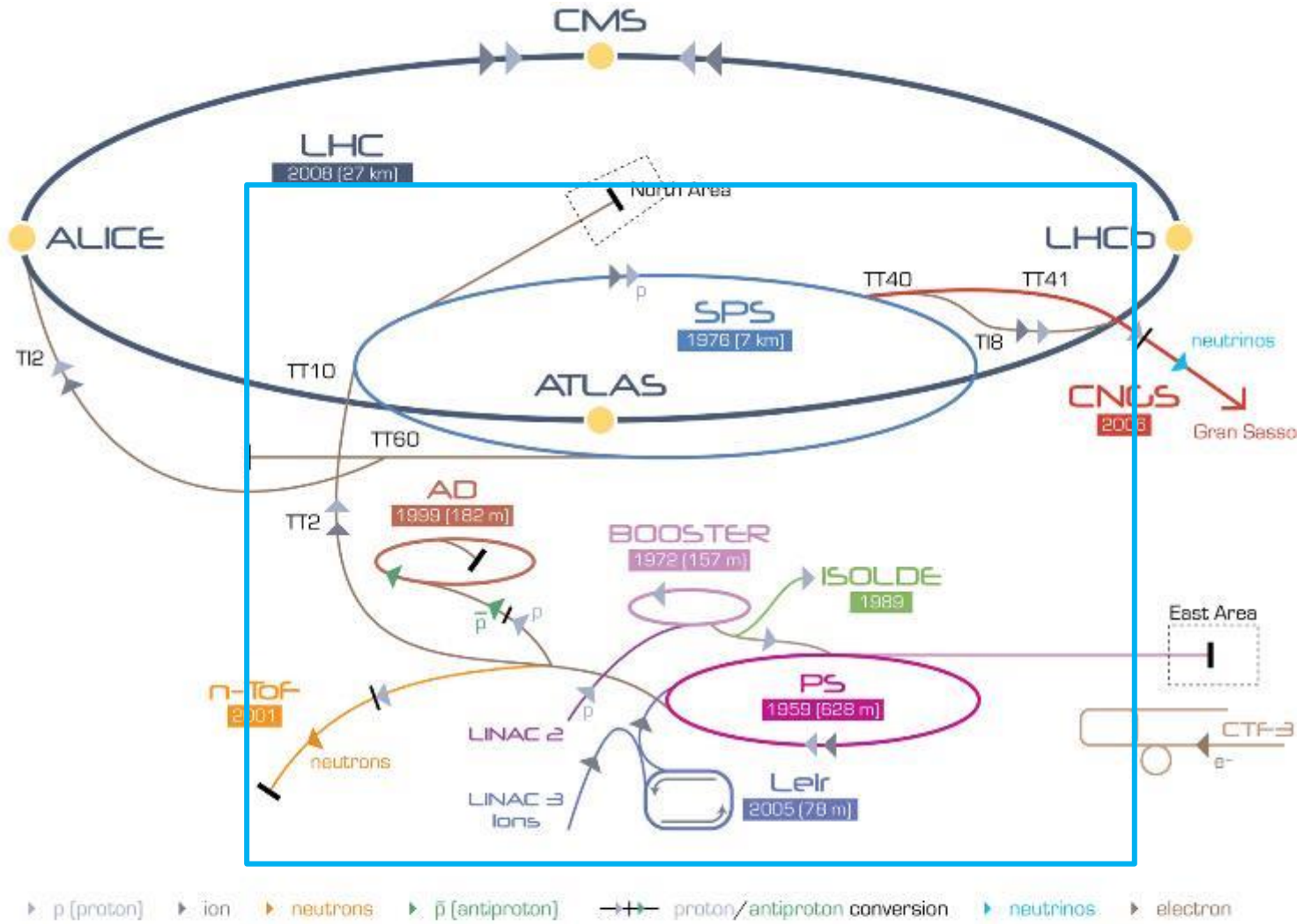
LHC's injector chain:

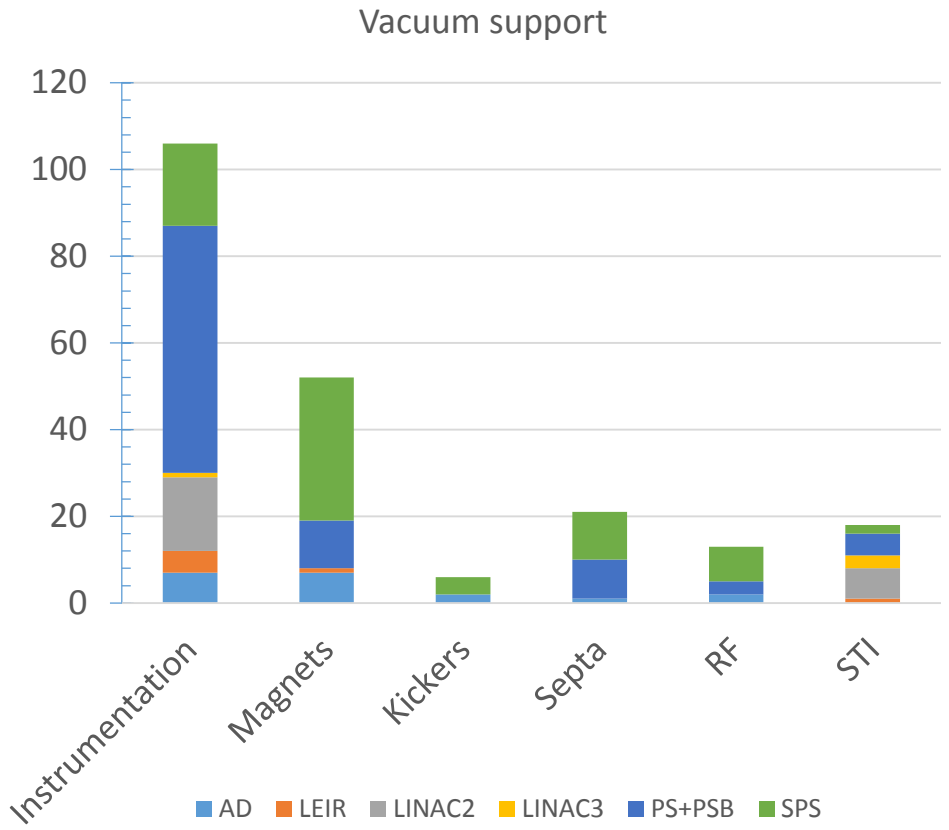
Vacuum activities during LS1

Jose A. Ferreira Somoza on behalf of TE-VSC-IVM team


CMS
LHC
2008 [27 km]
ALICE
LHCb
North Area
TT40
TT41
p
SPS
1976 [7 km]
TI8
neutrinos
TI2
TT10
ATLAS
CNGS
2006
Gran Sasso
TT60
AD
1999 [182 m]
TT2
BOOSTER
1972 [157 m]
ISOLDE
1989
East Area
n-ToF
2001
PS
1959 [628 m]
LINAC 2
CTF-3
neutrons
LINAC 3
Ions
LEIR
2005 [78 m]
p (proton)
ion
neutrons
p̄ (antiproton)
proton/antiproton conversion
neutrinos
electron
LHC Large Hadron Collider
SPS Super Proton Synchrotron
PS Proton Synchrotron
AD Antiproton Decelerator
CTF-3 Clic Test Facility
CNGS Cern Neutrinos to Gran Sasso
ISOLDE Isotope Separator OnLine DEvice
LEIR Low Energy Ion Ring
LINAC LINear ACcelerator
n-ToF Neutrons Time Of Flight

