Reviewers' comments:  
  
Reviewer #1: This manuscript presents a model to study the effects of injected interstitials in void swelling. The model is based on classical rate theory and equations are solved by finite element method. The model well predicts the formation of two swelling peaks, stemmed from injected interstitials and surface effect. The work could gain the interest of nuclear materials community especially experimentalists who are using ion irradiation to predict the materials behavior under neutron irradiation. However, before publication some justification on parameters selection and discussion is necessary. My main concern is about authors' comparison of void nucleation rate and experimental swelling. In Figure 5, authors compared the void swelling with void nucleation rate. How these quantities are comparable? Swelling represent the last stage on void precipitation (nucleation + growth + coarsening + coalescence) not just nucleation, and not all nucleated voids would necessarily survive to contribute to swelling. Authors need to discuss how they think these quantities are comparable.

**We compare the general shape, not the magnitude, of void nucleation rate and void swelling. In our view, locations of increased void nucleation at the onset of irradiation (low dose) will also be locations with the highest void swelling. We do recognize that the creation of void nuclei constitutes the creation of more defect sinks, and that the two are not directly comparable in magnitude. We have added language throughout the paper to signify this distinction.**

In addition, there are some other comments that need to be addressed before publication,      
1.     Damage efficiency is considered 0.05 for ion irradiation, however this value is not correct for Fe. Several Molecular Dynamics works have been done (e.g. L. Malerba, J. Nucl. Mater. 351 (2006) 28.) on Fe and it is shown that damage efficiency for heavy ions is about ~0.25 to 0.3.

**We have changed this value to 0.25, it was initially taken from G. Was’ book, p. 132, which states that 1MeV “heavy ions” have a displacement efficiency of ~4%, while 1MeV protons are about 25%. The given reference is far more specific, we thank the reviewers for pointing us in its direction. The new simulations in this work have now been run using a value of 0.25, or the approximate value from a 10keV cascade.**

2.     Emv is very critical parameter in void formation. Authors need to specify if they treated Emv as a fitting parameter or not and how the results are sensitive to this parameter.

**This value was chosen to be significantly larger than that found in recent molecular dynamics simulations of pure iron (0.55 eV, see ), yet lower than that in BCC steels, (1.08 eV for ChS68 and 0.98 eV for EK164 steels, see Kozlov et al., Mettaly, 2014(5):412-418). The actual value is known to vary between 0.75-1.4 eV for carbon-doped α -Fe [**[**Takaki1983**](#LyXCite-Takaki1983)**]. Therefore, 0.86eV was chosen to account for the presence of impurities, especially small amounts (10-100ppm) of carbon. We have added a more detailed justification of this value’s choice, and an explanation of why we chose it. This was the one fitting parameter in this study, therefore we have added a section of results that shows the sensitivity of the results to this parameter. It turns out that it is very sensitive!**

3.     Vacancy and interstitial capture radii also need justification for selection. It also would be beneficial for readers if authors specify the dislocation bias that these capture radii would cause.

**A new reference was sought for this work. We have chosen the molecular dynamics work of Shastry and de la Rubia, as it contained direct comparisons to theoretically predicted Pereils stresses for pure BCC iron. We therefore felt it to be very applicable to this study. Values of capture radii were chosen from Figures 5a-5b at T=0.4Tm, exactly the temperature used in the comparative experiments in our study.**

4.     Figure 3 represents the defect concentration. However it does not show that defects concentration is zero at surface. Authors should explain why the surface is not defined as sink?

**On this log-linear plot, a value of zero isn’t defined. Therefore, this last point doesn’t show up on the graph. However, the simulation explicitly uses a Dirichlet boundary condition of zero at the free surface for both vacancies and interstitials. We have changed the caption of Figure 3 to explain this apparent discrepancy, due to the way in which the plotting software works.**  
5.     It would be also beneficial for nuclear society if the authors put a plot which shows the evolution with time (5dpa, 10dpa, …).

