Some notes and instructions. This excerpt from our intro can focus us.

This white paper is firstly a compendium of Cosmic muon-induced backgrounds knowledge. Secondly, it contains new studies that build on current data. Thirdly, it incorporates advances made in simulation sophistication. Finally, it defines, and reduces, systematic errors in our knowledge of these backgrounds.

I think we can get a big chunk done in the next couple months, then spend February pulling together. We risk being irrelevant if we wait much longer. A final paper – at least a complete and polished draft - should be finished by the March Cosmic Frontier meeting. I first give an outline and then fill in the pieces a bit to understand the work required for each.

I. Intro:

II. Existing Measurements of Underground Neutron Backgrounds. Section per "experiment"

III. The Simulations
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       A. Compare previous simulation to Data

       B. Parameterizing Results (Mei & Hime methodology)

       C. Status and Outstanding Issues.

       D. New Advances in Geant and FLUKA.

IV. Using SIMs to understand the effect of depth on DM experiments.

       A. Muon Spectra vs Depth

              1. Use M&H to give a general introduction to the shape.
              2. Effect of Overburden and Material

       B. Muon-induced neutron generation

       C. Compare different technologies at Homestake depth.

       D. Scaling to Different Depths

               1. Soudan
               2. SNOLAB

V. Conclusion

I. Intro: There is a good start to this, we can finish it after the rest is written.

II. Existing Measurements of Underground Neutron Backgrounds

** this should not be long for each experiment, but the point is to make sure we have surveyed all the data out there and have references for people. In the NEXT section under simulation we will point out where the uncertainties are and which sim was used for each of the experiments and where the biggest problem is and what the best future experiment needs to be. ***

    A. Borexino   (Anthony and Tony) No text exists.

    B. LVD is done – Tony Empl and Vitaly K. should review it and modify. It could be shorter and it needs a complete set of references.

    C. Boulby Measurements (Monica) (http://arxiv.org/abs/0805.3110)
    The only thing here is a reference. It needs to be written.

    D. LSD (Monica) (M.Aglietta et al., Nuovo Cimento C 12, 467 (1989)).
    Likewise this one.

    E. Edelweiss (Monica or David).   Can we get Vitaly to help?

    F. SNO (Andrew) Still nothing from Andrew.

    G. The Neutron Multiplicity Meter (Melinda's text) – pretty much finished, except for a statement of results and it should be updated.

III. The Simulations
Quick description is there and 2 references. We can improve later. Now we need to flesh out what exists in the following way.
    A. Compare previous simulation to Data

    *** Each person working on the experiment summaries in section II needs to write a few sentences here summarizing how well the MC matches the data and what was actually used to compare. You may want to edit already existing text and bring the SIM part down here. We will glom experiments together afterward rather than separate paragraphs, once we see what theme emerges. For now, just fill in your section.

        Borexino   (Anthony and Tony)

        LVD (David, Monica and then Tony Empl and Vitaly K)

Boulby Measurements (Monica & David**)**

LSD (Monica & David)

Edelweiss (Monica or David).

SNO (Andrew)

The Neutron Multiplicity Meter (Melinda)

B. Parameterizing Results (Andrew will write a short intro to Mei & Hime methodology)

C. Status and Outstanding Issues.
Summarize A and B. Explain where sims work well and where they don't. What fits M&H and what doesn't. Outstanding issues**.**

D. New Advances in Geant and FLUKA.
Explain Shielding physics list and new stuff in FLUKA. Best way to approach this is to make a list of advances and what plot (if necessary) is a good illustration of the effect. This can include our recent work, like a plot of how many more neutrons we get and improved multiplicity. Angie's plots would work here. Here is a start to the list - please add to it.
Geant4: Cross sections, MuNuc,
FLUKA:

IV. Using SIMs to understand the effect of depth on DM experiments.
Explain the program of comparisons we have embarked on and why they eliminate past problems. Introduce the 3 sample technologies and geometries we will use.

A. Muon Spectra vs Depth

1. Use M&H to give a general introduction to the shape.
A first pass at this has been written – Chao and ?? should go over it

2. Effect of Overburden and Material

Describe MUSUN and Chao's method. Compare and contrast the resulting spectra. Explain how much difference you get (and where) using non-flat overburden and better rock information. Nothing yet written. I think this is in Chao's camp for the comparison, but also Angie could put something in about the effect for Soudan before and after MUSUN.

B. Muon-induced neutron generation

Start with a general intro to secondary particle multiplicity, flux, and spectra. Some is already written. Then we have to launch into some study showing the effect of not keeping all the secondary particles. Please offer some good plots for this section.

I think presentation of Chao's work on the neutrons caused by muons in the shielding may be reasonable here.

C. Compare different technologies at Homestake depth.

Describe the geometries of the Ge and LXe and LAr setups and give the results for each. Monica, Angie should present the tables of nuclear recoils, giving a definition of the cuts decided upon etc.

What will we do about the LAr? Is there someone we should draft to finish this?

D. Scaling to Different Depths

1. Soudan

Compare major differences between shallow and mid-range. Results from the NMM and Melinda's work could go here. Plus Angie's work on multiplicities, etc.

Bring out any issues discovered that cannot be easily scaled. Or come up with a good way to scale it.

2. SNOLAB

Summarize main points of a Deeper site compared to mid-range. One point to be made is that neutrons from alpha-n and fission necessitate a large neutron veto anyway... But muons are not a problem anymore. Craft this argument.

V. Conclusion

What did we learn about Depth and Uncertainties remaining? List and prioritize needs for the future - what bkgd experiments and sims are needed. Clearly this cannot be written until we finish the rest.