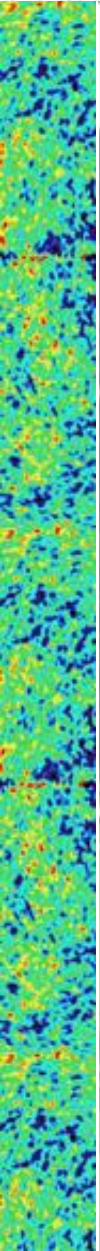




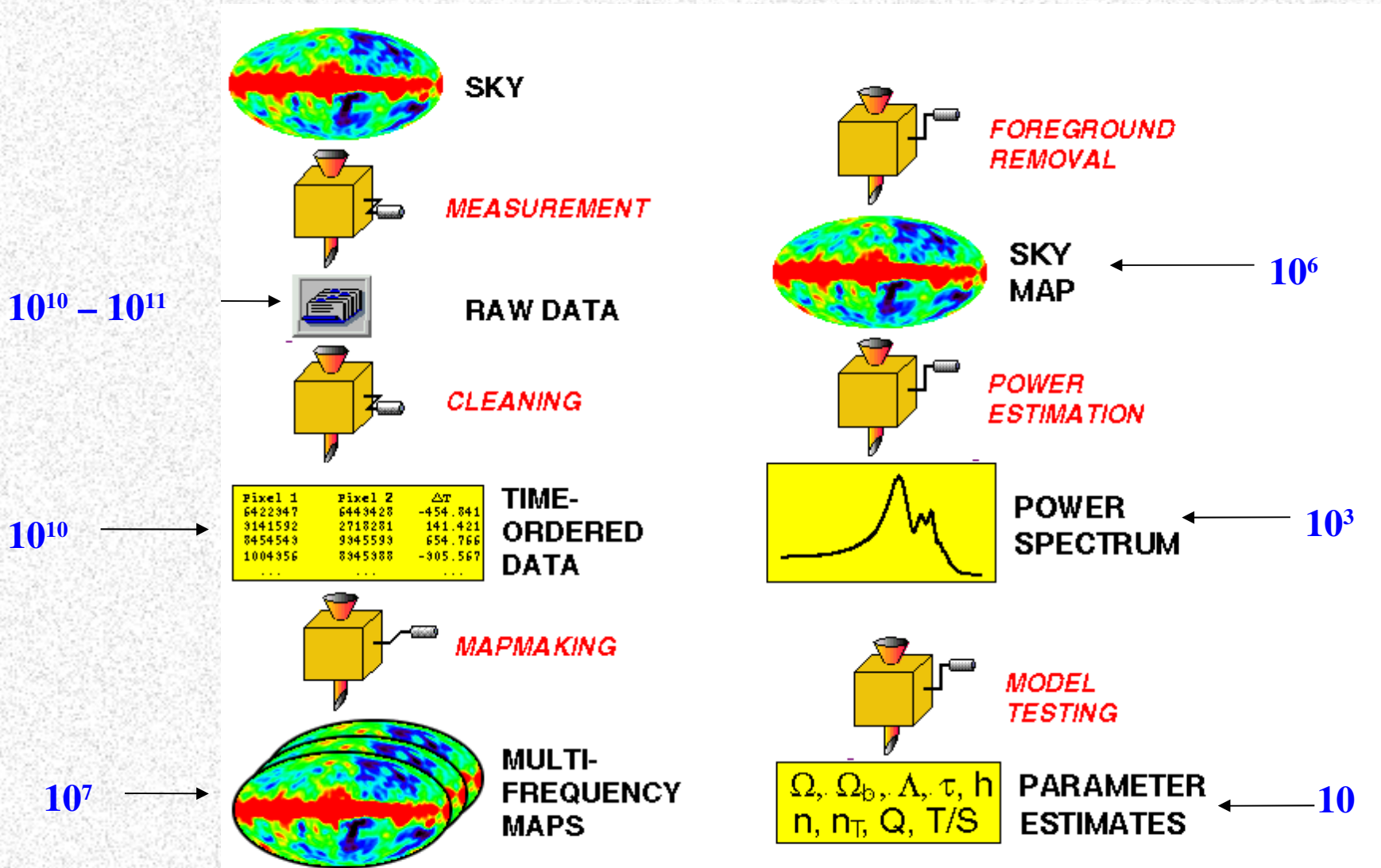
Cosmologia e Radioastronomia

II^a parte: Tratamento dos dados

Ivan Soares Ferreira
Divisão de Astrofísica - INPE
I Escola de Radioastronomia
Atibaia, SP
5 de agosto de 2006



A análise de dados da RCF



Projeto GEM – Galactic Emission Mapping



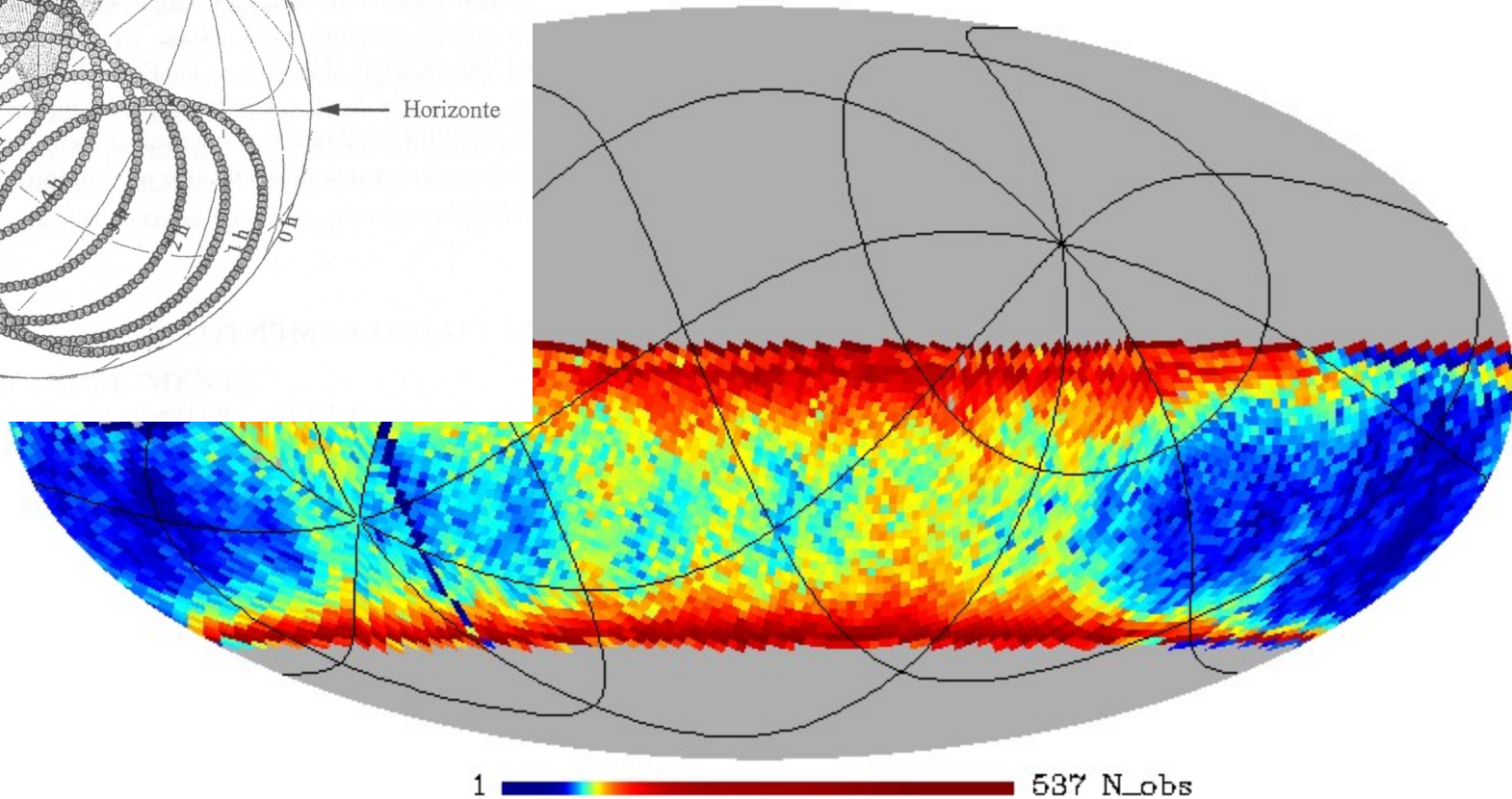
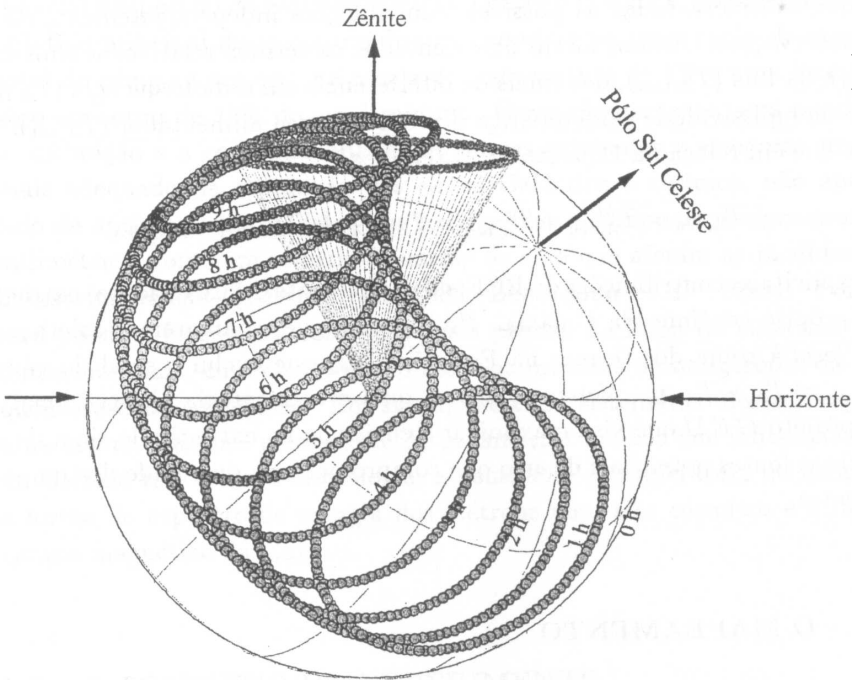
$D=5,5\text{m}$ (sem anteparos)

