LFR status

- Ground segment software **(status)**
- **Update of the k-coefficients** for usefull values of PE and SX (BP1)
  - Current set of Basic Parameters (BP1 and BP2)
  - Approximate effective transfer matrix of the electric antennas (ANT)
  - Transfer matrix of the magnetic antennas (SCM)
  - Example of a whistler event: phase shift error (in V12_AC) ?
- **Patch of the LFR FSW** for a correct computation of VPHI (BP1) ?

Thomas Chust, the LFR team and the RPW instrument consortium

LFR ground segment software (1)

ROC uses last version of our production pipeline (lfr-calbut v1.2.0) :
WF + ASM + BP

Calibration tables (RCT)

- Produced LFR calibration tables for BIAS, SCM and VHF.

Waveforms products CWF, SWF (continuous, snapshot)

- L1 to L1R pipeline is operational. It produces :

- CWF in SBM1, SBM2 and SURV mode.
- SWF in SURV mode.

LFR ground segment software (2)

Spectral products ASM (Averaged Spectral Matrices)

- L1 to L2 pipeline is operational. It produces ASM in SURV mode.

Spectral products BP (Basic Parameters)

- L1 to L2 pipeline is operational. It produces BP1 and BP2 in SBM1, SBM2 and SURV mode.

  WARNING : SBM2 BP2 are not yet validated (ongoing). The BP1s concerned with k-coefficients may not be valid and in any case are not yet fully calibrated (main purpose of this presentation).

LFR ground segment software (3)

Open issues:

- Calibrating ASM and BP data when BIAS is OFF using VHF preamplifier calibration table (ongoing).
- Converting ASM and BP data into the RTN frame (ongoing).
  [RTN or SRF? Which difference?]
- Calibrating BP1 with k-coefficients and ANT TF (ongoing).
- Concerning the choice of calibration tables to use in the calibration of ASM and BP, the LESIA recently sent a json template for a dictionary file. Once accepted and fulfill by all teams, this dictionary will allow us to choose the right table at the right time (ongoing).

LFR current set of Basic Parameters

"Instantaneous" 5 x 5 spectral matrix (256-point FFT)

$$\mathbf{SM}\left(\omega_j^{(m)}\right)=\begin{bmatrix} B_1B_1^* & B_1B_2^* & B_1B_3^* & B_1E_1^* & B_1E_2^* \\ cc & B_2B_2^* & B_2B_3^* & B_2E_1^* & B_2E_2^* \\ cc & cc & B_3B_3^* & B_3E_1^* & B_3E_2^* \\ cc & cc & cc & E_1E_1^* & E_1E_2^* \\ cc & cc & cc & cc & E_2E_2^* \end{bmatrix}$$

m = 0, 1, 2
for F0, F1, F2

Time Averaged Spectral Matrix (ASM)

$$\mathbf{ASM}\left(\omega_j^{(m)}\right)=\frac{1}{N_{SM}^{(m)}}\sum_{k=1}^{N_{SM}^{(m)}}\mathbf{SM}_k\left(\omega_j^{(m)}\right)=\langle\mathbf{SM}\rangle_{time}$$

***Frequency* average ...**

$$\mathbf{S}\left(\omega_j^{(m)}\right)=\langle\mathbf{ASM}\rangle_{frequency}$$

... before computations of the BPs (i.e. wave parameters)

Mono-**k** assumption: (Means, JGR, 1972) {

(Samson & Olson, GJRA, 1980) {

$\mathbf{n}\times\mathbf{E}=\frac{\omega}{k}\mathbf{B}$ → BP1 VPHI

$\frac{S_{ij}}{\sqrt{S_{ii}S_{jj}}}$ → BP2 CROSS

BP1 PB:	Power spectrum of the magnetic field (***B***)	
BP1 PE:	Power spectrum of the electric field (***E***)	**=> kcoef**
BP1 NVEC:	Wave normal vector (from ***B***)	
BP1 ELLIP:	Wave ellipticity estimator (from ***B***)	
BP1 DOP:	Wave planarity estimator (from ***B***)	
BP1 SX:	X_{SRF}(radial)-component of the Poynting vector	**=> kcoef**
BP1 VPHI:	Phase velocity estimator	**=> kcoef**
BP2 AUTO:	Autocorrelations	
BP2 CROSS:	Normalized cross correlations	

Update of the LFR onboard k-coefficients (16 first / 32)

Should be effective from STP103 (06/07-12/07)

```
:      SOLO_CAL_RPW_BIAS_V202003101607.cdf
       SOLO_CAL_RPW-SCM_SCM-FS-MEB-PFM_V20200428000000.cdf
used:  SOLO_CAL_RCT-LFR-BIAS_V20190123171020.cdf
sed:   SOLO_CAL_RCT-LFR-SCM_V20190123171020.cdf
:      AC_DIFF_G5
       R = 0
       2020-06-18
```

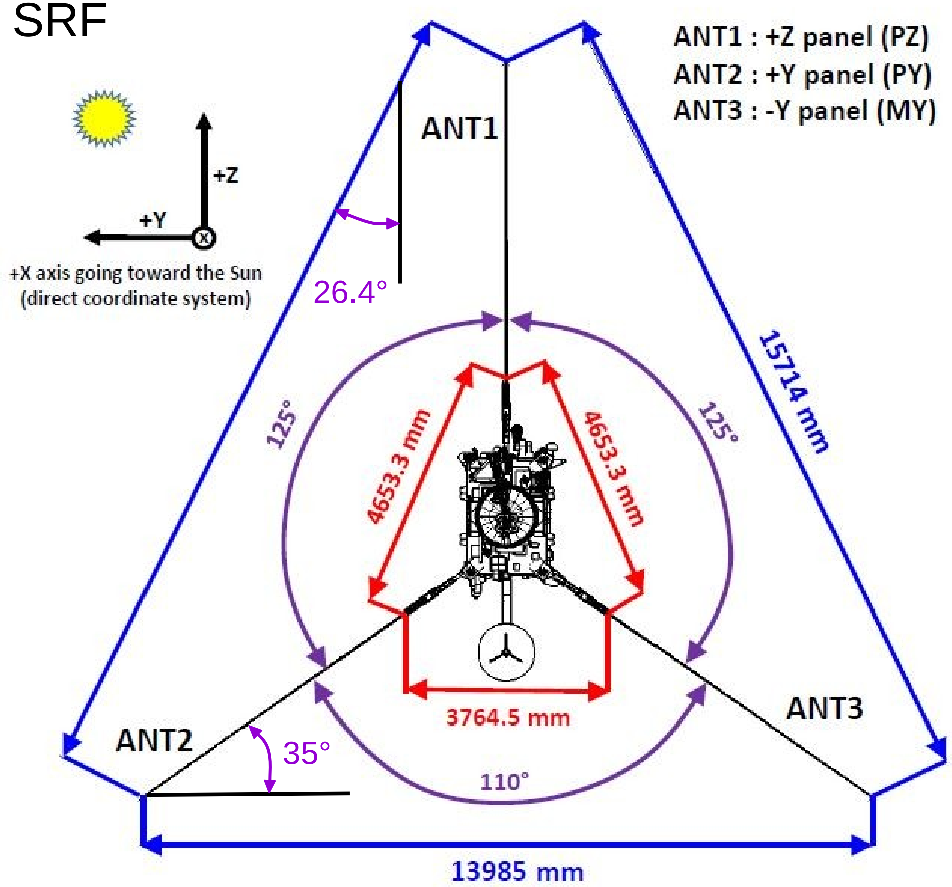
PE : transformation into SRF (2 ortho comp.)
SX : same for B + E-B relative calibration

