

```
self._modified()

# cython fast access
cdef inline DistributionFunction get_electron_distribution(self):
    return self._electron_distribution

@property
def composition(self):
    return self._composition

@composition.setter
def composition(self, object values):
    self._composition.set(values)

# cython fast access
cdef inline Composition get_composition(self):
    return self._composition

@cython.cdivision(True)
cpdef double z_effective(self, double x, double y, double z) except -1:
    """
    Calculates the effective Z of the plasma.

    .. math::
        Z_{\text{eff}} = \frac{\sum_{j=1}^N n_{\{j\}} Z_j^2}{\sum_{k=1}^N n_{\{k\}} Z_k}

    where n is the species density and Z is the ionisation of the species.

    :param x: x coordinate in meters.
    :param y: y coordinate in meters.
    :param z: z coordinate in meters.
    :return: Calculated Z effective.
    :raises ValueError: If plasma does not contain any ionised species.
    """

    cdef:
        double ion_density, sum_nz, sum_nz2
        Species species

    sum_nz = 0
    sum_nz2 = 0
    for species in self._composition:
        if species.ionisation > 0:
            ion_density = species.distribution.density(x, y, z)
            sum_nz += species.ionisation * ion_density
            sum_nz2 += species.ionisation * species.ionisation * ion_density
```

Research Software Engineering: The growth of a movement

Alys Brett, UKAEA

Nordic RSE get-together online, 30th Nov 2020

These slides: <https://doi.org/10.5281/zenodo.4298589>



UK Atomic
Energy
Authority

Head of the Software
Engineering Group



**SOCIETY OF RESEARCH
SOFTWARE ENGINEERING**

Past President
(2016-20)

The UK's national fusion lab

Mission to deliver **sustainable fusion energy**

Wide variety of software developed for fusion energy research + related technology and operations



