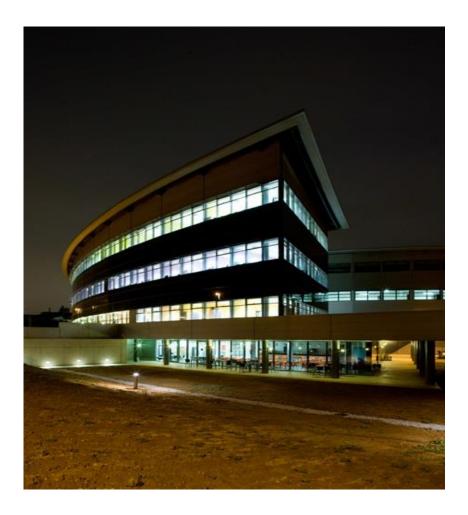


Equipment protection system checks at ALBA

Ferran Fernandez ARW2022



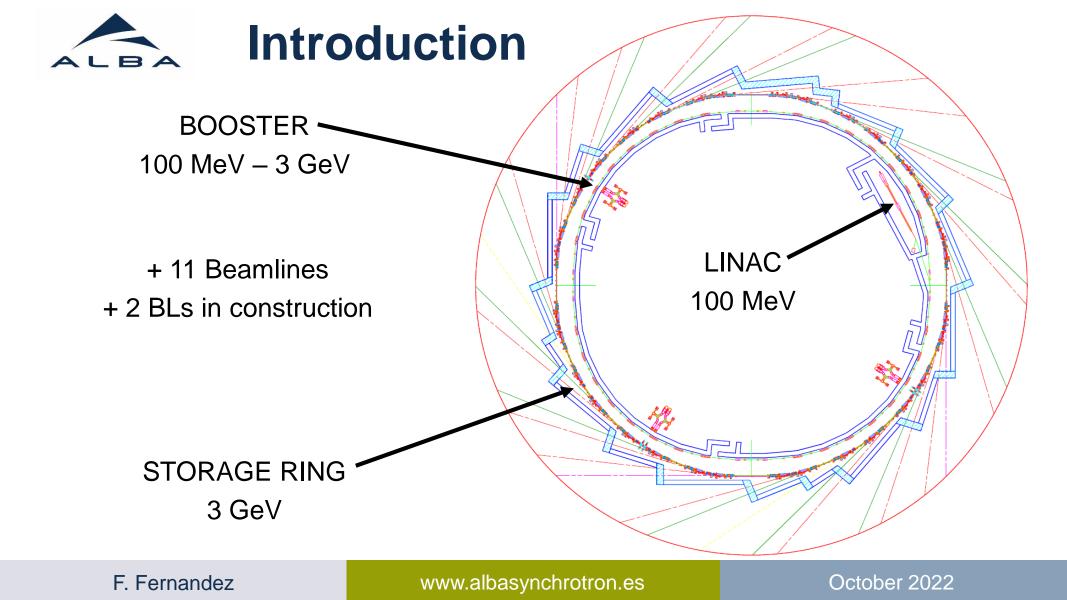
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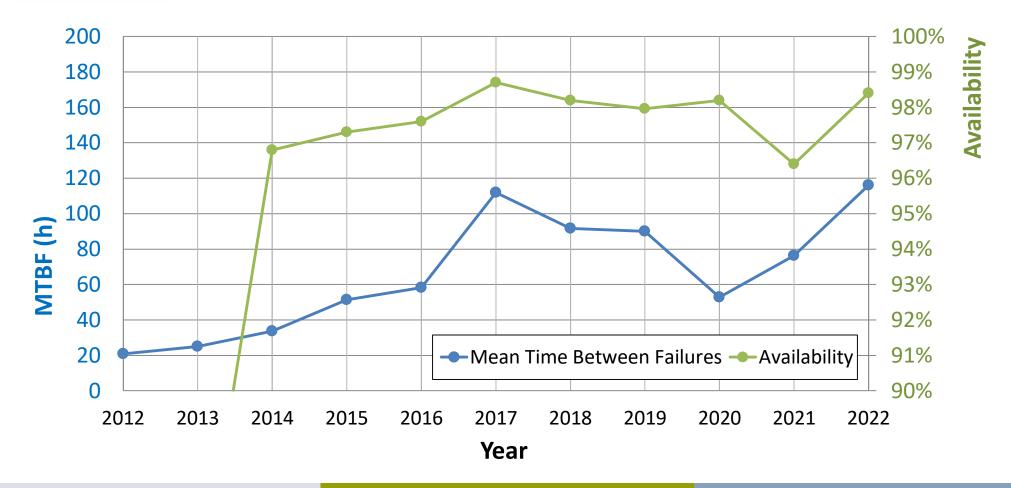
Outline

