PIPERADE : PENNING Trap for Radio-Isotopes at DESIR

PIPERADE @ Spiral2 DESIR

PIEGES DE PENNING POUR LES RADIOISOTOPES A DESIR

CENBG

PIPERADE collaboration :

P. Ascher, P. Alfaurt, M. Aouadi, G. Ban, B. Blank, K. Blaum, J.- F. Cam, P. Cheveau, P. Delahaye, L. Daudin, F. Delalee, P. Dupré, S. El Abbeir, M. Gerbaux, S. Grévy, H. Guérin, E. Liénard, D. Lunney, E. Minaya-Ramirez, S. Naimi, L. Perrot, A. de Roubin, L. Serani, B. Thomas, J.-C. Thomas

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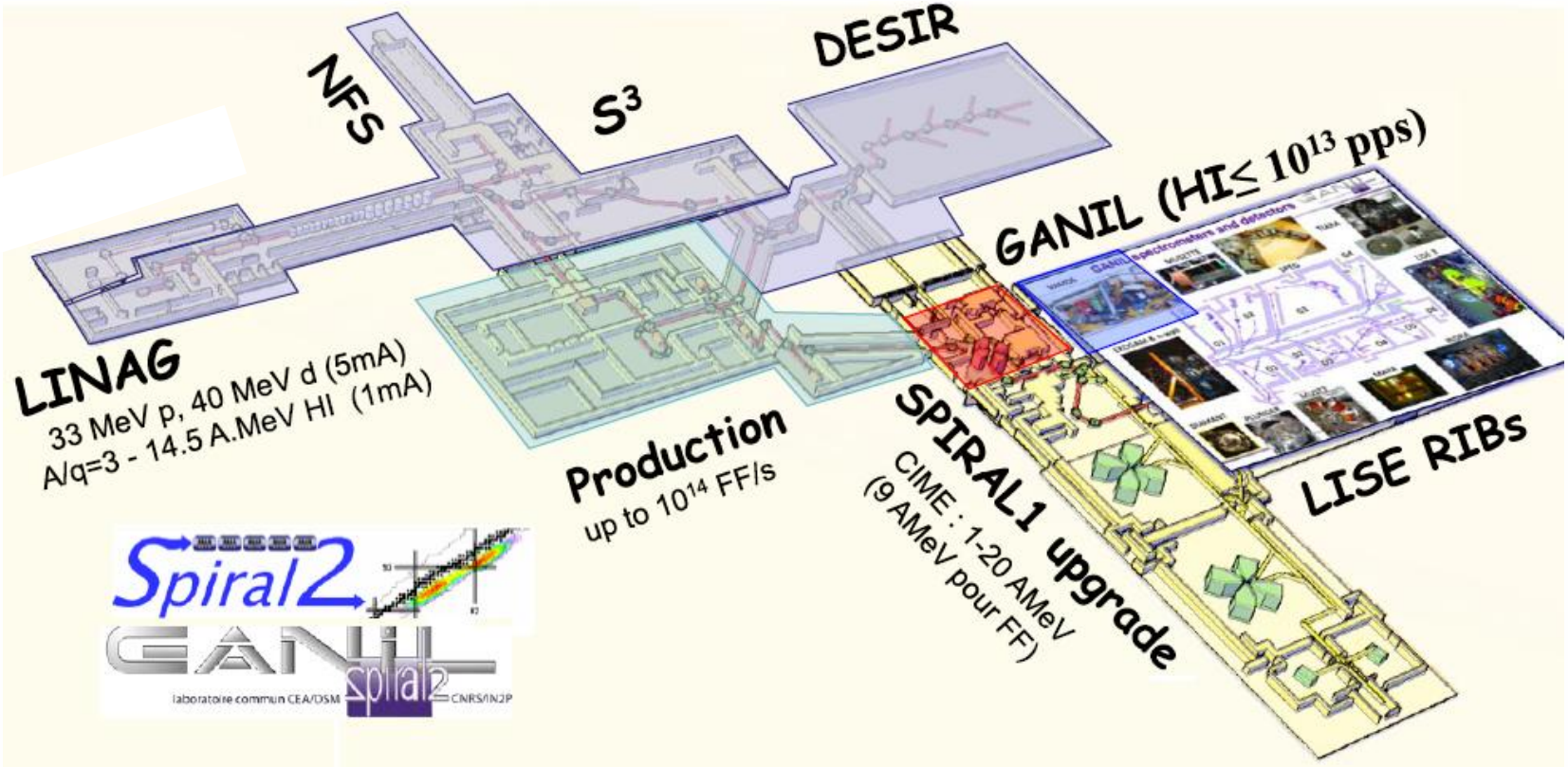
CENBG Service Instrumentation

- SPIRAL2 & The DESIR facility
- The PIPERADE set-up
  - GPIB (General Purpose Ion Buncher)
  - Double Penning Trap
- PIPERADE @ CENBG
- SPIRAL2 control system & Automation
- PIPERADE Control Command
- GPIB Equipments & Control System Architecture
- Trap Equipments & Control System Architecture

Phase 1 LINAC + NFS + S3 → Under construction *(Commissioning 2016 …2017)*

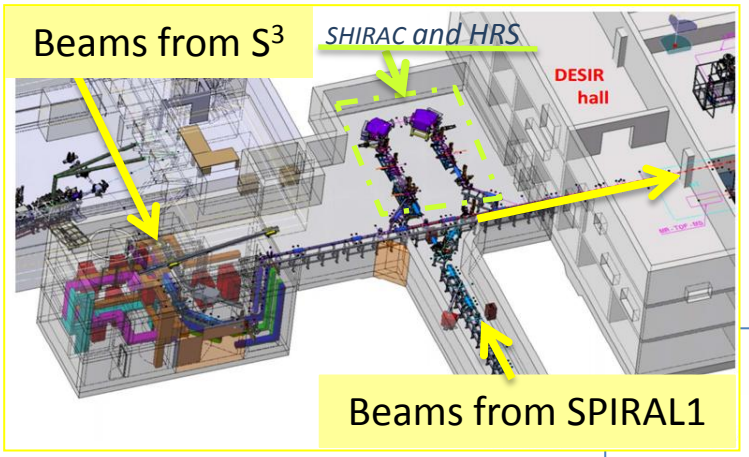
Phase 1+ DESIR → Construction mid-2017 *(Commissioning mid- 2019)*

Phase 2 Production building → > 2025?



