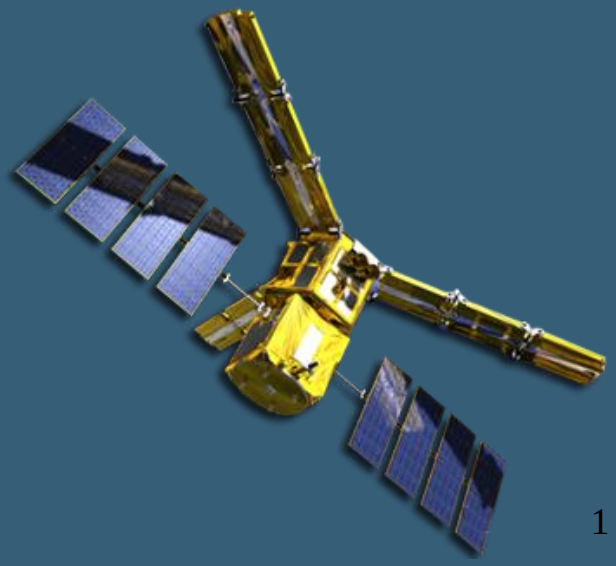
SMOS
The training course

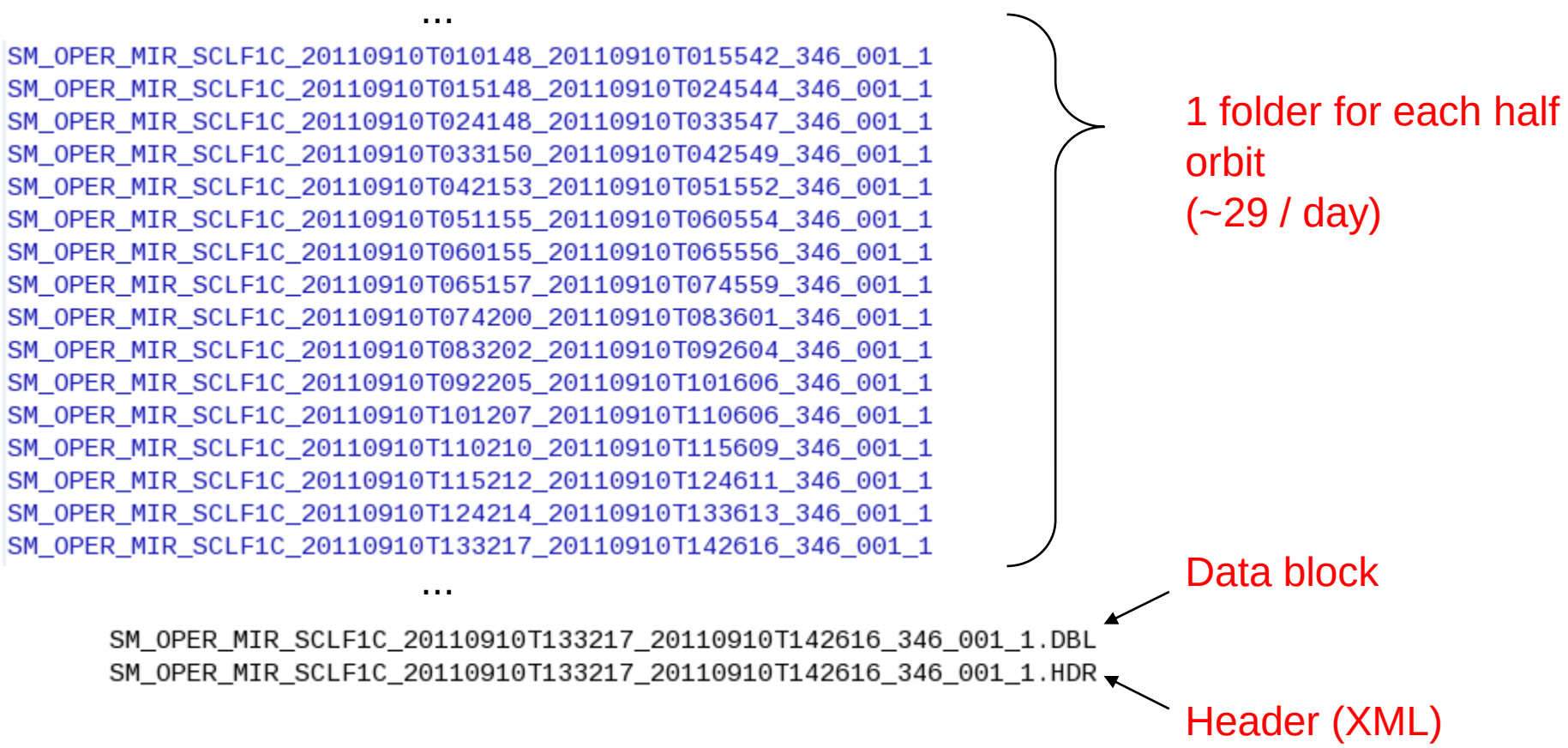
Reading L1c products
&
XY to HV



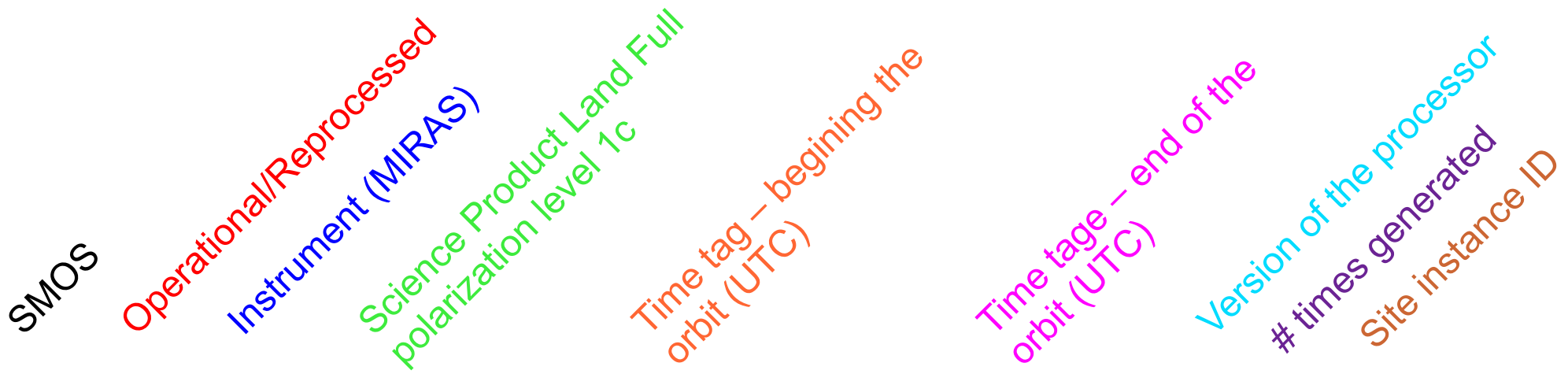
SMOS Workshop
27-29 September
Arles, France

Introduction

SMOS L1c products



Introduction



SM_OPER_MIR_SCLF1C_20110910T133217_20110910T142616_346_001_1/

SM_OPER_MIR_SCLF1C_20110910T133217_20110910T142616_346_001_1.DBL

SM_OPER_MIR_SCLF1C_20110910T133217_20110910T142616_346_001_1.HDR

1. Reading L1c with RWAPI

Installation & requirements