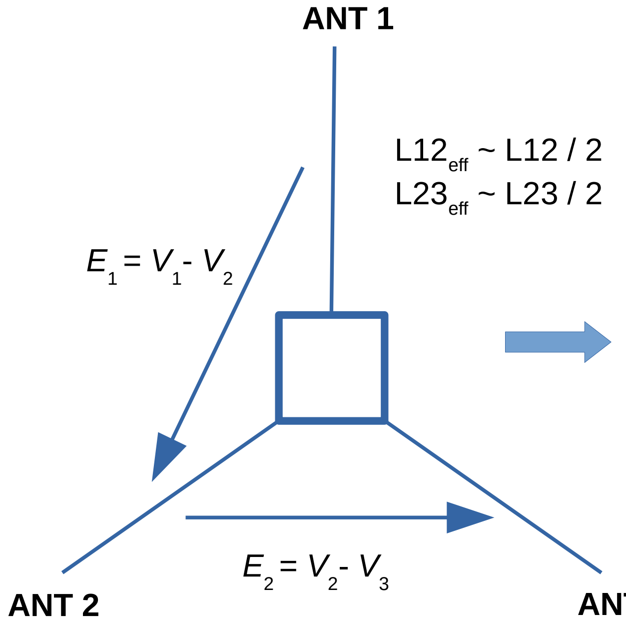
frequency (Hz)	kcoeff_1 (float)	kcoeff_2 (float)	kcoeff_3 (float)	kcoeff_4 (float)	kcoeff_5 (float)	kcoeff_6 (float)	kcoeff_7 (float)	kcoeff_8 (float)	kcoeff_9 (float)	kcoeff_10 (float)	kcoeff_11 (float)	kcoeff_12 (float)	kcoeff_13 (float)	kcoeff_14 (float)	kcoeff_15 (float)	kcoeff_16 (float)
1968.00	1.000000	1.250000	1.000000	-0.000000	0.680709	0.084467	-0.075378	0.002689	-0.006633	-0.004708	-0.828601	-0.100358	-0.615400	-0.121279	-0.684965	-0.072993
2736.00	1.000000	1.250000	1.000000	-0.000000	0.683845	0.046790	-0.077284	0.006480	-0.005590	-0.004755	-0.831959	-0.057230	-0.610072	-0.080905	-0.688697	-0.009801
3504.00	1.000000	1.250000	1.000000	-0.000000	0.684479	0.023171	-0.079053	0.009339	-0.004768	-0.004780	-0.831838	-0.030256	-0.601822	-0.055823	-0.691407	0.035243
4272.00	1.000000	1.250000	1.000000	-0.000000	0.684285	-0.000440	-0.080385	0.012018	-0.003927	-0.004456	-0.830962	-0.002683	-0.592844	-0.031602	-0.694529	0.078141
5040.00	1.000000	1.250000	1.000000	-0.000000	0.683102	-0.032862	-0.080902	0.015643	-0.003207	-0.004357	-0.828408	0.035232	-0.582548	0.000017	-0.694929	0.128425
5808.00	1.000000	1.250000	1.000000	-0.000000	0.679045	-0.077452	-0.080685	0.020638	-0.002670	-0.004105	-0.823017	0.088014	-0.569249	0.042608	-0.689826	0.190891
6576.00	1.000000	1.250000	1.000000	-0.000000	0.670473	-0.129371	-0.079861	0.026565	-0.002390	-0.003748	-0.812267	0.150402	-0.551233	0.090651	-0.677161	0.259483
7344.00	1.000000	1.250000	1.000000	-0.000000	0.660435	-0.171886	-0.078807	0.031303	-0.002101	-0.003724	-0.799841	0.200498	-0.530949	0.130834	-0.663375	0.317959
8112.00	1.000000	1.250000	1.000000	-0.000000	0.660779	-0.168973	-0.079255	0.030848	-0.001279	-0.003575	-0.798949	0.196290	-0.517772	0.135450	-0.669077	0.330162
8880.00	1.000000	1.250000	1.000000	-0.000000	0.677499	-0.077787	-0.082895	0.018871	-0.000068	-0.003632	-0.816823	0.084936	-0.519847	0.073541	-0.715673	0.249207
9648.00	1.000000	1.250000	1.000000	-0.000000	0.681470	0.022690	-0.084661	0.006578	0.000491	-0.003514	-0.819349	-0.036598	-0.515658	0.008594	-0.754707	0.152344
152.00	1.000000	1.250000	1.000000	-0.000000	0.250260	0.644123	-0.026544	-0.050484	-0.003991	-0.011837	-0.308949	-0.769155	-0.238878	-0.832557	-0.266696	-0.894962
280.00	1.000000	1.250000	1.000000	-0.000000	0.435058	0.536410	-0.045370	-0.038012	-0.004918	-0.008762	-0.530177	-0.636836	-0.422869	-0.688790	-0.463289	-0.733262
408.00	1.000000	1.250000	1.000000	-0.000000	0.533893	0.436249	-0.055709	-0.029291	-0.005497	-0.007015	-0.648099	-0.517161	-0.513439	-0.555338	-0.562708	-0.585619
536.00	1.000000	1.250000	1.000000	-0.000000	0.587681	0.359136	-0.061837	-0.022570	-0.006285	-0.006126	-0.713384	-0.424653	-0.558237	-0.453699	-0.611799	-0.472014
664.00	1.000000	1.250000	1.000000	-0.000000	0.618808	0.300719	-0.065342	-0.017659	-0.007364	-0.006185	-0.751394	-0.355742	-0.581250	-0.378724	-0.638215	-0.387033
792.00	1.000000	1.250000	1.000000	-0.000000	0.638057	0.256898	-0.067508	-0.013749	-0.007346	-0.005052	-0.774980	-0.303034	-0.594074	-0.323367	-0.652844	-0.323797
920.00	1.000000	1.250000	1.000000	-0.000000	0.650217	0.222509	-0.069381	-0.010659	-0.007270	-0.004845	-0.790133	-0.262800	-0.601775	-0.280832	-0.661824	-0.274364
1048.00	1.000000	1.250000	1.000000	-0.000000	0.659008	0.194906	-0.070656	-0.007736	-0.007396	-0.004562	-0.800838	-0.229373	-0.606966	-0.246803	-0.668286	-0.234006
1176.00	1.000000	1.250000	1.000000	-0.000000	0.665408	0.169230	-0.071854	-0.006071	-0.007568	-0.004507	-0.809481	-0.199492	-0.610956	-0.217468	-0.673320	-0.198444
1304.00	1.000000	1.250000	1.000000	-0.000000	0.670761	0.146243	-0.072662	-0.003866	-0.007289	-0.004516	-0.815947	-0.172497	-0.614190	-0.191600	-0.677752	-0.167006
1432.00	1.000000	1.250000	1.000000	-0.000000	0.674564	0.125896	-0.073488	-0.001698	-0.007126	-0.004639	-0.820815	-0.148492	-0.616342	-0.169058	-0.680765	-0.139056
1560.00	1.000000	1.250000	1.000000	-0.000000	0.677124	0.111511	-0.073890	-0.000368	-0.007175	-0.004652	-0.823828	-0.131910	-0.616715	-0.152930	-0.682387	-0.117971
1688.00	1.000000	1.250000	1.000000	-0.000000	0.677909	0.106444	-0.074376	0.000250	-0.006978	-0.004553	-0.824805	-0.125884	-0.615684	-0.145642	-0.682700	-0.106756
10.50	1.000000	1.250000	1.000000	-0.000000	-0.064163	0.691371	0.005238	-0.049219	0.001012	-0.010796	0.052509	-0.788477	0.071794	-0.856683	0.075569	-0.916724
18.50	1.000000	1.250000	1.000000	-0.000000	-0.138377	0.678801	0.008808	-0.050425	0.004210	-0.011572	0.136663	-0.788797	0.162978	-0.855399	0.174421	-0.916848
26.50	1.000000	1.250000	1.000000	-0.000000	-0.118979	0.682794	0.007025	-0.049553	0.001158	-0.010515	0.115928	-0.798322	0.146259	-0.866676	0.156269	-0.931405
34.50	1.000000	1.250000	1.000000	-0.000000	-0.086301	0.687445	0.004599	-0.050711	0.001742	-0.010776	0.079182	-0.809000	0.110229	-0.880463	0.116501	-0.944506
42.50	1.000000	1.250000	1.000000	-0.000000	-0.051160	0.691451	0.002795	-0.050467	0.002297	-0.008438	0.042965	-0.813893	0.074655	-0.888435	0.078498	-0.951999
50.50	1.000000	1.250000	1.000000	-0.000000	-0.017434	0.690637	-0.003165	-0.057706	0.007160	-0.013982	0.009704	-0.816750	0.037321	-0.898358	0.038160	-0.959488
58.50	1.000000	1.250000	1.000000	-0.000000	0.008883	0.692317	-0.001998	-0.051320	0.002576	-0.010018	-0.026732	-0.817230	0.010392	-0.894188	0.008285	-0.959643
66.50	1.000000	1.250000	1.000000	-0.000000	0.033912	0.691814	-0.006235	-0.051648	0.000089	-0.011058	-0.056269	-0.820826	-0.015915	-0.893520	-0.019992	-0.958181
74.50	1.000000	1.250000	1.000000	-0.000000	0.058759	0.689708	-0.008406	-0.051508	-0.000637	-0.010220	-0.085366	-0.818306	-0.041164	-0.890868	-0.047973	-0.954232
82.50	1.000000	1.250000	1.000000	-0.000000	0.081055	0.688097	-0.011295	-0.049474	-0.000468	-0.010783	-0.111820	-0.815674	-0.063871	-0.888986	-0.072991	-0.953335
90.50	1.000000	1.250000	1.000000	-0.000000	0.103966	0.685133	-0.012776	-0.050548	-0.001181	-0.011071	-0.137918	-0.812970	-0.087822	-0.884208	-0.099221	-0.947926
98.50	1.000000	1.250000	1.000000	-0.000000	0.122452	0.682203	-0.015249	-0.049152	-0.001474	-0.010516	-0.159991	-0.808639	-0.107694	-0.880608	-0.120736	-0.945213

