2018 DOE Accelerator Safety Workshop

SLAC, 21 – 23 August 2018

ESRF upgrade

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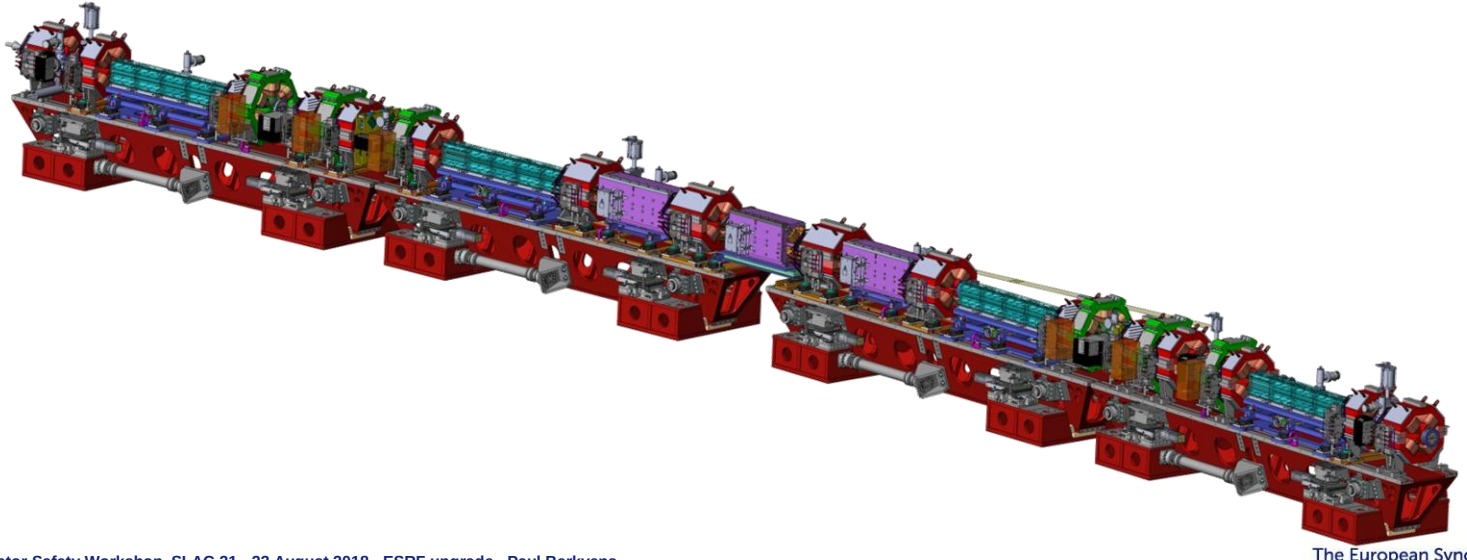
ESRF | The European Synchrotron

Contents

1. Short introduction to the ESRF
2. EBS project
3. Decommissioning of existing storage ring
4. EBS project: safety management



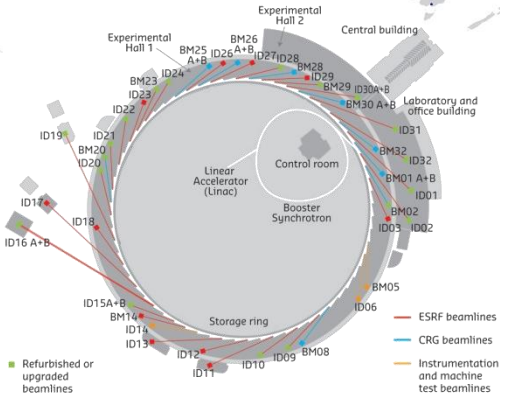
ESRF: SHORT INTRODUCTION

European Synchrotron Radiation Facility

3rd generation high energy synchrotron radiation facility

A research facility unique worldwide

- ✓ **6,500 scientific visitors** every year including **4,000 users**
- ✓ **2,000 proposals** per year: **900 accepted**, 1,550 experimental sessions
- ✓ **30%** of the research involves **industrial developments**

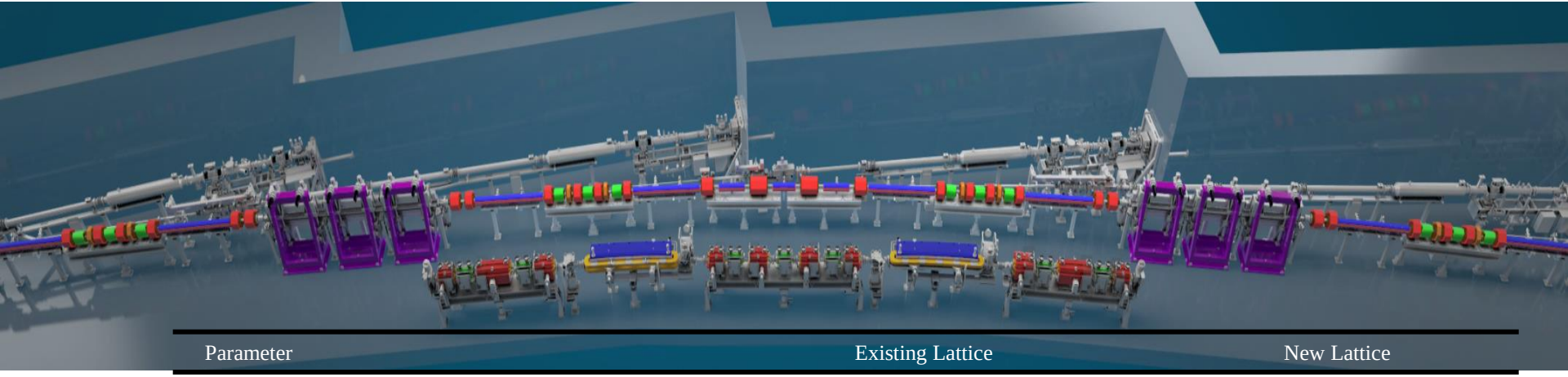


Scientific excellence recognised worldwide

- ✓N°1 in scientific output
- ✓N°2 in number of users
- ✓N°1 in reliability & quality
- ✓4 Nobel prize-winners among the ESRF users
- ✓25,166 reference articles during the period 1994-2014
- ✓ ~ 30 articles in *Nature* and *Science* per year
- ✓ Nearly 2,000 publications per year: ~ 5 every day

