



| The European Synchrotron

Plugging innovation ecosystems and industry into light sources

Ed MITCHELL

Head of Business Development, ESRF



X-rays have been used for **innovation** since their discovery in 1895 by Röntgen.

108 THE SATURDAY EVENING POST May 26, 1928

"This X-ray showed me how to reduce my score from 102 to 91"



HERE'S the original negative of a U. S. Royal," said the doctor, "made in my own office. "I made up my mind to diagnose my own putting trouble and to see for myself whether I wasn't missing a good many putts by using balls that were lopsided—off-center inside. "I tested many different makes of balls and found the answer—only the 'U. S.' Royal showed a perfect center accurately

show why the "U. S." Royal is the truest putting golf ball in the world. —why, under normal conditions, it never wobbles or rolls off, and why its flight is equally dependable.

Look at these unretouched photographs

out of round. Its tough resilient cover and exclusive inside construction are designed to stand every condition of actual play. Your professional or authorized dealer has them. In either mesh or recess marking—and the price is 75c.

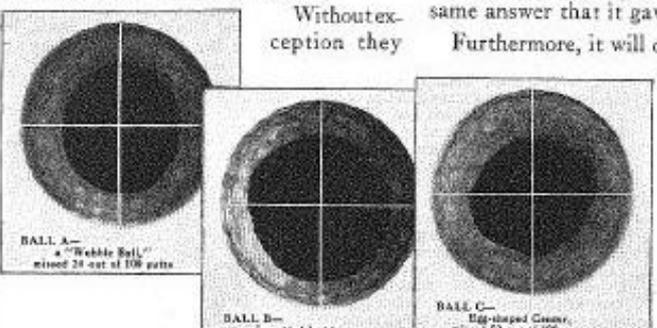
"How a Golf Ball is Made"

Let us send you a free copy of an absorbing human interest story of the building of a golf ball, by Robert H. ("Bob") Davis, internationally known author and editor. Address any one of our many branches or The Golf Ball Department, 1709 Broadway, New York.

Without exception they

The U. S. Royal will give you the same answer that it gave the doctor. Furthermore, it will drive as far as any other golf ball made—and last as long.

Wallop a "U. S." Royal as hard as you please. You can't knock it

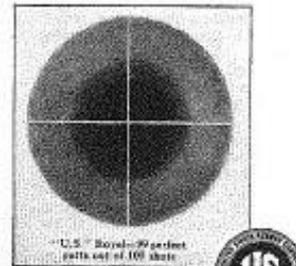


BALL A—
"Wobble Ball," missed 24 out of 100 putts

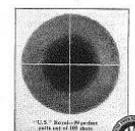
BALL B—
Lopsided inside, missed 40 out of 100 putts

BALL C—
Egg-shaped Green, missed 32 out of 100 putts

United States Rubber Company



United States Rubber Company



U. S. Royal—99 perfect putts out of 100 shots

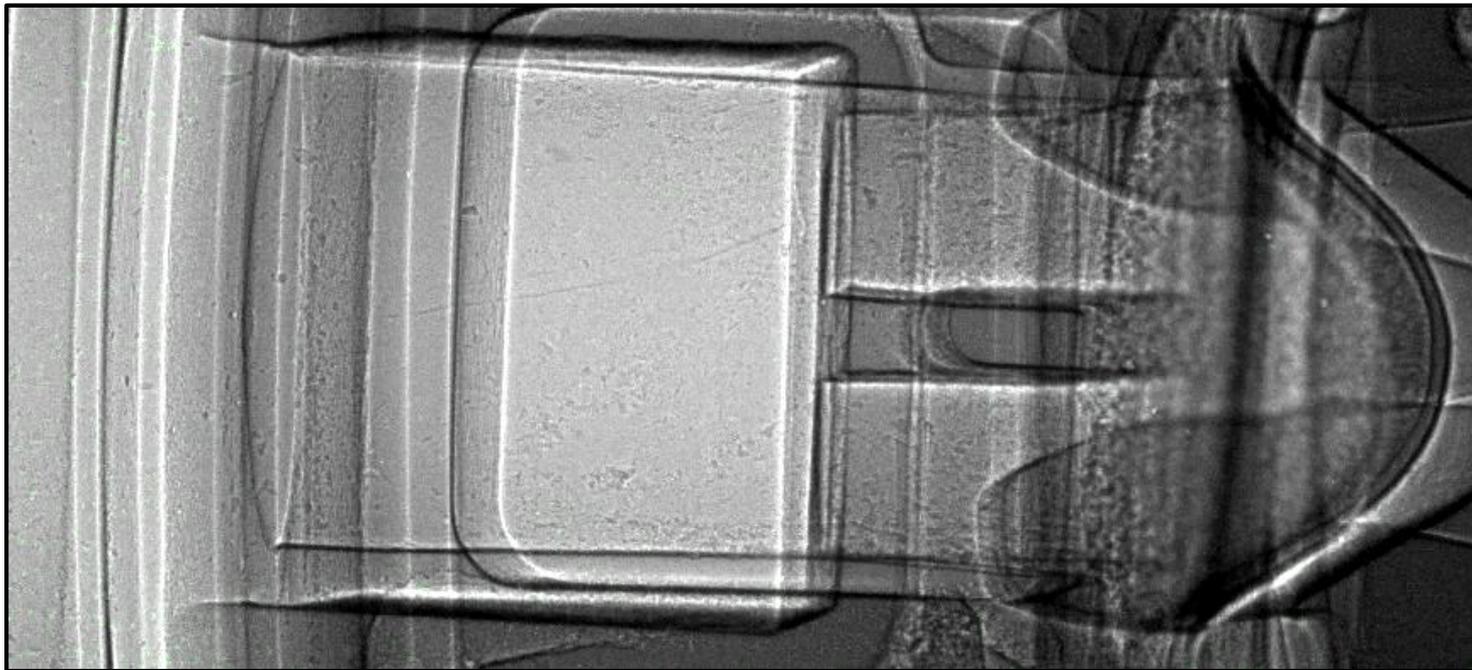
GOLF BALLS

IMPROVING DRUG INHALERS USING HIGH SPEED RADIOGRAPHY

Experiment done on ESRF beamline ID19



 **PRIOR**
PLM MEDICAL



ESRF: AN INTERGOVERNMENTAL ORGANISATION BASED ON SCIENTIFIC EXCELLENCE

19 PARTNER COUNTRIES
40 BEAMLINES (mostly hard X-ray)



13 MEMBER STATES

France	27.5%
Germany	24.0%
Italy	13.2%
United Kingdom	10.5%
Russia	6.0%
Benesync (Belgium, The Netherlands)	5.8%
Nordsync (Denmark, Finland, Norway, Sweden)	5.0%
Spain	4.0%
Switzerland	4.0%

