EXCALIBUR – EXPLOITING THE EXASCALE TO BOTTLE A STAR

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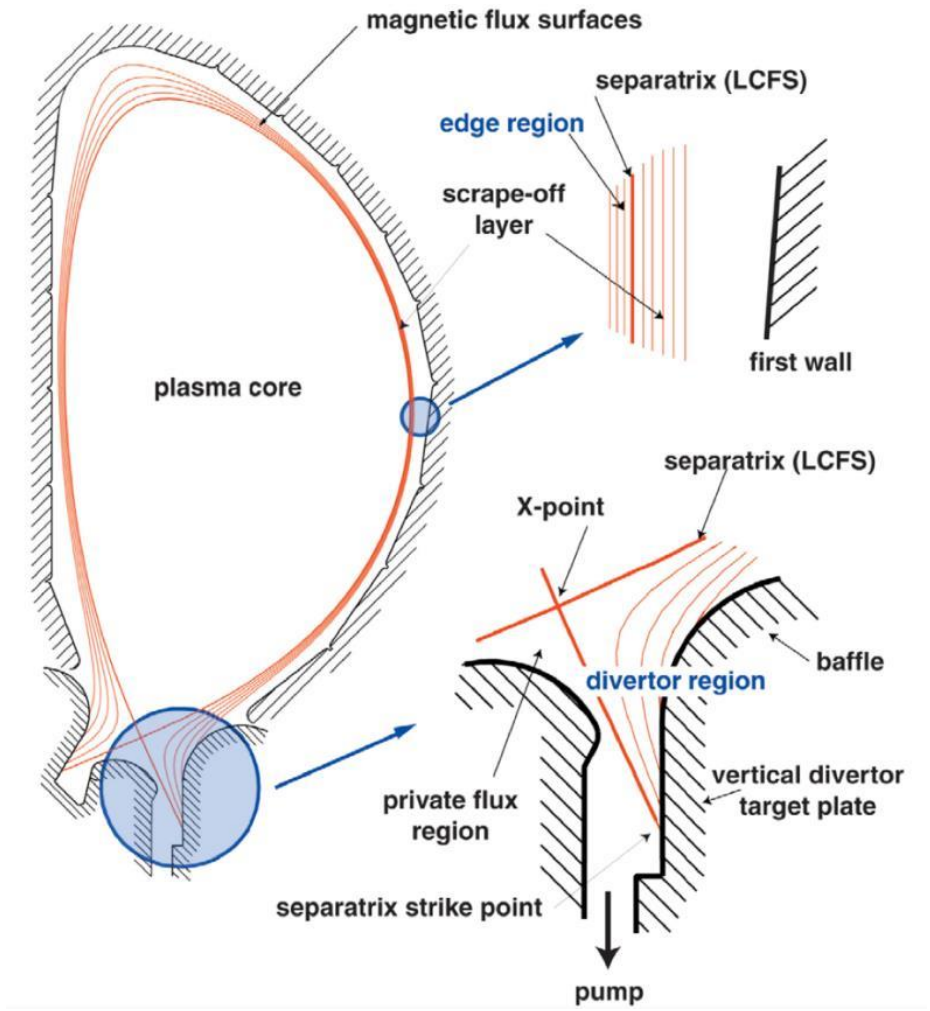
Why “ExCALIBUR”?

….build a UK wide “rainbow” team – take a multi / interdisciplinary approach

- Legacy codes tend not to be “actionable” **- VVUQ**
- Codes usually designed for “science”, not “engineering” **– MOR** methods not built in
- Codes designed in isolation – not designed for **“coupling”**
- Codes are always designed for one architecture – inflexible – not designed for **emerging architectures** or with **performance portability** in mind
- Codes are nearly always incredibly hard to adapt – many started off as PhD. projects – lack of **DSL based APIs**