• The RWAPI Matlab toolbox is delivered through a tar file with a *pdf* file explaining the installation procedure and containing a user guide.

• Installation requirements:
  - 64-bit Linux
  - Matlab 2009a

```
% Environment variables to be able to use the RWAPI toolbox
addpath([genpath('/home/leroux/Utilitaires/Rwapi_ARRAY/')]) ;
setenv('XML_RW_API_HOME','/home/leroux/Utilitaires/Rwapi_ARRAY/lib/rwapi/');


% When using the RWAPI toolbox, change directory to have the conf file
% xml_rw_api.usr_conf.xml
cd /home/leroux/Utilitaires/Rwapi_ARRAY/test
```

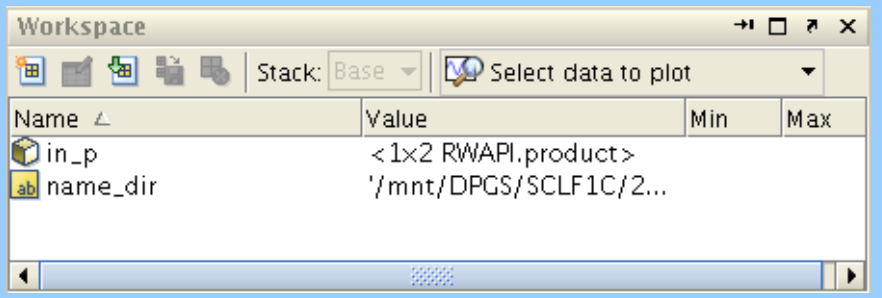
You can also create a link to this xml file in your working directory

