

MEDICINE. RESEARCH. HOPE.

Particle Therapy at MedAustron

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Controls Engineer

ABOUT MEDAUSTRON

Center for **particle therapy for cancer treatment** and for **research**.



Is one of only six comparable centers **worldwide**.



Helps cancer patients with an advanced and rare treatment method.

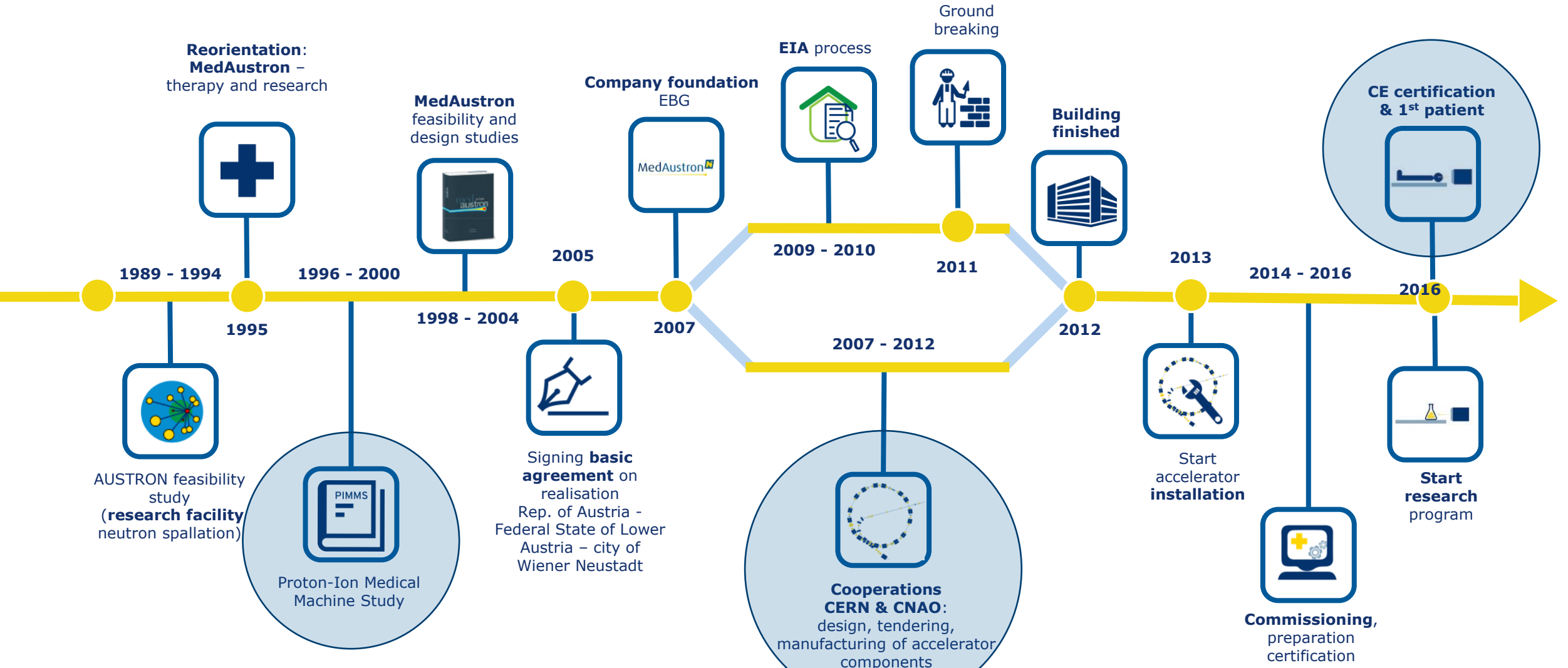


Improves particle therapy and **creates more evidence** through research.

