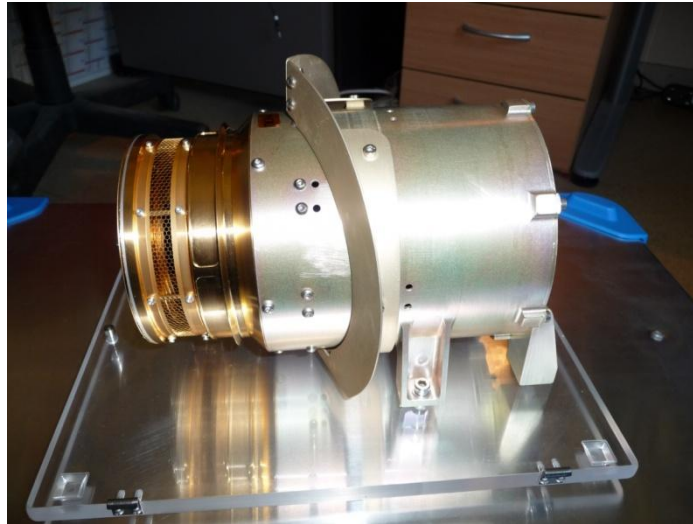


MERCURY ELECTRON ANALYZER – MMO

Meeting 14, 15, 16 July 2010



JAXA:

Y. Saito
Yokota

CESR:

J.-A. Sauvaud
C. Aoustin
M. Petiot
H.-C. Seran
J. Rouzaud
B. Lavraud

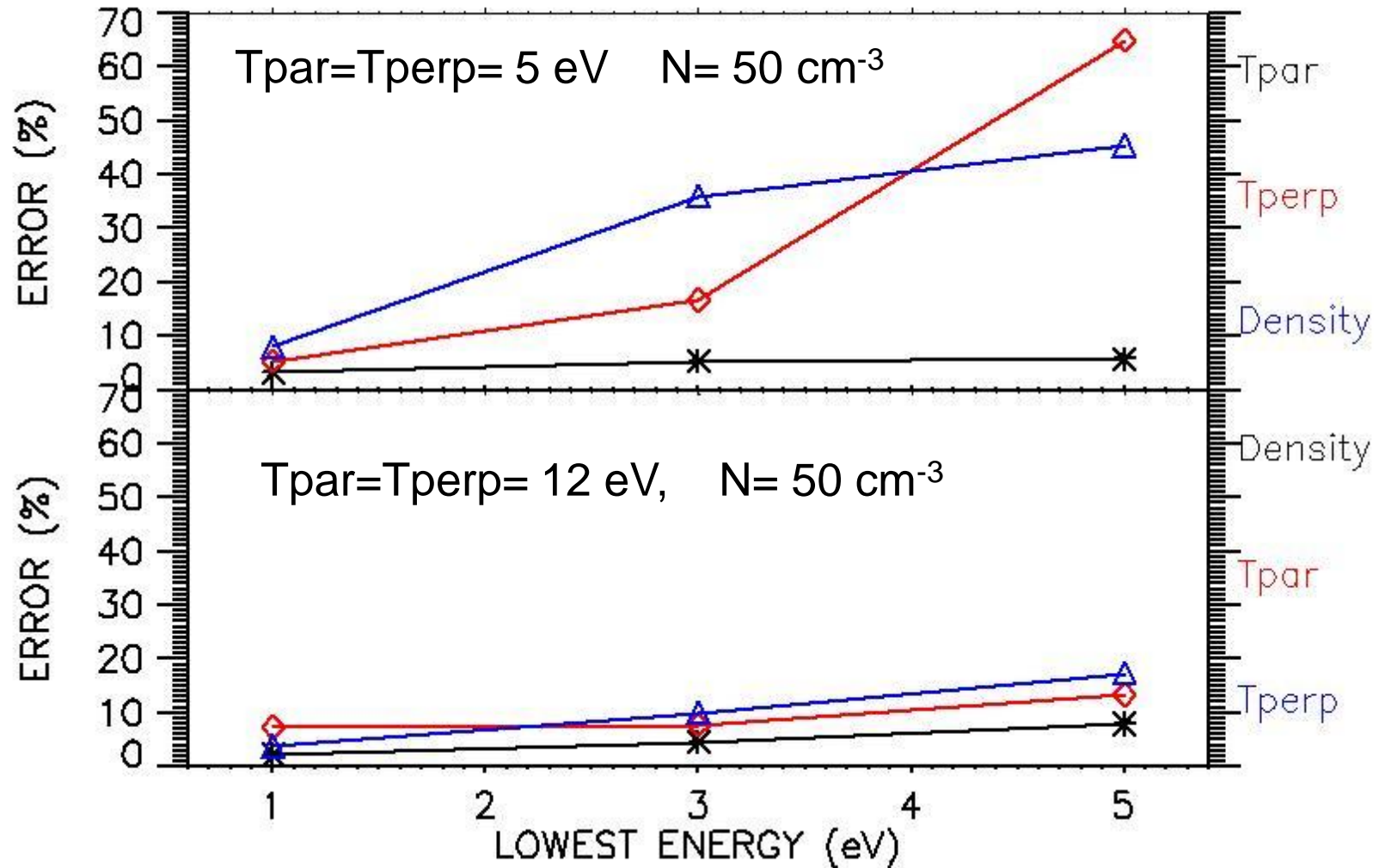
Interplanetary conditions

	Mercury	Earth	Jupiter	Neptun
Distance to the Sun (AU)	0,3 - 0,47	1,0	5,2	30,2
SW Density	73 - 32	7	0,3	0,008
Temp	17 - 13	8	2,7	0,8
B_{IMF} (nT)	46 - 21	6	3,4	0,14
E_{IMF} (mV/m)	18 - 8	2,4	1,3	0,05

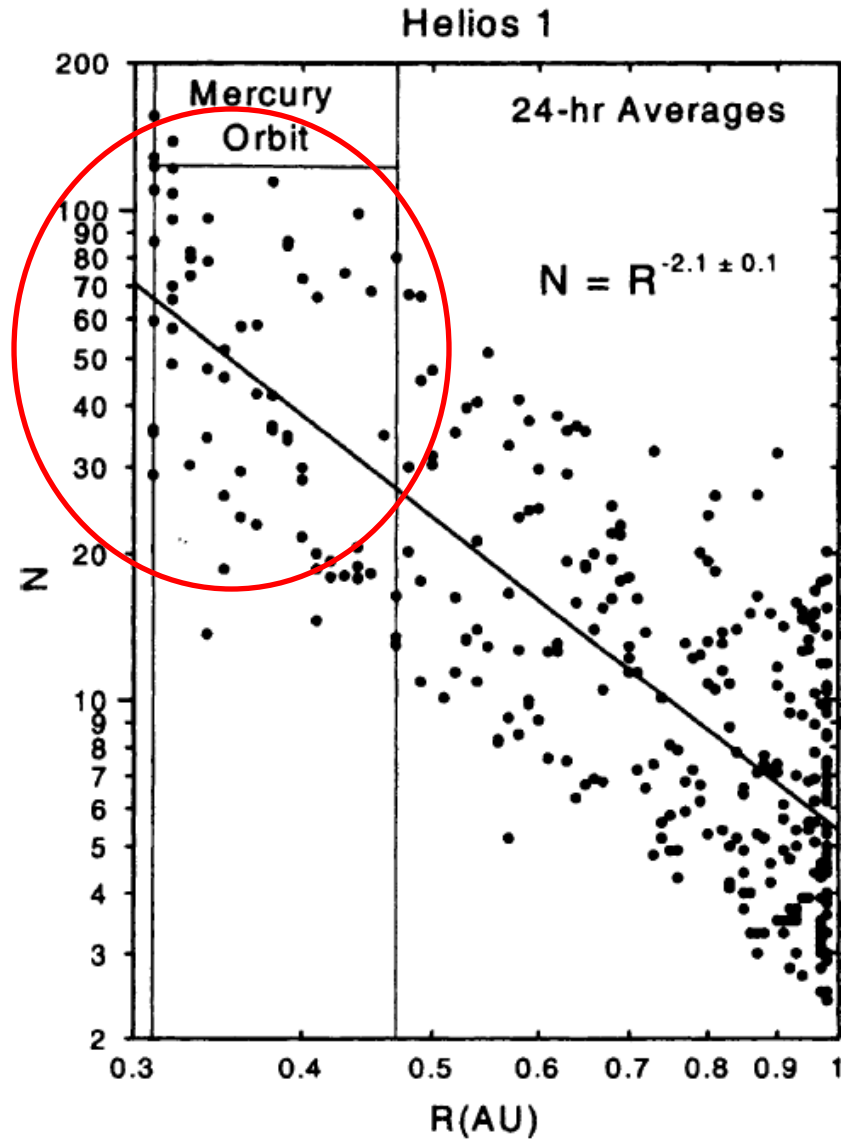
$$\rho V^3$$

$$VB^2$$

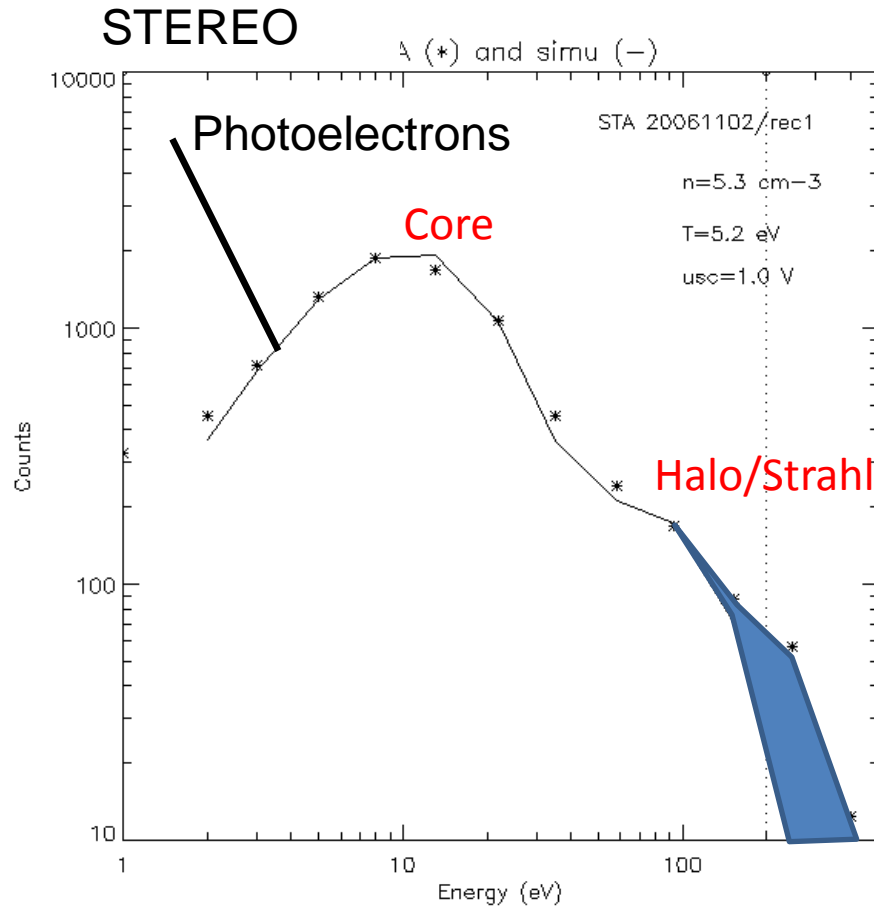
ERROR ON THE TEMPERATURE FOR VARIOUS E_{min}



