



| The European Synchrotron

Pioneering science for industry and innovation

Ed MITCHELL

Head of Business Development, ESRF



ESRF's Missions



Design, construct, operate and develop state-of-the-art X-ray synchrotron instruments to the benefit of the scientific communities of the Member and Associate countries



Serve the international community for the advancement of knowledge and to address global societal challenges



Train the next generation of scientists, engineers and technical staff



Support the use of X-rays by industry from Member and Associate countries to strengthen its competitiveness in the global scale

ESRF - A Knowledge Hub for industry

→ USING SYNCHROTRON X-RAY UNIQUE PROPERTIES



**BUSINESS
DEVELOPMENT OFFICE**



Confidential & rapid access



Mail-in services

>300 (71 unique 2023)

Clients

KPI 2024: 2.71 M€

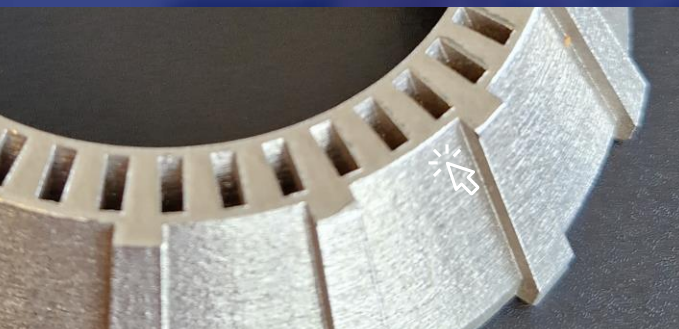
Actual as of today: 3.6 M€

Grants and cooperation

with industry partners

Quality control of 3D-printed metals

ESRF-EBS paves the way for **scanning sets of 100s or 1000s of samples** →
defect analysis



Inconel 3D manufactured

80mm in diameter

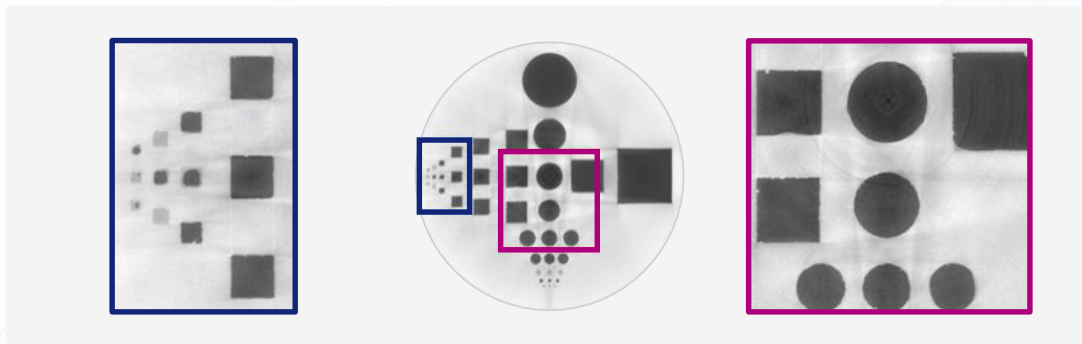
Quality control

Comparison with CAD model

LAB X-RAYS



ESRF X-RAYS



How does ESRF engage with industry?

Core team of 5 FTE working as “intrapreneurs” → biz dev, scouting, admin, access, suivi