Resolução (@ 5 GHz): 45'

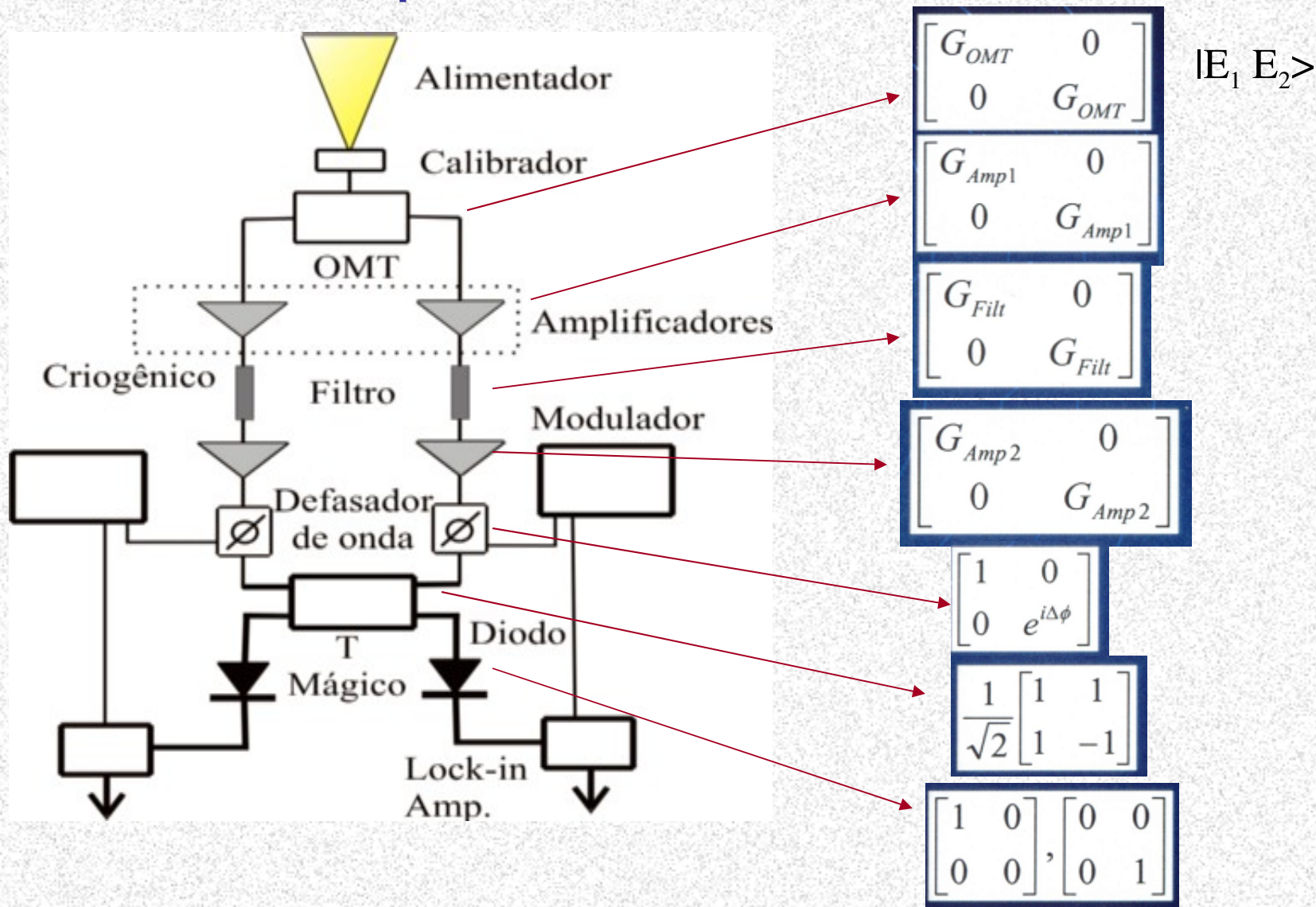
Perda em 5 GHz = -0,39 dB (devido à superfície)

GEM: varredura

No sítio em Cachoeira Paulista, cobre uma faixa do céu com declinação entre $-52^{\circ}23'14,1''$ e $+7^{\circ}8'50,98''$ (33% do céu).

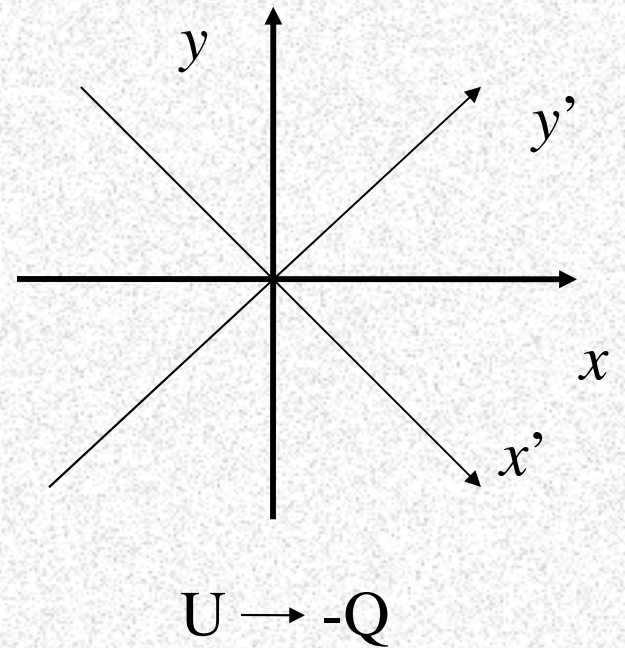
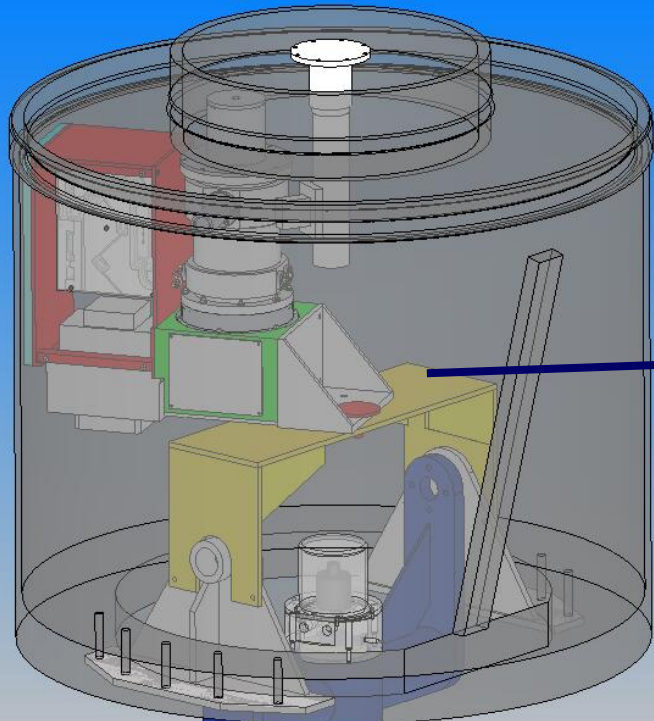


Polarímetro pseudo-correlacionador: 5 GHz



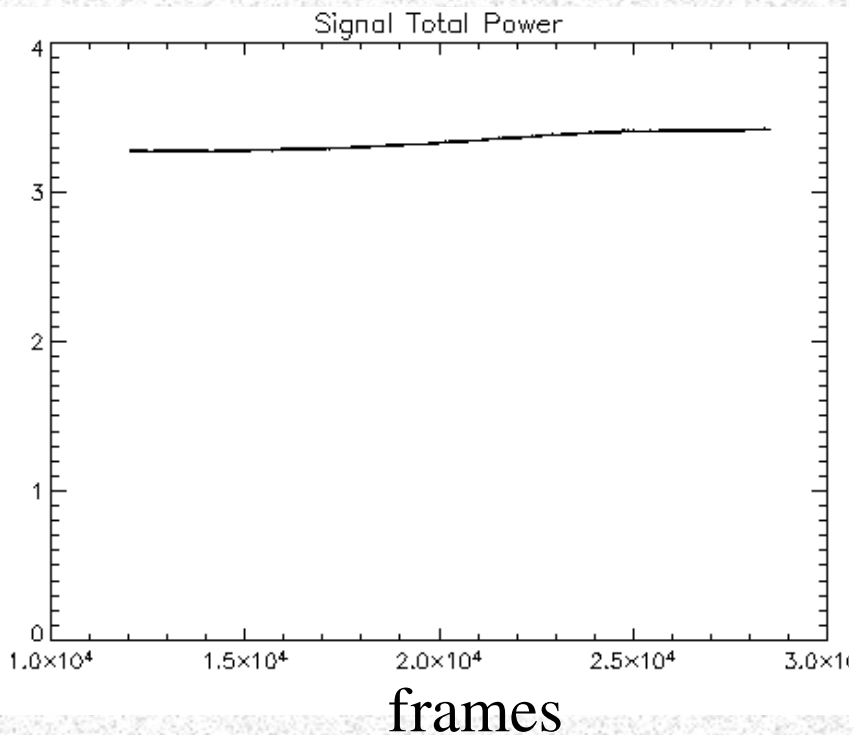
$$S = \frac{G_A^2 + G_B^2}{2} I + \frac{G_A^2 - G_B^2}{2} Q + G_A G_B [U \cos \Delta\phi - V \sin \Delta\phi],$$