1. Reading L1c with RWAPI

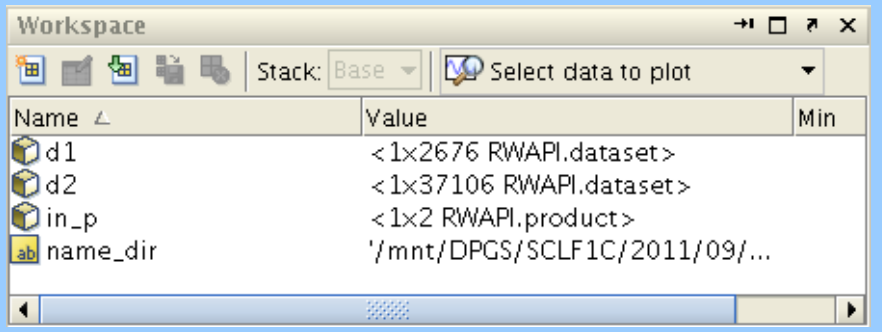
Reading L1c file

```
% Name of the directory of L1c data
name_dir = ['/mnt/DPGS/SCLF1C/2011/09/10/',...
'SM_OPER_MIR_SCLF1C_20110910T133217_20110910T142616_346_001_1'] ;
```

```
% Reading SMOS file
in_p = RWAPI.product(name_dir) ;
```




```
% 2 datasets in the product (as in a structure)
d1 = in_p.dataset(1) ;
d2 = in_p.dataset(2) ;
```



1. Reading L1c with RWAPI

Reading L1c file

Dataset 1: information about each snapshot

```
>> d1(1)

ans =

          Snapshot_Time: [1x1 struct]
            Snapshot_ID: 97484291
          Snapshot_OBET: 7349888826246031872
             X_Position: 1.6232e+06
             Y_Position: 1.2161e+06
             Z_Position: -6.8519e+06
             X_Velocity: -2.4941e+03
             Y_Velocity: -6.8770e+03
             Z_Velocity: -1.8120e+03
          Vector_Source: 3
                     Q0: 0.7206
                     Q1: -0.3098
                     Q2: -0.5736
                     Q3: 0.2361
                    TEC: 8.5726
              Geomag_F: 3.7765e+04
              Geomag_D: -50.2169
              Geomag_I: -67.3098
                Sun_RA: -23.7955
               Sun_DEC: 4.9339
                Sun_BT: 110000
              Accuracy: -134.3476
  Radiometric_Accuracy: [2.1255 0]
                X_Band: 0
   Quality_Information: [1x1 struct]
```

```
>> d1(1).Snapshot_Time

ans =

          Days: 4270
       Seconds: 48736
  Microseconds: 349634
```

Day of reference : 01/01/2000

```
>> d1(1).Quality_Information

ans =

     Software_Error_flag: 0
   Instrument_Error_flag: 0
          ADF_Error_flag: 0
  Calibration_Error_flag: 1
```

Dataset 2: information about each point (DGG)

```
>> d2(1)

ans =

        Grid_Point_ID: 6250103
   Grid_Point_Latitude: -87.0230
  Grid_Point_Longitude: -73.8300
   Grid_Point_Altitude: 2.2594e+03
       Grid_Point_Mask: 2
               BT_Data: [1x3 struct]
```

