STATUS OF VACUUM CONTROL SYSTEM UPGRADE OF ALPI ACCELERATOR

TUPDP038

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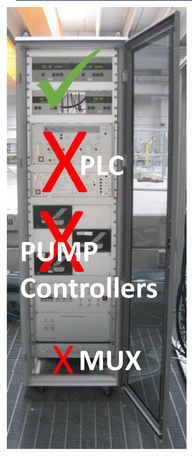
ABSTRACT:

The vacuum system of ALPI (Acceleratore Lineare Per Ioni) accelerator at LNL (Laboratori Nazionali di Legnaro), including around 40 pumping groups, was installed in the '90s [1]. The control and supervision systems, composed by about 14 control Racks, were developed in the same period by an external company, which produced custom solutions for the HW and SW parts. Control devices are based on custom PLCs, while the supervision system is developed in C and C#. The communication network is composed of multiple levels from serial standard to Ethernet passing true different devices to collect the data. The obsolescence of the hardware, the rigid system infrastructure, the deficit of spares parts and the lack of external support, impose a complete renovation of the vacuum system and relative controls [2]. In 2022 the legacy high level control system part was substituted with a new one developed in EPICS (Experimental Physics and Industrial Control System) and CSS (Control System Studio) [3]. After that, we started the renovation of the HW part with the installation and integration of two new flexible and configurable low level control system racks running on a Siemens PLC and exploiting serial server to control the renewed pumping groups and pressure gauges. The plan for the next years is to replace the legacy hardware with new one retrieving spare parts, provide service continuity, improve PLC software and extend the EPICS control system with new features. This paper describes the adopted strategy and the upgrade status.

LEGACY VACUUM CONTROL SYSTEM (VCS) RACK INSTALLED IN THE '90s

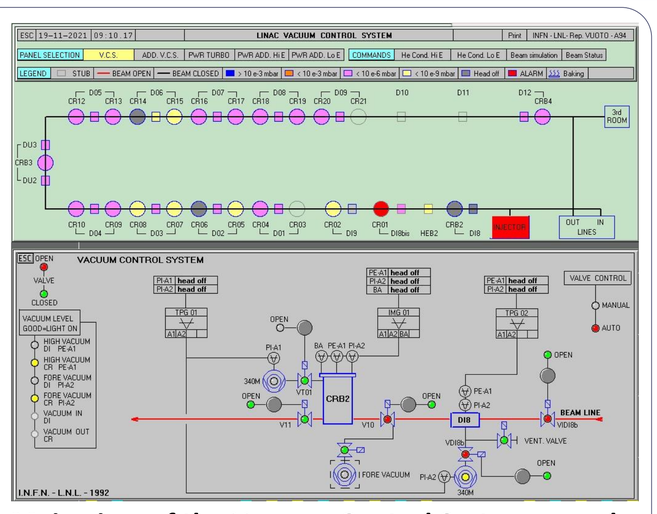


Spares available on the market

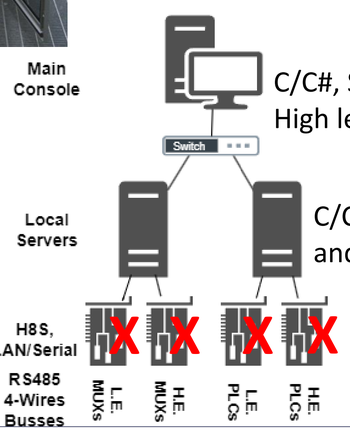
Custom electronic boards, no more supported

Discontinued, new products require system modification

Custom electronic boards, no more supported



Main view of the Vacuum Control System console



C/C#, Supervisor and High level functions

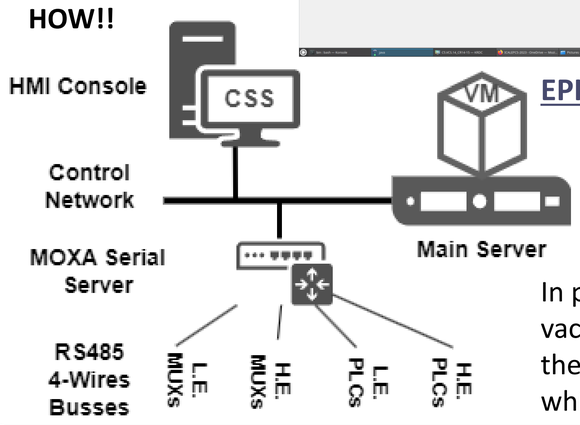
C/C#, Data Collector and raw data view

Discontinued
No spares

- **RIGID ARCHITECTURE**
- **MACRO COMPONENTS**
- **DATED OR DISCONTINUED HW**
- **LACK OF SPARES**
- **INCOMPLETE DOCUMENTATION**
- **DATED SW LANGUAGES**
- **MANUFACTURER OUT OF THE MARKET**

