.web.cern.ch/icalepcs2021/posters/thpv022_poster.pdf

MPS Overview

Timing (TMG) is the heart of the MPS creating or shutting the beam pulse through chopper and magnetron and being the messenger of the shutbeam event

Beam destination master (BDM) controls that conditions to get the beam to a destination are checked. Linked to all PLC all along the accelerator through Profinet

Section Beam Current Transmission is checking current of the beam all along the accelerator and compare them.
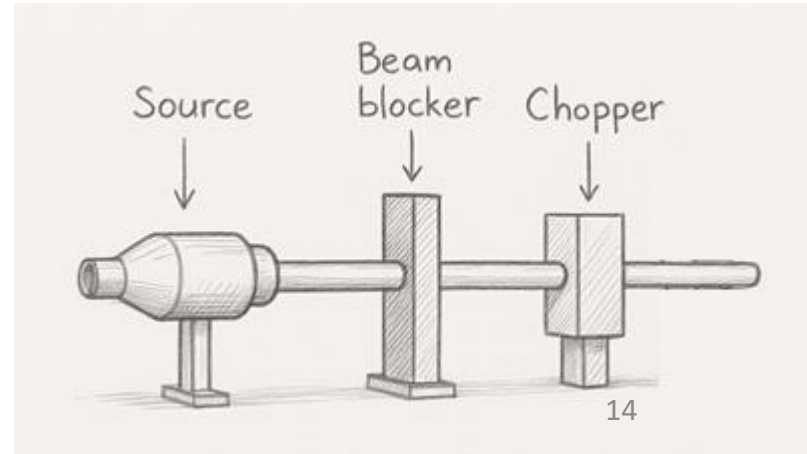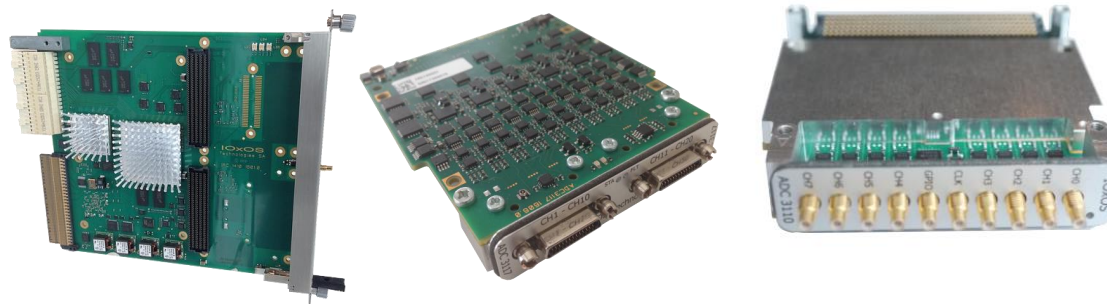
Other FPGA development based on IOxOS MTCA card

- **RF Fast Interlock : Stop the RF in case of RF incident. Comparison of RF signals with threshold.**

