1,2

1

th

n_{freq}

$T_{\mathrm{A}}^{\star}$

$2d\nu$

$d\nu$

$T_{\rm sys}$

Δt

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

σ_{K}

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

j

T^{ij}_{sys}

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

$$T^i_{\mathrm{sys}}$$

T^{j}_{sys}

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

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

F

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

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

k

A_{eff}

$$J_{\text{ant}}^{\text{sd}}$$

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

$$J_{\mathrm{ant}}^{\mathrm{sd,ij}}$$

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

$$J_{\mathrm{ant}}^{\mathrm{sd,i}}$$

$J_{\mathrm{ant}}^{\mathrm{sd,j}}$

$$n_{\text{ant}}\,(n_{\text{ant}}-1)/2$$

n_{ant}

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

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

η_{atm}

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

$$J_{\mathrm{ant}}^{\mathrm{int}}$$

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

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

ϕ_{rms}

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

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

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

σ_{Jy}

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

uv

λ/FWHM

Ω_{ant}

λ

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

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

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

Ω_{prim}

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

$$\Omega_{\text{syn}}$$

$J_{\mathrm{ant}}^{\mathrm{syn}}$

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

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

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

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

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

θ_{prim}

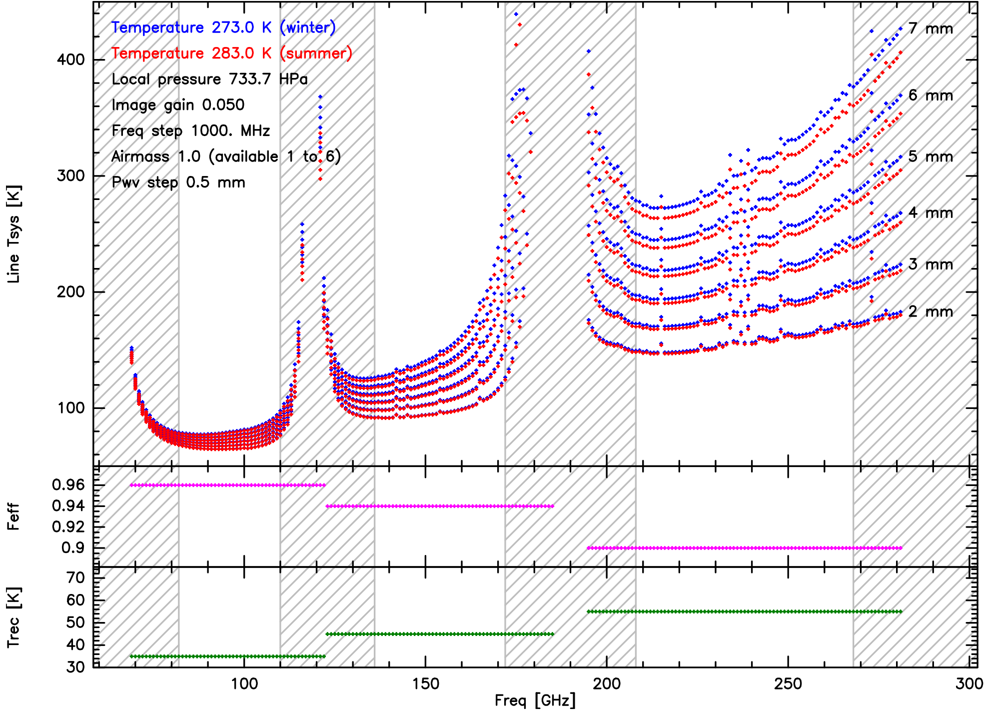
θ_{maj}

$\theta_{\min}$

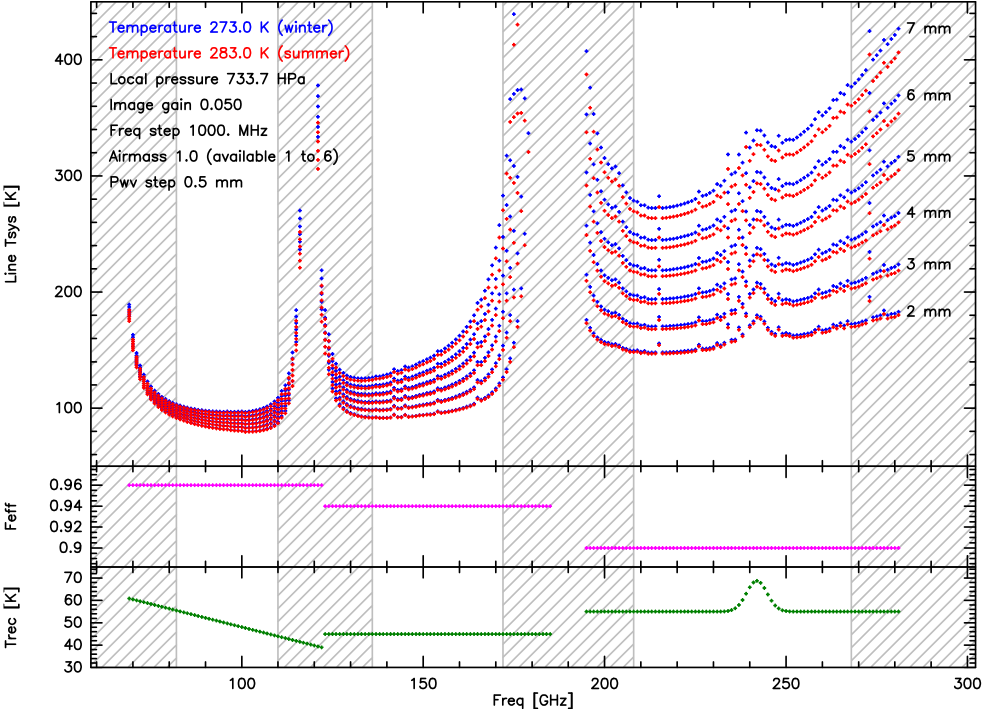
$4 (= 2^2)$

$16 (= 2^4)$

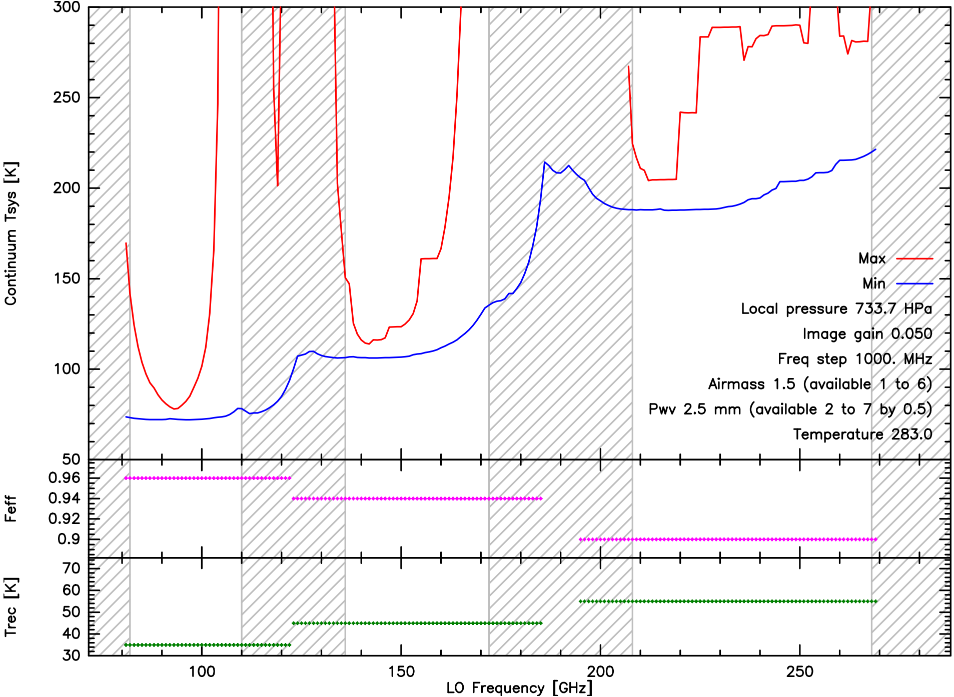
T_{sys}



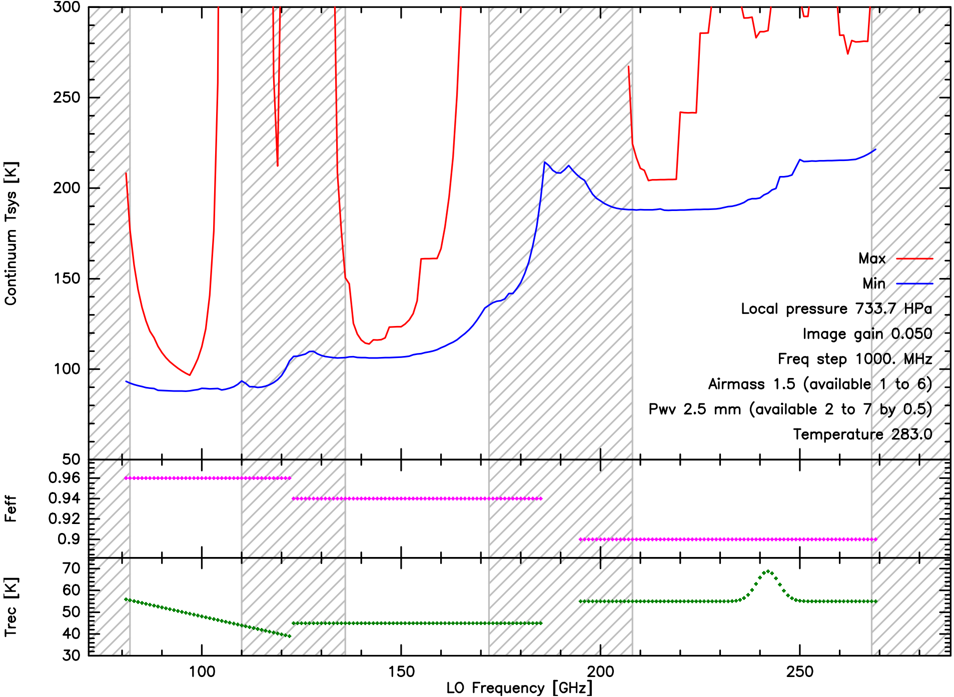
Temperature 273.0 K (winter)
Temperature 283.0 K (summer)
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.0 (available 1 to 6)
Pwv step 0.5 mm
7 mm
6 mm
5 mm
4 mm
3 mm
2 mm
Line Tsys [K]
Feff
Trec [K]
Freq [GHz]