6 ASSOCIATE COUNTRIES

Austria	1.75%
Israel	1.75%
Poland	1.00%
Portugal	1.00%
Czech Republic	0.60%
South Africa	0.30%

Access free, travel paid for member states.
Open to the world

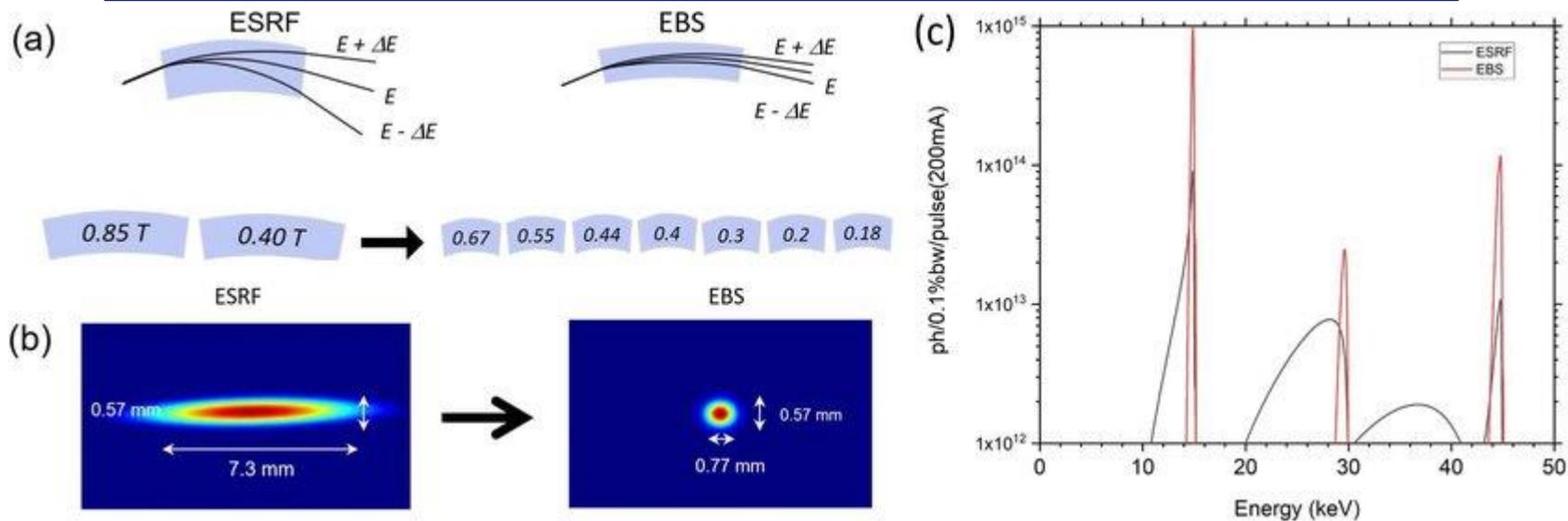
FROM 2015 TO 2024
68,000 USER VISITS FROM 67 COUNTRIES
7,000 INDIVIDUAL LABS OR UNIVERSITIES



19 PARTNER COUNTRIES

Access free, travel paid for member states.

ESRF Extremely Brilliant Source Upgrade (operational 2020) - More Intensity & Coherence, Less Electricity -



Poland	1.00%
Portugal	1.00%
Czech Republic	0.60%
South Africa	0.30%

10,000
Scientific
visitors each year

4 + 2
Nobel prizes

2,000
Scientific
pubs each year

10
ERC grants based
on ESRF-EBS

30%
of research with
industrial partners



GIANT is six thematic districts: science to tech valorisation to enterprises

GIANT
INNOVATION CAMPUS



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

“Infrastructures” have different flavours

➔ Research, Technological & Industrial



- Research, Technological and Industrial Infrastructures have complementary missions from scientific to development and testing facilities
- Usually **Research Infrastructures** are closer to fundamental and applied science needs
- Usually **Technological** and **Industrial** Infrastructures are closer to market demands



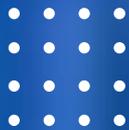
Yes, We're

Open



*Might
Could
Should
Must
Like*

Why work with industry?



- 1) **SOCIO-ECONOMIC IMPACT:** narratives around commercial use of our facilities, skills and intellectual property
- 2) **GOOD SCIENCE:** Challenging, real samples
- 3) **EFFICIENCY DRIVERS:** New access modes, standards, efficiency
- 4) **CAREERS:** Wider opportunities for staff
- 5) **CASH:** More resources

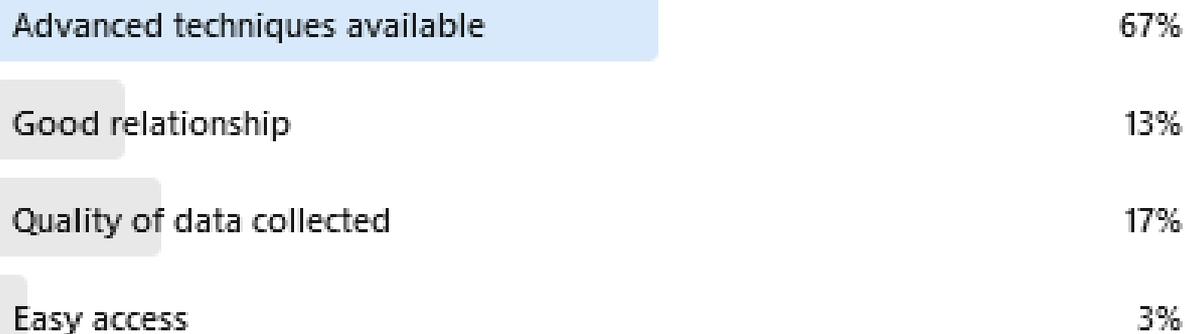


Why does industry work with us?