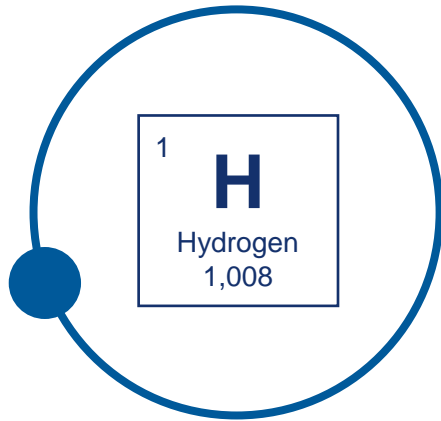


Has expertise in designing, building, commissioning, certifying & operating an accelerator.

COMPANY HISTORY



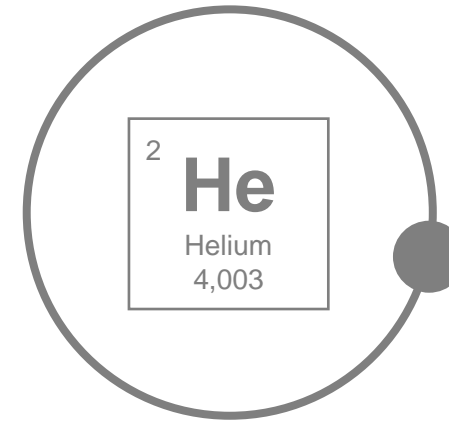
PARTICLES IN PARTICLE THERAPY



PROTONS
Up to 250 MeV



CARBON IONS
Up to 430 MeV/u



HELIUM IONS

Possible future candidate
– currently **subject of research**

Sparing of organs at risk and healthy tissue

Higher dose in the tumor /
application in
radioresistant tumors

INDICATIONS TREATED AT MEDAUSTRON



Total planned 2023:
550
Patients
11,000
Single Fractions

Central Nervous System	26%
Head & Neck	20%
Re-Irradiation	16%
Pediatrics	16%
Sarcoma	11%
Skull Base	6%
Prostate	3%
Gastrointestinal (upper)	2%
Gastrointestinal (lower)	<1%
Gynecological Tumors	<1%
Urogenital Tumors	<1%
Breast/Mamma-Ca	<1%

