



# SESAME'S CONTROL SYSTEM

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Workshop: PLC Based Control Systems : SA1E

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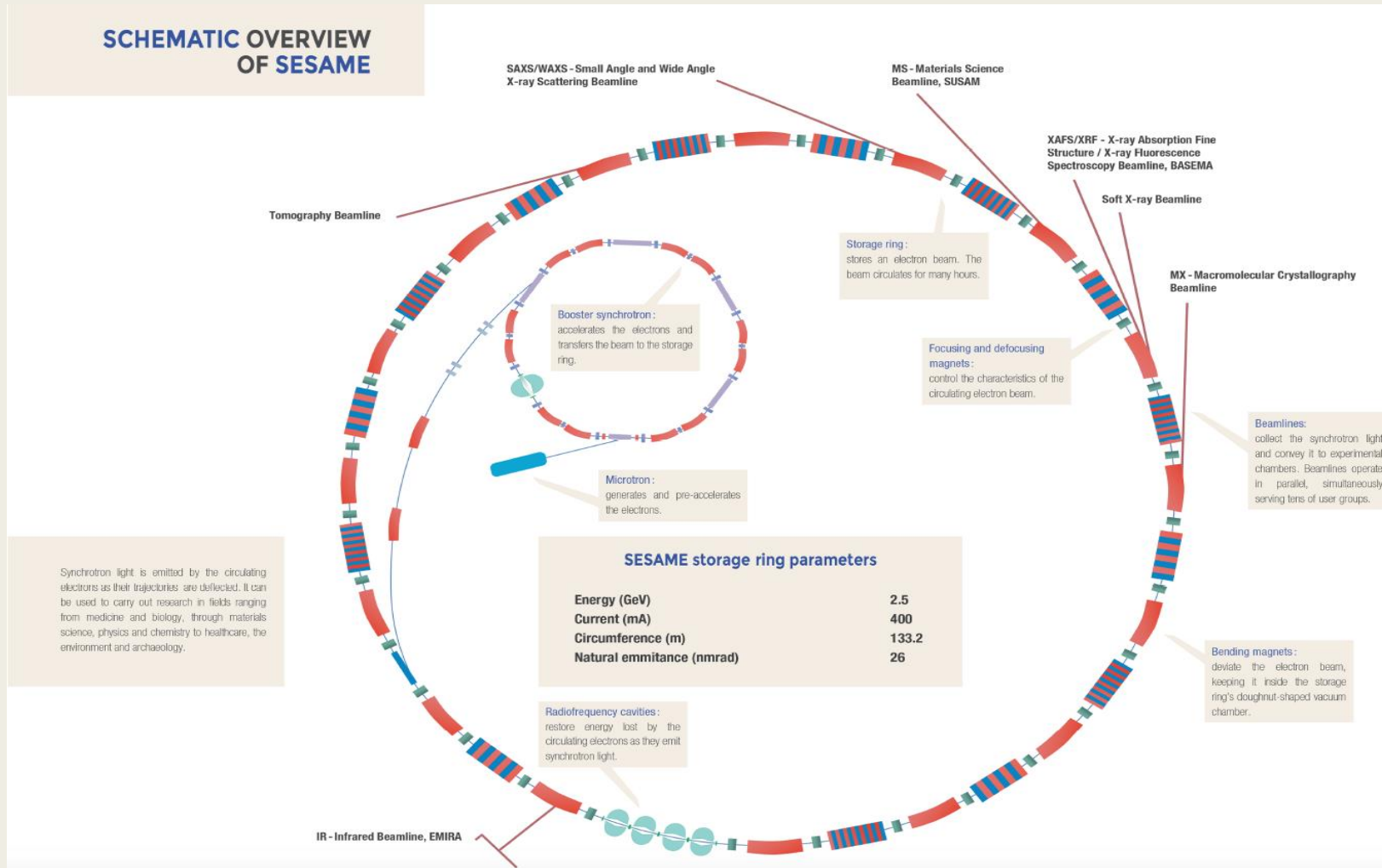
# What is SESAME?

- SESAME (**S**ynchrotron-light for **E**xperimental **S**cience and **A**pplications in the **M**iddle **E**ast)
- **Location:** Allan, Jordan
- A “third-generation” synchrotron light source that was officially opened on 16 May 2017
- It is expected to become operational in late 2017. Storage ring is currently under commissioning.
- It is the Middle East's first major international research centre
- The current Members of SESAME are Cyprus, Egypt, Iran ,Israel, Jordan, Pakistan, Palestine and Turkey.

# What is SESAME?



# SESAME Information



Energy; **2.5 GeV**

Circumference; **133m**

Emittance; **26 nm-rad**

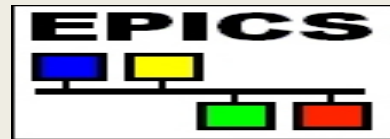
Space for future full energy injectors  
the storage ring tunnel

Day One Beamlines:

- XAFS/XRF
- Infrared

# Control System Overview

- Control system implementation uses (EPICS) base 3.14.12



- Development and administration platforms use Scientific Linux 6.4



- Siemens S7-300 PLCs are used for the Machine Protection System (MPS)



- Clients implementation uses Control System Studio (CSS) based on V.3.16



- Git version Control System is used to track development & documentation

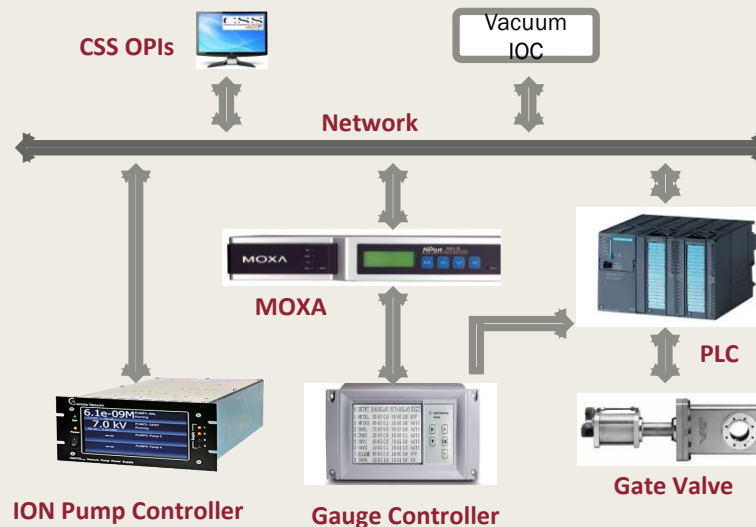


- Allen Bradley PLC is used for the Personal Safety System (PSS).



