

## Responses Regarding Functional-Area Plans

2018-05-04

Mike Sprague, Srin Arunajatesan, Shreyas Anathan, and David Maniaci met on April 30 - May 1, 2018 at NREL, to discuss the plans submitted by the A2e HFM and ExaWind functional-area planning teams. Thanks to everyone for the prompt turn-around!

Overall, the plans were solid in addressing the needs of the functional areas, and they had FTE allocations that were close to expectations (and resources available). In some cases, more coordination between functional areas is needed, and some resource modifications are needed. We discuss below specific points for each functional-area plan.

Along with this note, team members should consult the FTE allocation spreadsheet (attached with this message) that shows FTE distributions for each functional area and for each ExaWind and HFM team member. In considering staff distributions (as listed below for each functional area), the leadership had to balance resources, expertise, and individual interest. Importantly, we aim to **minimize fragmentation of individuals**.

Functional Area teams are requested to modify their plans to address the comments below and to submit those plans **no later than 14 May 2018**. Note that as we move into FY20 and closer to Phase 2 of ExaWind, we will likely down select on certain areas. **For each functional area, please verify that the associated plan has the following:**

- Goals/motivation and objectives statements (some groups only provided spreadsheets);
- Spreadsheet with tasks and time lines (some groups only provided lists of tasks, which made dependencies and timing difficult to follow) – an Excel spreadsheet is preferred, which will facilitate combining timelines into a single file;
- List of potential journal papers and likely conference attendance (in several cases time for writing papers and preparing talks was not called out).

## ExaWind Exascale Computing Project

### Nalu-Kokkos Integration

Team: *Domino*, Williams, Ananthan, Overfelt, Knaus, Rood, Roberts

FTE: 1.6 FTE/year

Comments:

- In regard to item 10 “non-fluids demonstration on a GPU”, dependency on solvers teams should be addressed.
  - Some clarification on what solver capabilities will be needed for this demonstration will be helpful for the solvers team.
- In regard to item 14 “fluids demonstration on a GPU”, please specify a specific case - something like the McAlister blade or one of the other demos planned in the Hybrid RANS-LES functional area.
- FTE resources allow for 1.6 FTE/year, but we acknowledge that number should be closer to 2.0.

### Solvers - MeuLU/Tpetra/Belos

Team: *Hu*, Prokopenko, Rajamanickam

FTE: 0.75 FTE/year

Comments:

- We added Rajamanickam to address Belos (momentum solve) related work, which should be called out more in the plan. – This was an oversight on our part in not calling for this earlier.
- Describe coordination with Hybrid RANS/LES functional area for appropriate proxy tests.

### **Solvers - BDDC**

Team: *Dohrmann, Domino, (Williams??)*

FTE: 0.48 FTE/year

Comments:

- Please remove the proposed work on a monolithic formulation, or provide strong existing evidence from literature that the resource investment will be worthwhile. Given resource limitations, this may be an option better pursued in Phase 2 of the project beyond FY20Q4 timeline.

### **Solvers - Hypre**

Planning Team: *Thomas, Świrydowicz, Ananthan*

FTE: 2.10 FTE/year

Comments:

- “Actions” need to be re-framed as “outcomes”, e.g., too much “Study”; how will those outcomes impact the use cases?
- Timeline is not clear (Gantt chart needed).
- Matrix reinitialization work should be moved earlier as it is high priority.

### **Turbulence Modeling - Hybrid RANS-LES**

Planning Team: *Moser, Melvin, Henry de Frahan, Barone*

FTE: 1.75 FTE/year

Comments:

- This is an important area, and we will pursue additional resources in ECP plus-up scenario.
- Please discuss/propose moving FY19 Q3 to FY19Q4.
- Validation seems overly ambitious; please comment.
- How does LES-only work align with the HFM LES functional area (lead by Yellapantula)? This work is focused solely on the hybrid model being developed at UT. How does this reconcile with the plans in A2e, which are strongly focused on the one-equation model based approaches.
- Will there be a comparison with the SST-DES capability now in Nalu?
- Concerned that the ABL capability needs more focus. Is the team considering literature regarding large domain LES of ABL (and in different stability regimes)?
- Please comment on addressing LES performance in transitioning across large gradients in mesh size (e.g., in nested meshes).
- Past experience suggests modeling lift, drag, and moment forces for the range of airfoils along a wind turbine blade is difficult. Coordinate with ECP- and A2e-Integration/Demonstration areas to validate the predictive capability for the 2D airfoils along the blade of the final use case.

## Spatial Discretization

Planning Team: *Knaus, Domino, (Capone)*

FTE: 0.25 FTE/Year

Comments:

- Staff availability/distribution only allowed 0.25 FTE/year, but more resources are clearly required, e.g., 1.0 - 2.0 FTE/year. Capone (ORNL new staff) will likely be able to engage at a significant level starting in August 2018.
- Please comment on possibility of partnership/collaboration with CEED ECP; e.g., shared milestone.
- Propose FY19 Q2 milestone mod to reflect plan
- Please drop #7 "Evaluate alternative high order discretization", which can be proposed in phase 2 of ExaWind project, but is seen as out of scope/resources here.
- #6 "write report" should be an assessment of the FY19 Q4 milestone. A concrete statement about the value of the higher-order schemes in terms of time to solution in this report would be helpful in planning the FY20Q4 use case.
- Comment on how #8-13 depend on outcome of #6 and hardware developments (e.g., GPGPU status); these tasks should only proceed at current levels only if supported by outcomes.
- Comment on evaluation of performance, which should focus on accuracy vs. time to solution (in addition to accuracy vs. model size). CTV is likely a good test case.
- For demonstration, please consider relevant problems like McAlister blade.