Polarímetro pseudo-correlacionador: 5 GHz

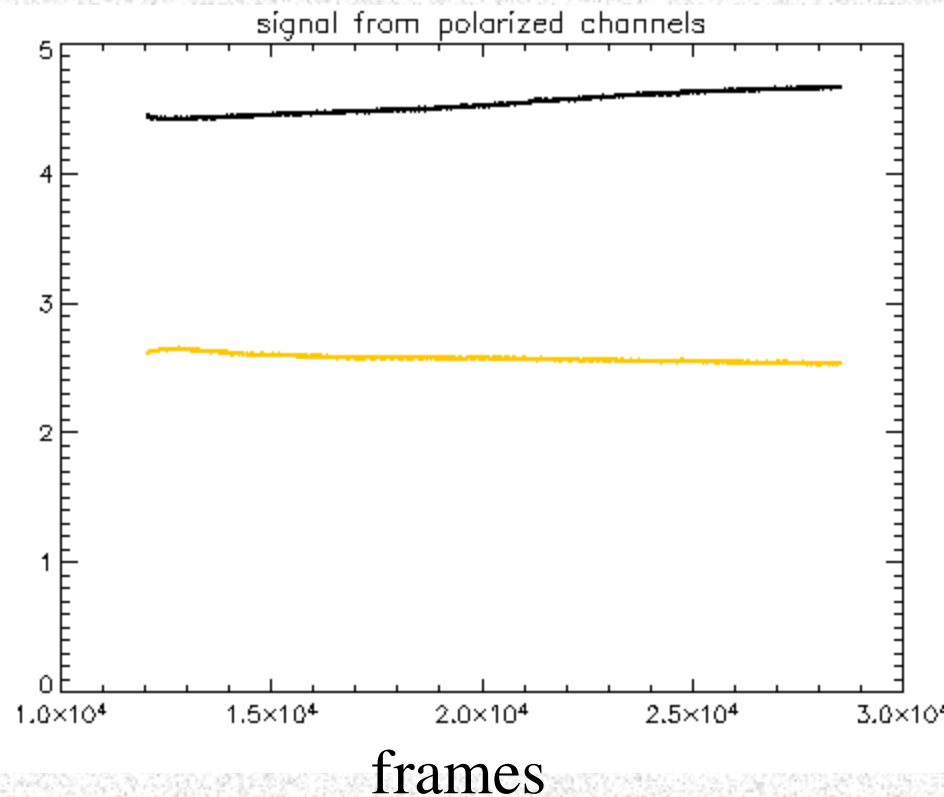


Série Temporal dos Dados

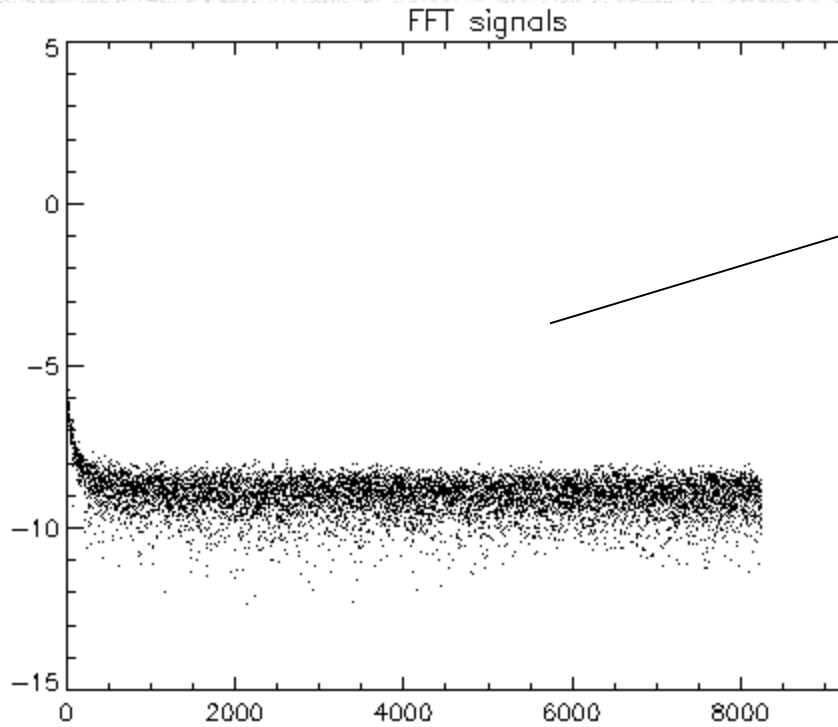
dia 29/05/2006



V

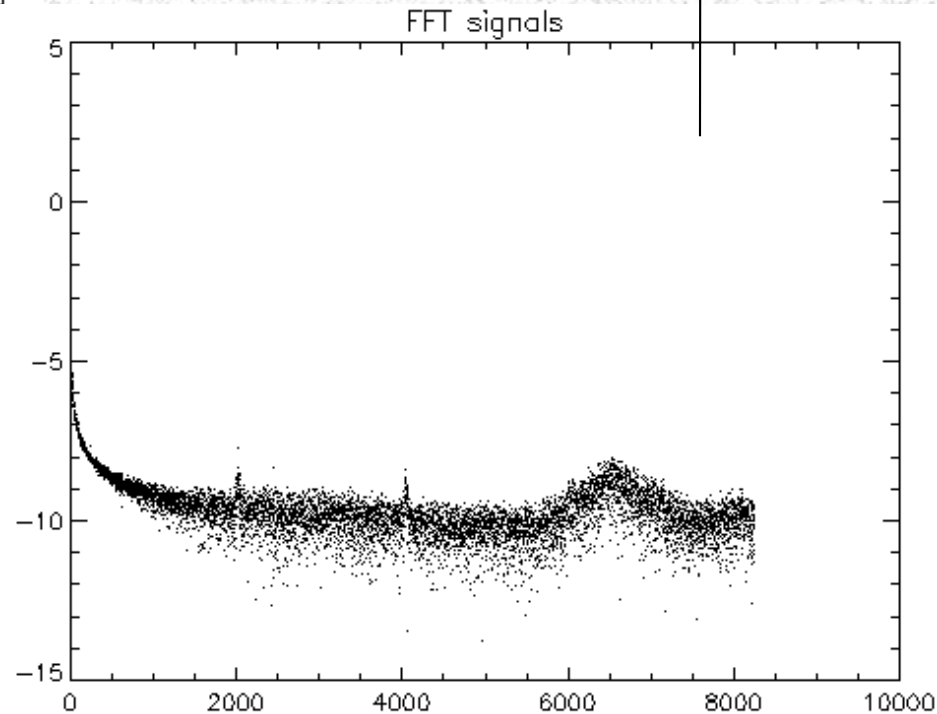


FFT da série temporal



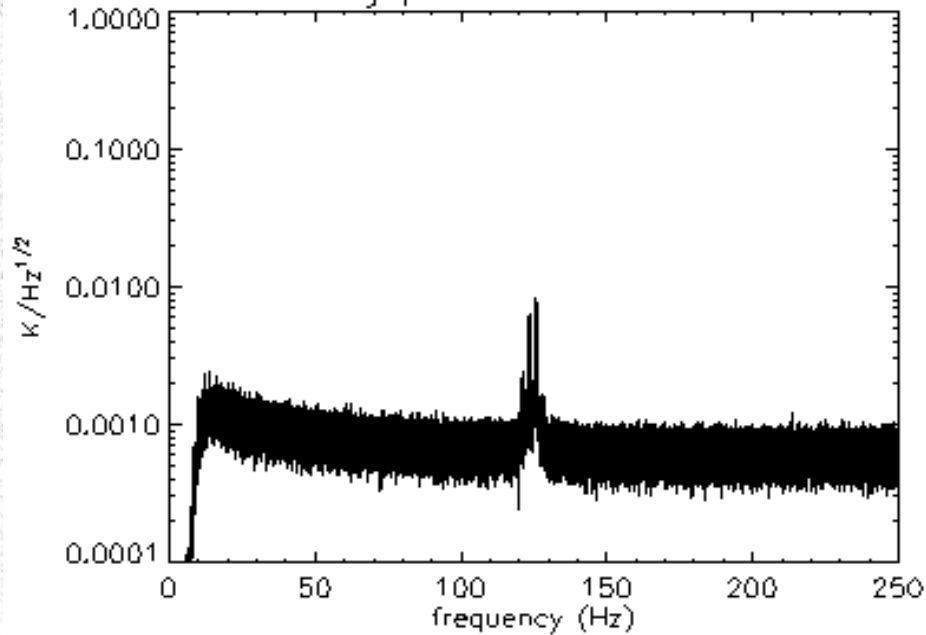
Canais de polarização

Canal de potência total

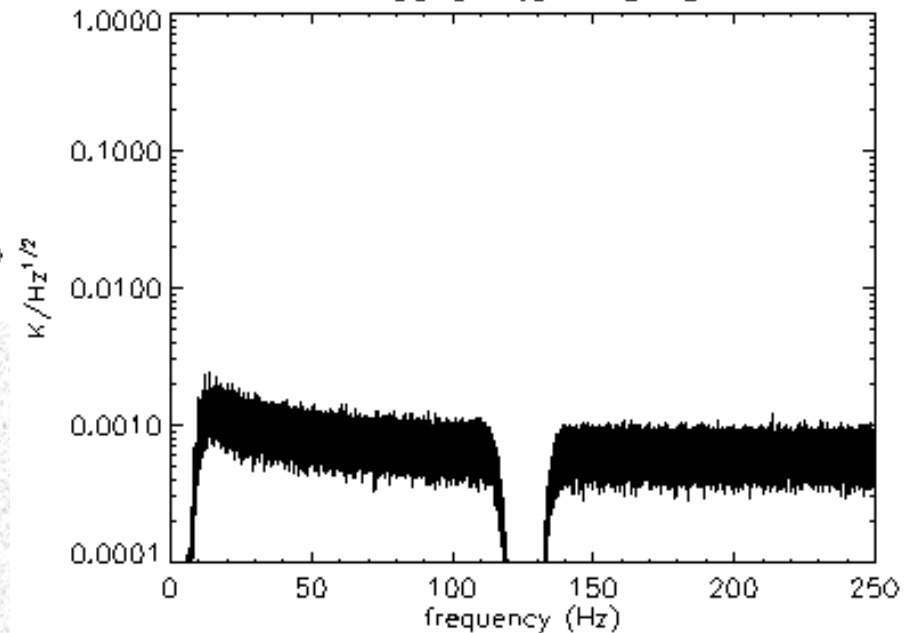


Limpeza da Série Temporal

Highpass filter – 10 Hz

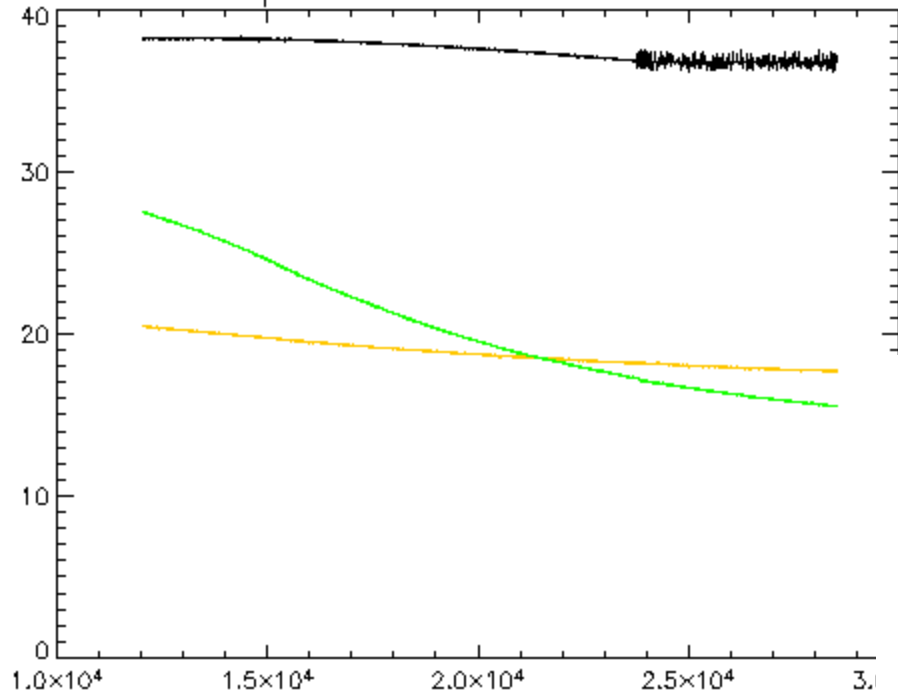