6 GeV storage ring
31 public beamlines
12 CRG beamlines

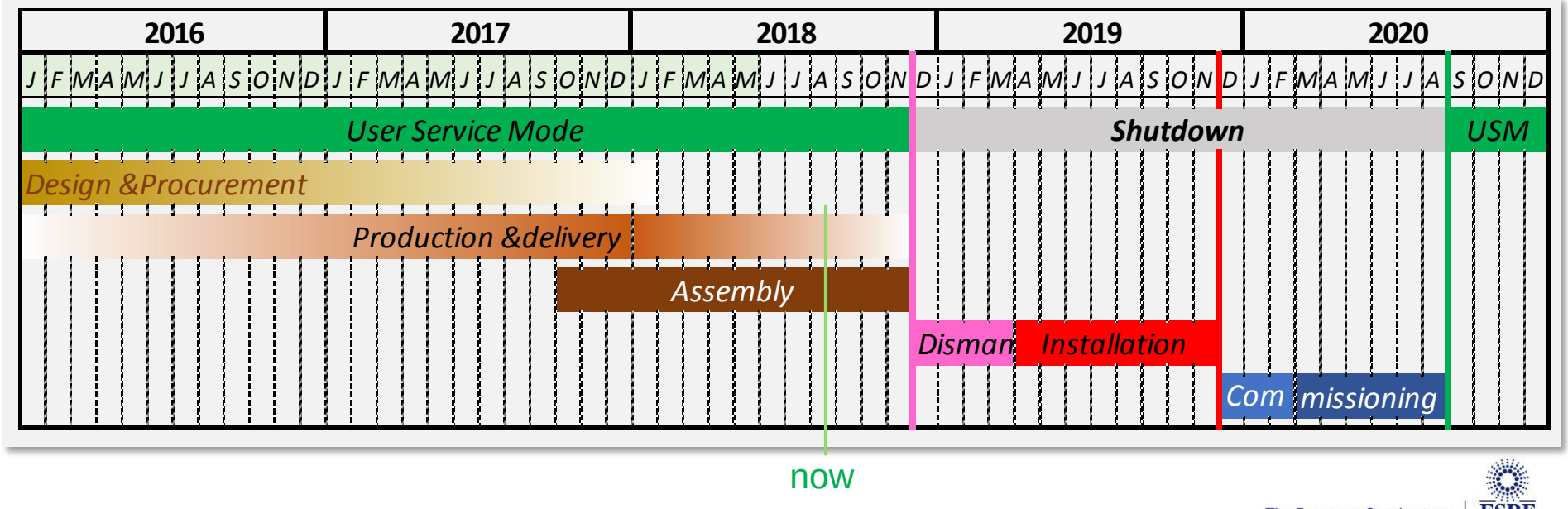
ESRF UPGRADE: EXTREMELY BRILLIANT SOURCE PROJECT



Parameter	Existing Lattice	New Lattice
Energy, *E* [GeV]	6.04	6.04
Circumference, *C* [m]	844	844
RF frequency, *fRF* [MHz]	352	352
Beam current [mA]	200	200
Horizontal Emittance [pm ·rad]	**4000**	**150**
Vertical Emittance [pm ·rad]	4	3
Beta at ID center, β*x* , β*y* [m]	37.6 , 3.0 (high β) 0.35 , 3.0 (low β)	3.6 , 3.6
Beam size at ID center, σ*x* , σ*y* [µm]	413 , 3.9 (high β) 50 , 3.9 (low β)	24 , 3.3
Beam div. at ID center, σ*x'* , σ*y'* [µrad]	10 , 1.3 (high β) 107, 1.3 (low β)	6.4 , 0.91

ESRF UPGRADE: EXTREMELY BRILLIANT SOURCE PROJECT

20 October	2017	Start girder assembly *(12 months)*
10 December	2018	Start long shutdown *(20 Months)*
		Dismantling *(3 months)* and Installation *(9 months)*
19 November	2019	Start accelerator commissioning
04 March	2020	Start beamlines commissioning
25 August	2020	Back to USM



DECOMMISSIONING OF THE EXISTING STORAGE RING

Revised technical study sent to French Nuclear Safety Authority (ASN) in April 2016:

- Proposed criteria for radiological classification of accelerator components, based on surface dose rate measurements;
- IRSN: technical expertise completed end February 2018 → positive evaluation;
- **Formal approval from ASN in July 2018.**

Radioactive waste management plan submitted to ASN in December 2017:

- Proposed radioactive zoning: part of the injection cell plus the scrapers;
- No radioactive waste: all elements inside radioactive zoning are considered as spare parts.

Radiological hazard analysis of works during long shutdown submitted to ASN in December 2017:

- Assessment of anticipated exposures for activities during the long shutdown, including civil engineering works.

RADIOLOGICAL HAZARD ANALYSIS

Radiological hazard analysis for works during long shutdown

Assessment of anticipated exposures

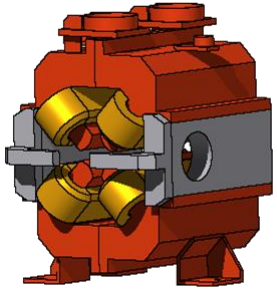
- Based on measured dose rates inside the tunnel (injection zone, scrapers and straight sections);
- Based on detailed planning of different tasks during dismantling;
- Conservative assumptions concerning time at contact with activated pieces.

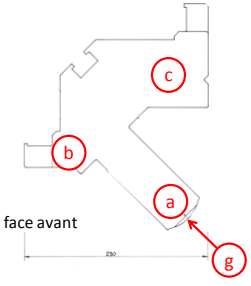
Anticipated collective effective dose: 160 μSv (4 months, 160 people).

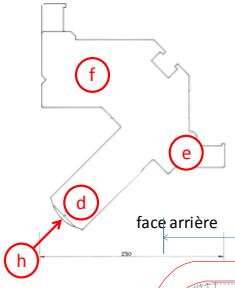
Anticipated individual effective doses: < 1 μSv – 13 μSv.

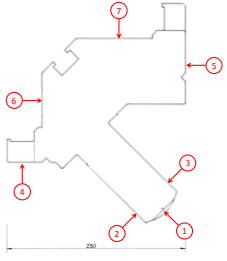
During civil works (generation of concrete dust): committed effective dose (50 years) : 8×10^{-4} μSv.