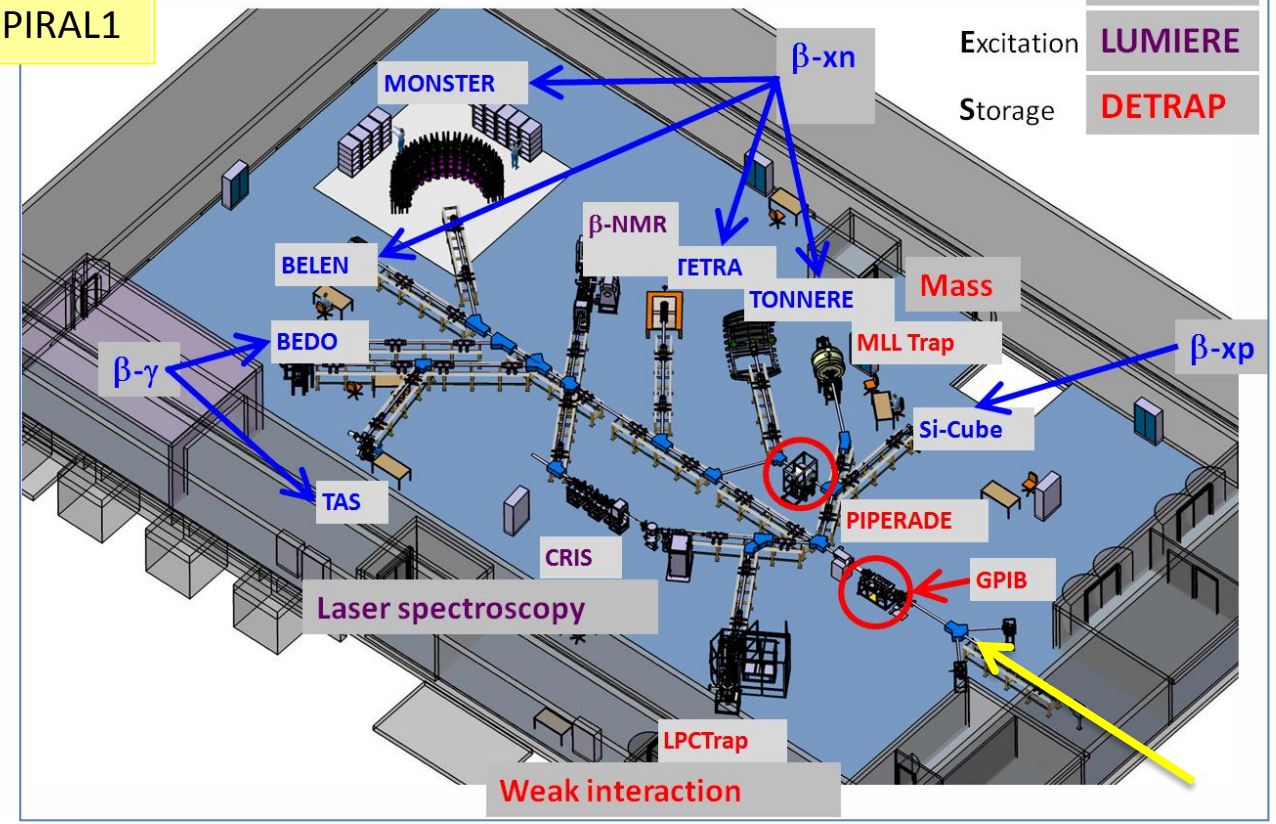
Collaboration spokesperson: *B. Blank, CENBG*
Facility coordinator: *J.-C. Thomas, GANIL*

SPIRAL2/DESIR beams & Experiments



DESIR Experiments

Decay BESTIOL
Excitation LUMIERE
Storage DETRAP



Main Goal **:** Delivering **very pure** and **large samples** of exotic nuclei to the DESIR setup

Requirements

→ **Mass resolution > 10^5** (to clean isobars not cleaned by the HRS + isomers)

