# EXCALIBUR PROJECT NEPTUNE KICK-OFF MEETING

Wayne Arter, on behalf of UKAEA

Zoom, 14th January 2021



UK Atomic Energy Authority

# AGENDA

## Rob Akers UKAEA PI Neptune in chair

| | | |
|---|---|---|
| Wayne Arter, UKAEA | 9.05-9.20 | Introduction |
| Ben Dudson, York | 9.20-9.45 | Plasma fluid referent model via exploratory Proxyapps |
| Steven Wright, York | 9.45-10.00 | Investigate DSL and code generation techniques |
| ---Break--- | | |
| Dave Moxey, Exeter | 10.20-10.50 | Performance of Spectral Elements |
| Felix Parra, Oxford | 10.50-11.10 | Referent model for plasma edge region |
| ---Break--- | | |
| Peter Challenor, Exeter | 11.20-11.35 | UQ (UKAEA funding outside ExCALIBUR) |
| Sue Thorne, STFC | 11.35-11.50 | Investigate matrix-preconditioning techniques |
| Peter Coveney, UCL | 11.50-12.05 | Study of Uncertainty Quantification (UQ) techniques |
| Serge Guillas, UCL | 12.05-12.20 | Study of Model Order Reduction (MOR) Techniques |
| Ben McMillan, Warwick | 12.20-12.35 | Optimal Use of Particles |
| ---Short break--- | | |
| Discussion | 12.40-end | |

# Contents

1. Preliminaries
2. Next 6-9 months
    a) Useful Information
    b) De-risk
    c) Steer
3. Points arising during meeting

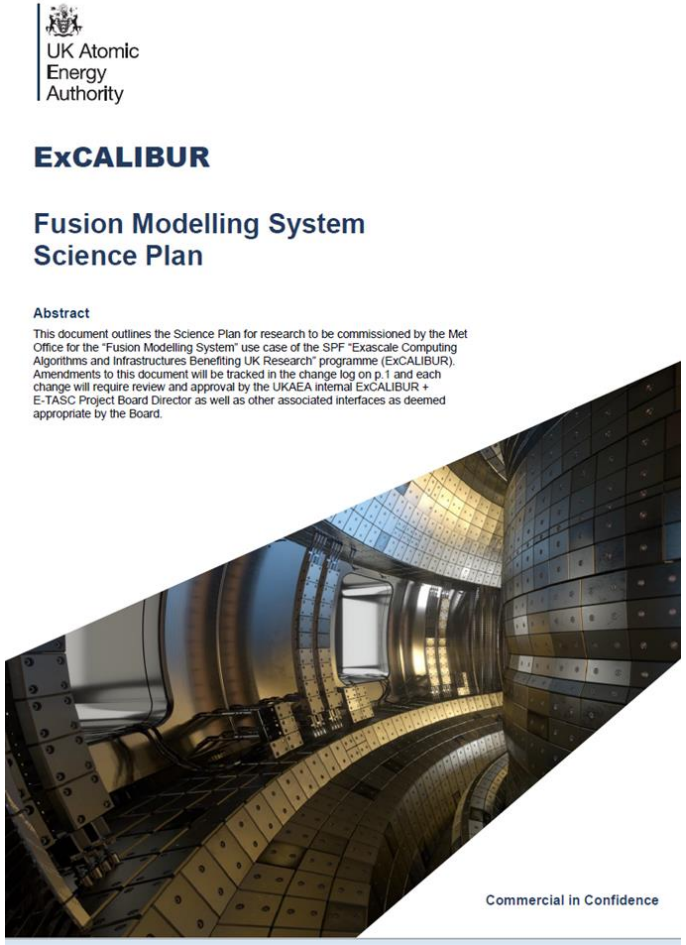
# 1. Preliminaries

## Thank you

# Once in a generation opportunity

## Update fusion plasma physics code design, processes and workflows

- For the Exascale, exploiting hierarchical architectures and/or GPU, with
- Object-oriented data structures
- *hp*-adaptive finite elements, possibly ‘reduced-noise’ particles
- Tight coupling, with e.g. enslavement to treat multiscale effects
- Sparse matrix solution by preconditioned iterative algorithms
- Inbuilt UQ by ensemble calculations, model reduction/surrogate, or otherwise
- Capability for integration into reactor design workflow
- Team and community effort



# 2a. Useful Information

https://github.com/ExCALIBUR-NEPTUNE/Documents

Redacted versions of winning bid documents, and LaTeX versions of work performed by UKAEA staff to date

tex/t12/rp1 Year One Summary Report
t21/rp1 Options for Geometry Representation
t23/rp1 Options for Particle Algorithms
t31/rp2 Report on user frameworks for tokamak multiphysics
t31/rp3 Report on user layer design for Uncertainty Quantification
t33/rp2 Report on design patterns specifications and prototypes
t33/rp3 Design patterns evaluation report

