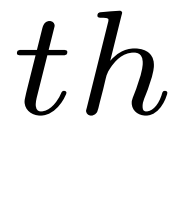
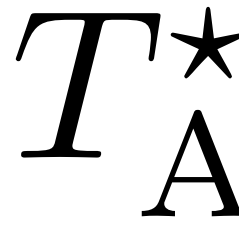
$1,2$

1



th

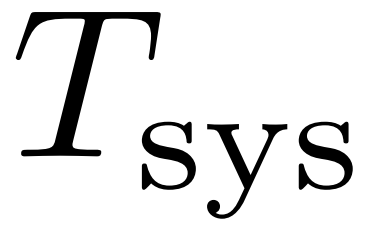
n_{freq}



$$T^{\star}_{\mathbf{A}}$$

$$2dv$$

dv



T_{sys}

$$\Delta t$$

$$2d\nu\,\Delta t$$

σ_{K}

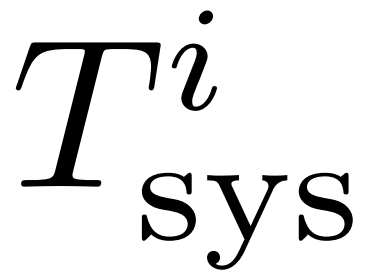
$$\sigma_{\mathrm{K}} = \frac{T_{\mathrm{sys}}}{\sqrt{2\,d\nu\,\Delta t}}.$$

i

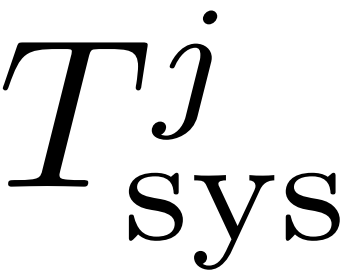
j

$$T^{ij}_{\mathrm{sys}}$$

$$T_{\rm sys}^{ij} = \sqrt{T_{\rm sys}^{i}\, T_{\rm sys}^{j}},$$



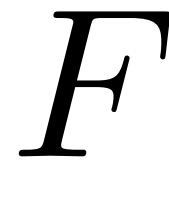
$$T^{i}_{\mathrm{sys}}$$



$$T^{j}_{\mathrm{sys}}$$

$(\eta_{\text{spec}} \leq 1.0)$

$$\sigma_{\mathrm{K}} = \frac{T_{\mathrm{sys}}}{\eta_{\mathrm{spec}} \sqrt{2\, d\nu\, \Delta t}}.$$



F

$$F = J^{\mathrm{sd}}_{\mathrm{ant}} T^{\star}_{\mathrm{A}}$$

$$J_{\mathrm{ant}}^{\mathrm{sd}} = \frac{2k\,F_{\mathrm{eff}}}{A_{\mathrm{eff}}},$$

k

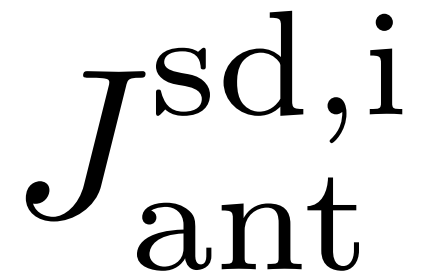
A_{eff}

$$J^{\mathrm{sd}}_{\mathrm{ant}}$$

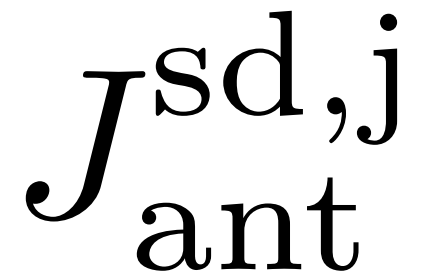
$$\sigma_{\mathrm{Jy}} = \frac{J^{\mathrm{sd}}_{\mathrm{ant}}\, T_{\mathrm{sys}}}{\eta_{\mathrm{spec}} \sqrt{2\, d\nu\, \Delta t}}.$$

$$J^{\mathrm{sd},\mathrm{ij}}_{\mathrm{ant}}$$

$$J_{\mathrm{ant}}^{\mathrm{sd,ij}} = \sqrt{J_{\mathrm{ant}}^{\mathrm{sd,i}}\, J_{\mathrm{ant}}^{\mathrm{sd,j}}},$$



$$J^{\mathrm{sd,i}}_{\mathrm{ant}}$$

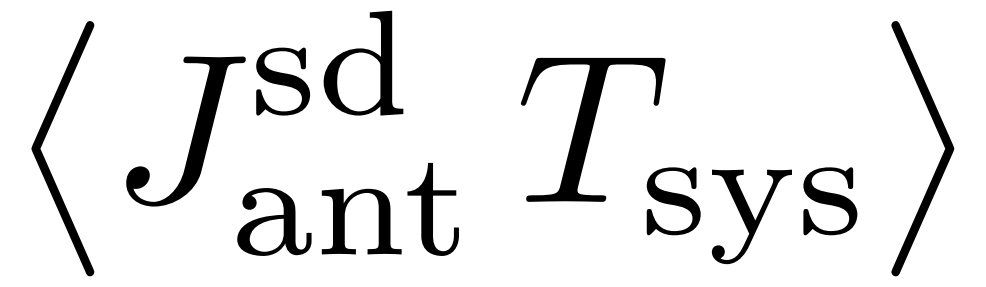


$$J^{\mathrm{sd,j}}_{\mathrm{ant}}$$

$n_{\mathrm{ant}}\left(n_{\mathrm{ant}}-1\right)/2$

n_{ant}

$$\sigma_{\mathrm{Jy}} = \frac{\left\langle J_{\mathrm{ant}}^{\mathrm{sd}}\, T_{\mathrm{sys}} \right\rangle}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}} \left(n_{\mathrm{ant}} - 1\right) d\nu\, \Delta t}},$$



$$\left\langle J^{\mathrm{sd}}_{\mathrm{ant}} \, T_{\mathrm{sys}} \right\rangle$$

η_{atm}

$$\eta_{\mathrm{atm}} \leq 1.0$$

$$J^{\mathrm{int}}_{\mathrm{ant}}$$

$$J_{\mathrm{ant}}^{\mathrm{int}} = \frac{J_{\mathrm{ant}}^{\mathrm{sd}}}{\eta_{\mathrm{atm}}}$$

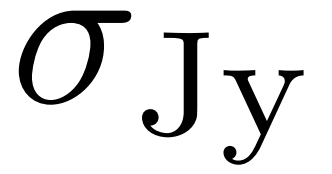
$$J_{\text{ant}}^{\text{int}} \geq J_{\text{ant}}^{\text{sd}}.$$