- Introduction
- Equipment Protection Systems (EPS) at ALBA
 - Description
 - "Protection laws" list
- EPS checks
 - What to check
 - How, how often, simulated vs. real,...
- Conclusions





Introduction



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ALBA Eq. Protec. Systems

Equipment Protection System (EPS)

- Based on PLCs
- Organized by subsystem: vacuum, magnets, front ends, radiofrequency, insertion devices...
- PLCs share information through powerlink
- "Slow": time to kill ~80ms

Critical signals sent to MPS

Machine Protection System (MPS)

- Based on timing system
- Signals from Libera BPMs (orbit interlock) and EPS PLCs
- Each event receiver (EVR) can send signal to event generator (EVG) that distributes signal to all EVR
- "Fast": time to kill ~0.1ms

BPMs signals sent to EPS

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ALBA Eq. Protec. Systems

Equipment Protection System (EPS)

- Each PLC receive signals from :
 - Sensors:
 - Thermocouples, thermal switches
 - Ion pumps (IP), cold cathode gages (CCG)
 - Flow switches, air switches
 - Limit switches (shutters, valves,...)
 - Others: inclinometers...
 - Other PLCs: SR valve closed, kill RF, kill Linac...
 - Orbit interlock from MPS

- Each PLC sends signals to:
 - Relays:
 - Stop power supply
 - Close vacuum valve
 - Stop RF high/driver voltage
 - Stop Linac electron gun/klystrons
 - Stop pulsed high voltage
 - Stop motor controller (ID)
 - .
 - Other PLCs: SR valve closed, kill RF, kill Linac...
 - Critical signals to MPS: kill RF

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ALBA Eq. Protec. Systems

Equipment Protection System (EPS)

EPS guarantees the some "laws" are followed

- Storage ring thermocouple warning ______ Kills Linac
- Storage ring thermocouple alarm
 Kills RF
- Vacuum trip (CCG + IP)
 Closes sector valves
- SR valve closed Kills RF and Linac
- Magnet thermal or flow switch Stops Power Supply
- Insertion device has a tilt
 Stops motor

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- **The configuration of the PLCs:** PLCs connected, thermocouples levels, signals enabled/disabled,... • **The hardware**: sensors are working, mechanical switches are not WHAT stuck, switches "open", connections are tight (false alarms)... • **The "chain" is working**: from sensor to switch, including cables, logic, connections... How often: weekly, monthly, yearly Force/simulate signal vs. real signal HOW **Exhaustive vs. random:** test all thermocouples of each PLC vs. pick •
 - some of them

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• Every "Monday Startup" we check the EPS configuration parameters