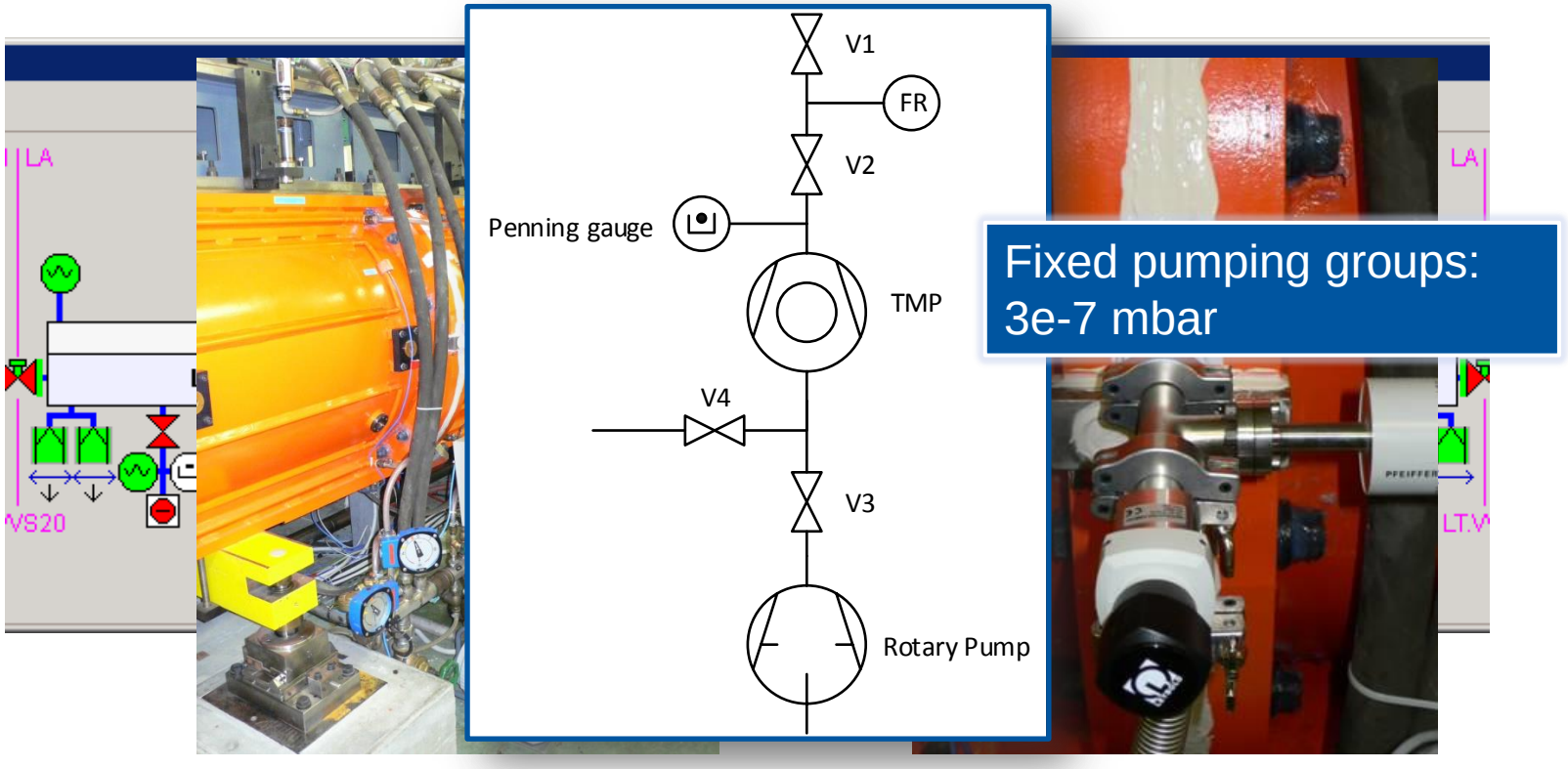
LS1 works: few numbers

Equipment	#
Ion Pumps	160
Valves	15
Gauges	40
Ti sublimators	100
TMP pumping groups	5