PROPRIETARY SERVICES
75% income

Rapid & confidential

Mail-in services

>300 clients

35 countries



TECH TRANSFER
25% income

Licensed > 30 technologies

In-house manufacturing

Consultancy



PUBLIC ACCESS

Results published

Competitive peer review

6-9 months delay



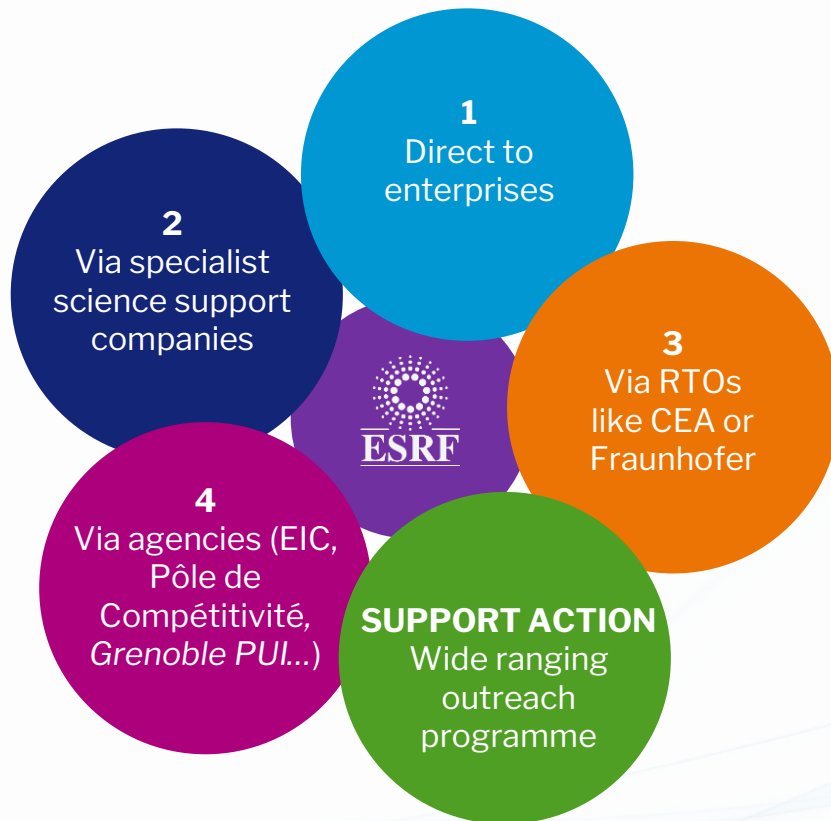
COLLABORATIONS & GRANTS

Industry proposed staff

Horizon Europe and national
(e.g. IRT, BMBF, RCUK, CZI)



Interaction networks... ...how we reach industry



THE ESRF MEETS INDUSTRY

September 2023 - May 2024

Presenting a new generation of easy-access industry services

Introducing the unique capabilities of the brand new EBS source

TARGET SECTORS

THE ESRF MEETS INDUSTRY

November

8 8-RADNEXT
Geneva (Switzerland)