## Sliding Meshes

Team: *Domino, Barone*

FTE: 0.18 FTE/year

Comments:

- There was a question about the requirement of #2 given #6 (misabeled #5 in plan); please consider if they can be combined.
- #1 should depend on outcome of FY19-Q2 milestone: Memory reduction techniques for higher-order simulations.
- Timeline seems too aggressive; please verify or describe need for additional FTE.

## Overset NGP

Team: *Ananthan, Rood, Sharma, Yellapantula, Sitaraman*

FTE: 1.20 FTE/year

Comments:

- Modify high-order work timing to reflect outcomes of FY19-Q2 milestone: Memory reduction techniques for higher-order simulations.
- Due to resource constraints, recommend removing hybrid DG/overset algorithm development.

## **Integration/Demonstration**

Team: *Barone, Lawson, (Capone)*

FTE: 0.45 FTE/year

Comments:

- Plan looks good, but needs more FTE assigned than currently available.
- Past experience suggests modeling lift, drag, and moment forces for the range of airfoils along a wind turbine blade is difficult. Coordinate with A2e-Integration/Demonstration and Hybrid RANS-LES areas to validate the predictive capability for the 2D airfoils along the blade of the final use case.

## **Visualization & Pre/Post-Processing**

Team: *Gruchalla*

FTE: 0.17 FTE/year

Comments:

- Likely requires more FTE assigned than currently available. Please comment on hiring plan.
- Please expand plan to consider the tools required by the A2e HFM "Analysis Utilities" area; it is likely that catalyst will be able to provide the particular analysis tools required.

## **Atmosphere to electrons High-Fidelity Modeling (HFM)**

### **Actuator Disc/Line**

Team: *Churchfield, Martinez*

FTE: 0.35 FTE/year

Comments:

- Plan seems too ambitious with respect to other high priority items; please modify work plan to reflect no more than 0.35 FTE/year.
- Please describe intended impact of advanced AL/AD work; what are the quantities of interest?
- Work items that would lie in OpenFAST (e.g., dynamic stall improvements) belong in the OpenFAST task and should be removed here (but can be called out as needed improvements).
- Please comment on appropriate timing of the currently planned FY19 Q2 milestone.

### **FSI - OpenFAST Coupling**

Team: *Sprague, Vijayakumar, Sharma*

FTE: 1.10 FTE/year

Comments:

- Planned work seems ambitious; please verify. Is additional staff required? Please comment on need to front-load staff in FY18 and first half of FY19.

- Concern with FSI validation is that any study in a regime with significant body motion will have great turbulence-model uncertainty. Testing of multiple airfoils is desired, for lift and drag under unsteady motion that are representative of wind turbine airfoil ranges.

### **ABL - Wall Models & Other BCs**

Team: *Churchfield*, Barone (wall models)

FTE: 0.25 FTE/year

Team: *Churchfield*, Knaus, Lund (other BCs)

FTE: 0.55 FTE/year

Comments:

- Where do the efforts for a simple OWEZ-relevant wall model reside?
- Please described more details around advanced wall modeling. What are the driving gaps? How are these efforts supporting the overall use cases? Does the plan need to include a task around these assessments?

### **Turbulence Modeling - LES**

Team: *Yellapantula*, Vijayakumar, Ananthan

FTE: 0.50 FTE/year

Comments:

- The plan calls out for more staff than available; please modify plan or state needs for additional FTE funding. Consult with Integration/Demonstration teams to see if some validation can occur there.
- Please coordinate with ECP Hybrid RANS-LES area; teams should have similar success metrics for ABL, e.g., capping inversion.
- This modeling approach seems heavily weighted in favor of the one-equation model based approach. How does this reconcile with the hybrid RANS-LES modeling approach in Exawind?

### **Overset Algorithms**

Team: *Ananthan*, Yellapantula, Fabiano, Sharma

FTE: 1.35 FTE/year

Comments:

- See above.

### **Uncertainty Quantification**

Team: *King*, Hamlington, Eldred, Frankel

FTE: 0.73 FTE/year

Comments:

- Planned work far exceeds available resources; please down-scope planned work under current FTE and propose plus-up-scenario work.

- The plan is too disjointed; please re-configure (and down-scope) the tasks into a more coherent plan directed at assessing uncertainty in the project use cases and how this UQ plan supports the HFM/ECP goals.

### **Integration/Demonstration**

Team: *Lawson*, Martinez, Blaylock, Bruner, Ananthan

FTE: 1.03 FTE/year

Comments:

- The demos and validation studies in this functional area should be with *integrated* capabilities. For example, the ABL-only simulations/validation should be done in the ABL area. Please work with other areas to reconcile overlaps.
- Add task on pursuing/developing NDA with Siemens for validation collaboration, or as coordination with related projects.
- Coordination with the Integration FA in Exawind to ensure both use cases are fully covered is needed.
- Past experience suggests modeling lift, drag, and moment forces for the range of airfoils along a wind turbine blade is difficult. Coordinate with ECP-Integration/Demonstration and Hybrid RANS-LES to validate the predictive capability for the 2D airfoils along the blade of the final use case.

### **Utilities For Analysis**

Team: *Ananthan*, Churchfield

FTE: 0.08 FTE/year

Comments:

- The available FTE was low here, but many of the tasks under “post-processing utilities” can/will be addressed in the ECP Visualization functional area; please coordinate.
- In regard to the FY18 Q4 HFM milestone, we may need ECP Viz utilities in place to be documented.