NeuMat network

1.3.25-28.2.30

~ £1.4M (FEC)

Judith Driscoll (Cambridge)

Adnan Mehonic (UCL)

Giuliani Di Martino (Camridge)

Alex Serb (Edinbugh)

Form interdisciplinary connections within the UK, to act as a unifying and learning platform, drawing together various fields to support the exploration and creation of ground-breaking technologies for novel neuromorphic hardware
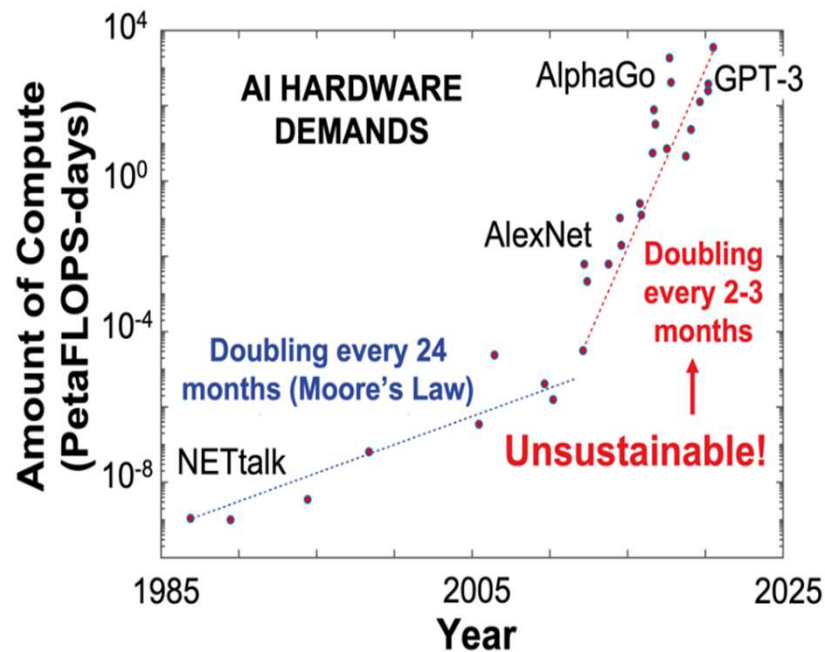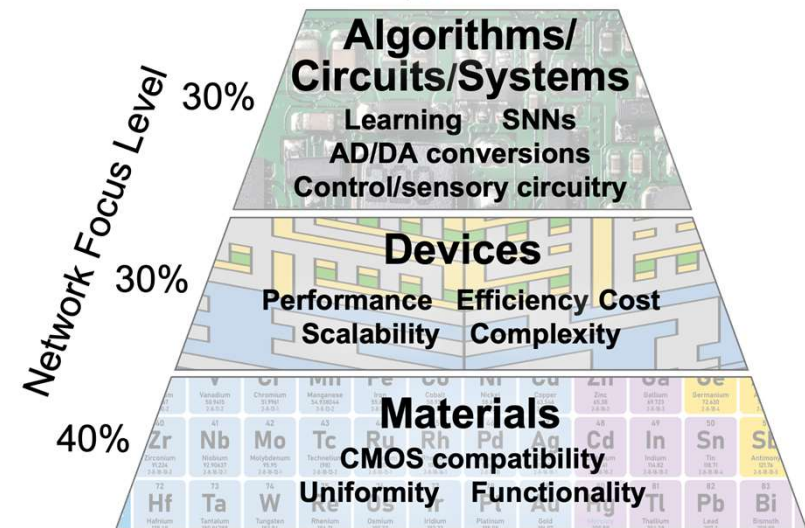
Fig. 1. The increase in computing power demands showing an unprecedented and *unsustainable* trend with time [1].
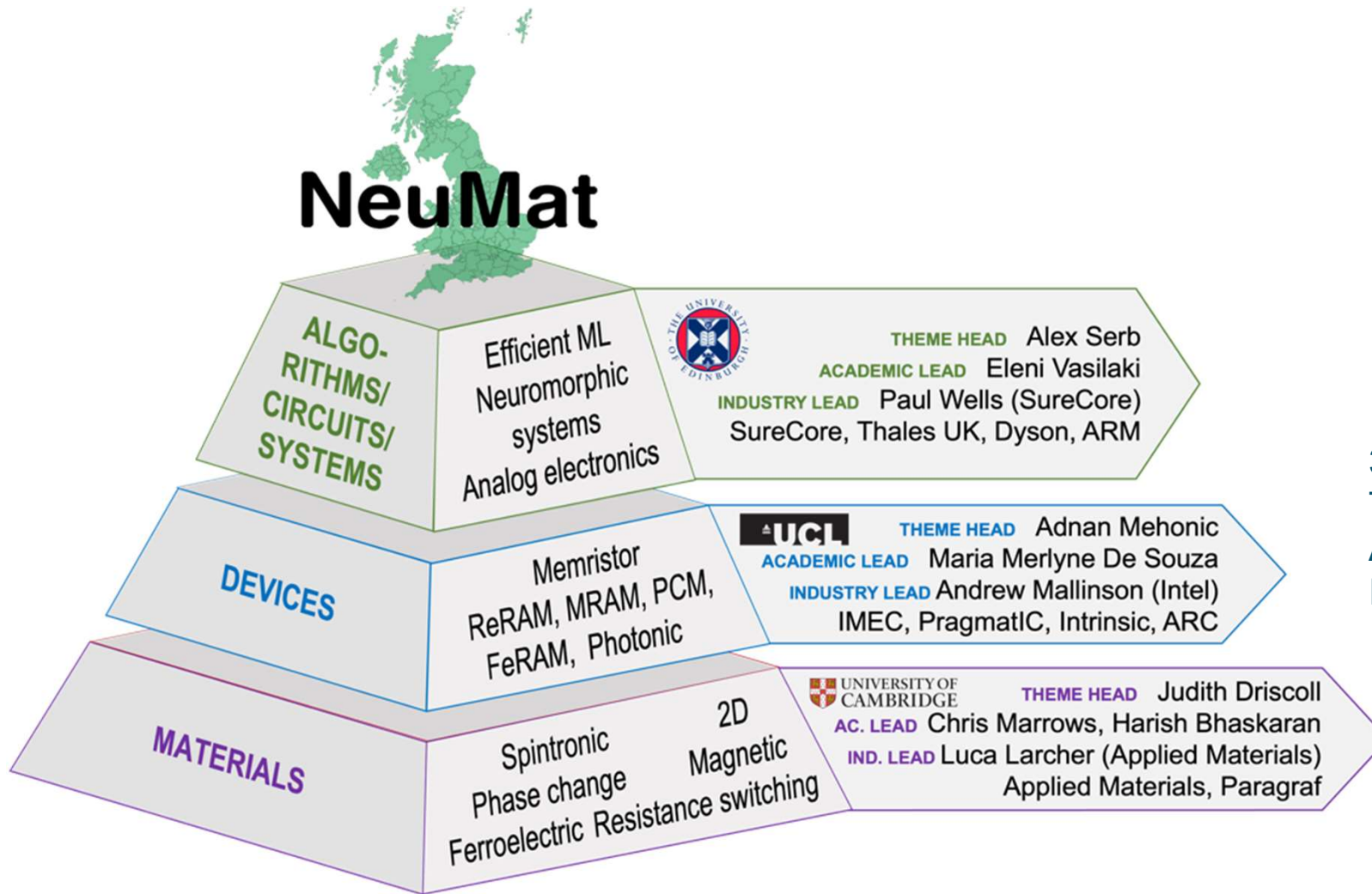
A. Mehonic, A. J. Kenyon, *Nature* **2022**, *604*, 255.