NEPTUNE High Priority Use Case

Neutrals and Plasma Turbulence Numerics for the Exascale

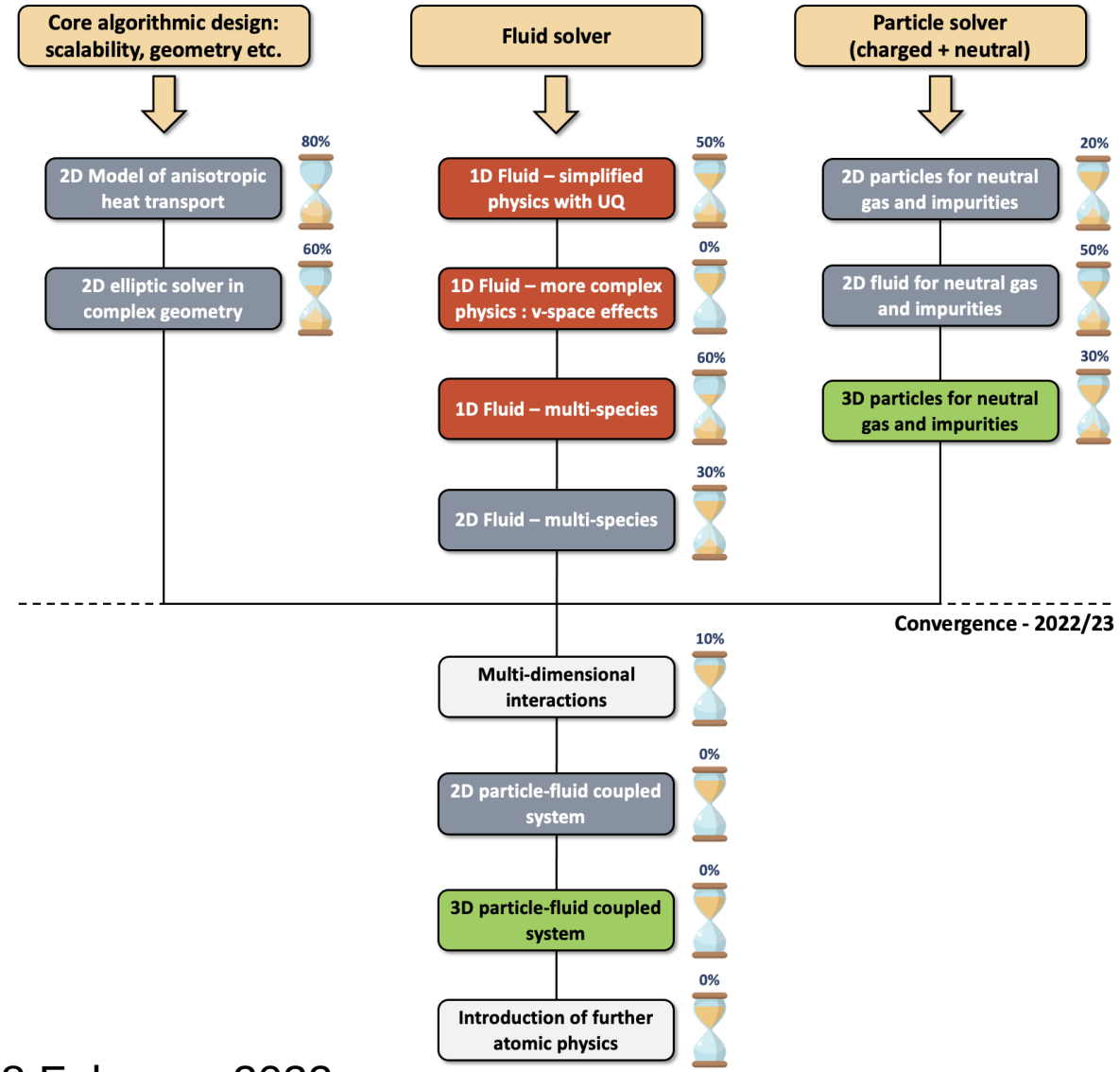


Modelling the plasma edge or 'exhaust'

- A long established exascale **grand-challenge, Multi-physics, Multi-scale** problem
- Complexity – **turbulence**, **atomic physics** etc.
- Incomplete mathematics ($1M Millennium Prize)
- For plasma, kinetic effects can't be ignored – requires **coupled fluid + particles**

Requires an interdisciplinary rainbow team...

Development by Proxyapps



NEPTUNE

1. Fluid solver: High order spectral-hp
2. …coupled to FEM-PIC
3. Performance Portability (SYCL/OneAPI)
4. Next gen Preconditioners (MCMC and Structure preserving methods)
5. Built in UQ and Model Order Reduction
6. Time stepping – parallel in time?
7. DSL front end (Julia?)
8. Converge Proxyapp based research in 2022 to start building full code/library