

# Nektar++ / anisotropic diffusion breakout session

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## Slides from chair

- Overview of anisotropic diffusion problem and Nektar proxyapp
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## Anisotropic diffusion proxyapp

- UKAEA interested in shallower angles of incidence, more extreme anisotropic ratios (at least 10-8) than used in Nektar thus far
  - Quite a bit of discussion on how to mesh the problem appropriately
    - Nektar team have tried i) band of smaller elements on the boundary, ii) using unstructured mesh
    - SM comments:
      - A French group have a [paper](#) on a similar problem using HDG (Nektar is using CG)
      - Probably want unstructured grid for neutrals, structured grid with more resolution for plasma
    - PF comment:
      - Might be better to decouple AD from the discontinuity and build a proxy app to look at the closed field line region instead
    - General agreement that mesh orientation is crucial
  - SM question: how well can spectral element methods handle v-space cut-offs? Effectively, they move the boundary in position-space, such that it can intersect elements
  - DM: Could treat it like a shock problem and compress the mesh?
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## (Coupled) slot convection problem

- Concern from UKAEA side that Firedrake model is only coupled in one direction - no back reaction from second model
  - Didn't seem to be much enthusiasm from UCL for further development to improve Firedrake model
  - UCL's main interest is building reduced order model, comparison to Smallab data
  - Suggestion for OP to implement CWIPI-coupled model in Nektar; incompressible NS solver in water, ADR in metal
  - Nektar-CWIPI already used for two-way coupling (for a combustion use case), but not "boundary coupled" in this way before
  - Lots of discussion on how to couple the two domains at the boundary - clear that a single wall temperature isn't good enough
  - Whether to concentrate on 2D or 3D?
    - 2D for now, but 3D with FabNEPTUNE eventually
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## Nektar development

- When can FEEC be incorporated?
  - Probably needs a dedicated student/postdoc

- Wouldn't really make sense to incorporate in existing code restructuring - basis function infrastructure is lower level than that
  - Could possibly do this in NEPTUNE 2, but DM happy to look at adjusting current workplan to accommodate
  - PF comment: Not as simple as just adding the new elements types - the sum factorisation trick wouldn't work for Hdiv, Hcurl-conforming elements without modification
  - For the naive approach, evaluation cost goes like  $p^{2d}$ ; sum factorisation gets you  $p^{d+1}$
  - Some discussion (PF, SM) of using "Serendipity" elements, but conclusion was they are only fast in limited set of circumstances
  - Is support for geometric multigrid on the roadmap?
    - Some work started with Hari Sundar (Utah) using Dendro(?), but early days at the moment
  - How is the higher-dimensional work going?
    - Slow progress at the moment; confident Vlasov-Poisson will be quick, 6D advection problem much more challenging
    - Product-of-vector-spaces approach will almost certainly improve scalability of 6D problem, but not clear by how much yet
  - Anything we can do to make Nektar collaborations with UKAEA / Other grantees work better?
    - More frequent interactions to head off problems
    - e.g. MCM preconditioning work with STFC suffered from patchy remote communication
  - Any plans to introduce adjoint solvers?
    - Not really on radar at the moment
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## General NEPTUNE

- Potential improvements to PMs
    - Breakout sessions to help subgroup collaborations (lots of enthusiasm for this)
    - RAG reporting via email, separate from PM, or perhaps a much shorter reporting section in the PMs, leaving more time for breakouts
  - More in-person meetings between grantees (ET: also looks good on MetOffice reports)
  - Is BOUT++ still involved?
    - Less emphasis since Ben Dudson left, York has some proposals to continue that work
  - DB's plan to continue NEPTUNE involvement?
    - Somewhat restricted by Leeds requirements - current plan might need adjustment
    - More engagement with UKAEA would be good
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## UQ-related

- How to approach UQ in Neptune?
  - Stress test of UQ methods for Exascale?
  - Stress test of UQ methods for coupled models?
- PF question: Any plans for UCL to do multi-level Monte Carlo (MLMC) analysis?
  - Not in UCL's plan before 2024 end, but potential to work on it out-of-scope (!) Might actually save everyone time in the long run...
  - Some discussion of related Nektar functionality that would be required for this (propagating initial guesses between p-levels / h-levels - former being worked on with Tim Dodwell, latter is

trickier)

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DM: Dave Moxey

ET: Ed Threlfall (Chair)

OP: Owen Parry

PF: Patrick Farrell

SM: Stefan Mijin