Values (rounded) as of May 2023

FACILITY OVERVIEW

Irradiation Rooms

Three rooms for patient treatments

Research

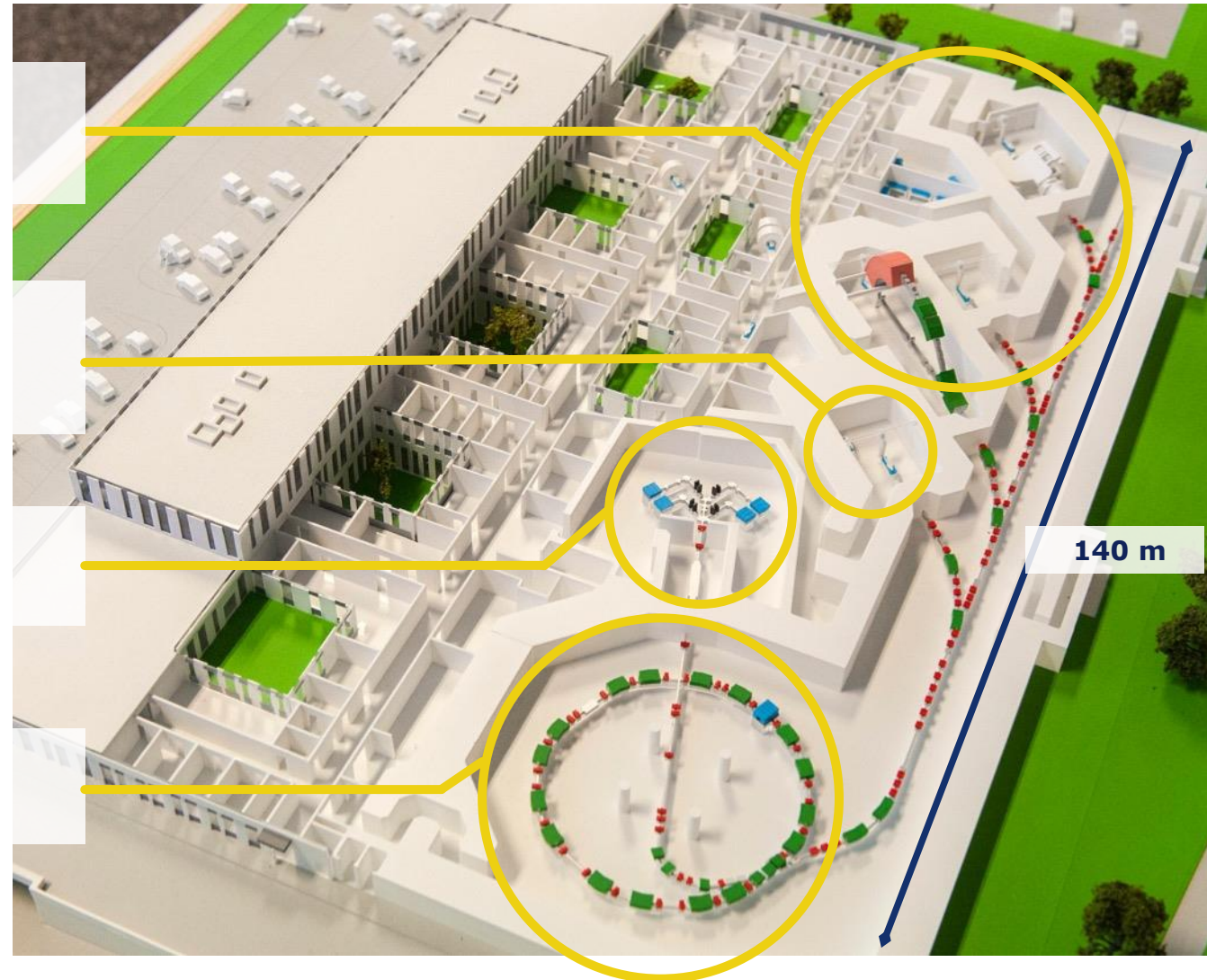
Irradiation room for non-clinical use

Ion Sources

and linear accelerator

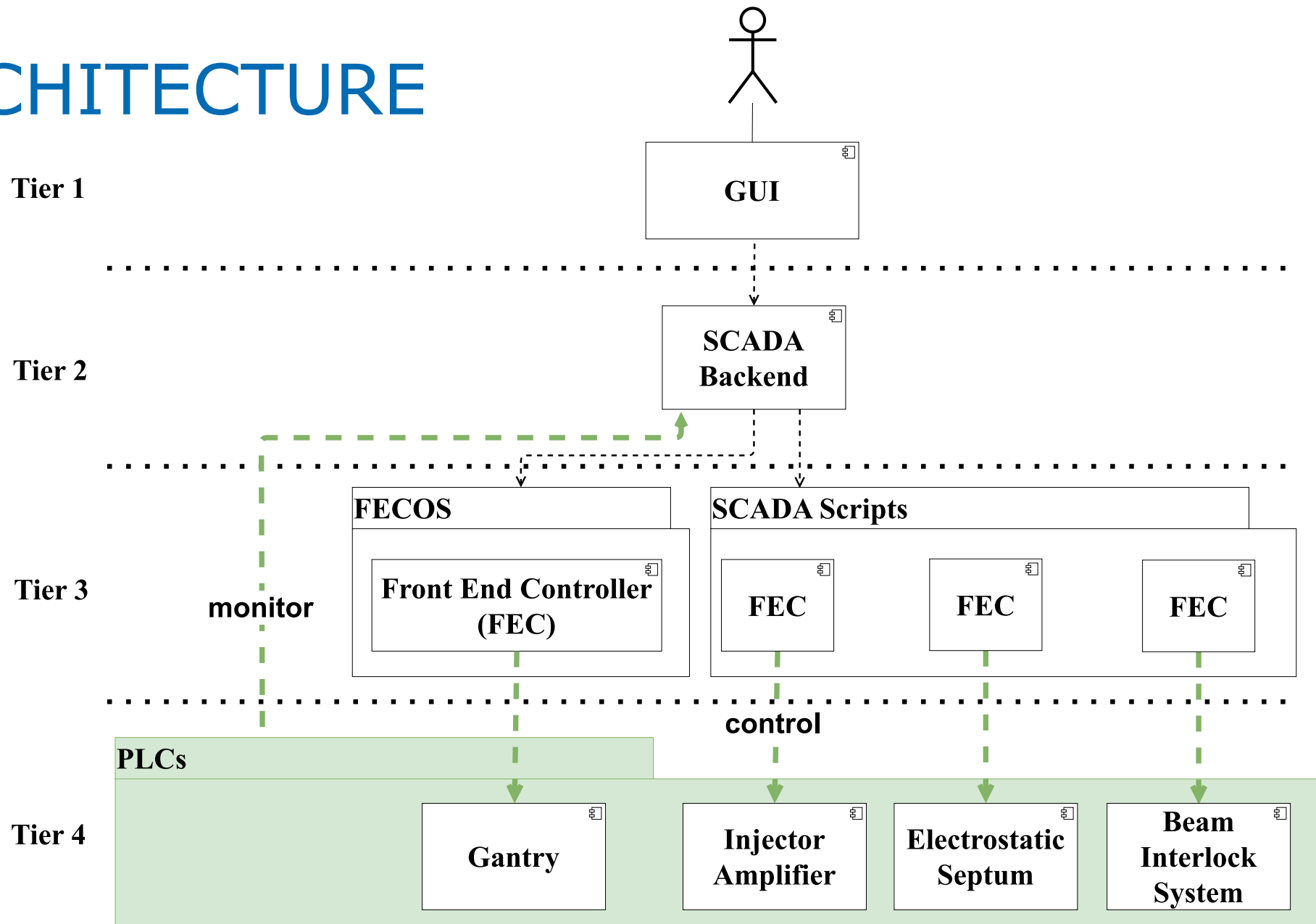
Synchrotron

= circular accelerator



PLCS IN THE MEDAUSTRON CONTROL SYSTEM

ARCHITECTURE



ONGOING CHALLENGES

OPERATIONAL SAFETY SYSTEM

- Purpose

- Protection of personal against unintended irradiation
- Device protection

- Key features

- Separated into 2 main PLCs
 - Beam Interlock System
 - Patrol Control System
- 2x SIMATIC S7 CPU 417-5H
- Protection of personal up to SIL 2 according to IEC 62061 (TÜV certified)
- Distributed communication via Profibus over 23 racks
- Connected to 900 different devices via 1600 inputs and 1000 outputs
- Protection of personal programmed in Continuous Function Chart
- Device protection programmed in Instruction List (script generated)

