

2.2 FPI Timing

FPI Time Standard

The time variable in all FPI data products mark the beginning of the data collection interval. Note that for other MMS data products, the time may mark the middle of the data interval. FPI data products after v1.0 include both the time and a "delta +/-" to indicate the time relative to the data interval. That is, for FPI the delta +/- is [10,0] sec for the SITL data product or [0.03, 0] sec for a DES burst product. It is important for users to understand the time conventions of each data product used especially when comparing data sets.

Accuracy of FPI Time Tags in the L2 Data

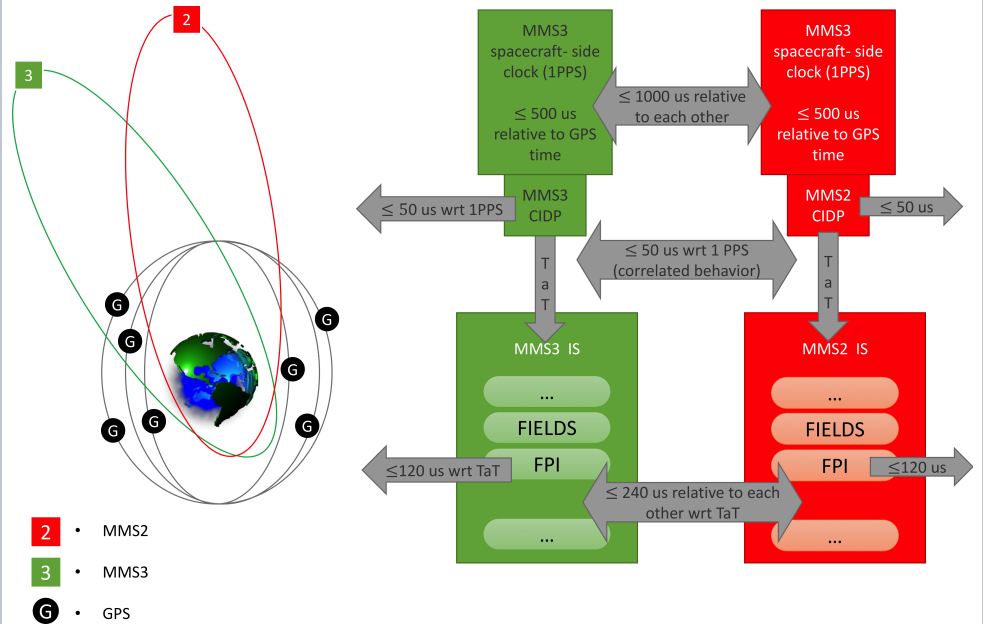
According to MRD (461-SYS-RQMT-0019L) RMRD_1307 & RMRD_1363: each spacecraft clock will be kept within 500 microsec with respect to GPS time ($1 \text{ PPS} \leq 500 \text{ microsec of GPS time}$).

CIDP to IDPU ICD (10160.17-CIDP_FPI_IDPU_ICD-01)
RC@IDPU_0180 allocates 50 microsec for the delay from CIDP receipt of the 1 PPS and its issuance of the triple-pulse time-at-tone (TaT)

According to MRD (461-SYS-RQMT-0019L) FPI was granted a waiver (MMS_DW-0233) to exceed the 100 microsec time-tagging requirement.

- The greatest error observed was 119.5 microsec and we generally allocate 120 microsec for conservatism
- Pre-launch testing report (FPI-SYS-RPT-0403) explains the exceedances as a limitation of the testing procedure
- The results show variability by instrument suite bay (Table 2-4 in FPI-SYS-RPT-0403)
- No adjustment of the received Time Tags is done to account for these delays.

In General: FPI time tag difference $\leq 670 \text{ microsec}$ with respect to GPS time



Assignment of Time Tags to Measurements of Individual FPI Spectrometers and/or Energy Observations

Please note that the timing of individual energy and deflection step combinations is NOT directly inferrable from simple linear spacing.

- The time tag for separate observations (say energy step 25, deflection state 0 and energy step 25, deflection state 1) are NOT derivable by dividing 30ms up into 128 evenly spaced intervals.
- Integration times of 195 microsec/1 millsec for DES/DIS are separated by variable settling times
- Settling time values can vary from ~20 microsec to ~250 microsec depending on the instrument type (DES or DIS), low vs high range in the power supply electronics, and upward versus downward sweep in the energy steps.

SPEDAS Notes for FPI Time Tagging

SPEDAS example code to explicitly shift FPI moments to "centered-time":

```
var_dis=['Ni','Ti_para_l2','Ti_perp_l2','vi']
FOR i=0, n_elements(var_dis)-1 DO BEGIN
    get_data,var_dis(i),data=d
    store_data,var_dis(i),data={x:d.x+0.075d,y:d.y}; shift FPI data to center time
ENDFOR
var_des=['Ne','Te_para_l2','Te_perp_l2','ve']
FOR i=0, n_elements(var_des)-1 DO BEGIN
    get_data,var_des(i),data=d
    store_data,var_des(i),data={x:d.x+0.015d,y:d.y}; shift FPI data to center time
ENDFOR
```

OR:

```
mms_load_fpi, /time_clip, trange=trange, probes=sc_num, datatype='dis-moms', level=fpi_level, data_rate=fpidatarate, versions=versions,
/center_measurement
mms_load_fpi, /time_clip, trange=trange, probes=sc_num, datatype='des-moms', level=fpi_level, data_rate=fpidatarate, versions=versions, /center_measurement
```



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