Which is the biggest advantage of collaborating with ESRF?

You can see how people vote. [Learn more](#)



ESRF - A Knowledge Hub for industry



USING THE UNIQUE PROPERTIES OF SYNCHROTRON X-RAYS



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 & cooperation

with industry partners

IMPACT



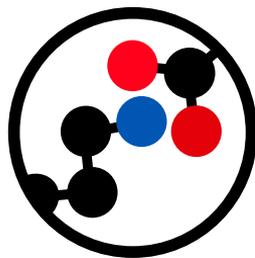
IMCA-CAT

Industrial Macromolecular Crystallography Association
Collaborative Access Team

Argonne
NATIONAL LABORATORY



Advanced
Photon
Source



IMCA-CAT

Industrial Macromolecular Crystallography Association
Collaborative Access Team

INDUSTRY

IMCA Members

abbvie

Bristol Myers Squibb™

janssen
PHARMACEUTICAL COMPANIES OF
Johnson & Johnson

MERCK

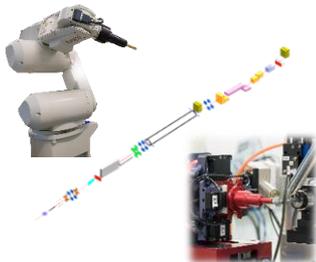
NOVARTIS

Pfizer

IMCA-CAT Subscribers

EXPERIMENT

Beamline 17-ID @ APS



- focused, intense beam
- mini beam 5-50 μm
- pucks: Unipuck, ACTOR, ALS

CAPABILITIES

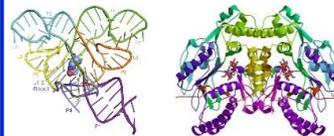
- diffraction rastering
- collect-along-vector
- auto collect & process



- proprietary
- rapid & frequent access
- mail-in, remote, on-site

PRODUCTIVITY

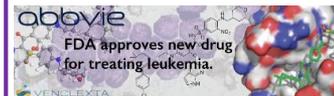
23,000+
structures annually



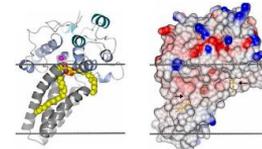
- high-throughput
- fast, encrypted data transfer
- real-time integration to company pipelines



DISCOVERY



- micro crystals
- membrane proteins
- MAD / SAD
- *in situ*



Drugs

Kisqali® (Novartis)
metastatic breast cancer

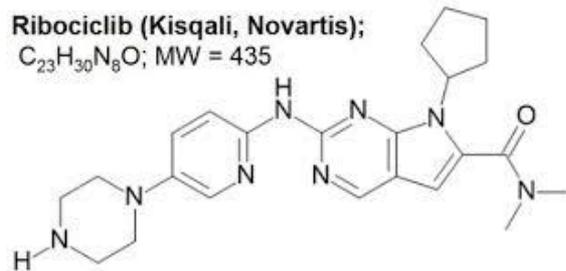
- FDA:
- Breakthrough Therapy
 - Priority Review

 **NOVARTIS**

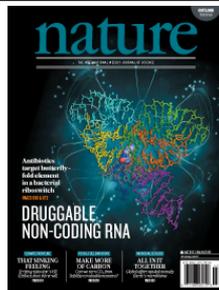
 **KISQALI**
ribociclib


APPROVED

Ribociclib (Kisqali, Novartis);
 $C_{23}H_{30}N_8O$; MW = 435



Ribocil (Merck)
antibiotic

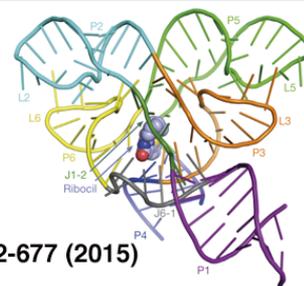


Science Highlight:
Discovering Antibiotics

Selective small-molecule inhibition
of an RNA structural element
by Howe, Wang, Fischmann, et al.

 **MERCK**
Be well

Nature 526, 672-677 (2015)



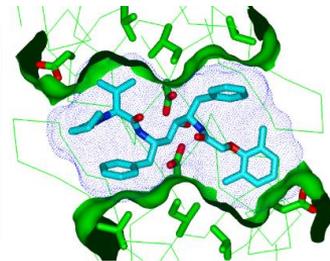
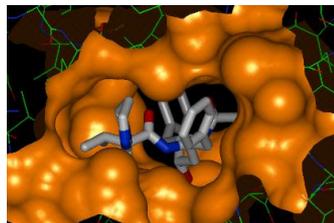
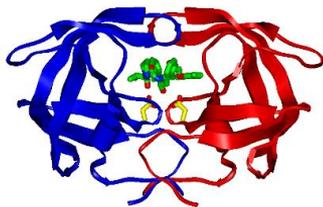
Venclexta™ (AbbVie)
chronic lymphocytic leukemia

- FDA:
- Breakthrough Therapy
 - Priority Review

The image is an advertisement for Venclexta. It features the AbbVie logo at the top left. The text reads "FDA approves new drug for treating leukemia." Below this, there are several chemical structures, including a ball-and-stick model of a cell, a ball-and-stick model of a molecule, and a 3D molecular model of a protein with a small molecule inhibitor bound to it. The Venclexta logo is at the bottom left.