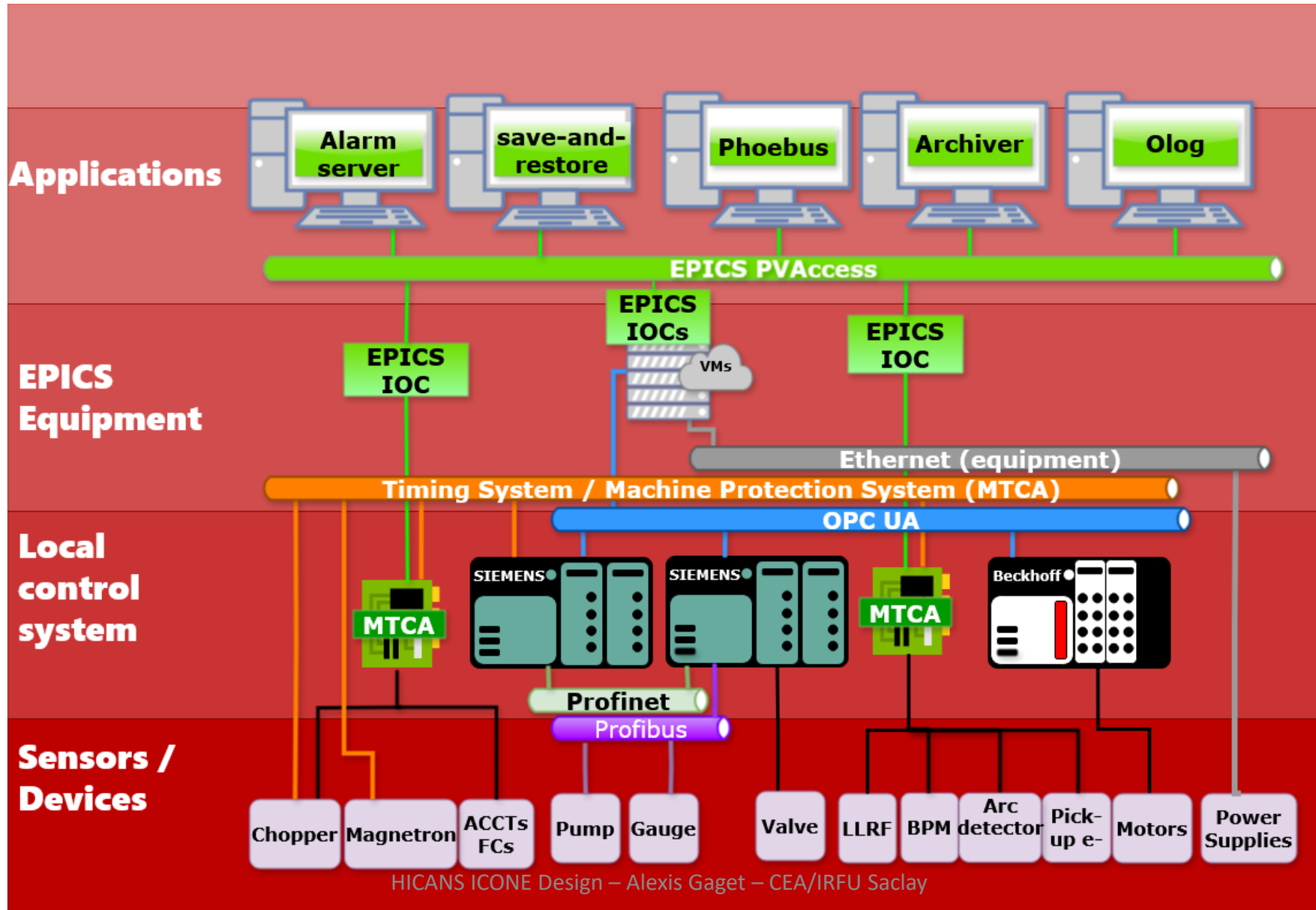- **Neutron Beam Loss monitor: count neutron lost in the pipe all along the accelerators.**

FPGA development on MTCA.4 at CEA (V. Nadot), talk for MTCA workshop at this meeting.