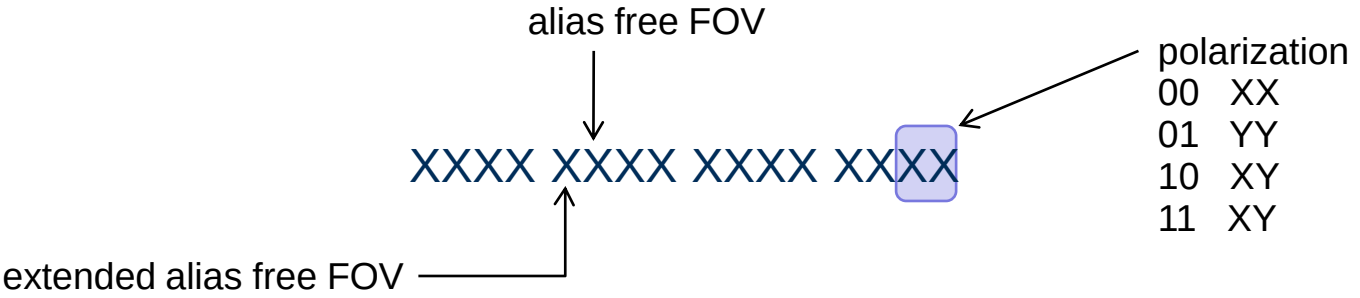
```
>> d2(1).BT_Data(i)

ans =

                  Flags: 6228
          BT_Value_Real: 232.2799
          BT_Value_Imag: 0
  Pixel_Radiometric_Accuracy: 6346
          Incidence_Angle: 35849
            Azimuth_Angle: 12360
    Faraday_Rotation_Angle: 478
  Geometric_Rotation_Angle: 10852
      Snapshot_ID_of_Pixel: 97484531
          Footprint_Axis1: 27839
          Footprint_Axis2: 17026
```

Scale factors can be found on pages 281-3 of document SO-TN-IDR-GS-0005 L1 Spec (available on SMOS blog / Docs)

1. Reading L1c with RWAPI

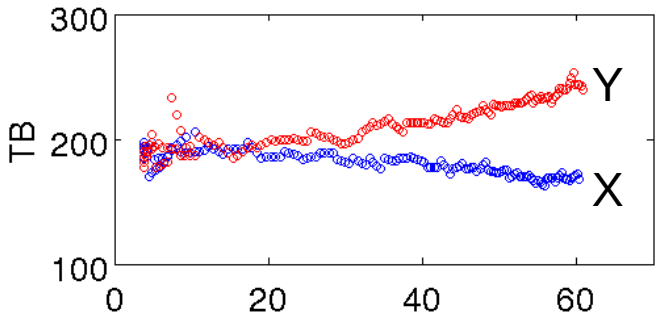
Flag & angular profile (XY)

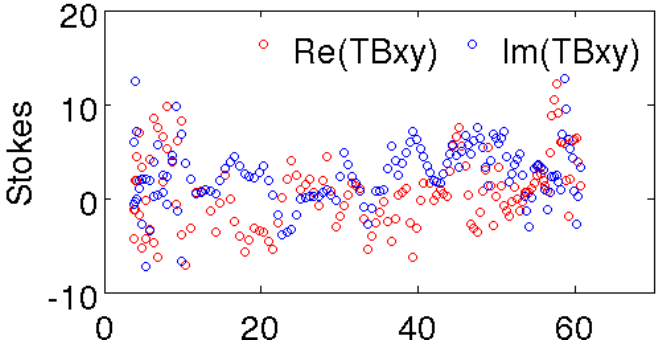
• The flag is saved in a decimal value, however it is a 16 bit word with a signification for each bit:



• This can be found with more details on page 284 of document SO-TN-IDR-GS-0005 L1 Spec (available on SMOS blog / Docs)