Killband filter – 5 Hz

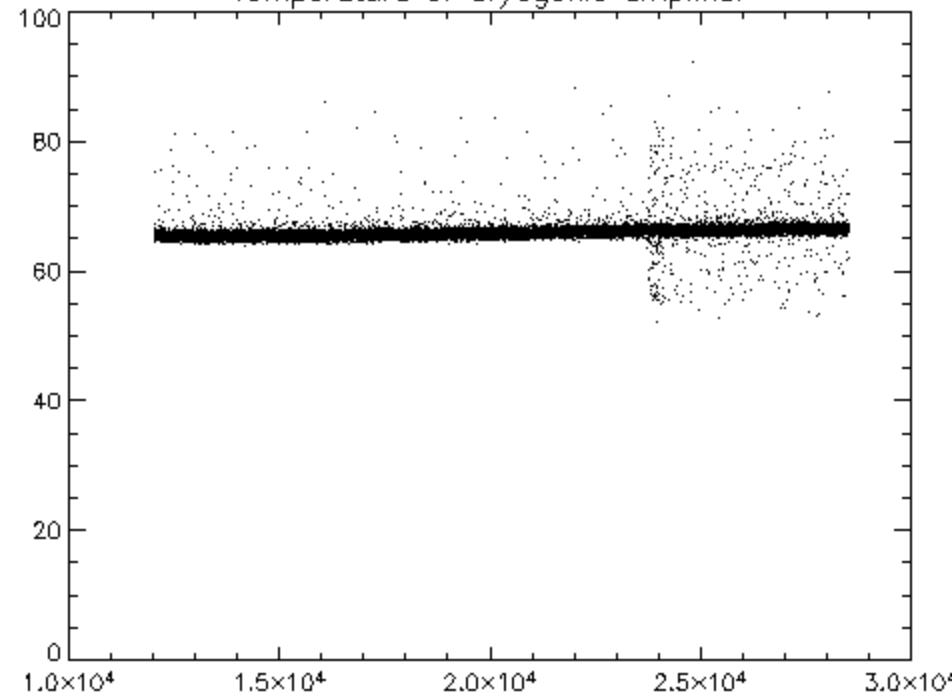


Monitoramento da estabilidade térmica do instrumento

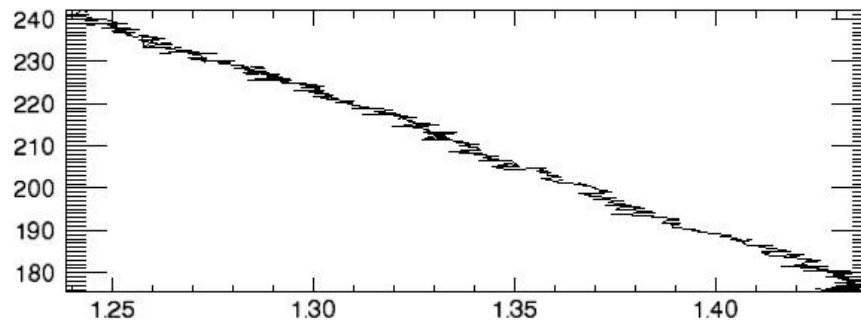
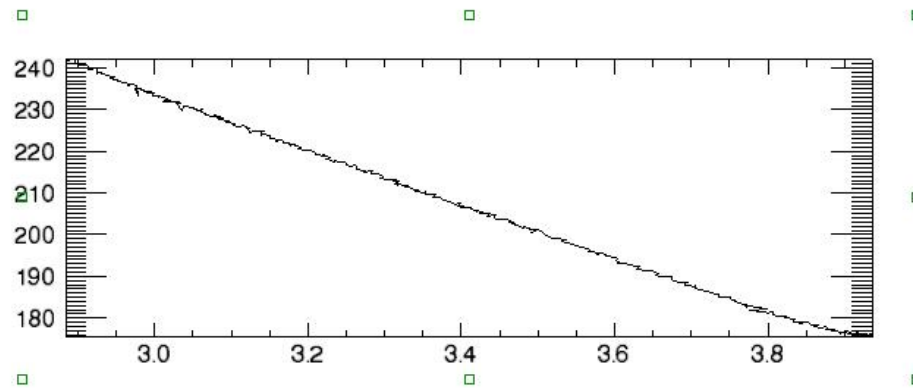
Temperature from electronic sections



Temperature of Cryogenic amplifier



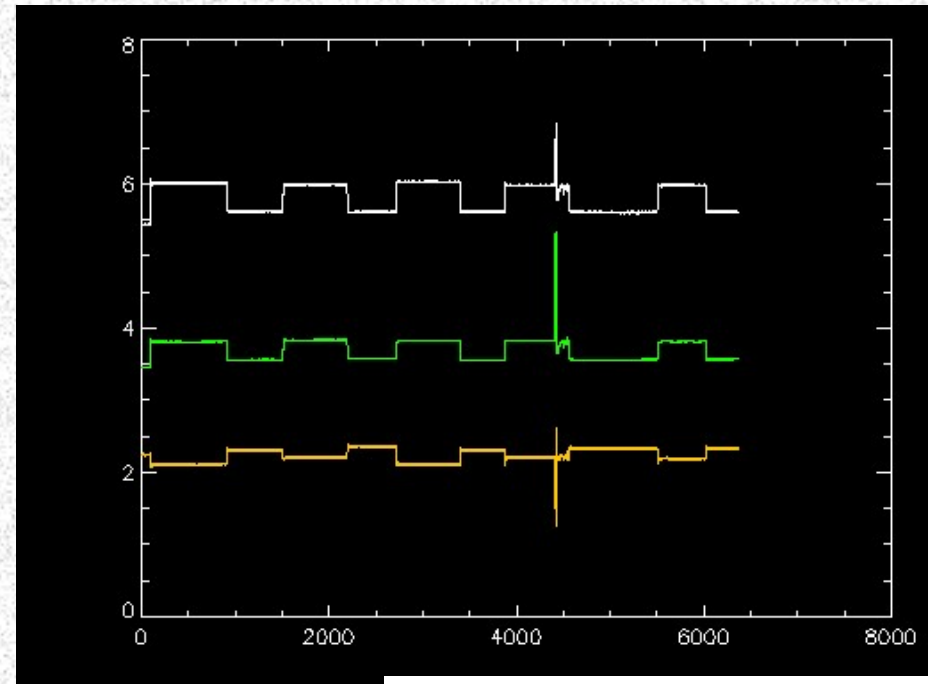
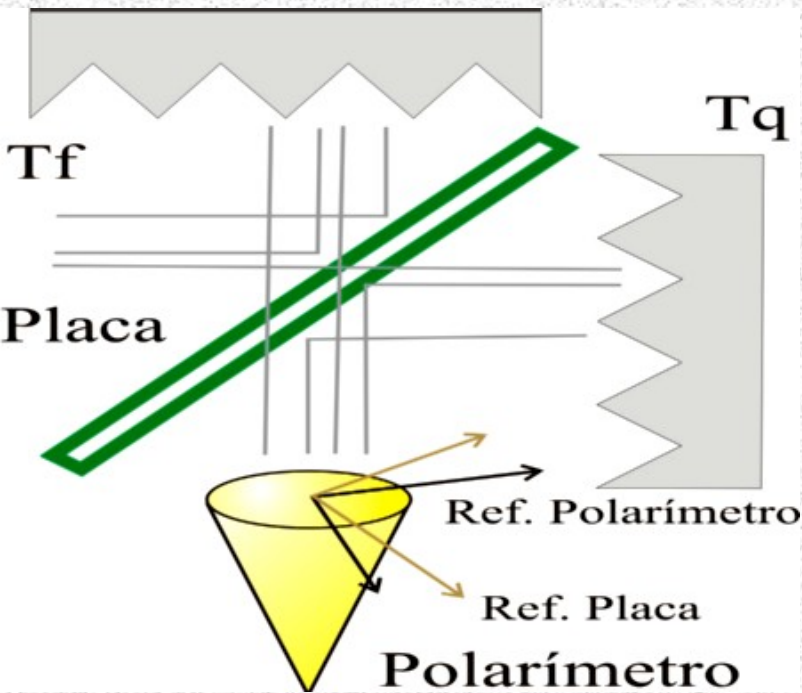
Relação entre o ruído do sistema e a temperatura do amplificador