Drugs

Kaletra[®] (Abbott)
AIDS



KALETRA[®]
(lopinavir/ritonavir)

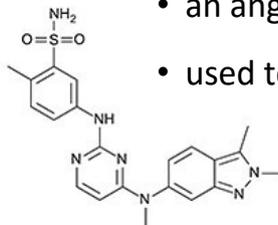
Januvia[®] (Merck)
type 2 diabetes



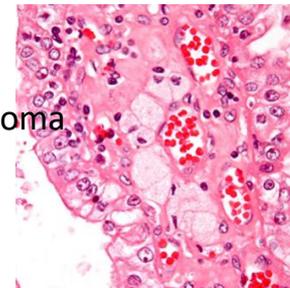
- approved by the FDA in 2006
- one of the most popular type 2 diabetes drugs on the market

Januvia[®]
(sitagliptin, MSD)

Votrient[®] (GSK)
kidney cancer



- an angiogenesis inhibitor
- used to treat advanced renal cell carcinoma



Votrient[®]
pazopanib

MAX IV



Photo ABML4

MAXIM

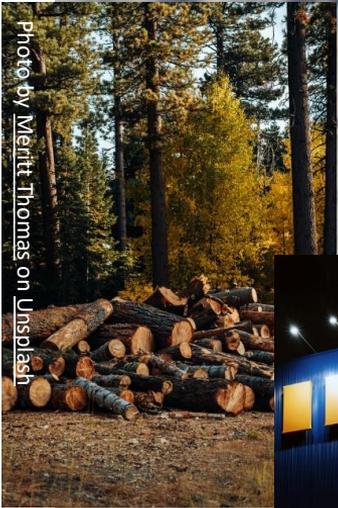


Photo by Merritt Thomas on Unsplash



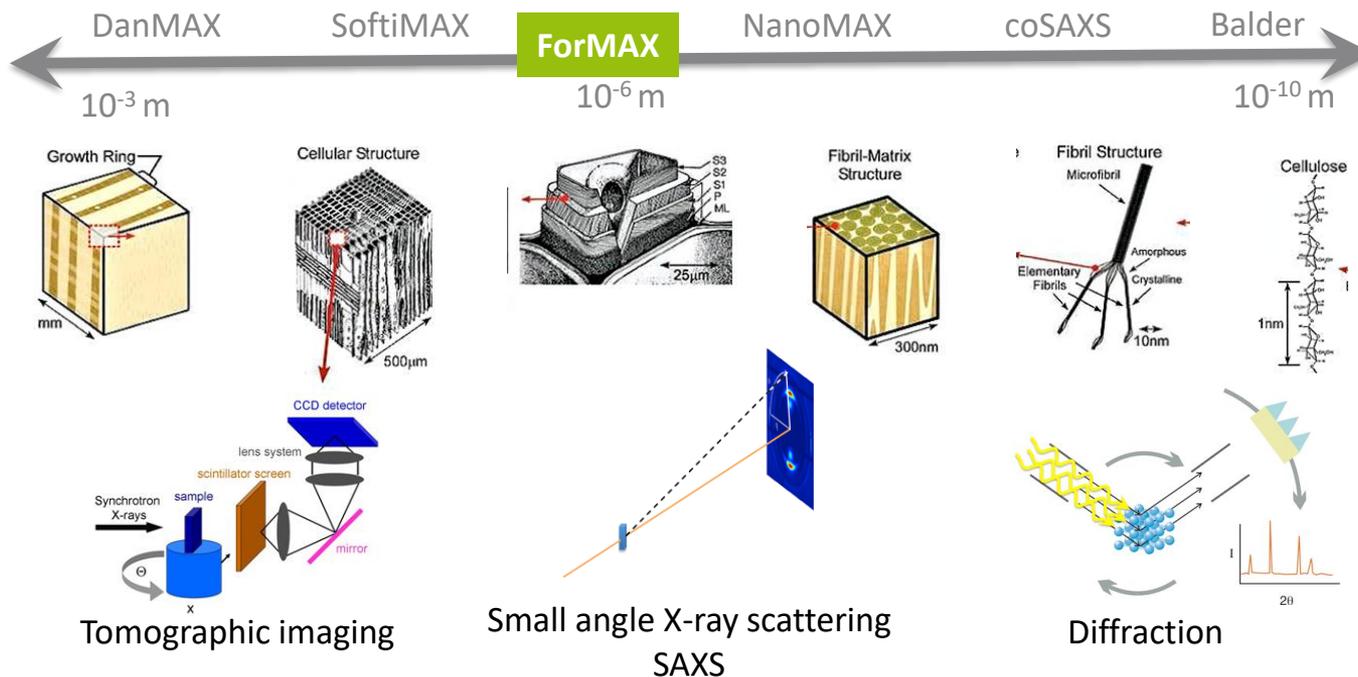
Photo by Rendy Novantino on Unsplash



Photo ABML4

Wood – from Logs to Lignin Molecules

Wood is a hierarchical multi-scale raw material





TREERESEARCH

“Collaboration on the research on new materials from the forest”

OPEN: November 2022

ForMAX:

- Supports R&D on biocomposites, nanocellulose, modification of wood, the pulping process, fibre ultrastructure and fibre-fibre bonding
- Provides advanced material characterisation, including complex real-time processes
- Contribute to the Swedish forest industry competitiveness (paper/pulp industries – Tetra Pak).