Checkers	Scann report: Attribute historics: EPS BKs:								
Check also RF PLCs	Test done on: 20221011_115739								
SR PLCs	All changes for each attribute since last BK update on date 2020-09-13 19:45:35 will be displayed.								
	For more information about historical changes, check it at 'Attribute historics' tab above.								
SR01 SR02 SR03 SR04									
	FE04: (TOBL)FRONT_END_DISABLED changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user jbanuelos on date 2022/10/03 at 10:35:20. FE04: (TOBL)FRONT_END_DISABLED changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user jbanuelos on date 2022/10/03 at 10:35:57. FE04: (TOBL)FRONT_END_DISABLED changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user jvillanueva on date 2022/10/03 at 10:36:29. FE04: (TOBL)FRONT_END_DISABLED changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user jvillanueva on date 2022/10/03 at 10:36:29. FE13: A07A0401CC1_FEFEXM1_F1301_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user mixicente on date 2022/08/30 at 12:38:18.								
SR05 SR06 SR07 SR08	FE04: (ToBL)FRONT_END_DISABLED changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user jbanuelos on date 2022/10/03 at 10:35:57.								
	FE04: (TOBL)FRONT_END_DISABLED changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user jvillanueva on date 2022/10/03 at 10:36:29.								
SR09 SR10 SR11 SR12	FE04: (ToBL)FRONT_END_DISABLED changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user jvillanueva on date 2022/10/04 at 16:16:59.								
	FE13: A07A0401CC1_FEFIXM1_F1301_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user mrvicente on date 2022/08/30 at 12:38:18.								
SR13 SR14 SR15 SR16	PETS: A0/A0401CC1_PEPIAWI_PTS01_D1 changed parameter PORCETO from 1.000+00 to 0.000+00 by dser minicente on date 2022/08/30 at 12:40.40.								
	FE22: A11A0401CC1_FEFIXM1_F2201_DI changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user banque on date 2022/08/31 at 07:56:31.								
	FE22: A11A0401CC1_FEFIXM1_F2201_DI changed parameter DISABLE from 0.00E+00 to 1.00E+00 by user banque on date 2022/08/31 at 07:59:23.								
FE PLCs	FE22: A11A0401CC1_FEFIXM1_F2201_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user banque on date 2022/08/31 at 07:59:23.								
	FE22: A11A0401CC1_FEFEXM1_F2201_DI changed parameter FORCE TO from 1.00E+00 by user banque on date 2022/08/31 at 07:59:23.								
FE01 FE02 FI03 FE04									
	FE22: A11A0401CC1_FEFIXM1_F2201_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user mrvicente on date 2022/08/30 at 15:56:36. FE24: A11G0201CC1_FEFIXM1_F2401_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user msos on date 2022/08/31 at 09:18:01.								
FE06 FE09 FE11 FE13	FE24. AT log/or CCT_FEFXMT_F2401_DL changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user misos on date 0222/0451 at 09:801.								
	E524: A11G0201CC1 E5ETXM1 52401 DL chapted parameter EORCE TO from 1 005±00 to 0 005±00 by user most on date 2022/08/21 at 10:12:11								
FE16 FE20 FE22 FE24	FE24, All Good CCCT FETKM 1 2401 Dictanged parameter FORCE TO from 1.00E+00 to 0.00E+00 by user moso on date 2022/08/31 at 10:13:11.								
	FE29: A1400502CCT FEBRU F201 DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user jbanuelos on date 2022/08/25 at 11:54:15.								
FE29 FE34	FE29: A1400502CC1 FEBRTU F2901 DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user jbanuelos on date 2022/08/25 at 11:55:03.								
	F29: A14D0502CC1_FEBRTU_F2901_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user jbanuelos on date 2022/08/25 at 11:55:45.								
ID PLCs	FE29: A14D0502CC1_FEBRTU_F2901_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user jbanuelos on date 2022/08/25 at 12:00:03.								
ID FLCS	FE29: A14D0502CC1_FEBRTU_F2901_DI changed parameter FORCE TO from 1.00E+00 to 0.00E+00 by user mrvicente on date 2022/08/26 at 10:33:34.								
ID04 ID06 ID11 ID13									
	FE34: Some attributes missing.								
ID20 ID22 ID24 ID29	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user arubio on date 2021/01/13 at 18:31:09.								
1020 1022 1024 1029	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user arubio on date 2021/01/13 at 18:34:05.								
	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user arubio on date 2021/01/14 at 13:33:30.								
	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user arubio on date 2021/02/15 at 12:25:56.								
	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user jmarcos on date 2021/05/11 at 09:02:22.								
Reset form	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user nserra on date 2022/08/16 at 14:17:41.								
	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user nserra on date 2022/08/16 at 14:25:56.								
Write Log	ID06: IDIVU_S0301_CCTS1_TILT1_AF changed parameter WARNING UP from -2.47E-02 to -2.50E-02 by user jgiraldo on date 2022/09/20 at 17:34:38.								

Scan finished. Press write log button for further info.

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Some hardware is very easy to test with real signals, exhaustive

- General water flow cut (1/year)
 - All flow switches -> OFF
 - All cooled magnets & power supply -> OFF
 - All Front Ends photon shutters -> CLOSE