• Angular signature



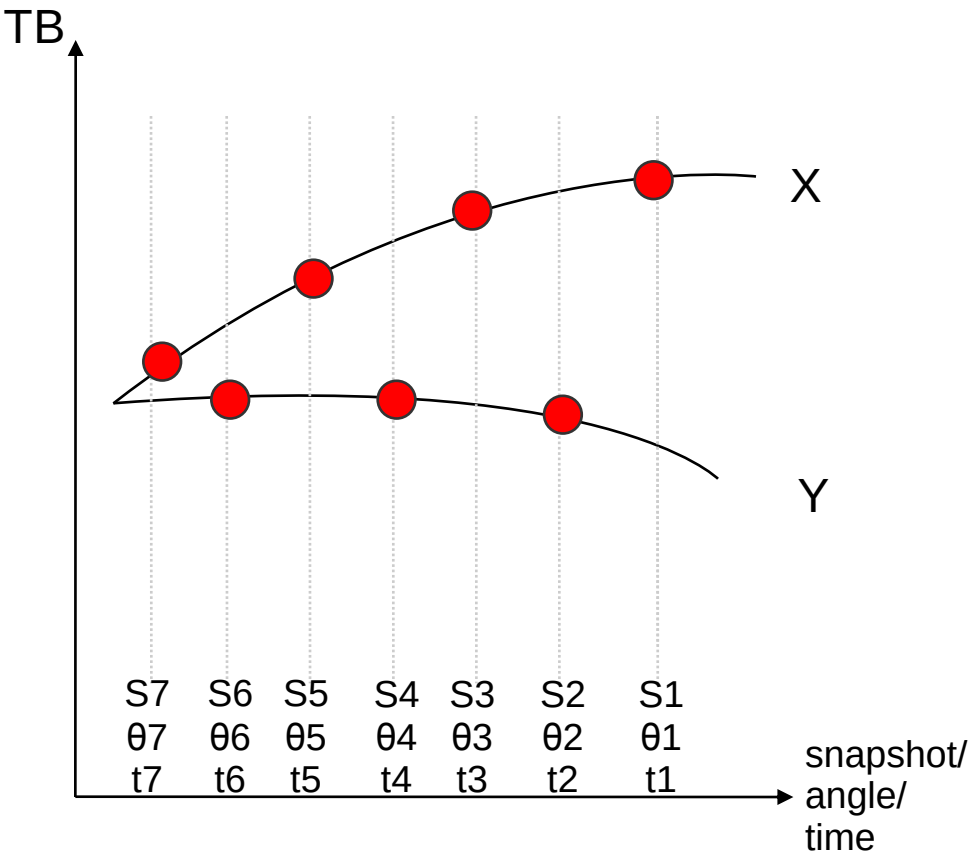


1. Reading L1c with RWAPI

How are acquired the brightness temperatures ?