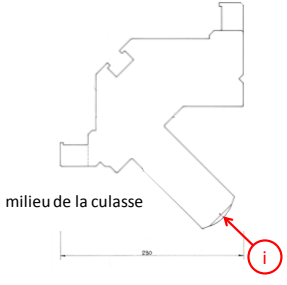
DECOMMISSIONING OF THE EXISTING STORAGE RING

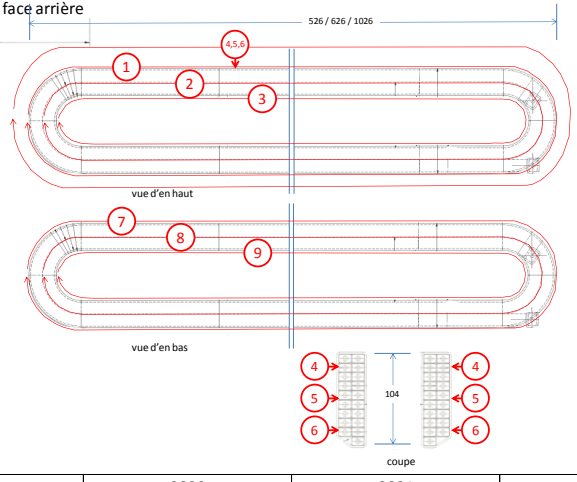


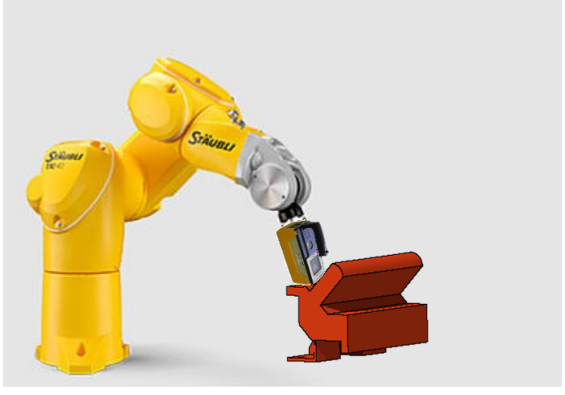


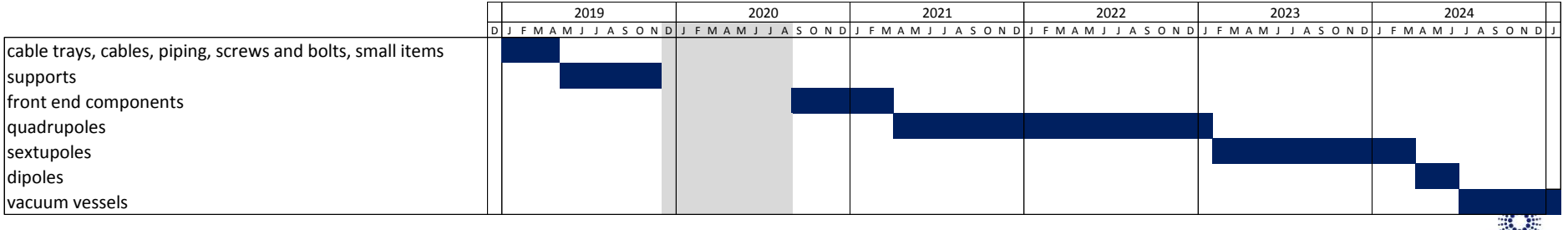






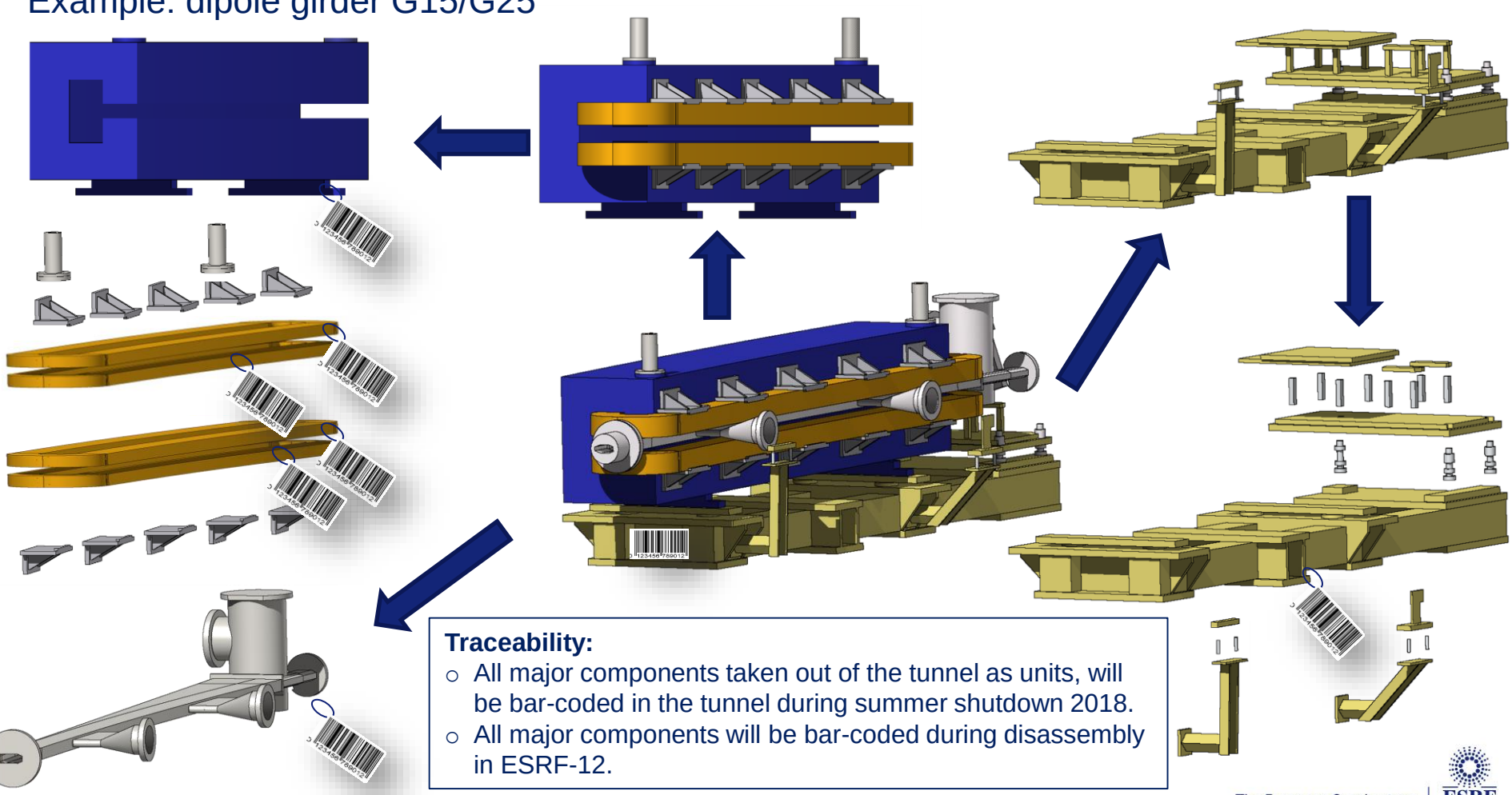






DISASSEMBLY OF STORAGE RING COMPONENTS IN ESRF-12

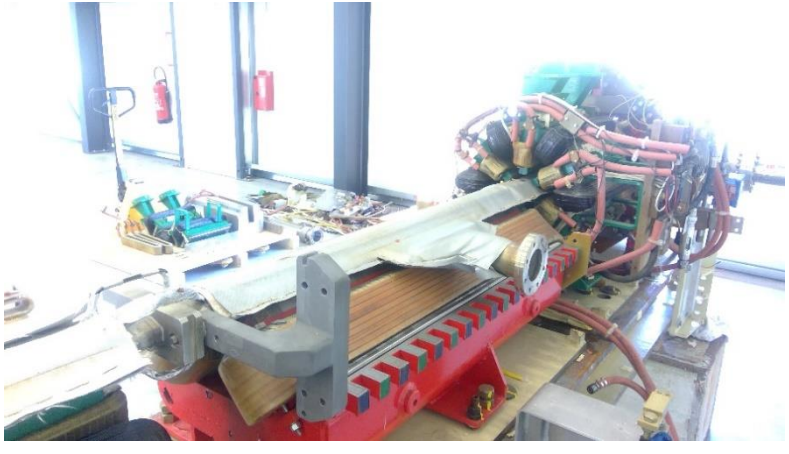
Example: dipole girder G15/G25



Traceability:

- All major components taken out of the tunnel as units, will be bar-coded in the tunnel during summer shutdown 2018.
- All major components will be bar-coded during disassembly in ESRF-12.

DISASSEMBLY OF G10 GIRDER ON 27 APRIL 2018



EBS STORAGE RING RADIATION SAFETY ASSESSMENT

Purpose of the radiation safety assessment

- Show that with the beam loss collimator scheme we can maintain ESRF's radiation protection policy:

$$\int_{4\ hours} \frac{dE}{dt} \cdot dt < 0.5\ \mu Sv/h\ \times\ 4\ h = 2\ \mu Sv$$

- Evaluate anticipated and public exposure in normal operation.
- Evaluate potential exposures from accidental situations.
- Evaluate activation issues around collimators.
- Injection with front ends open.
- Define required interlocked radiation monitors systems.