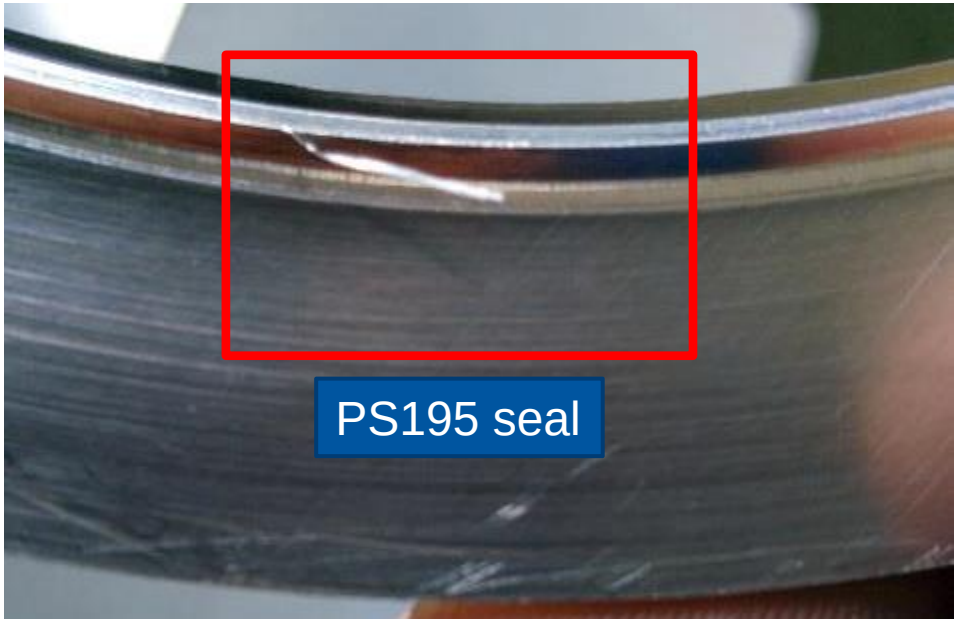


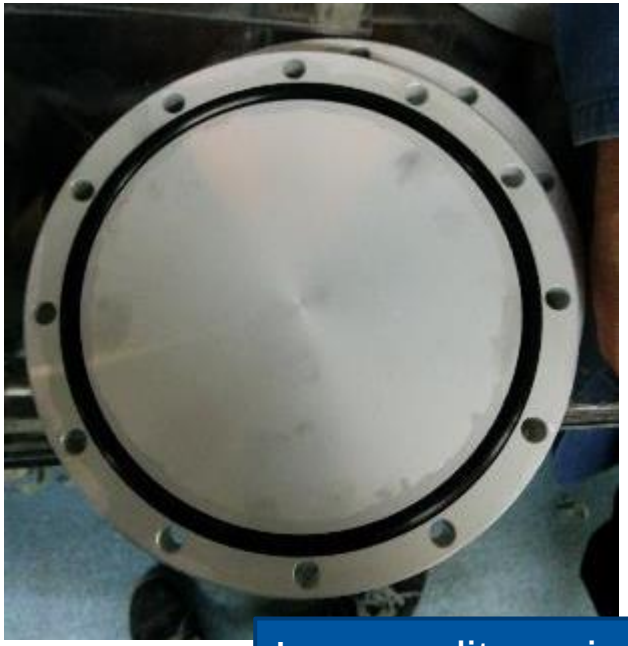
Problems found during LS1

- 2xVPIs in tank2 of LINAC2 lost



Problems found during LS1: Seals





Dust from fiber glass (insulation)

LS1 works: Work in hot areas

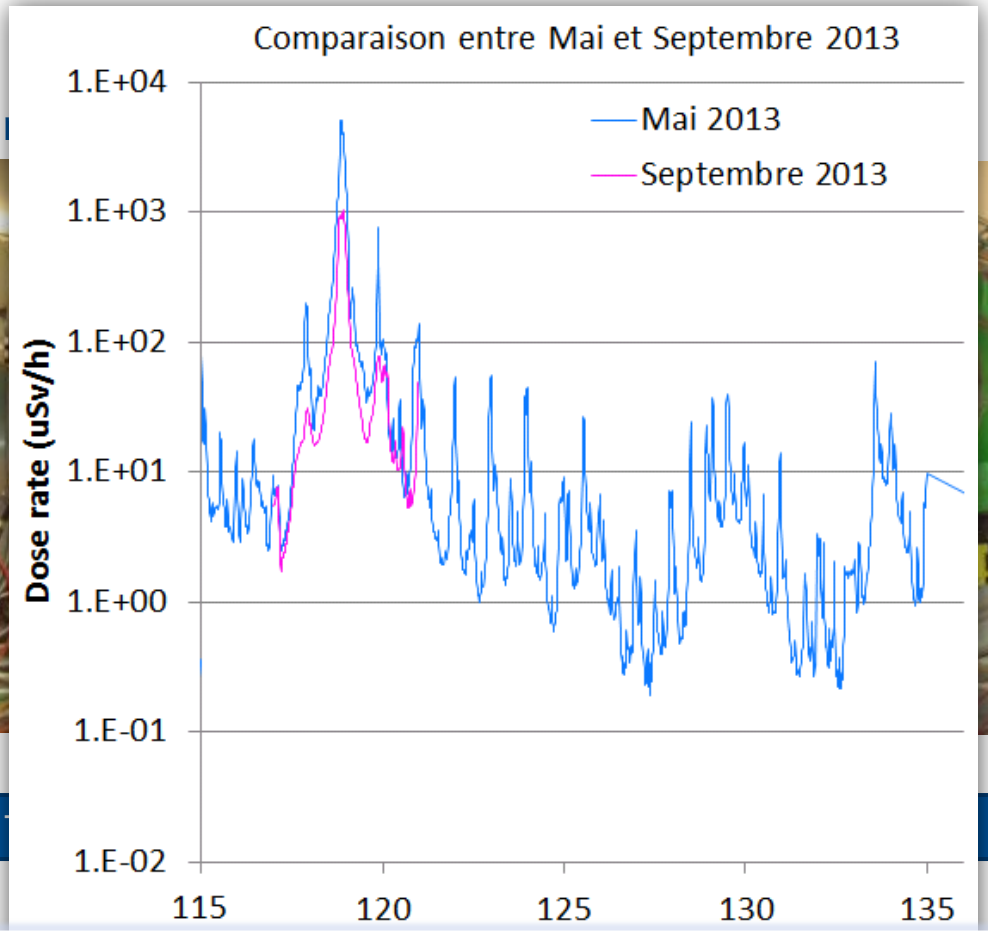
- Recabling LSS1 (SPS). 120 m of beam line dismantled (reduction of ambient dose) in summer 2013. Reinstallation spring 2014.