Joint funding from Wallenberg Foundation and industry



“ForMAX”

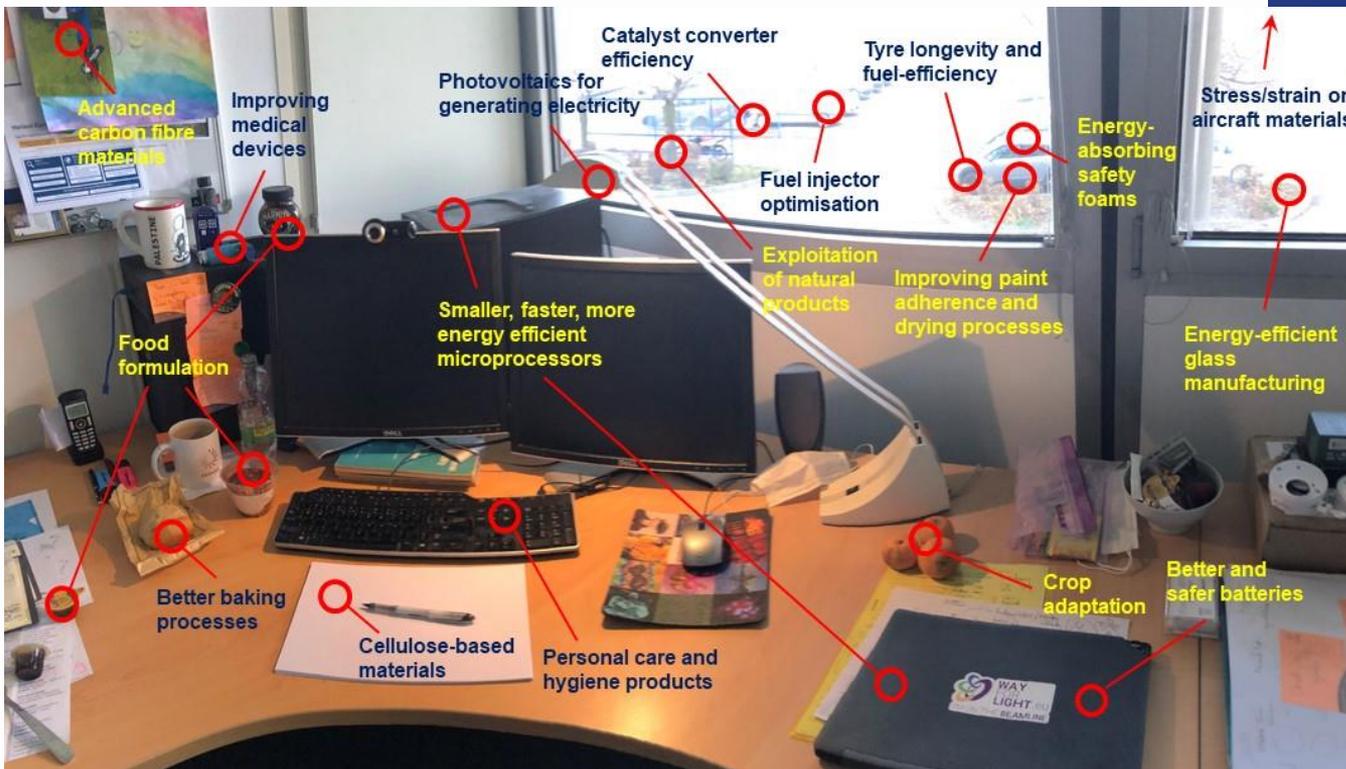
SAXS/WAXS/tomo beamline

<https://treerearch.se/en/research-infrastructure/formax/>



ESRF - A Knowledge Hub for industry

→ USING THE UNIQUE PROPERTIES OF SYNCHROTRON X-RAYS



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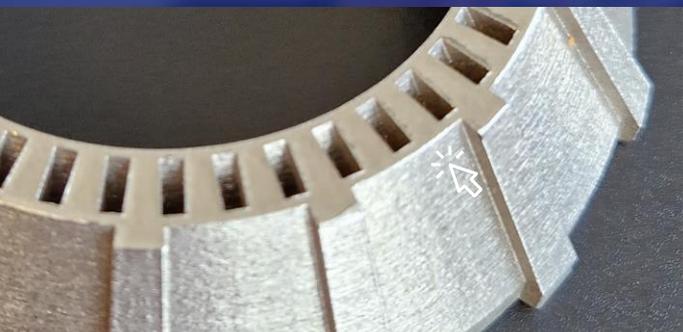
Actual as of today: 3.6 M€

Grants & cooperation

with industry partners

Quality control of 3D-printed metals

ESRF-EBS Upgrade has paved the way for **scanning sets of 100s or 1000s of samples** → e.g. defect analysis

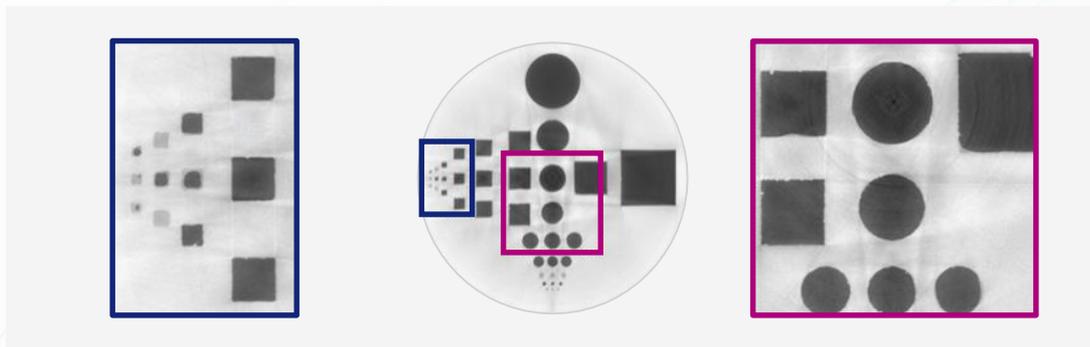


Inconel 3D manufactured

80mm in diameter

Quality control

Comparison with CAD model



Batteries: Looking for the perfect recipe



ENERGY

CATALYSIS
& CHEMISTRY

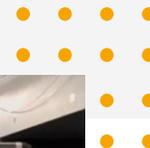
ENERGY-STORAGE

HIGH PERFORMANCE

NEXT-GENERATION

QUALITY

ENVIRONMENT IMPACT



→ HIGH-THROUGHPUT POWDER DIFFRACTION

- Scanning time: **1s**
- Change sample & read QR-code: **0.095s**
- Number of samples: **1056**
- Total experimental time: **22 minutes**
- Automated smart data workflow

→ Technology has resulted
in a service start-up



BASF
We create chemistry



The European Synchrotron



Perceptions are hard to change

Our view of the ESRF:

- Unique research facility
- State-of-the-art
- Fantastic science

Look what we can do!



