σ

J_i

$$A_{ij}$$

S

u, v

1

$$\widetilde{V}_{ijk}$$

i

j

k

V_{ij}

$$\widetilde{V}_{ijk} = g_i(t)g_j^*(t)b_{ijk}(t)V_{ij}(u_k(t), v_k(t)) + noiseterm$$

$u_k(t)$

$v_k(t)$

ij

t

$$g_i(t)$$

$b_{ijk}(t)$

P_a

$\delta\nu$

T_a

$$P_a = kT_a\delta\nu$$

$$e^{-\tau_{atm}}$$

η_f

$$T_a^*$$

$$T_a^* = \frac{(1 + g_{im})}{\eta_f} e^{\tau_{atm}} T_a$$

$$(1 + g_{im})$$

g_{im}

T_b

I_ν

$$T_b = \frac{c^2}{2k\nu^2} I_\nu$$

S_ν

$$T_a^* = \frac{\eta_a A}{2k} S_\nu = \frac{1}{J} S_\nu$$

$$J = \frac{2k}{\eta_a A}$$

$$T_{noise} = T_{bg} + T_{sky} + T_{spill} + T_{rec}$$

T_{bg}

T_{sky}

$$T_{spill}$$

T_{rec}

4π

$$T_{atm}$$

τ_{atm}

$$T_{sky}$$

$=$

$$\eta_f(1 - e^{-\tau_{atm}})T_{atm}$$

T_{spill}

$$(1-\eta_f)T_{ground}$$

T_{sys}

$$T_{noise}$$

$$T_{sys} = \frac{1 + g_{im}}{\eta_f} e^{\tau_{atm}} T_{noise}$$

δt

n

A

η_a

η_q

η_p

$$\sigma = \frac{1}{\eta_q \eta_p} \frac{\sqrt{2}k}{\eta_a A} \frac{T_{sys}}{\sqrt{\delta\nu\delta t}}$$

$$\sigma = \frac{1}{\eta_q \eta_p} \frac{2k}{\eta_a A} \frac{T_{sys}}{\sqrt{n(n-1)\delta\nu\delta t}}$$

$$W_{ij}$$

$$10^6$$

10^{-3}

$$W_{ij} = \frac{1}{\sigma_{ij}^2}$$

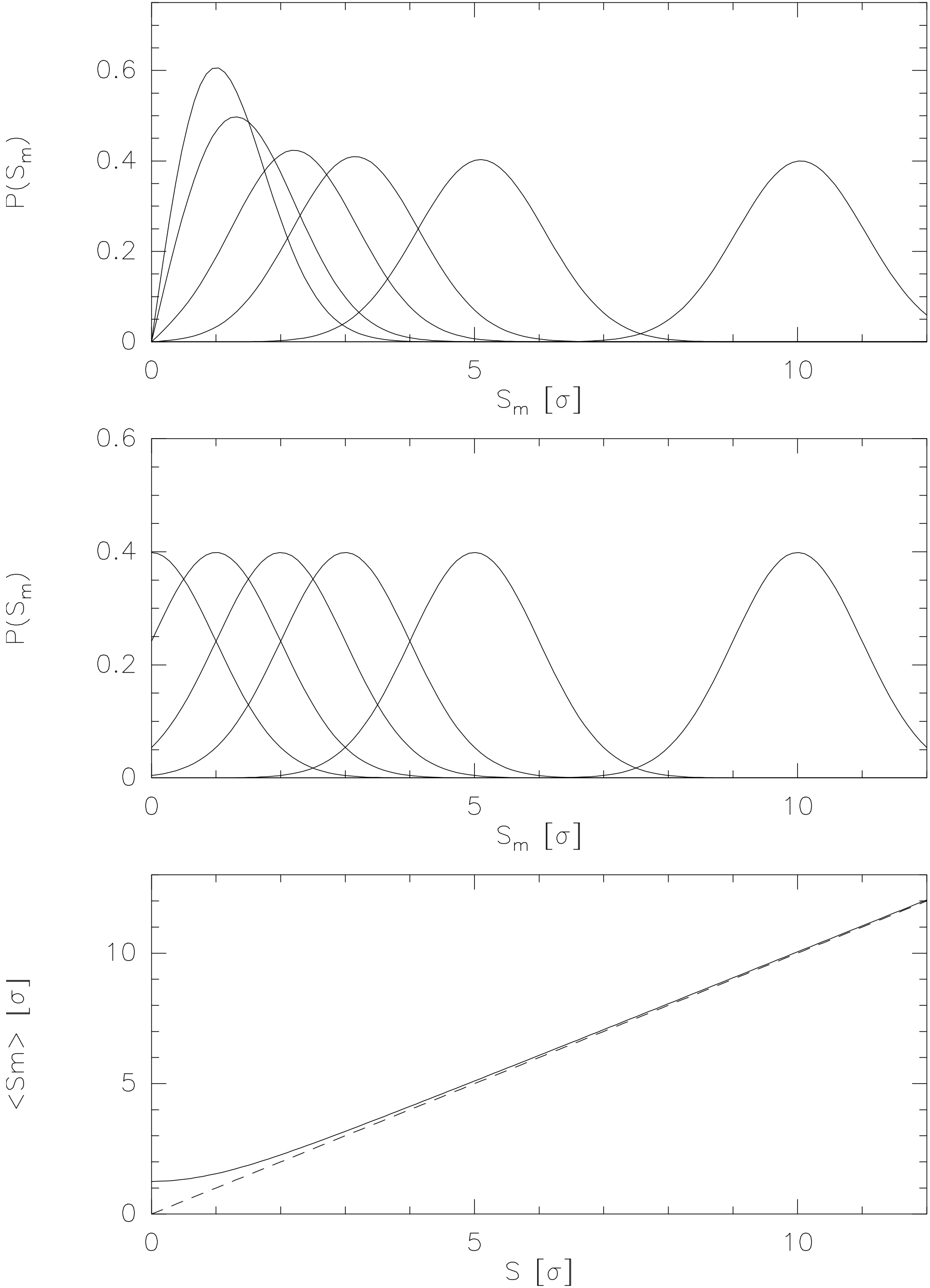
$$V_{ij}(t) = a_{ij}(t)e^{i\varphi_{ij}(t)}$$