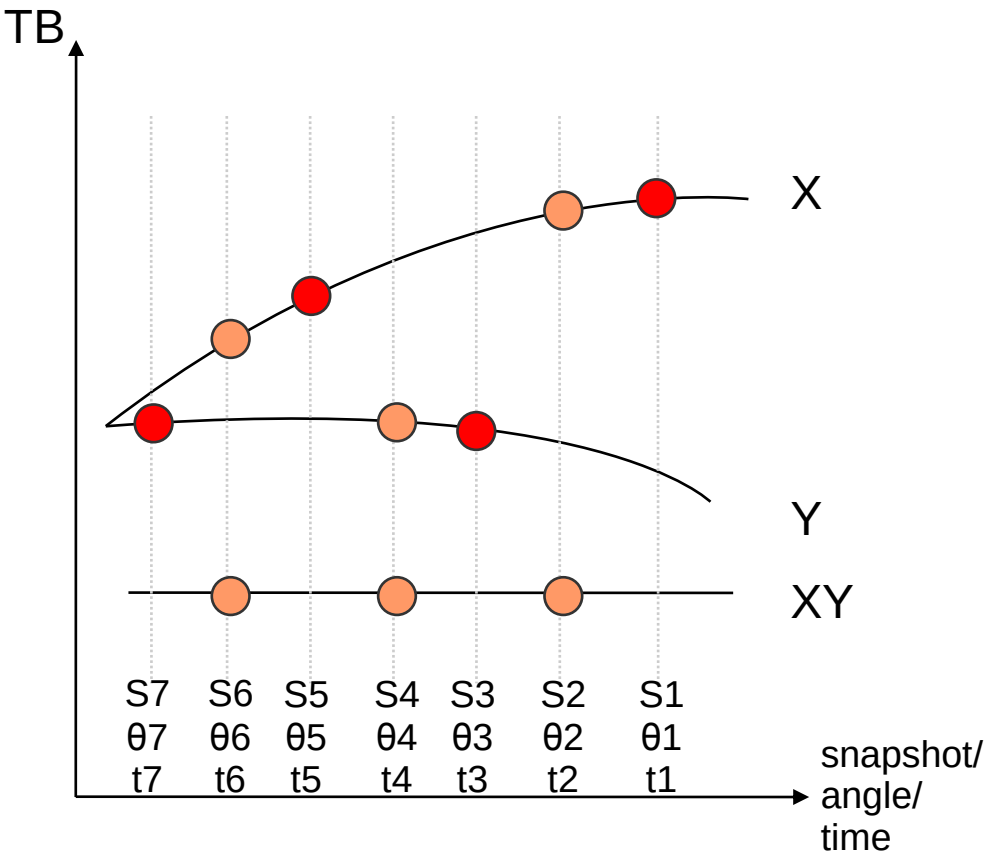
DUAL POL

Sequence: X → Y → X → Y …
Period T=1.2s



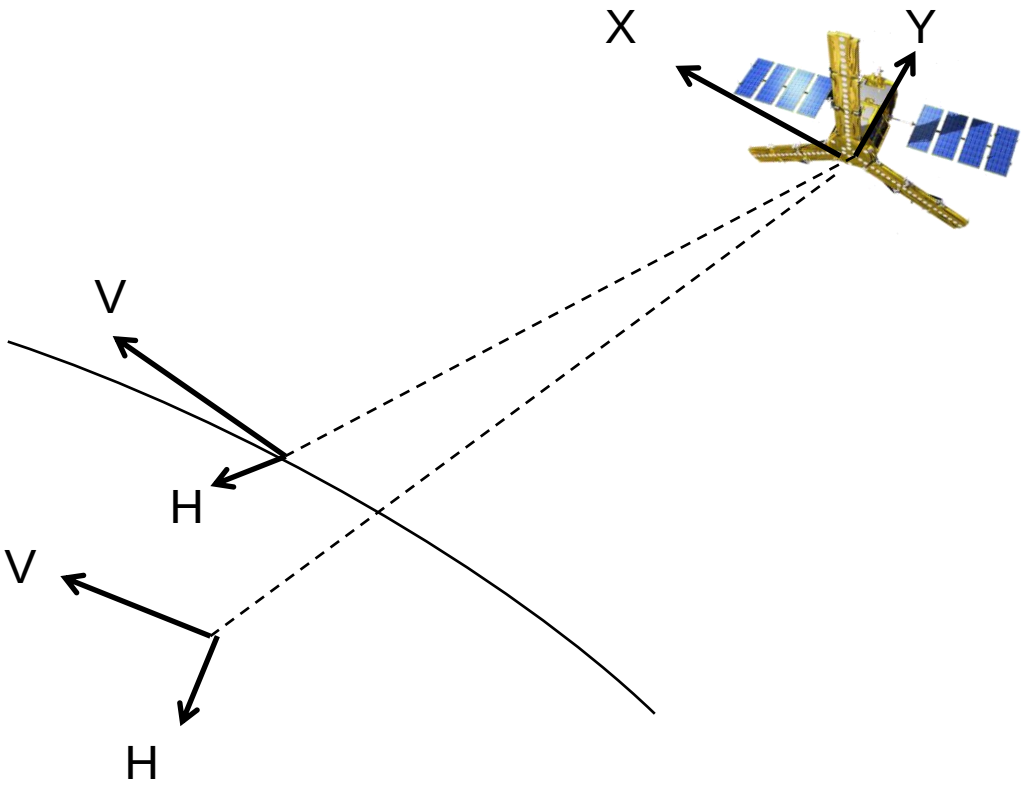
FULL POL

Sequence: X → X+XY → YY → Y+XY → X …
Period T=1.2s (0.4+0.8)



2. XY2HV by CESBIO

Theory



Geometric angle to account for the rotation of the HV frame to the XY frame

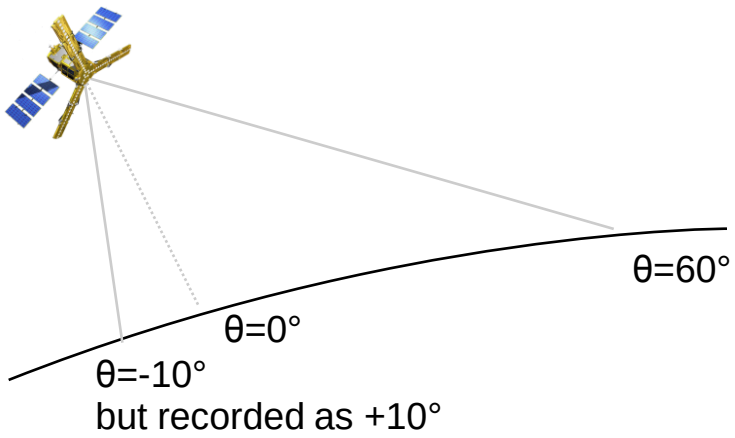
Faraday angle to account for the ionosphere which is charged of ions

Even if in the documents, it is written H and V, it was meant to be X and Y !

