## 2018 DOE Accelerator Safety Workshop

#### SLAC, 21 – 23 August 2018

**ESRF upgrade** Paul Berkvens



## **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



ESRI

### **ESRF: SHORT INTRODUCTION**

- **European Synchrotron Radiation Facility** 3<sup>rd</sup> 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
- $\checkmark$  N°1 in scientific output
- $\checkmark$  N°2 in number of users
- $\checkmark$  N°1 in reliability & quality
- ✓ 4 Nobel prize-winners among the ESRF users
- $\checkmark$  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

Laboratory and

CRG beamlines

Instrumentatio and machine test heamlines





## ESRF UPGRADE: EXTREMELY BRILLIANT SOURCE PROJECT

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	Parameter	Existing Lattice	New Lattice				
	Energy, E [GeV]	6.04	6.04				
	Circumference, C [m]	844	844				
	RF frequency, <i>fRF</i> [MHz]	352	352				
	Beam current [mA]	200	200				
	Horizontal Emittance [pm ·rad]	4000	150				
	Vertical Emittance [pm ·rad]	4	3				
	Beta at ID center, $\beta x$ , $\beta y$ [m]	37.6 , 3.0 (high β) 0.35 , 3.0 (low β)	3.6, 3.6				
	Beam size at ID center, $\sigma x$ , $\sigma y$ [µm]	413 , 3.9 (high β) 50 , 3.9 (low β)	24 , 3.3				
DOE Acc	Beam div. at ID center, $\sigma x'$ , $\sigma y' [\mu rad]$ selerator Safety Workshop, SLAC 21 - 23 August 2018 - ESRF upgrade - Paul Berkvens	10 , 1.3 (high β) 107, 1.3 (low β)	6.4 , 0.91 The European Synchrotron   ESRF				

#### **ESRF UPGRADE: EXTREMELY BRILLIANT SOURCE PROJECT**

20 October	2017	Start girder assembly (12 months)
<b>10 December</b>	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



now

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#### **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  $\rightarrow$  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);
- o Based on detailed planning of different tasks during dismantling;
- Conservative assumptions concerning time at contact with activated pieces.

Anticipated collective effective dose: 160  $\mu$ Sv (4 months, 160 people).

Anticipated individual effective doses: < 1  $\mu$ Sv – 13  $\mu$ Sv.

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



#### **DECOMMISSIONING OF THE EXISTING STORAGE RING**



		2019	2020		2021	2022	2023	2024
	D	JFMAMJJASOND	JFMAMJJAS	OND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASOND	JFMAMJJASONDJ
cable trays, cables, piping, screws and bolts, small items								
supports								
front end components								
quadrupoles								
sextupoles								
dipoles								
vacuum vessels								

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#### **DISASSEMBLY OF STORAGE RING COMPONENTS IN ESRF-12**

#### Example: dipole girder G15/G25

, AAA

#### 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.



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#### **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:

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

- 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.



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#### EBS STORAGE RING RADIATION SAFETY ASSESSMENT

#### FLUKA model of new storage ring



Model of standard cell of storage ring





#### NORMAL BEAM LOSSES: BEAM LOSS COLLIMATOR – LOCAL SHIELDING



#### stored beam losses



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#### Support groups Survey and alignment group

	experiment	s / control									
	hutc	hes	optics	hutch	technical zor	ne	tunnel	roof	tur	nnel	
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					
shutdo	wn								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					
shutdo	own								0.05	50	
total		4.99		0.70		0		0.48		20	31.17 μSv/y



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#### ANTICIPATED PUBLIC EXPOSURES



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 $1.8 + 1 + 0.34 = 3.14 \mu Sv (24/7 occupancy)$ 

#### **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



z (cm)

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#### **EBS RADIATION SHIELDING REVIEW**

# 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 The European Synchrotron



#### **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



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

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#### **COLLIMATOR CELL: TRANSIENT ACTIVATION AFTER 200 mA BEAM DUMP**

effective dose rate (µSv/h)





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## **COLLIMATOR CELL: TRANSIENT ACTIVATION AFTER 200 mA BEAM DUMP**



#### SHUTDOWN PLANNING: STORAGE RING REMOVAL AND INSTALLATION

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DOE Accelerator Safety Workshop, SLAC 21 - 23 August 2018 - ESRF upgrade - Paul Berkvens





#### **GENERAL SAFETY MANAGEMENT OF SHUTDOWN ACTIVITIES**

Project management for removal and installation activities:

- Project management by Accelerator Project Office (APO)
  - o 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