🐹 🗶									ALBA EQUIPME	NT PROTECTIO	N SYSTEM									\lor \diamond \otimes
Tools																				
									ALBA a	ccelerators EP	S									
Commu	inications				Radiofre	equency								Front-Ends					INSERTION	DEVICES
ALL S	YSTEMS	📣 BO	📣 SR06-	A 👘 📣 SRO	6-B 🤷 🍁 SF	R10-A 🦉	SR10-B	🖈 SR14-A	📣 SR14-8	📣 FE01	🔹 FE02	FI03	🙊 FE04	FE05	📣 FE06	FE07	FE08	🙊 FE09	Ø 1002	ID 0 4
RESET	PWRLNK	A RESET	<u> </u>	r 🔬 RES	ET 🔬 RI	ESET 2	<u>î</u> RESET	<u> </u>	<u> </u>		▲ RESET	RESET	A RESET	RESET	<u> </u>	RESET	RESET		Ø RESET	RESET
Ma LT/BO/BT	gnets ST. RING				Vacı					FE10	📣 FE11	FE12	🖈 FE13	FE14	FE15	FE16	FE17	FE18	IVU ID 11 BL11NCD	IVU ID 13 BL13XALOC
A BEND	A BEND / TRIM	IT		BO Q1	B0 Q2	BO Q3	BO Q4		ВТ	DECET	A RESET	RESET	A RESET	RESET	RESET	A RESET	RESET	RESET	RESET	RESET
		A RESET		🛕 RESET	A RESET	A RESET	A RESET		A RESET	RESET	A RESET	RESET	A RESET	RESET	RESET	A RESET	RESET	RESET		
🔹 QUAD	📣 QUAD	SR01	SR02	SR03	SR04	SR05	SR06	SR07	SR08	FE19	🖈 FE20	🔶 FE21	📣 FE22	FE23	📣 FE24	FE25	FE26	FE27	EU125 ID20 BL20LOREA	MPW80 ID22 BL22XAS
SEXT	🍁 SEXT / SKEW	<u>∧</u> RESET	<u> </u>	<u>∧</u> RESET	<u>∧</u> RESET	A RESET	<u>∧</u> RESET	A RESET	A RESET	RESET	▲ RESET	A RESET	A RESET	RESET	A RESET	RESET	RESET	RESET	RESET	RESET
🏠 COR / PU	🙊 COR / PU	SR09	SR10	SR11	SR12	SR13	SR14	SR15	SR16	FE28	🍁 FE29	FE30	FE31	FE32	FE33	🔹 FE34			APPLE ID24 BL24CIRCE	APPLE ID29 BL29XMCD
RESET	RESET	A RESET	A RESET	<u> </u>	<u> </u>	A RESET	<u>∧</u> RESET	<u> </u>	A RESET	RESET	<u> </u>	RESET	RESET	RESET	RESET	A RESET			RESET	RESET
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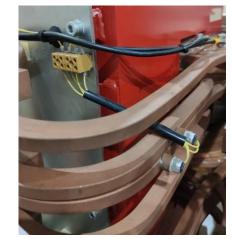
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Some hardware is very difficult to test

- Magnets maintenance (1/year)
 - Connections are tight (prevent false trips)
 - If thermal switches circuit "open" -> power supplies OFF
 - Coils temperature > 60deg -> power supplies OFF -> Not tested







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Radiation Protection As Low As Reasonably Achievable



Equipment Protection System checks As Much As Reasonably Achievable

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A plan of "what / how /how often" EPS checks is decided based on

- Danger
- Redundancy
- Past failures
 - Checks plan must be "alive"
- AMARA

For this, a goog fault tracking, impact on beam hours, is a must



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	SPBX	PLC ITLK	
		(ToBL)FRONT_END_INTERLOCKED	
ANY TC WARN	FEMOVM_F0401_T1_TC_TH	STOP LINAC	
	FEMOVM_F0401_T2_TC_TH	PLC WARN	
	FEMOVM_F0401_T3_TC_TH		
	FEMOVM_F0401_T4_TC_TH		
	FEPSHU_F0401_T1_TC_TH		ok
	FEPSHU_F0401_T2_TC_TH		ok
	FEPSHU_F0401_T3_TC_TH		ok
	FEPSHU_F0401_T4_TC_TH		
	FEXBPM_F0401_TA_TC_TH		
	FEXBPM_F0401_TB_TC_TH		
MOVM TC ITLK	FEMOVM_F0401_T1_TC_TH	FEPSHU_F0401_PSHU	
	FEMOVM_F0401_T2_TC_TH	(ToBL)FRONT-END_INTERLOCKED	
	FEMOVM_F0401_T3_TC_TH	PLC WARN	
	FEMOVM_F0401_T4_TC_TH		
MOVM FLW ITLK	FEMOVM_F0401_FLW_FLW1_DI	FEPSHU_F0401_PSHU	
		(ToBL)FRONT-END_INTERLOCKED	
	FEMOVM_F0401_FLW_FLW2_DI	PLC WARN	
PSHU FLW ITLK	FEPSHU_F0401_FLW_FLW1_DI	Stop SRRF [OUT]	ok
	FEPSHU_F0401_FLW_FLW2_DI	PLC ITLK	ok
		Stop LINAC [OUT]	ok
FIXM FLW ITLK	FEFIXM1_F0401_FLW_FLOWL_DI	(ToBL)FRONT-END_INTERLOCKED	
XBPM TC ITLK	FEXBPM_F0401_TA_TC_TH	DIINTBO_A02D0101_IN4_ITLK_DO	
	FEXBPM F0401 TB TC TH	(ToBL)FRONT-END DISABLED	

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Conclusions

- Due to new devices, maintenance, upgrades,...
 EPS is changing -> checks is a MUST
 - Use fault tracking to convince people
- Check everything: config., hardware, "chain",
- Plan an EPS checks (AMARA + experience)
- **Operations** is the right team to do it



Thanks to

- Javier Bañuelos, the operator who is doing the EPS checks project
- Marc Sos, the operator who maintains our EPS database and did the EPS config. Checks GUI

Questions?

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