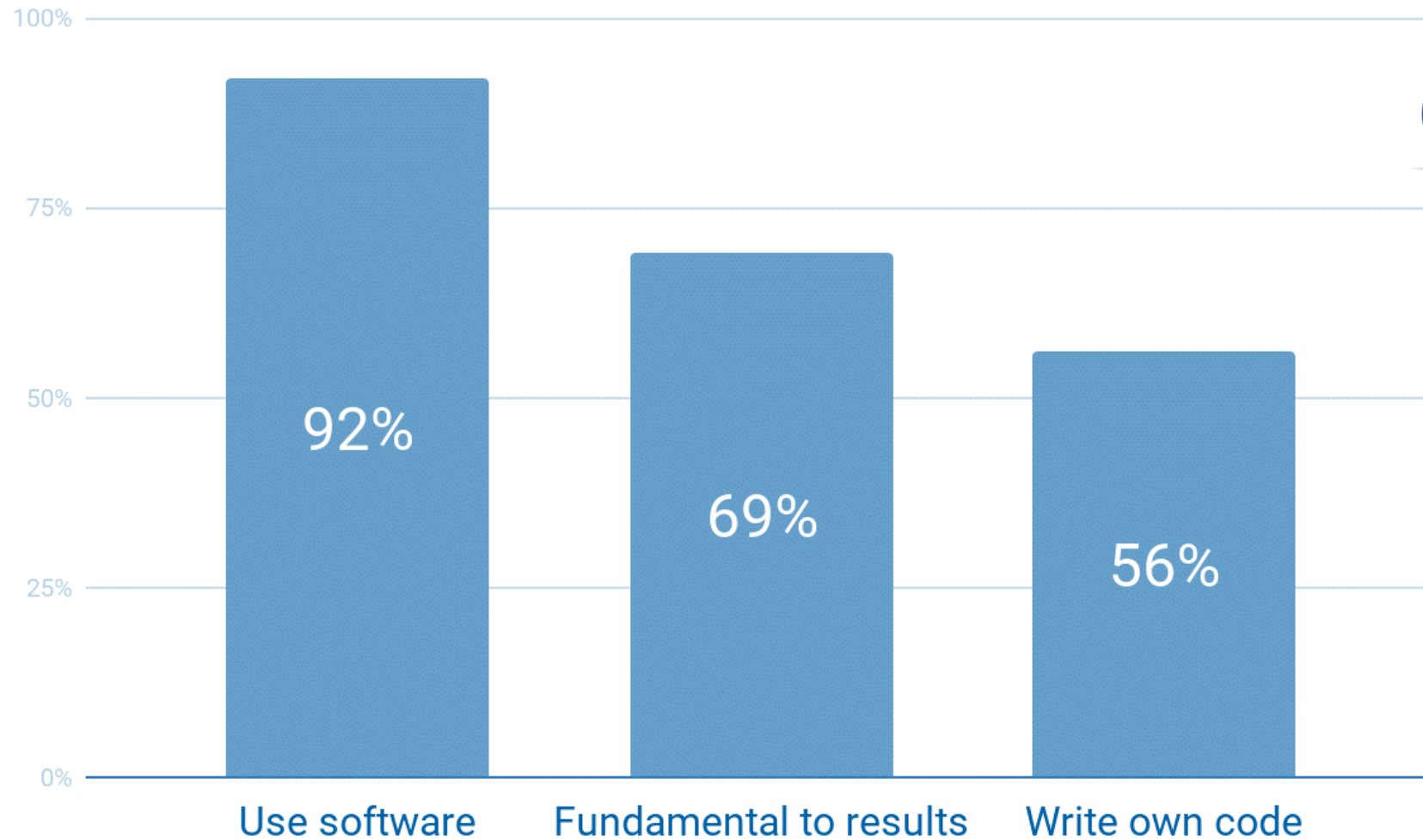
UK Atomic
Energy
Authority





Software in Research

Software is ubiquitous in research



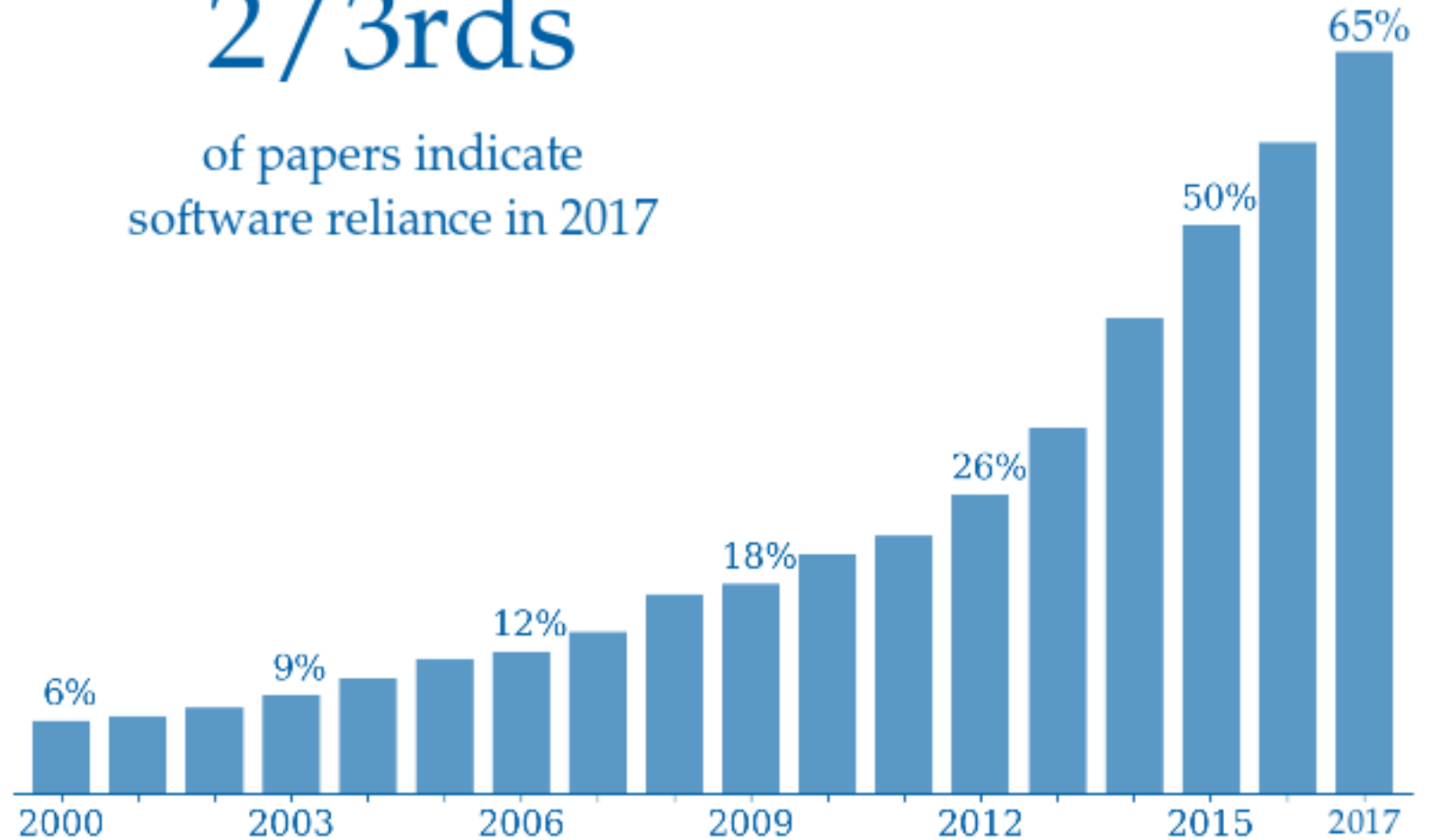
<https://goo.gl/gmHwGm>

Most research is computational



2/3rds

of papers indicate
software reliance in 2017



Need for software experts – convincing others

We need research software to be:

- **Correct** tested, testable
- **Understandable** transparency, sustainability
- **Reproducible** research methods & ethics
- **(Re)Usable** (unlocking knowledge)
- **Easy to change** (new knowledge!)



Why is this so hard?

Who writes research software?