Ions of interest usually less produced than contaminants

→ Purification of large samples **(> 10^4 ions/bunch)**

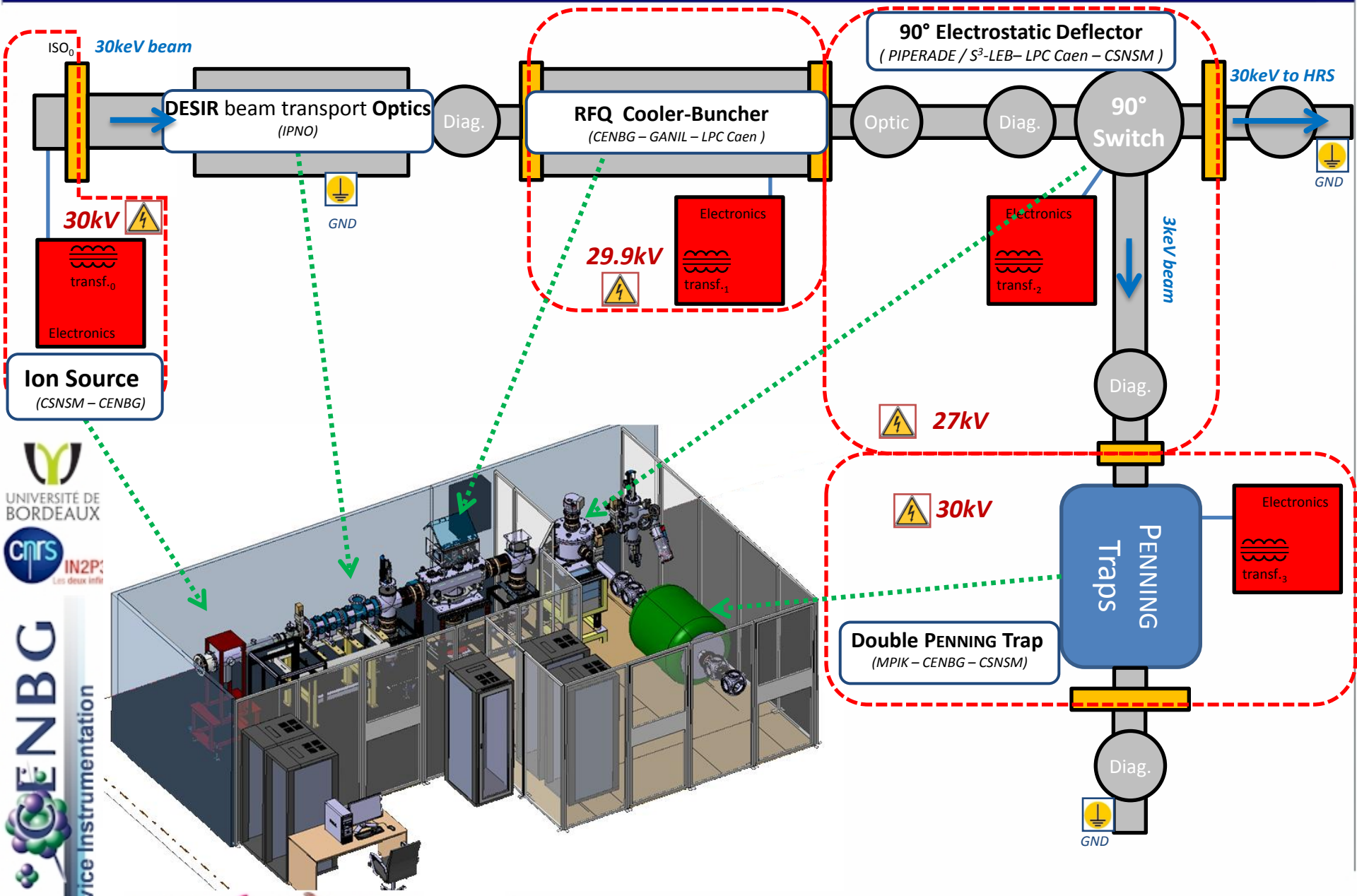
→ "**Fast**" cleaning process

→ High transmission efficiency

→ Double PENNING trap (1 for purification, 1 for accumulation)

but require a cooled & bunched ion beam :

→ RFQ Cooler-Buncher « GPIB » (General Purpose for Ion Buncher)

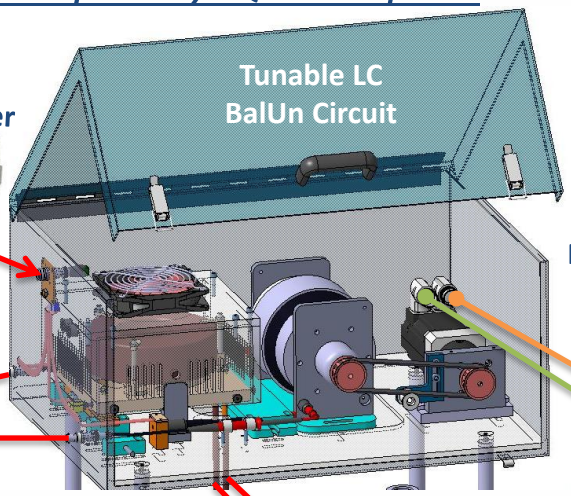

ISO0
30keV beam
DESIR beam transport Optics
(IPNO)
Diag.
RFQ Cooler-Buncher
(CENBG – GANIL – LPC Caen)
Optic
Diag.
90° Switch
90° Electrostatic Deflector
(PIPERADE / S3-LEB– LPC Caen – CSNSM)
30keV to HRS
GND
30kV
transf.0
Electronics
Ion Source
(CSNSM – CENBG)
29.9kV
transf.1
Electronics
transf.2
Electronics
3keV beam
Diag.
27kV
30kV
PENNING Traps
Electronics
transf.3
Double PENNING Trap
(MPIK – CENBG – CSNSM)
Diag.
GND

Radio Frequency Quadrupole

Sine Generator

RF Amplifier

Tunable LC BalUn Circuit



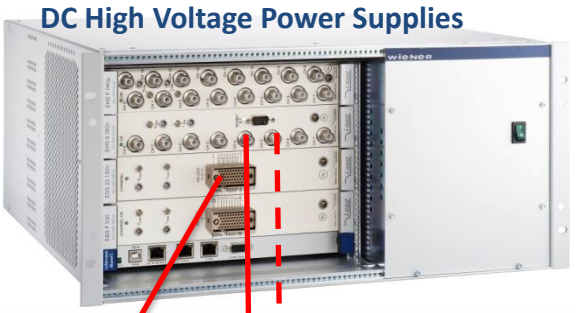
Motor Drive

Oscilloscope

High Voltage RF (250kHz-2MHz/4kVpp)

Electrostatic fields (32 HV PS)

DC High Voltage Power Supplies



Buncher

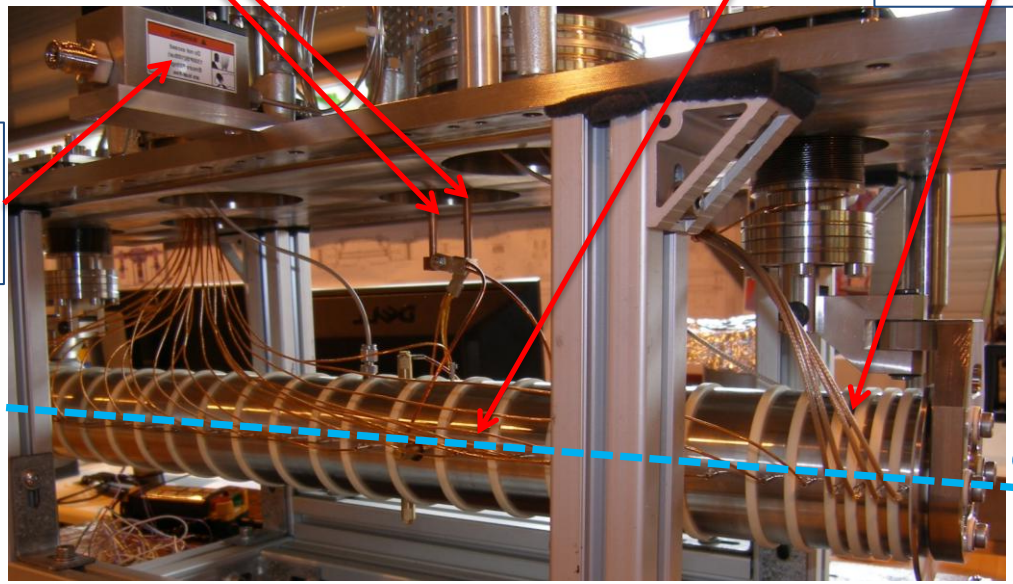
Bunch Controler

Fast HV switches

Cooler

Buffer gas He

Mass Flow controller



CW Beam

Cooled & Bunched Beam

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ENBG Service Instrumentation