Calibração do sinal

Conversão de tensão (volts) para temperatura de antena (Kelvin):

$$\text{Volts} = G * T_A$$



$$I_x = T_f + (T_q - T_f)R_{TE} + (T_p - T_f)\epsilon_{TE};$$

$$I_y = T_f + (T_q - T_f)R_{TM} + (T_p - T_f)\epsilon_{TM};$$

$$Q = (T_q - T_f)(R_{TE} - R_{TM}) + (T_p - T_f)(\epsilon_{TE} - \epsilon_{TM});$$

$$U = 0.$$



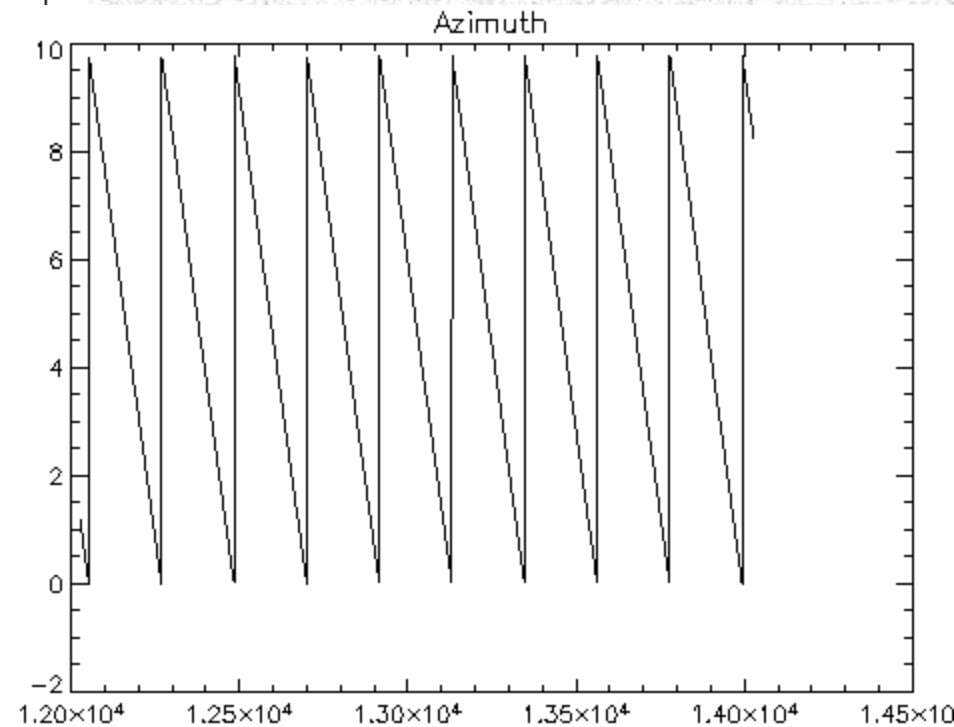
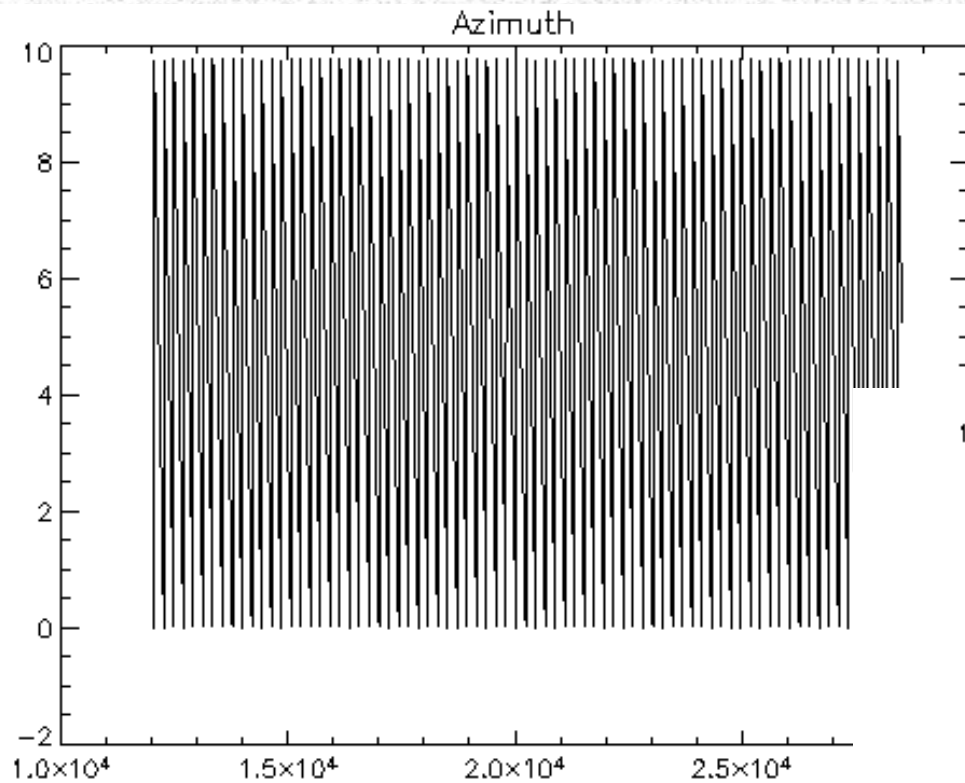
$$I'_x = I_x \cos^2 \phi + I_y \sin^2 \phi;$$

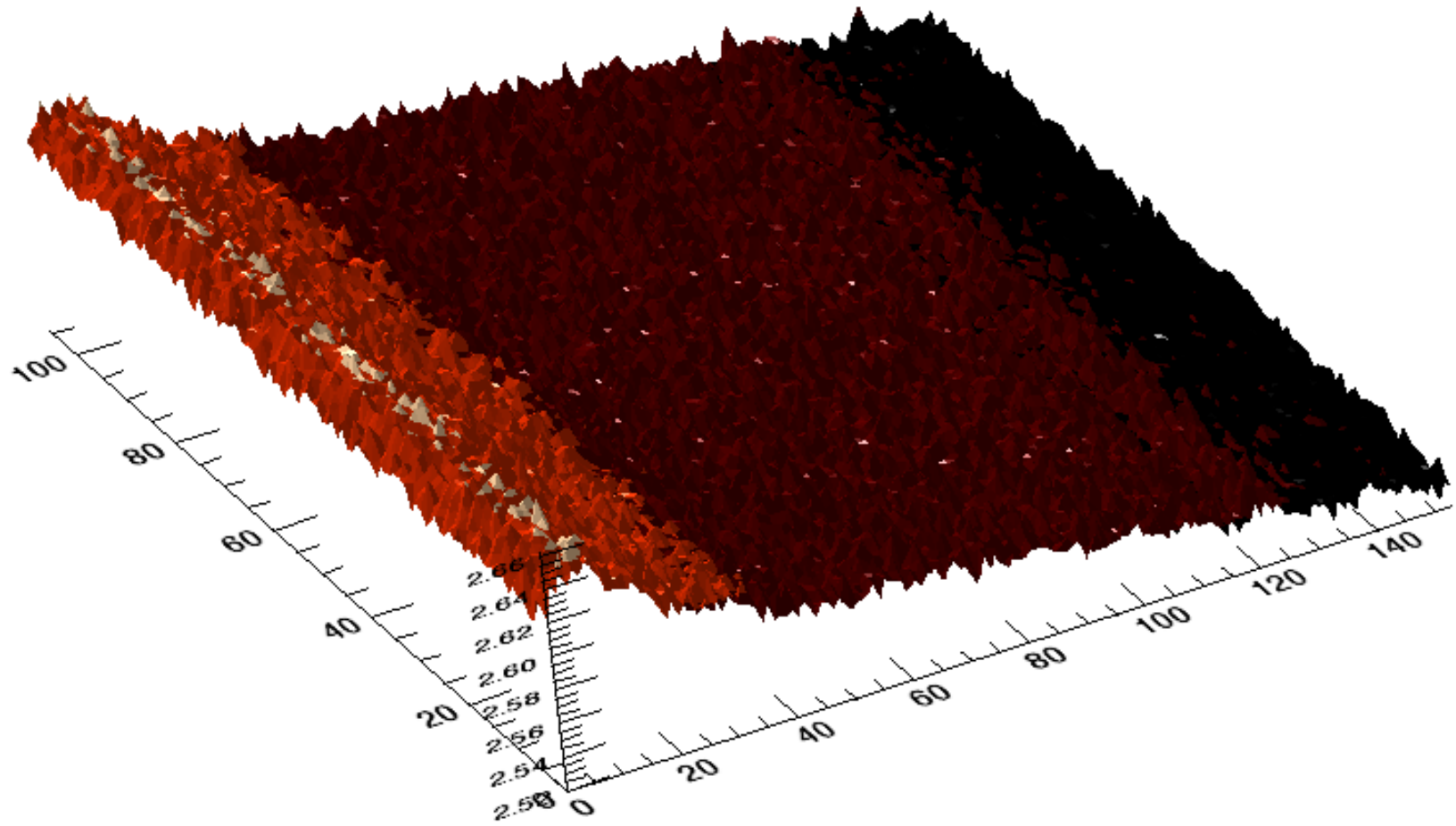
$$I'_y = I_x \sin^2 \phi + I_y \cos^2 \phi;$$