# Vacuum Control System

Device	Brand	Control Interface
ION Pump Controller	Digital QPC (Gamma Vacuum)	Ethernet
Gauge Controller	XGS-600 (Agilent)	RS232, I/O
Gate Valve	VAT	I/O



Overview - Vacuum - CS-Studio

Overview - Vacuum

**Storage Ring Vacuum Overview**

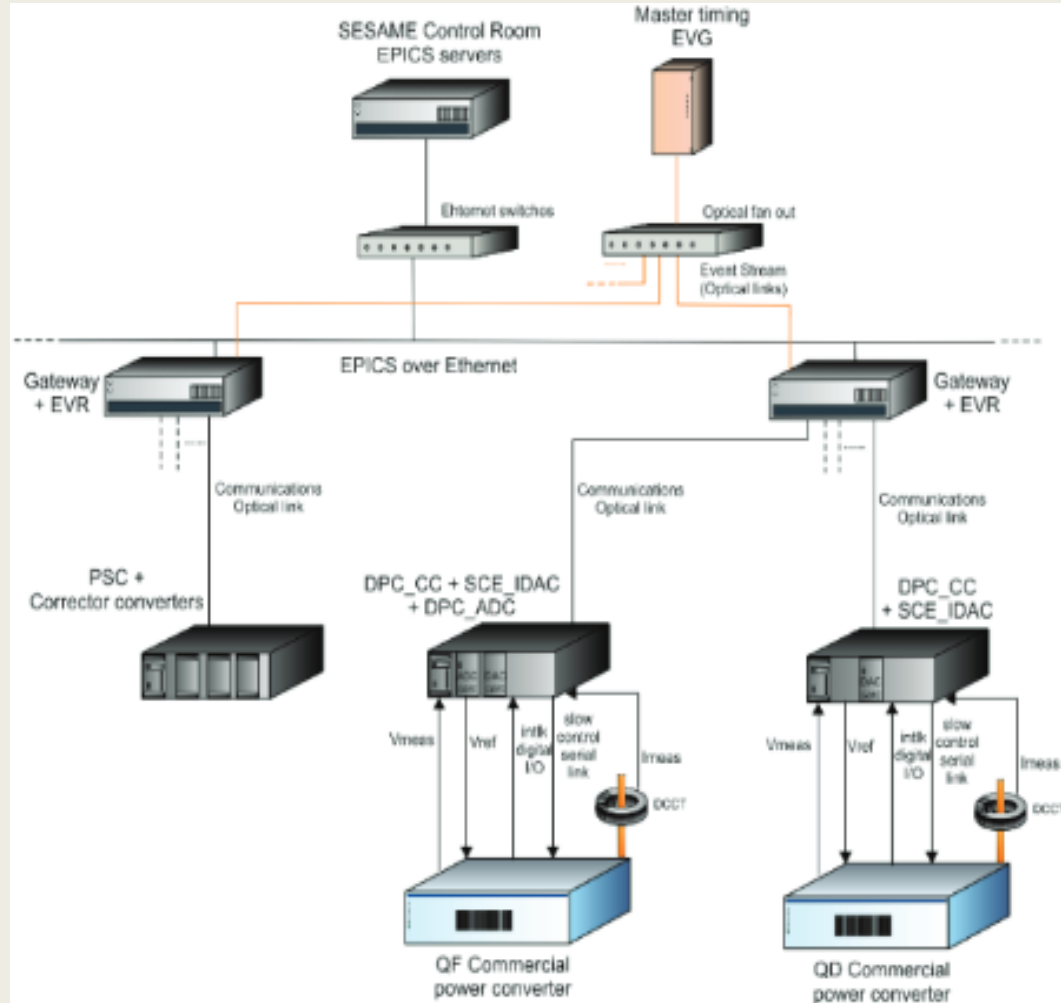
IP1 IP2 IP3 IP4 IMG V1 V2

Cell	IP1	IP2	IP3	IP4	IMG	V1	V2
<b>Vacuum Cell 1</b>							
C01L	1.21E-9	1.55E-9	8.81E-10		3.153E-10		
C01B	3.09E-10	1.26E-10	2.74E-11	1.86E-10	9.437E-12	●	●
C02S	1.61E-9	1.49E-9					
C02B	3.24E-10	3.87E-10	2.94E-11	7.17E-10	8.281E-11		
<b>Vacuum Cell 2</b>							
C03L	4.86E-10	1.12E-9	4.88E-10	5.63E-10	3.328E-10		
C03B	1.41E-10	6.64E-11	1.67E-11	1.58E-10	3.328E-10	●	●
C04S	0E0	0E0					
C04B	5.99E-11	3.49E-11	1.36E-11	2.24E-10	7.502E-12		
<b>Vacuum Cell 3</b>							
C05L	3.85E-10	8.19E-10	2.07E-9		6.332E-11		
C05B	1.66E-10	2.78E-11	1.05E-11	2.79E-10	3.887E-11	●	●
C06S	3.2E-10	1.73E-9					
C06B	9.68E-11	5.55E-11	1.96E-11	2.94E-10	2.148E-10		
<b>Vacuum Cell 4</b>							
C07L	3.09E-10	3.84E-10	1E-11		1.438E-10		
C07B	3.49E-11	1.69E-11	1E-11	4.34E-11	1.237E-11	●	●
C08S	6.48E-11	7.88E-10					
C08B	1E-11	7.55E-11	2.98E-11	8.11E-11	1.451E-11		
<b>Vacuum Cell 5</b>							
C09L	2.26E-10	6.55E-10	3.17E-9		1.209E-10		
C09B	6.79E-11	4.09E-11	1.22E-11	1.35E-10	8.661E-12	●	●
C10S	1.45E-10	1.23E-9					
C10B	5.86E-11	4.07E-11	1.68E-11	1.57E-10	2.807E-11		
<b>Vacuum Cell 6</b>							
C11L	2.16E-10	6.47E-10	4.65E-9		1.428E-9		
C11B	5.29E-10	2.43E-10	6.11E-11	1.91E-10	1.116E-9	●	●
C12S	1.91E-10	1.25E-9					
C12B	1.1E-10	7.13E-11	5.47E-11	3.18E-10	3.919E-11		
<b>Vacuum Cell 7</b>							
C13L	2.22E-10	6.79E-10	9.75E-9		1.791E-10		
C13B	1.2E-10	6.14E-11	2.09E-11	1.34E-10	6.495E-11	●	●
C14S	1.72E-10	1.6E-9					
C14B	1.4E-10	8.36E-11	1.17E-11	3.2E-10	3.413E-10		
<b>Vacuum Cell 8</b>							
C15L	3.4E-10	6.88E-10	6.47E-10		2.026E-10		
C15B	8.18E-11	4.96E-11	2.24E-11	2E-10	4.427E-11	●	●
C16S	2.61E-10	1E-11					
C16B	1.26E-10	5.82E-11	3.09E-11	4.61E-10	1.802E-10		