Industrial translation:

- Expensive & difficult to use
- Risky
- Fundamental science

Not for me.





BRAUN
MAX FACTOR



PANTENE
PRO-V

Secret **P&G**

CLAIROL

Procter & Gamble

COVERGIRL®



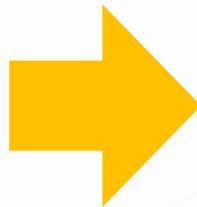
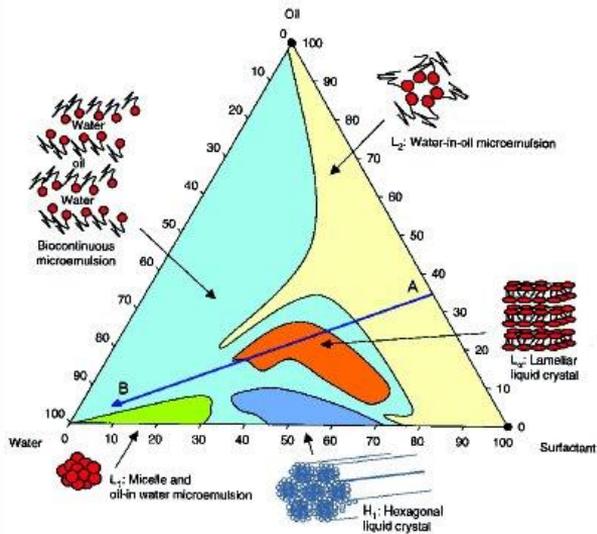
Zest



Febreze

nice'n easy





How does ESRF engage with industry?

Core team of 5 FTE working as “intrapreneurs” → biz dev, scouting, admin, access, follow-up
+ specialised Industry Liaisons on key beamlines



PROPRIETARY SERVICES
(+feasibility access)
75% income

Rapid & confidential

Mail-in services

>300 clients

35 countries



TECH TRANSFER
25% income

Licensed > 30 technologies

In-house manufacturing

Consultancy



Science and
Technology
Facilities Council



PUBLIC ACCESS

Results published

Competitive peer review

6-9 months delay



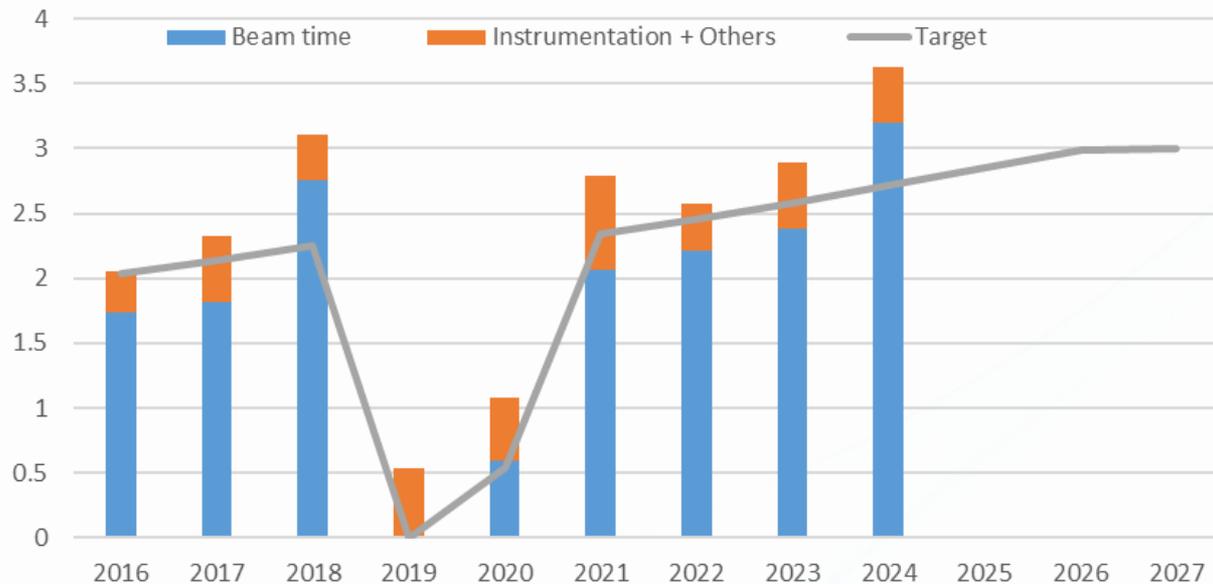
**COLLABORATIONS
& GRANTS**

Industry proposed staff

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



Commercial income at ESRF



Annual target initiated in 2016 at around 2MEuros

5% year-on-year growth demanded

Commercial income only, excluding grants and collaborations

“Synchrotron as a Service”

Provide what the clients actually need.

Automated.