8 The Greener Manufacturing Show
Cologne (Germany)

12 Protein Structure Determination in Industry (31st PSDI)
Cambridge (UK)

14 Battery Innovation Days
Bordeaux (France)

21 CARRC
Paris (France)

September

3 FEMS EuroMat 2023
Frankfurt (Germany)

6 ICBA - International Congress for Battery Recycling
Valencia (Spain)

18 Nano Innovation 2023
Rome (Italy)

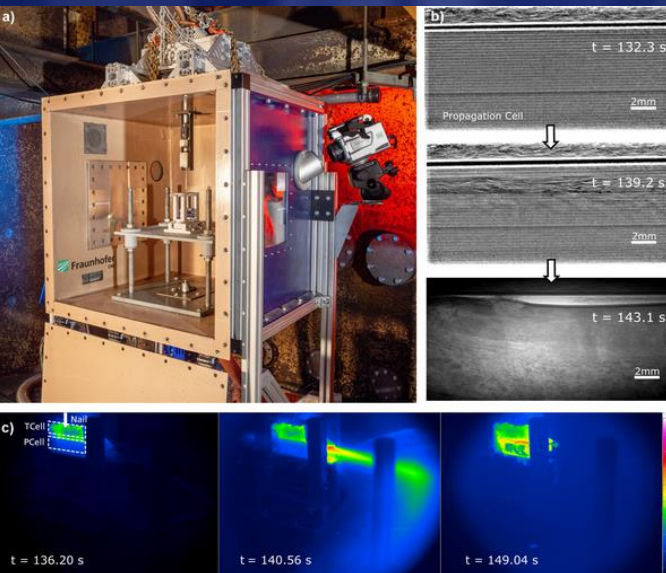
October

18 Les Rendez-Vous Carnot
Lyon (France)

STREAMLINE TOUR 2023

Studying battery failure @ ESRF on IDI9

REAL TIME SCANNING



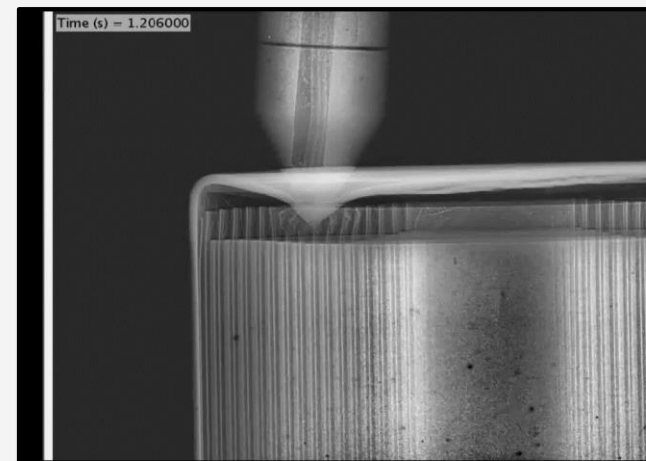
CHALLENGES

- Complex and high speed of catastrophic failure
- Myriad possibilities for failure propagation
- Interactions between multiple cells



SOLUTIONS

- In situ battery abuse-test chamber
- Ultra-high-speed synchrotron X-ray radiography Complementary measurements



“Technology Infrastructure” Services



Studying battery failure @ ESRF

Archer Aviation signs deal with NASA on battery development

23 JANUARY 2024 • IN NEWS

“We’re extremely proud to partner with NASA, who has pioneered the eVTOL industry over the last three plus decades, in support of our collective mission to ensure U.S. leadership in aerospace continues for decades to come,” said Adam Goldstein, Archer’s Founder and CEO.

As part of the joint efforts around battery characterisation, NASA and Archer will focus on further testing the safety, energy and power performance capabilities of the battery cells. Tests will be performed using one of the most advanced high speed X-ray facilities in the world, the European Synchrotron Radiation Facility (ESRF), to understand how the cells function during extreme abuse cases.

Archer has chosen these cells to power the proprietary electric powertrain system Archer has designed, developed and is beginning to mass manufacture for its production electric air taxi, Midnight. The battery cell form factor chosen by Archer, a cylindrical cell, has a track record of safety, performance and scalability proven through decades of volume manufacturing, deployed across many applications globally, including in millions of electric vehicles.





Open, FAIR curated data on battery failures

Exploited by a wide (unknown) community

Cell description: Li-ion 18650
 Cell type: Li-ion
 Cell format: 18650
 Capacity: 3.4 Ah
 State of charge: 100% (4.2V)
 Bottom vent: No
 Wall thickness: 250 µm
 Orientation of cell: Positive end up
 Trigger mechanism: ISC
 Location of ISCD radially: 3 layers in
 Location of ISCD longitudinally: Middle
 Side of ISCD in Image: Left
 Location of FOV longitudinally: Top
 Frame rate: 2000 Hz
 Frame dimension (Hor x Ver): 2016 x 1111 pixels
 Pixel size: 10 µm
 Credit: NREL, NASA, and UCL

Cell description: Li-ion 18650
 Cell type: Li-ion
 Cell format: 18650
 Capacity: 3.4 Ah
 State of charge: 100% (4.2V)
 Bottom vent: No
 Wall thickness: 220 µm
 Orientation of cell: Positive end up
 Trigger mechanism: thermal
 Location of ISCD radially: N/A
 Location of ISCD longitudinally: N/A
 Side of ISCD in Image: N/A
 Location of FOV longitudinally: Middle
 Frame rate: 2150 Hz
 Frame dimension (Hor x Ver): 1823 x 1141 pixels
 Pixel size: 10 µm
 Credit: NREL, NASA, and UCL