Spiral2 DESIR PIPERADE

EPICS

Clients : OPI (Operator Programming Interface)
HMI (Human Machine Interface) on Linux PC

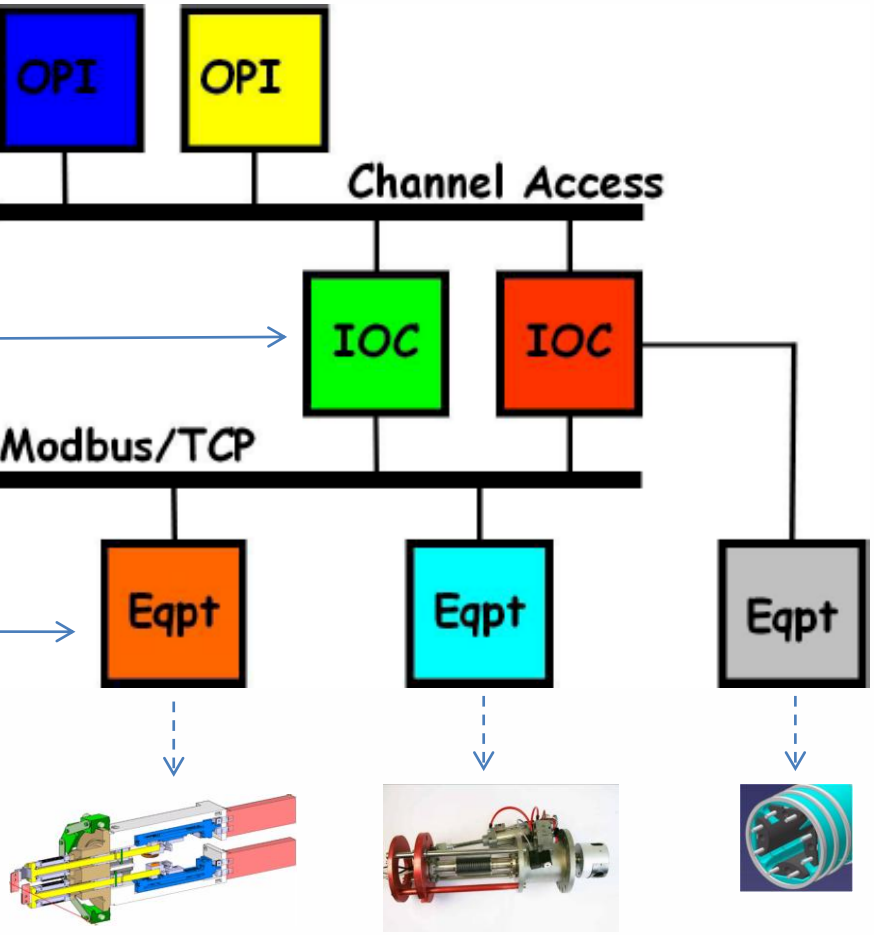
Communication : Ethernet Network
*Protocol: **Channel Access***
(publish & subscribe Processed Variables) → PV

Servers : IOC (Input-Output Controler)
Real Time IOC (VME crate / VxWorks) or Soft IOC (Linux PC)

FieldBus/ (Ethernet)
Modbus/TCP Protocol

Equipments :

- *High Voltage Power Supplies (Optics – Steerers)*
- *High Current Power Supplies (Dipoles)*
- *Beam Diagnostics (FC ; Profilers ; Emittancemeter ; Si)*
- *Motors (Slits)*
- *Industrial Programmable Logic Controlers (PLCs)*



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Spiral2 DESIR PIPERADE

SPIRAL2 Automation Architecture → Vacuum , Interlocks, Insertions, Motors

Human Machine Interface [**Distant *HMI* - *Supervision***]

OPI *[EPICS Client / Linux PC]*

Channel Access / Ethernet

IOC EPICS IOC

[EPICS Server / Linux PC Linux or VME Crate]

Modbus / Ethernet

Vacuum PLC

[Siemens S7-1500]

Interlock PLC (+ Insertions & Motors drives)

[Siemens S7-1500]

[Local Vacuum HMI]

[SIMATIC HMI Touch Panel]

[Local INTLK HMI]

[SIMATIC HMI Touch Panel]

DESIR PLCs

Profinet

Profinet

BeamLines (controled area)

Equipment 1

Equipment 2

Equipment 3

Equipment 4

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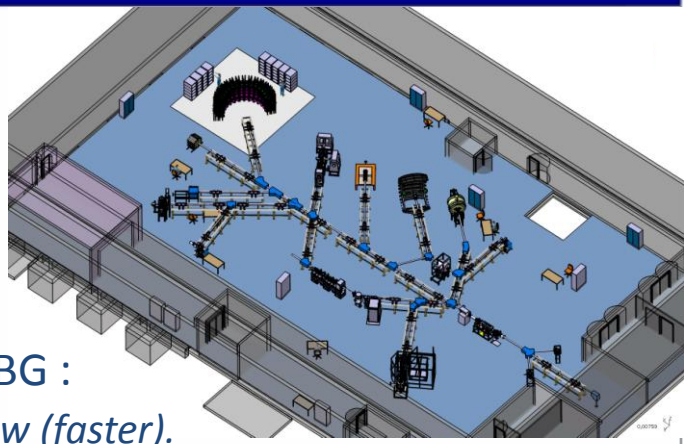
GANIL

Service Instrumentation

Spiral2 DESIR

PIPERADE



Main DESIR Beam Line CC (RFQ-CB & HRS)

→ EPICS @ DESIR

- PIPERADE Ion source, Optics & *RFQ-CB* CC @ CENBG :
  - *Developed & Running since 2013 with LabView (faster).*
  - *Equipments & architecture are SP2 EPICS compatible.*
  - *Migration to EPICS after HRS CC developments.*
  - *HRS EPICS CC started end 2015 @ CENBG*

Experiments like PIPERADE PENNING TRAPs could be EPICS controlled **or not**

- Specific needs (Timing sequences, Scans, Data acquisition)
- Other Traps with same need are running CS Framework.
- CS Framework based on LabView Programming Language.