11 F0 + 13 F1 + 12 F2 = 36 frequency bins

Approximate effective transfer matrix of ANT

SRF





A1Y ~ +3.5 m

A1Z ~ -7.04 m

A2Y ~ -6.99 m

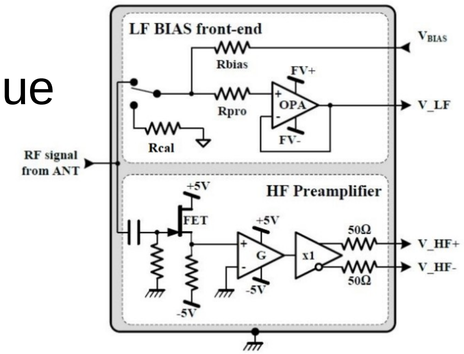
A2Z ~ 0.0

$$\begin{bmatrix} E_1(\omega) \\ E_2(\omega) \end{bmatrix} = \begin{bmatrix} 0 & A_{1Y}(\omega) & A_{1Z}(\omega) \\ 0 & A_{2Y}(\omega) & A_{2Z}(\omega) \end{bmatrix}_{SRF} \cdot \begin{bmatrix} E_X(\omega) \\ E_Y(\omega) \\ E_Z(\omega) \end{bmatrix}_{SRF}$$

$$\begin{bmatrix} E_Y(\omega) \\ E_Z(\omega) \end{bmatrix}_{SRF} = \underbrace{\frac{1}{A_{1Y}A_{2Z} - A_{1Z}A_{2Y}} \begin{bmatrix} A_{2Z}(\omega) & -A_{1Z}(\omega) \\ -A_{2Y}(\omega) & A_{1Y}(\omega) \end{bmatrix}_{SRF}} \cdot \begin{bmatrix} E_1(\omega) \\ E_2(\omega) \end{bmatrix}$$

$$\mathbf{M}_{ANT\ \mathrm{to}\ SRF} \simeq \begin{bmatrix} 0. & -0.143 \\ -0.142 & -0.071 \end{bmatrix} (m^{-1})$$

- Frequency dependence up to 10kHz is an open issue
- Is the LF PA taken into account in the BIAS TF ? => Yes



Computation of the k-coefficients for PE

Power spectrum of the electric field

$$\langle E_{Y'} E^*_{Y'} + E_{Z'} E^*_{Z'} \rangle = \left\langle {}^{\mathrm{T}}\mathbf{E}_{ANT} \cdot \frac{1}{|A_{1Y'} A_{2Z'} - A_{1Z'} A_{2Y'}|^2} \begin{bmatrix} |A_{2Y'}|^2 + |A_{2Z'}|^2 & -A^*_{1Y'} A_{2Y'} - A^*_{1Z'} A_{2Z'} \\ -A_{1Y'} A^*_{2Y'} - A_{1Z'} A^*_{2Z'} & |A_{1Y'}|^2 + |A_{1Z'}|^2 \end{bmatrix} \cdot \mathbf{E}^*_{ANT} \right\rangle$$

$$= \frac{|A_{2Y'}|^2 + |A_{2Z'}|^2}{|A_{1Y'} A_{2Z'} - A_{1Z'} A_{2Y'}|^2} \left(S_{44} + \frac{|A_{1Y'}|^2 + |A_{1Z'}|^2}{|A_{2Y'}|^2 + |A_{2Z'}|^2} S_{55} - 2\,\Re\left[\frac{A^*_{1Y'} A_{2Y'} + A^*_{1Z'} A_{2Z'}}{|A_{2Y'}|^2 + |A_{2Z'}|^2} S_{45} \right] \right)$$

Calibration factor

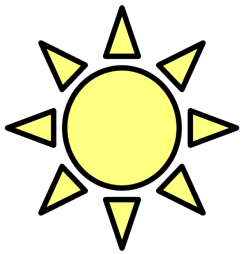
$$\Rightarrow \quad \mathrm{PE} = S_{44}\, k^{pe}_{44} + S_{55}\, k^{pe}_{55} + \Re\left[S_{45}\, k^{pe}_{45} \right]$$

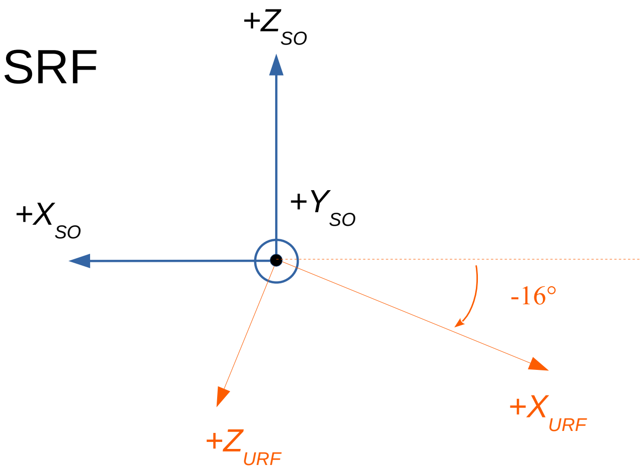
with

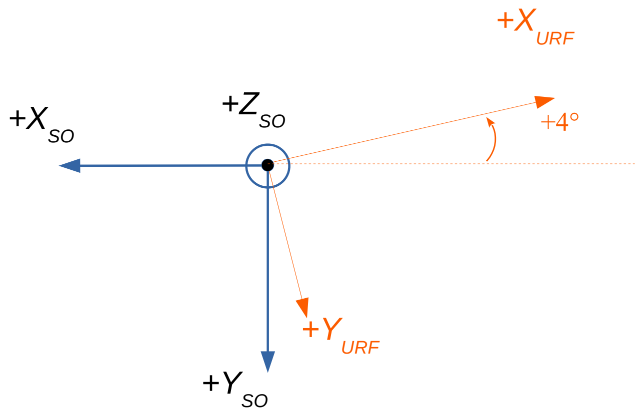
$$\begin{cases} k^{pe}_{44} = 1 \\ k^{pe}_{55} = \dfrac{|A_{1Y'}|^2 + |A_{1Z'}|^2}{|A_{2Y'}|^2 + |A_{2Z'}|^2} \\ k^{pe}_{45} = -2\, \dfrac{A^*_{1Y'} A_{2Y'} + A^*_{1Z'} A_{2Z'}}{|A_{2Y'}|^2 + |A_{2Z'}|^2} \end{cases}$$