- Vacuum consolidation north area of SPS

>5 mSv/h

Recabling LSS1 of SPS

5 mSv/h

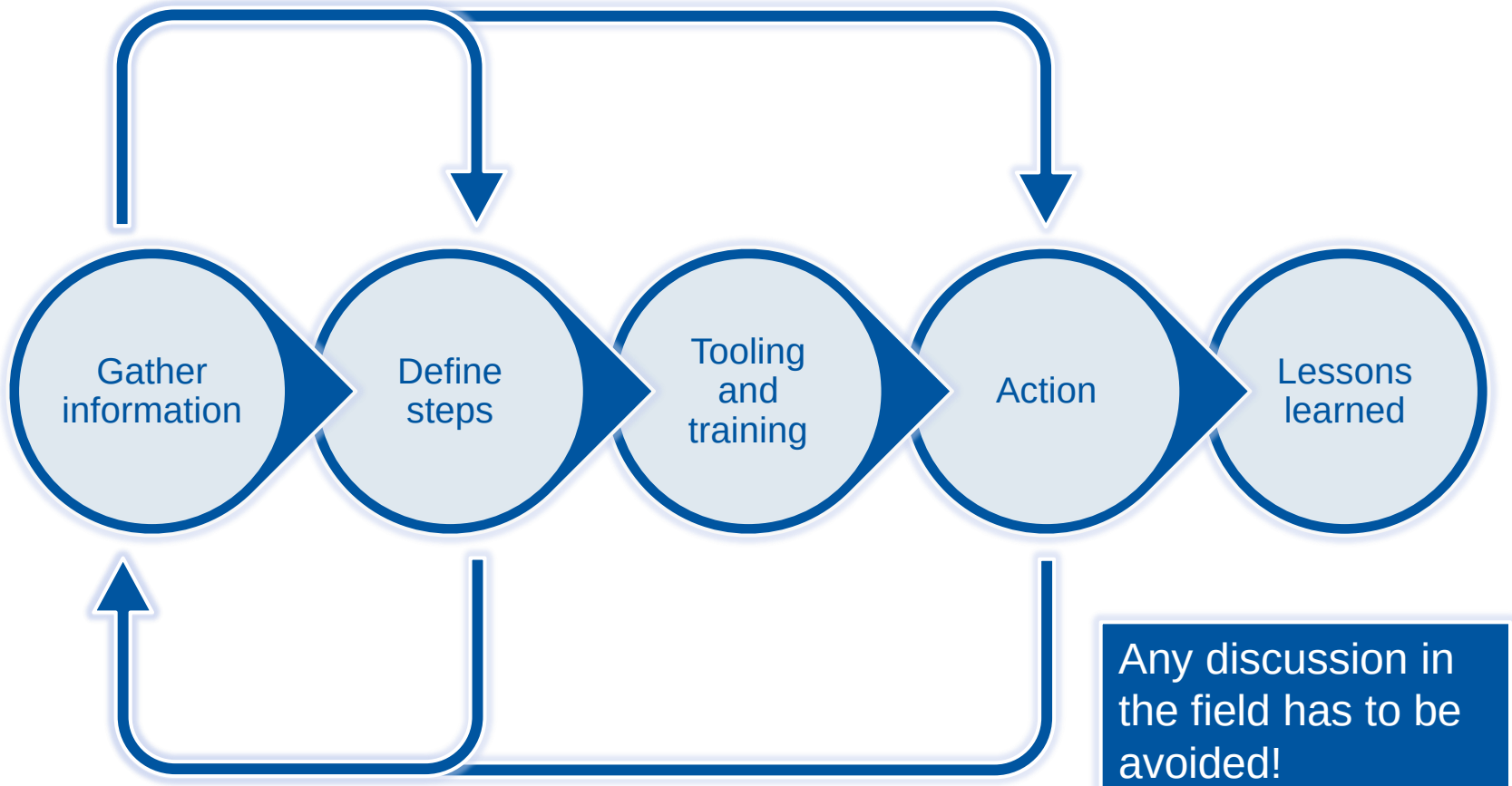


4 mSv/h

Peak dose rate reduction factor ≈ 5 (initial estimation ≈ 2)

Average dose rate reduction factor in LSS1+ ≈ 3.2

Interventions in hot areas: steps

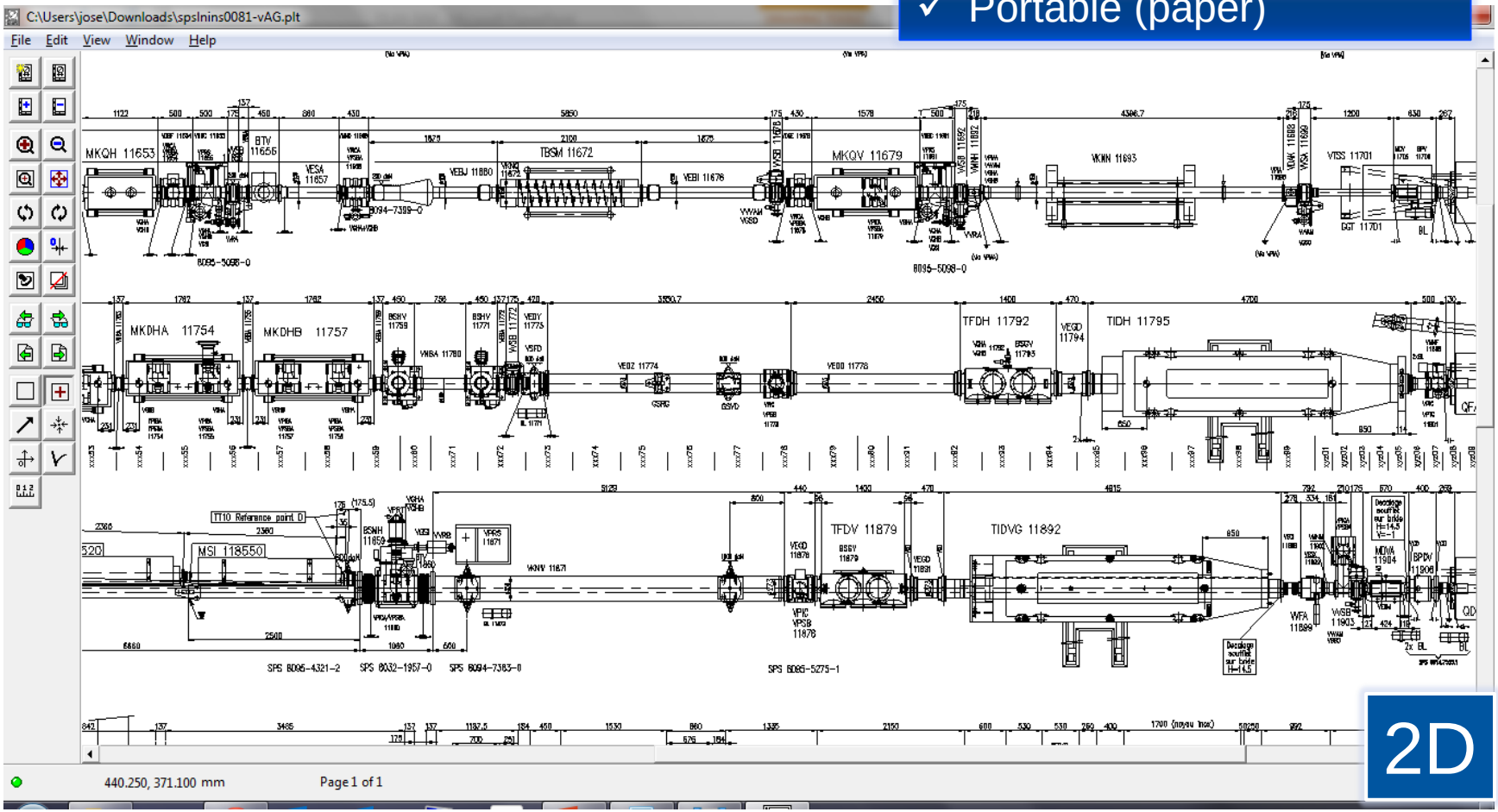


Sources of information

1. Drawings and pictures (2D, 3D)
2. Immersive 3D
    1. High-Definition Surveying (Laser scans)
    2. 360º cameras
3. Robot inspections