ϕ_{rms}

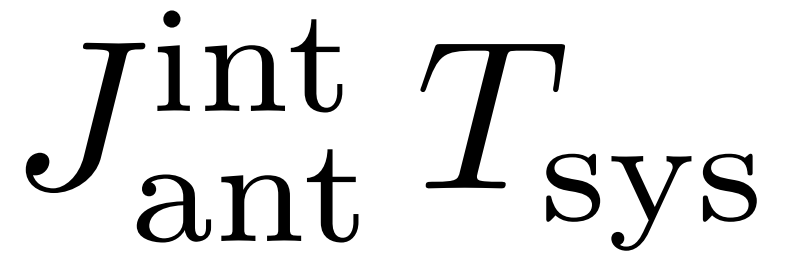
$$\eta_{\mathrm{atm}} = e^{-\frac{\phi^2_{\mathrm{rms}}}{2}} \leq 1.0.$$

$$\sigma_{\mathrm{Jy}} = \frac{\left\langle J_{\mathrm{ant}}^{\mathrm{int}}\, T_{\mathrm{sys}} \right\rangle}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}} \left(n_{\mathrm{ant}} - 1\right) d\nu\, \Delta t}}.$$

$$\sigma_{\rm Jy} = \frac{\left\langle J_{\rm ant}^{\rm int}\, T_{\rm sys} \right\rangle}{\eta_{\rm spec}\,\sqrt{n_{\rm ant}\,(n_{\rm ant}-1)\,d\nu\,\Delta t}}, \quad \text{with} \quad J_{\rm ant}^{\rm int} = \frac{J_{\rm ant}^{\rm sd}}{\eta_{\rm atm}} \quad \text{and} \quad \eta_{\rm atm} = e^{-\frac{\phi_{\rm rms}^2}{2}} \leq 1.0,$$



σ_{Jy}



$$J_{\mathrm{ant}}^{\mathrm{int}}\, T_{\mathrm{sys}}$$

uv

λ/FWHM

$$\Omega_{\mathrm{ant}}$$

λ

$$\Omega_{\mathrm{ant}}\, A_{\mathrm{eff}} = \lambda^2 .$$

$$F = J_{\mathrm{ant}} T_{\mathrm{A}}^{\star}$$

$$J_{\mathrm{ant}} = \frac{2k\,\Omega_{\mathrm{ant}}\,F_{\mathrm{eff}}}{\lambda^2}.$$

Ω_{prim}

$$J_{\rm ant}^{\rm int} = \frac{J_{\rm ant}^{\rm sd}}{\eta_{\rm atm}} = \frac{1}{\eta_{\rm atm}} \frac{F_{\rm eff}}{B_{\rm eff}} \frac{2k\,\Omega_{\rm prim}}{\lambda^2}.$$

$$\Omega_{\mathrm{syn}}$$

$$J^{\text{syn}}_{\text{ant}}$$

$$B_{\mathrm{eff}}^{\mathrm{int}} = 1$$

$$F_{\mathrm{eff}}^{\mathrm{int}} = 1$$

$$J_{\mathrm{ant}}^{\mathrm{syn}} = \frac{2k\,\Omega_{\mathrm{syn}}}{\lambda^2}.$$

$$\sigma_{\mathrm{K}} = \frac{\sigma_{\mathrm{Jy}}}{J_{\mathrm{ant}}^{\mathrm{syn}}} \quad \text{with} \quad J_{\mathrm{ant}}^{\mathrm{syn}} = \frac{2\pi\, k\, \theta_{\mathrm{maj}} \theta_{\mathrm{min}}}{4\, \ln 2\, \lambda^2},$$

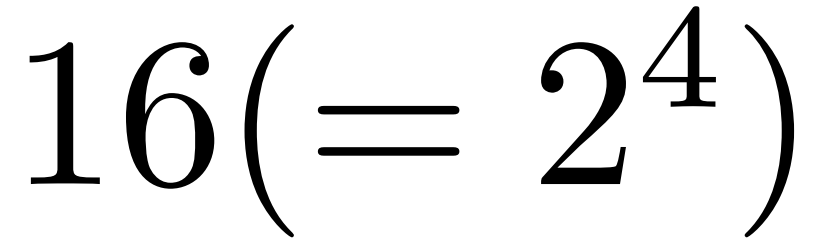
$$\sigma_{\mathrm{K}} = \frac{\Omega_{\mathrm{prim}}}{\Omega_{\mathrm{syn}}} \left\langle \frac{F_{\mathrm{eff}}\, T_{\mathrm{sys}}}{B_{\mathrm{eff}}\, \eta_{\mathrm{atm}}} \right\rangle \frac{1}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}}\,(n_{\mathrm{ant}}-1)\, d\nu\, \Delta t}} = \frac{\theta^2_{\mathrm{prim}}}{\theta_{\mathrm{maj}}\, \theta_{\mathrm{min}}} \left\langle \frac{F_{\mathrm{eff}}\, T_{\mathrm{sys}}}{B_{\mathrm{eff}}\, \eta_{\mathrm{atm}}} \right\rangle \frac{1}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}}\,(n_{\mathrm{ant}}-1)\, d\nu\, \Delta t}},$$