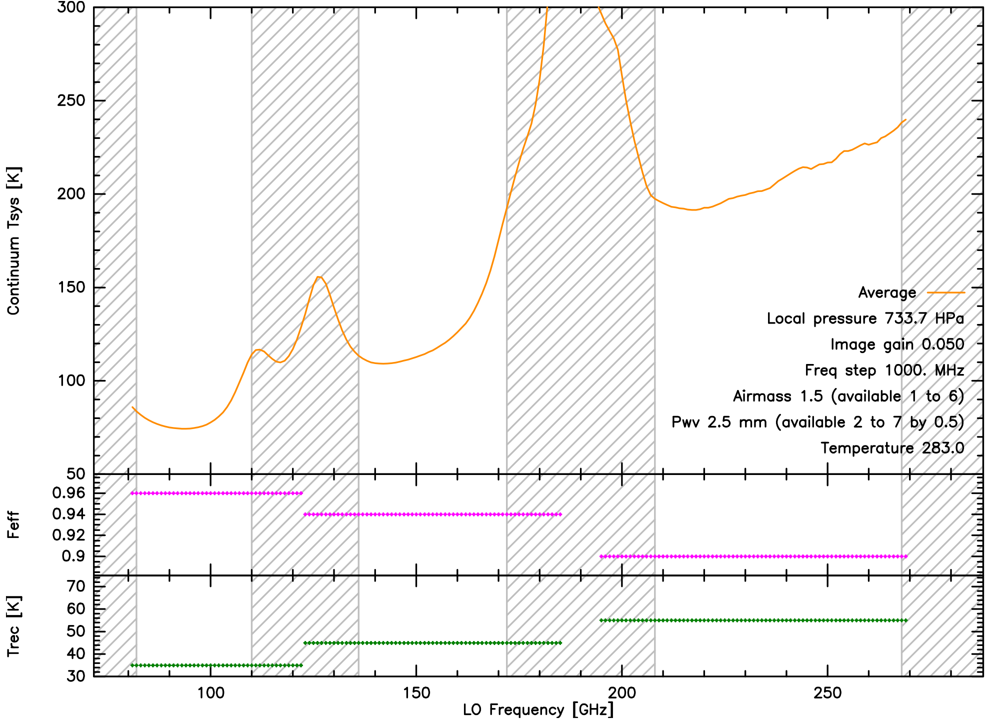
Temperature 273.0 K (winter)
Temperature 283.0 K (summer)
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.0 (available 1 to 6)
Pwv step 0.5 mm
7 mm
6 mm
5 mm
4 mm
3 mm
2 mm
Line Tsys [K]
Feff
Trec [K]
Freq [GHz]



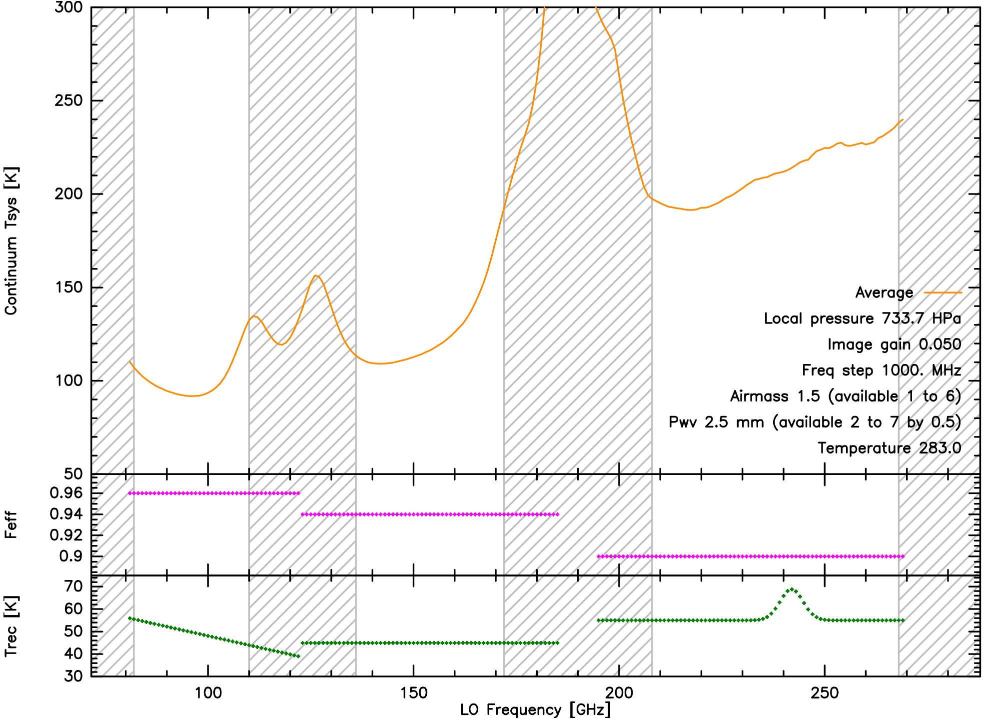
Continuum Tsys [K]
300
250
200
150
100
50
Max
Min
Local pressure 733.7 HPa
Image gain 0.050
Freq step 1000. MHz
Airmass 1.5 (available 1 to 6)
Pwv 2.5 mm (available 2 to 7 by 0.5)
Temperature 283.0
Feff
0.96
0.94
0.92
0.9
Trec [K]
70
60
50
40
30
100
150
200
250
LO Frequency [GHz]