Drawings

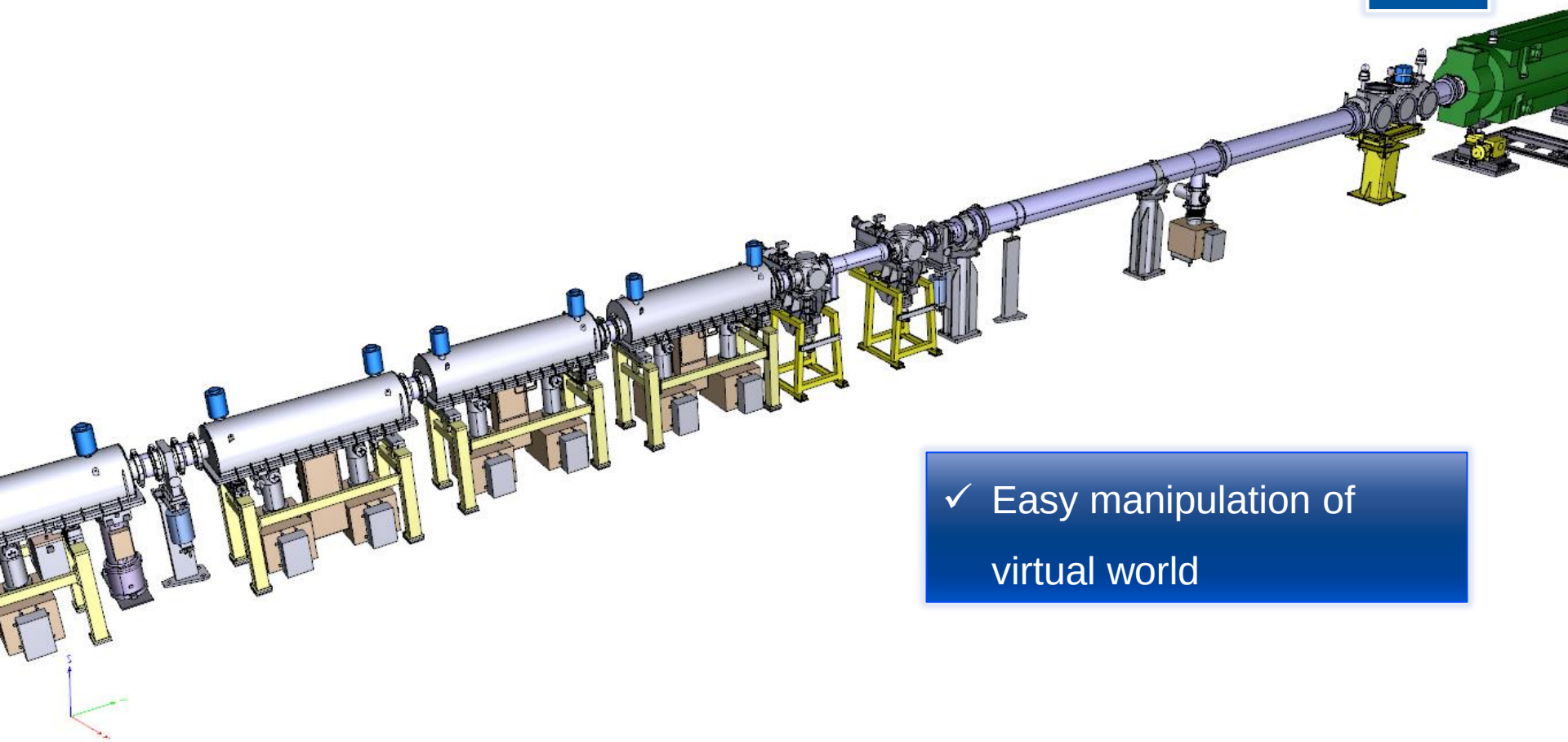
✓ Portable (paper)