DEPENDANCE OF THE SOLAR WIND DENSITY WITH RADIAL DISTANCE



THE SOLAR WIND AT 1 AU



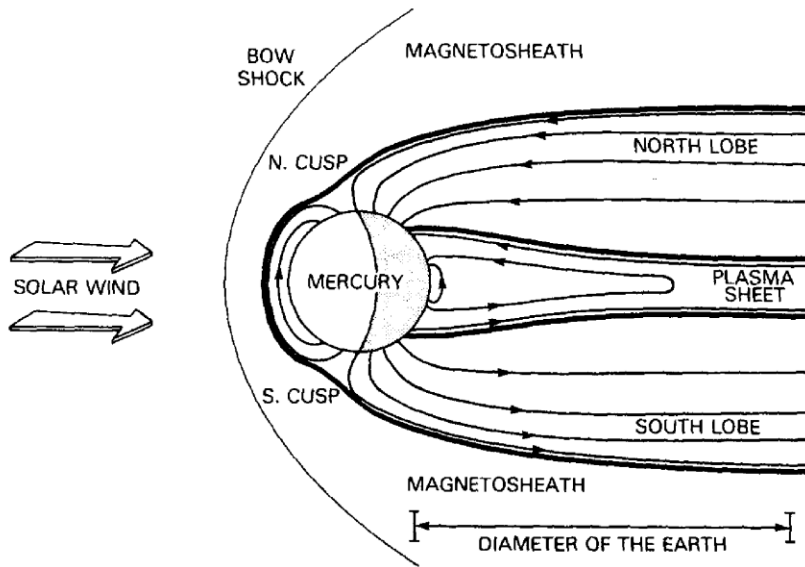
AT 0.3 AU:

The peak will be displaced around 20-30 eV at Mercury orbit

Mercury: Density x10

Note the measurements are made down to 2 eV

MERCURY, THE MAGNETOSPHERE



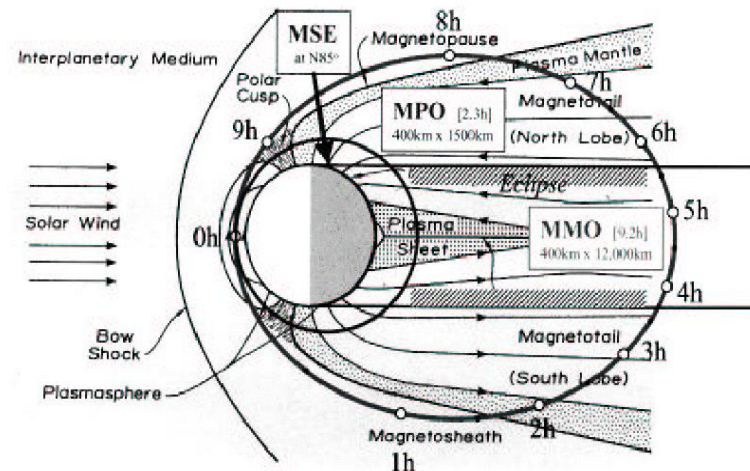
Magnetic field = 900 nT

No ionosphere

Exosphere = $H^{(+)}$, $He^{(+)}$, $Na^{(+)}$

Bepi-Colombo MMO

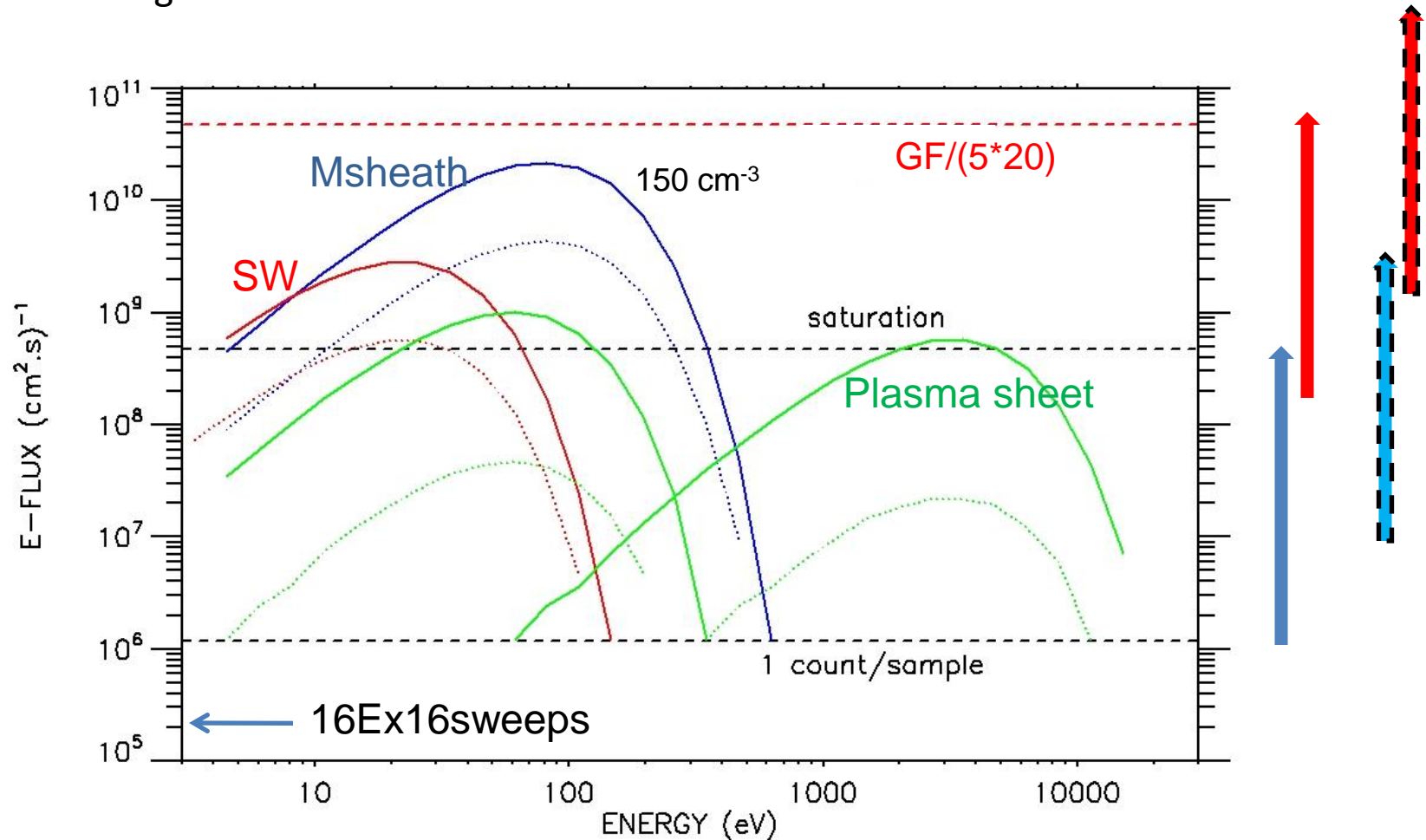
Orbit : polar- 9.2 h



Max time in magnetosphere : 6 h

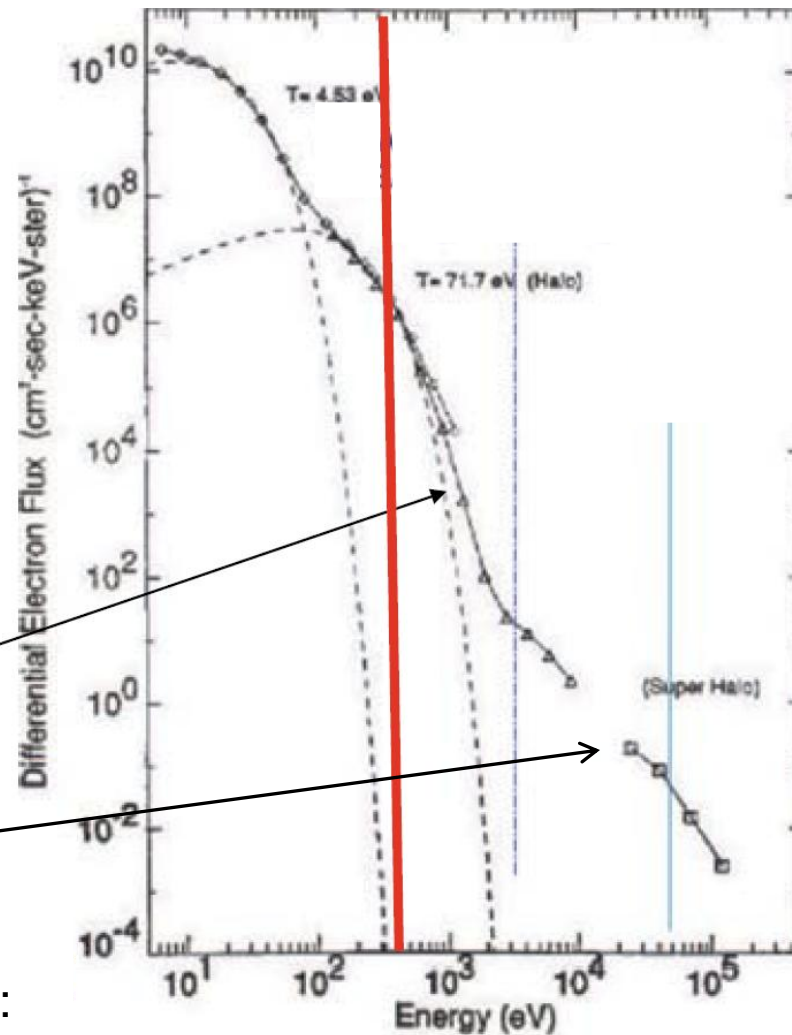
Scientific requirements

To measure a very large range of electron fluxes: from the almost empty magnetospheric lobe up to the dense solar: 2 sensor heads with different and variable geometric factors



'High energy electron measurements'

