

NRF Synchrotron Workshop

The EBS programme at the ESRF and first science

Francesco SETTE Director General – ESRF







ESRF: BRINGING NATIONS TOGETHER TO ATTRACT EXCELLENCE IN SCIENCE AND TECHNOLOGY

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22 PARTNER COUNTRIES

13 Member states: France Germany Italy United Kingdom Russia Benesync (Belgium, The Netherlands) Nordsync	27.5 % 24.0 % 13.2 % 10.5 % 6.0 % 5.8 % 5.0 %	ESRF Grenoble France	 1 this synch 1st fou synch ~650 State 100 M€/ 	rotron rotron rotron V Operation Budget
(Denmark, Finland, Norway, Swede				
Switzerland	4.0 %			
9 Associate countries: Austria	1.75 %	22 partner countries s	10 000 cientific visits per yea	44 ar beamlines
Israel	1.75 %			
Centralsync	1.05 %			
(Czech Republic, Hungary, Slovakia)				
Poland	1.00 %	4	2000	330 M£
Portugal	1.00 %	Nobel Prizes	publications	over 2009-2022
India	0.66 %		per year	2009-2022: delivery of a new portfolio
South Africa	0.30 %			of beamlines 2015-2022: construction of a new generation of synchrotron, EBS

ESRF UPGRADE PROGRAMME - THE QUEST FOR INCREASED BRILLIANCE AND COHERENCE



Synchrotron X-ray brilliance and coherence to the benefit of science

The objectives of the ESRF-EBS project:

- Decrease the storage ring horizontal emittance
 - (= a factor 100 better than the 3rd SR generation)
- Increase the source brilliance (= a factor 100)
- Increase the coherence of the beam (= a factor 40)
- \geq Re-use the existing infrastructure (90%)
- Minimise the impact on the ESRF activity (dark-brown time)
- Reduce environmental impact reduce electrical power consumption by ~20%

THIS DREAM BECOMES POSSIBLE THANKS TO THE INVENTION OF THE HMBA LATTICE BY P. RAIMONDI AND ESRF COLLEAGUES



Previous ESRF lattice (cell)

Double Bend Achromat = (2 dipoles + 15 quad. sext.) per cell ID length = 5 m (standard) / 6m / 7m



EBS lattice (cell)

Hybrid 7 Bend Achromat = (4 dipoles-lg + 3 dipole-quad + 16 quad., 6 sext., 2 oct.) ID length = 5 m





Emittances with EBS: H/V=10 – x100 brighter X-rays



UPGRADE OF EXISTING STORAGE RINGS TO A NEW LOW HORIZONTAL EMITTANCE LATTICE IS NO LONGER A DREAM: MANY FACILITIES WORLWIDE IMPLEMENTING OR CONSIDERING AN HMBA BASED UPGRADE



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FUTURE SYNCHROTRON SOURCES IN THE WORLD

MANY NEW PROJECTS ARE BEING INSPIRED BY THE ESRF-EBS INVENTION





From the idea – 2011/13



To the design – 2015/16



To the installation – 2016/19



To the 1st electrons – 28-11-2019







The 25th August 2020, first official USM shift starts



• 28 beamlines take beam

• 200 mA

- $\varepsilon_x = 150 \ pm \cdot rad$
- $\varepsilon_z = 20 pm \cdot rad$

On-schedule beam delivery proofs the very advanced state of the new machine



CPMUS AT SMALLER GAP: INCREASED BRILLIANCE









X-ray beam profiles at different photon energies of the 1st harmonic - slits 60x60µm² @ 28m

A gain of factor of 5 in flux due to smaller beam size Second harmonic intensity is reduced by at least a factor of 10

FIRST BEAM AT ID15A



40 keV

70 keV

100 keV

monochromatic beam from a U35 [Laue-Laue monochromator with approx. 3. 10⁻³ energy resolution]

(band width narrower than undulator harmonics)

images taken at ~65 meter with PCO-edge camera with 1:1 optics (6.7 mm pixel size)



ESRF AT THE TIME OF THE COVID-19 PANDEMIC

- 41/46 beamlines open to users: ESRF and CRG beamline
- ESRF KEPT FULLY OPERATIONAL FROM 25-08-2020 TO NOW!



User Programme Applied measures:

- a) Remote access capability implemented (October-December 2020) on ALL ESRF Public and CRG beamlines
- b) Increased Beamline staff by 12 Post-Doc positions
- Long term sustainability staff
- Experiment efficiency when users are physically present
- Effect on students: hands-on, interactions, new ideas, etc.





USER STATISTICS AND ACTIVITIES FROM 25 AUGUST 2020 UNTIL 15 JUNE 2021



41 out of 46 beamlines hosted user's experiments 10 550 shifts (84 550 hours) delivered: 8657 for public users, 1518 for CRG, 375 for proprietary research 1 527 user experiments, 1149 for public users (75%), 122 for CRG (8%) and 256 for proprietary research (17%) 1097 fully remote (72%), 165 only one user (11%), and 265 with users (17%)



REMOTE ACCESS EXPERIENCE: GREAT FEEDBACKS FROM THE USER COMMUNITY



ENRIITC @ENRIITC_eu · Mar 17

When it comes to **#TeamSpirit** and goals orientation, there are no distances wide enough!!! **#TogethertoImprove #Sciencefromeverywhere #ESRF** @esrfsynchrotron

Sarios Hadjimichael @MariosHadjimic1 · Mar 16

When you have a remote beamtime and you don't really know how to help, so you watch your beamline scientist and try and send as much positive energy as possible @esrfsynchrotron

Show this thread





...

Marta Mirolo @m_mirolo - Feb 27 · When it's Saturday morning and instead of going to the beamline, the beamline comes to you #workingfromhome #smartworking @SoM_esrf @esrfsynchrotron @QuantumCat_





Bauer_Research @BauerResearch

Remote beamtime at ID26 of the @esrfsynchrotron. Some enjoy it, some miss the Real beamline :-D Many thanks to the groupmembers working hard at their laptops... ...

ESRF





ESRF-EBS, AN EXTREMELY BRILLIANT SOURCE TO TACKLE GLOBAL CHALLENGES

- **1. Health, Health Innovation**, overcoming diseases and pandemics
- 2. Material for tomorrow, and innovative and sustainable industry
- **3. Clean Energy transition**, sustainable energy storage and clean hydrogen technologies
- **4. Planetary research** (terrestrial and extraterrestrial)
- 5. Environmental and climatic challenges,
- 6. Bio-based economy and food security
- 7. Humanity and world cultural heritage



FIRST EBS SCIENCE AT THE ESRF

SOUTH AFRICA SCIENTIFIC COMMUNITY ACCESS TO ESRF – 2013-2021



46 Public Proposals Accepted with 77 SA Scientists, 2013-2021

Access to beamtime via public proposals reflects only 40.7% of the proposal types allowing access to SA-affiliated scientists 51 in-house proposals involved 25 different SA scientists and took place on many different beamlines: *BM02 (2), BM05 (34), BM30B (2), BM32 (2), ID13 (1), ID15A (1), ID19 (5), ID21 (1), ID22 (2) and ID29 (1)*

BM05: mainly diamond optics and some paleontology





ESRF PUBLICATIONS IN REFEREED JOURNALS WITH A SA AFFILIATED AUTHOR

FUTURE SCIENCE WITH X-RAYS: UNDERSTANDING COMPLEXITY IN CONDENSED AND LIVING MATTER

The European Synchrotron

ESRF-EBS: TRAINING THE NEXT GENERATION OF SCIENTISTS AND ENGINEERS

"I've always enjoyed meeting people from different cultures. It's my first experience of living in Europe and my first opportunity to mix with European cultures.... At the ESRF you get a lot of daily exposure to other nationalities as well as to the world of research..... I stemmed into solid state chemistry and now X-ray crystallography. One good thing about X-ray research is that it covers so many disciplines that there's a whole new world of learning out there"

MASHIKOANE WILSON MOGODI, South-African ESRF post-doctoral scientist in materials science at ID22, from 23/01/2017 to 31/12/2018
 ➢ Full portrait published on https://humans.esrf.fr/wilson-mogodi

Fortune MOKOENA: ESRF Mechanical Engineer student from 13/07/20 to 31/05/21.

His mission : Design and study of equipment for BEATS tomography beamline at SESAME and ESRF beamlines

Blueprint of a future beamline at the African Light Source

39 postdoc have joined the EBS adventure

"I first came to the ESRF for a paleontology experiment three years ago, and I thought this would be an extremely interesting research facility to work in: a place where experiments that are impossible elsewhere can take place, with great support from the staff and where new and different ideas come together.

Today, after a long and convoluted journey due to Covid19, I am very excited that I am finally a part of the ESRF-EBS adventure."

KUDAKWASHE JAKATA, South-African ESRF post-doctoral scientist in materials science at BM05

Full portrait published on <u>https://humans.esrf.fr/</u>

ESRF-EBS: TRAINING THE NEXT GENERATION OF SCIENTISTS AND ENGINEERS

39 postdoc have joined the EBS adventure

Rare crocs under the beam #weekendusers

19-06-2018

This is the story of an enthusiastic PhD student from the Evolutionary Studies Institute at the University of Witwatersrand in South Africa who brought together palaeontologists and curators from three different continents to the ESRF to study fossils of rare crocodiles she had never even seen in real life. The goal: to see through the rock that embeds the crocs, so valuable information could shed light on the evolution of these species.

KATHLEEN DOLLMAN – South-African ESRF post-doctoral scientist in paleontology on BM05, ID19 and BM18 since 01/03/2021

An ESRF international PhD programme, managed by the ESRF higher education and doctoral office

"I love to do my PhD in a research facility where everyone is driven by new findings, and technology breakthroughs. Working as a mechanical engineer at the ESRF is fascinating as multiple disciplines are integrated to produce the brightest X-rays. The ESRF synchrotron environment gives you broad exposure to a wide range of mechanical engineering fields, such as fluid dynamics, thermal dynamics, mechanical design, vibrations and fluidstructure interaction."

