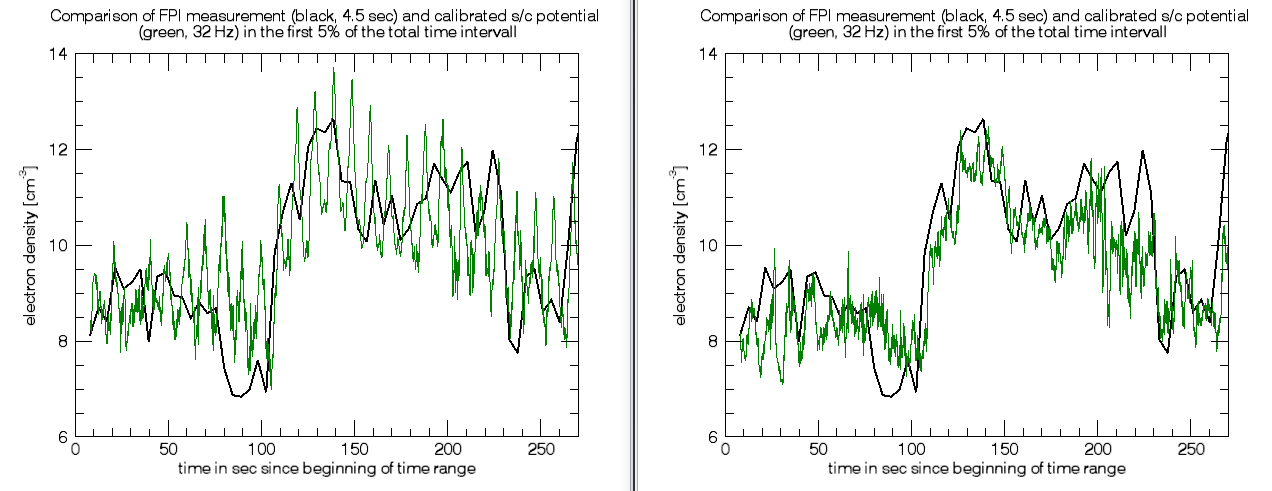
**Electron Density Derivation/Spacecraft Potential Calibration Routines Guide**

The routines that will be explained in this document can be used to calibrate (fast mode) spacecraft potential data from MMS to electron plasma densities. The routines complement the “*SC\_PotentialToolkit*” by Owen W. Roberts for periods when the ASPOC instrument was operating, meaning that the potential was controlled. The derivation is based on the same equations as explained in “*SCPotentialQR\_fin.docx*” (<http://ftp.iwf.oeaw.ac.at/pub/webdata/sw_density_product/>).

Moreover, the main intention is for periods with electron densities ne > ~20 cm-3. The calibration gets more and more inaccurate as densities get smaller. Additional, large E-fields deteriorate the density product.

The SDC Quicklook Tool can be used to look for adequate (i. e. ASPOC ON, high plasma density, low E-field) time periods: <https://lasp.colorado.edu/mms/sdc/public/plots/#/quicklook?plot_type=all_mms1_summ&year=2021&month=10&day=29&time=0000_1440>

***Routines***

* Routines in folder *MPFIT*: Fitting routines by Craig B. Markwardt: need to be compiled, the easiest way is to copy the .pro files to C:\Program Files\Exelis\IDL85\lib
* *density\_derivation\_ASPOC\_ON.pro*: This is the main routine used for the derivation. Detailed instructions can be found in the code. **In order for the routine to work, all the routines below need to be compiled in IDL**. This can either be done my manually opening and compiling all or by placing them into your IDL working path.
* *expfit1.pro*: one exponential model function
* *expfit2.pro*: two exponential model function
* *exp\_fit\_1.pro*: function that uses MPFIT to derive the fitting parameters for the average photoelectron curve using binned data and using expfit1.pro
* *exp\_fit\_2.pro*: function that uses MPFIT to derive the fitting parameters for the average photoelectron curve using binned data and using expfit2.pro
* *spin\_rem.pro*: function that derives an average spin model for the user defined time period and subtracts it from the input (which is the spacecraft potential data). The spin model is computed by using MPFIT with a model function of 10 superposed sine functions. The plot on the right shows an example of the derived electron density with (right) and without (left) spin tone removal applied.

***Reading the data***

Derived plasma data are provided in two different formats: .sav and ascii

the .sav files can be opened in IDL using the restore command

*restore, filename=’filename.sav’*

The keyword /verbose to get the variable names. The variables should include the spedas time, a time string and the derived electron density.

If you have any questions or encounter any problems with the data you can contact Daniel Teubenbacher (daniel.teubenbacher@oeaw.ac.at)