UPGRADE STRATEGY

- NEW HIGH LEVEL SW EPICS BASE
- REPLACEMENT OF VACUUM PUMPS AND VCS RACKS WITH NEW ONES BASED ON SIEMENS S7-1500
- RECOVER SPARES FROM UPGRADED SYSTEMS
- **KEEP THE KNOW HOW!!**

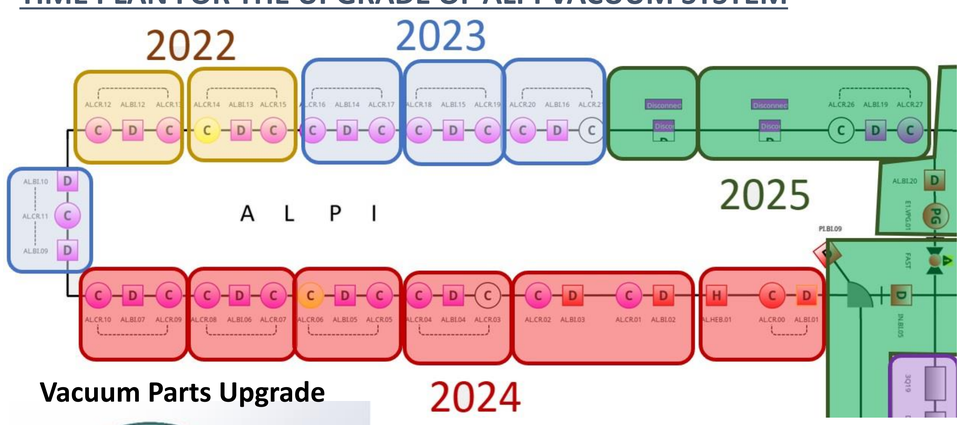


EPICS AND CSS BASED VACUUM CONTROL SYSTEM

- **MORE ROBUST**
- **EASIER TO MAINTAIN**
- **BASED ON COMMERCIAL HW**

In production from end of 2021, the EPICS based vacuum control system was the first step to support the replacement VCS racks and vacuum HW upgrade which will take some year.

TIME PLAN FOR THE UPGRADE OF ALPI VACUUM SYSTEM



Vacuum Parts Upgrade

PFEIFFER VACUUM
ACP28, HiPace 300M, TPG500

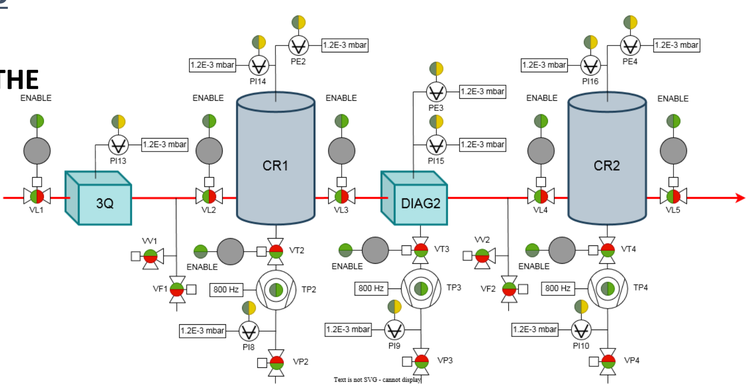
EDWARDS
Next 730

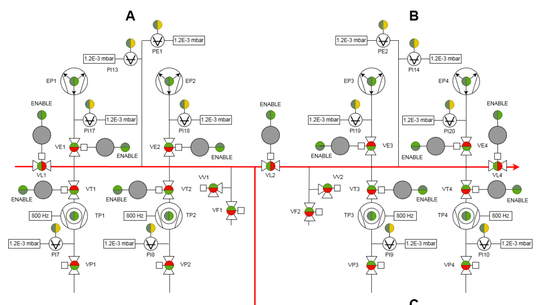
New VCS Rack

- **DESIGN AND SW KNOW-HOW INTERNAL**
- **COMMERCIAL PARTS DISPOSED IN ACCESSIBLE WAY**
- **MODULAR PARTS AND SELF DIAGNOSTIC**
- **BASED ON SIEMENS S7-1500 →** WIDELY USED, PART OF THE SOFTWARE DEVELOPMENT CAN BE EXTERNALIZE
- **UPS POWER SUPPLY**
- **LAN COMMUNICATION WITHIN THE RACKS**
- **DRY CONTACTS INTERFACE FOR BACKWARD COMPATIBILITY**
- **LAN/SERIAL CONVERTERS FOR VACUUM INSTRUMETATION**
- **LARGE VACUUM DEVICE SUPPORT (EASLY EXPANDIBLE)**
- **EPICS INTEGRATION VIA *S7nodave***
- ***15*" LOCAL HMI IS ACCESSIBLE REMOTELY**