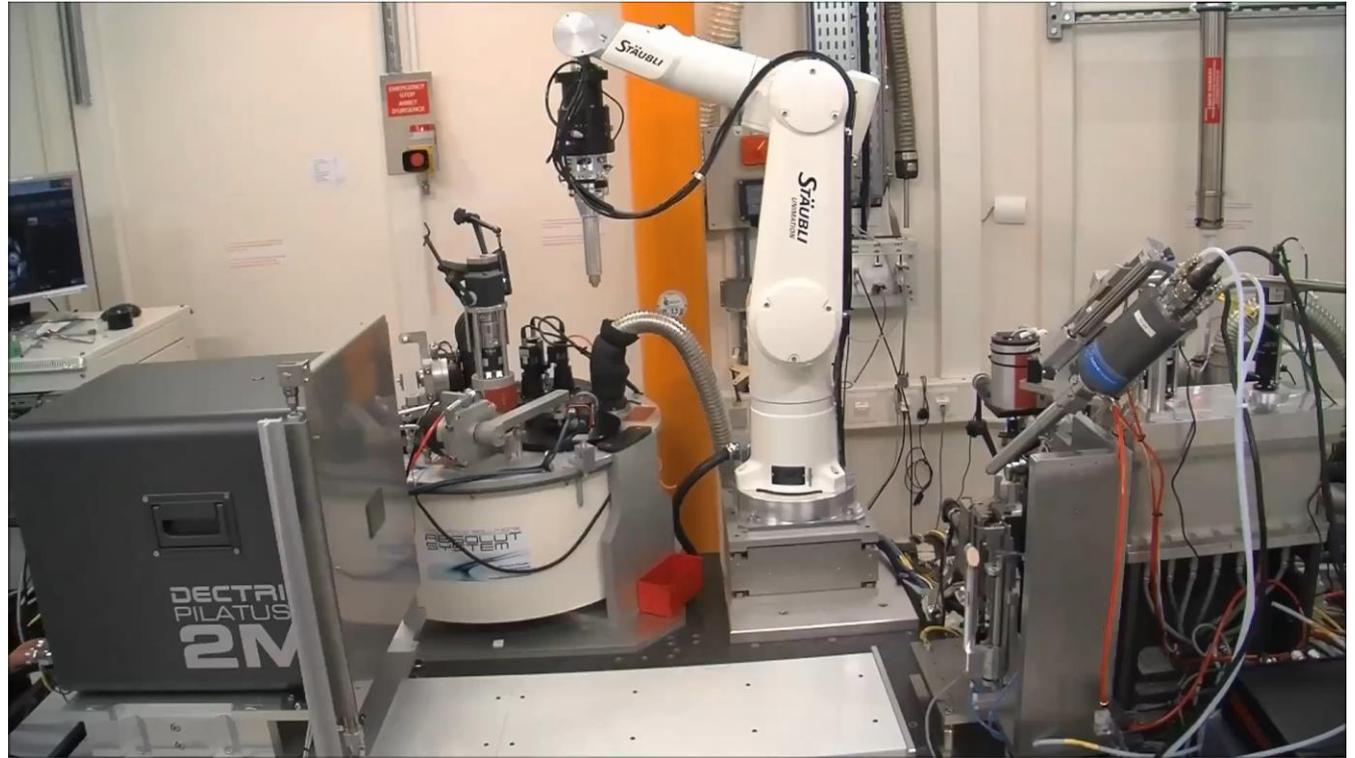
Reliable.

Rapid.

Cost effective.

High quality.

Trusted.

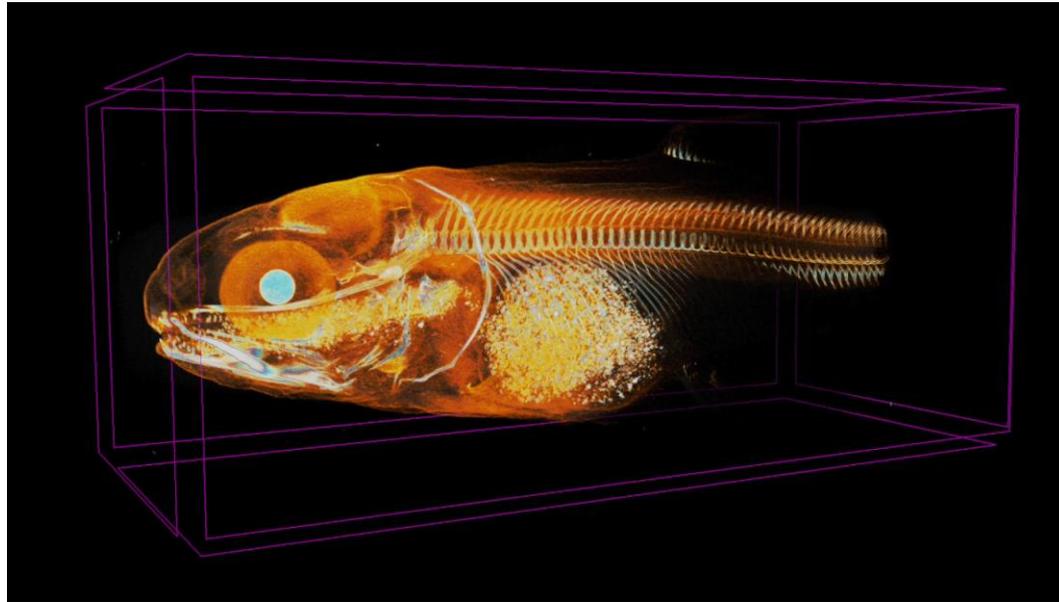


Interaction networks... ...how we reach industry



NO-STAINING HIGH-PERFORMANCE 3D IMAGING

X-RAY COMPUTED TOMOGRAPHY– with an RTO intermediary



Biomar interested in how experimental diets affect fish digestion process, which is why they saw a great potential in non-destructive 3D imaging as a complement to dissection and histological analysis.

<https://www.dti.dk/synchrotron-imaging-of-low-density-materials/visualization-of-soft-tissue-in-small-fish-phase-contrast-ct/43911,3>

X-R



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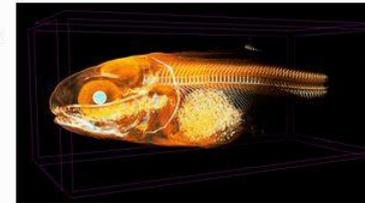
News

Non-destructive 3D imaging expands aquafeed research tools

Thursday, April 21, 2022

The [Danish Technological Institute](#) (DTI), in collaboration with BioMar, investigated batches of fish larvae after being fed different experimental diets. BioMar was interested in how the experimental diets affect the digestion process of fish, and the company found great potential in non-destructive 3D imaging as a complement to dissection and histological analysis.