MAJOR CHALLENGES

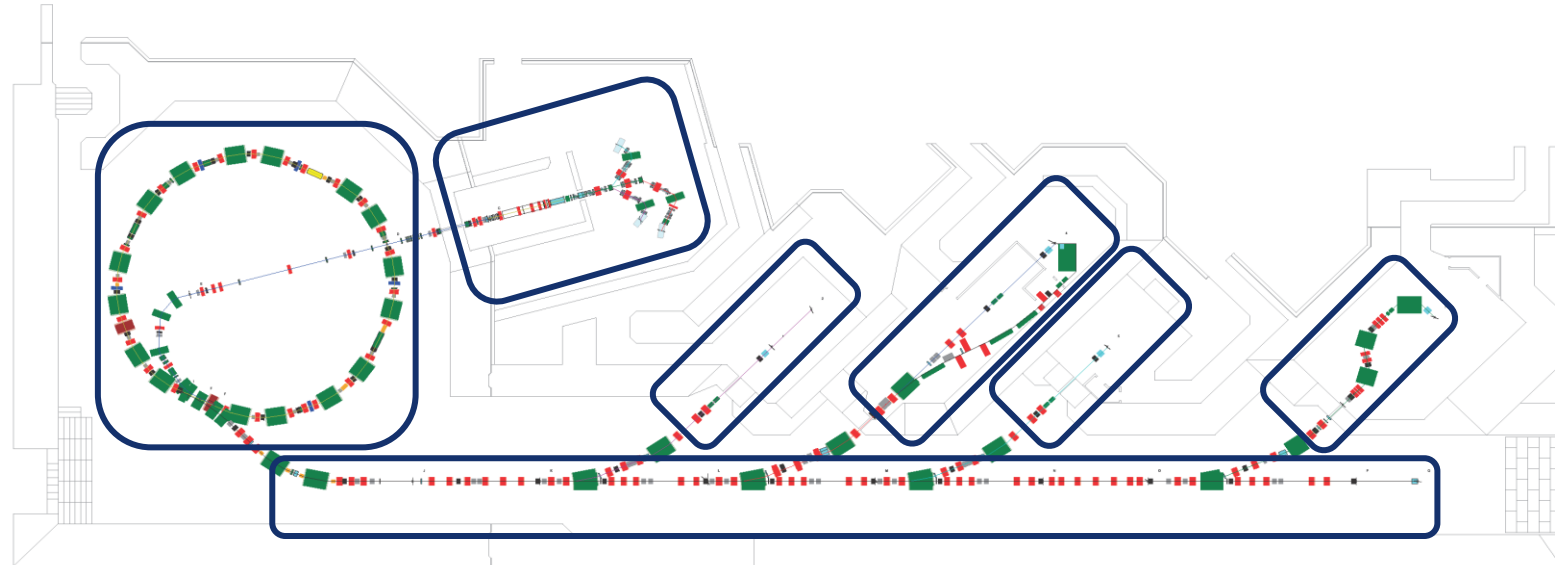
- Single CPU for the entire accelerator
 - Service activities and changes are exclusive of machine time in case of a CPU stop

- Difficult to ensure that only indented source code is changed
 - Lack of regression testing makes code refactoring almost impossible

- Site Acceptance Test is a lengthy task occupying the entire accelerator
 - Lack of factory acceptance tests

MAJOR CHALLENGES – SINGLE CPU

- Option 1 – Separation of concerns



- Advantages

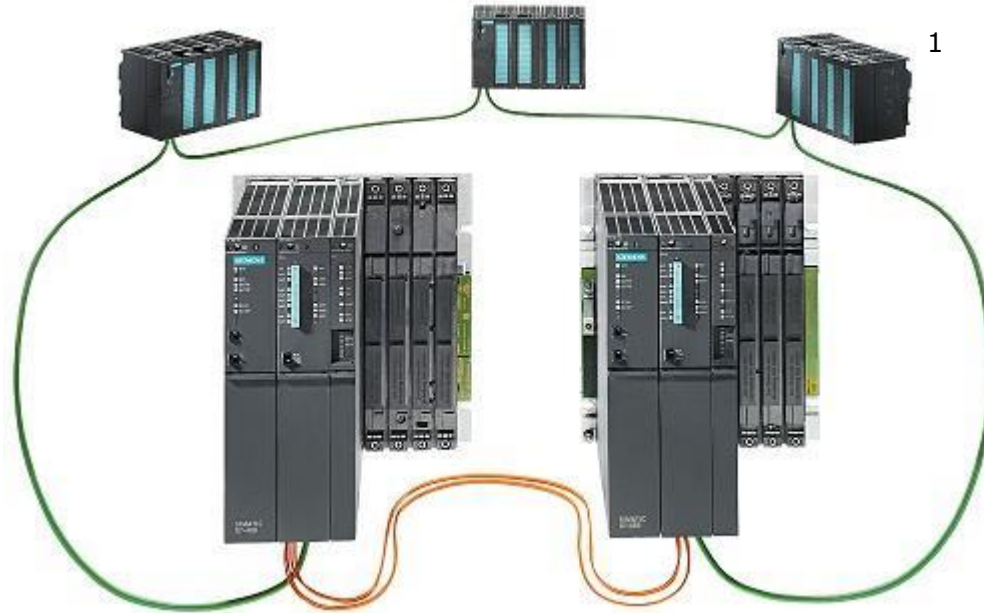
- Parallel commissioning
- Reduced downtime in case of a failure
- Better traceability of code changes