θ_{prim}

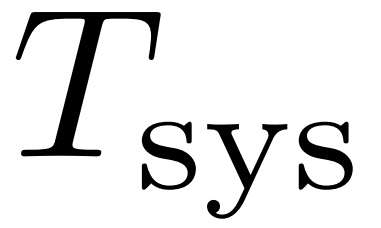
θ_{maj}

θ_{min}

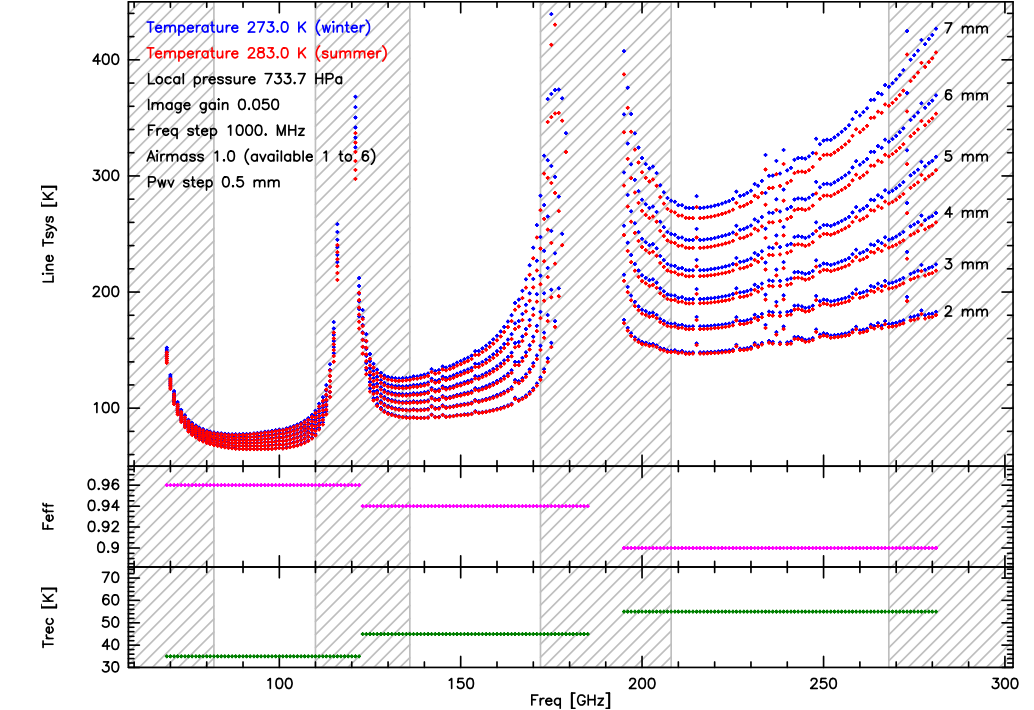
$4 (= 2^2)$

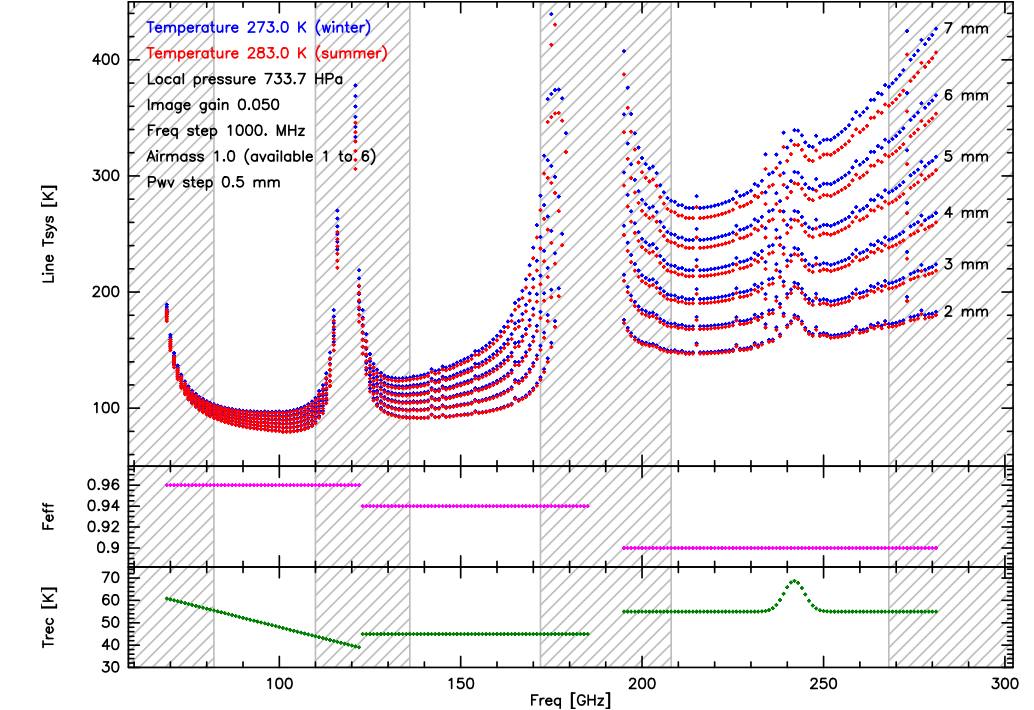


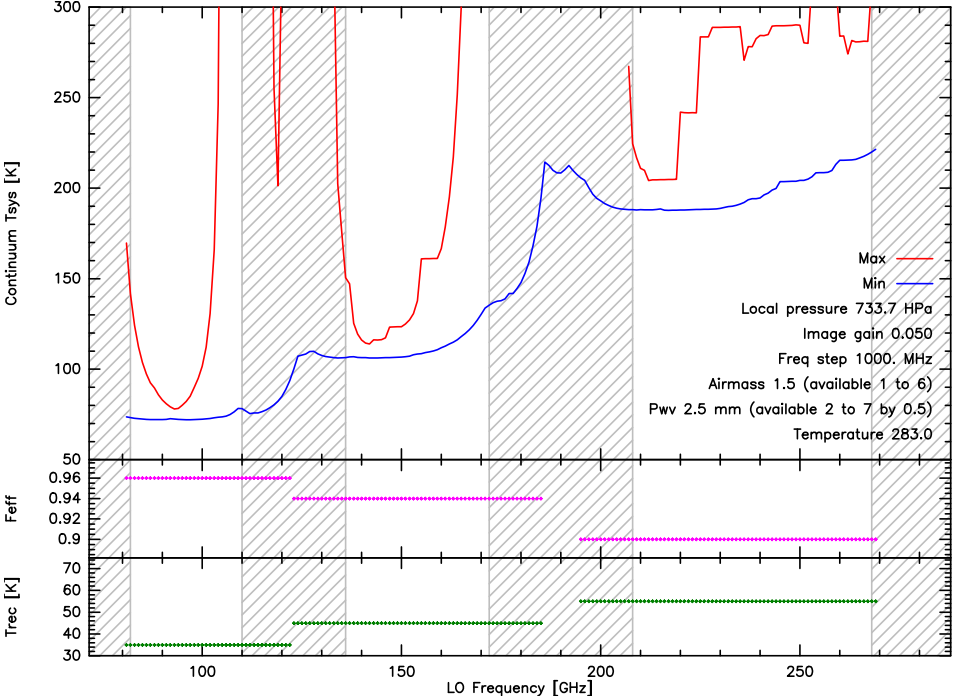
$16 (= 2^4)$

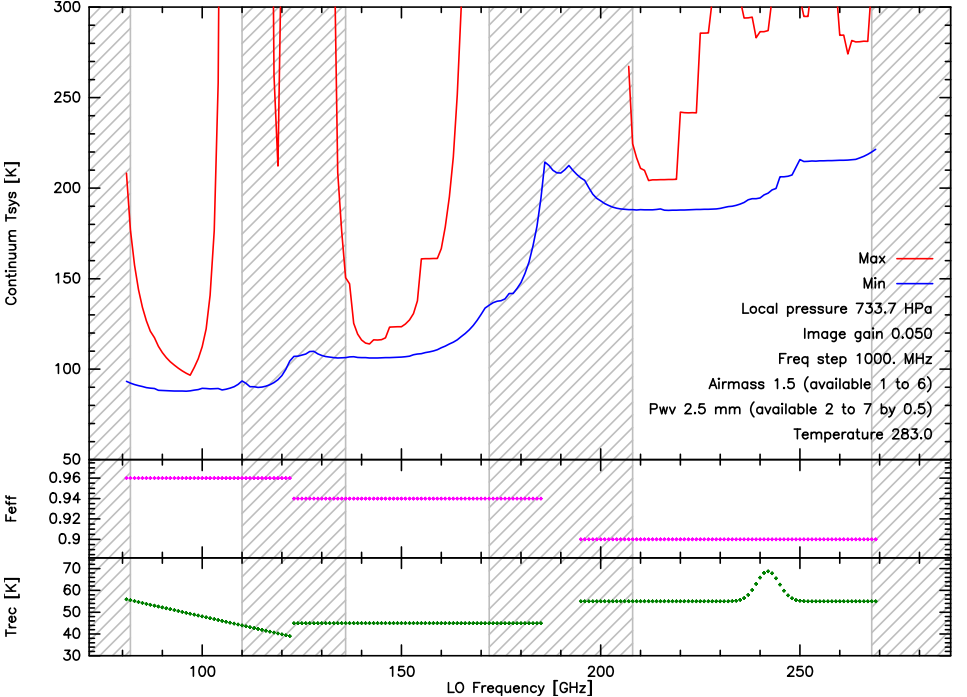


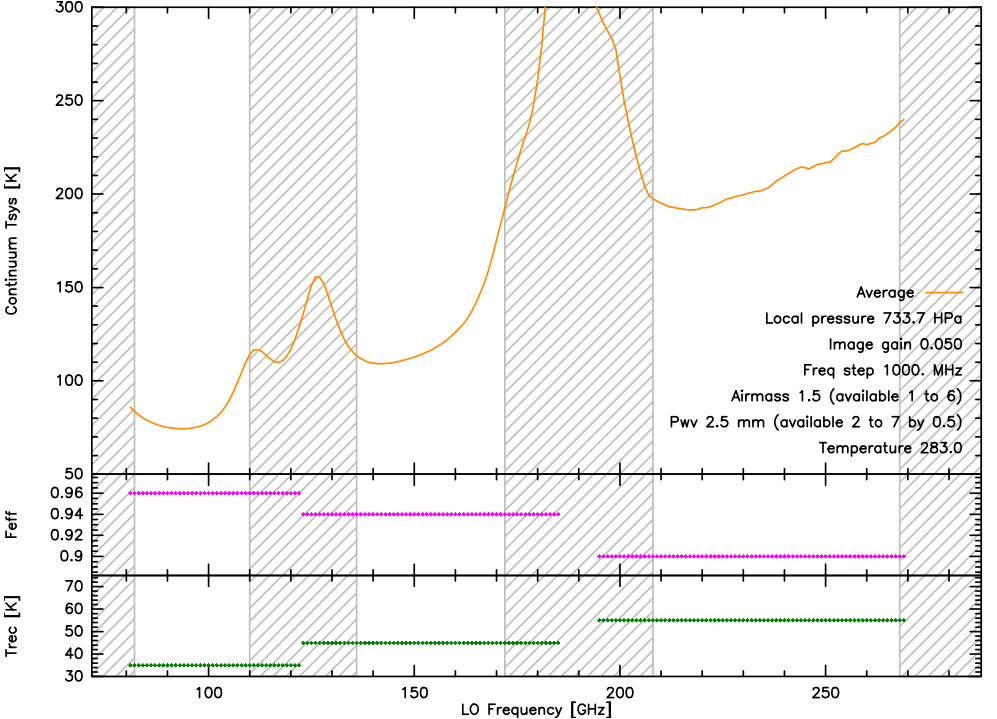
T_{sys}

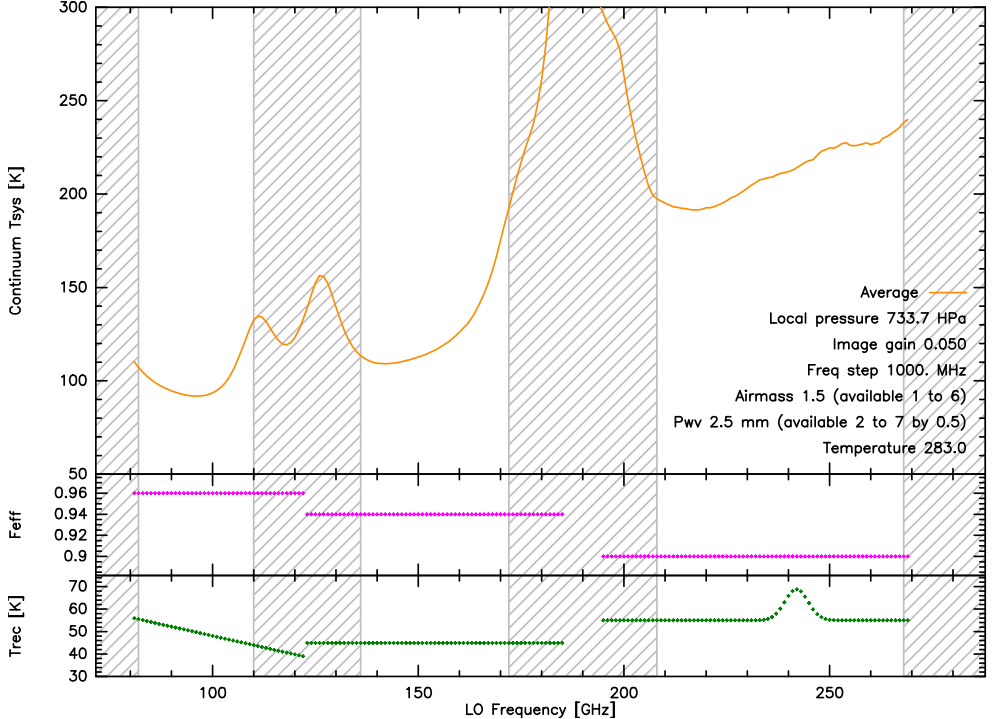

Temperature 273.0 K (winter)
Temperature 283.0 K (summer)
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.0 (available 1 to 6)
Pwv step 0.5 mm
7 mm
6 mm
5 mm
4 mm
3 mm
2 mm
Line Tsys [K]
Feff
Trec [K]
Freq [GHz]


Temperature 273.0 K (winter)
Temperature 283.0 K (summer)
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.0 (available 1 to 6)
Pwv step 0.5 mm
7 mm
6 mm
5 mm
4 mm
3 mm
2 mm
Line Tsys [K]
Feff
Trec [K]
Freq [GHz]


Continuum Tsys [K]
300
250
200
150
100
50
Max
Min
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.5 (available 1 to 6)
Pwv 2.5 mm (available 2 to 7 by 0.5)
Temperature 283.0
Feff
0.96
0.94
0.92
0.9
Trec [K]
70
60
50
40
30
100
150
200
250
LO Frequency [GHz]


Continuum Tsys [K]
300
250
200
150
100
50
Max
Min
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.5 (available 1 to 6)
Pwv 2.5 mm (available 2 to 7 by 0.5)
Temperature 283.0
Feff
0.96
0.94
0.92
0.9
Trec [K]
70
60
50
40
30
100
150
200
250
LO Frequency [GHz]


Continuum Tsys [K]
300
250
200
150
100
50
Average
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.5 (available 1 to 6)
Pwv 2.5 mm (available 2 to 7 by 0.5)
Temperature 283.0
Feff
0.96
0.94
0.92
0.9
Trec [K]
70
60
50
40
30
100
150
200
250
LO Frequency [GHz]