2D

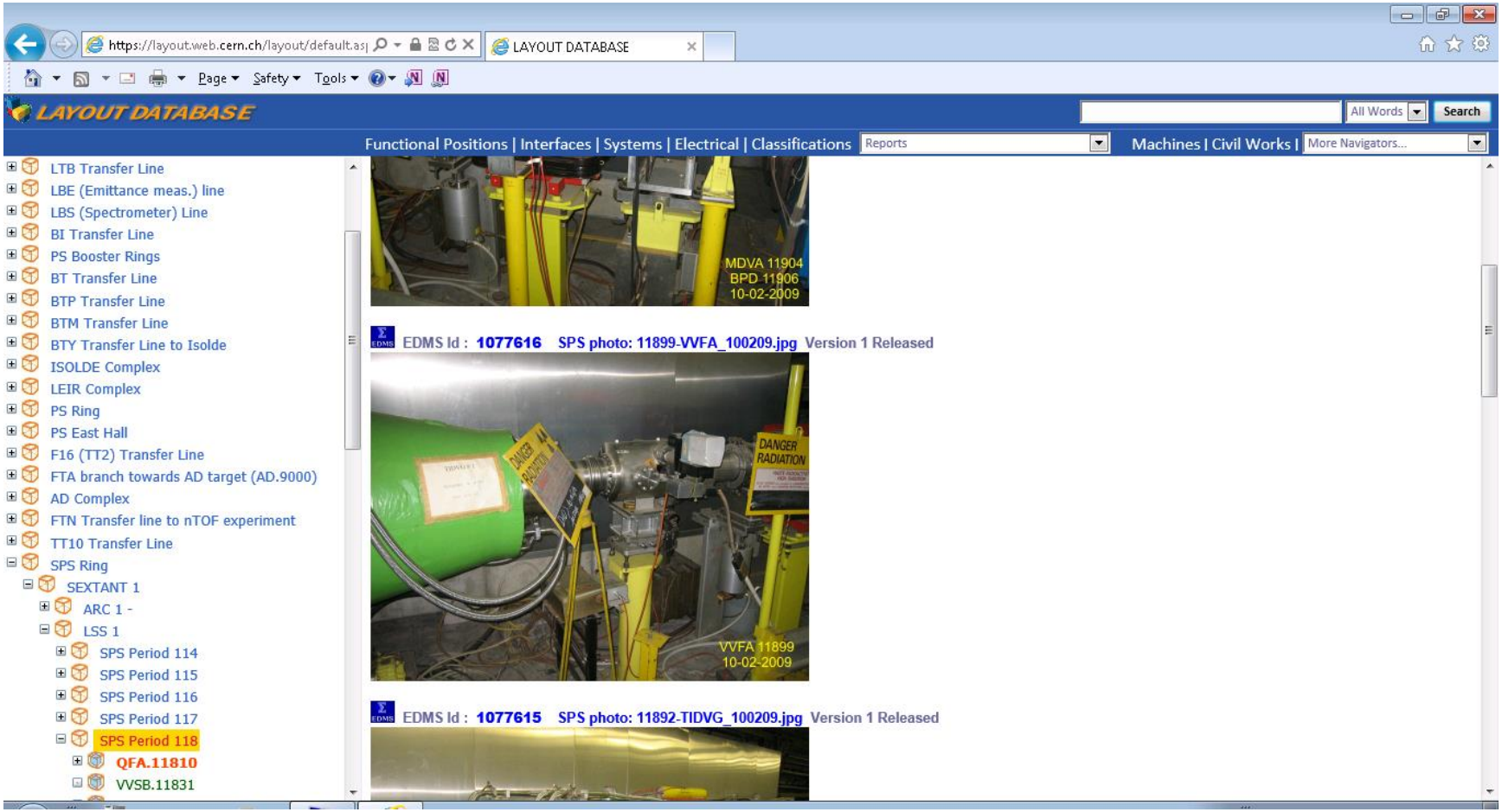
Drawings

3D



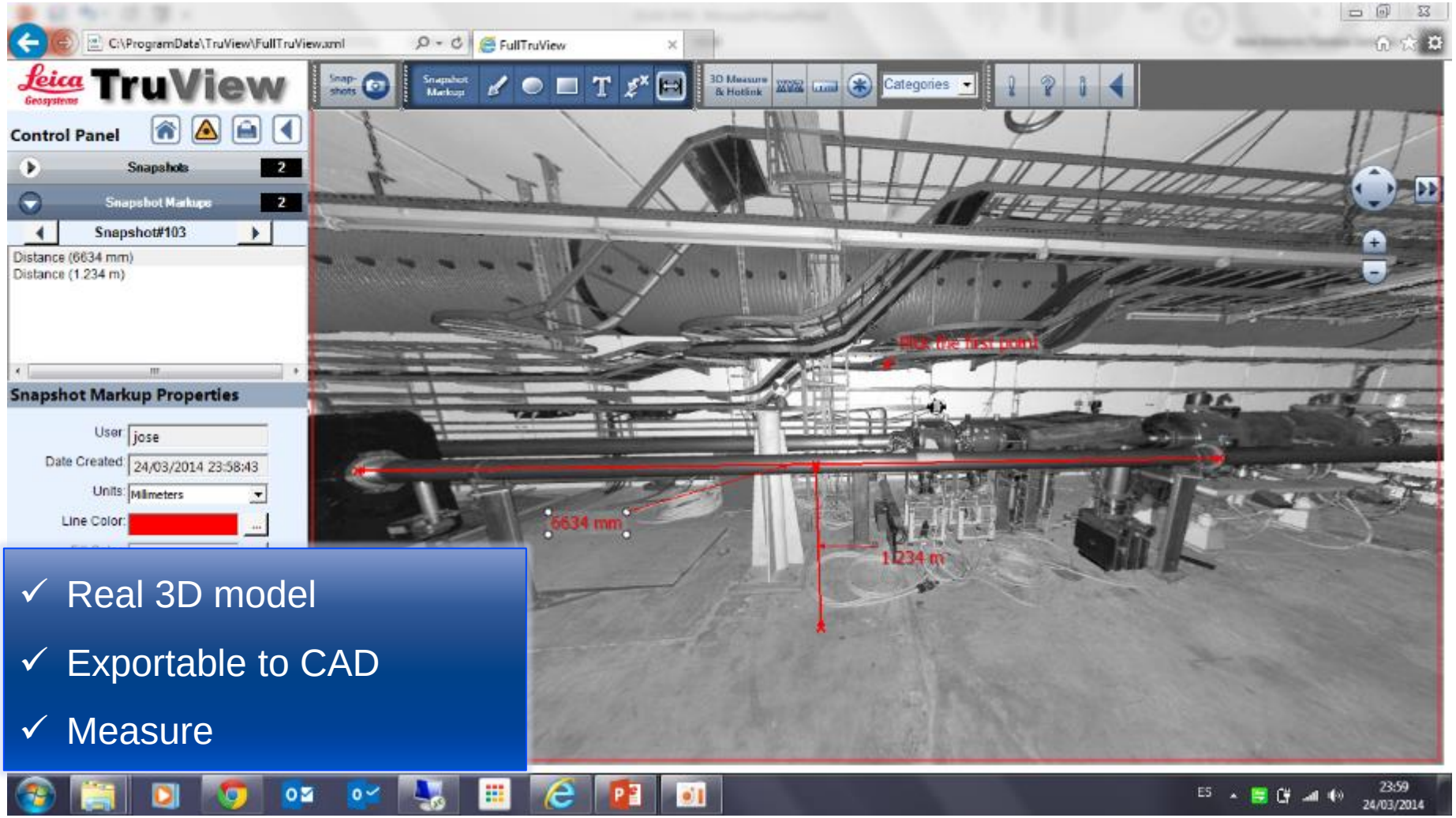
- ✓ Easy manipulation of virtual world

Pictures


https://layout.web.cern.ch/layout/default.asp
LAYOUT DATABASE
Page
Safety
Tools
LAYOUT DATABASE
All Words
Search
Functional Positions | Interfaces | Systems | Electrical | Classifications
Reports
Machines | Civil Works |
More Navigators...
LTB Transfer Line
LBE (Emittance meas.) line
LBS (Spectrometer) Line
BI Transfer Line
PS Booster Rings
BT Transfer Line
BTP Transfer Line
BTM Transfer Line
BTY Transfer Line to Isolde
ISOLDE Complex