Schematic | Vavles | Interlocks | Heat Absorbers

Close

# Power Supplies Control System



Magnets Power Supplies - CS-Studio

Magnets Power Supplies

Storage Ring DC Power Supplies

Dipoles Power Supply

SR-PS-BM Fault 0.000 V -0.000 A 152.45 Details

State Voltage Current

Cycle Magnets  Open Loop  Off  Waveform

PS Ramping  Standby  ON  DC

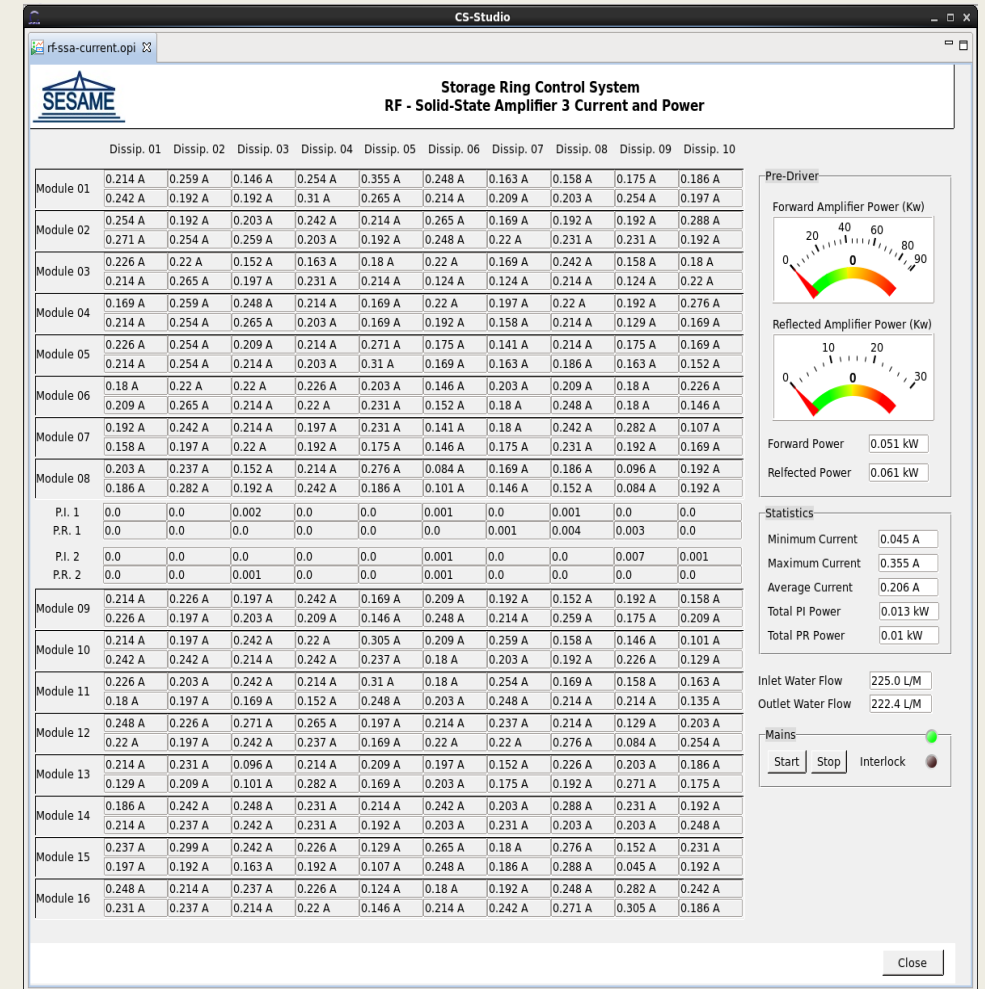
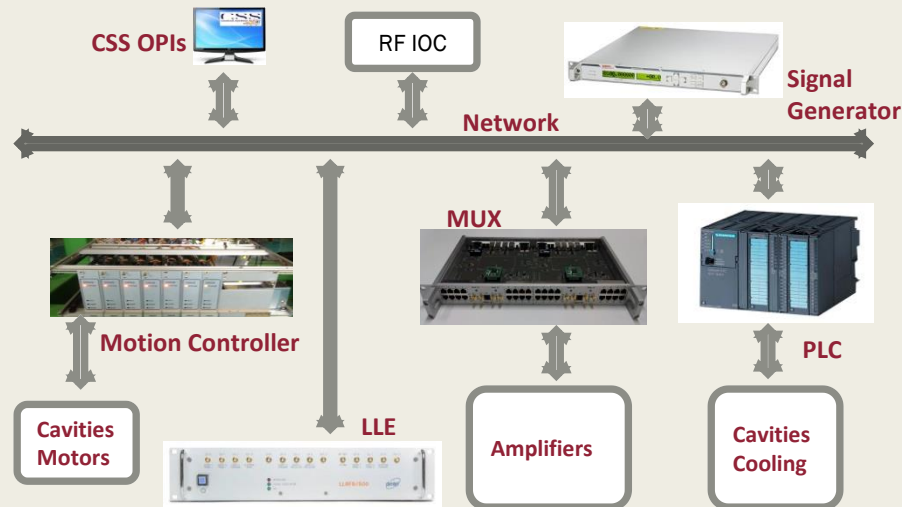
State Voltage Current