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
Continuum Tsys [K]
Feff
Trec [K]
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]

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

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

F_{eff}

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

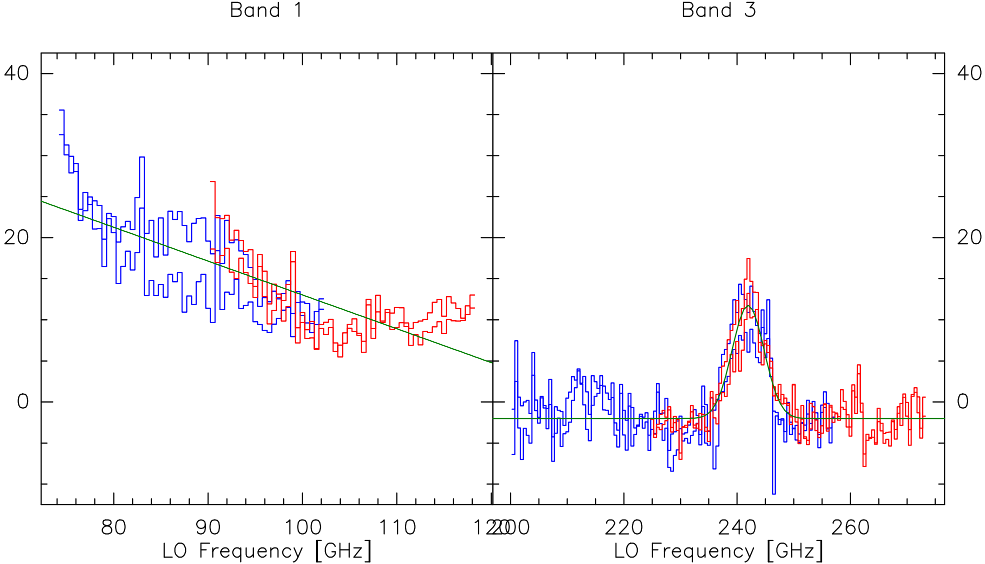
τ_s

T_{atm}

T_{cab}

T_{rec}

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



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

\

2×8

n_{pol}

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

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

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

Δt_{tel}

Δt_{on}

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

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

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

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

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

n_{track}

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

Δt_{obs}

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

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

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

0 deg

$-10\,\mathrm{deg}$

$-20\,\mathrm{deg}$

$-30\,\deg$

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

$$\boxed{\Delta t_{\mathrm{on}} = \Delta t_{\mathrm{obs}} \times \eta_{\mathrm{obs}}}$$

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

η_{obs}

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

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

$\Omega_{\min}$

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

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

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

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

d_{prim}

η_{tot}

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

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

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

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

η_{freq}

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

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

η_{freq}

n_{sou}

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

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

A_{map}

n_{beam}

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

A_{beam}

θ

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

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

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

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

Δt_{slew}

n_{point}

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

η_{mos}

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

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

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

$$\theta_{\text{alias}}$$

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

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

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

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

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

$$\Delta t_{\min}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

P_{ant}

θ, ϕ

$\mathcal{V}$

θ

ϕ

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

sr

dimensionless

$$d\Omega$$

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

2π

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

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

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

F_{sou}

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

B

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

θ_0, ϕ_0

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

F_{obs}

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

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

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

B_{obs}

Ω

$$\Omega_{\mathrm{fb}}$$

Ω_{mb}

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

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

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

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

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

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

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

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

$$dw$$

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

dA

m^2

R

T

$$dw = k\,T.$$

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

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

$$h\nu \sim kT$$

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

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

m^{-2}

η_{ant}

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

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

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

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

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

$$dw(\theta_0, \phi_0, \nu) = k\,T,$$

$4\pi \text{ sr}$

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

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

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

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

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

α

$\alpha \sim 1.2$

$$(\sigma)$$

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