2. XY2HV by CESBIO

Theory

DUAL POL	FULL POL
$\begin{bmatrix} TB_H \\ TB_V \end{bmatrix}_\theta = \begin{bmatrix} \cos^2(\alpha) & \sin^2(\alpha) \\ \sin^2(\alpha) & \cos^2(\alpha) \end{bmatrix}_\theta^{-1} \begin{bmatrix} TB_X \\ TB_Y \end{bmatrix}_\theta$	$\begin{bmatrix} TB_H \\ TB_V \\ TB_3 \\ TB_4 \end{bmatrix}_\theta = \begin{bmatrix} \cos^2(\alpha) & \sin^2(\alpha) & -\cos(\alpha)\sin(\alpha) & 0 \\ \sin^2(\alpha) & \cos^2(\alpha) & \cos(\alpha)\sin(\alpha) & 0 \\ \sin(2\alpha) & -\sin(2\alpha) & \cos(2\alpha) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}_\theta^{-1} \begin{bmatrix} TB_X \\ TB_Y \\ {}_{2re}TB_{XY} \\ {}_{-2im}TB_{XY} \end{bmatrix}_\theta$



a = faraday angle + geometric rotation angle (in product)

Needs to have all Tbs at the same angle to go from XY to HV

⇩

Interpolation by time

2. XY2HV by CESBIO

Application to RWAPI L1c output

```
[TBhv_struct] = XY2HV(in_p,in_dgg) ;
```

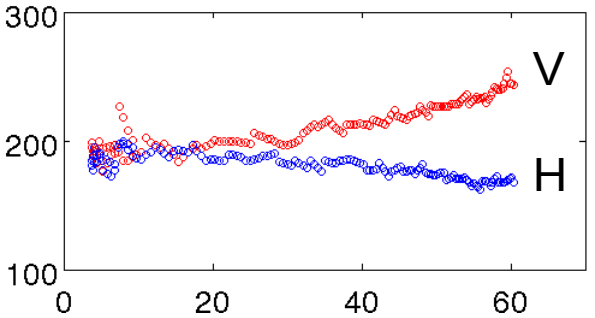
Table of the nodes (DGG) of interest

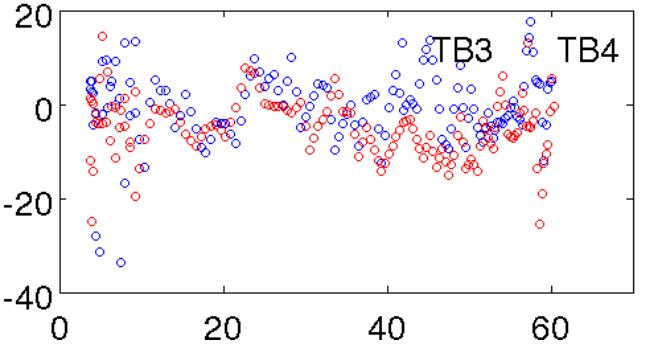
Product from RWAPI

Output : array of structures of the same size as in_dgg

```
>> in_dgg=6247065;
>> [TBhv_struct] = XY2HV(in_p,in_dgg) ;
>> TBhv_struct

TBhv_struct =

        dgg: 6247065
        pol: 'F'
        TBh: [167x1 double]
        TBv: [167x1 double]
        TB3: [167x1 double]
        TB4: [167x1 double]
      RATBh: [167x1 double]
      RATBv: [167x1 double]
      RATB3: [167x1 double]
      RATB4: [167x1 double]
      Theta: [167x1 double]
         Az: [167x1 double]
    Snap_ID: [167x1 double]
       Time: [167x1 struct]
       Flag: [167x2 double]
        lat: -83.7830
        lon: -25.5020
        alt: 1.8076e+03
       mask: 2
```

```
>> plot(TBhv_struct.Theta,TBhv_struct.TBv,'bx')
>> hold on
>> plot(TBhv_struct.Theta,TBhv_struct.TBh,'rx')
```





2. XY2HV by CESBIO

Application to BEAM output

• XY2HV has been adapted to BEAM output but it is a different Matlab function that is applied to a CSV file.