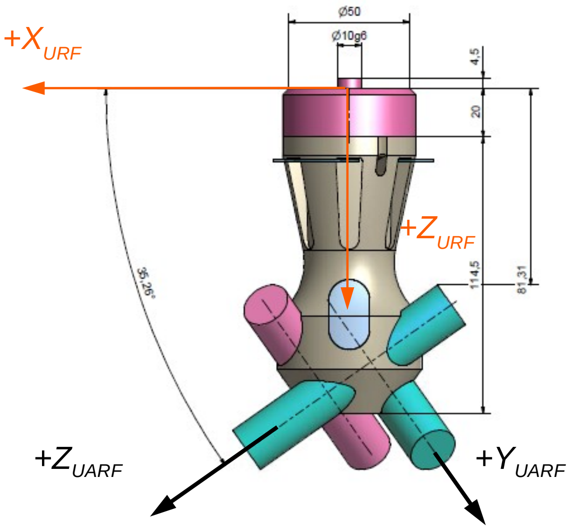
WARNING: The TF of BIAS and LFR are implicitly embodied in the TF matrix of ANT (just a common calibration factor)

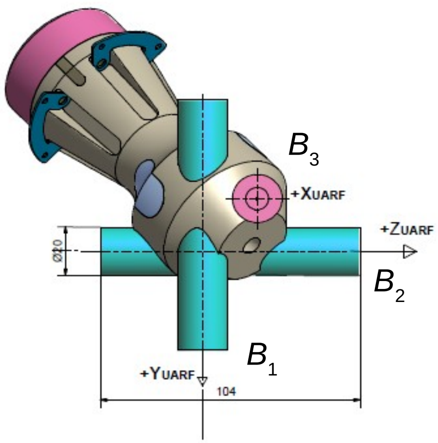
Current alignment of SCM











$$\bar{\bar{\mathbf{R}}}_{Y_{URF}}(+35.26^\circ)\cdot \mathbf{Z}_{UARF} = \mathbf{X}_{URF}$$

$$\bar{\bar{\mathbf{R}}}_{X_{URF}}(+45^\circ)\cdot \bar{\bar{\mathbf{R}}}_{Y_{URF}}(+35.26^\circ)\cdot \mathbf{X}_{UARF} = \mathbf{Z}_{URF}$$

$$\bar{\bar{\mathbf{R}}}_{X_{URF}}(+45^\circ)\cdot \bar{\bar{\mathbf{R}}}_{Y_{URF}}(+35.26^\circ)\cdot \mathbf{Y}_{UARF} = -\mathbf{Y}_{URF}$$

Transformation matrices from UARF to SRF and from SCM to UARF coordinates:

$$\bar{\bar{\mathbf{M}}}_{SFR-UARF} = \begin{bmatrix} 0.501 & 0.600 & -0.624 \\ 0.744 & -0.667 & -0.0437 \\ -0.442 & -0.442 & -0.778 \end{bmatrix} \qquad \bar{\bar{\mathbf{M}}}_{UARF-SCM} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

Transfer matrix of SCM and notations

$$\mathbf{B}_{SCM}(\omega) = \begin{bmatrix} B_1(\omega) \\ B_2(\omega) \\ B_3(\omega) \end{bmatrix}_{SCM} = \overline{\overline{\mathbf{A}}}_M(\omega) \cdot \mathbf{B}(\omega) = \begin{bmatrix} C_{1Y}(\omega) & C_{1Z}(\omega) & C_{1X}(\omega) \\ C_{2Y}(\omega) & C_{2Z}(\omega) & C_{2X}(\omega) \\ C_{3Y}(\omega) & C_{3Z}(\omega) & C_{3X}(\omega) \end{bmatrix}_{SCM} \cdot \begin{bmatrix} B_Y(\omega) \\ B_Z(\omega) \\ B_X(\omega) \end{bmatrix}_{SCM}$$

Normalized transfer matrix :

$$\overline{\overline{\mathbf{A}}}_M(\omega) = C_{1Y}(\omega) \times \bar{\bar{\mathbf{c}}}(\omega) = C_{1Y}(\omega) \begin{bmatrix} 1 & c_{1Z}(\omega) & c_{1X}(\omega) \\ c_{2Y}(\omega) & c_{2Z}(\omega) & c_{2X}(\omega) \\ c_{3Y}(\omega) & c_{3Z}(\omega) & c_{3X}(\omega) \end{bmatrix}_{SCM}$$

$$\begin{bmatrix} B_X(\omega) \\ B_Y(\omega) \\ B_Z(\omega) \end{bmatrix}_{SRF} = \overline{\overline{\mathbf{M}}}_{SRF-SCM} \cdot \left[\overline{\overline{\mathbf{A}}}_M^{-1}(\omega)\right]_{SCM} \cdot \mathbf{B}_{SCM}(\omega) = \frac{1}{C_{1Y}(\omega)} \underbrace{\overline{\overline{\mathbf{M}}}_{SRF-SCM} \cdot \left[\bar{\bar{\mathbf{c}}}^{-1}(\omega)\right]_{SCM}} \cdot \mathbf{B}_{SCM}(\omega)$$

$$\overline{\overline{\mathbf{M}}}_{SRF-SCM} = \overline{\overline{\mathbf{M}}}_{SRF-UARF} \cdot \overline{\overline{\mathbf{M}}}_{UARF-SCM}$$

$$\widetilde{\overline{\overline{\mathbf{M}}}}_{SRF} = \overline{\overline{\mathbf{M}}}_{SRF-SCM} \cdot \left[\bar{\bar{\mathbf{c}}}^{-1}(\omega)\right]_{SCM} = \begin{bmatrix} \widetilde{m}_{X1} & \widetilde{m}_{X2} & \widetilde{m}_{X3} \\ \widetilde{m}_{Y1} & \widetilde{m}_{Y2} & \widetilde{m}_{Y3} \\ \widetilde{m}_{Z1} & \widetilde{m}_{Z2} & \widetilde{m}_{Z3} \end{bmatrix}(\omega)$$

Computation of the k-coefficients for SX

X_{SRF}-component of the Poynting vector

$$\langle S_{X'} \rangle = \langle (\mathbf{E} \times \mathbf{B^*})_{X'} \rangle = \langle E_{Y'}\, B^*_{Z'} \rangle - \langle E_{Z'}\, B^*_{Y'} \rangle$$

$$= \left\langle \frac{A_{2Z'}\,E_1 - A_{1Z'}\,E_2}{A_{1Y'}\,A_{2Z'} - A_{1Z'}\,A_{2Y'}}\, \frac{1}{C^*_{1Y}}\, \tilde{m}^*_{Z'j}\, B^*_j \right\rangle - \left\langle \frac{-A_{2Y'}\,E_1 + A_{1Y'}\,E_2}{A_{1Y'}\,A_{2Z'} - A_{1Z'}\,A_{2Y'}}\, \frac{1}{C^*_{1Y}}\, \tilde{m}^*_{Y'j}\, B^*_j \right\rangle$$

$$= \frac{\left(A_{2Y'}\,\tilde{m}^*_{Y'j} + A_{2Z'}\,\tilde{m}^*_{Z'j}\right)\langle E_1\, B^*_j\rangle - \left(A_{1Y'}\,\tilde{m}^*_{Y'j} + A_{1Z'}\,\tilde{m}^*_{Z'j}\right)\langle E_2\, B^*_j\rangle}{\left(A_{1Y'}\,A_{2Z'} - A_{1Z'}\,A_{2Y'}\right) C^*_{1Y}}$$