$$Q' = Q \cos 2\phi;$$

$$U' = -Q \sin 2\phi,$$

Reconstrução do apontamento: azimute

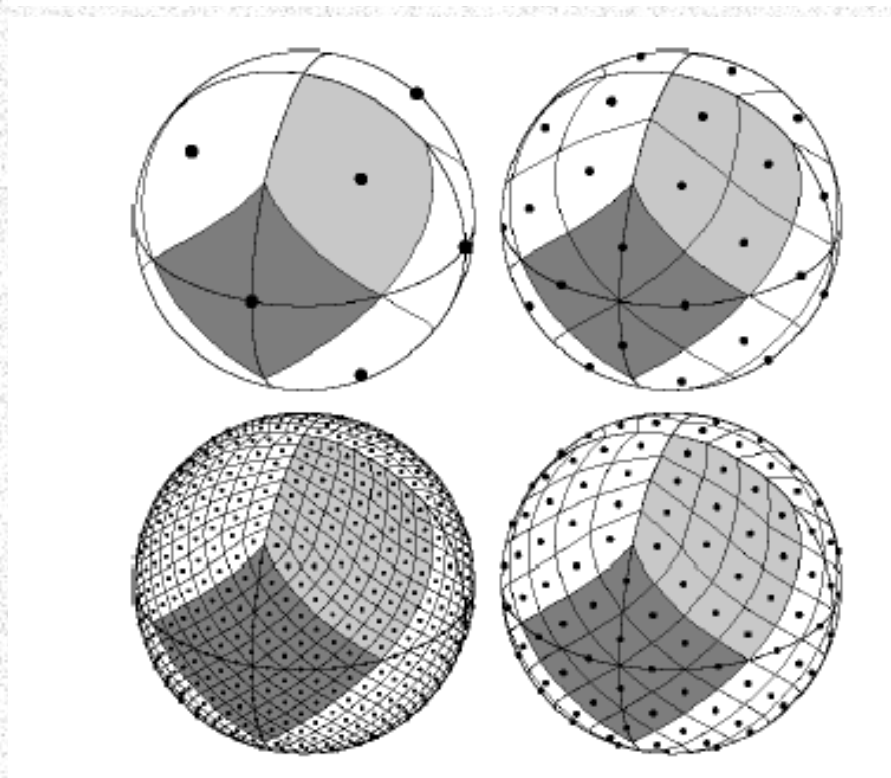
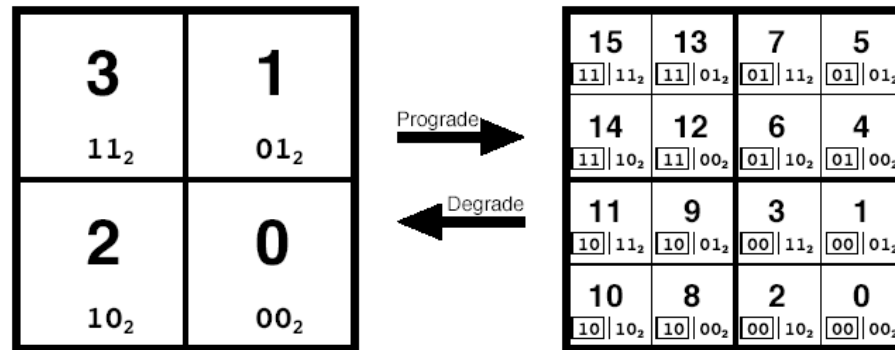




Reconstrução do apontamento

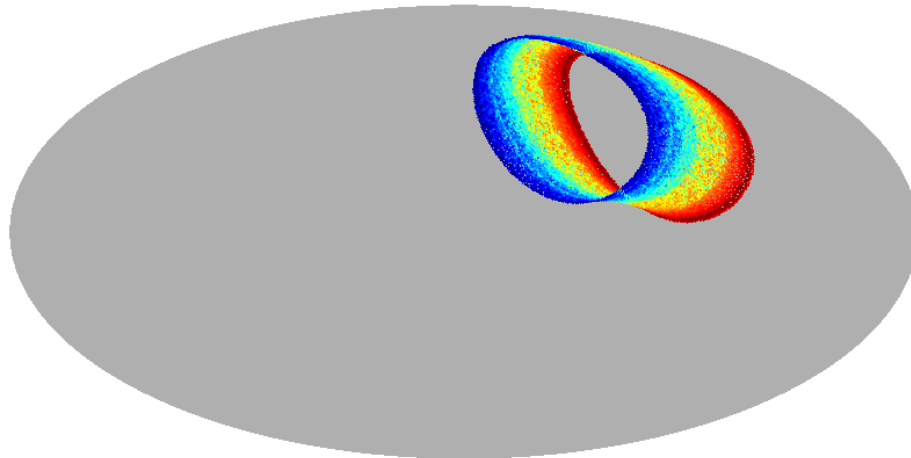
- Horário da observação (nome do arquivo convertido para UT)
- Conversão de frames para time steps
- (UT, El, Az, lat, long) -> (l, B)
Com auxílio das bibliotecas astrolib (hor2eq, euler, etc)...
- Matriz de rotação para os canais polarizados (Ref. da Antena -> Ref. Esfera celeste.)