"Our collaboration with DTI has tremendously aided in expanding our research tools to increase our knowledge of fish physiology. The overarching gain to include this top-of-the-art technology is to continue improving what we offer to the aquaculture industry in form of a feed. In other words, each pellet we produced is based on solid science, and this exciting collaboration provided us with the right tools," said Pedro Gómez, senior scientist, Biomar Denmark.



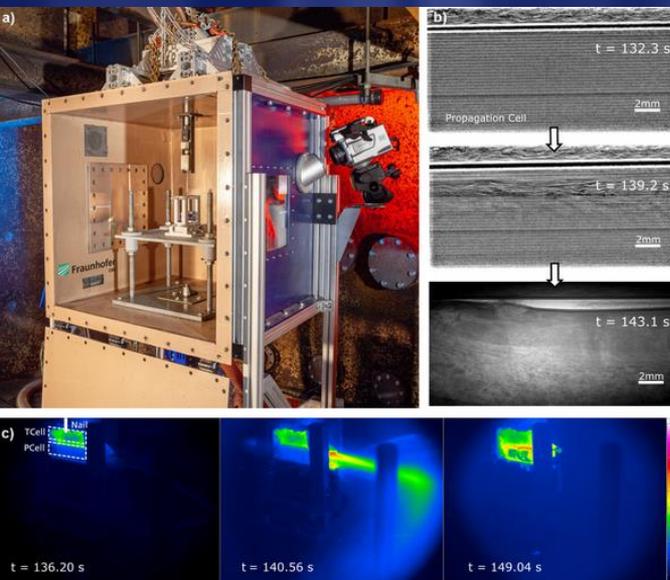
d in how
ts affect fish
s, which is
great potential
e 3D imaging
t to dissection
analysis.

<https://www.dti.dk/synchrotron-imaging-of-low-density-materials/visualization-of-soft-tissue-in-small-fish-phase-contrast-ct/43911,3>



Studying battery failure @ ESRF

REAL TIME SCANNING



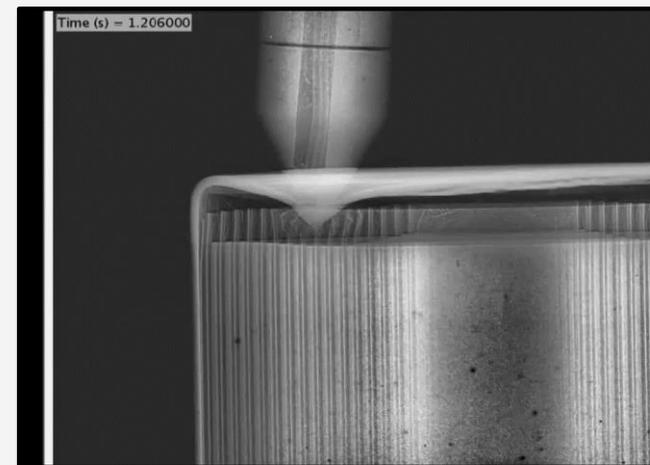
CHALLENGES

- 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



Commercial A-to-Z Service in partnership with Fraunhofer



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.

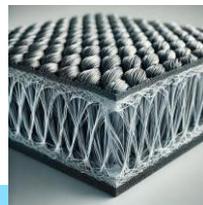


SUBSIDISED ACCESS FOR SMALL COMPANIES & START-UPS



Takis Biotech (It)

COVID therapy
ID23-2/micro-protein
crystallography



Amadema (Cy)

Composites
ID16/nano-CT



Hey Planet (Dk)

Food ingredients
BM05/micro-CT



a hub for materials research

ESRF is now partnering with the European Innovation Council!

 Free consulting services

 5 Tailored Services for EIC
Beneficiaries

 Visit the **EIC** service catalogue and
find us in the **pathfinder** section!





Initial Expert Consultancy

- Respond to industrial R&D needs/questions using cutting-edge X-ray characterisation techniques
- Remote one-on-one or group meetings
- Free of charge

Fast Track Access to X-ray Services

- Quick access to advanced X-ray techniques for routine materials and products characterisation
- Measure sample structures at different scales, from atomic to macro, whilst being non-destructive

Tailor-made Support and Experimentation

- Build a tailored support and exploitation of synchrotron X-ray techniques for a longer-term R&D support
- Specific experiment environments, set-ups



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

www.innovaxn.eu



Why work with industry?

- Impact for stakeholders
- Networking for staff
- Cash generation

How to work with industry?

- Outreach
 - Build understanding & trust
 - Match synchrotron to industry
 - Make industry a strategic goal
-
- Learn every day.





nephews

coordinated
by SOLARIS

Opportunities for Training: HERCULES 2026

NEPHEWS has funding for **4 African PhD researchers** registered with an African university to participate in the renowned **HERCULES EUROPEAN SCHOOL**:

- A **five week-course** coordinated by the Université Grenoble Alpes providing training in the field of **Neutrons, X-ray Synchrotron Radiation, and Free Electron Lasers** for Biology, Chemistry, Physics, Materials Science, Geosciences, Industrial applications.
- **Lectures, practicals, tutorials, and visits to: ALBA** in Barcelona, **KIT** in Karlsruhe, **DESY** and **European XFEL** in Hamburg, **Elettra** and **FERMI** in Trieste, **ESRF** and **ILL** in Grenoble, **SOLEIL** in Paris-Saclay and **PSI** in Villigen.
- The language of the course is **English**.

www.beamtime.eu



Held annually in early Spring. Applications from young African researchers for the NEPHEWS bursaries will open in April 2025, closing in mid May 2025 for the course in Spring 2026.



Snowshoe outing - HERCULES 2020



Thank you for
your attention

Ed MITCHELL

Head of Business Development, ESRF

mitchell@esrf.eu

[in /in/e-mitchell/](https://www.linkedin.com/in/e-mitchell/)

ESRF for Industry

industry@esrf.eu

www.esrf.eu/Industry