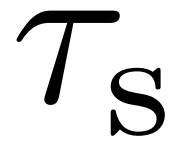

Continuum Tsys [K]
300
250
200
150
100
50
Average
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.5 (available 1 to 6)
Pwv 2.5 mm (available 2 to 7 by 0.5)
Temperature 283.0
Feff
0.96
0.94
0.92
0.9
Trec [K]
70
60
50
40
30
100
150
200
250
LO Frequency [GHz]

$$T_{\mathrm{sys}} = \frac{(1 + G_{\mathrm{im}}) \exp\{\tau_{\mathrm{s}}\, A\}}{F_{\mathrm{eff}}} \left[F_{\mathrm{eff}}\, T_{\mathrm{atm}}\, (1 - \exp\{-\tau_{\mathrm{s}}\, A\}) + (1 - F_{\mathrm{eff}})\, T_{\mathrm{cab}} + T_{\mathrm{rec}}\right],$$

$$G_{\mathrm{im}}$$

F_{eff}

$$A = 1/\sin(\text{elevation})$$



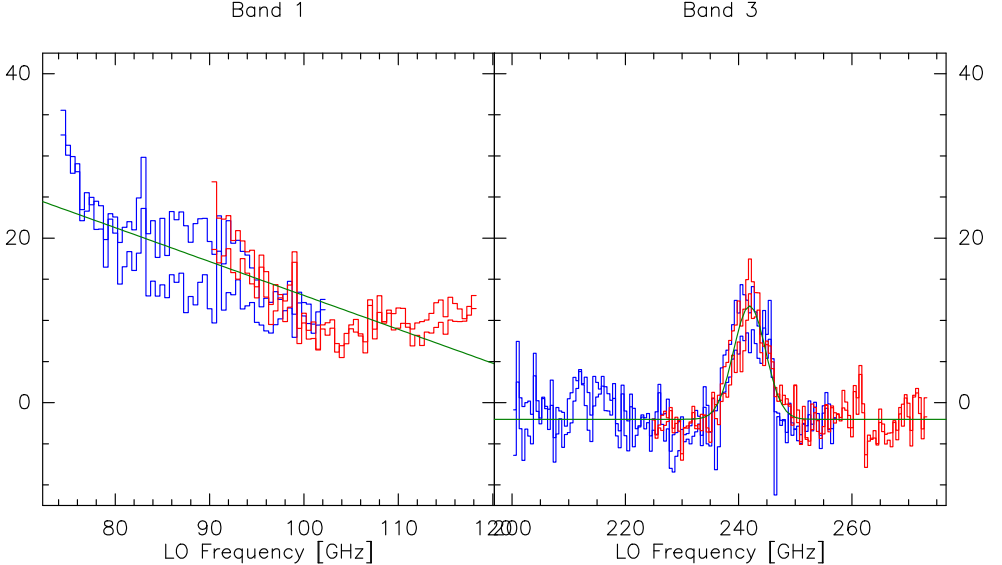
T_{S}

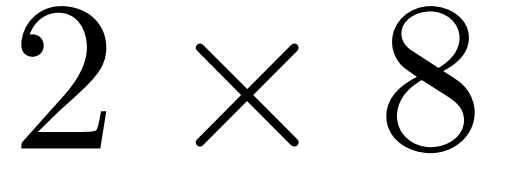
$T_{\rm atm}$

T_{cab}

T_{rec}

$$\frac{1}{< T_{\rm sys} >^2} = \frac{1}{N} \sum \frac{1}{T_{\rm sys}^2}.$$


Band 1
Band 3
40
20
0
80
90
100
110
120
200
220
240
260
LO Frequency [GHz]
LO Frequency [GHz]



$$2 \times 8$$

n_{pol}

$$\sigma_{\mathrm{Jy}} = \frac{J_{\mathrm{ant}}^{\mathrm{int}}\, T_{\mathrm{sys}}}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}} \left(n_{\mathrm{ant}} - 1\right) d\nu\, n_{\mathrm{pol}}\, \Delta t_{\mathrm{on}}}}.$$

$$\sigma_{\rm Jy} = \frac{J^{\rm int}_{\rm ant}\, T_{\rm sys}}{\eta_{\rm spec}\sqrt{n_{\rm ant}\,(n_{\rm ant}-1)\,d\nu\,n_{\rm pol}\,\Delta t_{\rm on}}} \quad \text{with} \quad J^{\rm int}_{\rm ant} = \frac{J^{\rm sd}_{\rm ant}}{\eta_{\rm atm}} \quad \text{and} \quad \eta_{\rm atm} = e^{-\frac{\phi^2_{\rm rms}}{2}} \leq 1.0,$$

$$\sigma_{\mathrm{K}} = \frac{\sigma_{\mathrm{Jy}}}{J_{\mathrm{ant}}^{\mathrm{syn}}} \quad \text{with} \quad J_{\mathrm{ant}}^{\mathrm{syn}} = \frac{2\pi\, k\, \theta_{\mathrm{maj}} \theta_{\mathrm{min}}}{4\, \ln 2\, \lambda^2}.$$

$$\Delta t_{\mathrm{tel}}$$

Δt_{on}

$\Delta t_{\mathrm{setup}} \sim 40$

$$\Delta t_{\mathrm{setup}}$$

$$\Delta t_{\mathrm{setup}} = \Delta t_{\mathrm{setupmin}} + \left(n_{\mathrm{freq}} - 1\right) \Delta t_{\mathrm{setup/freq}},$$

$$\Delta t_{\text{setupmin}}$$

$$\Delta t_{\mathrm{setup/freq}}$$

n_{track}

$$n_{\mathrm{track}} \times \Delta t_{\mathrm{setup}}$$

$$\Delta t_{\mathrm{obs}}$$

$$\Delta t_{\mathrm{obs}} = \Delta t_{\mathrm{tel}} - n_{\mathrm{track}} \times \Delta t_{\mathrm{setup}}.$$

$$n_{\mathrm{track}} = \frac{\Delta t_{\mathrm{tel}}}{\Delta t_{\mathrm{visible}} + \Delta t_{\mathrm{setup}}},$$

$$\Delta t_{\mathrm{visible}}$$

0 deg

$-10\,\mathrm{deg}$

$$-20\,\deg$$

$-30\,\mathrm{deg}$

$$\Delta t_{\mathrm{tel}} < \Delta t_{\mathrm{visible}} + \Delta t_{\mathrm{setup}}$$

$$\Delta t_{\rm on} = \Delta t_{\rm obs} \times \eta_{\rm obs}$$

$$\eta_{\text{obs}} < 1.0$$

η_{obs}

$$n_{\mathrm{gaincal}} = 1$$

$$\eta_{\text{obs}} = \frac{1}{\Omega_{\text{obs}}} \quad \text{with} \quad \Omega_{\text{obs}} = \Omega_{\text{min}} + n_{\text{gaincal}}\, n_{\text{freq}}\, \Omega_{/\text{freq/gaincal}}, \quad \Omega_{\text{min}} = 1.3, \quad \text{and} \quad \Omega_{/\text{freq/gaincal}} = 0.3.$$