Software
Engineer

Researcher
Developer

Researcher

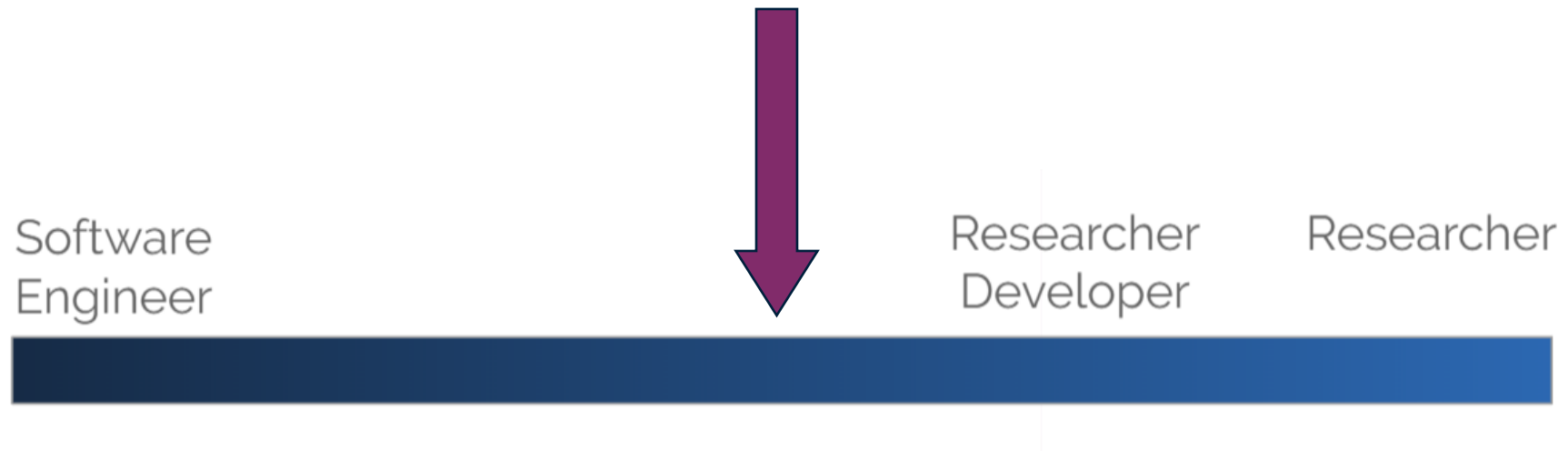


Researcher career structures don't reward software focus

Analyst Developer Analyst Programmer Analyst Programmer - SITS (x 3) Analyst/Programmer Applications Developer Applied Scientist Architectural Robotics Developer Assistant Data Programmer Assistant Project Manager Atmospheric Correction and Radiative Transfer Model Scientist Audio Software Developer - KTP Associate Bioinformatician Bioinformatician In Potato Genomics and Genetics Bioinformatician/Computational Bioscientist in Microbiology Bioinformaticians Bioinformatics Analyst Bioinformatics Postdoctoral Researcher Bioinformatics scientist Biometric Software Systems Developer Biospository Software Developer C++ / 3D Graphics Software Engineer Casebooks Project Editor (Research Assistant/Associate) Climate Researcher (Research Associate) Clinical Study Programmer CoMPLEX Research Associate Computational Biologist / Bioinformatician Computational Scientist Computational Scientist in Computational Fluid Dynamics & Industrial Applications Computational Scientist in Structural Mechanics and Industrial Applications Computer Scientist Computer Vision Researcher Content Developer/Programmer Control Engineer-IMG - 3 posts CREATE Data Specialist Data Analyst Data Integration Coordinator Data Manager x3 Database and Software Engineer Database Manager/Researcher Database Programmer Digital Media Technician E-Learning Portal Manager (KTP Associate) e-Learning Systems Development Analyst e-Learning Systems Development Analyst (Moodle, SQL) E-Learning Web Developer E-Portfolio Learning Technologist Embedded Systems Engineer Engineering Technician Environmental Scientist EPSRC Studentship on Algorithmic Construction of Finsler-Lyapunov Functions Experimental Officer in Bioinformatics Experimental Psychologist Finance Assistant Gaia Alerts Software Developer Gaia Software Developer (Gaia UK Team) GIS Applications Specialist Graduate Programmer / Software Developer Graphics Programmer Health Data Manager / Scientist High Throughput Bioinformatician High Throughput Sequencing Bioinformatician (Two posts) HIVE Manager/ HIVE Co-ordinator HIVE Senior Researcher and Technical Lead Hydro-informatics Scientific Software Developer Image Analysis Manager for Cancer Imaging Information Systems Developer Instrumentation Engineer Investigator Statistician IT Developer IT Services Manager IT Services Specialist (e-Learning Systems) IT Support Technician (Unix / Windows Systems) Knowledge Transfer Partnership (KTP) Associate: Innovent Technologies LTD Knowledge Transfer Partnerships (KTP) Associate - Software Developer (KTP Associate) Robot Motion Scientist (Research Fellow) KTP Associate (Fixed Term Contract for 24 months) KTP Associate (Precision Agriculture Data Analyst) KTP Associate (e-Learning) KTP Associate (Fixed Term Contract for 24 months) KTP Associate: Electronics / Robotics Engineer Learning Technologist Leicester Respiratory BRU IT Developer Lincolnton Psychologist Manager/Project Technician Marie Curie Early Stage Researcher Marie Curie Early Stage Researcher in Radar Rainfall for Integrated Water Quality Modelling Marine Earth Observation Scientists Medical Statistician Medical Statistician/Senior Medical Statistician Metrology Engineer Mobile Application Developer NASC IT Support - Programmer and Systems Administrator (Fixed-term) NIHR Research Methods Fellow PDRAs on EU Project on Automated Multisensor Surveillance Planning Officer Policy Modeller 2014 