

# Covariance Matrix Fit Users' Guide

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## Abstract

This technote details a new method for performing fits for oscillation parameters by using covariance matrices.

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## 1 Introduction

This technote is intended to be a Users' guide documenting how the the Covariance Matrix Fit (CMF) analysis is run start-to-finish such that it is reproducible.

## 2 Structure

The CMF code lives within `nova/CovarianceMatrixFit`. Within this directory there are several directories:

```
core    : the core classes that CMF is built on: EventLists, VarVals,
    ↪ ShifterAndWeighter
data    : contains root files for calibration systematic uncertainties
dataProducts: data products and structs commonly used in CMF analysis
fhicl   : contains all fhicl files
macros  : useful .C files
modules : art modules and plugins which are run with fhicl files
scripts : scripts for, i.e. submitting to the grid
utilities : only the bin utility lives here, this may be removed in the
    ↪ future
```

## 3 Generating Covariance Matrices

This section contains information on how to generate covariance matrices for a given systematic uncertainty both locally.

### 3.1 Locally

In order to generate a covariance matrix locally, a single fhicl file can be run <sup>1</sup>,

```
cmf_covariancematrixmakerjob.fcl
```

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<sup>1</sup>I'd recommend copying this to your `SER/nova/ana/users/$U` area and running from there.

<sup>2</sup>Ensure you're using the CMF version of this file. Another version, `covariancematrixmakerjob.fcl` exists, but is related to the FNEX framework and is not what you should be running.

Inside this fhicl file, there are three options that a user should configure:

```
TREEFILE : Path to EventList file. For now these are located in /nova/ana/  
    ↪ users/brebel/skimmed  
SYSTPAR  : Systematic parameter to vary  
NUMITER  : Number of iterations of the systematic to run (i.e. number of  
    ↪ universes)
```

The options for which systematics you can choose can be found in `CMF_SystematicParameters`

↪ `.fcl`

Once these substitutions have been made, a covariance matrix can be generated with the following command

```
art -c cmf_covariancematrixmakerjob.fcl
```

## 3.2 On The Grid

Running on the grid is made easy by the existence of a bash script, located in

```
CovarianceMatrixFit/scripts/CMF_Run_Covariance_Grid.sh
```

which has a usage:

```
usage: CMF_Run_Covariance_Grid.sh <systematics> <eventlist file> <local  
    ↪ products> <output dir>  
<systematics>: specify one of calib, genie, mec, nue, norm, reco, xsec1,  
    ↪ xsec2, xsec3  
<eventlist file>: full path to event list tree file in pnfs  
<local products>: name of the local products directory  
<output dir>: top level directory for output matrix root files
```

where the `<local products>` is the name of a tar file (without the `.tar.bz2`) which should be stored in your scratch area (`/pnfs/scratch/users/${USER}`).

This script by default will run a set of several uncertainties defined by the `<systematics>` tag. Each systematic uncertainty will have by default 2000 systematic universes across 200 grid jobs. This can be modified by changing the variables in the `setVariables()` function in the bash script.