WIND



Halo

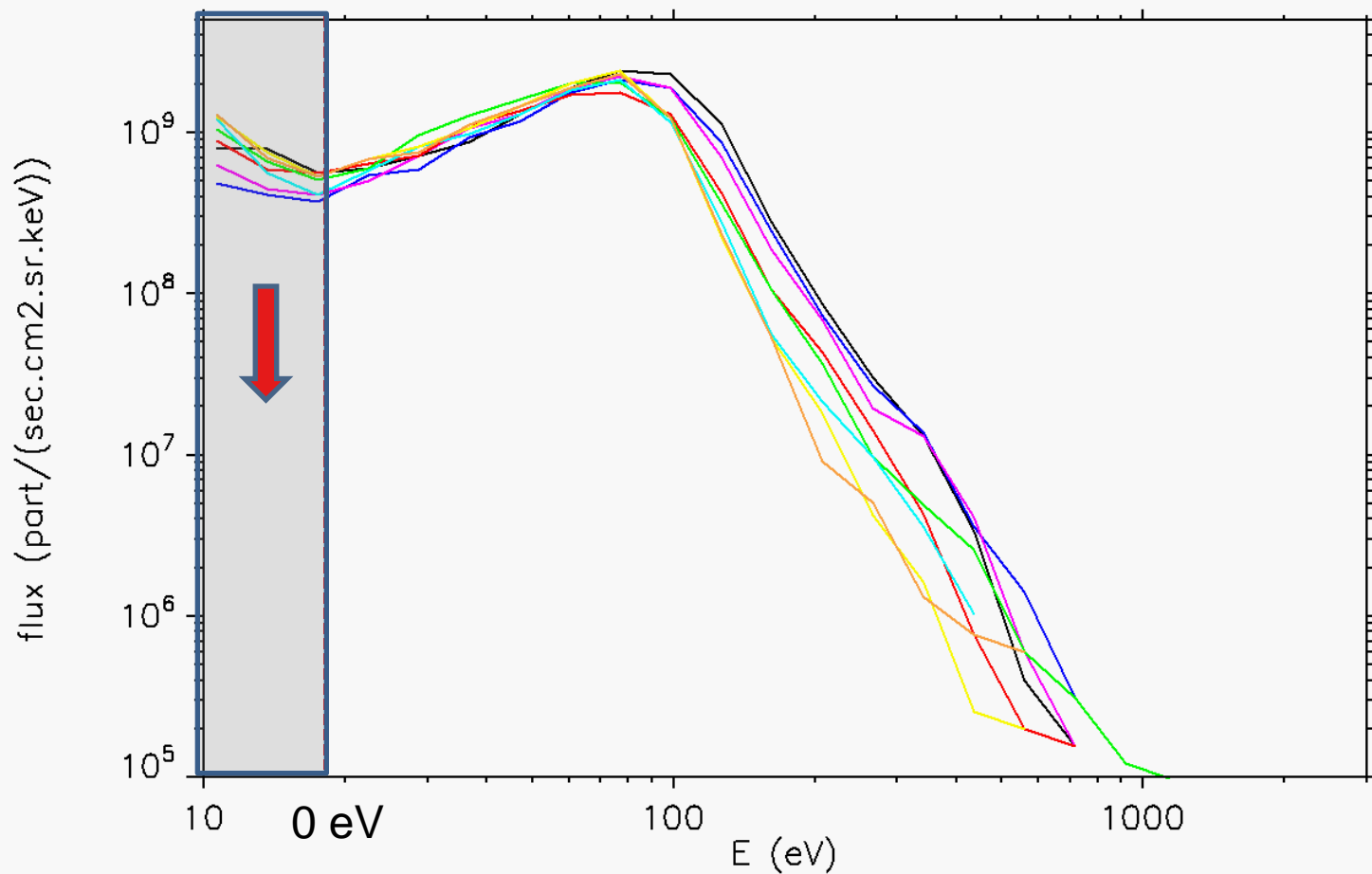
Super Halo

Measurable using 10-30 spins:
accumulation time: 40 s -120 s

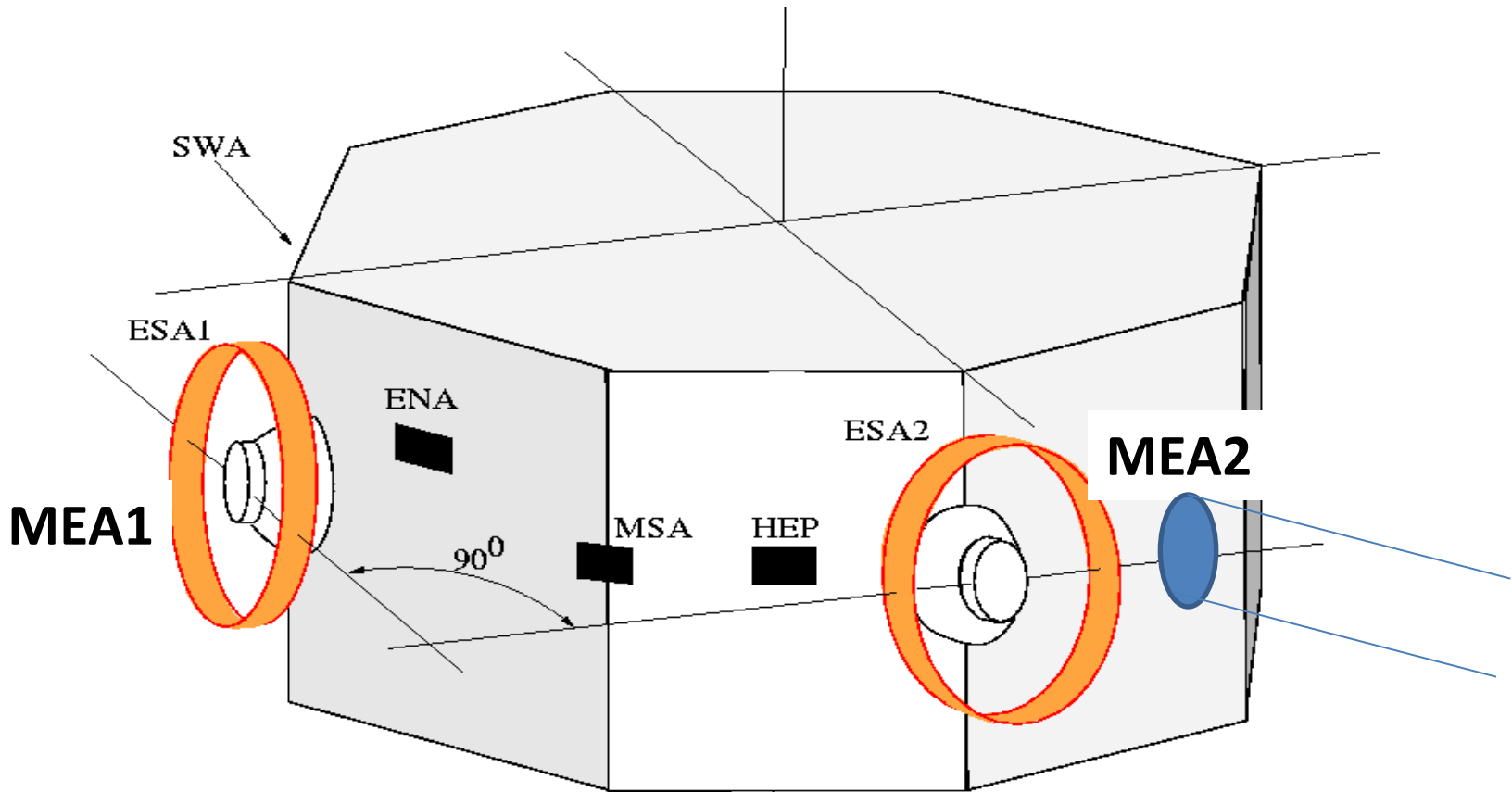
CORRECTIONS FOR THE S/C POTENTIAL

INTERBALL-ELECTRON

25/Aug/1996 01:02:00



MEA locations on MMO

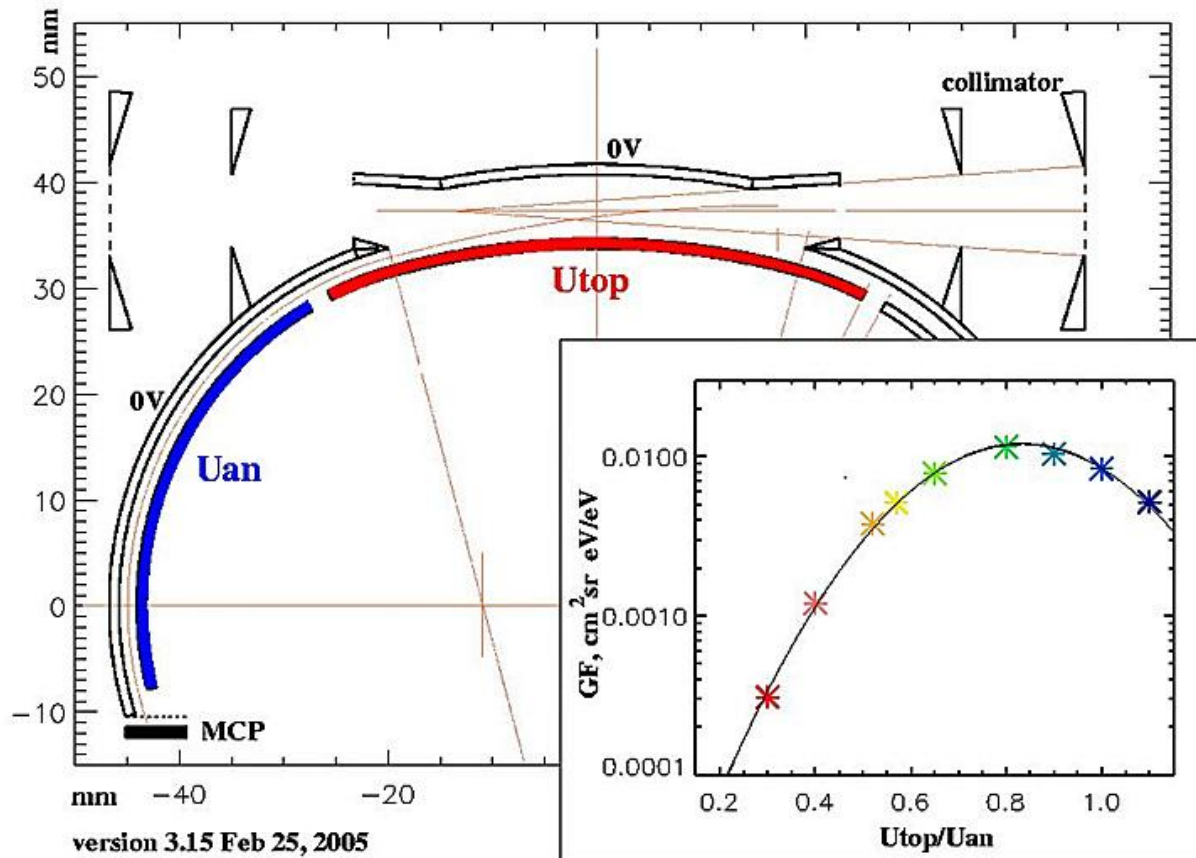


MEA-2: because of the mast 2 anodes are completely blocked and 2 others are partially obscured