→ ***CS Framework (GSI) for PIPERADE TRAP Control System.***

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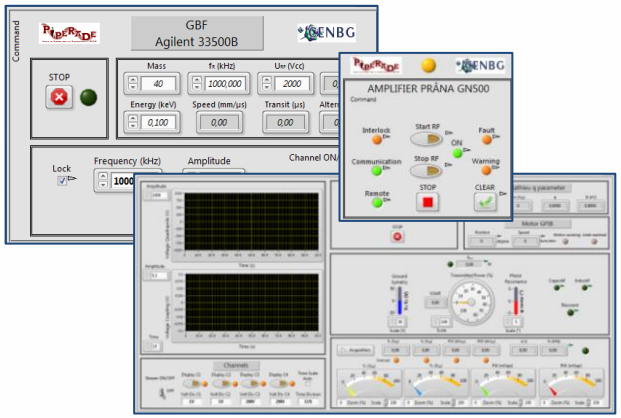
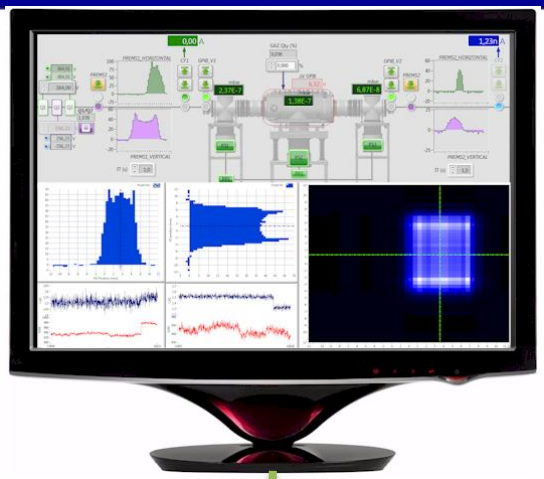




Ethernet

Vacuum PLC

Ethernet Switch

Fiber Optic

Ethernet Switch

High Voltage Platform (PRAD-GPIB) 30kV

Profinet

SNMP

TCP

Modbus TCP

VICT

TCP

RS232 (Power ON/OFF & Status)