Ω_{min}

$\Omega_{/\mathrm{freq}/\mathrm{gaincal}}$

$$\Omega_{\rm obs} = 1.6$$

$\Omega_{\text{obs}} = 1.9,$

$\lambda/(2d_{\mathrm{prim}})$

d_{prim}

$$\eta_{\mathrm{tot}}$$

$$\eta_{\mathrm{tot}} = \frac{\Sigma \Delta t_{\mathrm{on}}}{\Delta t_{\mathrm{tel}}}$$

$$\eta_{\text{tot}} \leq 0.25$$

$$\sigma_{\mathrm{Jy}} = \frac{J_{\mathrm{ant}}^{\mathrm{int}}\, T_{\mathrm{sys}}}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}} \left(n_{\mathrm{ant}} - 1\right) d\nu\, n_{\mathrm{pol}}\, \Delta t_{\mathrm{on}}}},$$

$$\Delta t_{\rm on} = \eta_{\rm obs}\,\eta_{\rm freq}\,\left(\Delta t_{\rm tel} \,-\, n_{\rm track} \times \Delta t_{\rm setup}\right),$$

η_{freq}

$$\eta_{\mathrm{freq}} = 1.0$$

$$\eta_{\mathrm{freq}} \sim 0.5$$

η_{freq}

n_{sou}

$$\sigma_{\mathrm{Jy}} = \frac{J_{\mathrm{ant}}^{\mathrm{int}}\, T_{\mathrm{sys}}}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}} \left(n_{\mathrm{ant}} - 1\right) d\nu\, n_{\mathrm{pol}}\, \Delta t_{\mathrm{on}}}}$$

$$\Delta t_{\rm on} = \eta_{\rm obs}\,\eta_{\rm freq}\left(\frac{\Delta t_{\rm tel}\;-\;n_{\rm track}\times\Delta t_{\rm setup}}{n_{\rm sou}}\right).$$

A_{map}

n_{beam}

$$n_{\mathrm{beam}} = \frac{A_{\mathrm{map}}}{A_{\mathrm{beam}}}$$

$$A_{\mathrm{beam}}$$

θ

$$A_{\mathrm{beam}} = \frac{0.8\,\pi\,\theta^2_{\mathrm{prim}}}{4\,\ln(2)},$$

$$\sigma_{\mathrm{Jy}} = \frac{J_{\mathrm{ant}}^{\mathrm{int}}\, T_{\mathrm{sys}}}{\eta_{\mathrm{spec}} \sqrt{n_{\mathrm{ant}} \left(n_{\mathrm{ant}} - 1\right) d\nu\, n_{\mathrm{pol}}\, \Delta t_{\mathrm{on}}}}$$

$$\Delta t_{\rm on} = \eta_{\rm obs}\eta_{\rm mos}\left(\frac{\Delta t_{\rm tel} - n_{\rm track} \times \Delta t_{\rm setup}}{n_{\rm beam}}\right), \quad \text{and} \quad \eta_{\rm mos} = \frac{\Delta t_{\rm point/cycle}}{\Delta t_{\rm point/cycle} + \Delta t_{\rm slew}},$$

$$\Delta t_{\mathrm{point/cycle}}$$

$$\Delta t_{\mathrm{slew}}$$

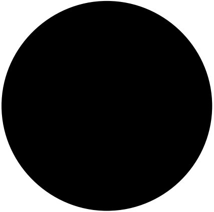
n_{point}

$$n_{\mathrm{point}} = n_{\mathrm{beam}} \left(\frac{7}{4}\right)^2 ,$$

η_{mos}

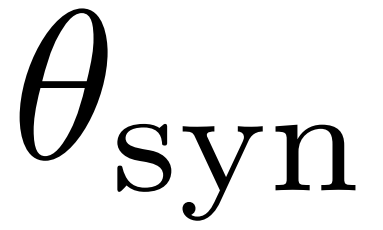
$$\Delta t_{\min} \leq \Delta t_{\text{int}/\text{scan}}$$

$$\Delta t_{\min} = 10$$



$$\frac{\Delta t_{\mathrm{int/scan}}}{1s} << \frac{6900}{\theta_{\mathrm{alias}}/\theta_{\mathrm{syn}}},$$

$$\theta_{\mathrm{alias}}$$



θ_{syn}

$$\Delta t_{\mathrm{int/scan}} \leq \eta \, \frac{6\,900}{1\,\mathrm{sec}} \sqrt{\frac{\theta_{\mathrm{maj}} \theta_{\mathrm{min}}}{A_{\mathrm{map}}}},$$

η

$\sec$

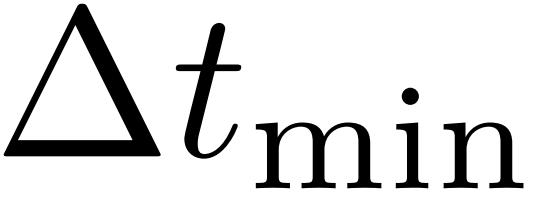
10

$$\leq \Delta t_{\mathrm{int/scan}} = \min\left(45\,\mathrm{sec}, \eta\,\frac{6\,900}{1\,\mathrm{sec}}\,\sqrt{\frac{\theta_{\mathrm{maj}}\theta_{\mathrm{min}}}{A_{\mathrm{map}}}}\right) \quad \text{with} \quad \eta = 0.5.$$

$$\Delta t_{\mathrm{slew}} = 11$$

$$0.47 \leq \eta_{\mathrm{mos}} \leq 1.0.$$

$$\eta_{\mathrm{mos}} = 0.67$$



$\Delta t_{\min}$

$n_{\mathrm{repeat/point/cycle}}$

$$\eta_{\mathrm{mos}} = \frac{\Delta t_{\mathrm{point/cycle}}}{\Delta t_{\mathrm{point/cycle}} + \Delta t_{\mathrm{slew}}}$$

$$\Delta t_{\mathrm{cycle}} = n_{\mathrm{point/track}} \left(\Delta t_{\mathrm{point/cycle}} + \Delta t_{\mathrm{slew}} \right),$$

$$\Delta t_{\mathrm{point/cycle}} = n_{\mathrm{repeat/point/cycle}}\, \Delta t_{\mathrm{int/scan}}.$$

$$\Delta t_{\mathrm{calmax}} = 25$$

$$n^{\max}_{\mathrm{repeat/point/cycle}} = \frac{\Delta t_{\mathrm{calmax}}/n_{\mathrm{point/track}} - \Delta t_{\mathrm{slew}}}{\Delta t_{\mathrm{int/scan}}},$$

$$\eta_{\mathrm{mos}} = 1 - \frac{n_{\mathrm{point/track}}\,\Delta t_{\mathrm{slew}}}{\Delta t_{\mathrm{calmax}}}.$$

$$n_{\text{point/track}}^{\text{large}} = \text{floor}\left(\frac{\Delta t_{\text{calmax}}}{\Delta t_{\text{int/scan}} + \Delta t_{\text{slew}}}\right).$$