Quadrupoles Power Supplies

State	Voltage	Current	68.887	21.160
<b>Focusing Quadrupoles</b>				
SRC01-PS-QF1Fault	0.007 V	0.014 A	68.861 Details	21.160 Details
SRC01-PS-QF2Fault	0.004 V	0.021 A	68.861 Details	21.160 Details
SRC02-PS-QF1Fault	0.006 V	0.036 A	68.861 Details	21.160 Details
SRC02-PS-QF2Fault	0.006 V	0.024 A	68.861 Details	21.160 Details
SRC03-PS-QF1Fault	0.005 V	0.014 A	68.861 Details	21.160 Details
SRC03-PS-QF2Fault	0.005 V	0.026 A	68.861 Details	21.160 Details
SRC04-PS-QF1Fault	0.005 V	0.017 A	68.861 Details	21.160 Details
SRC04-PS-QF2Fault	0.005 V	0.020 A	68.861 Details	21.160 Details
SRC05-PS-QF1Fault	0.004 V	0.019 A	68.861 Details	21.160 Details
SRC05-PS-QF2Fault	0.006 V	0.018 A	68.861 Details	21.160 Details
SRC06-PS-QF1Fault	0.005 V	0.022 A	68.861 Details	21.160 Details
SRC06-PS-QF2Fault	0.005 V	0.013 A	68.861 Details	21.160 Details
SRC07-PS-QF1Fault	0.005 V	0.018 A	68.861 Details	21.160 Details
SRC07-PS-QF2Fault	0.006 V	0.004 A	68.861 Details	21.160 Details
SRC08-PS-QF1Fault	0.004 V	0.034 A	68.861 Details	21.160 Details
SRC08-PS-QF2Fault	0.006 V	0.012 A	68.861 Details	21.160 Details
SRC09-PS-QF1Fault	0.006 V	0.018 A	68.861 Details	21.160 Details
SRC09-PS-QF2Fault	0.006 V	0.019 A	68.861 Details	21.160 Details
SRC10-PS-QF1Fault	0.006 V	0.003 A	68.861 Details	21.160 Details
SRC10-PS-QF2Fault	0.005 V	0.004 A	68.861 Details	21.160 Details
SRC11-PS-QF1Fault	0.006 V	0.035 A	68.861 Details	21.160 Details
SRC11-PS-QF2Fault	0.005 V	0.032 A	68.861 Details	21.160 Details
SRC12-PS-QF1Fault	0.005 V	0.009 A	68.861 Details	21.160 Details
SRC12-PS-QF2Fault	0.006 V	0.015 A	68.861 Details	21.160 Details
SRC13-PS-QF1Fault	0.004 V	0.007 A	68.861 Details	21.160 Details
SRC13-PS-QF2Fault	0.005 V	0.011 A	68.861 Details	21.160 Details
SRC14-PS-QF1Fault	0.004 V	-0.006 A	68.861 Details	21.160 Details
SRC14-PS-QF2Fault	0.005 V	0.013 A	68.861 Details	21.160 Details
SRC15-PS-QF1Fault	0.005 V	0.002 A	68.861 Details	21.160 Details
SRC15-PS-QF2Fault	0.006 V	0.012 A	68.861 Details	21.160 Details
SRC16-PS-QF1Fault	0.004 V	0.016 A	68.861 Details	21.160 Details
SRC16-PS-QF2Fault	0.004 V	0.006 A	68.861 Details	21.160 Details
<b>Defocusing Quadrupoles</b>				
SRC01-PS-QD1Fault	0.003 V	0.011 A	21.160 Details	21.160 Details
SRC01-PS-QD2Fault	0.004 V	0.026 A	21.160 Details	21.160 Details
SRC02-PS-QD1Fault	0.003 V	0.007 A	21.160 Details	21.160 Details
SRC02-PS-QD2Fault	0.003 V	0.013 A	21.160 Details	21.160 Details
SRC03-PS-QD1Fault	0.004 V	0.002 A	21.160 Details	21.160 Details
SRC03-PS-QD2Fault	0.003 V	0.001 A	21.160 Details	21.160 Details
SRC04-PS-QD1Fault	0.004 V	0.017 A	21.160 Details	21.160 Details
SRC04-PS-QD2Fault	0.003 V	0.000 A	21.160 Details	21.160 Details
SRC05-PS-QD1Fault	0.004 V	0.017 A	21.160 Details	21.160 Details
SRC05-PS-QD2Fault	0.004 V	0.022 A	21.160 Details	21.160 Details
SRC06-PS-QD1Fault	0.004 V	0.001 A	21.160 Details	21.160 Details
SRC06-PS-QD2Fault	0.003 V	0.024 A	21.160 Details	21.160 Details
SRC07-PS-QD1Fault	0.004 V	-0.001 A	21.160 Details	21.160 Details
SRC07-PS-QD2Fault	0.003 V	0.022 A	21.160 Details	21.160 Details
SRC08-PS-QD1Fault	0.003 V	0.016 A	21.160 Details	21.160 Details
SRC08-PS-QD2Fault	0.003 V	-0.004 A	21.160 Details	21.160 Details
SRC09-PS-QD1Fault	0.004 V	-0.001 A	21.160 Details	21.160 Details
SRC09-PS-QD2Fault	0.003 V	0.014 A	21.160 Details	21.160 Details
SRC10-PS-QD1Fault	0.003 V	0.029 A	21.160 Details	21.160 Details
SRC10-PS-QD2Fault	0.003 V	-0.001 A	21.160 Details	21.160 Details
SRC11-PS-QD1Fault	0.003 V	0.032 A	21.160 Details	21.160 Details
SRC11-PS-QD2Fault	0.003 V	0.012 A	21.160 Details	21.160 Details
SRC12-PS-QD1Fault	0.003 V	0.003 A	21.160 Details	21.160 Details
SRC12-PS-QD2Fault	0.004 V	0.007 A	21.160 Details	21.160 Details
SRC13-PS-QD1Fault	0.004 V	0.007 A	21.160 Details	21.160 Details
SRC13-PS-QD2Fault	0.003 V	0.016 A	21.160 Details	21.160 Details
SRC14-PS-QD1Fault	0.003 V	0.009 A	21.160 Details	21.160 Details
SRC14-PS-QD2Fault	0.003 V	0.015 A	21.160 Details	21.160 Details
SRC15-PS-QD1Fault	0.003 V	0.014 A	21.160 Details	21.160 Details
SRC15-PS-QD2Fault	0.003 V	0.016 A	21.160 Details	21.160 Details
SRC16-PS-QD1Fault	0.003 V	0.008 A	21.160 Details	21.160 Details
SRC16-PS-QD2Fault	0.003 V	0.016 A	21.160 Details	21.160 Details
<b>Sextupoles</b>				
<b>Focusing Sextupoles</b>				
SR-PS-SF1	Fault	0.012 V	-0.001 A	19.214 Details
SR-PS-SF2	Fault	0.011 V	0.001 A	19.214 Details
<b>Defocusing Sextupoles</b>				
SR-PS-SD1	Fault	0.024 V	-0.002 A	30.285 Details
SR-PS-SD2	Fault	0.024 V	0.001 A	30.285 Details