Calibration factor

$$= \frac{\sqrt{|A_{2Y'}|^2 + |A_{2Z'}|^2}}{\left(A_{1Y'}\,A_{2Z'} - A_{1Z'}\,A_{2Y'}\right) C^*_{1Y}} \left[\frac{A_{2Y'}\,\tilde{m}^*_{Y'j} + A_{2Z'}\,\tilde{m}^*_{Z'j}}{\sqrt{|A_{2Y'}|^2 + |A_{2Z'}|^2}}\, S_{4j} - \frac{A_{1Y'}\,\tilde{m}^*_{Y'j} + A_{1Z'}\,\tilde{m}^*_{Z'j}}{\sqrt{|A_{2Y'}|^2 + |A_{2Z'}|^2}}\, S_{5j} \right]$$

$$\mathrm{SX'} = S_{41}\, k^{sx'}_{41} + S_{42}\, k^{sx'}_{42} + S_{43}\, k^{sx'}_{43} + S_{51}\, k^{sx'}_{51} + S_{52}\, k^{sx'}_{52} + S_{53}\, k^{sx'}_{53}$$

with

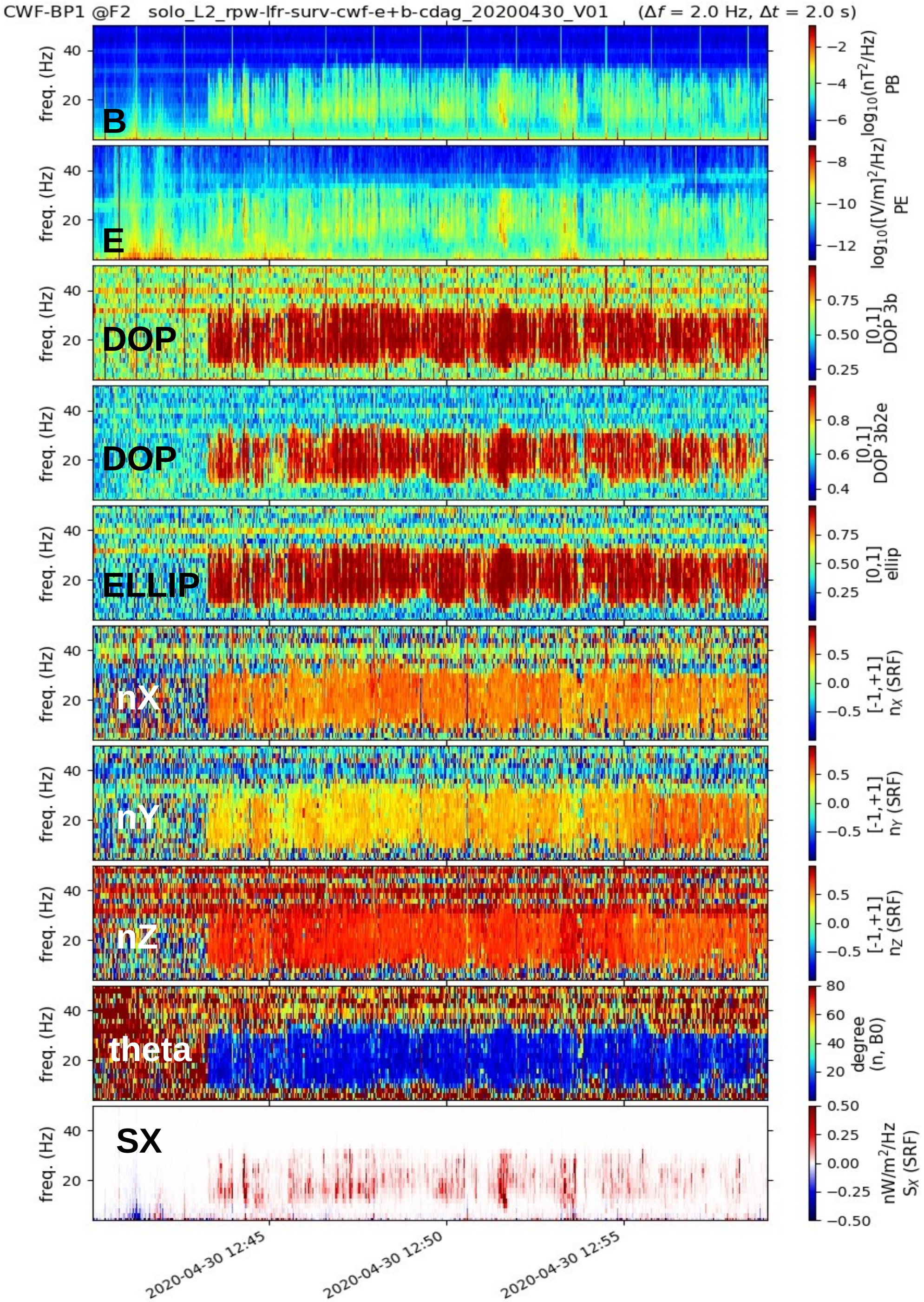
$$\begin{cases} k^{sx'}_{4j} = + \dfrac{A_{2Y'}\,\tilde{m}^*_{Y'j} + A_{2Z'}\,\tilde{m}^*_{Z'j}}{\sqrt{|A_{2Y'}|^2 + |A_{2Z'}|^2}} \times \exp\left[i\left(\varphi_{C_{1Y}} - \varphi_{A_{1Y'}A_{2Z'} - A_{1Z'}A_{2Y'}}\right)\right] & j = 1, 2, 3 \\ k^{sx'}_{5j} = - \dfrac{A_{1Y'}\,\tilde{m}^*_{Y'j} + A_{1Z'}\,\tilde{m}^*_{Z'j}}{\sqrt{|A_{2Y'}|^2 + |A_{2Z'}|^2}} \times \exp\left[i\left(\varphi_{C_{1Y}} - \varphi_{A_{1Y'}A_{2Z'} - A_{1Z'}A_{2Y'}}\right)\right] & \end{cases}$$

WARNING: As for ANT, the TF of LFR is implicitly embodied in the TF matrix of SCM (just a common calibration factor)