VARIABLE TRANSMISSION

Inner sphere divided in 2 parts with different voltages

→ attenuation coefficient up to 100



Solution equivalent to make 'out of tune' 2 serial analyzers

LOWEST ENERGIES

- The lowest energy should be selectable in order to avoid unnecessary data (very high count rates)
- Either using the S/C potential provided by MEFISTO or by telecommand.
- The sweep will thus have a flat low voltage part
- The corresponding counts are set to zero

MEA 1 (Full geometrical factor)

U_{TOP}/U_{Analyz}	0.8	0.42	0.34	0.27
$GF \text{ cm}^2 \text{ sr eV/eV}$	$4 \cdot 10^{-3}$	$6.7 \cdot 10^{-4}$	$2.0 \cdot 10^{-4}$	$6.7 \cdot 10^{-5}$
GF_0/GF	1	6	20	60
$\Theta \text{ deg}$	1.8	7.0	8.2	9.0
$\Delta\Theta \text{ deg}$	5.9	4.5	3.0	3.6
K	8.67	8.48	8.57	8.51
$\Delta E/E$	0.11	0.16	0.11	0.09

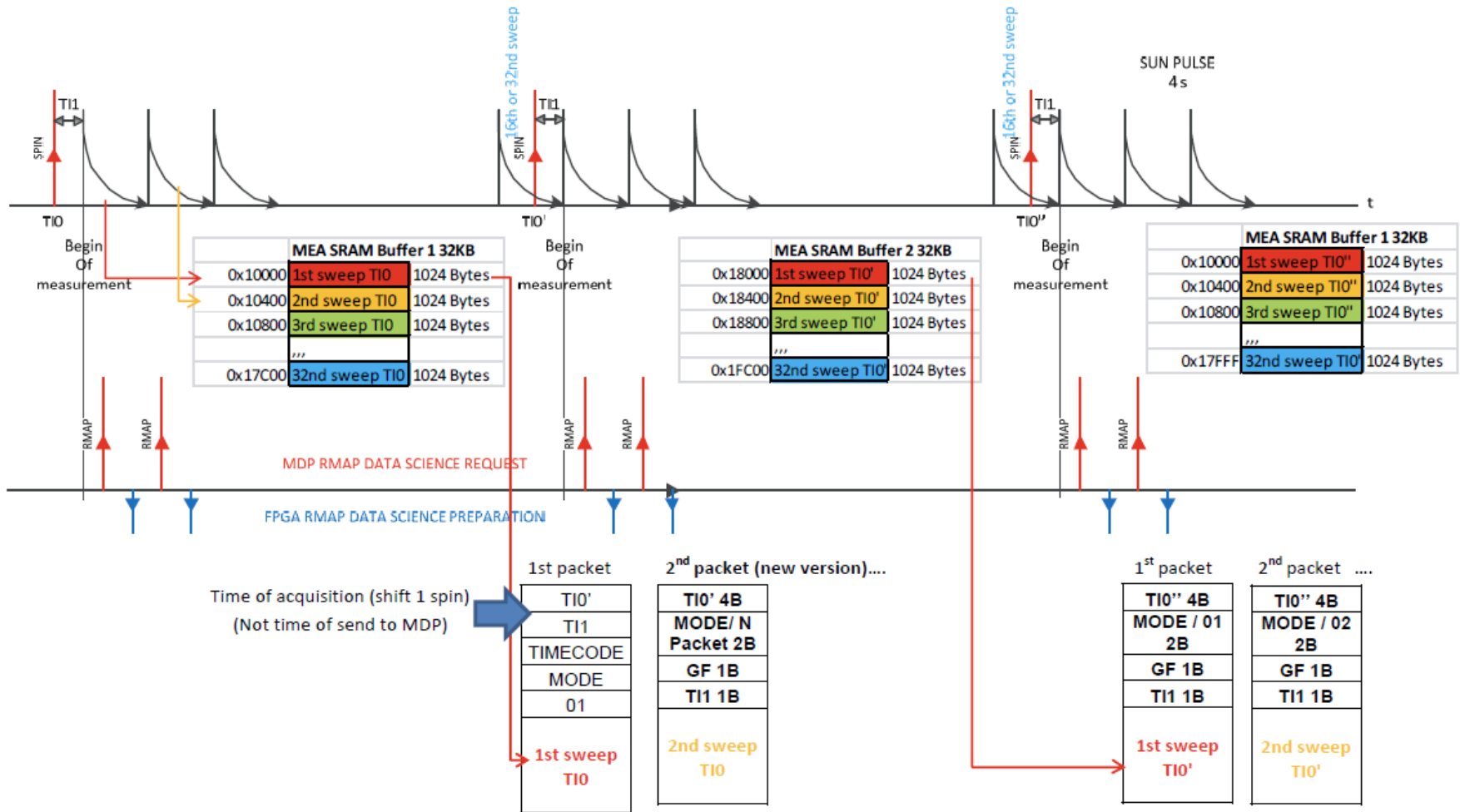
MEA-2

U_{TOP}/U_{Analyz}	0.8	0.52	0.37	0.28
$GF \text{ cm}^2 \text{ sr eV/eV}$	$2 \cdot 10^{-4}$	$6.7 \cdot 10^{-5}$	$1.6 \cdot 10^{-5}$	$4 \cdot 10^{-6}$
GF_0/GF	20	60	250	1000
$\Theta \text{ deg}$	1.8	6.3	7.5	9.0
$\Delta\Theta \text{ deg}$	5.9	5.0	3.0	3.5
K	8.67	8.62	8.57	8.51
$\Delta E/E$	0.11	0.13	0.11	0.08

Entrance grid



New packet header: Modification to have a time increment in the first 6 bytes, the mode and the geometrical factor in the header



Time of acquisition (shift 1 spin) = $TIO' + T11 + (n^{\circ} \text{ packet} - 1) \times T_{\text{spin}} / 32$ or $(T_{\text{spin}} / 16)$

$T_{\text{spin}} / 32$ = sweep time in mode with 32 sweeps; $T_{\text{spin}} / 16$ = sweep time in mode with 16 sweeps;

TIO' (4B) = Time index from MDP (RMAP), time of spin when packet are send to the MDP, 4Bytes; **T11 (1B)** = "spin phase" defined by TC, timing between sun pulse and

begin of measure. **GF** = Geometry factor (0 ⇔ 1 | 1 ⇔ factor 1 | 2 ⇔ factor 2 ...). **MODE** = 0 ⇔ 16 en/16swp | 1 ⇔ 16 en/32swp...

NECESSARY HK INFORMATIONS

HK : pass to ground every several minutes= Temperature, currents, MCP bias and currents. Important HK have to be passed by the scientific data.

Energy table: to be added by MDP to to the scientific packet

Geometry factor : inside the packet header

Mode: way to compute Pitch-angle, High?, Medium?, Low?, Engineering?, 8 bits

How to decide when to stop the sweep? Information about the step number will come from MDP: 1 (high energy)-32 , to be also added to the scientific data by MDP

How to decide the way to construct pitch-angle distributions From a TC sent from the ground

Table: N_{ion} , T_{ion} , spacecraft potential to be constructed onboard and used by MDP to fix the step where to stop the sweep.

CONTROL OF THE GEOMETRICAL FACTOR AND OF THE ENERGY SWEEP ENGINEERING MEDIUM RATE MODE

Elementary step counter : 8 b
HV top part of the analyzer: 12 b
HV of the low part of the analyzer: 12 b

$32 \text{ b}/4 = 8 \text{ b/s}$

Time to have a full control of the 128 double steps: $128 \text{ spins} = 512 \text{ seconds}$

CORRECTION FOR SPACECRAFT POTENTIAL

The spacecraft potential Φ_{sc} will be estimated with the following equation:

$$\Phi_{sc} = -A(\Phi_{sensor} + \Phi_{offset})$$

Where Φ_{sensor} is the average Langmuir sensor to spacecraft potential, A is scale factor taking into account the perturbation of the “local” plasma environment by the spacecraft, the antennas and their photoelectrons,

Φ_{offset} is the potential difference between the Langmuir sensor and the plasma which can vary from near zero in high density plasmas to about two volts in low density plasmas.

The values of A and of Φ_{offset} will be determined in flight calibration effort by comparing the calculated electron densities and density deduced from wave measurements.

25200.0001	5655.9191	1269.4221	284.9111	63.9461	14.3521
23469.3281	5267.4851	1182.2411	265.3441	59.5541	13.3661
21857.5161	4905.7281	1101.0481	247.1201	55.4641	12.4481
20356.3981	4568.8151	1025.4301	230.1491	51.6551	11.5931
18958.3731	4255.0411	955.0071	214.3431	48.1071	10.7971
17656.3591	3962.8151	889.4191	199.6221	44.8031	10.0561
16443.7681	3690.6591	828.3361	185.9131	41.7261	9.3651
15314.4511	3437.1941	771.4481	173.1451	38.8611	8.7221
14262.6931	3201.1361	718.4671	161.2541	36.1921	8.1231
13283.1691	2981.2911	669.1251	150.1791	33.7061	7.5651
12370.9151	2776.5431	623.1711	139.8651	31.3921	7.0461
11521.3121	2585.8571	580.3731	130.2601	29.2361	6.5621
10730.0581	2408.2671	540.5151	121.3141	27.2281	6.1111
9993.1451	2242.8741	503.3931	112.9821	25.3581	5.6911
9306.8421	2088.8391	468.8221	105.2231	23.6161	5.3001
8667.6721	1945.3831	436.6241	97.9961	21.9941	4.9361
8072.3981	1811.7791	406.6381	91.2661	20.4841	4.5971
7518.0061	1687.3511	378.7111	84.9981	19.0771	4.2821
7001.6881	1571.4681	352.7021	79.1611	17.7671	3.9881
6520.8311	1463.5431	328.4791	73.7241	16.5471	3.7141
6072.9971	1363.0311	305.9201	68.6611	15.4101	3.4591
					3.2211
					3.0000