Main synoptic architecture

HICANS ICONE Design – Alexis Gaget – CEA/IRFU Saclay

Main synoptic architecture

HICANS ICONE Design – Alexis Gaget – CEA/IRFU Saclay
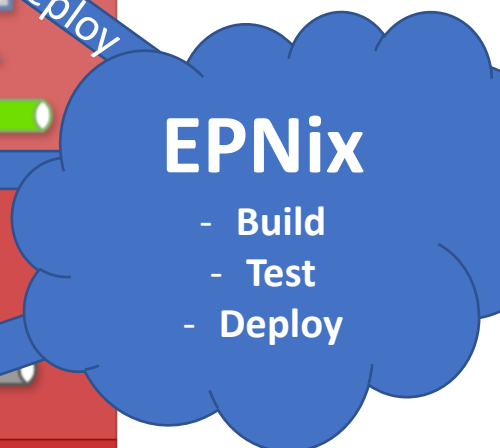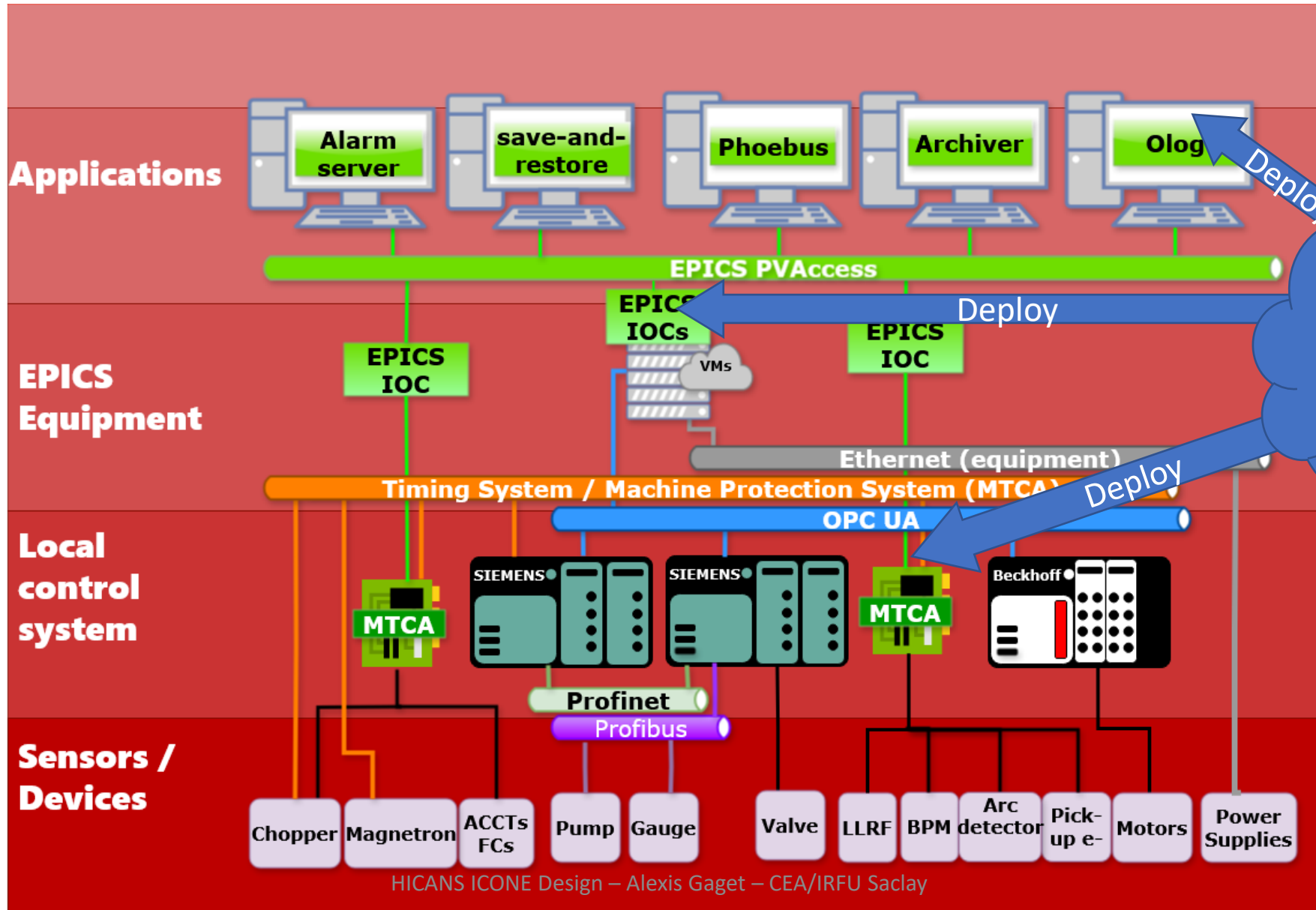
Thanks for your attention

Any questions ?

- ICONE : https://www.icone-neutron.fr/

- Nix : https://nixos.org/

- EPNix : https://epics-extensions.github.io/EPNix/

- Machine Protection System at SARAF (A. Gaget): https://accelconf.web.cern.ch/icalepcs2023/posters/thpdp102_poster.pdf

- MRF Timing System Design at SARAF (A. Gaget): https://accelconf.web.cern.ch/icalepcs2021/posters/thpv022_poster.pdf