LEIR Complex
PS Ring
PS East Hall
F16 (TT2) Transfer Line
FTA branch towards AD target (AD.9000)
AD Complex
FTN Transfer line to nTOF experiment
TT10 Transfer Line
SPS Ring
SEXTANT 1
ARC 1 -
LSS 1
SPS Period 114
SPS Period 115
SPS Period 116
SPS Period 117
SPS Period 118
QFA.11810
VVSB.11831
MDVA 11904
BPD 11906
10-02-2009
EDMS Id : 1077616 SPS photo: 11899-VVFA_100209.jpg Version 1 Released
DANGER RADIATION
VVFA 11899
10-02-2009
EDMS Id : 1077615 SPS photo: 11892-TIDVG_100209.jpg Version 1 Released

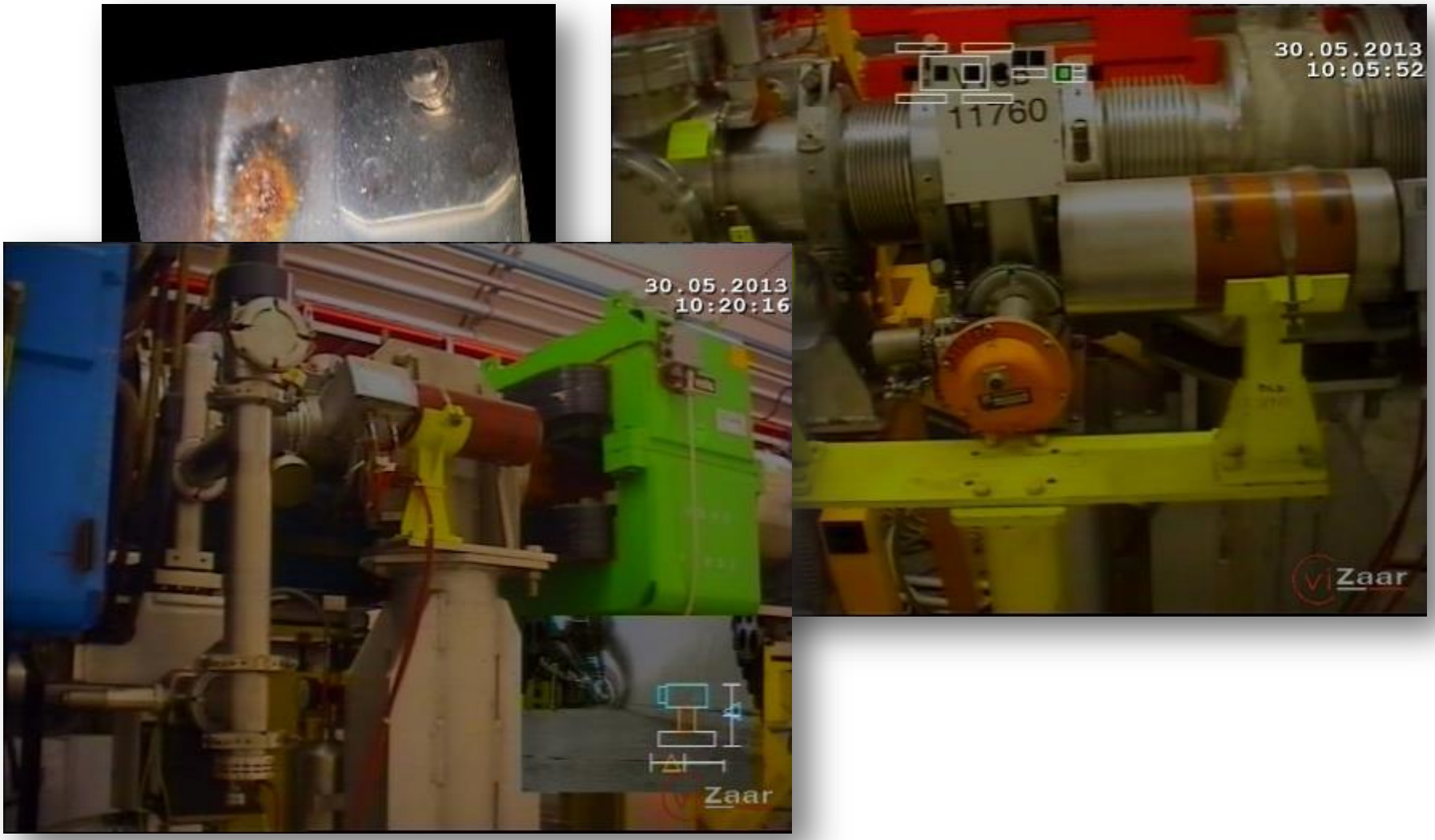
Immersive 3D (High Definition Survey)