$$\Delta t_{\mathrm{cyclemax}}$$

$$n^{\max}_{\text{point/track}} = \frac{\Delta t_{\text{cyclemax}}}{\Delta t_{\min} + \Delta t_{\text{slew}}} \sim 150.$$

$$\Delta t_{\mathrm{int/scan}} = \min \left\{ \Delta t_{\mathrm{int/scan}}, \left(\frac{\Delta t_{\mathrm{cyclemax}}}{n_{\mathrm{point/track}}} - \Delta t_{\mathrm{slew}} \right) \right\}.$$

$$\eta_{\min} = \frac{\Delta t_{\min}}{\Delta t_{\min} + \Delta t_{\text{slew}}} = 0.47.$$

$$n_{\mathrm{beam}} = \frac{A_{\mathrm{map}}}{A_{\mathrm{beam}}}, \quad \text{where} \quad A_{\mathrm{beam}} = \frac{0.8\,\pi\,\theta^2_{\mathrm{prim}}}{4\,\ln(2)}.$$

$$n_{\text{point}} = n_{\text{beam}} \left(\frac{7}{4}\right)^2, \quad \text{and} \quad n_{\text{point/track}} = \min\left(n_{\text{point}}, \frac{n_{\text{point}}}{n_{\text{track}}}\right).$$

$$10\,\mathrm{sec} \leq \Delta t_{\mathrm{int/scan}} = \min\left(45\,\mathrm{sec}, \eta\,\frac{6\,900}{1\,\mathrm{sec}}\sqrt{\frac{\theta_{\mathrm{maj}}\theta_{\mathrm{min}}}{A_{\mathrm{map}}}}\right) \quad \text{with} \quad \eta = 0.5.$$

$$n^{\text{large}}_{\text{point/track}} = \text{floor}\left(\frac{\Delta t_{\text{calmax}}}{\Delta t_{\text{int/scan}} + \Delta t_{\text{slew}}}\right), \quad \text{where} \quad \Delta t_{\text{slew}} = 11\,\text{sec}, \quad \text{and} \quad \Delta t_{\text{calmax}} = 25\,\text{min}.$$

$$\left(n_{\mathrm{point/track}} \leq n^{\mathrm{large}}_{\mathrm{point/track}}\right)$$

$$n^{\max}_{\mathrm{repeat/point/cycle}} = \frac{\frac{\Delta t_{\mathrm{calmax}}}{n_{\mathrm{point/track}}} - \Delta t_{\mathrm{slew}}}{\Delta t_{\mathrm{int/scan}}}.$$

$$(n_{\text{point/track}} > n^{\text{large}}_{\text{point/track}})$$

$$n_{\mathrm{repeat/point/cycle}}^{\mathrm{max}} = 1$$

$$n_{\text{point/track}} \leq n^{\max}_{\text{point/track}}, \quad \text{where} \quad n^{\max}_{\text{point/track}} = \frac{\Delta t_{\text{cyclemax}}}{\Delta t_{\min} + \Delta t_{\text{slew}}} \sim 150, \quad \text{and} \quad \Delta t_{\text{cyclemax}} = 60\,\text{min}.$$

$$\text{if} \quad n_{\text{point/track}} > n^{\text{large}}_{\text{point/track}}, \quad \text{then} \quad \Delta t_{\text{int/scan}} = \min\left\{\Delta t_{\text{int/scan}}, \left(\frac{\Delta t_{\text{cyclemax}}}{n_{\text{point/track}}} - \Delta t_{\text{slew}}\right)\right\}.$$

$$\eta_{\mathrm{mos}} = \frac{\Delta t_{\mathrm{point/cycle}}}{\Delta t_{\mathrm{point/cycle}} + \Delta t_{\mathrm{slew}}}, \quad \text{and} \quad \Delta t_{\mathrm{point/cycle}} = n^{\mathrm{max}}_{\mathrm{repeat/point/cycle}}\, \Delta t_{\mathrm{int/scan}},$$

$$\Delta t_{\text{cycle}} = n_{\text{point/track}} \left(\Delta t_{\text{point/cycle}} + \Delta t_{\text{slew}} \right) .$$

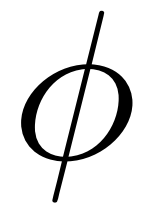
$$\sigma_{\rm Jy} = \frac{J^{\rm int}_{\rm ant}\, T_{\rm sys}}{\eta_{\rm spec}\sqrt{n_{\rm ant}\,(n_{\rm ant}-1)\,d\nu\,n_{\rm pol}\,\Delta t_{\rm on}}}, \quad \text{and} \quad \Delta t_{\rm on} = \eta_{\rm obs}\eta_{\rm mos}\left(\frac{\Delta t_{\rm tel} \;-\; n_{\rm track}\times\Delta t_{\rm setup}}{n_{\rm beam}}\right).$$

P_{ant}

θ, ϕ

ν

θ

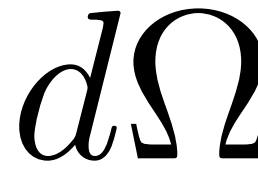


$$\phi$$

$$\Omega_{\mathrm{ant}}(\nu) = \iint_{4\pi} P_{\mathrm{ant}}(\theta, \phi, \nu)\, d\Omega,$$

sr

dimensionless



$$d\Omega$$

$(= \sin\theta \, d\theta \, d\phi)$

$$2\pi$$

$$\Omega_{\mathrm{fb}}(\nu) = \iint_{2\pi} P_{\mathrm{ant}}(\theta, \phi, \nu)\, d\Omega, \quad \text{and} \quad \Omega_{\mathrm{mb}}(\nu) = \iint_{\text{main lobe}} P_{\mathrm{ant}}(\theta, \phi, \nu)\, d\Omega.$$

$$F_{\text{eff}} = \frac{\Omega_{\text{fb}}}{\Omega_{\text{ant}}}, \quad \text{and} \quad B_{\text{eff}} = \frac{\Omega_{\text{mb}}}{\Omega_{\text{ant}}}.$$

$$F_{\mathrm{sou}}(\nu) = \iint_{\mathrm{source}} B(\theta, \phi, \nu)\, d\Omega,$$

F_{sou}

$$\mathrm{W\,m^{-2}\,Hz^{-1}}$$

B

$W\,m^{-2}\,Hz^{-1}\,sr^{-1}$

θ_0, ϕ_0

$$F_{\rm obs}(\theta_0, \phi_0, \nu) = \iint_{\rm source} B(\theta, \phi, \nu)\, P_{\rm ant}(\theta - \theta_0, \phi - \phi_0, \nu)\, d\Omega,$$