# RF Control System

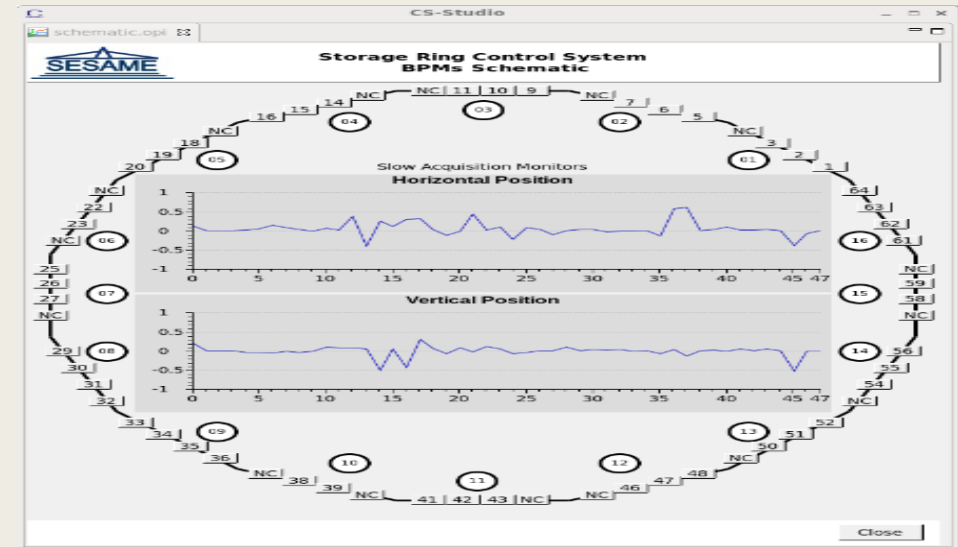
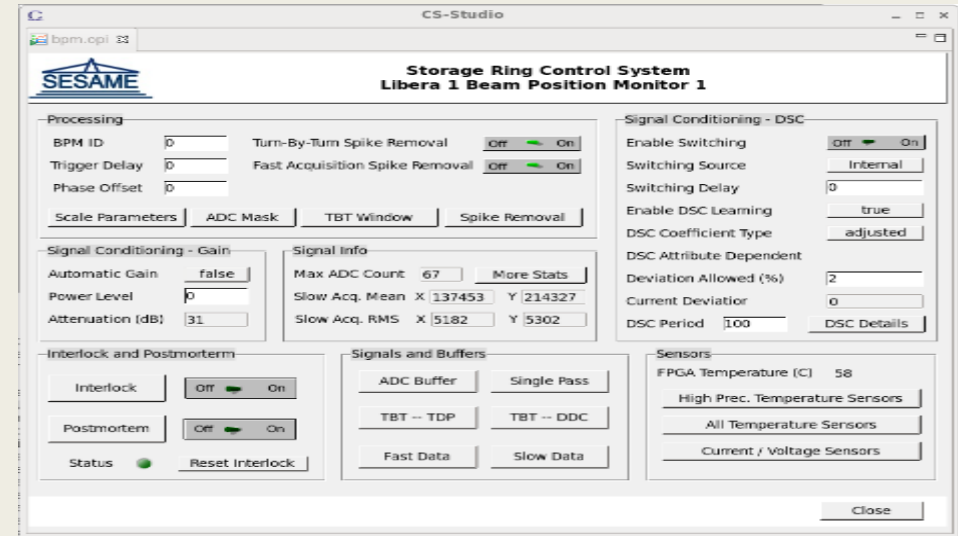
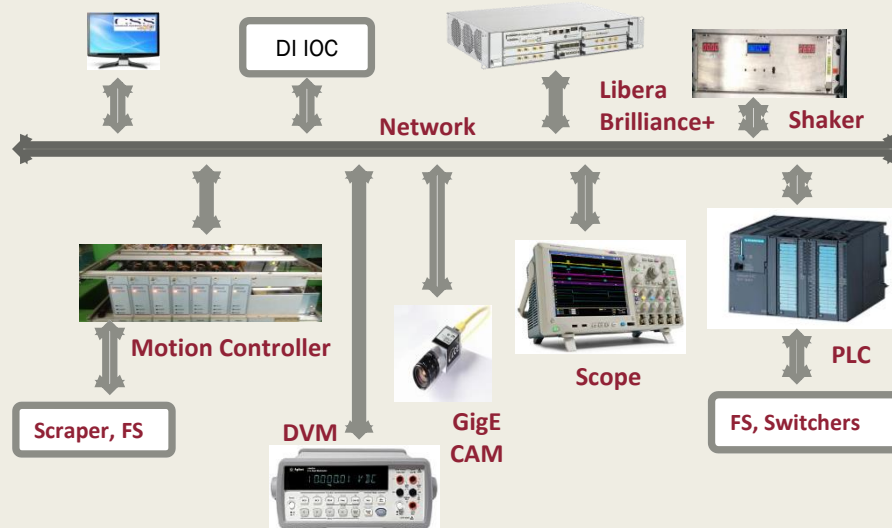
Device	Brand	Control Interface
LLE	Dimtel	Ethernet
Cavities	ELETTRA	I/O
Amplifiers	SEGMA-Phi	Ethernet (MUX Board)
Motion Controller	Galil	Ethernet
Signal Generator	Work Microwave	Ethernet





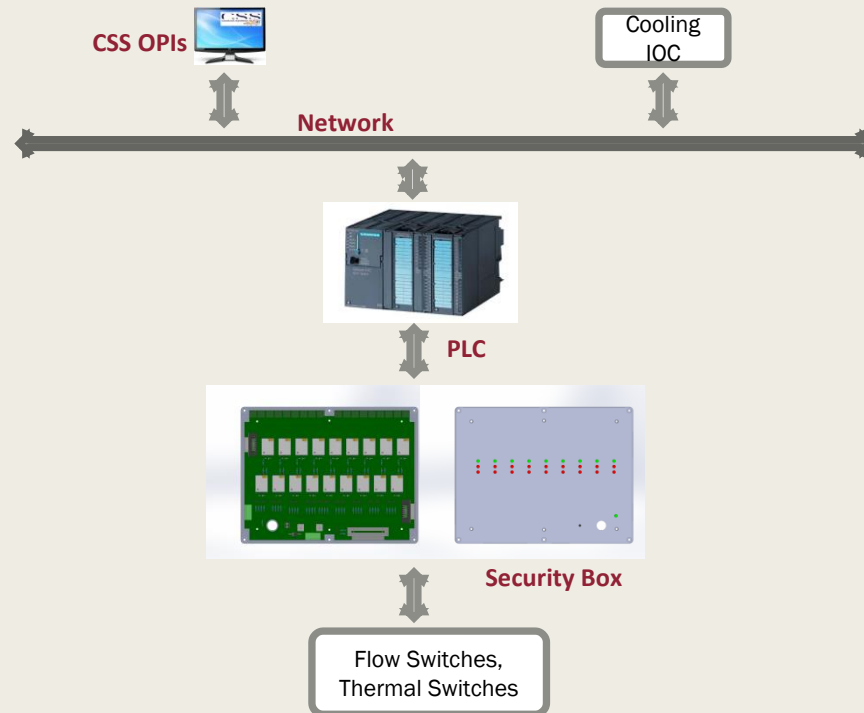
# Diagnosics Control System

Device	Brand	Control Interface
Libera Brilliance+	I-tech	Ethernet
Florescent Screens	VAb	I/O
Shaker	In-house	RS232, I/O
Function Generator	Tektronix	Ethernet
Oscilloscope	Tektronix	Ethernet
Motion Controller	Galil	Ethernet
Camera	Basler	Ethernet
Digital Voltmeter	Agilent	Ethernet
RF Switchers	NA	I/O



# Cooling Control System

Device	Brand	Control Interface
Security Box	In-House	I/O





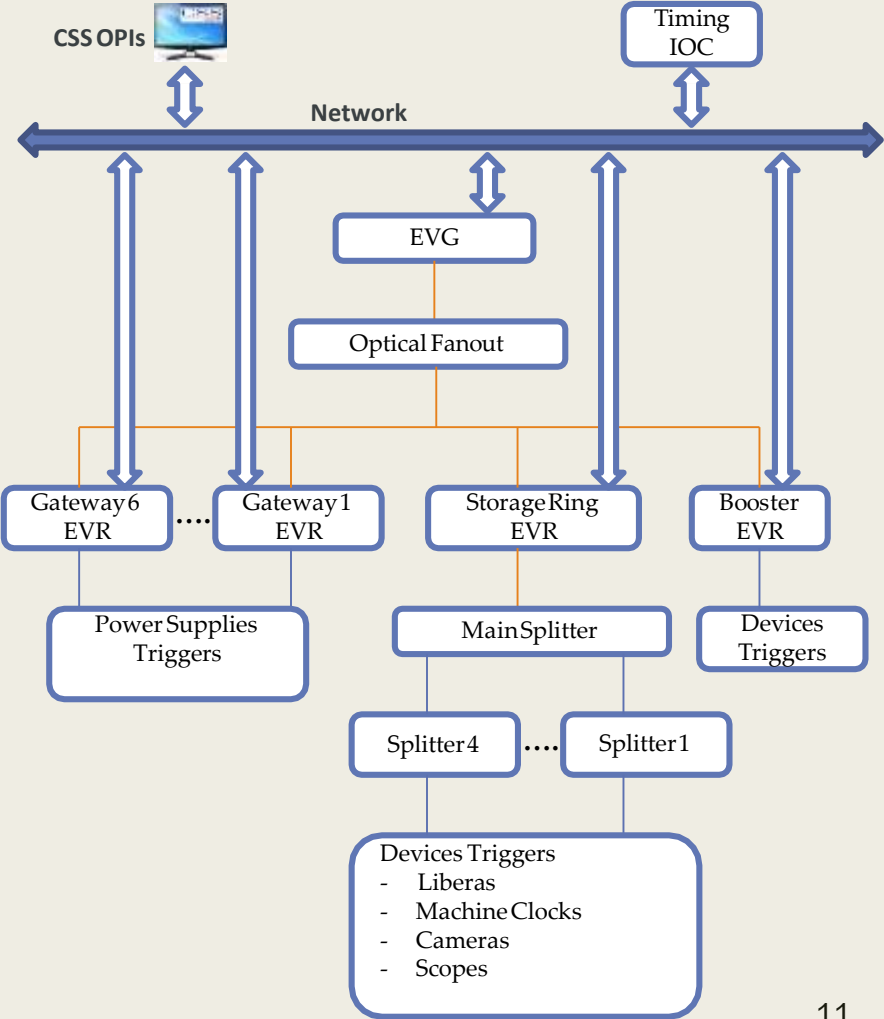
### Storage Ring Control System MPS - Security Boxes