- Le SBCT : un système de protection machine rapide pour la surveillance du courant faisceau (V. Nadot), at this meeting.
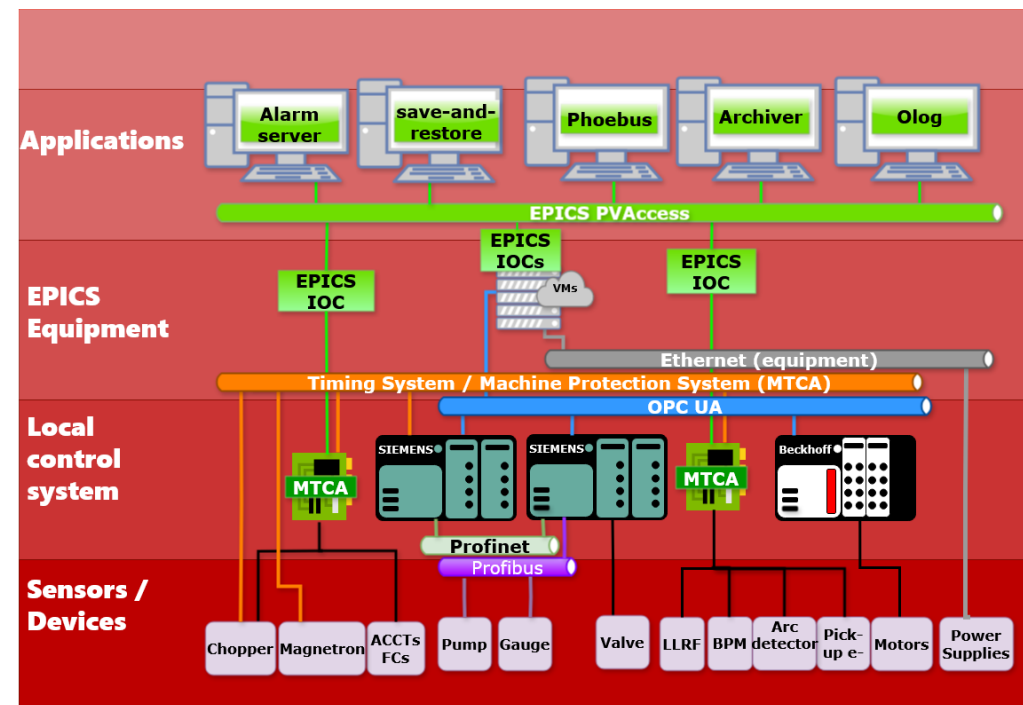
Annex

Hardware platform

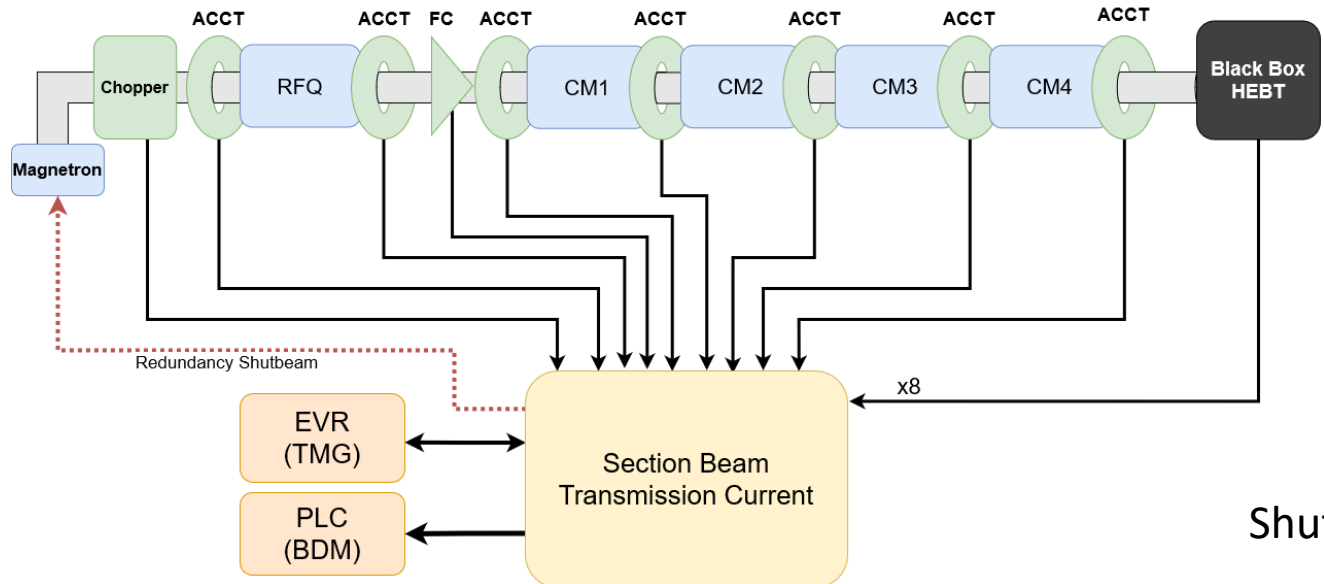| Requirements of the devices	Sampling/monitoring frequency range	COTS solutions
Fast acquisition	5 MS/s 250 MS/s	MTCA.4 IOxOS IFC 1410 & FMC ADC-3111
Semi-fast acquisition	50 KS/s up to 5 MS/s	MTCA.4 - IOxOS IFC 1410 & IOxOS FMC ADC-3117 MTCA.4 - Desy Z7IO && D-Tacq ELF24
Remote I/Os control LAN	100 ms up to 1s	Industrial PC / Virtual Machines on a dedicated server Beckhoff
Process for vacuum/ cryogenics & Remote I/Os & Interlock	100 ms up to 1s	Siemens 1500 PLC & I/O boards/ Profinet/Profibus Fieldbuses & remote I/Os