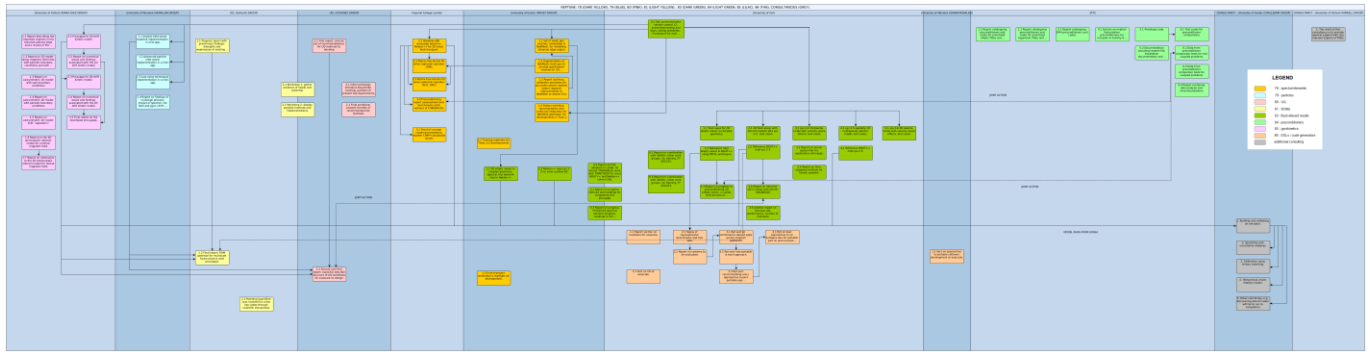
Lockdown implications – ultimate decision rests with BEIS

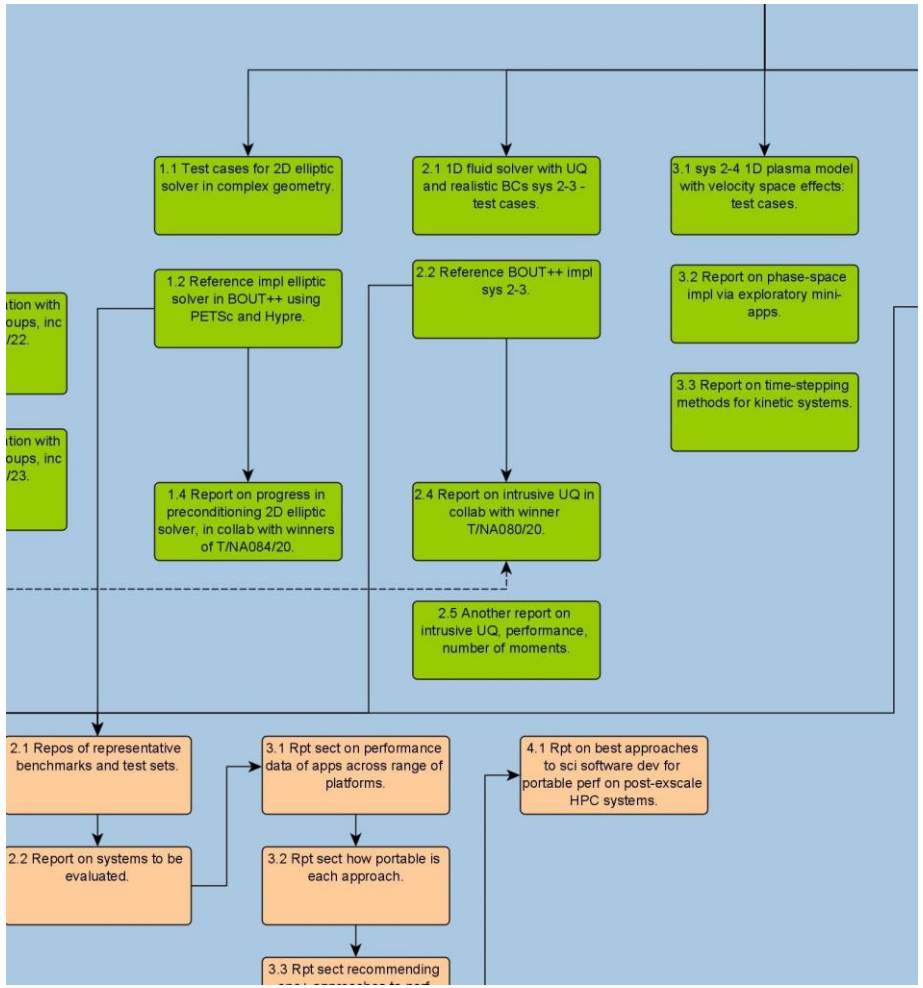
Mid-March meeting - features to lighten the reporting load

Fortnightly meetings to report work performed - accompany by one interesting/relevant/timely talk of 20-50min

Canonical slide format available

# Graphical interactions between Tasks





# 2b, 2c. De-risk and Steer

## Fusion Modelling System by Call Number

- Enable CCFE to possess a finite element and particle code for tokamak edge modelling that is ‘maintainable’ and ‘actionable’, developing via a series of proxyapps, each of which might be separately useful (T/NA083/20)
- *hp* finite elements to provide machine precision accuracy. Example of UK-based development of spectral/hp element package Nektar++ including Nekmesh (78)
- Desirable to have gyro-averaged plasma model (85)
- Establish state-of-the-art and future trends in key areas – particles (79), UQ (80), MOR (81), Preconditioning (84), DSL/code generation (86)