EBS storage ring radiation safety assessment

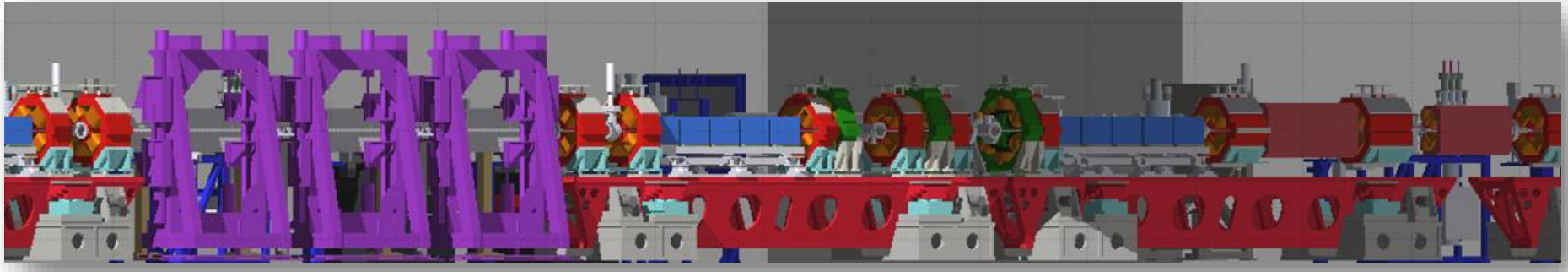
SG/RP/Doc/2017-1en, version 29/08/2017

1. Introduction
2. Radiation protection objectives
3. Methodology
4. Beam loss collimation
5. Normal beam losses
6. Abnormal beam losses
7. Labyrinths and penetrations
8. Vacuum related issues
9. Injection with front ends open
10. Activation issues
11. Anticipated occupational and public exposures in normal operation
12. Interlocked radiation monitors

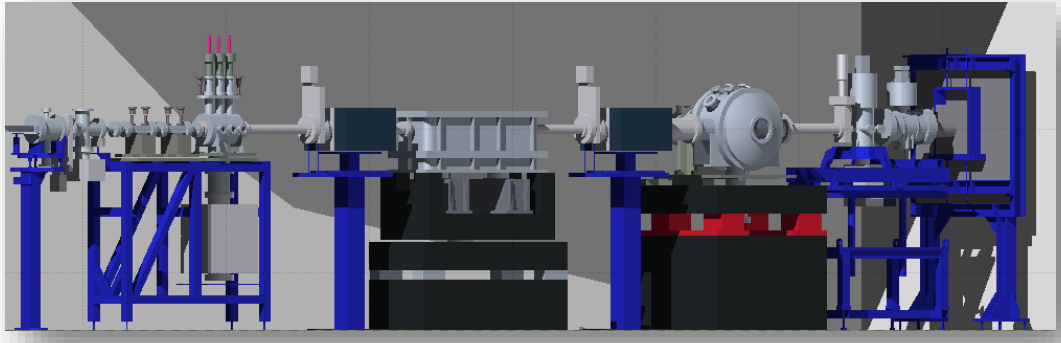
Compliance with 2013/59/EURATOM Directive