BDM – Beam Destination Master

- **BDM based on PLC Siemens**

- **BDM gets data from low level PLC and compare it to conditions for a beam destination.**

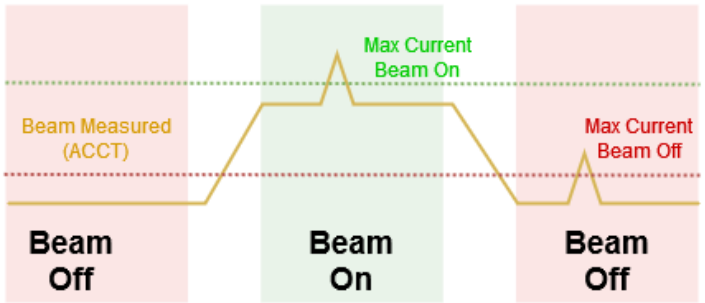- **If an error occurs, the beam stopper is inserted and a signal is sent to the Timing.**
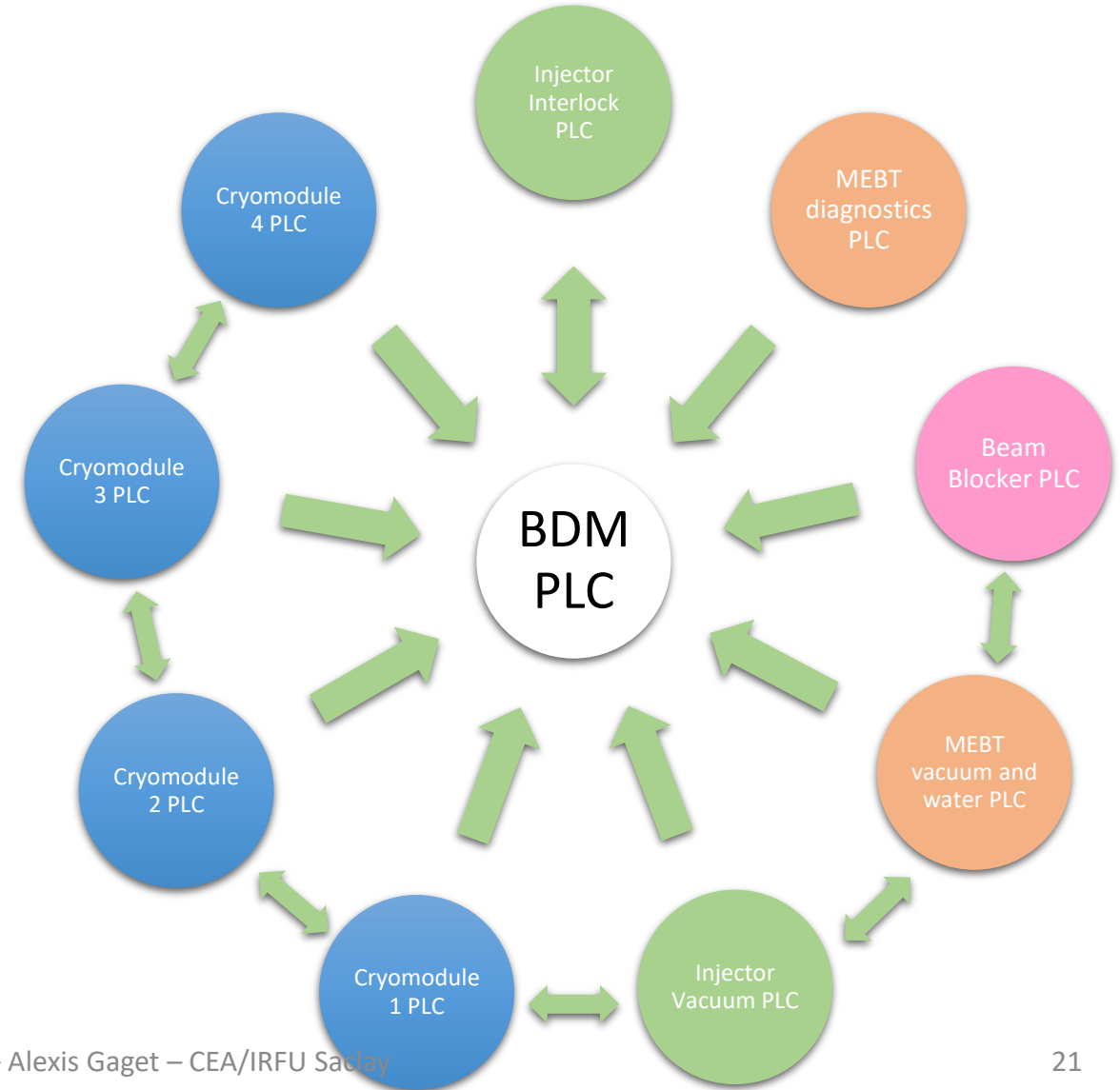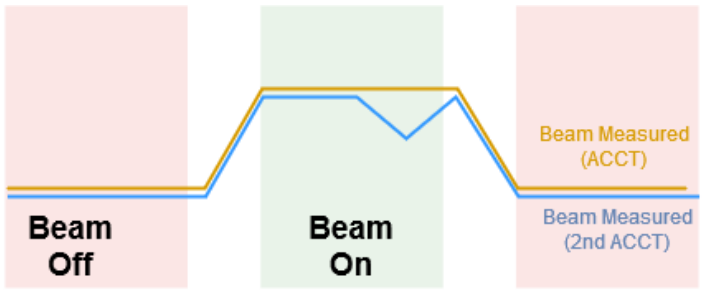
Section Beam Current Transmission - SBCT