32 'steps' 2776.5- 3.22 eV

	1269.4221	284.9111	63.9461	14.3521
	1182.2411	265.3441	59.5541	13.3661
	1101.0481	247.1201	55.4641	12.4481
	1025.4301	230.1491	51.6551	11.5931
	955.0071	214.3431	48.1071	10.7971
	889.4191	199.6221	44.8031	10.0561
	828.3361	185.9131	41.7261	9.3651
	771.4481	173.1451	38.8611	8.7221
	718.4671	161.2541	36.1921	8.1231
	669.1251	150.1791	33.7061	7.5651
2776.5431	623.1711	139.8651	31.3921	7.0461
2585.8571	580.3731	130.2601	29.2361	6.5621
2408.2671	540.5151	121.3141	27.2281	6.1111
2242.8741	503.3931	112.9821	25.3581	5.6911
2088.8391	468.8221	105.2231	23.6161	5.3001
1945.3831	436.6241	97.9961	21.9941	4.9361
1811.7791	406.6381	91.2661	20.4841	4.5971
1687.3511	378.7111	84.9981	19.0771	4.2821
1571.4681	352.7021	79.1611	17.7671	3.9881
1463.5431	328.4791	73.7241	16.5471	3.7141
1363.0311	305.9201	68.6611	15.4101	3.4591
				3.2211
				back

25200.0001	5655.9191
23469.3281	5267.4851
21857.5161	4905.7281
20356.3981	4568.8151
18958.3731	4255.0411
17656.3591	3962.8151
16443.7681	3690.6591
15314.4511	3437.1941
14262.6931	3201.1361
13283.1691	2981.2911
12370.9151	2776.5431
11521.3121	Back
10730.0581	
9993.1451	
9306.8421	
8667.6721	
8072.3981	
7518.0061	
7001.6881	
6520.8311	
6072.9971	

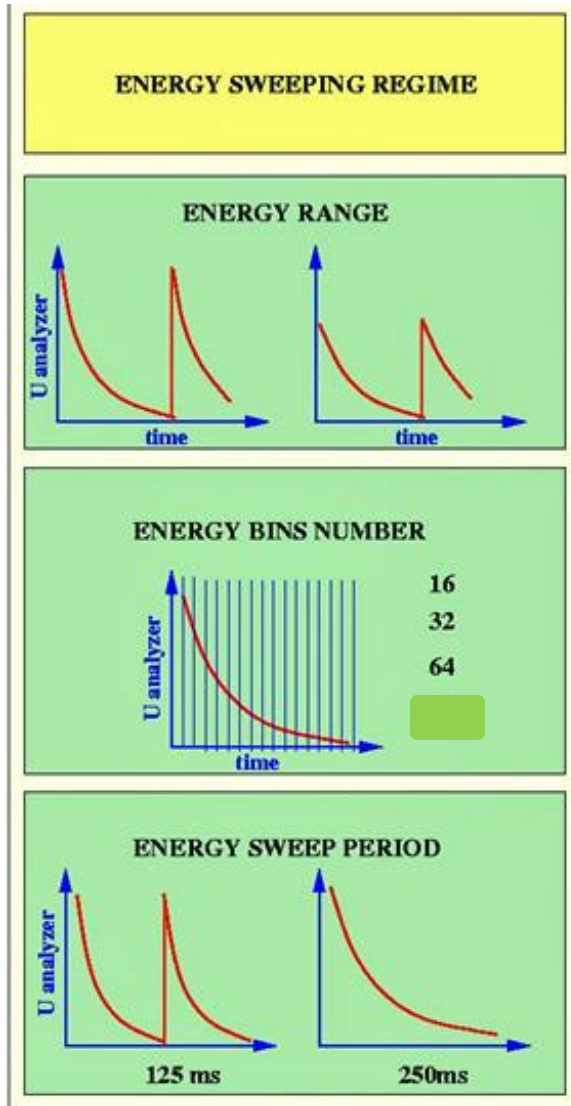
64 'steps'
284.9- 3.22 eV

“Photo-electrons”

284.9111	63.9461	14.3521
265.3441	59.5541	13.3661
247.1201	55.4641	12.4481
230.1491	51.6551	11.5931
214.3431	48.1071	10.7971
199.6221	44.8031	10.0561
185.9131	41.7261	9.3651
173.1451	38.8611	8.7221
161.2541	36.1921	8.1231
150.1791	33.7061	7.5651
139.8651	31.3921	7.0461
130.2601	29.2361	6.5621
121.3141	27.2281	6.1111
112.9821	25.3581	5.6911
105.2231	23.6161	5.3001
97.9961	21.9941	4.9361
91.2661	20.4841	4.5971
84.9981	19.0771	4.2821
79.1611	17.7671	3.9881
73.7241	16.5471	3.7141
68.6611	15.4101	3.4591
		3.2211

Back

OPERATING MODES



32 or 64 energy spectra per spin

4 energy sweep possibilities:

-3-300 (Photo-electrons)

-3-3000 (Solar wind)

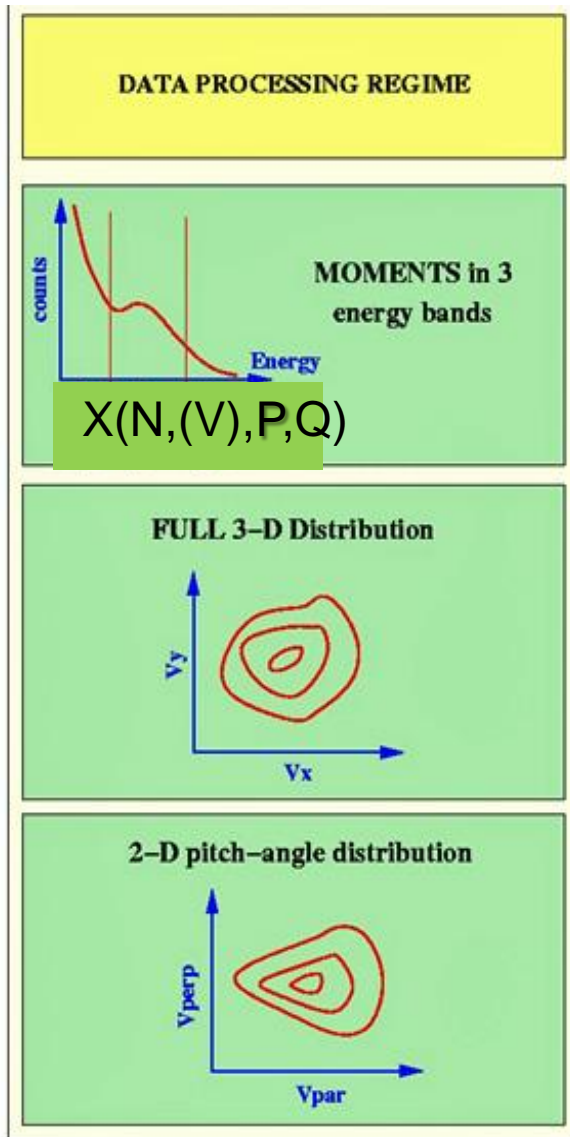
-3-25,200 (Magnetosphere)

-3000-25,200 (Super strahl and accelerated e^-)

2 different numbers of energies, 32 for moment computation, 64 for photo-electrons without moments

The sweep is stopped at photoelectron boundary, determined from S/C potential or after flight calibration

OPERATING MODES



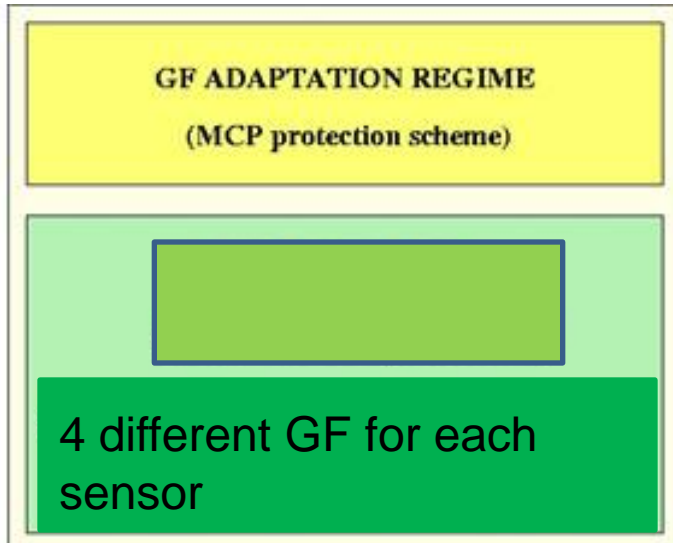
Moments corrected from the spacecraft potential

3D distributions:

Pitch-angle: from the onboard B field or from the partial pressure tensor (2sec and 4 sec)

+ Omni-directional energy spectrum, ODES

OPERATING MODES



Choice made from previous spins or change can be inhibited by TC

HOW TO SUPPRESS HIGH COUNT RATE DUE TO PHOTO-ELECTRONS AND TAKE INTO ACCOUNT THE SATELLITE POTENTIAL

1) Direct method

Density
$$\iiint (C_a / (K_a v_a^4)) \cdot v_a \sqrt{1 + q \frac{v_{\Phi}^2}{v_a^2}} \cdot (v_a dv_a) \cdot \cos\theta \cdot d\theta \cdot d\phi$$

Velocity	$1 + q \frac{v_{\Phi}^2}{v_a^2}$
----------	----------------------------------

Pressure tensor $1 + q \frac{v_{\Phi}^2}{v_a^2})^{3/2}$

Heat flux $1 + q \frac{v_{\Phi}^2}{v_a^2})^{3/2}$

Spacecraft potential : $V_{sc} = -A(\Phi_{\text{sensor}} + \Phi_{\text{offset}})$

Difficult to determine in-flight

HOW TO SUPPRESS HIGH COUNT RATE DUE TO PHOTO-ELECTRONS AND TAKE INTO ACCOUNT THE SATELLITE SPACECRAFT

2) Indirect method

-Compute the moments from the highest energy down to the energy which is guessed to equal two times the satellite potential.
(hypothesis: potential=0 in the computations)

-Pass partial moments for each energy lower than 2 times the guessed potential (hypothesis: potential=0)

-The value of the potential is changed according to the orbit

Ex: For a solar wind potential of 10 volts, moments are computed from 2776 eV to 27.22 eV and 5 partial moments for lower energies are transmitted.

Spacecraft potential : $V_{sc} = -A(\Phi_{\text{sensor}} + \Phi_{\text{offset}})$ found on ground and partial moments are corrected.