EBS STORAGE RING RADIATION SAFETY ASSESSMENT

FLUKA model of new storage ring

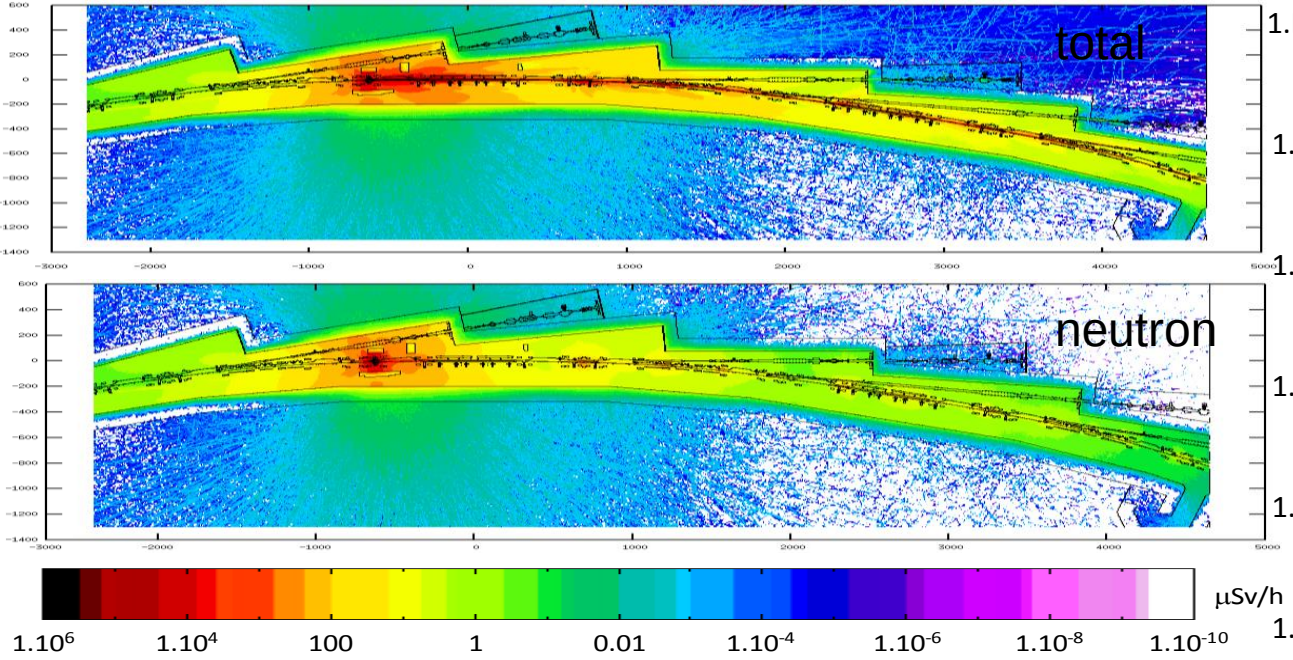


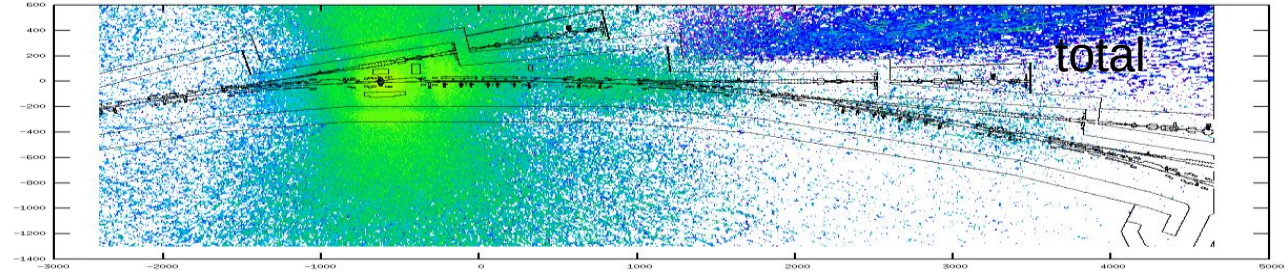
Model of standard cell of storage ring

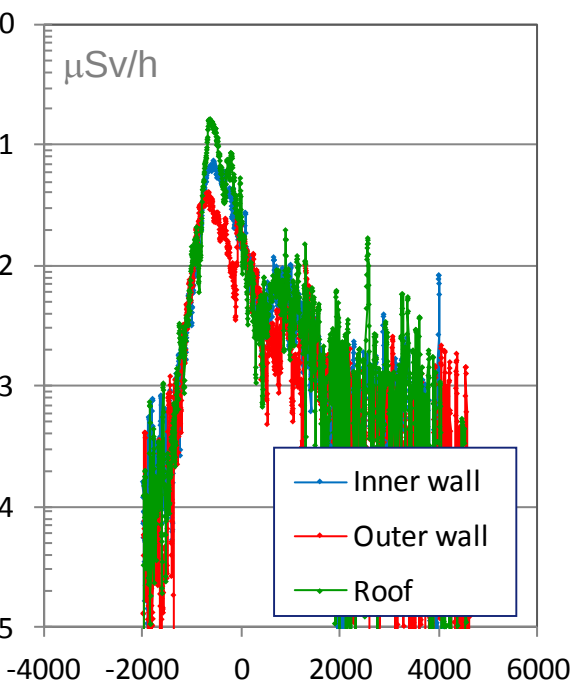


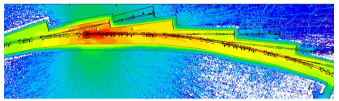
FLUKA model of optics hutch

NORMAL BEAM LOSSES: BEAM LOSS COLLIMATOR – LOCAL SHIELDING









stored beam losses

ANTICIPATED OCCUPATIONAL EXPOSURES

Support groups
Survey and alignment group

	experiments / control hutches		optics hutch		technical zone		tunnel roof		tunnel	
50/24	µSv/y	%	µSv/y	%	µSv/y	%	µSv/y	%	µSv/h	days/y
usm	18.69	5			13.84	0	30.94	2		
mdt	4.04	95	10.18	5	9.50	0				
shutdown									0.05	50
total		4.78		0.51		0		0.62		20

30.90 µSv/y

(3 mrem/y)

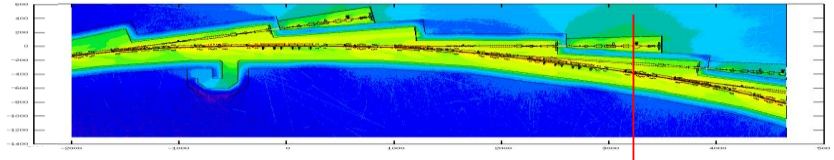
85/72	µSv/y	%	µSv/y	%	µSv/y	%	µSv/y	%	µSv/h	days/y
usm	16.67	5			11.66	0	24.06	2		
mdt	4.38	95	13.91	5	12.84	0				
shutdown									0.05	50
total		4.99		0.70		0		0.48		20

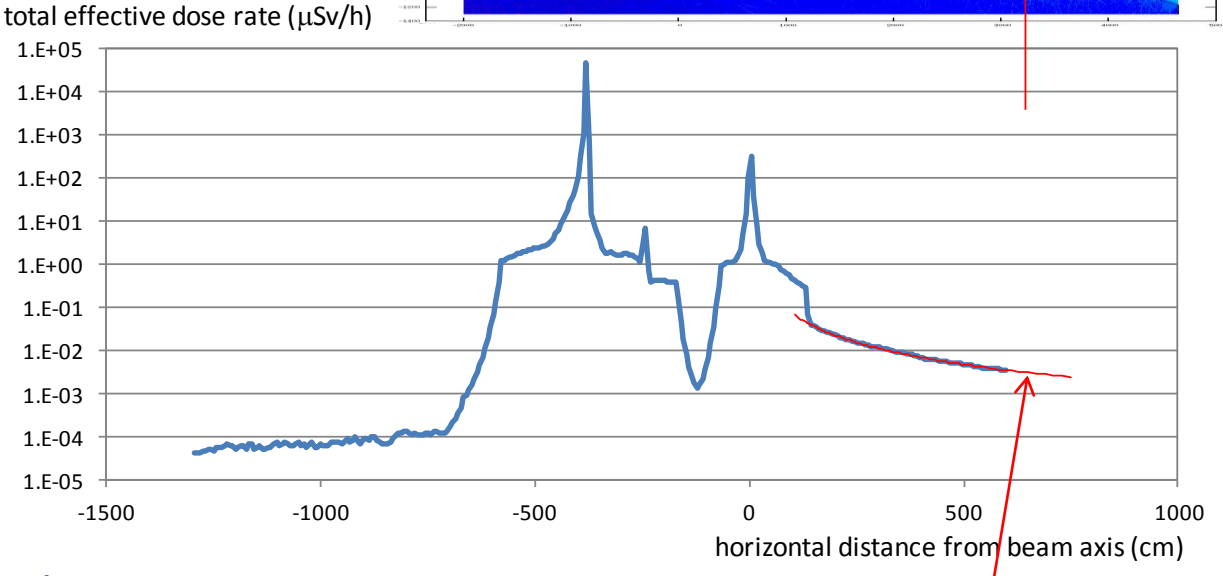
31.17 µSv/y

(3.1 mrem/y)

ANTICIPATED PUBLIC EXPOSURES

Gas bremsstrahlung: direct radiation





x = 5500 cm:

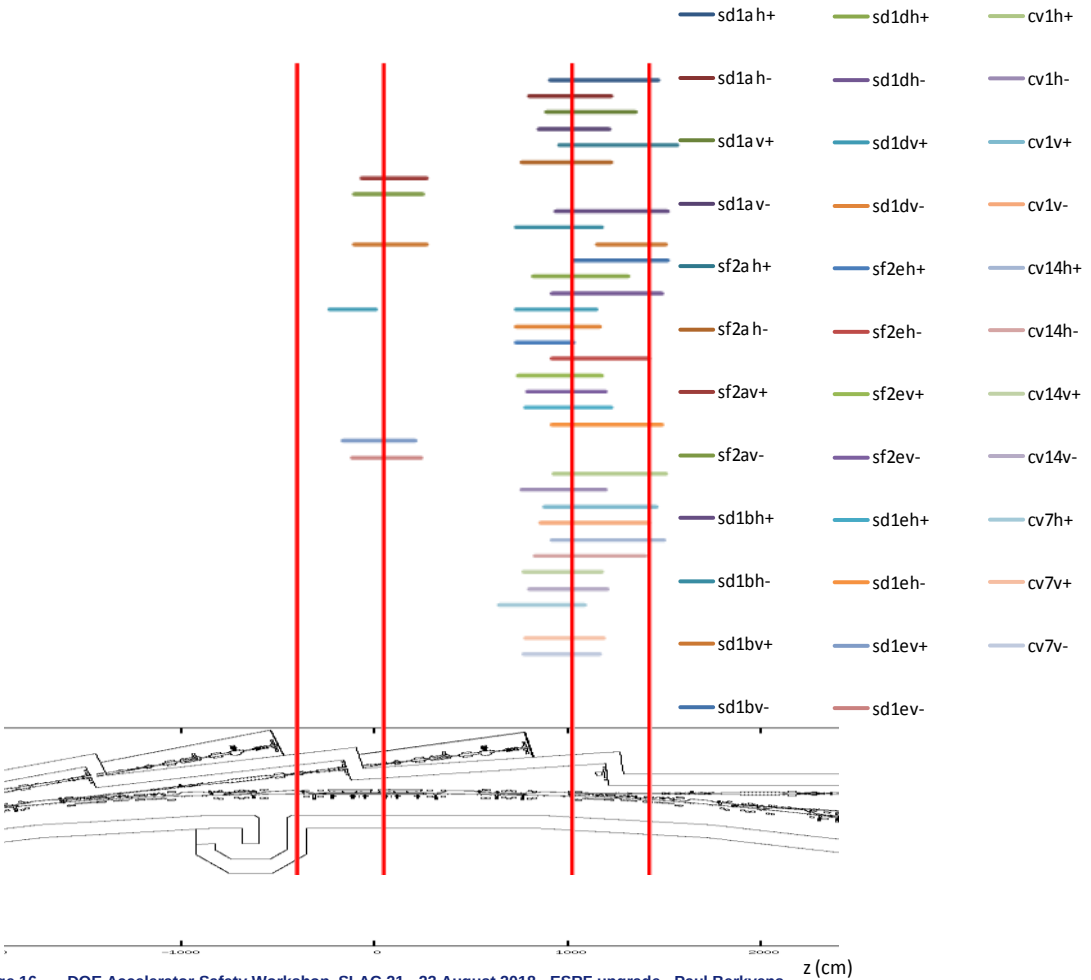
8.2 10^{-5} µSv/h at 200 mA

→ **0.34 µSv** (24/7 occupancy)

$$E(x) = 186.3 \frac{1}{x^{1.7}} \ \mu Sv/h$$

Anticipated public exposure at reference point:
1.8 + 1 + 0.34 = **3.14 µSv** (24/7 occupancy)

INTERLOCKED RADIATION MONITORS



4 neutron monitors / unit cell:

z = -420 cm

z = 50 cm

z = 1050 cm

z = 1460 cm

Beam loss scenarios:
faulty steerers

EBS radiation shielding review
27-28 June 2017

Meeting charge

The Committee is asked to critically review the radiation protection safety assessment and, in particular, to advise the ESRF on the following points:

- ALARA: is the optimisation process correctly carried out?
- Are the proposed operational limits and conditions of operation adequate?
- Are all radiation protection issues related to the operation of the new storage ring correctly covered in the safety assessment?
- Is the methodology used for the shielding study appropriate?
- Do the different beam loss scenarios included in the shielding study correctly cover all sources of anticipated and potential exposures, directly related to the operation of the new storage ring?
- Are the values for the anticipated occupational and public exposures realistic?
- Is the proposed interlocked radiation monitoring system adequate and will the system ensure the derived dose limits defined by ESRF?

Sayed Rokni (Chair)
Radiation Protection Department Head
SLAC National Accelerator Laboratory

Yoshihiro Asano
NewSUBARU
Former director of safety design group SPring8/RIKEN

Doris Forkel-Wirth
Radiation Protection Group Head
CERN

Stefan Roesler
Operational Radiation Protection Head
CERN

EBS RADIATION SHIELDING REVIEW

Executive summary

….

This report is the result of the Committee members' review of the large set of very well-prepared documents, and critical review of materials presented during the meeting and discussion with EBS project staff and deliberation among the Committee members.

Based on this review, the Committee believes that EBS project has positively responded to each of the questions in the Charge letter.

…

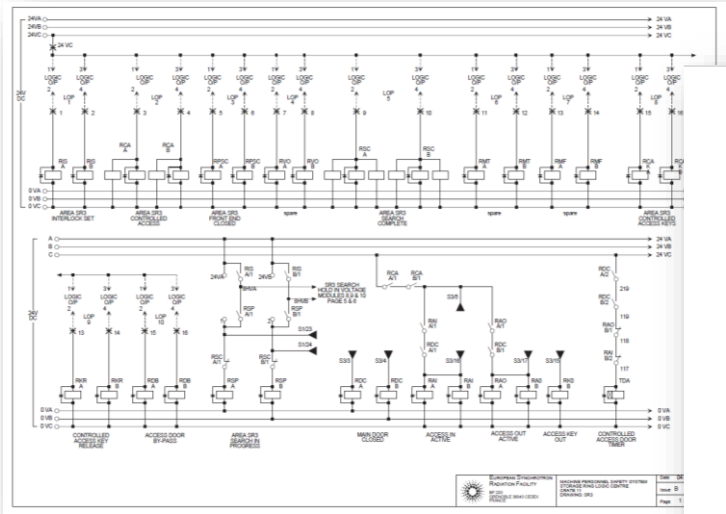
The beam tracking studies coupled with the detailed FLUKA simulations that are presented in the radiation safety assessment set a high standard for radiation assessment for synchrotron radiation facilities that is commendable.

Throughout the report, a number of Recommendations have been listed. Completion of the Recommendations will ensure a safe and compliant commissioning and operation of the EBS.

PERSONNEL SAFETY SYSTEM

Accelerator + Beamlines Personnel Safety Systems

- Use existing systems, with a number of modifications
- Technical design report sent to ASN, July 2018
- Formal review by the ASN (IRSN) in 2018 / 2019



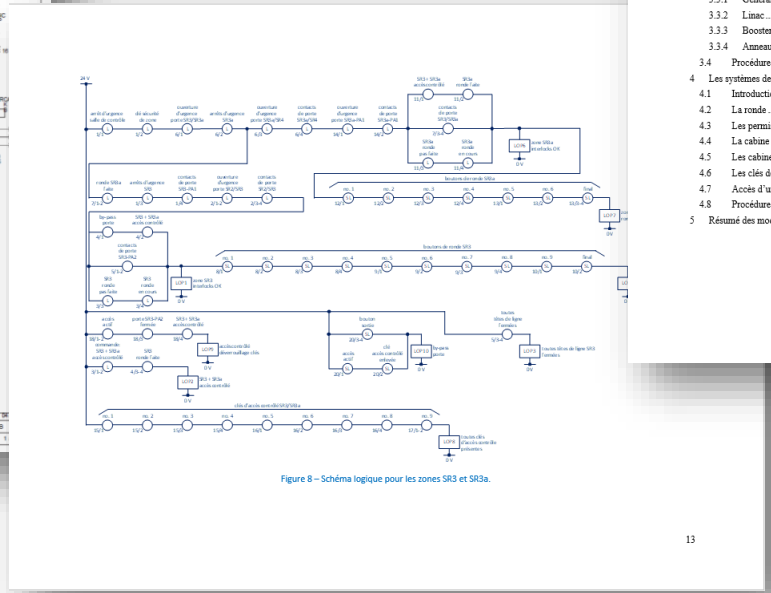


Figure 8 – Schéma logique pour les zones SR3 et SR3a.