Cell S(cell)	Cell S(cell)	Cell S(cell)	Cell S(cell)
BM ●●	BM ●●	BM ●●	BM ●●
QF1 ●●	QF1 ●●	QF1 ●●	QF1 ●●
QF2 ●●	QF2 ●●	QF2 ●●	QF2 ●●
QD1 ●●	QD1 ●●	QD1 ●●	QD1 ●●
QD2 ●●	QD2 ●●	QD2 ●●	QD2 ●●
SF1 ●●	SF1 ●●	SF1 ●●	SF1 ●●
SF2 ●●	SF2 ●●	SF2 ●●	SF2 ●●
SD1 ●●	SD1 ●●	SD1 ●●	SD1 ●●
SD2 ●●	SD2 ●●	SD2 ●●	SD2 ●●
Cell S(cell)	Cell S(cell)	Cell S(cell)	Cell S(cell)
BM ●●	BM ●●	BM ●●	BM ●●
QF1 ●●	QF1 ●●	QF1 ●●	QF1 ●●
QF2 ●●	QF2 ●●	QF2 ●●	QF2 ●●
QD1 ●●	QD1 ●●	QD1 ●●	QD1 ●●
QD2 ●●	QD2 ●●	QD2 ●●	QD2 ●●
SF1 ●●	SF1 ●●	SF1 ●●	SF1 ●●
SF2 ●●	SF2 ●●	SF2 ●●	SF2 ●●
SD1 ●●	SD1 ●●	SD1 ●●	SD1 ●●
SD2 ●●	SD2 ●●	SD2 ●●	SD2 ●●
Cell S(cell)	Cell S(cell)	Cell S(cell)	Cell S(cell)
BM ●●	BM ●●	BM ●●	BM ●●
QF1 ●●	QF1 ●●	QF1 ●●	QF1 ●●
QF2 ●●	QF2 ●●	QF2 ●●	QF2 ●●
QD1 ●●	QD1 ●●	QD1 ●●	QD1 ●●
QD2 ●●	QD2 ●●	QD2 ●●	QD2 ●●
SF1 ●●	SF1 ●●	SF1 ●●	SF1 ●●
SF2 ●●	SF2 ●●	SF2 ●●	SF2 ●●
SD1 ●●	SD1 ●●	SD1 ●●	SD1 ●●
SD2 ●●	SD2 ●●	SD2 ●●	SD2 ●●
Cell S(cell)	Cell S(cell)	Cell S(cell)	Cell S(cell)
BM ●●	BM ●●	BM ●●	BM ●●
QF1 ●●	QF1 ●●	QF1 ●●	QF1 ●●
QF2 ●●	QF2 ●●	QF2 ●●	QF2 ●●
QD1 ●●	QD1 ●●	QD1 ●●	QD1 ●●
QD2 ●●	QD2 ●●	QD2 ●●	QD2 ●●
SF1 ●●	SF1 ●●	SF1 ●●	SF1 ●●
SF2 ●●	SF2 ●●	SF2 ●●	SF2 ●●
SD1 ●●	SD1 ●●	SD1 ●●	SD1 ●●
SD2 ●●	SD2 ●●	SD2 ●●	SD2 ●●

Reset
Close

# Timing System Control Status

Device	Brand	Control Interface
Event Generator	MRF	Ethernet
Event Receiver	MRF	Ethernet



# PLC Systems at SESAME

- **Purpose:** Machine protection for each sub-system
- **PLC:** SIEMENS S7-300
- **Software:** STEP7, TIA PORTAL
- **Programming Language:** Ladder Logic
- **CPUs:** CPU314, CPU315-2DP
- **I/O Modules:** DI32, DO32, AI8, AO8, TC8
- **Communication Modules:** CP-343-1, CP342-5
- **Communication Protocols:** PROFIBUS, PROFINET
- **Distributed I/O Modules:** ET200M (IM153-4)

# PLC Systems at SESAME

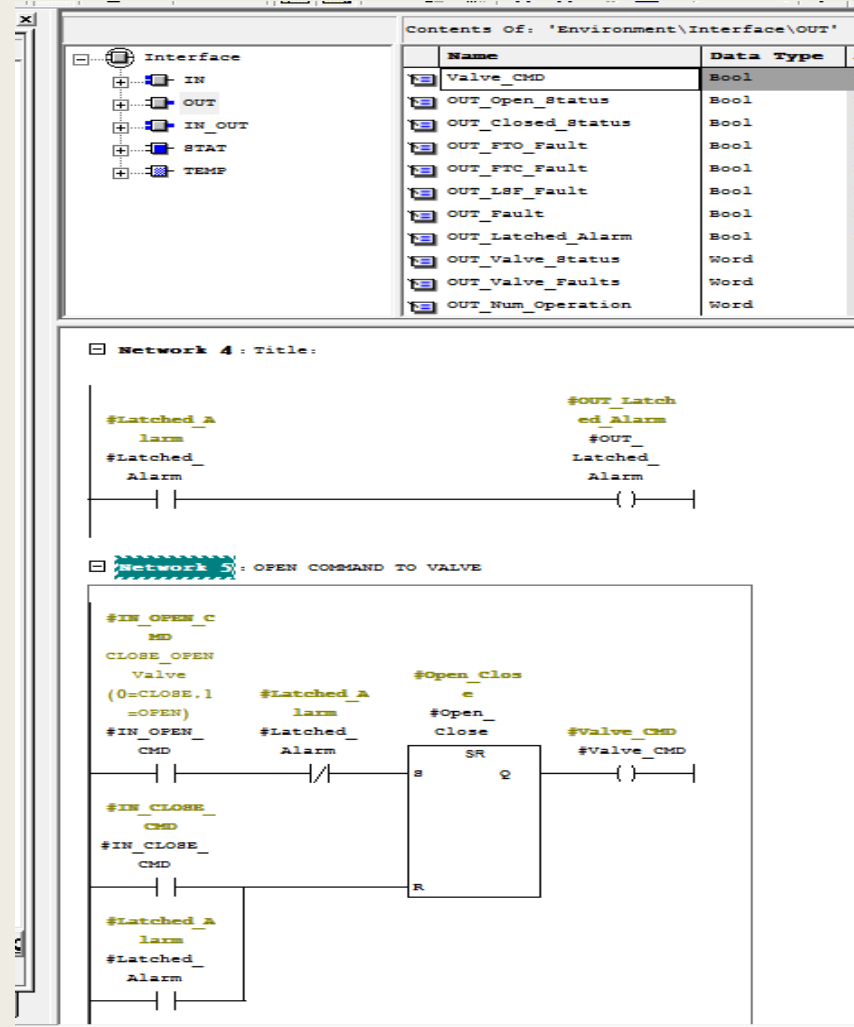
- Nine CPUs and set of I/O modules are used for the following sub-systems:
  - Microtron (CPU315-2DP)
  - Transfer Line 1 (CPU315-2DP)
  - Booster Vacuum & Diagnostics (CPU315-2DP)
  - Booster Cooling & Power Supplies (CPU315-2DP)
  - Booster RF (CPU314)
  - Transfer Line 2 (CPU314)
  - Storage Ring Vacuum & Diagnostics (CPU314)
  - Storage Ring Cooling & Power Supplies (CPU314)
  - Storage Ring RF (CPU315-2DP)