HOW TO CHANGE THE GEOMETRICAL FACTOR IN-FLIGHT

-Based on saturation

Solar wind/Sheath: if the count rate averaged over X spins at an energy of 25 eV or 100eV are higher than $1 \times 10^5 / (\text{sec} \cdot \text{anode})$ ($1/2 \times 10^6 \times 0.2 \text{ cm}^2$)

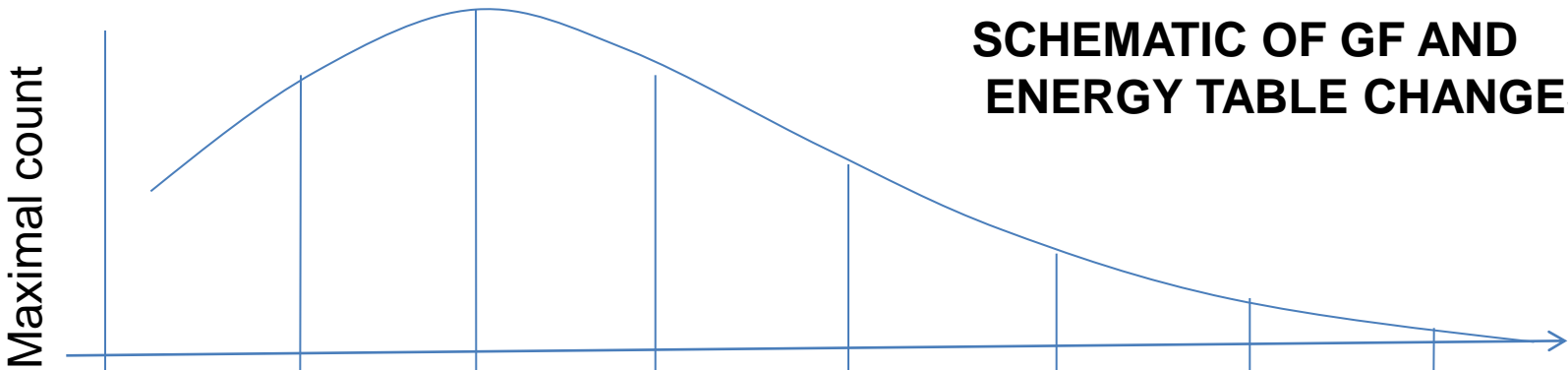
Mercury magnetosphere: if the counts at 40 eV or 200 eV or 2000 eV are higher than $1 \times 10^5 / (\text{sec} \cdot \text{anode})$ ($1/2 \times 10^6 \times 0.2 \text{ cm}^2$)

Finally: compute the sum of the counts at 25, 40, 100 and 200 eV and if one of these counts exceed the threshold: increase the geometrical factor

-Based on too few events:

Solar wind, Sheath, Magnetosphere: If the average total number of counts/spin is lower than 1000 during X spins

SCHEMATIC OF GF AND ENERGY TABLE CHANGES



MEA-1 GF factor	60	250	1000	250	60	20	20	20
MEA-2 GF factor	60	1	1	1	60	20	6	1
MEA-2 ETable	T1	T3	T3	T3	T1	T1	T1	T1
MEA-1 ETable	T2	T2	T2	T2	T2	T2	T2	T2
Sensor deciding	MEA-2	MEA-2	MEA-2	MEA-2	MEA-2	MEA-2	MEA-1	MEA-1

T1: 3eV – 25 keV
 T2: 3eV - 3 keV
 T3: 3keV – 25 keV

OMNIDIRECTIONAL ENERGY SPECTRA

$$\text{ODES}_i = \sum_{j,k} [C_{i,k}/\varepsilon_k] \langle \cos(\theta) \rangle$$

i: energy

k: anodes (polar angle)

j: azimuth – rotation

ε_k allows to take into account the variations of the transmission of the analyzer with azimuth

ODES will be corrected on ground from the satellite potential which modify the geometrical factor and the energy transmission

PITCH-ANGLE DISTRIBUTION

- Correspond to the sweep when the magnetic field is inside the plane of measurements - once per spin

- 16 anodes are transmitted

- N energies are transmitted

The direction time when B will be in the measurement plane is computed

- either from the magnetometer data, once the offsets are corrected (by whom?)

- or from the symmetry direction of the partial pressure tensor for E between 150 and 300 eV

MINIMUM INFORMATION REQUIRED LOW BIT RATE

(1) Moments are computed taking into account the satellite potential from MEFISTO

Each sensor: 218 b/s; 436 b/s for both sensors (146 b/s compressed)

Moments every spin from 1 sensor = 52 b/s (1) $13 \times 16 / 4$

Omnidirectional energy spectrum every spin $(16 \times 16) / 4 = 64$ b/s

Pitch angle distributions at 4 energies every 4 spins: $4 \times 16 \times 16 / 16 = 64$ b/s

Option: 3D every 150 spins (600 seconds): $16 \times 8 \times 8 \times 16 / 600 = 38$ b/s

MINIMUM INFORMATION REQUIRED LOW BIT RATE

(2) Without potential correction

Each sensor: 206 b/s; 412 b/s for both sensors (138 b/s)

Moments every 4 spin from 1 sensor = 78 b/s (2) $6E(13 \times 16b/16)$

Omnidirectional energy spectrum every spin $(16E \times 16b)/4 = 64 \text{ b/s}$

Pitch angle distributions at 4 energies every 4 spins: $4E \times 16 \text{ anodes} \times 16b/20 = 64 \text{ b/s}$

+3D every 150 spins (600 seconds): $16E \times 88 \Omega \times 16b/600 = \mathbf{38 \text{ b/s}}$

MEA energy tables:

Name	Description	Energy Range	Step Number	Comment
T0	Photoelectrons	3 - 300eV	64	32(?) TBD
T1	Full Range	3eV - 25keV	32	
T2	Low Energies	3eV - 3keV	32	
T3	High Energies	3keV – 25 keV	32	

MCP calibration procedure:

Definitions:

UMCP Total MCP voltage, V, (that is MCP bias + 400V)

UMCP_D Digital reference (0 -> x0FFX, 4 LSB are not used) 13V step.

WUMCP The working point, Total voltage, V

WUMCP_D Digital reference of the working point

Description:

8 successive values with a step 65V (x0050 in digital reference), around the **WUMCP_D**. Thus the values are:

$$\text{UMCP} = \text{WUMCP} + [-234.0, -169.0, -104.0, -39.0, 26.0, 91.0, 156.0, 221.000]$$

$$\text{UMVP_D} = \text{WUMCP_D} + [-288, -208, -128, -48, 32, 112, 192, 272]$$

Thus we need 8 telecomands during any MR mode with time step 30s.

After this sequence a telecomand to return to **WUMCP** previous point should be done.

MEDIUM BIT RATE ENGINEERING MODE

(1) Moments are computed taking into account the satellite potential from MEFISTO

MEA-1: 1384 b/s

Moments every 1/2 spin from MEA-1 = 104 b/s (1) $1 \times 10^{13} \times 16/2$

Omnidirectional energy spectrum every 1/2 spin $(32 \times 10^{16} \text{b})/2 = 256 \text{ b/s}$

Pitch angle distributions at 8 energies every 1/2 spin: $8 \times 10^{16} \text{anodes} \times 16 \text{b}/2 = 1024 \text{ b/s}$

MEA-2: 692 b/s

Moments every 1 spin from MEA-1 = 52 b/s (1) $1 \times 10^{13} \times 16/4$

Omnidirectional energy spectrum every 1 spin $(32 \times 10^{16} \text{b})/4 = 128 \text{ b/s}$

Pitch angle distributions at 8 energies every 1 spin: $8 \times 10^{16} \text{anodes} \times 16 \text{b}/4 = 512 \text{ b/s}$

3D: $16 \times 10^{16} \times 8 \times 16 \text{b}/4 = 5632 \text{ b/s}$

TOTAL MEA-1+MEA-2: 7708 (2570) b/s

MEDIUM BIT RATE ENGINEERING MODE

(2) Moments are computed with zero potential

MEA-1: 1264 b/s

Moments every 1/2 spin from MEA-1 = 624 b/s (2) $6 \times 10^{13} \times 16/2$

Omnidirectional energy spectrum every 1/2 spin $(32 \times 10^{16} \text{b})/2 = 128 \text{ b/s}$

Pitch angle distributions at 4 energies every 1/2 spin: $4 \times 10^{16} \text{anodes} \times 16 \text{b}/2 = 512 \text{ b/s}$

MEA-2: 632 b/s

Moments every 1 spin from MEA-2 = 312 b/s (1) $6 \times 10^{13} \times 16/4$

Omnidirectional energy spectrum every 1 spin $(32 \times 10^{16} \text{b})/4 = 64 \text{ b/s}$

Pitch angle distributions at 4 energies every 1 spin: $4 \times 10^{16} \text{anodes} \times 16 \text{b}/4 = 256 \text{ b/s}$

3D-1 spin, 1 detector: $16 \times 10^{16} \text{anodes} \times 16 \text{b}/4 = 5632 \text{ b/s}$

TOTAL MEA-1+MEA-2: 7528 (2743) b/s

MEDIUM BIT RATE ENGINEERING PHOTOELECTRON MODE

MEA-1: 1152 b/s 64 steps starting at 280 eV

Omnidirectional energy spectrum every 1/2 spin $(64 \times 16b)/2 = 128 \text{ b/s}$

Pitch angle distributions at 8* energies every 1/2 spin: $4 \times 16 \text{ anodes} \times 16b/2 = 1024 \text{ b/s}$

* Changed by telecommand and made of 3 elementary steps

MEA-2: 632b/s Normal E sweep

Moments every 1 spin from MEA-2= 312 b/s (1) $6 \times 13 \times 16/4$

Omnidirectional energy spectrum every 1 spin $(32 \times 16b)/4 = 64 \text{ b/s}$

Pitch angle distributions at 4 energies every 1 spin: $4 \times 16 \text{ anodes} \times 16b/4 = 256 \text{ b/s}$

3D-1 spin, 1 detector: $16 \times 88 \times 16b/4 = 5632 \text{ b/s}$

TOTAL MEA-1+MEA-2: 7528 (2743) b/s

MEDIUM BIT RATE SCIENCE MODE

(1) Moments are computed taking into account the satellite potential from MEFISTO

MEA-1: 1128 b/s

Moments every 1/2 spin from MEA-1 = 104 b/s (1) $1 \times 13 \times 16 / 2$

Omnidirectional energy spectrum every 1/2 spin $(32 \times 16 \text{ b}) / 2 = 256 \text{ b/s}$

Pitch angle distributions at 6 energies every 1/2 spin: $6 \times 16 \text{ anodes} \times 16 \text{ b} / 2 = 768 \text{ b/s}$

MEA-2: 692 b/s

Moments every 1 spin from MEA-1 = 52 b/s (1) $1 \times 13 \times 16 / 4$

Omnidirectional energy spectrum every 1 spin $(32 \times 16 \text{ b}) / 4 = 128 \text{ b/s}$

Pitch angle distributions at 8 energies every 1 spin: $8 \times 16 \text{ anodes} \times 16 \text{ b} / 4 = 512 \text{ b/s}$

3D-2 spins: $16 \times 88 \Omega \times 16 \text{ b} / 8 = 2816 \text{ b/s}$

TOTAL MEA-1+MEA-2: 4636 b/s (1546)