13

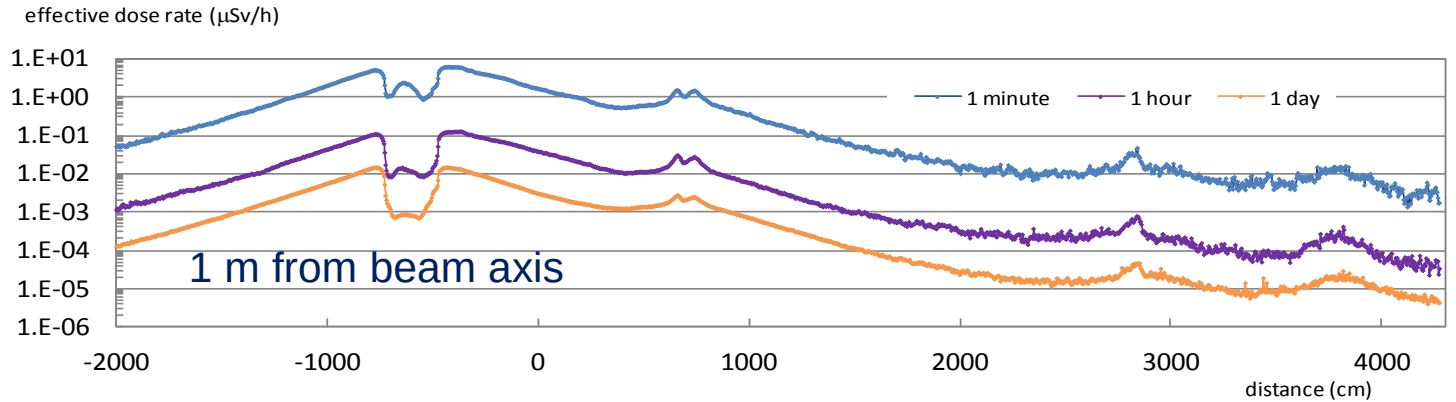
Les systèmes de sécurité du personnel des accélérateurs et des lignes de lumière de l'ESRF

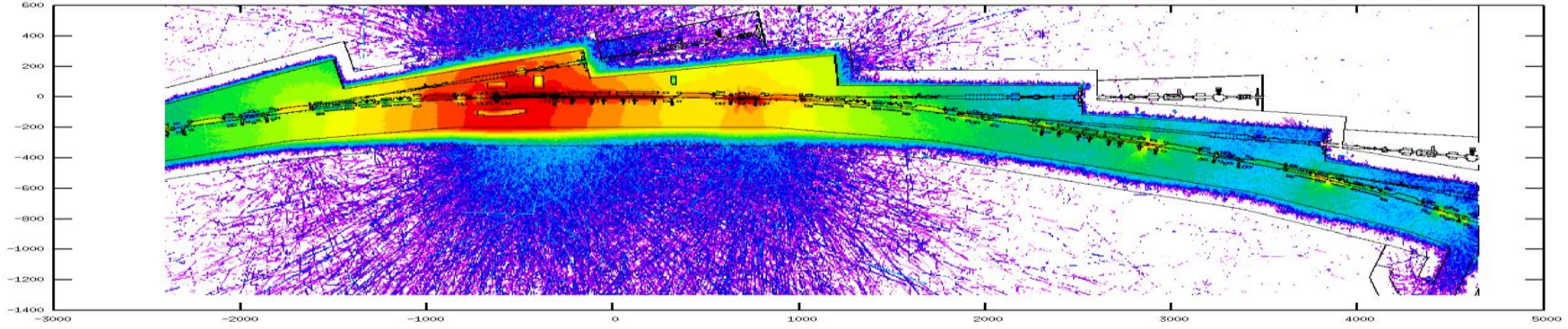
SG/RP/Doc/PSS/2018-1fr, version 30/06/2018