Cell description: Li-ion D-cell
 Cell type: Li-ion
 Cell format: D-cell
 Capacity: 4.5 Ah
 State of charge: 100% (4.1V)
 Bottom vent: No
 Wall thickness: 380 µm
 Orientation of cell: Positive end up
 Trigger mechanism: ISC
 Location of ISCD radially: 5 layers in
 Location of ISCD longitudinally: Middle
 Side of ISCD in Image: Right
 Location of FOV longitudinally: Middle
 Frame rate: 2000 Hz
 Frame dimension (Hor x Ver): 2016 x 1111 pixels
 Pixel size: 10 µm
 Credit: NREL, NASA, and UCL

Cell description: Li-ion 18650
 Cell type: Li-ion
 Cell format: 18650
 Capacity: 21 Ah
 State of charge: 100% (4.2V)
 Bottom vent: No
 Wall thickness: 250 µm
 Orientation of cell: Positive end up
 Trigger mechanism: ISC
 Location of ISCD radially: 6 layers in
 Location of ISCD longitudinally: Middle
 Side of ISCD in Image: Right
 Location of FOV longitudinally: just above middle
 Frame rate: 2000 Hz
 Frame dimension (Hor x Ver): 2016 x 1111 pixels
 Pixel size: 10 µm
 Credit: NREL, NASA, and UCL

Cell description: Li-ion 18650
 Cell type: Li-ion
 Cell format: 18650
 Capacity: 21 Ah
 State of charge: 100% (4.2V)
 Bottom vent: No
 Wall thickness: 250 µm
 Orientation of cell: Positive end up
 Trigger mechanism: nail
 Location of ISCD radially: N/A
 Location of ISCD longitudinally: N/A
 Side of ISCD in Image: N/A
 Location of FOV longitudinally: Middle
 Frame rate: 2000 Hz
 Frame dimension (Hor x Ver): 2016 x 1111 pixels
 Pixel size: 10 µm
 Credit: NREL, NASA, and UCL

Cell description: Li-ion 18650
 Cell type: Li-ion
 Cell format: 18650
 Capacity: 21 Ah
 State of charge: 100% (4.2V)
 Bottom vent: No
 Wall thickness: 250 µm
 Orientation of cell: Positive end up
 Trigger mechanism: thermal
 Location of ISCD radially: N/A
 Location of ISCD longitudinally: N/A
 Side of ISCD in Image: N/A
 Location of FOV longitudinally: Middle
 Frame rate: 2000 Hz
 Frame dimension (Hor x Ver): 2016 x 1111 pixels
 Pixel size: 10 µm
 Credit: NREL, NASA, and UCL



Transportation & Mobility Research

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Battery Failure Databank

The Battery Failure Databank features data collected from hundreds of abuse tests conducted on commercial lithium-ion batteries. Methods of abuse include nail penetration, thermal abuse, and internal short-circuiting.

This databank provides the heat output from cells undergoing thermal runaway, the breakdown of heat from the cell casing and its ejected contents, as well as the mass of the cells before and after thermal runaway and the quantity of mass ejected from the cell. The databank also organizes the stored data for understanding test-to-test variability for each cell type and trigger mechanism combination.

Additionally, most tests feature associated high-speed X-ray radiography videos for review alongside the data.

Download the Battery Failure Databank

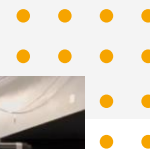
Spreadsheet last updated February 2024



ENERGY

CATALYSIS
& CHEMISTRY

Batteries: Looking for the perfect recipe...

**ENERGY-STORAGE****HIGH PERFORMANCE****NEXT-GENERATION****QUALITY****ENVIRONMENT IMPACT**

HIGH-THROUGHPUT POWDER DIFFRACTION @ ID31

- Scanning time: **1s**
- Change sample & read QR-code: **0.095s**
- Number of samples: **1056**
- Total experimental time: **22 minutes**
- Automated data processing
- Routine commercial access twice/month



