Final GLoBES Summer Project Summary

Where we find the project in September

The project was left with significant challenges regarding implementation of the near detector. The distinct feeling was that the reason it was. Ot working was due to the statistical model defined in the rules section of the GLoBES definition file:

Definition from the ND file as it was then:

```
rule(#nue_app)<
        @signal = 1.0@#FHC_app_osc_nue : 1.0@#FHC_app_osc_nuebar
        @background =  1.0@#FHC_app_bkg_nue : 1.0@#FHC_app_bkg_nuebar : 1.0@#FHC_app_bkg_numu

        @sys_off_function = "chiNoSysSpectrum"
        @sys_off_errors   = {}
        @sys_on_function  = "chiZero" //chiMultiExp
        @sys_on_errors    = {}
        //@energy_window = 0.5 : 18
>
```

Definition from the FD file as had previously worked well:

```
rule(#nue_app)<
        @signal = 1.0@#FHC_app_osc_nue : 1.0@#FHC_app_osc_nuebar
        @sys_on_multiex_errors_sig = { #err_nue_sig } : {#err_nue_sig}
        @background =  1.0@#FHC_app_bkg_nue : 1.0@#FHC_app_bkg_nuebar : 1.0@#FHC_app_bkg_numu : 1.0@#FHC_app_bkg_numubar : 1.0@#
        @sys_on_multiex_errors_bg = {#err_nue_bg} : {#err_nue_bg} : {#err_numu_bg} : {#err_numu_bg} : {#err_nutau_bg} : {#err_nu
        @errordim_sys_on = 0
        @errordim_sys_off = 2
        @sys_on_function = "chiMultiExp"
        @sys_off_function = "chiNoSysSpectrum"
        @energy_window = 0.5 : 18.0
>
```

So, the top statistical model shows a chiZero comparison method which is not producing any errors as all the values are set to zero. Below we can see a clear reference to data files.

Gabriela suggests a fix in July:

```
rule(#nue_app)<
        @signal = 1.0@#FHC_app_osc_nue : 1.0@#FHC_app_osc_nuebar
        @sys_on_multiex_errors_sig = { #err_nue_sig } : {#err_nue_sig}
        @background =  1.0@#FHC_app_bkg_nue : 1.0@#FHC_app_bkg_nuebar : 1.0@#FHC_app_bkg_numu : 1.0@#FHC_app_bkg_numubar : 1.0@
        @sys_on_multiex_errors_bg = {#err_nue_bg} : {#err_nue_bg} : {#err_numu_bg} : {#err_numu_bg} : {#err_nutau_bg} : {#err_n
        @errordim_sys_on = 0
        @errordim_sys_off = 2
        @sys_on_function = "chiMultiExp"
        @sys_off_function = "chiNoSysSpectrum"
        @energy_window = 0.5 : 18.0
>
```

Gabriela changed direction with the method to treat this bug and realised the way forward was to turn the error method back to the way it was before. Looking here we can see it is identical.

Then we must compare her file to see what actual changes (if any) can contribute to the development of this model. As far as I can see it is almost identical to the file for the regular original far detector simulation. Then I decided to compare the near detector file

and far detector files she had sent in July. These two files were identical – so this suggests there was no actual need to change the structure of the GLoBES file between the two different detectors. This means I can now try to implement the code. Before this I will quickly check to see if there was important information in her email.

"Thank you for the updates! I took a test and I discovered what happened. I thought that chiMultiExp function would sum up the chi squares from all experiments in one single script, by summing up the events in both near and far detectors and then calculating the chi square between true and test values (that is why you could use chiZero in the ND). What happens is that chiMultiExp calculates the chi squared on each experiment and then sums up all the chi squres. So, you SHOULD use chiMultiExp in both near and far detectors .glb files. I have added the .glb files and the script on this email."

I think this confirms this conclusion. So now the output will be the **summed** chi squared result from both detectors. I replaced the code accordingly.

```
LAMASS = 0.067 // 40kt (taken from official document)
```

Also note that I changed the mass of the liquid argon detector in definitions.inc to the value given in Gabriela's files. It also took me a while to change this for all 10 of the near detector globes files because I had made eleven so that a smear could be done through the detector tube.

This outputs the chi squared data which I will then need to process using my python file. It is worth noting that running the code is taking a very long time indeed right now. In the end – this took two days. The code contained some issues clearly as the resulting data looks as follows:

The smeared source (using 11 ND globes files) is on the right, and the single source approximation is on the left these graphs should look like the blue Mathematica graph below.