Strain on national energy systems, **challenges to environmental sustainability**, and **constraints on security capabilities**.

Energy efficient AI Hardware: Fundamental innovation is required first in materials and nanoelectronic devices, then up the stack in circuits, AI algorithms, and alternative computing.

NeuMat

ALGO-RITHMS/ CIRCUITS/ SYSTEMS

Efficient ML
Neuromorphic systems
Analog electronics

THEME HEAD Alex Serb
ACADEMIC LEAD Eleni Vasilaki
INDUSTRY LEAD Paul Wells (SureCore)
SureCore, Thales UK, Dyson, ARM

DEVICES

Memristor
ReRAM, MRAM, PCM, FeRAM, Photonic

THEME HEAD Adnan Mehonic
ACADEMIC LEAD Maria Merlyne De Souza
INDUSTRY LEAD Andrew Mallinson (Intel)
IMEC, PragmatIC, Intrinsic, ARC

MATERIALS

Spintronic   2D
Phase change   Magnetic
Ferroelectric Resistance switching

THEME HEAD Judith Driscoll
AC. LEAD Chris Marrows, Harish Bhaskaran
IND. LEAD Luca Larcher (Applied Materials)
Applied Materials, Paragraf

3 Themes, topics under each
Theme Heads (THs)
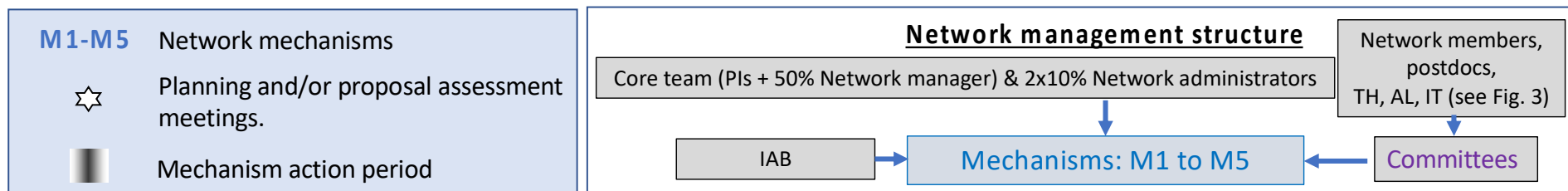Academic Leads (ALs)
Industry Leads (ILs)

Potential companies listed.
Others welcome to join.