Post - Doctoral Research Assistant INSTRON Post Doctoral Research Worker Post Doctoral Researcher in the application of Digital Technology Post-Doctoral Research Assistant in Simulation and Visualization Post-Doctoral Research Associate Post-Doctoral Research Associate (Pathogen Genomics) Post-Doctoral Research Fellow Postdoctoral Fellow - population genetics / evolutionary genetics Postdoctoral Fellow in Bioinformatics Postdoctoral Fellow in Cancer Therapeutics Postdoctoral Research Assistant Postdoctoral Research Associate Postdoctoral Research Fellow Postdoctoral Research Scientist Postdoctoral Researcher in Declarative (Logic and Functional) Programming Postdoctoral Researcher Postdoctoral Scientist Postdoctoral statistician Postdoctoral Training Fellow - Statistical and Computational Genetics of Autism Principal / Senior Bioinformatician Principal Bioinformatician Product Development Engineer (Rail) Publishing Portal Web Developer Radio Frequency Engineer Reader in Computer Science Reporting Analyst Research (Software) Engineer Research Assistant Research Associate Research Fellow Research Image Data Manager, Biomedical Engineering Research Officer Research Officer â€” Social Protection Research postgraduate Research Programmer Research Scientist Research Scientist / Senior Research Scientist Research Scientist in Machine Learning and Computer Vision Research Software Developer Research Software Developer for the Herchel Smith Professor of Organic Chemistry Research Software Engineer Research Studentship Research Worker Researcher SAP Trainee Technical Analyst Scientific Officer with Michela Garofalo Scientist SEAHA Studentship: Extracting epidemiological data from collections SEEG Data Archive Manager Senior / Research Associate in Clinical Integration and Image Analysis for Fetal Surgery Senior Analyst Programmer (Business Analysis) Senior Analyst/Programmer Senior Bioinformatician Senior Bioinformatician / Bioinformatician Senior Computational Statistician - Spatial Models Senior Data Acquisition Scientist / Data Acquisition Scientist Senior Data Manager Senior Database Administrator Senior IT Developer Analyst Senior Mathematical Modeller Senior Media Developer Senior Postdoctoral Researcher - Evolutionary and Computational Analysis of Infectious Disease (Phylodynamics) Senior Research Assistant Senior Research Associate Senior Research Associate â€” Molecular Modelling & Simulation Senior Research Associate in Quantitative Clinical MRI Senior Research Fellow Senior Research Fellow/Research Fellow in Vibration Diagnostics and Prognostics/Digital Signal Processing Senior Research Laboratory Technician Senior Research Technician Senior Software Developer in Bioinformatics Senior Software Engineer / Software Engineer Senior Statistical Epidemiologist Senior Systems Administrator Senior Technician / Demonstrator (UCMK) Senior Web Developer SharePoint Developer Software Developer Software Developer (Bioinformatics) Software Developer (KTP Associate) Software Developer x 2 Software Developer/Programmer Software Developers in e-Learning Software Engineer Software/ Database Developer (KTP Associate) Sports Programme Manager Statistical Geneticist Statistical Programmer/Data Scientist Statistician Statistician/Epidemiologist Student and Enrolment Services Manager SWCAR Information Assistant System Administrator Systems Developer Systems, Data and Applications Team Leader Teaching Fellow in Computational Methods UTRCI Research Scientist, Control Systems Web Application Programmer Web Developer