MEDIUM BIT RATE SCIENCE MODE

(2) Moments are computed with $V_s/c = 0$

MEA-1: 1392 b/s

Moments every 1/2 spin from MEA-1 = 624 b/s (1) $6E \times 13 \times 16/2$

Omnidirectional energy spectrum every 1/2 spin $(32E \times 16b)/2 = 256$ b/s

Pitch angle distributions at 4 energies every 1/2 spin: $4E \times 16 \text{anodes} \times 16b/2 = 512$ b/s

MEA-2: 696 b/s

Moments every 1 spin from MEA-1 = 312 b/s (1) $6E \times 13 \times 16/4$

Omnidirectional energy spectrum every 1 spin $(32E \times 16b)/4 = 128$ b/s

Pitch angle distributions at 4 energies every 1 spin: $4E \times 16 \text{anodes} \times 16b/4 = 256$ b/s

3D-2 spins: $16E \times 88 \Omega \times 16b/8 = 2816$ b/s

TOTAL MEA-1+MEA-2: 4904 b/s (1635)

REDUCED MEDIUM BIT RATE SCIENCE MODE

(1) Moments are computed taking into account the satellite potential from MEFISTO

Either: 2076 b/s (692):

MEA-1: 1384 b/s

Moments every 1/2 spin from MEA-1 = 104 b/s (1) $1 \times 10^{13} \times 16/2$

Omnidirectional energy spectrum every 1/2 spin $(32 \times 10^{16} \text{b})/2 = 256 \text{ b/s}$

Pitch angle distributions at 8 energies every 1/2 spin: $8 \times 10^{16} \text{anodes} \times 16 \text{b}/2 = 1024 \text{ b/s}$

MEA-2: 692 b/s

Moments every 1 spin from MEA-1 = 52 b/s (1) $1 \times 10^{13} \times 16/4$

Omnidirectional energy spectrum every 1 spin $(32 \times 10^{16} \text{b})/4 = 128 \text{ b/s}$

Pitch angle distributions at 8 energies every 1 spin: $8 \times 10^{16} \text{anodes} \times 16 \text{b}/4 = 512 \text{ b/s}$

Or: 2816 b/s (939)

3D-2 spins: $16 \times 10^{16} \times 16 \text{b}/8 = 2816 \text{ b/s (939)}$

REDUCED MEDIUM BIT RATE SCIENCE MODE

(2) Moments are computed with $V_{sc} = 0$

Either: 2088 b/s (696):

MEA-1: 1392 b/s

Moments every 1/2 spin from MEA-1 = 624 b/s (1) $6E \times 13 \times 16/2$

Omnidirectionnal energy spectrum every 1/2 spin $(32E \times 16b)/2 = 256$ b/s

Pitch angle distributions at 4 energies every 1/2 spin: $8E \times 16 \text{anodes} \times 16b/4 = 512$ b/s

MEA-2: 696 b/s

Moments every 1 spin from MEA-1 = 312b/s (2) $6E \times 13 \times 16/4$

Omnidirectionnal energy spectrum every 1 spin $(32E \times 16b)/4 = 128$ b/s

Pitch angle distributions at 4 energies every 1 spin: $4E \times 16 \text{anodes} \times 16b/4 = 256$ b/s

Or: 2048 b/s (470)

3D-2 spins: $16E \times 88 \Omega \times 16b/8 = 2048$ b/s

HIGH BIT RATE SCIENCE MODE

Total: 33792 (11264)

MEA-1 3D-1/2 spin: $32 \text{ Ex}88 \Omega \times 16 \text{ b}/2 = 22528 \text{ b/s}$

MEA-2 3D – 1 spin: $32 \text{ Ex}88 \Omega 16 \text{ b}/4 = 11264 \text{ b/s}$

MEA MODES

LBRWI=	M, ODES, PA	146 bps	32E 32 sweeps
LBRWO=	M, ODES, PA	138	“
MBReWI =	M, ODES, PA, 3D	2570	“
MBReWO=	M, ODES, PA, 3D	2743	“
MBResmph=	M, ODES, PA, 3D	2743	64E 32 sweeps
MBRsmWI=	M, ODES, PA, 3D	1546	32E 32 sweeps
MBRsmWO=	M, ODES, PA, 3D	1635	“
MBRredWI1 =	M, ODES, PA	692	“
MBRredWI2=	3D	939	“
MBRredWO1 =	M, ODES, PA	696	“
MBRredWO2 =	3D	470	“
HBR =	3D	11264	“

LBRWI : Low bit rate with the satellite potential from MEFISTO

MBReWO: Medium Bit Rate engineering without the MEFISTO potential

INFORMATIONS NEEDED ONBOARD

-Spin pulse

-Magnetic field with offset removed or

-True phase angle of the plane containing the magnetic field

-Spacecraft potential (in fact Φ_{sensor} : $V_{\text{sc}} = -A(\Phi_{\text{sensor}} + \Phi_{\text{offset}})$)

-Information transmitted between MEA-1 and MEA-2: symmetry direction of the electron distribution function ? Or computed from each sensor?

Burst mode, to MDP

16phi x 16cells x 64E x 16b x 2sensors/4s = 131072 bps

32phi x 16cells x 32E x 16b x 2sensors/4s = 131072 bps

16phi x 16cells 16E x 16b x 2sensors/4s = 32768 bps

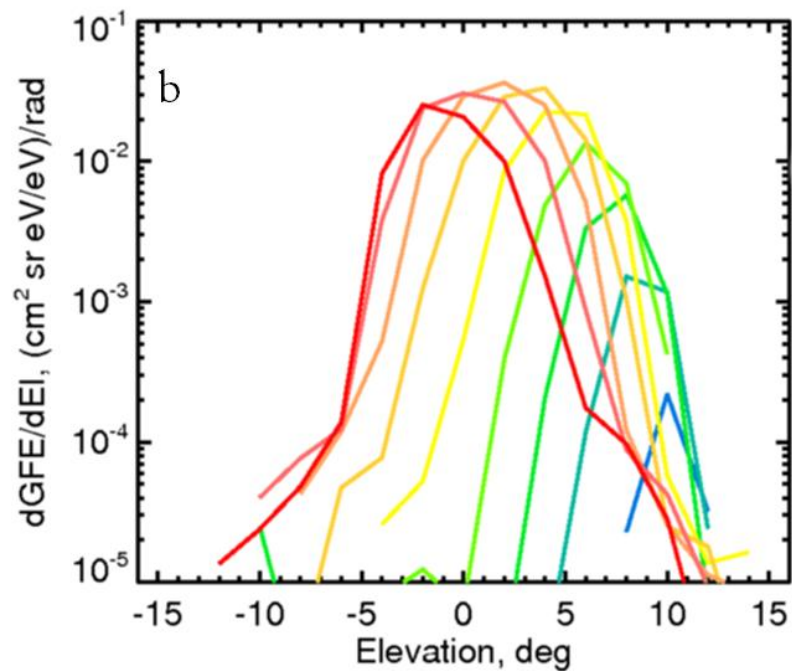
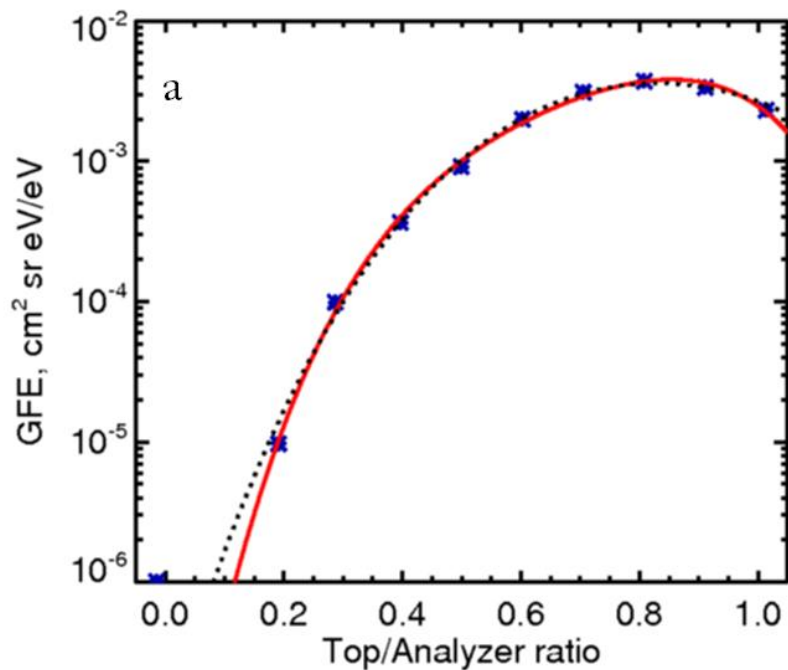
**From MEA-1 and MEA-2 to MDP: 32768 bytes x 2 every 4 seconds
= 131072 bps**

MEA

GENERAL PROPERTIES

MEA EQM

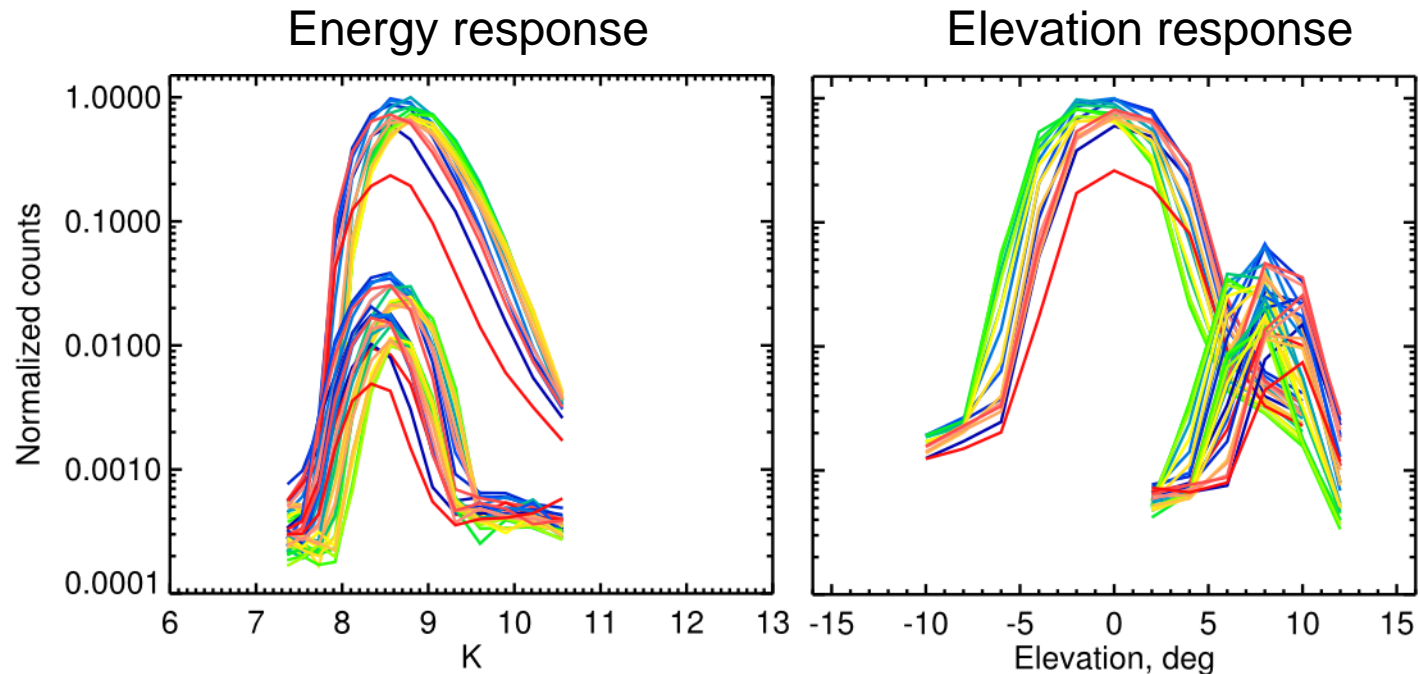
General properties for different GF values