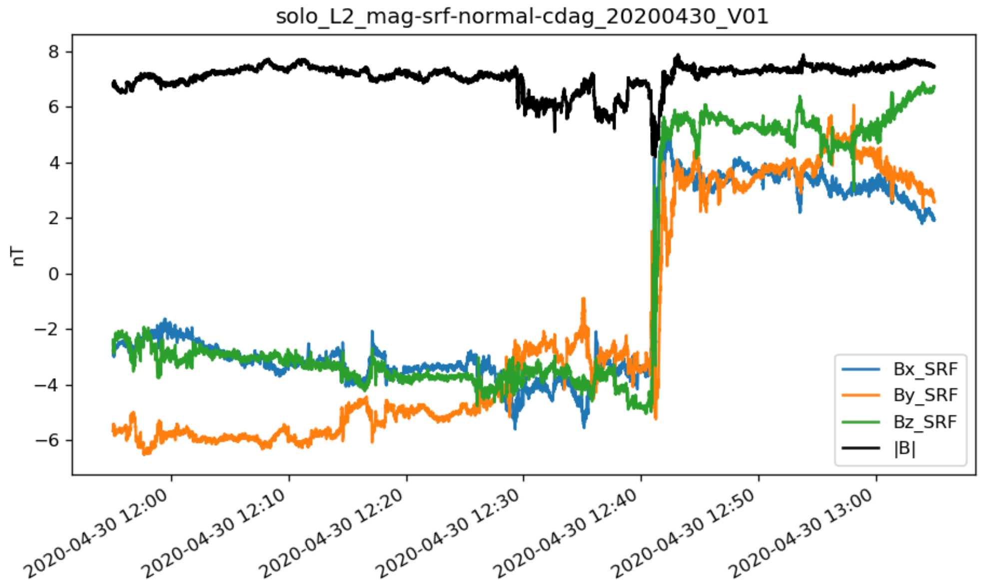
30/04 **2020**

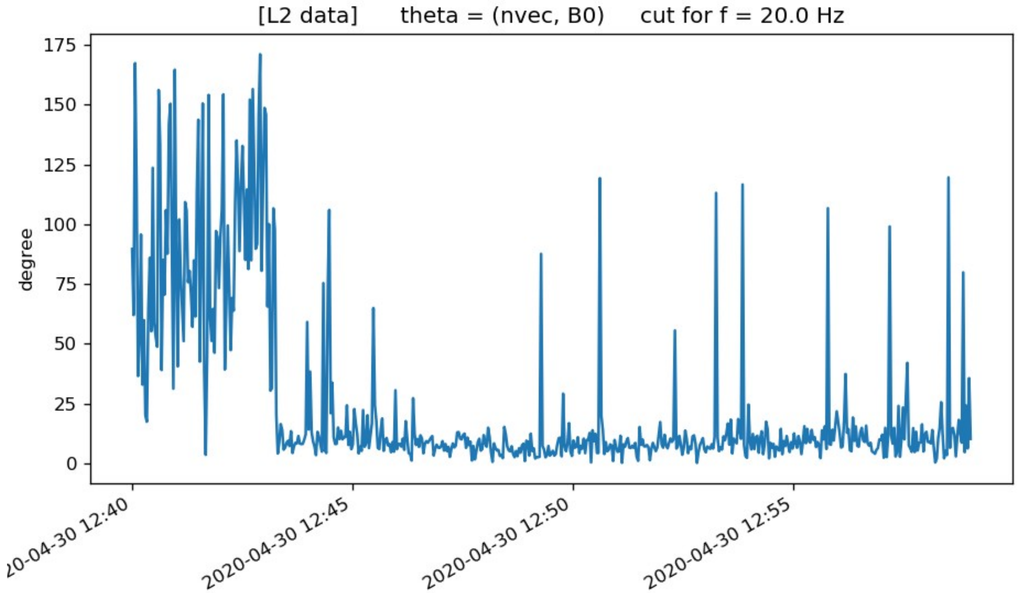
BP from CWF @F2

L2



WARNING: MAG data for this time may not be so accurate (Tim H.)