PLC distributed I/O

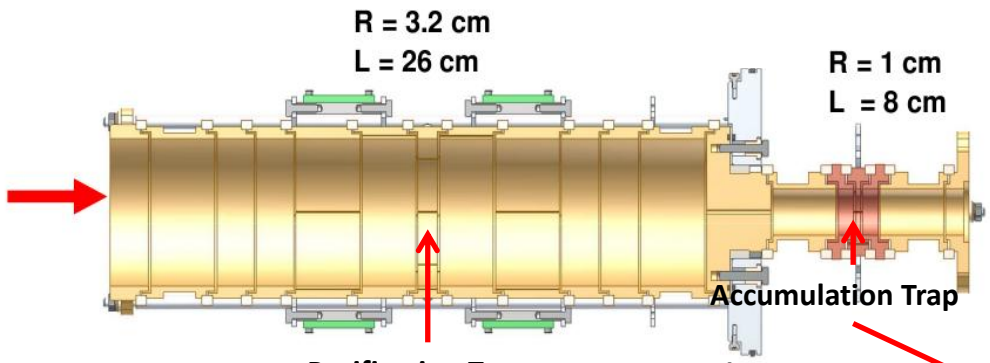
Cooler

High Voltages

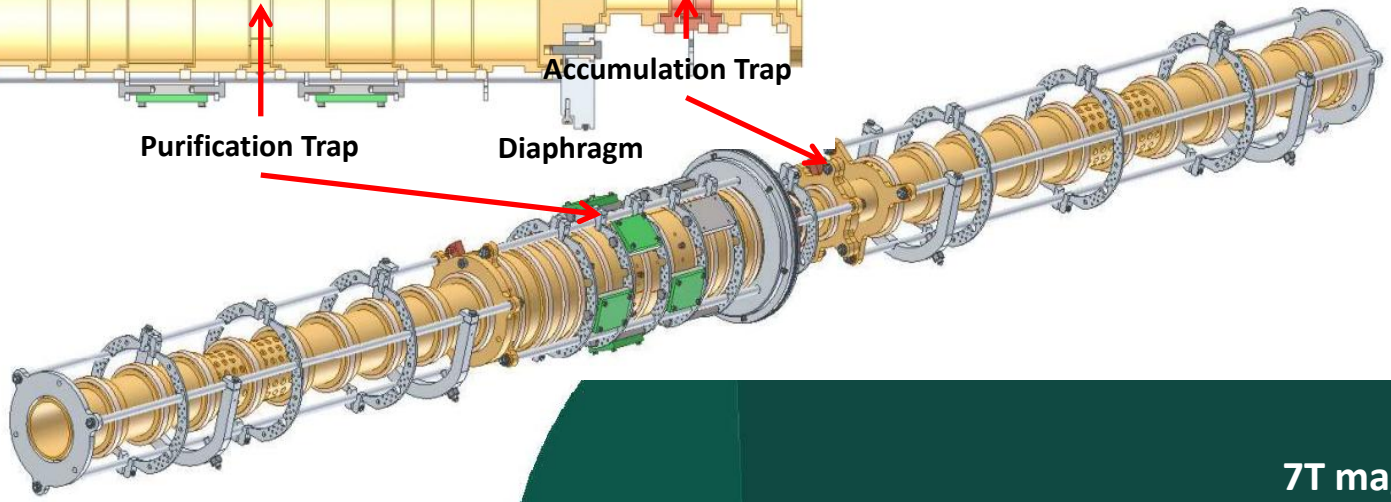
Buncher

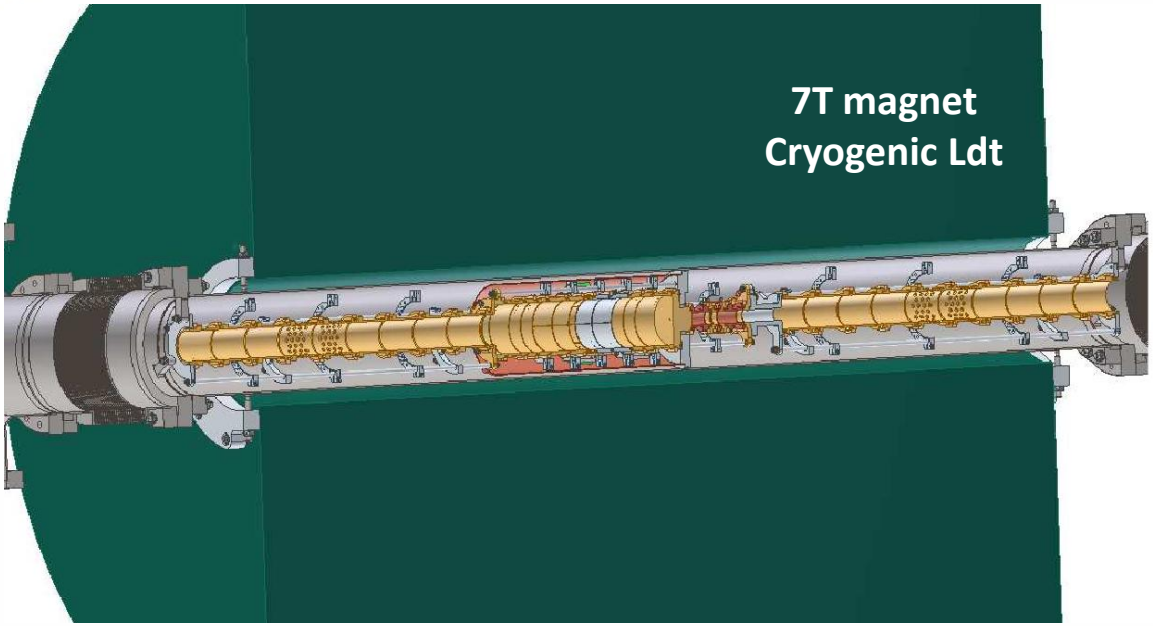
Radio Frequency Quadrupole

DESIGN of the Double PENNING Trap



Performed @ MPIK-Heidelberg





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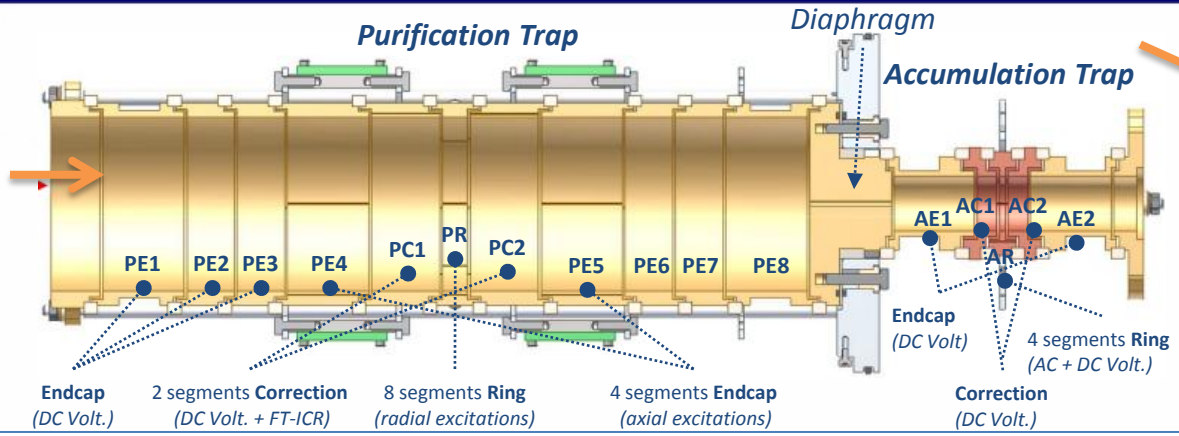
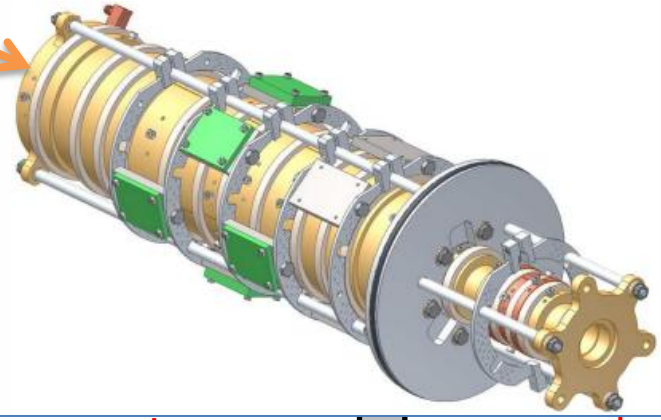




Optics & Trapping Voltages
→DC Power Supplies to control

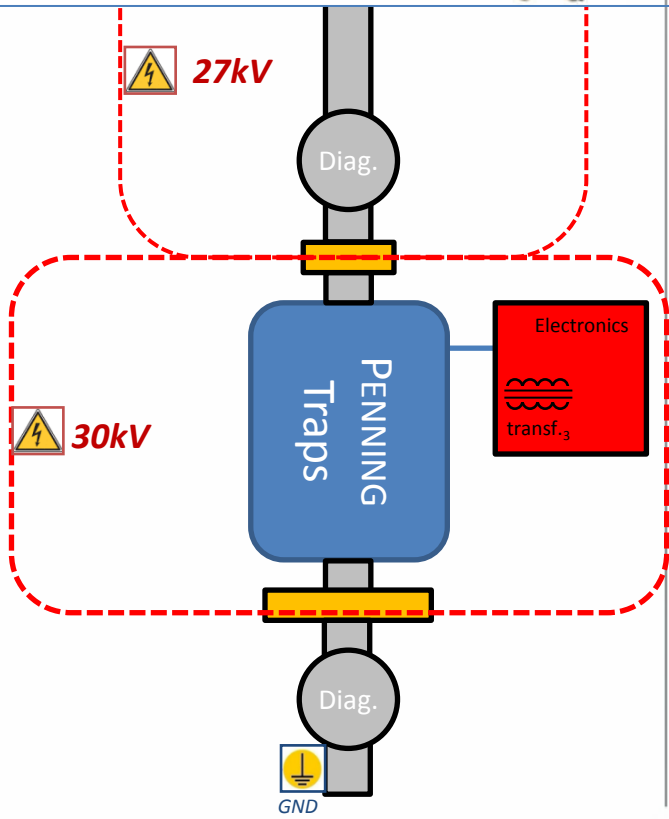
Dipolar, Quadrupolar, … Excitations
→Function Generators (Freq, Time, Amplitude & Phase)

FT-ICR Detection
→Transient recorder + FFT Analyzer

Programmable Timing Sequence
→Pulse Pattern Generator (PPG) : triggers

MCP Detection
→Counting & Time of flight

Faraday Cup
→Beam Current Measurement



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Service Instrumentation
Spiral2 DESIR
PIPERADE

