Dear authors, please see below the comments from the peer review:

Reviewer 1: In general, the paper gives a broad overview of many different efforts ongoing at NRG. The work described is both novel and highly relevant to the field of fast reactor thermal hydraulics. However, the paper is somewhat lacking in specific details with many references provided to provide more insights into the work.

I feel the discussion in section 5.1 is particularly lacking in details. Specifically, more information of the multiscale modeling should be provided in this paper including which reactor components were modeled with system thermal hydraulic techniques and which were modeled with 3D CFD, as well as the information transfer that occurs in the coupling scheme.

We have a separate paper at the meeting about the coupling methodologies in which more details are explained which could not be included in this paper because of page limitations. We added now a specific reference to that other paper in Par5.1.

The paper is 13 pages in length excluding the references section (16 pages if references are included). I am not sure how strict the 10 page length recommendation is. I feel it will be hard for authors to maintain the same format of this paper while reducing the length down to the 10 page limit as the paper already contains a very concise description of many different topics. It may be better for the authors to create two papers (i.e. one presenting the modeling results presented with spectra and 3D CFD, and one presenting the coupling strategies with preliminary results). This would have the added benefit of allowing the authors to expand more on each topic.

Originally, two papers were foreseen. One paper exclusively dealing with the STH SPECTRA developments and one paper on the CFD and multi-scale aspects. It was recommended to merge these papers.

Reviewer 2: This paper presents a good overview of NRG's activities in the PIONEER program. Some minor suggestions for improvement are:

-Ch2: It would be nice to if the author could add a few words on the relative position of LMFR, HTGR and MSR in the PIONEER program.

Added: ‘Currently, the emphasis in PIONEER is on molten salt systems, while the efforts on high temperature and liquid metal fast reactors are mainly but not solely carried out in European collaborative projects and international benchmarks e.g. organized by the IAEA and the OECD/NEA.’

- Par3.1: Can you add a few words on the motivation behind the in-house development of SPECTRA?

Added: ‘allowing to have full control over the code and easy implementation of new models’

-Par3.2: Does any of the SPECTRA validation cases include neutronic feedback? How is the validation of the neutronic model taken care of?

Added in Par3.1 that: ‘All SPECTRA developments, models and verification and validation efforts (https://dyfuzjastudio.com/marekstempniewicz/files/Spectra-Vol3.pdf) are documented in the code manuals [5]’.

-Par3.3: Can you make a conclusion on the basis of the validation activities w.r.t. the capabilities and shortcomings of the code? Further developments to be done?

There is no Par3.3, however we consider that the question is related Par3.2. The validation activities and applications to this date have not resulted in further needs for development in the area of liquid metal fast reactor applications. However, the reviewer may notice that severe accidents have not been considered yet. So, that would be an obvious future development.

We added the sentence: ‘Please note that the applications do not extend to severe accident conditions. Based on needs, this could be a future development.’

-Par4.2&3: See previous comment.

For Par4.2 it is already mentioned that ‘the validation status for non-ideal cases, like deformed or blocked fuel assemblies is much less mature. Recognizing this, in the more recent European collaborative projects, an effort has been made to create new datasets for validation and, related to that, new simulation campaigns are under preparation at NRG to support these experiments and finally use their data for validation.’

For Par4.3 it is already mentioned that ‘Components like the reactor core, heat exchangers, and pumps still require careful attention.’ The following sentence has been added: ‘Especially heat exchanger modelling is being further developed at NRG.’

-Par5.1: it would be nice to compare the performance of the coupled approach to the stand alone approaches shown in fig. 4.

This is a good suggestion. We added a figure (10) showing a comparison between STH only and a coupled simulation in which the complex transient behavior resulting from 3D effects is clearly captured by the multi-scale simulation but misses in the STH only simulation.

Dear authors, please submit a revised paper addressing minor comments above by 20 September. It is not needed to cut the paper down to 10 pages but please do not expand beyond 16 pages.

Even with the requested additions and changes by the reviewers, we managed to reduce the total amount of pages to 15 by decreasing the size of some of the pictures.

You may apply the modifications to your paper and submit the modified version (together with any additional files) for review.