VCS SOFTWARE CONFIGURATIONS

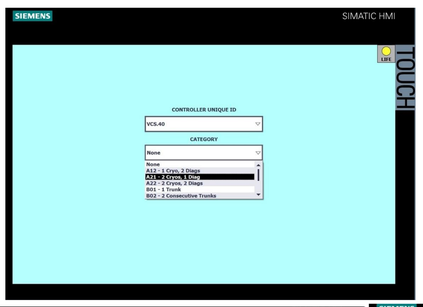
- **COMMON HW PLATFORM**
- **ONE CONFIGURABLE SW FOR ALL THE EXPECTED LAYOUTS (21 Cases):**
  - **ALPI (3)**
  - **STRAIGHT TRANSPORT LINE (3)**
  - **SPECIAL LINES (4)**
  - **MUX LINES (11)**
- **CONTROLLING UP TO:**
  - **6 PRIMARY PUMPS**
  - **6 TURBOMOLECULAR PUMPS**
  - **6 ENTRAPMENT PUMPS**
- **SUPPORTING VARIUS DEVICE BRANDS AND MODELS**
- **GUIDED AND INTERACTIVE CONFIGURATION VIA LOCAL HMI**
- **DETECT AND BLOCK CONFIG CONFLICT**

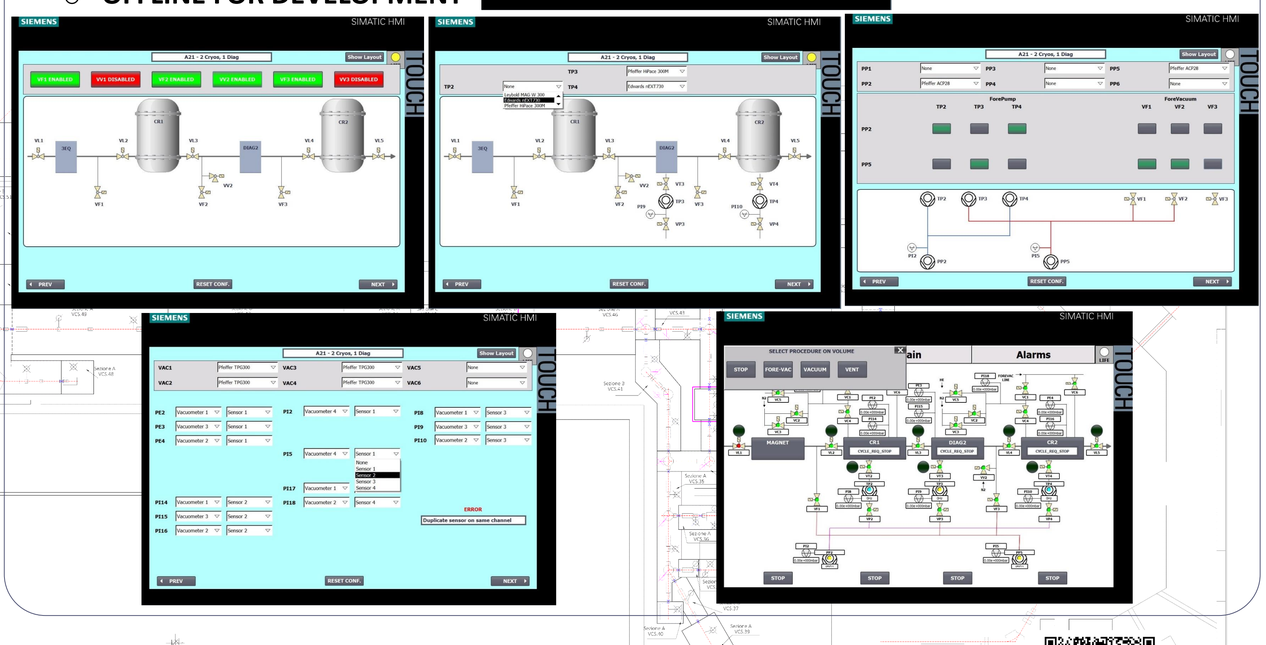




SW DEVELOPMENT

- **MODULAR APPROACH**
- **INCREMENTAL AND BACKWARD COMPATIBILIE**
- **2 PROJECTS:**
  - **ONLINE**
  - **OFFLINE FOR DEVELOPMENT**





CONCLUSION AND NEXT STEPS

The VCS rack is a **consolidated platform for the vacuum system of the LNL**, constituting a key point for the new installation and renovation of the entire LNL accelerator complex, which will include a total of about **50 racks**. To achieve the final goal several steps are still needed, here we reports the major :

- Update the **communication** within adjacent racks or other systems
- Upgrade the **EPICS integration** and the high level functionalities
- Complete all the **expected configurations**
- SW migration from **TIA** V15.1 to the most recent version
- Define and adopt a strategy to keep **versioning of the configuration** in use in each VCS rack
- Define a strategy to **handle small HW differences between the PLC** of different VCS (e.g. due to different device version)

INFN-LNL: http://www.lnl.infn.it

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