194 different job titles

Research Software Engineer (RSE)



**Professional software engineering
+ understanding of research**



Modern research is
team research

What do RSEs do?

Build **quality** software as **part of** research projects

Help researchers to...

- Navigate computing infrastructure
- Learn software skills
- Establish good practices



A brief history of the RSE
movement in the UK

2012: Origin of the RSE movement

Term
RSE
Coined



2012

SSI Collaborations Workshop



Term **“Research Software Engineer”** adopted



Late 2012: First University RSE group

Term
RSE
Coined

First
RSE
Group



2012

First University RSE Group - late 2012
University College London
(James Hetherington)

"New model of organising software
expertise in a University"



2013/14: UK RSE Association



RSE Workshop - Sep 2013



“Should we create a community to represent RSEs?”

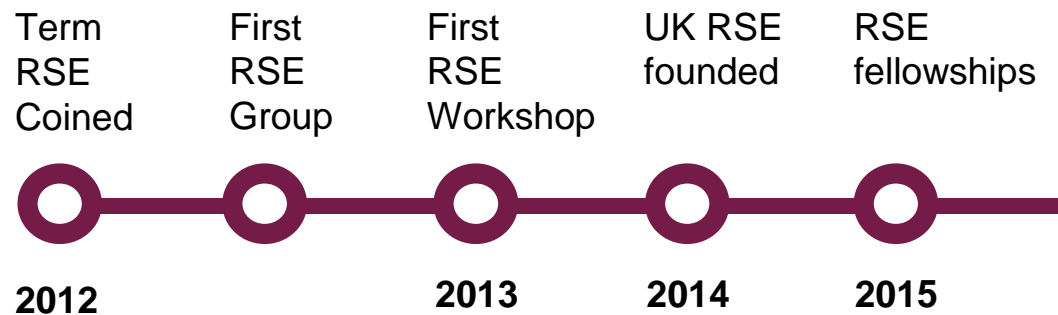
UK RSE founded 2014

160 members in 3 months

First elected committee - late 2014



2015/16: Growing awareness and support



Support from funders: fellowships created

Growth of networks & groups

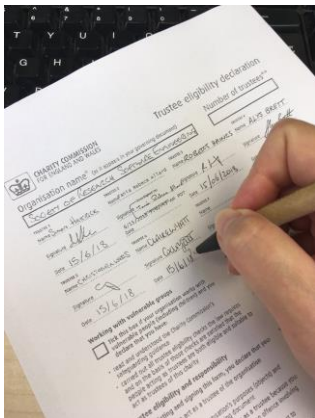
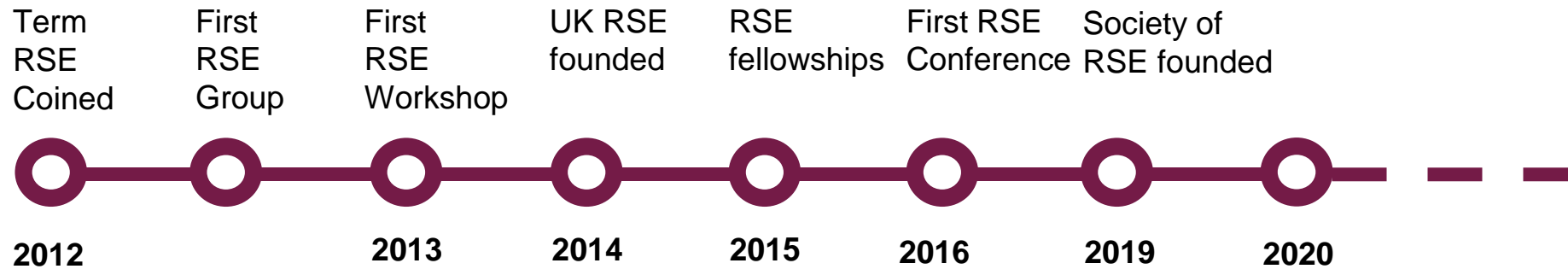
- RSE network + coordinator role
- More RSE groups around the country



2016: First RSE Conference



2019 - 2020: Establishing an independent organisation



Membership and community



Full voting members:

350



Mailing list:

700 members



Slack:

2112 members



Twitter:

4714 followers



RSECon 16
204 attendees



RSECon 18
334 attendees



RSECon 17
224 attendees

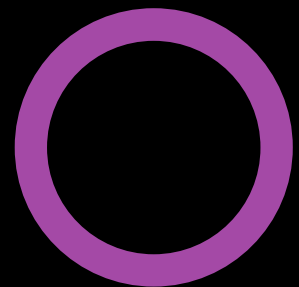


RSE Con 19
360 attendees

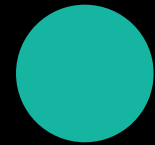
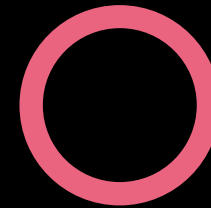
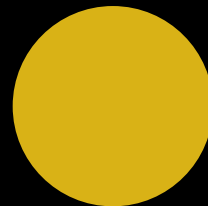
2020: Series of Online Research Software Events

Rolling programme of talks, workshops,
demos, discussions and more...

<https://sorse.github.io/programme/>



SORSE



Next steps



New president: Paul Richmond

6 new board members

- ▶ Sponsorship for events
- ▶ Links with other organisations
- ▶ Engagement with commercial companies
- ▶ Working Groups of members
- ▶ Mentoring program



RSE Groups



Benefits of RSE groups

For RSEs



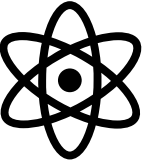
- ✓ Stable careers
- ✓ Peer group
- ✓ Recognition & development

For research projects



- ✓ Flexible access to expertise
- ✓ Sharing between projects
- ✓ Access to niche skills

For researchers



- ✓ Help & advice
- ✓ Training
- ✓ Infrastructure
- ✓ Focus for wider network

The growth of RSE groups in the UK

28 groups in 2020

Average annual growth rate
~30%



RSE Leaders networking and support

Changing roles and structures in traditional institutions is hard

RSE leaders peer support network

Online discussion and twice-yearly meet up

Aspiring RSE Leaders Workshop (2019)

Providing new and aspiring RSE leaders in the UK with the knowledge and network needed to drive the expansion of RSE groups



International RSE activity



International RSE associations

USA:
www.us-rse.org

Nordic Countries: www.nordic-rse.org

UK: www.society-rse.org

Netherlands: nl-rse.org

Belgium: www.be-rse.org

Germany: www.de-rse.org

Australia & New Zealand:
<https://rse-aunz.github.io>

South Africa:
<https://rsse-africa.sanbi.ac.za/>

International RSE leaders workshops

Bringing together RSE leaders from around the world to help each other by pooling knowledge, coordinating efforts & establishing collaboration.

Read more at researchsoftware.org

2018 - London



The Alan Turing Institute

EPSRC

Engineering and Physical Sciences Research Council

October 2020 - Online



Nordic RSE community

2020



Nordic-RSE
initiative
started

First Nordic RSE
meet-up

?



What's next?

How can you help?



BIG GOAL

SMALL

STEPS



COMMUNITIES

ARE

POWERFUL

Thankyou!

Contact alys.brett@ukaea.uk [@alysbrett](https://twitter.com/alysbrett)

Acknowledgements



The RSE community is the result of the combined efforts of many people including current and past RSE committee members and conference organisers



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