$E/V=k$ varies with the geometrical factor

MEA EQM

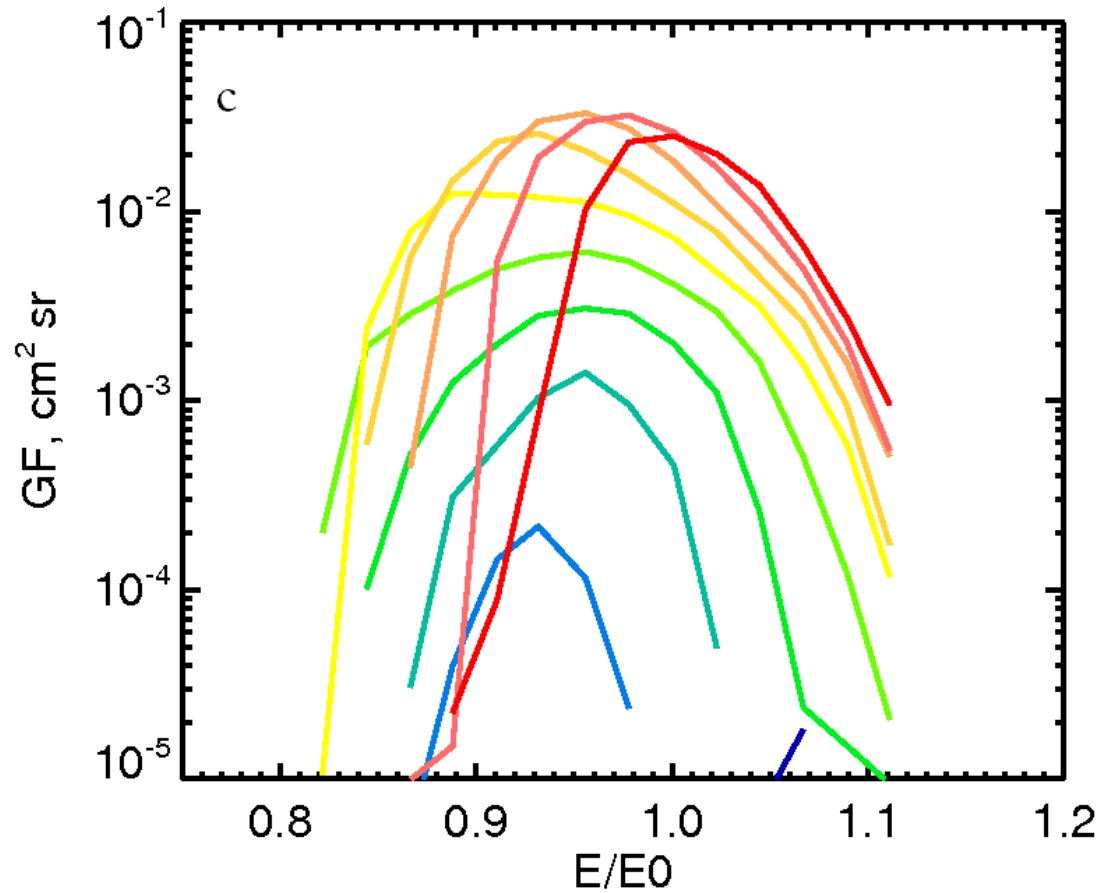
General properties for different GF values



GF attenuation	K0 (Energy/Uanalyzer)	$\Delta E/E$	Elevation,deg	Δ Elevation, deg
1	8.7	9.2%	0	5
34	8.4	8.3%	8	3
78	8.3	8.0%	8.5	2

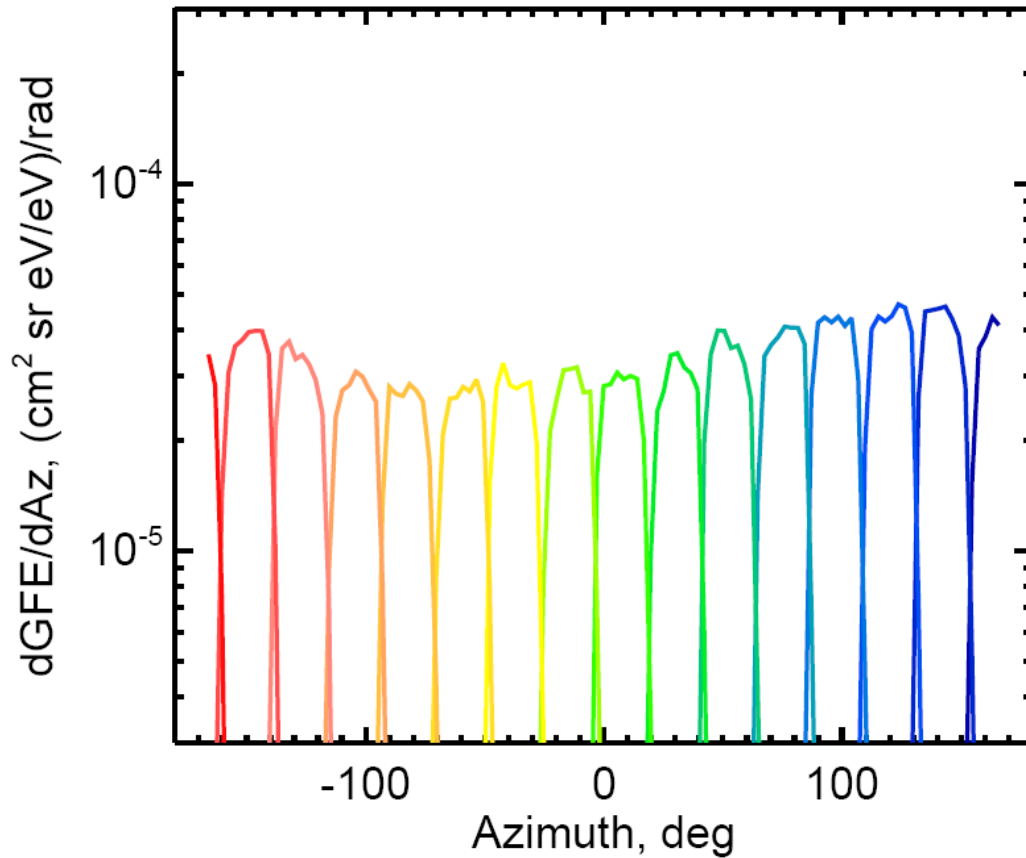
MEA EQM

General properties for different GF values



MEA EQM

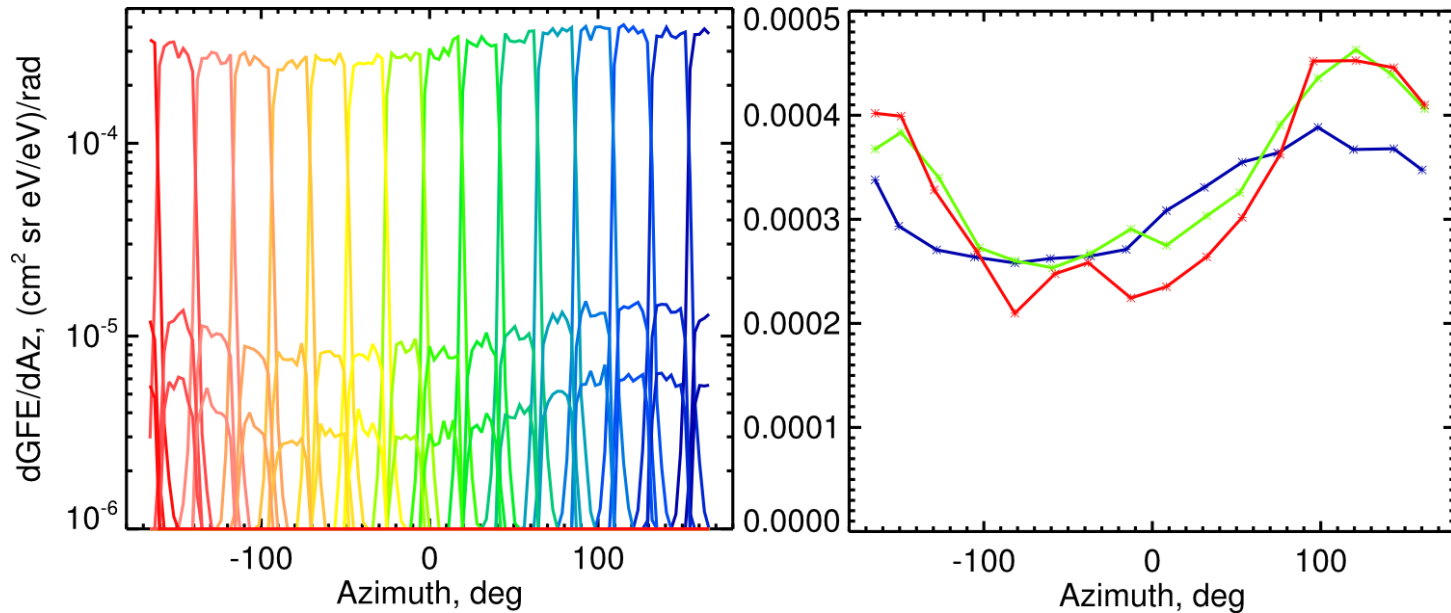
General properties for different GF values



For a given GF, transmission varies with azimuth

MEA EQM

Azimuthal variation of the geometrical factor



Left: Azimuth response of the 16 anodes for 3 values of the geometrical factor

Right: GF in linear scale versus azimuth. The blue, green and red curve respectively correspond to $U_{top}/U_{an}=0.85$, 0.3 and 0.25 . GF values are normalized to the maximal GF.

MEA EQM

Variable geometric factor