• Different algorithm since the acquisition time is not retrieved by BEAM (the interpolation is here based on the Snapshot ID and not on the time).

```
[data,names_products] = XY2HV_beam(in_file) ;
```

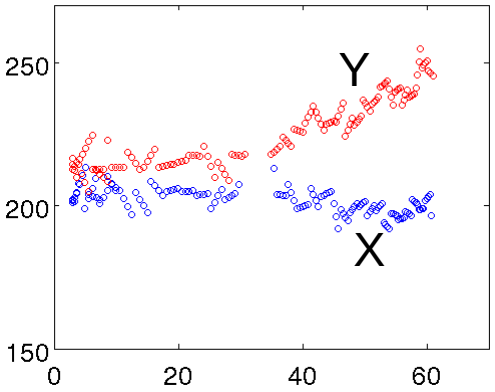
BEAM output file (CSV)

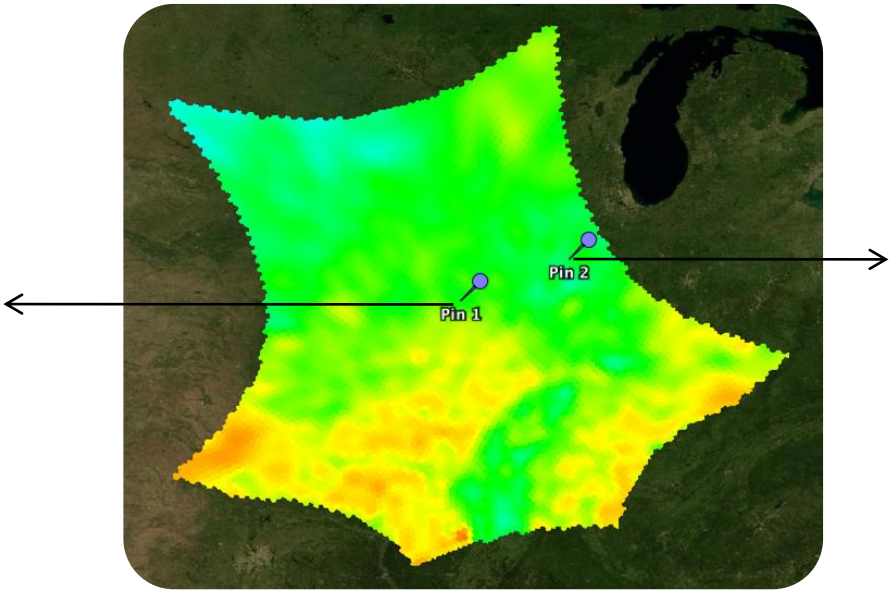
array of cells containing the names of the L1C products identified in the CSV file

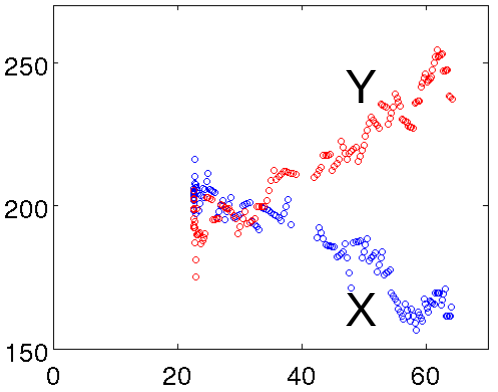
output array of cells containing the original data and HV data

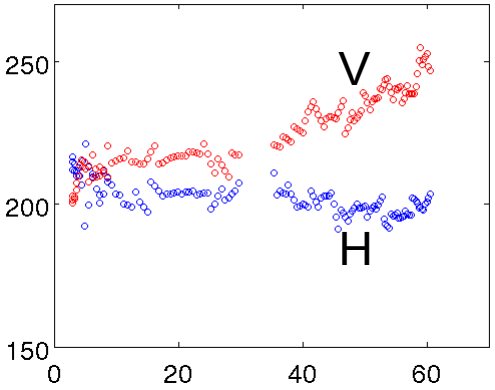
2. XY2HV by CESBIO

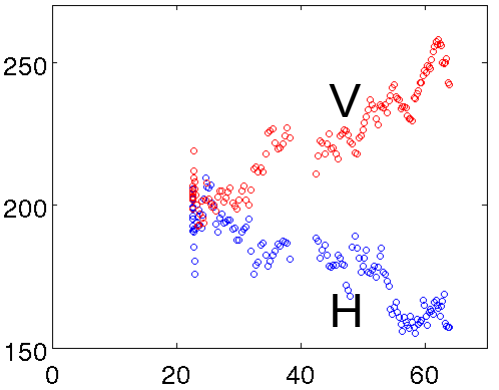
Comparison between XY and HV











DOWNLOADS

Where to find the RWAPI Matlab toolbox and the XY2HV Matlab functions

- RWAPI toolbox:
  - contact Ali Mahmoodi from Array
    - ali@array.ca

- XY2HV:
  - visit the SMOS blog
    - http://www.cesbio.ups-tlse.fr/SMOS_blog/?page_id=749