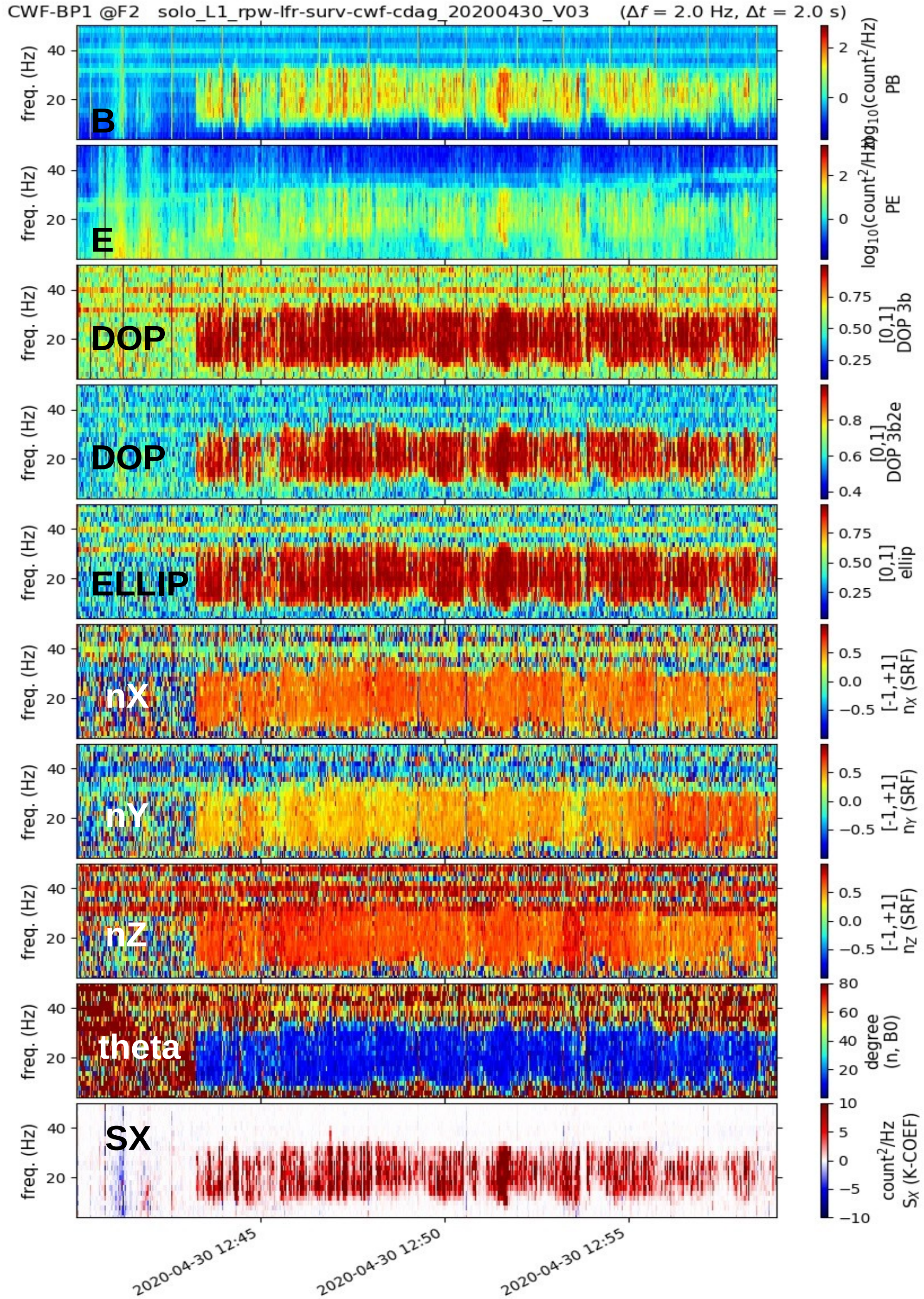


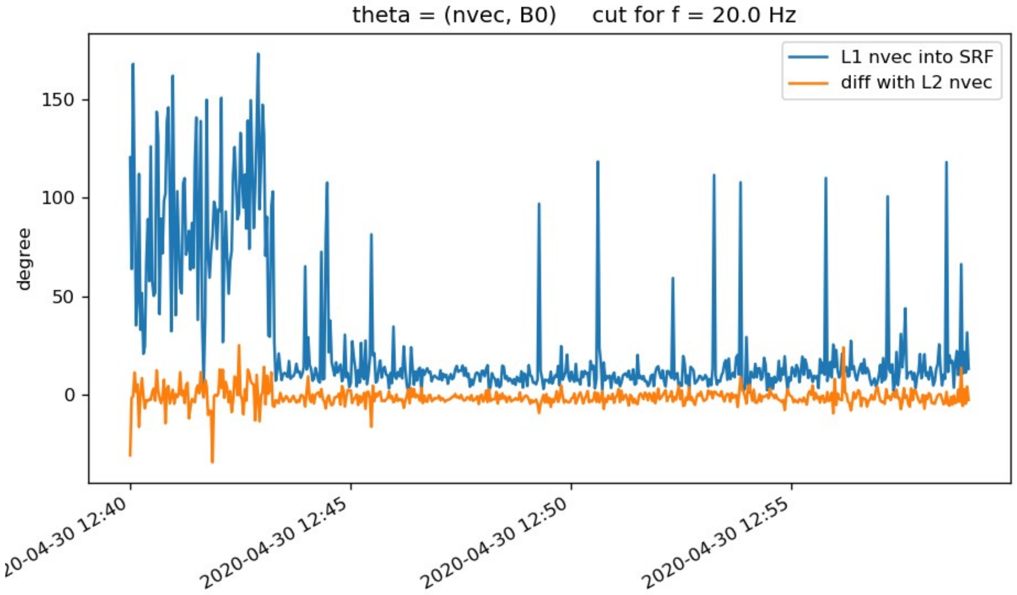


30/04 **2020**

BP from CWF @F2

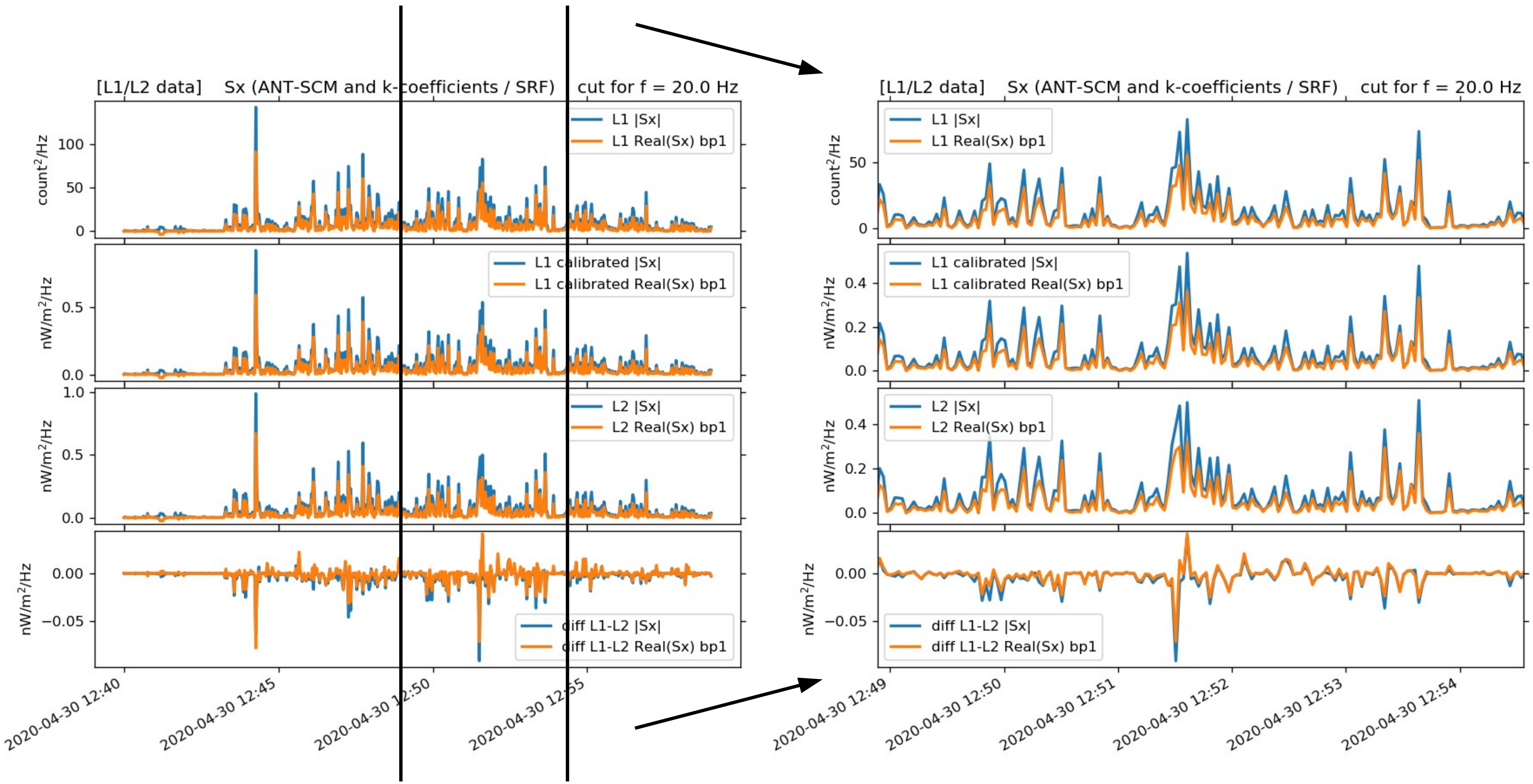
L1





- L1 SCM data allow to determine with a relatively good accuracy the direction of the wave normal vector **k** (several °)
- Correct setting of k-coefficients allows the determination of the Poynying flux along the radial direction *X_SFR* from the L1 SCM & BIAS-ANT data (see next slide for quantitative details)