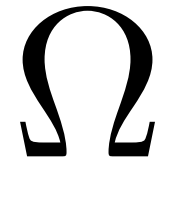
$$F_{\mathrm{obs}}$$

$$F_{\rm obs}(\theta_0, \phi_0, \nu) = \iint_{\rm source} B(\theta, \phi, \nu)\, \tilde{P}_{\rm ant}(\theta_0 - \theta, \phi_0 - \phi, \nu)\, d\Omega,$$

$$\tilde{P}_{\mathrm{ant}}(\theta_0 - \theta, \phi_0 - \phi, \nu) = P_{\mathrm{ant}}(\theta - \theta_0, \phi - \phi_0, \nu).$$

$$B_{\rm obs}(\theta_0,\phi_0,\nu) = \frac{1}{\Omega}\iint_{\rm source} B(\theta,\phi,\nu)\,\tilde{P}_{\rm ant}(\theta_0-\theta,\phi_0-\phi,\nu)\,d\Omega,$$

B_{obs}



Ω

Ω_{fb}

Ω_{mb}

$B_{\mathrm{ant}}(\theta_0, \phi_0, \nu)$

$$= \frac{1}{\Omega_{\mathrm{ant}}} \iint_{\mathrm{source}} B(\theta, \phi, \nu)\, \tilde{P}_{\mathrm{ant}}(\theta_0 - \theta, \phi_0 - \phi, \nu)\, d\Omega,$$

$$B_{\mathrm{fb}}(\theta_0, \phi_0, \nu)$$

$$= \frac{1}{\Omega_{\mathrm{fb}}} \iint_{\mathrm{source}} B(\theta, \phi, \nu)\, \tilde{P}_{\mathrm{ant}}(\theta_0 - \theta, \phi_0 - \phi, \nu)\, d\Omega,$$

$$B_{\mathrm{mb}}(\theta_0, \phi_0, \nu)$$

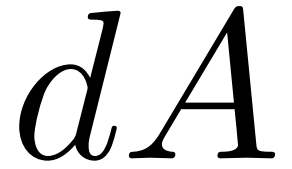
$$= \frac{1}{\Omega_{\mathrm{mb}}} \iint_{\mathrm{source}} B(\theta, \phi, \nu)\, \tilde{P}_{\mathrm{ant}}(\theta_0 - \theta, \phi_0 - \phi, \nu)\, d\Omega.$$

$$B_{\mathrm{fb}} = \frac{1}{F_{\mathrm{eff}}}\, B_{\mathrm{ant}} \quad \text{and} \quad B_{\mathrm{mb}} = \frac{F_{\mathrm{eff}}}{B_{\mathrm{eff}}}\, B_{\mathrm{fb}}.$$

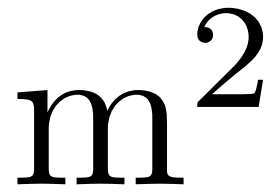
$$dw(\theta, \phi, \nu) = B(\theta, \phi, \nu)\ \cos\theta\, d\Omega\, dA,$$

dw

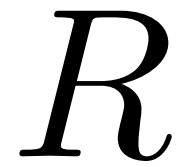
$\mathrm{W\,Hz^{-1}}$



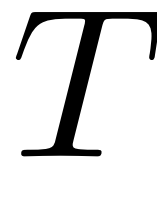
$$dA$$



m^2



R



T

$$dw = kT.$$

$$T_{\mathrm{mb}}(\theta_0, \phi_0, \nu) = \frac{1}{\Omega_{\mathrm{mb}}} \iint_{\mathrm{source}} B(\theta, \phi, \nu)\, \tilde{P}_{\mathrm{ant}}(\theta_0 - \theta, \phi_0 - \phi, \nu)\, d\Omega.$$

$$(h\nu \ll kT)$$

$$h\nu \sim kT$$

$$k = 1.380658 \times 10^{23}\,\mathrm{J\,K^{-1}}$$

$$dw(\theta_0, \phi_0, \nu) = \frac{1}{2} A_{\text{eff}} \iint_{\text{source}} B(\theta, \phi, \nu) \, \tilde{P}_{\text{ant}}(\theta_0 - \theta, \phi_0 - \phi, \nu) \, d\Omega.$$

m^{-2}

η_{ant}

$$\eta_{\mathrm{ant}} = \frac{A_{\mathrm{eff}}}{A_{\mathrm{geo}}} < 1,$$

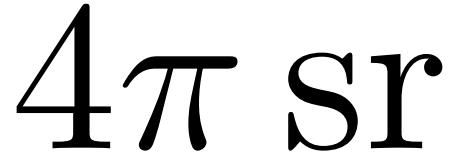
$$A_{\mathrm{geo}} = \pi \left(\frac{D_{\mathrm{ant}}}{2} \right)^2 .$$

$$A_{\mathrm{eff}}(\nu)\,\Omega_{\mathrm{ant}}(\nu) = \lambda^2,$$

$$B(\theta, \phi, \nu) = \frac{2\,kT}{\lambda^2},$$

$$dw(\theta_0,\phi_0,\nu) = \frac{1}{2}\,A_{\rm eff}\iint_{\rm source} B(\theta,\phi,\nu)\,\tilde{P}_{\rm ant}(\theta_0-\theta,\phi_0-\phi,\nu)\,d\Omega = \frac{1}{2}\,A_{\rm eff}\,\Omega_{\rm ant}(\nu)\,\frac{2\,kT}{\lambda^2}.$$

$$dw(\theta_0, \phi_0, \nu) = kT,$$



$$4\pi\,\mathrm{sr}$$

$$A_{\mathrm{eff}}(\nu)\,\Omega_{\mathrm{fb}}(\nu) = \lambda^2\,F_{\mathrm{eff}}(\nu) \quad \text{and} \quad A_{\mathrm{eff}}(\nu)\,\Omega_{\mathrm{mb}}(\nu) = \lambda^2\,B_{\mathrm{eff}}(\nu).$$

$$B_{\mathrm{eff}}(\nu) = \eta_{\mathrm{ant}}\, A_{\mathrm{geo}}\, \frac{\Omega_{\mathrm{mb}}(\nu)}{\lambda^2}.$$

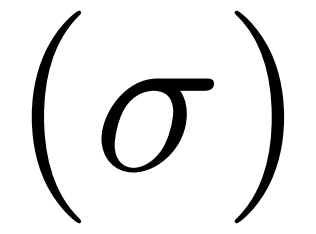
$$A_{\mathrm{geo}} = \frac{\pi}{4}\, D^2, \quad \frac{\Omega_{\mathrm{mb}}(\nu)}{\lambda^2} = \frac{\pi}{4\ln 2}\, \left(\frac{\theta_{\mathrm{mb}}}{\lambda}\right)^2,$$

$$\theta_{\mathrm{mb}} = \alpha \frac{\lambda}{D},$$

$$B_{\mathrm{eff}}(\nu) = \frac{\pi^2}{16 \ln 2} \alpha^2 \, \eta_{\mathrm{ant}}(\nu) \simeq 0.8899 \, \alpha^2 \, \eta_{\mathrm{ant}}(\nu).$$

α

$$\alpha \sim 1.2$$



$$\left(\sigma \right)$$

$$\eta_{\rm ant}(\nu) = \eta^0_{\rm ant}\ \exp\left\{-\left(\frac{4\pi\sigma}{\lambda}\right)^2\right\}.$$