Pixelisation: HEALpix



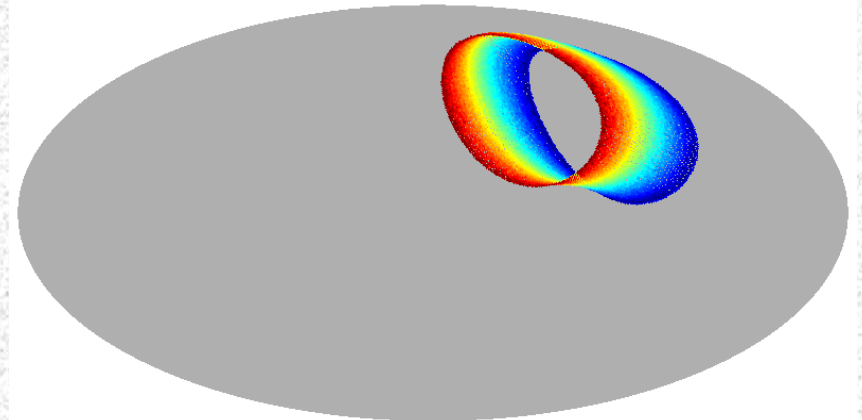
Mapa preliminar


Canal A-pol



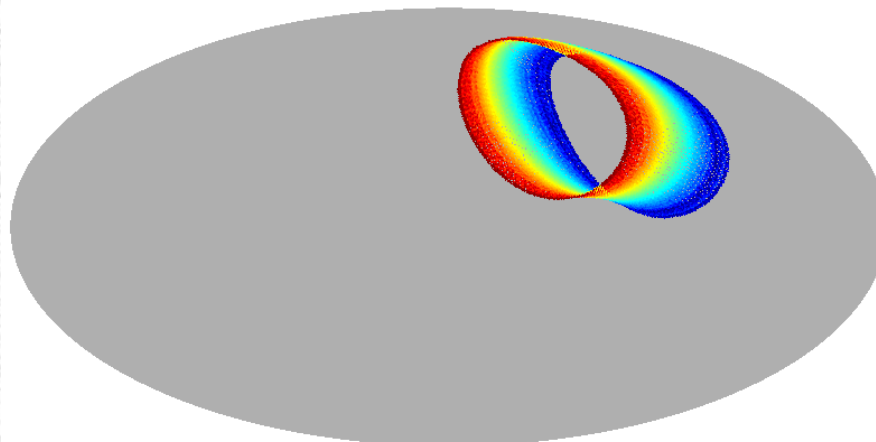
2.5  2.7 Volts

Canal B-pol



4.4  4.7 Volts

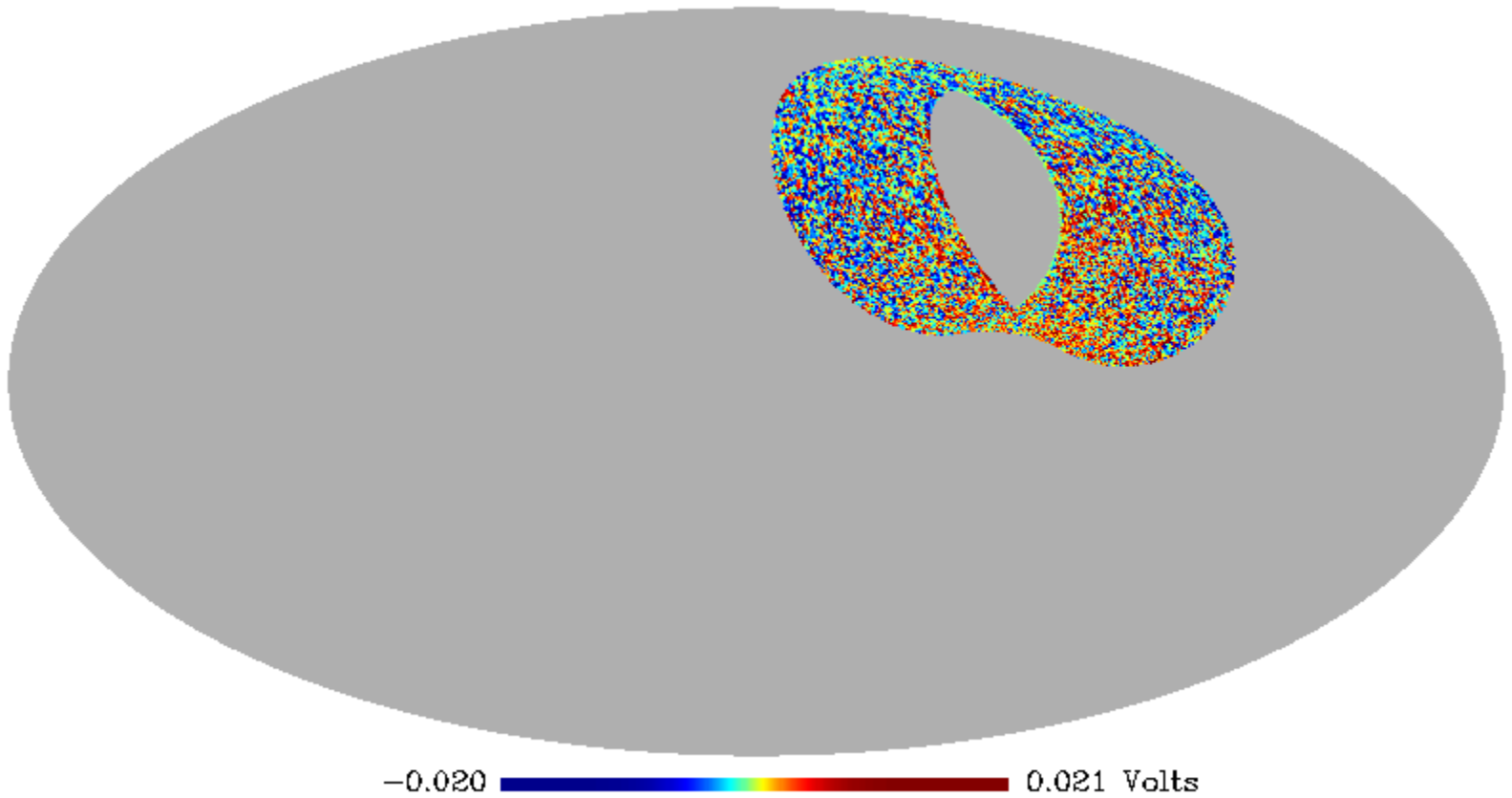
Canal C-int



3.3  3.4 Volts

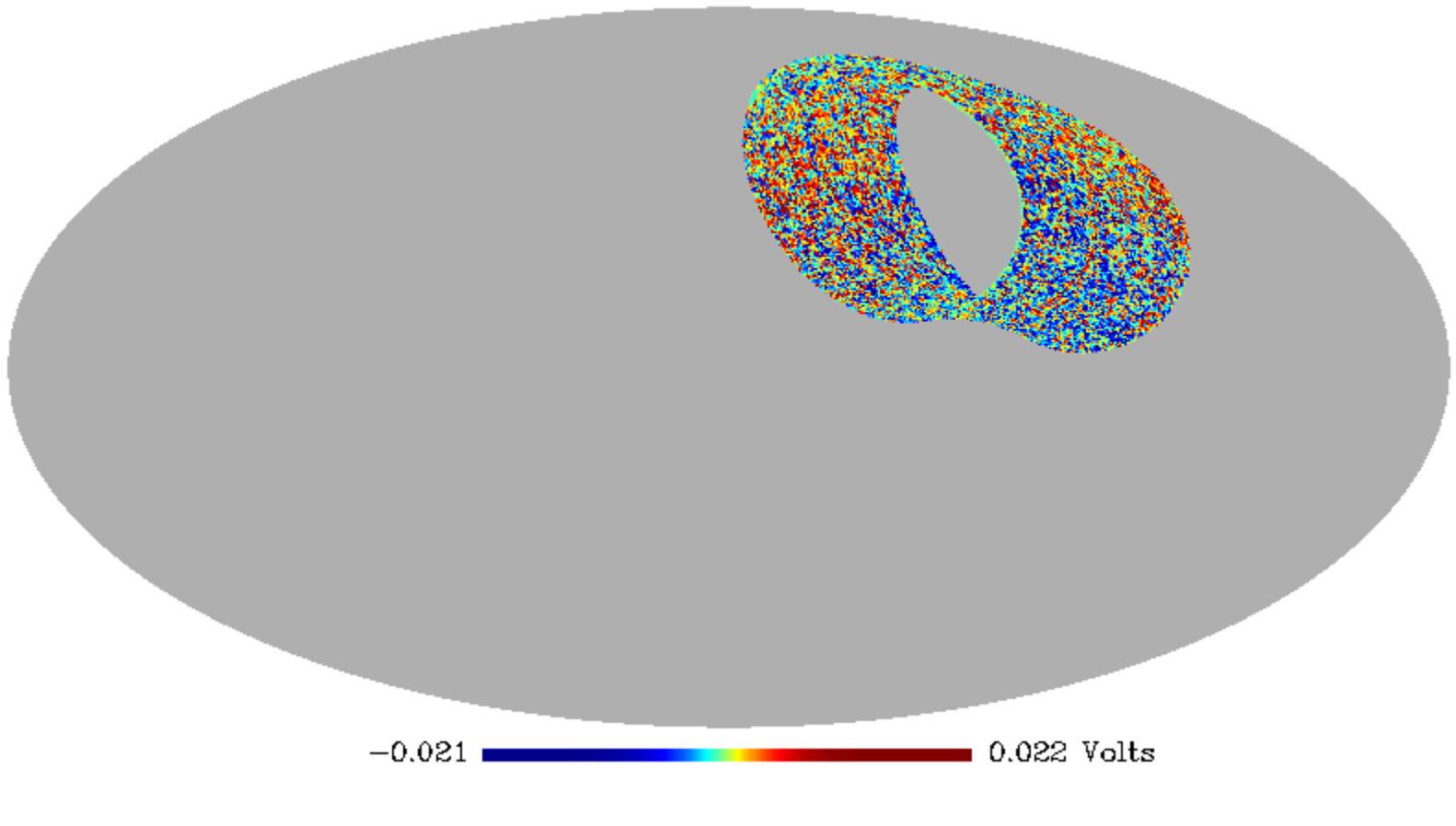
Mapa corregido

Canal A-pol corrected



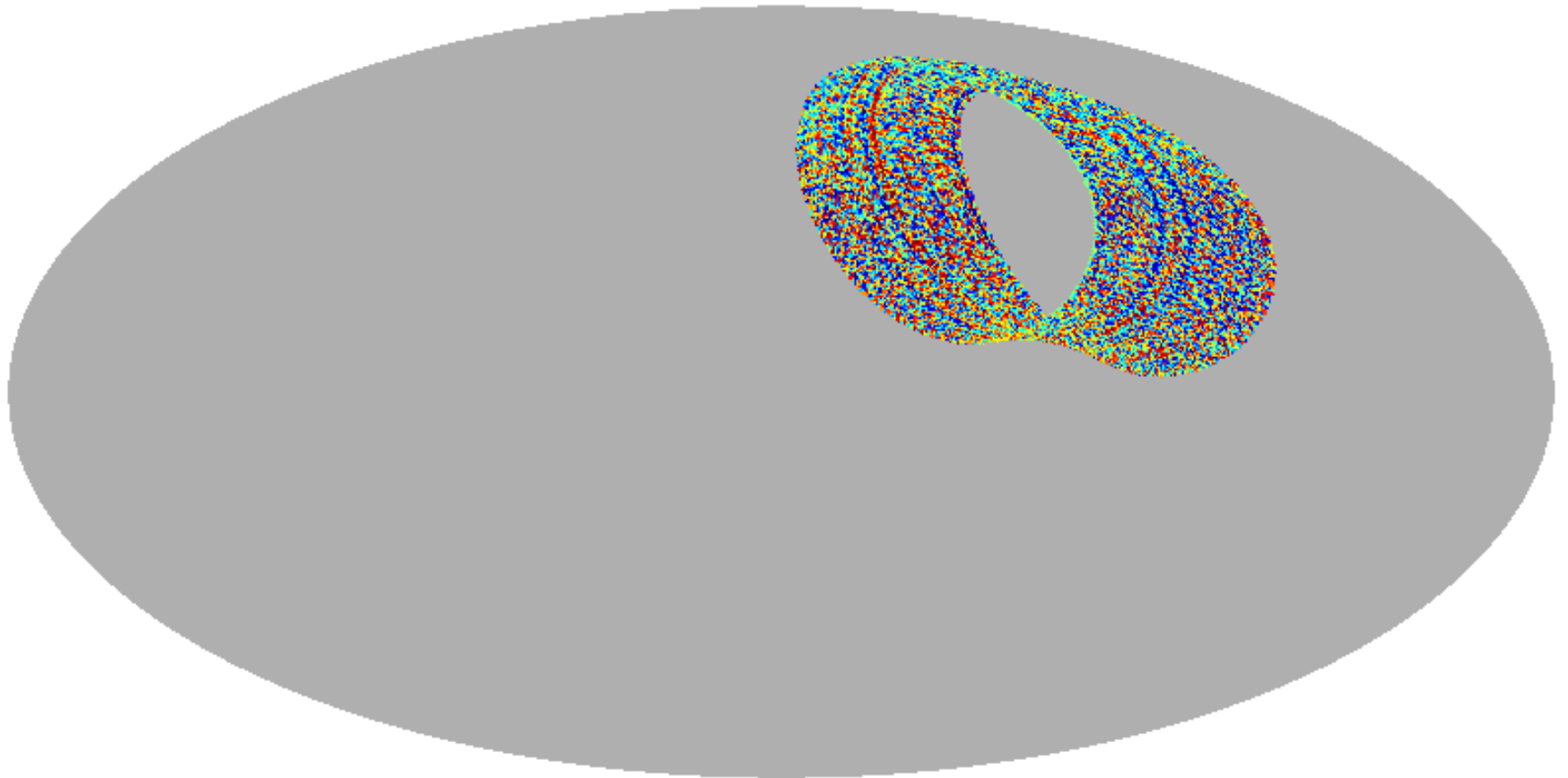
Mapa corregido

Canal B-pol corrected



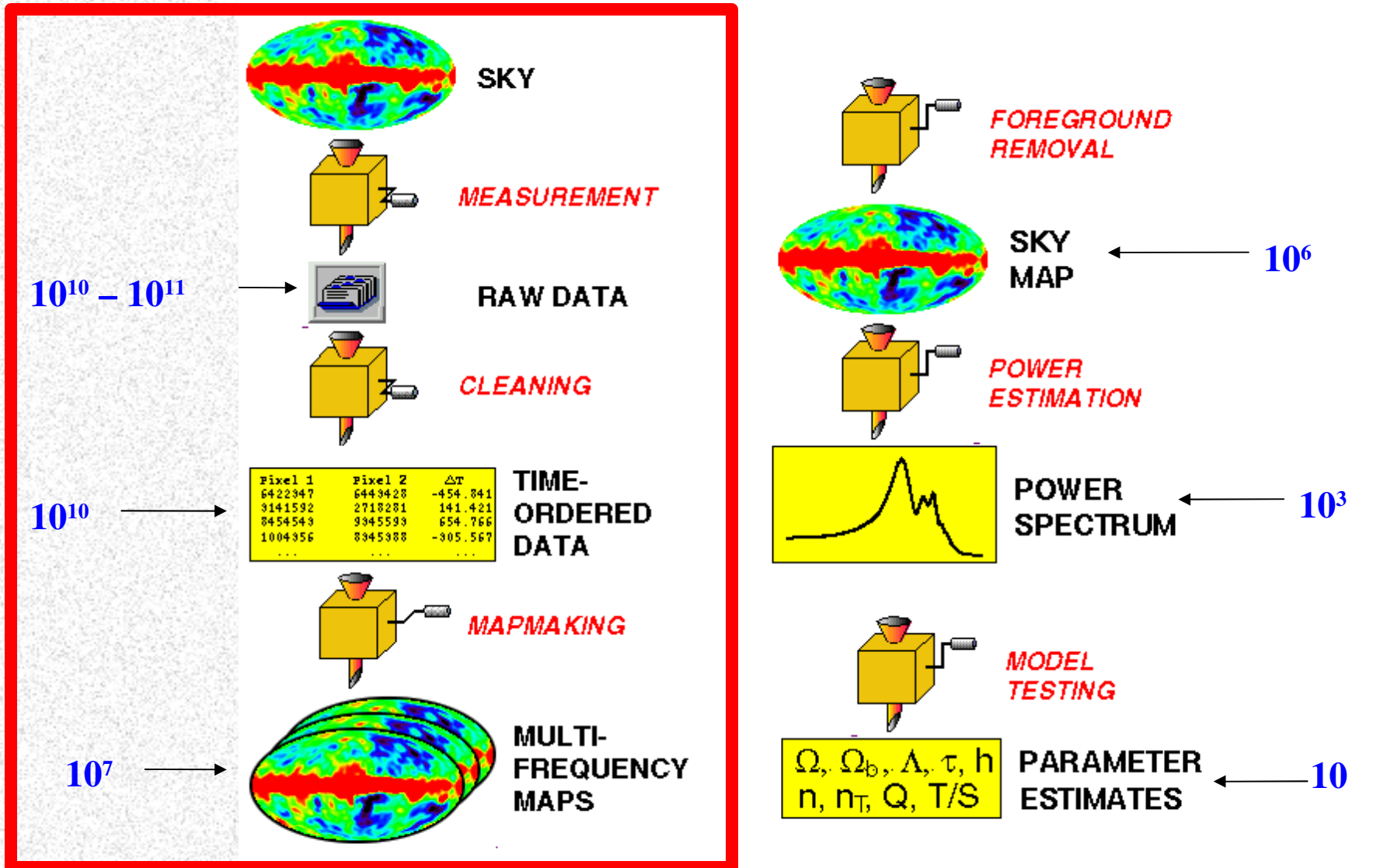
Mapa corregido

Canal C-int corrected



-0.0092  0.0083 Volts

A análise de dados da RCF



Espectro de potência

$$\Delta T(\theta, \phi) = \sum_{l=0}^{\infty} \sum_{m=-l}^l a_{lm} Y_{lm}(\theta, \phi)$$