- Disadvantages

- Increased cost – 14 CPUs instead of 2

MAJOR CHALLENGES – SINGLE CPU

- Option 2 – Redundancy



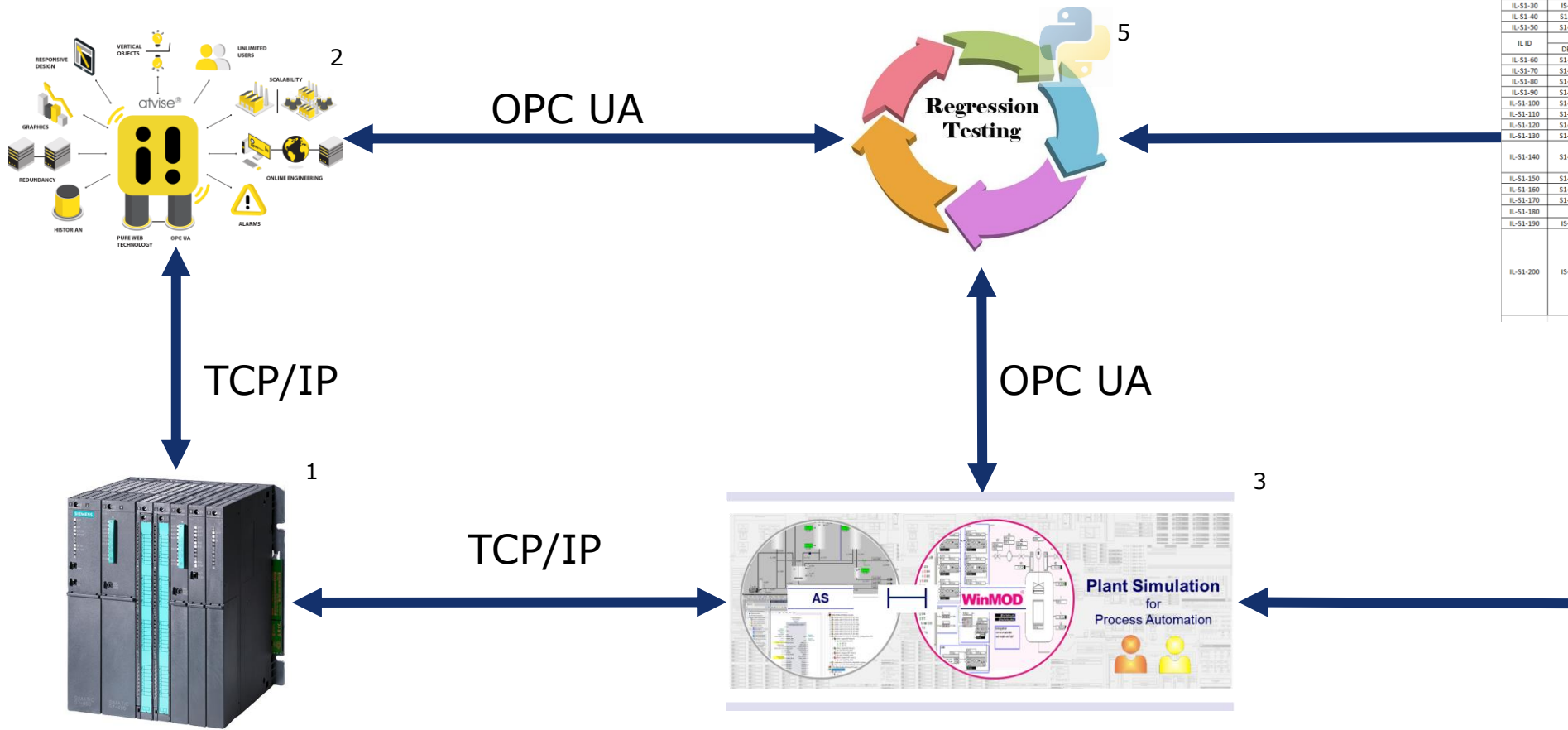
- Advantages

- Switchover during program changes
- Increased availability

- Disadvantages

- Increased cost – 4 CPUs instead of 2

MAJOR CHALLENGES – REGRESSION TESTS & FAT



CAUSE & EFFECT TABLE

IL ID	Sensor						Actuator		
	DEVICE IDENT	CAUSE COMMENT	CAUSE	Delay	Level	DEVICE IDENT	CAUSE	Level	
IL-S1-10	BMZ	Fire alarm	fireAlarm	0	FALSE				
IL-S1-20	IS-04-xxx-EBN	INH	EBN	0	FALSE				
IL-S1-30	IS-18-000-EBN	ACR	EBN	0	FALSE	S1-00-000-SRC	IL	FALSE	
IL-S1-40	S1-01-000-FCN	Error	fault	0	FALSE				
IL-S1-50	S1-01-000-VVG	Status	opened	0	FALSE				
IL ID	Sensor						Actuator		
	DEVICE IDENT	CAUSE COMMENT	CAUSE	Delay	Level	DEVICE IDENT	CAUSE	Level	
IL-S1-60	S1-00-000-MCX	thermal interlock	thermil	0	FALSE	PO-01-000-POB-A	STANDBY	FALSE	
IL-S1-70	S1-00-000-MCX	thermal interlock	thermil	0	FALSE	PO-01-001-POB-A	STANDBY	FALSE	
IL-S1-80	S1-01-000-MBH	thermal interlock	thermil	0	FALSE	PO-01-000-POA-B	OFF	FALSE	
IL-S1-90	S1-01-000-MBH	water interlock	wateril	0	FALSE	PO-01-002-POB-A	STANDBY	FALSE	
IL-S1-100	S1-01-000-MCX	thermal interlock	thermil	0	FALSE	PO-01-003-POB-A	STANDBY	FALSE	