Technology driving a start-up



We create chemistry



STREAMLINE



The European Synchrotron



ESRF

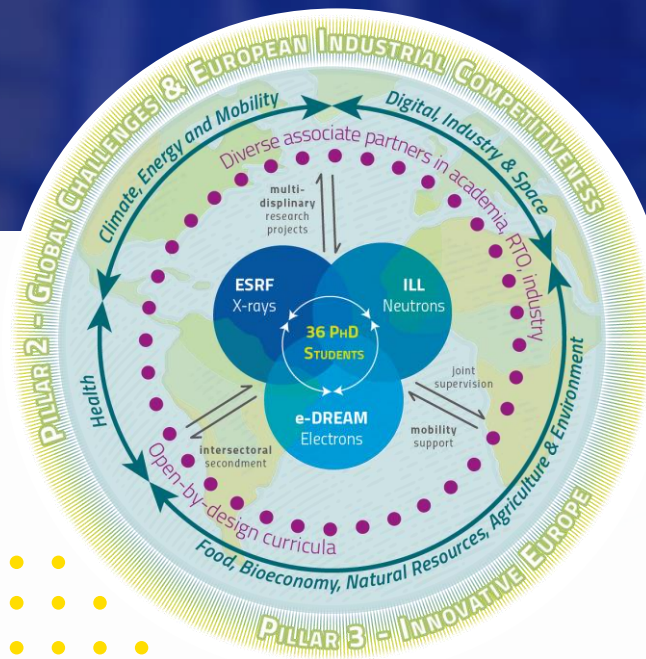


40 PhD projects using ESRF & ILL
40 industry partners driving the research challenges
Next generation ambassadors

www.innovaxn.eu



New MSCA COFUND: "NEXTSTEP"



NEXTSTEP will be 36 PhD students at ESRF (15), ILL (15) & e-DREAM (6)*

- ESRF coordinator, first student cohort expected in Sept 2025
- 3.7MEuro EC contribution



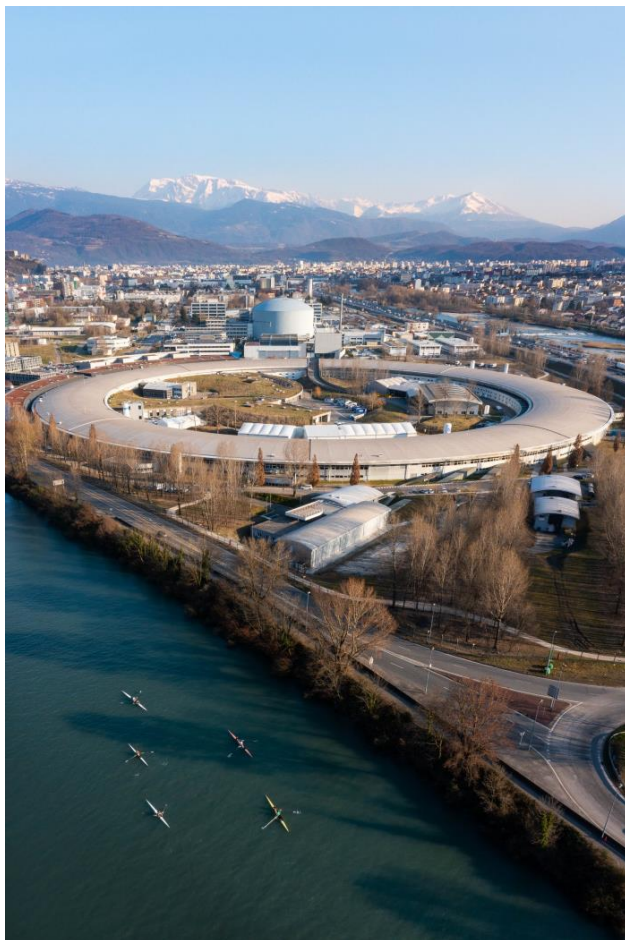
Each PhD project must be in collaboration with an academic, industrial or RTO associate

- EMBL is pre-identified as an associate



PhD topics on sustainable development and innovation challenges:

- Health; Digital, Industry & Space; Food, Bioeconomy, Natural Resources, Agriculture & Environment; Climate, Energy & Mobility



**Thank you for
your attention**

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