$$C_l = \langle |a_{lm}|^2 \rangle$$

$$\chi_{2l+1}^2 \Rightarrow \frac{\Delta C_l}{C_l} = \sqrt{\frac{2}{2l+1}}$$

$$l \sim \frac{\pi}{\theta}$$

$$\theta = 23' \Rightarrow l \sim 500$$

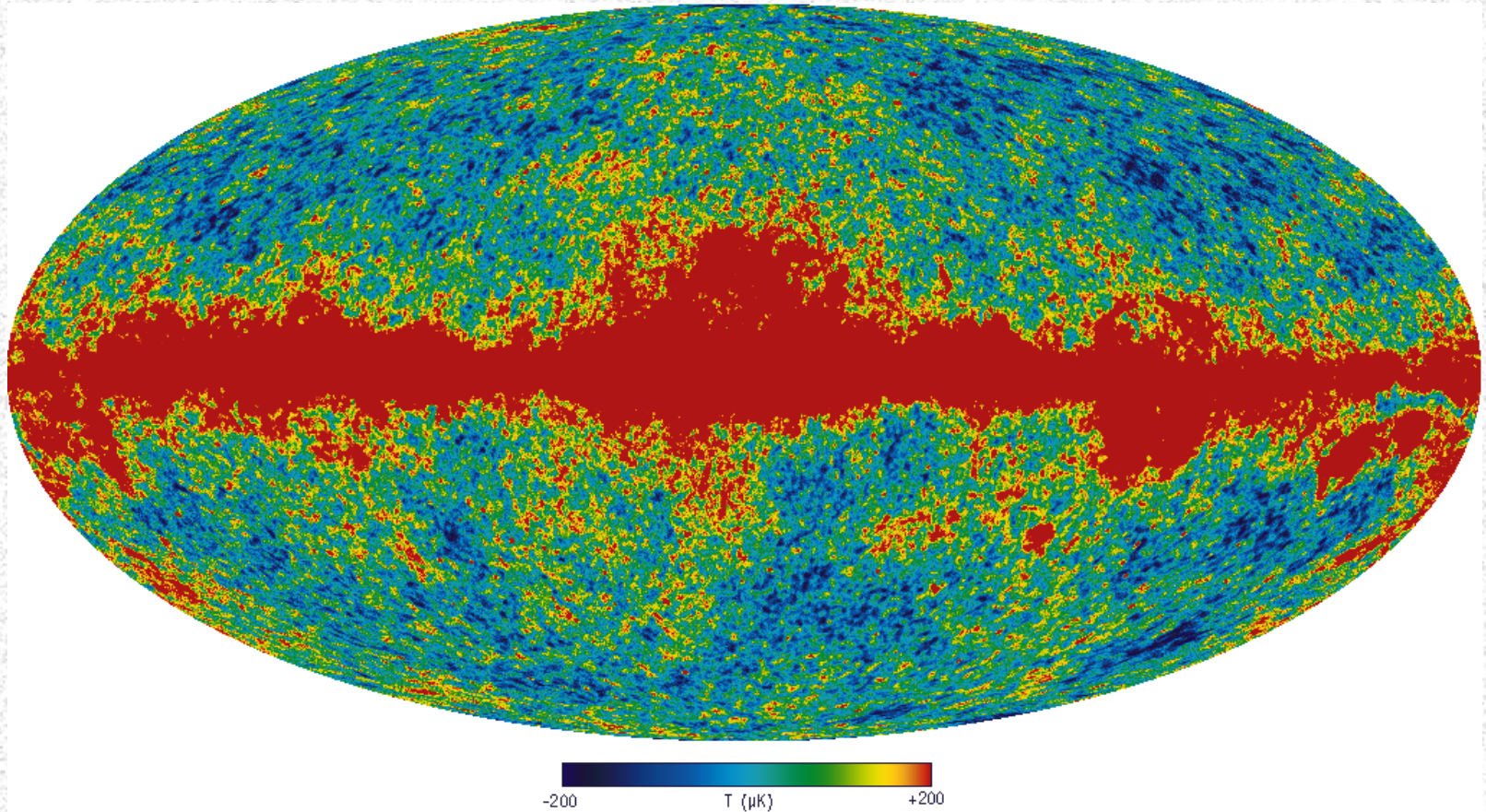
PROBLEMA

1. Região limitada no céu
2. Estratégia de varredura do instrumento
3. Filtragem (e.g. highpass)
4. Convolução com o feixe do instrumento
5. Discretização da esfera celeste (pixels)
6. Ruído

SOLUÇÃO: Método MASTER

$$\langle \tilde{C}_\ell \rangle = \sum_{\ell'} M_{\ell\ell'} F_{\ell'} B_{\ell'}^2 P_{\ell'}^2 \langle C_{\ell'} \rangle + \langle \tilde{N}_\ell \rangle$$

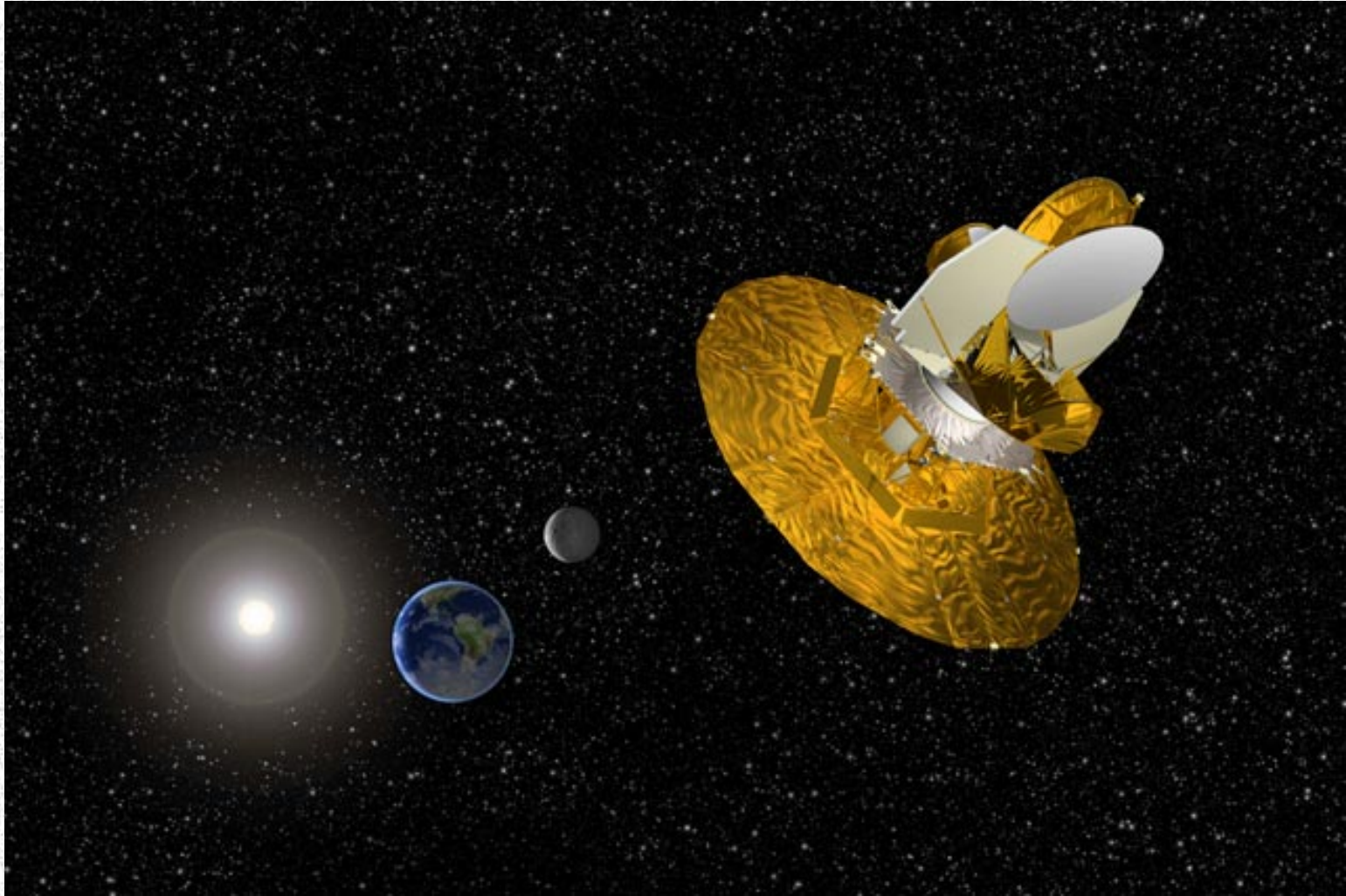
No entanto...



Mapa do instrumento WMAP disponível para download

<http://lambda.gsfc.nasa.gov>

WMAP



Espectro de potência dos FOREGROUNDS:

