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Superconducting High Field Magnets and Science Discovery

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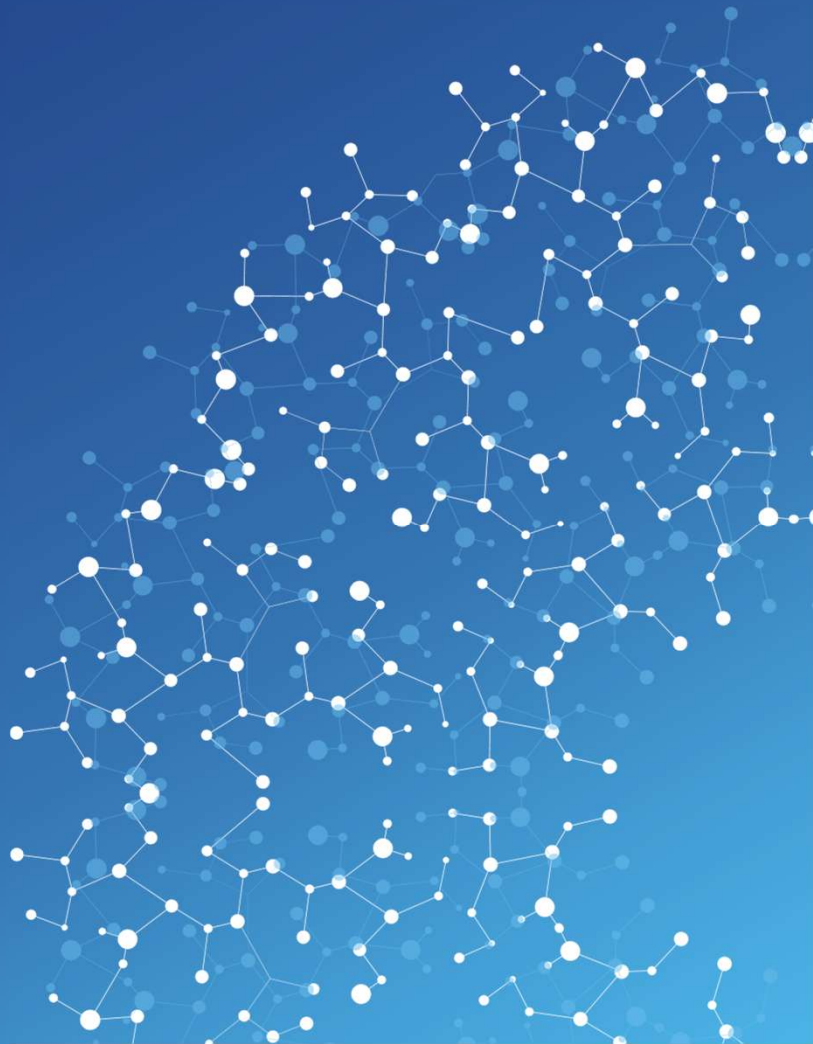
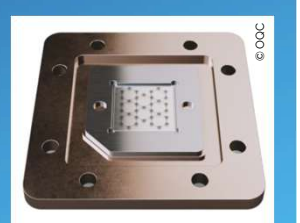


Why “Science Discovery”, and why does it matter?

High field (and low temperature) physics sits behind all the advanced electronic materials that underpin economic growth, and benefit humanity

- **Semiconductors** for next generation, lower power (mobile), faster devices
- **Superconductors** for secure, sustainable energy
- **Quantum devices** for quantum computing, communication, and sensing

→ This is not ‘just’ curiosity-driven science – to engineer **materials** into **devices**, you need to understand their **physics**



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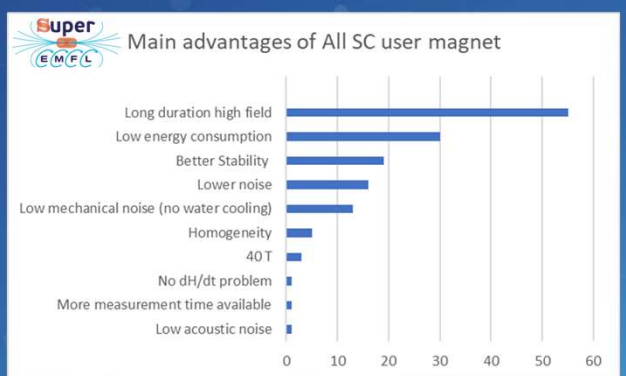
Why does “superconducting” matter?

Research benefits

- Lower noise - unlock some effects at lower fields due to improved S:N
- High homogeneity possible for resonance methods
- Larger sample space sizes (cryogenic design efficiency)
- High uptime, in principle can be available 24/7

Host facility benefits

- Compact physical footprint and easy service provision
  - Need to allow magnetic footprint
- Lower total lifetime cost when backed by efficient helium recovery and reliquifier capability



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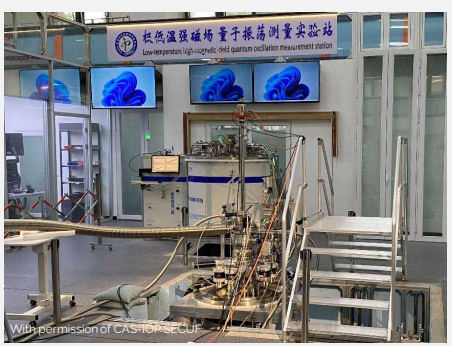
State-of-the-art in superconducting high field (>20 Tesla) user magnets

NHMFL, Tallahassee, FL

- World first, 32 T
- User magnet from outset
- 40 T development

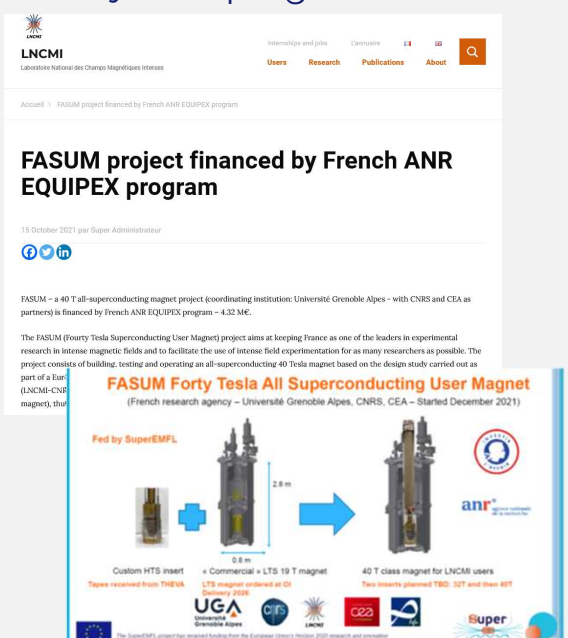
SECUF, CAS-IOP, Huairou, CN

- 28-30 T
- 26 T “NMR grade”



LNCMI, Grenoble, FR

- 30 & 40 T goals
- Project in progress



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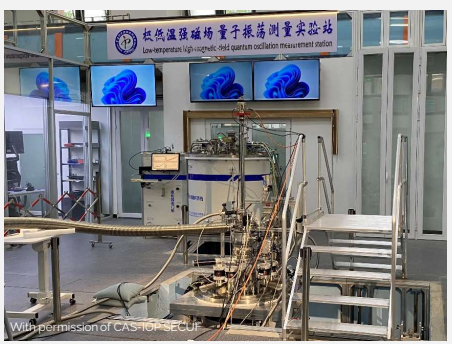

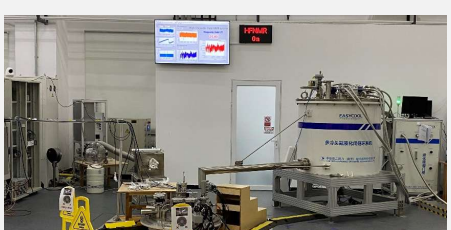

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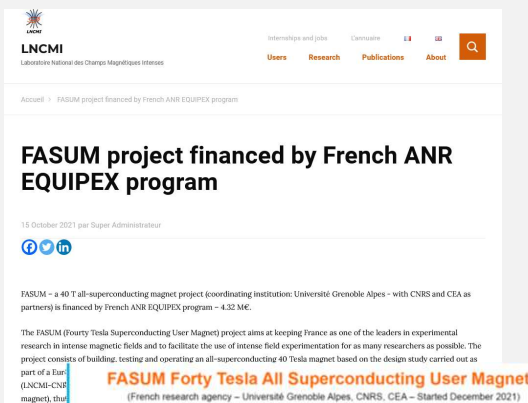

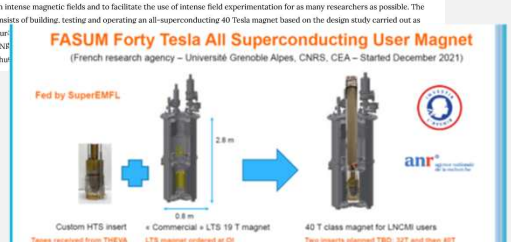

- High field lab – commercial partnerships
- “In-house” HTS insert coils backed by commercial (Oxford Instruments) LTS outsert magnets

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The critical role of National Laboratories

The dual role of National Laboratories is key

- User facilities – ensure technology meets real needs
- Technology development – leverage in-house expertise in what is **new**

Use commercial expertise for risk mitigation

→ Commercial partnerships with National Labs supports goals of high field technology and access

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Magnetic field dissemination and research acceleration

To accelerate “Discovery Science”, wider access to high field is needed

- Get researchers without field capability onto the ladder, c. 14 T
- Enable researchers now limited at 14 T to get to 20-25 T in their own/close lab
- Release greater National Laboratory capacity via all-sc magnet investment

→ Funding

→ Partnerships (also funding)

Side note: It’s not only about magnetic field – low (1-4 K) and ultra-low (mK) temperature sample environment is needed in combination

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Thank you

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