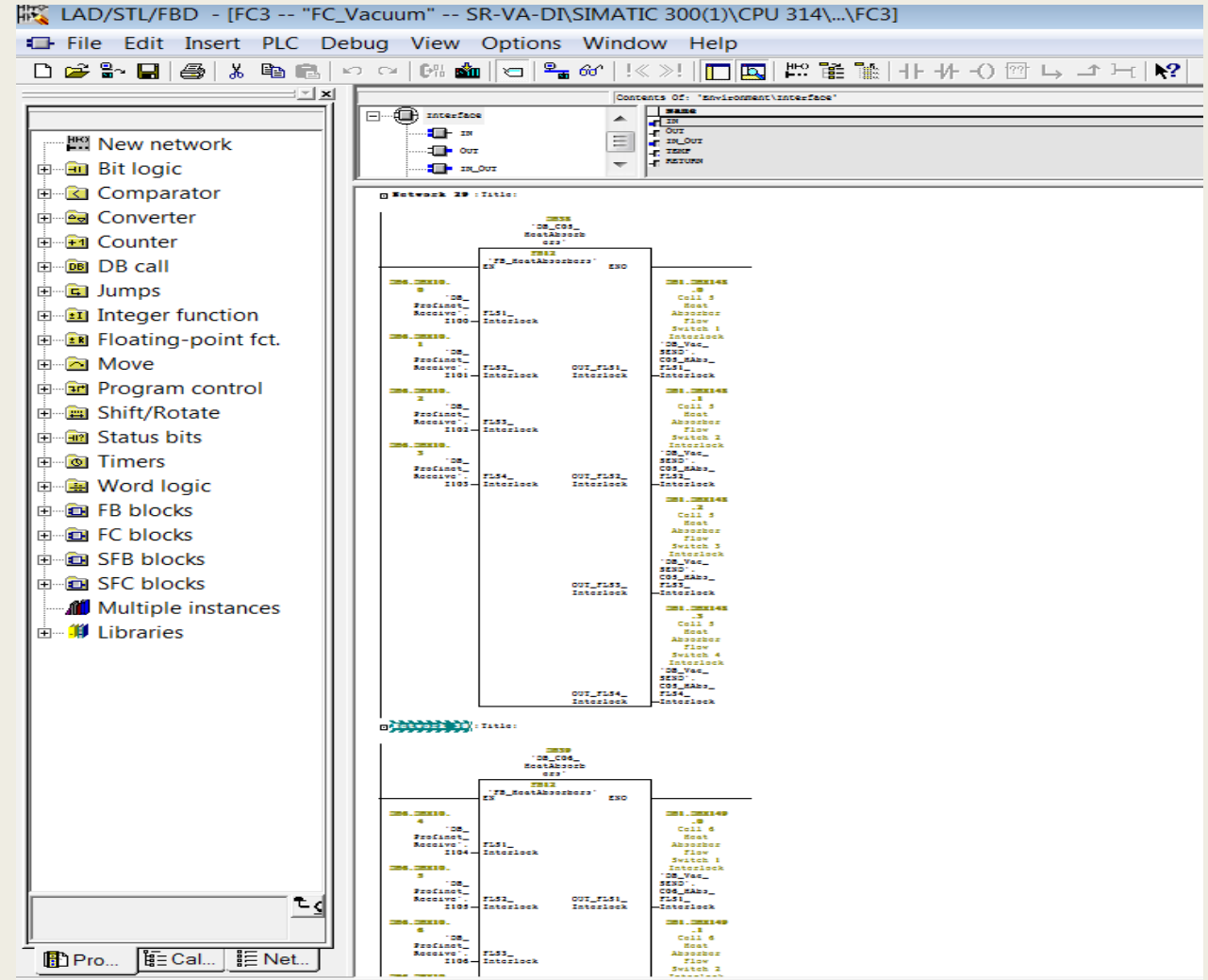
# PLC Programming - Strategy

- Building the programming in an organized way
- Make it easy to be modified
- Make it easy for troubleshooting
- Assign One Function Block (FB) for each device which will have the main logic for that device.
- Assign number of instance Data Blocks (DB) depends on the number of devices for each sub-system.
- Calling all FBs inside one Function (FC) or more
- Calling all the Functions (FCs) inside the main Organization Block (OB)

# PLC Programming - Strategy



FB



FC

# PLC Programming - Strategy

SIMATIC Manager - [SR-VA-DI -- C:\Program Files (x86)\Siemens\Step7\S7Proj\SR-VA-DI]