Optics & Trapping Voltages
→DC Power Supplies & HV Switches to control

ISEG Multichannel Crate (1)

Stahl Electronics Low noise
+-500V DC Power Supplies (22)

Stahl Low noise Switches (15)

Dipolar, Quadrupolar, … Excitations
→Function Generators

Agilent Waveform Generators (5)

FT-ICR Detection
→Transient recorder + FFT Analyzer

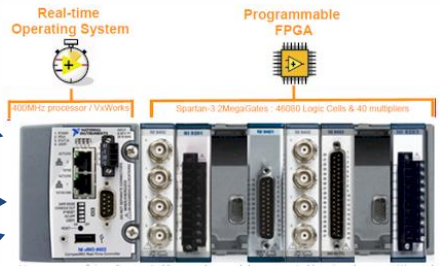
SPECTRUM
4 transient recorders/ PCI card
16bit ADCs
130MS/s
2GSample Memory

Programmable Timing Sequence
→Pulse Pattern Generator (PPG)

MCP Detection
→Counting & Time of flight

Faraday Cup
→Current Measurement

SHIPTRAP & ISOLTRAP
RIO PPG software on



Standalone NI Compact RIO controler (2)

Equipments controlled by CS @ High Voltage

CS Framework

Trigger IN (buncher)

Trig OUT (ex : start TOF)

TTL TTL

Ethernet (LAN)

CRIO Diag (FC – MCP)

Ethernet Switch

Fiber Optics

Fiber Optics

High Voltage Platform (PRAD-TRAP) 30kV

Ethernet

Ethernet Switch

TTL TTL CRIO PPG

TRIGGERs

PC with 4 Transient Rec.

USB

USB

2ch. WG

PR V_{C1} (quad. cycl.)
PR V_{C2} (oct. cycl.)

2ch. WG

PE V_z (axial dipol.)
PE V_{Zq} (axial quad)

16ch. +-500V DC PS

4 x 2ch. Fast switches

16ch. +-500V DC PS

4 x 2ch. Fast switches

2ch. WG

AR V_c (quad. cycl.)

2ch. WG

AR V_- (dipole mag.)
AR V_+ (dipole mod. cycl.)

HV Multichannel

2ch. WG

PR V_- (dipole mag.)
PR V_+ (dipole mod.cycl.)

PT excitations

Optics & Trapping Voltages

FT-ICR

AT excitations

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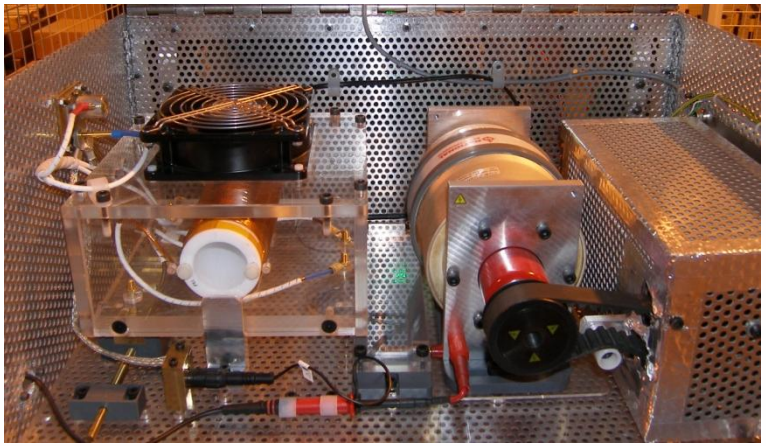
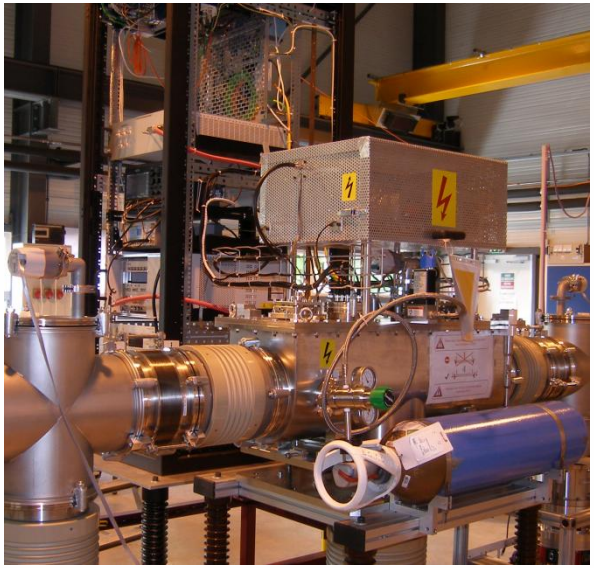
PIPERADE: some pictures