ALICIA POTGIETER, South-African PhD student in mechanical engineering, since 26/10/2020.

Full portrait published on 23 June to celebrate the UNESCO International Day of Women in Engineering on https://humans.esrf.fr/

SOUTH AFRICA AT THE ESRF

NEW OPPORTUNITIES FOR RESEARCH, EDUCATION AND TRAINING

ESRF thanks a South African scientist – Jonah Choiniere from the University of Johannesburg – to serve in the Beamtime Allocation Panel C06 for ID17 and ID19, and soon BM18

Anton du Plessis, Associate Professor at Stellenbosch University Researcher in Additive Manufacturing New collaboration with the ESRF starting on ID19 and ID31

ESRF HAS A LONG ASSOCIATION TO THE DREAM OF AN AFRICAN LIGHT SOURCE

The Africa Light Source Foundation Towards a Light Source for the African Continent www.africanlightsource.org

- African Light Source Foundation
 - Hosted the first African Light Source conference in 2015 (Grenoble)
 - Contributed to the organisation of and speakers (including ESRF DG) at the second African Light Source conference in 2019 (Accra)
 - ESRF DG a member of the International Advisory Committee of the AfLS
 - ESRF staff involved as Executive Committee member
 - Participation to the development of a Conceptual Design Report for an advanced light source on the African Continent
- Training of African researchers and engineers
- The proven ESRF international model and EBS technology as a basis for an African Light Source

R&D AND CHALLENGES FOR 2021 - 2025

NEW FLAGSHIP BEAMLINES CONSTRUCTION

SRF

ESRF: KEEPING SCIENCE AND INNOVATION AT THE FOREFRONT

R&D AND CHALLENGES FOR 2021 -2025

ESRF Data Strategy Implementation Plan (DSIP) 2022-31

Based on the ESRF IT Data Strategy paper presented in November 2020

OBJECTIVES:

- Experiments efficiently leading to publications and new knowledge
- > Data potential exploitable in the medium and long term

NEEDS:

- > Experiments at the ESRF carried out with the required real-time data analyses, processing and reduction capabilities
- Minimal infrastructure and expertise to exploit external IT resources, which are and will be available locally, nationally, in Europe and in the Member Countries in general

PRESENT SITUATION:

The ESRF IT Data Strategy implementation backbone has been set: data policy, metadata, DOI, data format, e-log-book, BLISS, EOSC Ass., etc.

ESRF Data Strategy Implementation Plan (DSIP) 2022-31 MAIN DELIVERABLES

ESRF DATA CENTRES:

- From 0.48 today to 1 MW power capacity in 2025-26
- 0.5 MW increase (+100%)
- From two to three Data Centres

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Data production (PB)	20	30	40	50	60	70	80	90	100	110	120
Evolution (%)		+50	+33	+25	+20	+17	+14	+13	+11	+10	+9

SRF Information Technology Data Strategy 2022 - 2026

A Götz

ESRF DATA ANALYSIS MANAGEMENT IT STAFF:

- From 34 today to 52 dedicated FTEs in 2025
- > 18 FTEs increase (+53%)
- Scientific Data and Algorithms Group (ExpD)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
omputing - CPU										
Needs (CPU core nb)	5505	7003	8502	10000	11498	12997	14495	15994	17492	18990
Purchase	2000	2000	2000	2500	3000	3500	4000	4000	4000	4000
omputing - GPU										
Needs (GPU nb)	125	183	242	300	358	417	475	534	592	650
Purchase	72	72	96	130	130	130	190	190	200	240
isk Storage	-									
Needs (Po)	20	25	30	35	40	45	50	55	60	65
Purchase	9	5	5	16	5	14	10	10	21	10
rchiving - Tapes		_								
Needs (Po)	141	221	321	441	581	741	921	1121	1341	1581
Purchase	60	80	100	120	140	160	180	200	220	240
On-Line Data Analysis										
Needs (Units)	39	63	87	109	109	109	109	109	109	109
Purchase	24	24	39	46	24	39	46	24	39	46
Acquisition										
Needs (Units)	18	23	28	31	36	41	46	51	56	61
Purchase	5	5	5	16	10	10	10	21	10	10
	-	-								

- The new EBS storage ring is up and running with excellent performance
- FULL USM operation is resumed, despite the COVID-19 pandemic
- THE ESRF UPGRADE PROGRAMME IS GETTING
 CLOSER TO COMPLETION
- ESRF IS PROVIDING NEW EXCITING OPPORTUNITIES IN X-RAY SCIENCE TO THE SYNCHROTRON COMMUNITY WORLDWIDE

PIONEERING SYNCHROTRON SCIENCE