File Edit Insert PLC View Options Window Help

< No Filter >

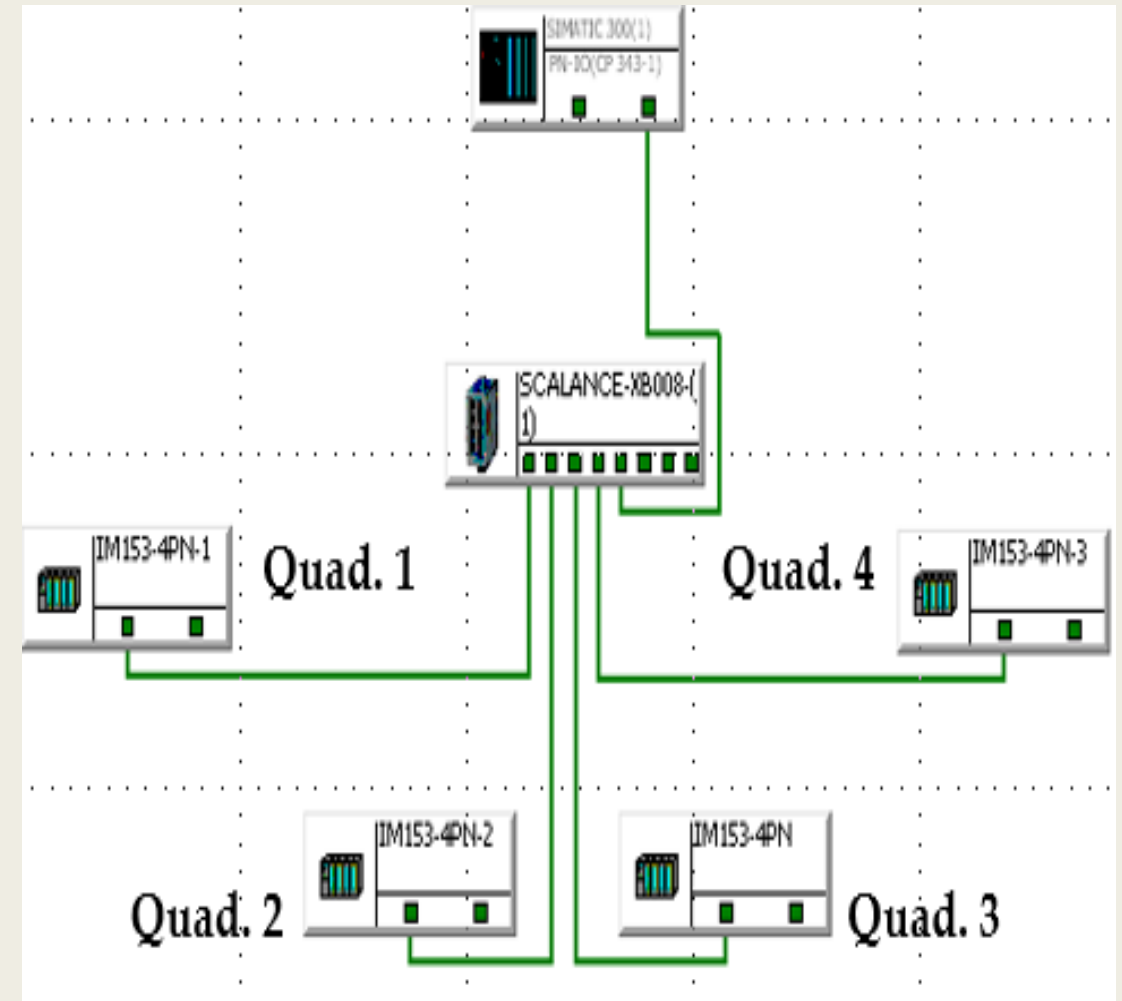
Object name	Symbolic name	Created in la...	Size in the w...	Type
System data	—	—	—	SDB
OB1	Main Block	LAD	132	Organization Block
FB10	FB_Valve	LAD	718	Function Block
FB11	FB_GaugeController	LAD	118	Function Block
FB12	FB_HeatAbsorbers	LAD	70	Function Block
FB13	FB_FScreen	LAD	674	Function Block
FC1	FC_PLC/EPICS Com...	LAD	476	Function
FC2	FC_Profinet_Comm.	LAD	326	Function
FC3	FC_Vacuum	LAD	10698	Function
FC4	FC_Diagnostics	LAD	1052	Function
FC5	AG_SEND	STL	1664	Function
FC6	AG_RECV	STL	1206	Function
FC7	Auto_Logic	LAD	348	Function
FC11	PNIO_SEND	STL	1182	Function
FC12	PNIO_RECV	STL	1052	Function
FC100	XTON	LAD	132	Function
DB1	DB_Vac_SEND	DB	220	Data Block
DB2	DB_Vac_RECEIVE	DB	56	Data Block
DB3	DB_Diag_SEND	DB	60	Data Block
DB4	DB_Diag_RECEIVE	DB	40	Data Block
DB5	DB_Profinet_Send	DB	44	Data Block
DB6	DB_Profinet_Receive	DB	60	Data Block
DB7	DB_Profinet_Stataus	DB	40	Data Block
DB10	DB_C01_Valve1	DB	60	Instance data block for FB 10
DB11	DB_C01_Valve2	DB	60	Instance data block for FB 10
DB12	DB_C03_Valve1	DB	60	Instance data block for FB 10
DB13	DB_C03_Valve2	DB	60	Instance data block for FB 10
DB14	DB_C05_Valve1	DB	60	Instance data block for FB 10
DB15	DB_C05_Valve2	DB	60	Instance data block for FB 10
DB16	DB_C07_Valve1	DB	60	Instance data block for FB 10
DB17	DB_C07_Valve2	DB	60	Instance data block for FB 10
DB18	DB_C09_Valve1	DB	60	Instance data block for FB 10
DB19	DB_C09_Valve2	DB	60	Instance data block for FB 10
DB20	DB_C11_Valve1	DB	60	Instance data block for FB 10
DB21	DB_C11_Valve2	DB	60	Instance data block for FB 10
DB22	DB_C13_Valve1	DB	60	Instance data block for FB 10
DB23	DB_C13_Valve2	DB	60	Instance data block for FB 10
DB24	DB_C15_Valve1	DB	60	Instance data block for FB 10
DB25	DB_C15_Valve2	DB	60	Instance data block for FB 10
DB26	DB_Q1_GaugeContr...	DB	40	Instance data block for FB 11
DB27	DB_Q1_GaugeContr...	DB	40	Instance data block for FB 11
DB28	DB_Q2_GaugeContr...	DB	40	Instance data block for FB 11
DB29	DB_Q2_GaugeContr...	DB	40	Instance data block for FB 11
DB30	DB_Q3_GaugeContr...	DB	40	Instance data block for FB 11
DB31	DB_Q3_GaugeContr...	DB	40	Instance data block for FB 11
DB32	DB_Q4_GaugeContr...	DB	40	Instance data block for FB 11
DB33	DB_Q4_GaugeContr...	DB	40	Instance data block for FB 11
DB34	DB_C01_HeatAbsorb...	DB	40	Instance data block for FB 12
DB35	DB_C02_HeatAbsorb...	DB	40	Instance data block for FB 12
DB36	DB_C03_HeatAbsorb...	DB	40	Instance data block for FB 12
DB37	DB_C04_HeatAbsorb...	DB	40	Instance data block for FB 12
DB38	DB_C05_HeatAbsorb...	DB	40	Instance data block for FB 12

Main Blocks



# Distributed I/O modules

- Storage Ring signals are distributed into 16 cells and 4 quadrants.
- Putting the PLC modules in one place will not be possible because of cabling.
- Using distributed I/O modules ET200M (IM153-4) based on Profinet communication was the solution.



# PLC Hardware and Cabling

- Organize the PLC modules inside the racks
- Organize cables inside the trunks
- Installing Terminal Blocks  
(Simatic Top Connect, ABB)
- Labeling is important
- Adding space for future use



**Thank You**