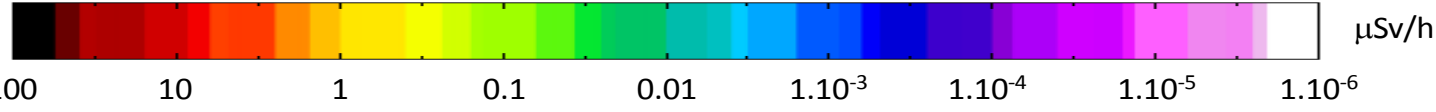
Table des matières

1

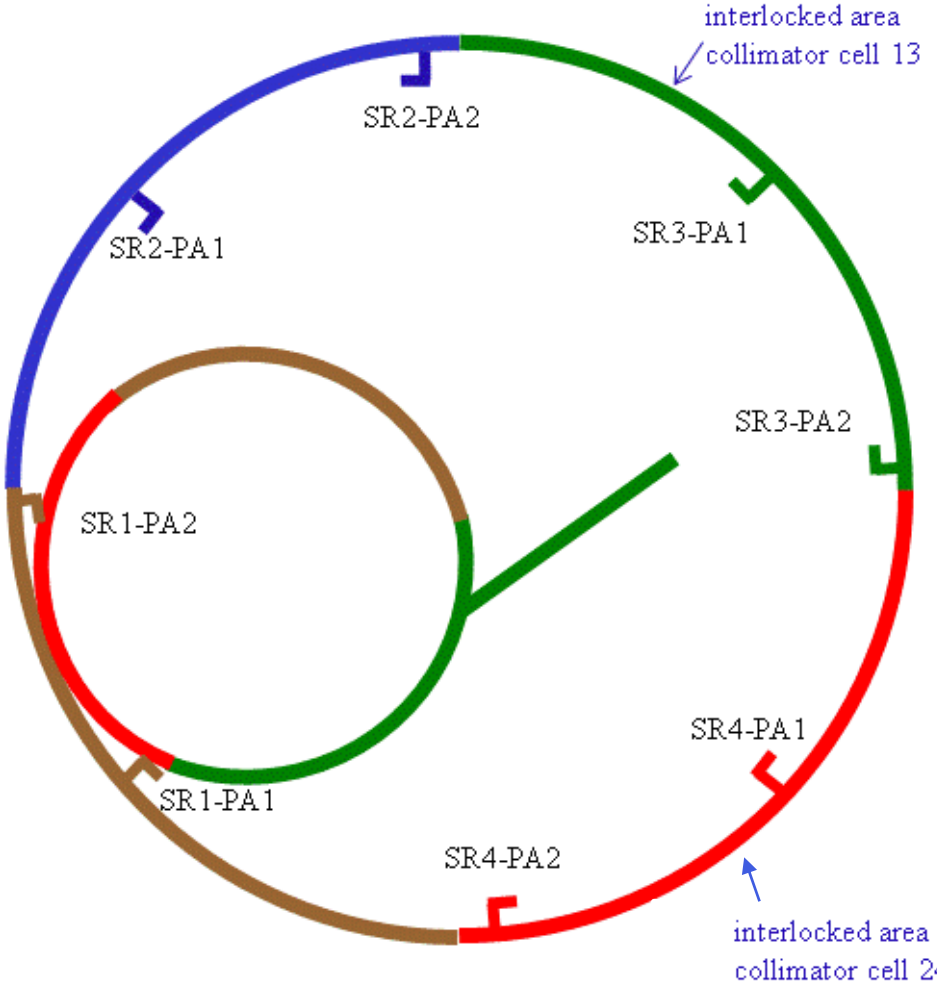
COLLIMATOR CELL: TRANSIENT ACTIVATION AFTER 200 mA BEAM DUMP

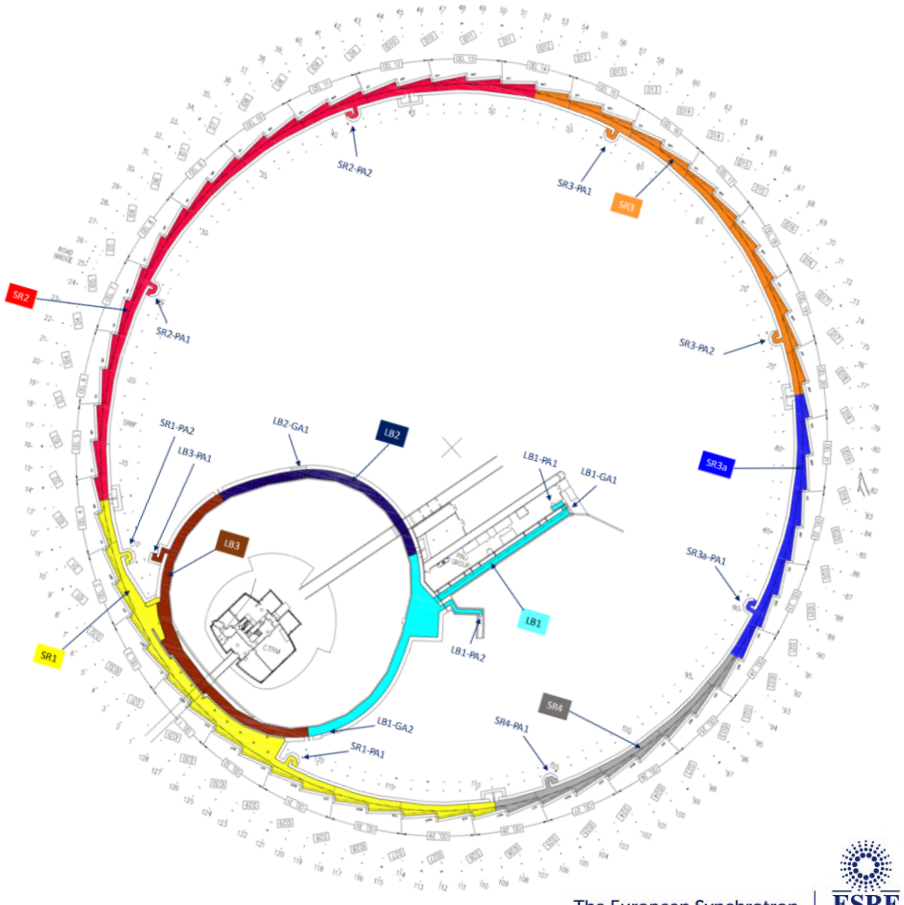




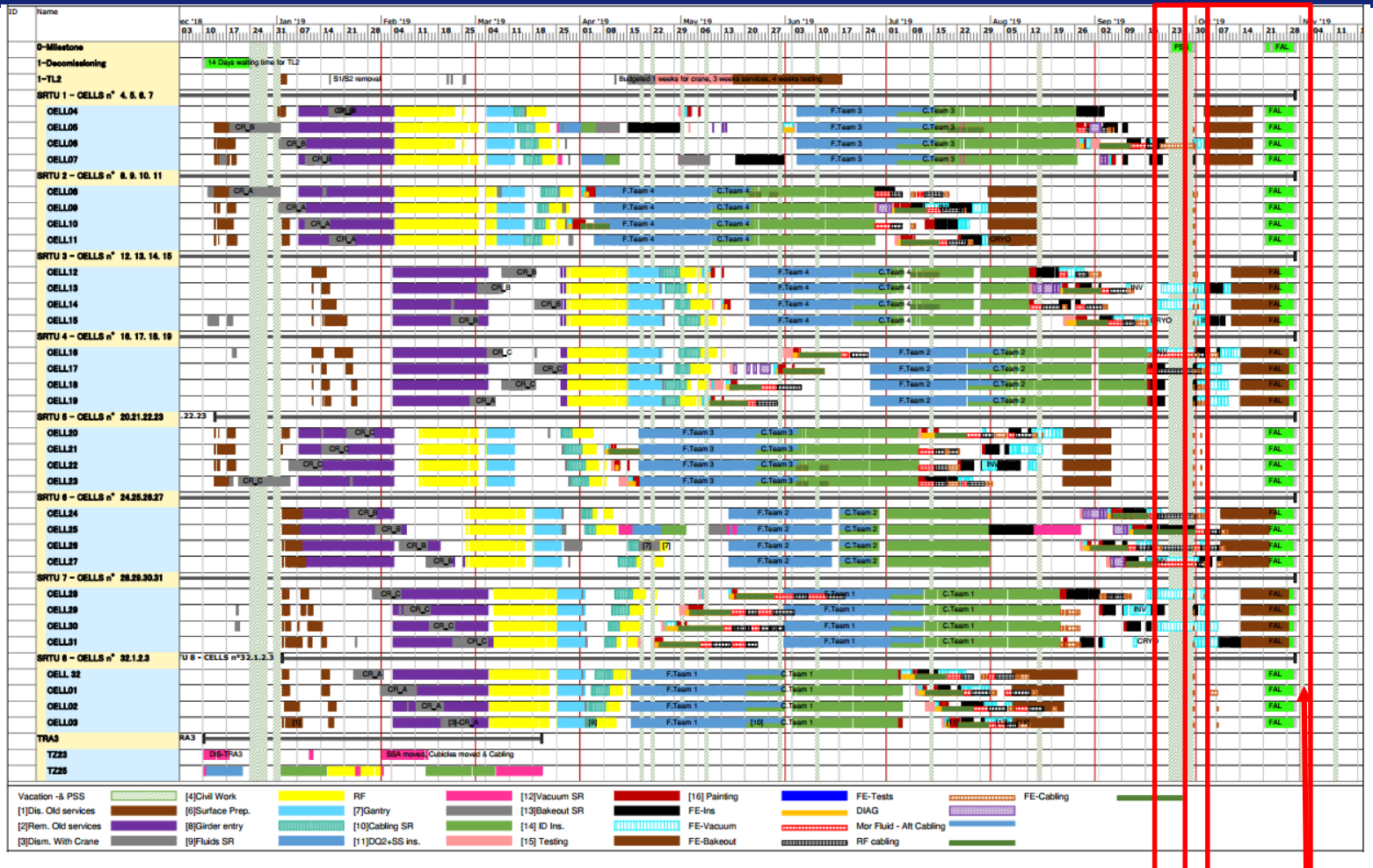


COLLIMATOR CELL: TRANSIENT ACTIVATION AFTER 200 mA BEAM DUMP





SHUTDOWN PLANNING: STORAGE RING REMOVAL AND INSTALLATION



GENERAL SAFETY MANAGEMENT OF SHUTDOWN ACTIVITIES

Project management for removal and installation activities:

- Project management by Accelerator Project Office (APO)
  - Pantaleo Raimondi (project leader)
  - Paul Berkvens (safety engineer)

  - Due to very tight planning:
    - All tasks must be prepared in great detail
    - Prevention plans with detailed “modes opératoires”

  - During shutdown, daily meetings of APO, coordinators and supervisors
    - PB present or acting safety engineer (Safety Group Unit leaders)

  - During all shifts: presence of (acting) safety engineer
    - Isolated safety issues should be reported by supervisors to (acting) safety engineer
    - More general safety issues will be dealt with during daily coordination meetings

MANY THANKS FOR YOUR ATTENTION