Quantitative comparisons: L1 versus L2 assessments

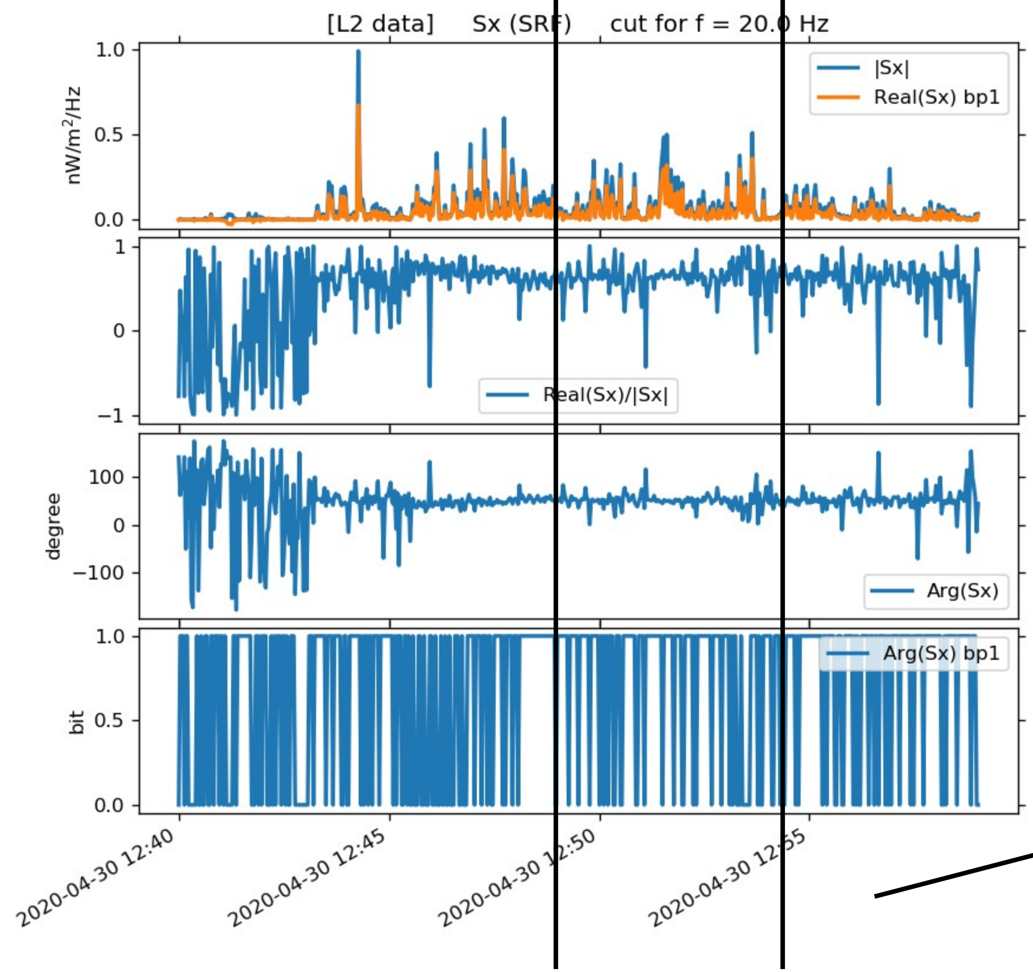


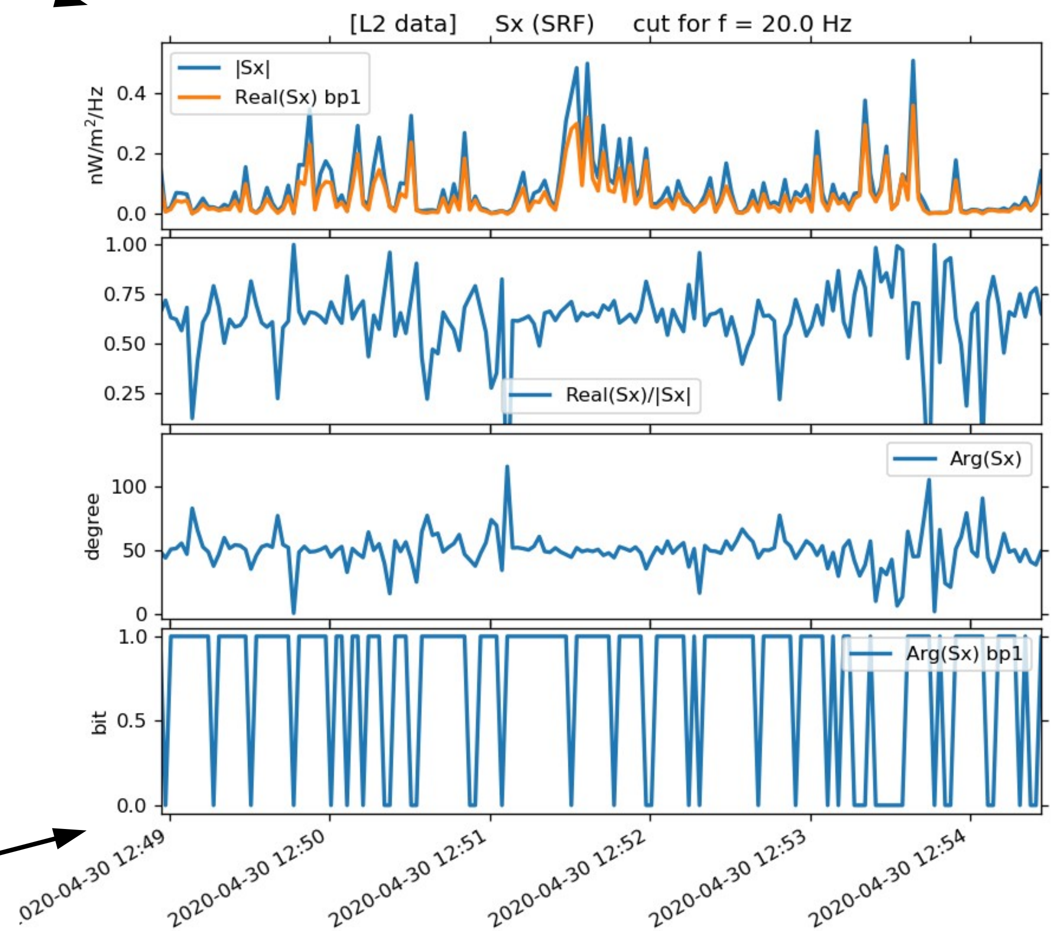
- The determination of a correct set of k-coefficients is validated
- It allows a direct assessments of Sx_SRF from the L1 data with a relatively good accuracy (~10%)

Is there a systematic phase shift error ?

L2

Very likely due to E_Z … (with E_Y it's OK)





Parallel propagating whistler waves are expected to have **a purely real** Poynting vector (there is no longitudinal component which could contribute to an imaginary part)

Computation of the k-coefficients for VPHI

$$\mathbf{n}\times\mathbf{E} = \frac{\omega}{k}\mathbf{B} \longrightarrow v_\varphi = \frac{\omega}{k} = \frac{n_{Y'}\langle E_{Z'}B^*_{X'}\rangle - n_{Z'}\langle E_{Y'}B^*_{X'}\rangle}{\langle B_{X'}B^*_{X'}\rangle}$$

Phase velocity

$$v_\varphi = \frac{C_{1Y}\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}}{A_{1Y'}A_{2Z'}-A_{1Z'}A_{2Y'}} \times \Bigg[n_{Y'}\left(\frac{-A_{2Y'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}}S_{4j} + \frac{A_{1Y'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}}S_{5j}\right) - n_{Z'}\left(\frac{A_{2Z'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}}S_{4j} - \frac{A_{1Z'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}}S_{5j}\right)\Bigg] \Big/ \Big[|\tilde{m}_{X'1}|^2 S_{11} + |\tilde{m}_{X'2}|^2 S_{22} + |\tilde{m}_{X'3}|^2 S_{33} + 2\Re[\tilde{m}_{X'1}\tilde{m}^*_{X'2}S_{12}] + 2\Re[\tilde{m}_{X'1}\tilde{m}^*_{X'3}S_{13}] + 2\Re[\tilde{m}_{X'2}\tilde{m}^*_{X'3}S_{23}]\Big]$$

Calibration factor

$$\begin{cases} \mathrm{VPHI} = \dfrac{\Re[\mathrm{NEBX'}]}{\mathrm{BX'BX'}} \\ \mathrm{ArgNEBX'} = \mathrm{Arg}[\mathrm{NEBX'}] \end{cases}$$

$$\begin{cases} \mathrm{NEBX'} = n_{Y'}(S_{41}k^{ny'}_{41} + S_{42}k^{ny'}_{42} + S_{43}k^{ny'}_{43} + S_{51}k^{ny'}_{51} + S_{52}k^{ny'}_{52} + S_{53}k^{ny'}_{53}) + n_{Z'}(S_{41}k^{nz'}_{41} + S_{42}k^{nz'}_{42} + S_{43}k^{nz'}_{43} + S_{51}k^{nz'}_{51} + S_{52}k^{nz'}_{52} + S_{53}k^{nz'}_{53}) \\ n_{Y'j} = m_{Y'j}n_j \\ n_{Z'j} = m_{Z'j}n_j \qquad j = 1, 2, 3 \\ \mathrm{BX'BX'} = |\tilde{m}_{X'1}|^2 S_{11} + |\tilde{m}_{X'2}|^2 S_{22} + |\tilde{m}_{X'3}|^2 S_{33} + 2\Re[\tilde{m}_{X'1}\tilde{m}^*_{X'2}S_{12}] + 2\Re[\tilde{m}_{X'1}\tilde{m}^*_{X'3}S_{13}] + 2\Re[\tilde{m}_{X'2}\tilde{m}^*_{X'3}S_{23}] \end{cases}$$

$$\begin{cases} k^{ny'}_{4j} = \dfrac{-A_{2Y'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}} \times \exp[i(\varphi_{C_{1Y}} - \varphi_{A_{1Y'}A_{2Z'}-A_{1Z'}A_{2Y'}})] \\ k^{nz'}_{4j} = \dfrac{A_{2Z'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}} \times \exp[i(\varphi_{C_{1Y}} - \varphi_{A_{1Y'}A_{2Z'}-A_{1Z'}A_{2Y'}})] \\ k^{ny'}_{5j} = \dfrac{A_{1Y'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}} \times \exp[i(\varphi_{C_{1Y}} - \varphi_{A_{1Y'}A_{2Z'}-A_{1Z'}A_{2Y'}})] \\ k^{nz'}_{5j} = \dfrac{-A_{1Z'}\tilde{m}^*_{X'j}}{\sqrt{|A_{2Y'}|^2+|A_{2Z'}|^2}} \times \exp[i(\varphi_{C_{1Y}} - \varphi_{A_{1Y'}A_{2Z'}-A_{1Z'}A_{2Y'}})] \end{cases}$$

Correct onboard computation of VPHI (BP1)

- A **patch of the LFR FSW** is needed !
- Next Earth flyby is in December 2021 …
- This let time for the LFR team to update the FSW