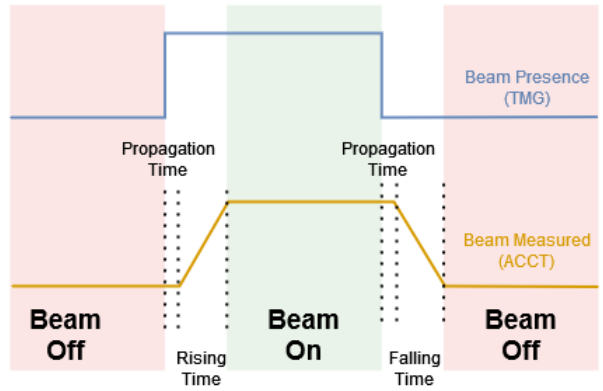Beam Amplitude Checking
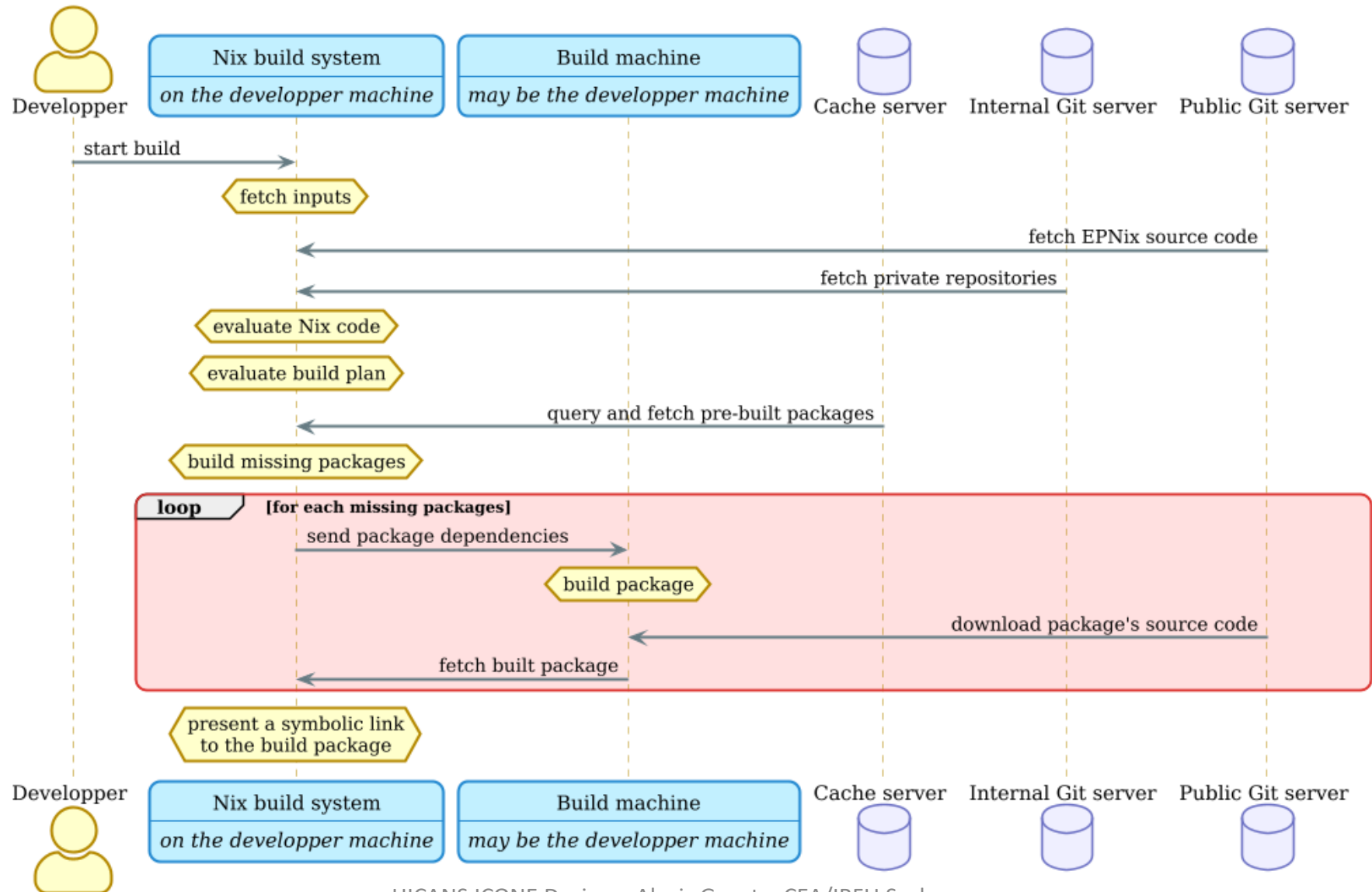
Current differences
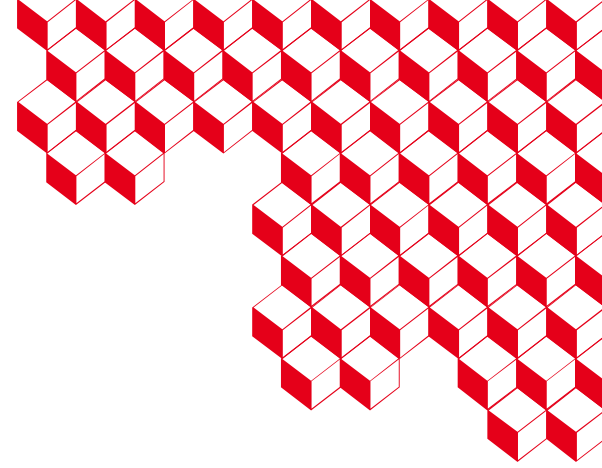
ShutBeam Redundancy