Tunable LC BaLun Circuit



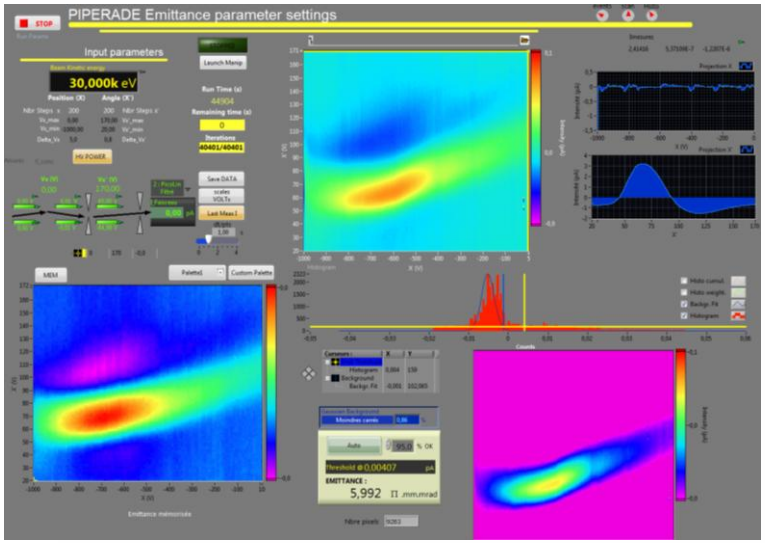
GPIB-CB



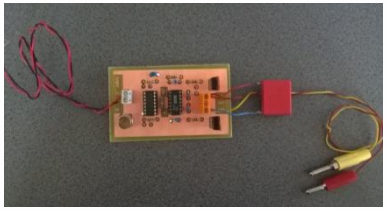
PENNING Traps

FEBIAD ion source

Emittance cooling



Fast-Switches



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Spiral2 DESIR PIPERADE

PIPERADE @ Spiral2 DESIR

PIEGES DE PENNING POUR LES RADIOISOTOPES A DESIR

Thanks for your attention and to the PIPERADE collaboration

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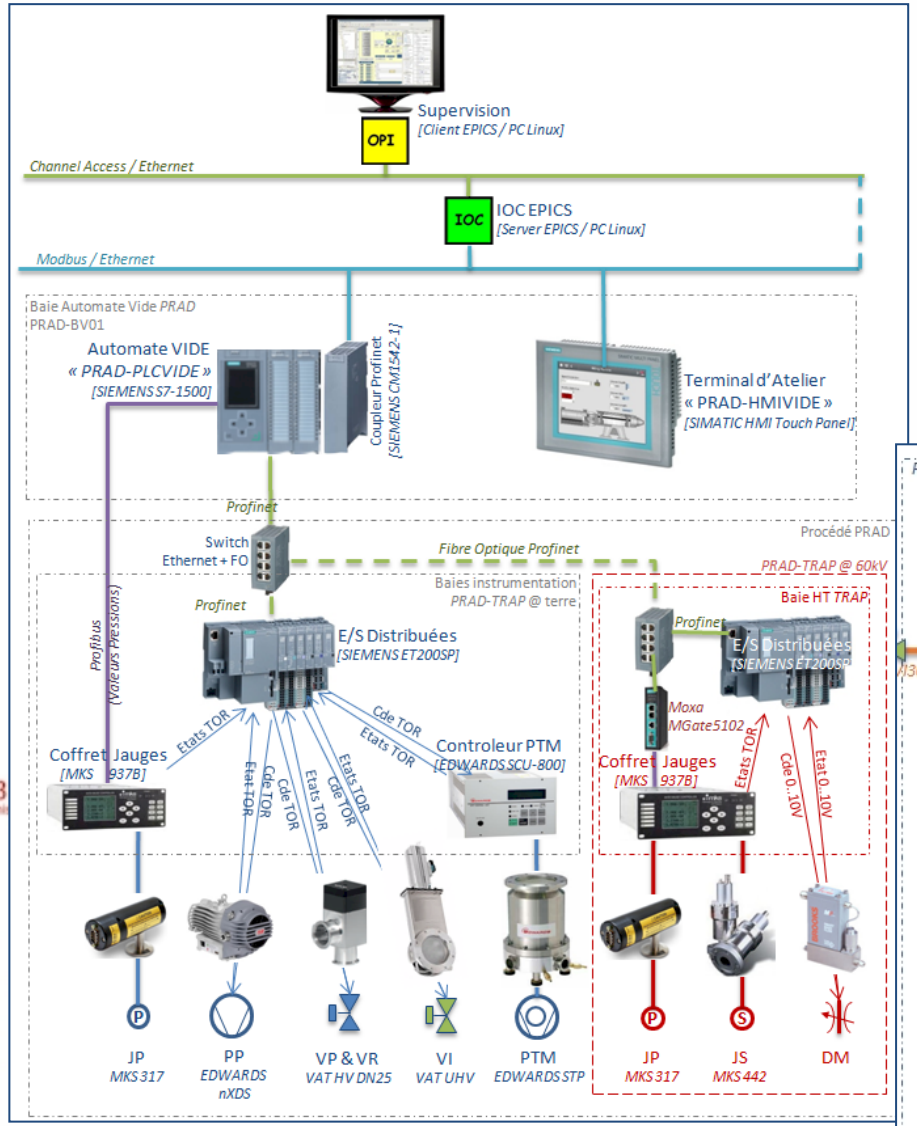
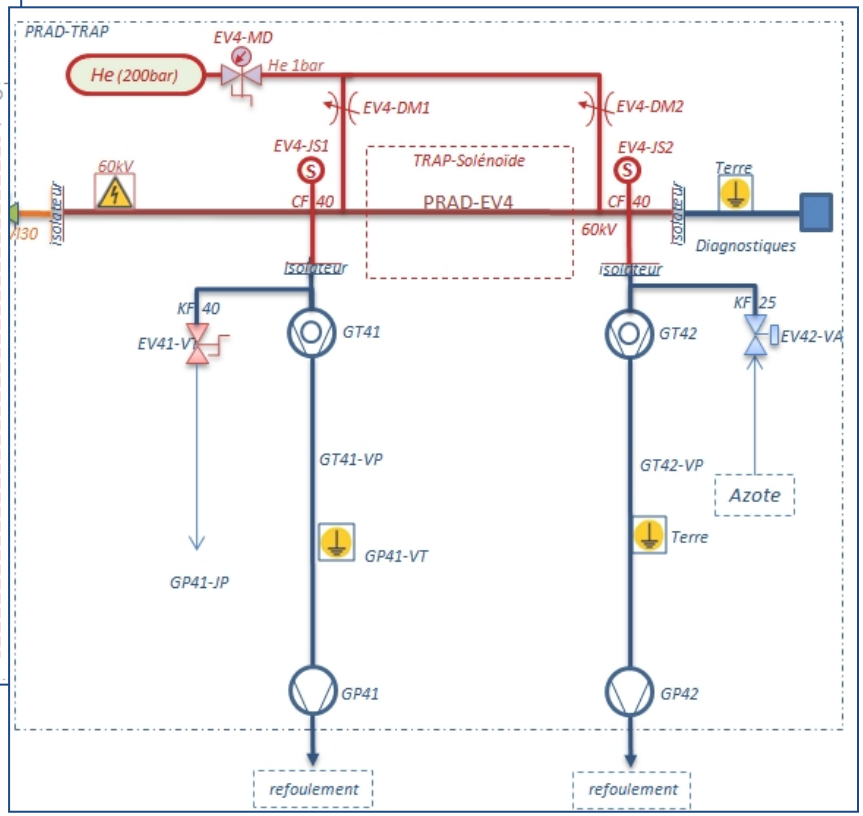
CENBG Service Instrumentation

PIPERADE VACUUM System : SPIRAL2 like

example : TRAP Vacuum



- *Siemens PLC*
- *Touch Pannel for Local Control*
- *EPICS with Modbus-TCP*
- *Pumps at GND voltage*
- *Distributes I/O with Profinet (Fiber Optics if needed)*
- *Profibus for Gauges*



FT-ICR detection (Fourier Transform Ion Cyclotron Resonance)