Immersive 3D (High Definition Survey)



Immersive 3D (360º video)

Robot Inspections



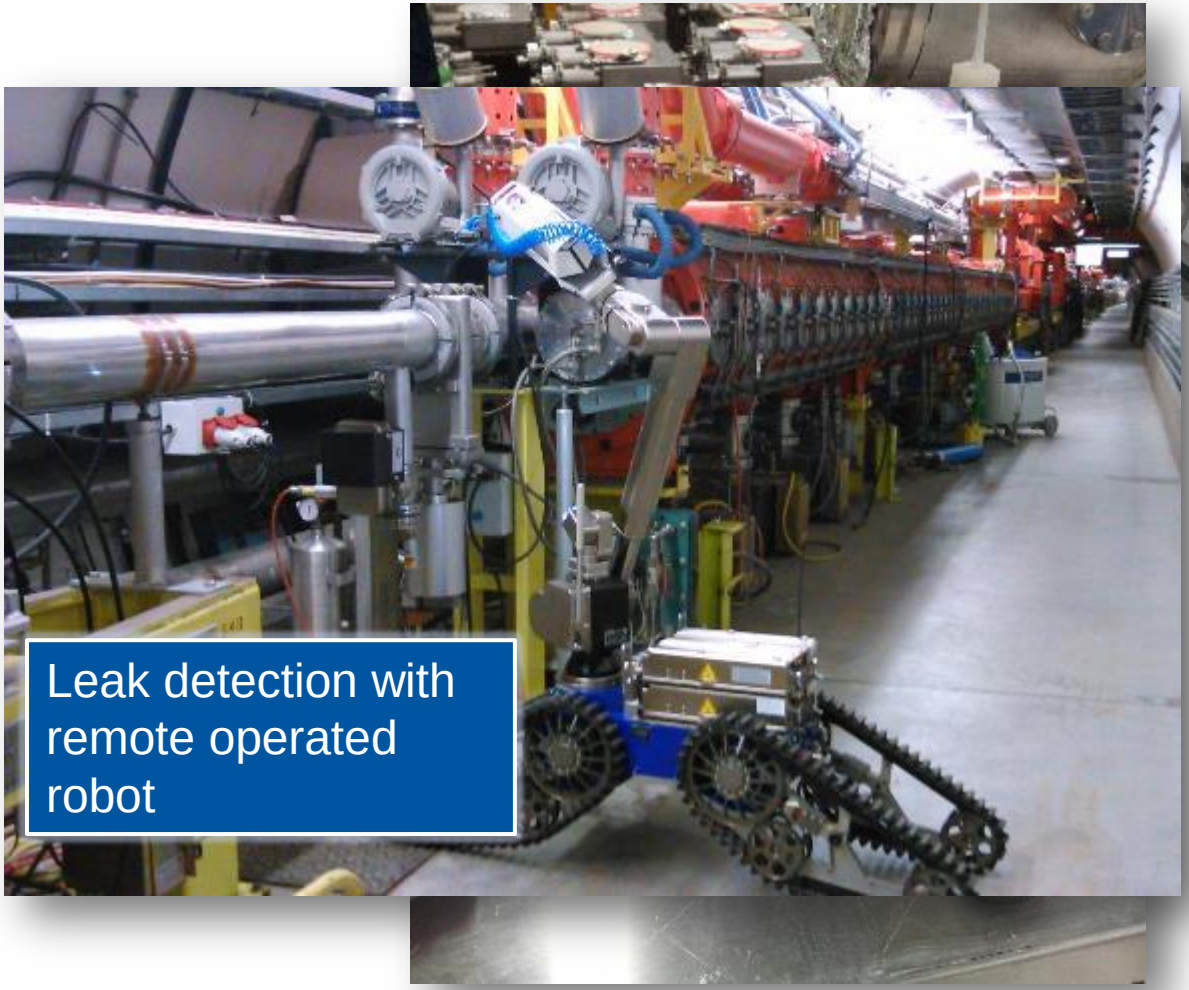
Outcome: Work Dose Planning

Work and dose planning - LSS1 reinstallation: vacuum

Reinstallation vacuum equipments LSS1

								Working time [man.hours]	Effective avg. dose rate [µSv/h]	Collective dose [man.µSv]	Collective dose [man.µSv]	Working time real [man.hours]	Collective real dose [man.µSv]	Collective real dose [man.µSv]	
						Totals:		60,8	236	14334	14334	0	0	0	
Prior intervention To be completed and checked by work coordinator(s) and experts									Prior intervention To be checked and completed by RP			Posterior intervention To be completed by work coordinator or/and RP			
1	2	3	4	5	6	7	8		9	10	11	12	13	14	15
No.	Work description (Task)	Responsible person	Dep/Grp (executing)	WorkTeam	Location (check table 'DoseRates')	Persons [No.]	Exposure time [min]		Dose rate [µSv/h]	Estimated dose [µSv]	Estimated total dose [µSv]	Real time [min]	Real dose [µSv]	Real total dose [µSv]	Remarks
1	**Vacuum sector 143**										**3780**			**0**	
1,00	Install VVSB 11960	Jose A. Ferreira	TE/VSC/IVM		11960	3	45		41	92					
1,01	Install pumps MKPA 11931	Jose A. Ferreira	TE/VSC/IVM		11931	4	120		80	640					
1,02	Install pumps MKPA 11936	Jose A. Ferreira	TE/VSC/IVM		11936	4	120		80	640			0		
1,03	Install pumps MKPC 11952	Jose A. Ferreira	TE/VSC/IVM		11952	4	40		60	160					
1,04	Install pumps MKP 11955	Jose A. Ferreira	TE/VSC/IVM		11955	4	60		42	168					
1,05	Connect 4xbellows	Jose A. Ferreira	TE/VSC/IVM		11931-11955	2	40		57	76					
1,06	Install VVSB 11903	Jose A. Ferreira	TE/VSC/IVM		11903	2	45		800	1200					
1,07	Connect VVSB 11903 to MDVA 11904 (NEWmagnet) and BPCE 11906 (new monitor)	Jose A. Ferreira	TE/VSC/IVM		11904	2	15		800	400					
1,08	Connect QDA 11910	Jose A. Ferreira	TE/VSC/IVM		11910	2	10		1000	333					
1,09	Pump down	Jose A. Ferreira	TE/VSC/IVM		11903-11960	2	15		140	70					
1,10	Leak detection				11903-11960	0	????		140						robot (time)
1,10	Leak detection	Jose A. Ferreira	TE/VSC/IVM		11903-11960	0	????		10						robot (time)
2	**Vacuum sector 150**										**361**			**0**	
2,01	Connect vacuum 8 xchambers	Jose A. Ferreira	TE/VSC/IVM		11971-11990	2	40		50	67					Without TBSJ
2,02	Install pump 11993	Jose A. Ferreira	TE/VSC/IVM		11993	2	15		120	60			0		To be done in BA5 or A6 -
2,03	Connect TBSJ (entrée 1m)					2	5		200	33					
2,04	Connect TBSJ (sortie - de 40cm)	Jose A. Ferreira	TE/VSC/IVM		11995	2	5		150	25			0		
2,05	Pump down	Jose A. Ferreira	TE/VSC/IVM		11971-11995	2	15		176	88					
2,06	Leak detection				11971-11995	1	15		176	44					Perche pour sprayer
2,07	Leak detection	Jose A. Ferreira	TE/VSC/IVM		11971-11995	1	15		176	44					
3	**Vacuum sectors 131-132-133**										**49**			**0**	
3,01	Remove old group and install new chamber	Jose A. Ferreira	TE/VSC/IVM		11653	2	45		8	12					
3,01	Connect MKQH 11653	Jose A. Ferreira	TE/VSC/IVM		11653	2	20		8	5			0		
3,01	Connect 2xpumps	Jose A. Ferreira	TE/VSC/IVM		11653	2	30		8	8			0		
3,01	Pump down	Jose A. Ferreira	TE/VSC/IVM		11653	2	15		8	4			0		
3,01	Leak detection	Jose A. Ferreira	TE/VSC/IVM		11653	2	10		8	3			0		
3,01															
3,01	Vacuum sector 132													0	
3,01	Pump down	Jose A. Ferreira	TE/VSC/IVM		11672	2	15		6	3			0		
3,01	Leak detection	Jose A. Ferreira	TE/VSC/IVM		11672	2	10		6	2			0		
3,01															
3,01	Vacuum sector 133													0	
3,01	Remove old group and install new chamber	Jose A. Ferreira	TE/VSC/IVM		11679	2	45		3	4,5			0		
3,01	Connect MKQV 11679	Jose A. Ferreira	TE/VSC/IVM		11679	2	20		3	2			0		
3,01	Connect 2xpumps	Jose A. Ferreira	TE/VSC/IVM		11679	2	30		3	3			0		
3,01	Pump down	Jose A. Ferreira	TE/VSC/IVM		11679	2	15		3	1,5			0		
3,01	Leak detection	Jose A. Ferreira	TE/VSC/IVM		11679	2	10		3	1			0		
6	**Vacuum sector 142 (TT10)**										**660**			**0**	
6,01	Connect chambers and equipment from 102871 to 103000	Jose A. Ferreira	TE/VSC/IVM		102871-103000	2	120		165	660			0		
										0					
7	**Vacuum sector 135**										**24**			**0**	
7,01	Install valve VVSB 11740	Jose A. Ferreira	TE/VSC/IVM		11740	2	30		5	5			0		

Tooling



Leak detection with remote operated robot

Telemax

HeliJet

Tooling

Robot vs Human

- Costs
- Difficult operation (trained personnel)
- Time consuming
- Remote operation → 0 dose

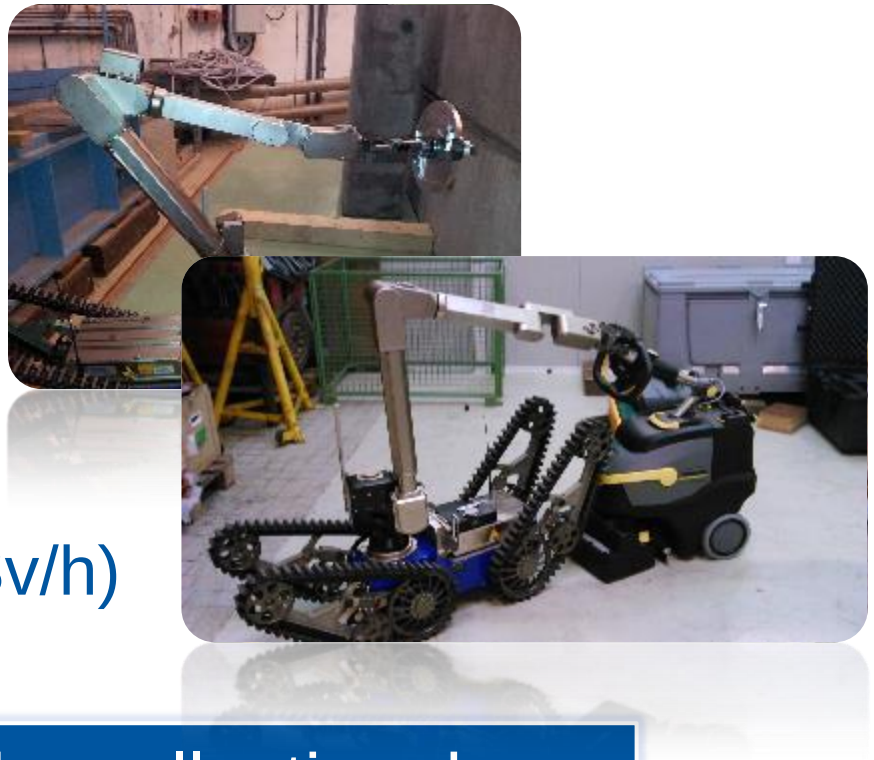
<u>Remove 1 clamp</u>

Torque wrench:	2-3 minutes
Cordless impact wrench:	20-30 seconds
Robot:	15-30 minutes

Interventions during LS1

Robot:

- Inspection
- Leak detection
- Removal of clamps
- Cleaning
- Install 1 flange (12 mSv/h)



>60% reduction of the collective dose

Conclusions

- An important period is coming to an end
- Objectives during this period: consolidation + support other activities
- Some complex tasks in very hot areas
- The use of new techniques are extremely helpful to reduce the collective dose

Thank you for your attention!