We aim to enable rapid advances in hardware capability

Key Objectives

- **Objectives**

- **Live Discussions**: Host 5(5) main(minor) meetings featuring leading international speakers.

- **Student Internships**: Offer 20 summer internships across various institutions.

- **Educational Opportunities**: 3 Winter schools providing in-depth education and training.

- **Community Engagement**: Advertise the network widely to the entire UK community.

- **Public Education**: Using professional videos, educate the UK public about the wide-ranging field of novel neuromorphic/AI hardware.

- **Create a Roadmap**: Develop a roadmap titled "Materials and Devices Challenges for Novel AI and Neuromorphic Hardware." This document will set the course for a subsequent network.

- **Future Network**: Document clear plans for a follow-on network, enabling successful continuity.

Network Mechanisms and Committee Meetings	Year 1	Year 2	Year 3	Year 4	Year 5
M1. Electronic/Online Promotion Activities (AM)					
Postdoc Committee meetings					
M2. Live discussion meetings (AM/AS)	MINOR MAJOR				
Meeting Committee meetings					
M3. Summer UG studentship internships (GD/JD)					
Summer Student Committee meetings					
M4. Winter schools (training, videos, outreach) (GD/AS)					
Postdoc committee meetings					
M5. Roadmap/Report/ Follow-on-Network (JD)					
PIs and Theme Head meetings					
Other Committtee Meetings					
Core team management meetings					
International advisory board (IAB) meetings					

M1-M5 Network mechanisms

☆ Planning and/or proposal assessment meetings.

▮ Mechanism action period

Network management structure

Core team (PIs + 50% Network manager) & 2x10% Network administrators

IAB → Mechanisms: M1 to M5 ← Committees

Network members, postdocs, TH, AL, IT (see Fig. 3)

IAB: Regina Dittman (Julich), Abu Sebastian (IBM), Daniele Ielmini (Leti), Stuart Parkin (MPI), Steve Furber (Manchester), James Myers (Imec UK)

For mechanisms **M2** and **M3,** proposals will be submitted in advance, calls announced online and during network meetings. Assessed against academic excellence, interdisciplinarity, detailed planning, EDI matters, host suitability (considering factors such as transportation and accommodation costs), potential outcomes, and cost-effectiveness.

The Different Mechanisms

M1. **Online stuff.** Website, social media, podcasts (under M1) made by early career researchers High-level research talks and primers/tutorials at network meetings, recordings being made by ECRs.

M2. **5 major meetings** (2.5 day, 100 people / meeting) will be hosted at and planned by the PIs at their home institutions (Cam x2, UCL x2 and Edinburgh x1), with **half days focused on industry needs** and directions. Successful industry collaborations will be highlighted on social media. We will have 2 keynote speakers per meeting. 1 invited speaker/meeting (10 network meetings) and 1 IAB member at each meeting.Travel grants given.

5 minor (focused) meetings (2.5 day, 50 people / meeting).

M3. **Summer placements.** 20 UG students (more if institutions can contribute)

M4. **3 Winter schools**. 2.5 day schools . 3 schools. 100 student per school. EDI training included. 3 professional videos made.

M5. A **roadmap** from this network will be published in the journal AM is the Editor-in-Chief (EIC) of, APL Machine Learning. AM organised a roadmap on Materials Challenges for Neuromorphic Computing for APL Materials, AIP (when JD was EIC).

Roadmap to guide the topics in a **follow-on network** to NeuMat**.** The PIs and theme heads will plan the roadmap and follow-on network, kicked off by the penultimate minor network meeting.

5-page report summarising key areas from the roadmap and network successes. It will be sent to policy advisers, e.g. EPSRC, RAEng, RS, BEIS, and societies, and a high-profile report made by one or more of them.

Quantifiable Deliverables

Target Deliverables

- **Fostering Partnerships**: Forge 15 new collaborations among diverse communities.

- **Bridging Academia and Industry**: Establish 10 fresh connections between academic institutions and industrial players to accelerate the development of device prototypes.

- **Securing Funding**: Attract £20M in funds from government and industry (UK and abroad).

- **Training & Diversity**: Train up to 300 researchers in total through 3 Winter Schools, with an emphasis on including at least 100 individuals from diverse backgrounds in terms of gender, ethnicity, and geographical location.

- **Nurturing Early Career Researchers**: Create a self-sustaining cohort of over 50 early-career researchers, ensuring a future generation of talent in the field.

Reaching out to *whole* of UK

Reach out to relevant Doctoral Training Centres (DTCs), related networks, NGOs, professional organizations, Knowledge Transfer Networks (KTNs), and catapult centres.

Actively managed social media channels (LinkedIn, X, etc) with assistance from the Royal Academy of Engineering (RAEng).

Post monthly network newsletters, and ensure committee members further disseminate info.

ALs/Ils, RAEng, & Innovate UK, etc, to promote NeuMat widely to contacts.

Committee membership cycled regularly. People bid to be on them and others vote at the meetings.