IL-S1-110	S1-01-000-MCX	thermal interlock	thermil	0	FALSE	PO-01-004-POB-A	STANDBY	FALSE	
IL-S1-120	S1-01-001-MCX	thermal interlock	thermil	0	FALSE	PO-01-005-POB-A	STANDBY	FALSE	
IL-S1-130	S1-01-001-MCX	thermal interlock	thermil	0	FALSE	PO-01-001-POA-C	OFF	FALSE	
IL-S1-140	S1-01-00x-MQZ	water interlock	wateril	0	FALSE	PO-01-002-POA-C	OFF	FALSE	
IL-S1-150	S1-01-000-MQZ	thermal interlock	thermil	0	FALSE	PO-01-001-POA-C	OFF	FALSE	
IL-S1-160	S1-01-001-MQZ	thermal interlock	thermil	0	FALSE	PO-01-002-POA-C	OFF	FALSE	
IL-S1-170	S1-01-002-MQZ	thermal interlock	thermil	0	FALSE	PO-01-003-POA-C	OFF	FALSE	
IL-S1-180	BMZ	Fire alarm	fireAlarm	0	FALSE	PO-01-005-POB-A			
IL-S1-190	IS-04-xxx-EBN	INH	EBN	0	FALSE	PO-01-001-POB-A			
						PO-01-000-POA-B			
						PO-01-002-POB-A			
						PO-01-003-POB-A			
						PO-01-002-POA-C			
						PO-01-005-POB-A			
IL-S1-200	IS-18-000-EBN	ACR	EBN	0	FALSE	PO-01-004-POB-A	OFF	FALSE	
						PO-01-002-POA-C			
						PO-01-003-POA-C			



THANK YOU FOR YOUR ATTENTION!



REFERENCES AND SOURCES

1. <https://www.siemens.com/global/en/products/automation/systems/industrial/plc/simatic-s7-400.html>
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