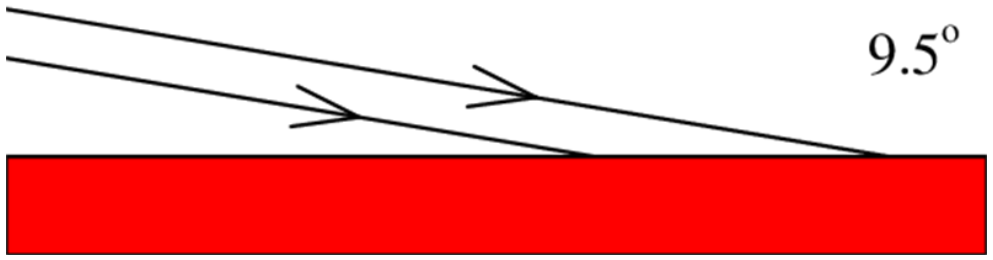
Larger T/NA078, 83,85 offered

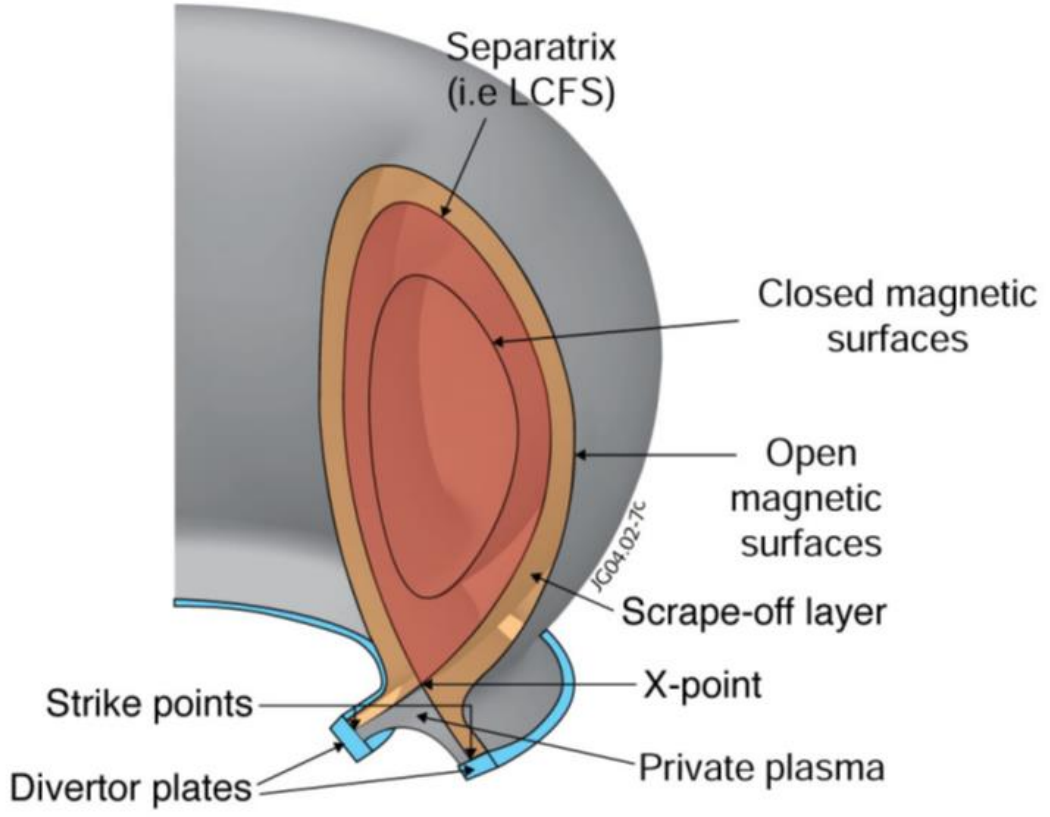
- Enough resource to fund a postdoc
- Weighted towards “Alignment to Work Package objectives”

# 2b. De-risk (T/NA078, 83)

## Demonstrate application of spectral elements to special issues of tokamak edge

1. Interaction with neutrals leads to large sources and sinks of mass and momentum
2. Flow into engineered surface at approx. sonic speed
   *Two-degree* incidence design
3. Magnetic field causes anisotropy
   $10^5$ factor possible in spatial scale



# 2c. Steer

## Next few months are critical

Settle on ways to collaborate, e.g. Slack Channel versus email

Take major decisions regarding algorithms, libraries, design patterns, outline interfaces etc.

# Points during Meeting

1. You are allowed to edit slides for material not intended to be made publicly available (assuming you want published).
2. *Please* get training in use of git, UKAEA can help provide, ask on Slack.
3. We started collecting acronyms and symbols, see https://github.com/ExCALIBUR-NEPTUNE/Documents subdirectory tex/index_of_acronyms_and_symbols
4. We hope to keep reporting light – but do please let us know if you have significant (=affect deliverable) problems

And

Enhanced script is to be found in this same kom_documents directory