**We don’t have the ability to plot defect evolution with dpa, as this model does not consider the continued creation and dynamics of defect clusters as cluster dynamics or the Master equation would. However, we have included a plot of defect concentrations until they reach steady state, in order to show how defect concentrations evolve with the chosen parameters.**  
6.     Plot legend and caption are not consistent in Figure 7.

**Thank you for catching this discrepancy, we have revised the figure caption to synchronize with the legend, the latter of which was correct.**  
7.     C\* is not defined in equation 12.

**This term was defined earlier, in equation 10 (now equation 8).**

8.     Dpa rate mentioned in table 2 and Figure 6 needs description whether it is dpa rate at peak or not. In ion irradiation dpa is varying in depth so there is no unique dpa.

**This is indeed the peak DPA rate, we have indicated this in both Table 2 and the caption for Figure 6.**  
  
  
Reviewer #2: Review  
  
This paper presents a simple rate theory model to interpret ion irradiation behavior. The model shows the double damage peak observed in experiment, and demonstrates that the peak is a result of injected interstitials increasing recombination and thus "exposing" the peak.  It also shows that the double peak only occurs in a narrow band of temperatures. The model is not quantitative, and the authers never claim that it is. They also clearly state the limitations of the approach.  
  
This is an excellent paper that deserves to be published. However, it does need various revisions, listed below. Some are detailed formatting issues and some are questions about wording.  
  
\*     The formatting of Equations 1 and 2 makes them hard to follow. The equal signs should be aligned.

**Done, it is indeed easier to read now.**

\*     Equation 3 extends into the next column, making it hard to read the equation and Table 2.

**We have split the equation so that it fits within one column.**

\*     The sentence immediately after Eq. 9 needs to be fixed (… from was…)

**Fixed, thank you!**

\*     The sentence crossing between pages 3 and 4 is incomplete

**We could not find this sentence, as the sentence ending page 3 follows to the equation which describes it on page 4.**

\*     The second paragraph in in section 2.2 is too specific. The reader does not need to know the name of the preconditioner in MOOSE. Just state that the full Jacobian was used, including the off-diagonal blocks.

**We feel it is necessary to state the preconditiner used, as it is required to ensure the results are precisely reproducible. In addition, we don’t calculate the full Jacobian, as MOOSE utilizes a Jacobian-free Newton-Krylov solver. Some Jacobian terms may be specified to precondition the problem, and help decrease the number of non-linear iterations to convergence.**

\*     In that same paragraph, you justify the use of the full Jacobian by saying it strikes a balance for a Jacobian-free solve. However, for a two variable system with the full Jacobian implemented, a NEWTON solve is probably more efficient than a Jacobian-free solve.

**This code actually uses a Jacobian-free solve for non-linear iterations, and a Newton solve for linear iterations in between. This is described in the original MOOSE paper (D. Gaston et al. Nucl. Eng. Des., 239(10):1768-1778, 2009.).**

\*     In Eqs. 16 - 19, you use a (I) and (J) without explaining what the notation means. I assume it signifies the nodal values of the variable, but this is not stated.

**We have already defined J, and per your suggestion we have defined I as well.**

\*     The sentence bridging between page 5 and 6 discusses two y-axes, but every figure in the paper only has one y-axis

**Good catch, this was an old sentence from when the figures had separate y-axes. We instead had decided to put everything on one y-axis and make the figures bigger. Thank you for catching that.**

\*     In the highlights, you state that "The double peak is predicted only to be evident within a narrow (30C) temperature window for self- irradiation of pure iron." This is clearly evident in Fig. 7 and is an interesting finding. However, it isn't actually discussed anywhere else in the paper.

**This is mentioned in the abstract, “…which are very sensitive to the irradiation temperature …” We have added a sentence to the end introduction to explicitly call attention to this fact, so that the reader recognizes its significance.**

\*     Also in the highlights section, the wording used to describe why "Caution should be taken when interpreting ion irradiation data" is never used anywhere else in the paper. What is said in the Conclusions should probably match the highlights section. I think that the wording in the highlights section is clearer.

**Good point, we have synchronized the conclusions section with the clearer highlights section.**