Beam On/Off management

EPNix – sequence diagram

Spring EPICS Meeting at Saclay (Paris)

From 20-24 april 2026

- *Alexis Gaget*   *alexis.gaget@cea.fr*
  Françoise Gougnaud   *françoise.gougnaud@cea.fr*
  Paul Lotrus   *paul.lotrus@cea.fr*

The meeting

- Between 150-200 peoples come from all over the world to talk about EPICS

- 3 Days of plenary sessions – 15-20min speech

- 1 and ½ day of workshop
  - GUI
  - Timing
  - Training session EPICS (TBC)
  - MTCA
  - Etc …

- Visits of CEA installation
  - To be determined (Neurospin, Synergium, Laser, Astrophysic …)

- 1 dinner gala

The venue

- Ecole Normal Superieur (ENS) Paris-Saclay
  - Member of the Paris-Saclay University such as CEA

- Amphitheater Alain Aspect – 400 seats

- 3 Rooms for workshop
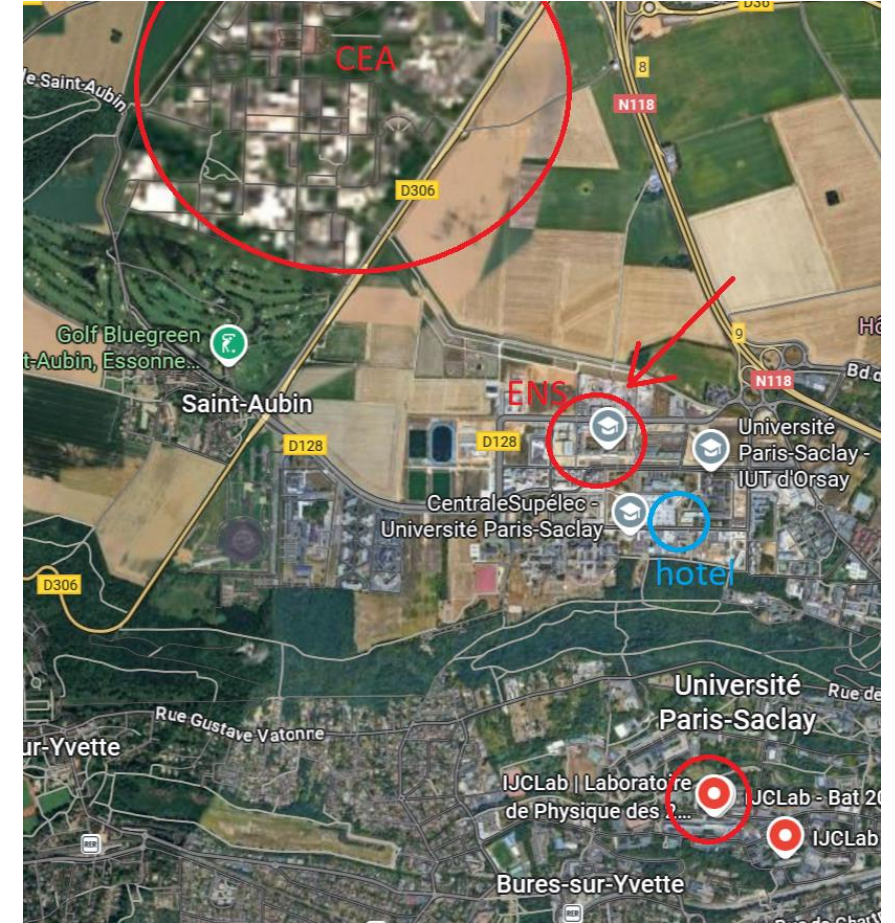
See you soon

- Thank you for your attention, and we hope to see you next spring with a lot of interesting topics.

- More information will be available soon; please check :
  - Tech-Talk (https://epics.anl.gov/tech-talk/)
  - Matrix room EPICS (https://matrix.to/#/#epics:epics-controls.org).
  - IN2P3 Control mailing list

11 years ago at Saclay

28 years ago at Saclay

SACLAY Collaboration Meeting - September 9-11, 1997

- Introduction to Archiving
- Data Taking
- Data Aging
- EDD/DM 2.4 Modifications
- MMI Prototyping Efforts
- SNL Extensions

Contacts:

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Paul Lotrus	paul.lotrus@cea.fr