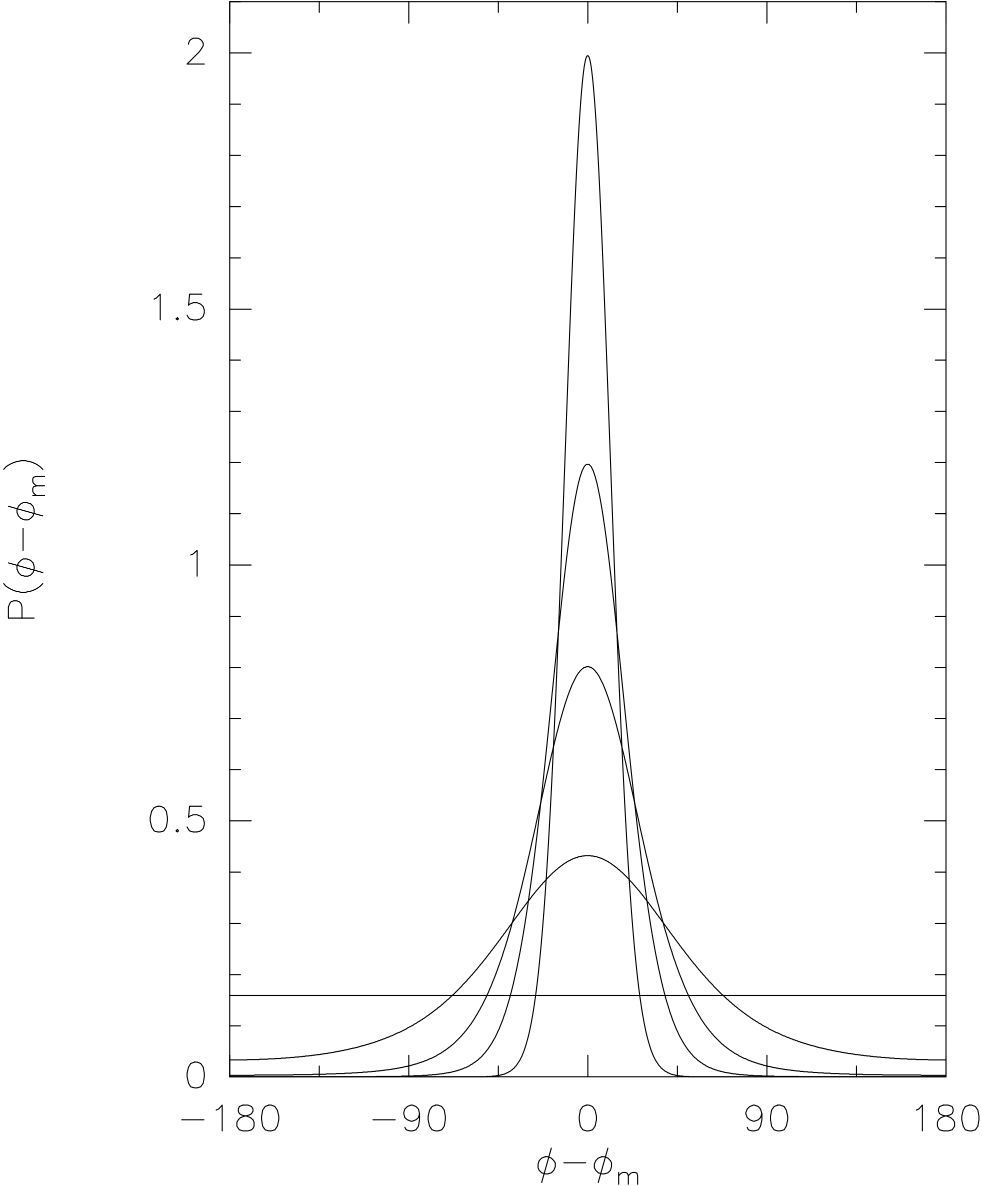
$$\widetilde{\varphi}_{ij} + \widetilde{\varphi}_{jk} - \widetilde{\varphi}_{ik}$$

$$\varphi_{ij} + \varphi_{jk} - \varphi_{ik}$$

$$\frac{\widetilde{a}_{ij}\widetilde{a}_{kl}}{\widetilde{a}_{ik}\widetilde{a}_{jl}}$$

$$\frac{a_{ij}a_{kl}}{a_{ik}a_{jl}}$$


P(S_m)
0.6
0.4
0.2
0
0
5
10
S_m [σ]
P(S_m)
0.6
0.4
0.2
0
0
5
10
S_m [σ]
<Sm> [σ]
10
5
0
0
5
10
S [σ]



2
1.5
1
0.5
0
P(ϕ−ϕ_m)
−180
−90
0
90
180
ϕ−ϕ_m

ϕ

$$e^{-\phi^2/2}$$

$$G_{ij}(t) = g_i(t) \cdot g_j^*(t)$$

$$\widetilde{V_{ij}} = g_i \cdot g_j^* S$$

$$\widetilde{\varphi}_{ij} = \phi_j - \phi_i$$

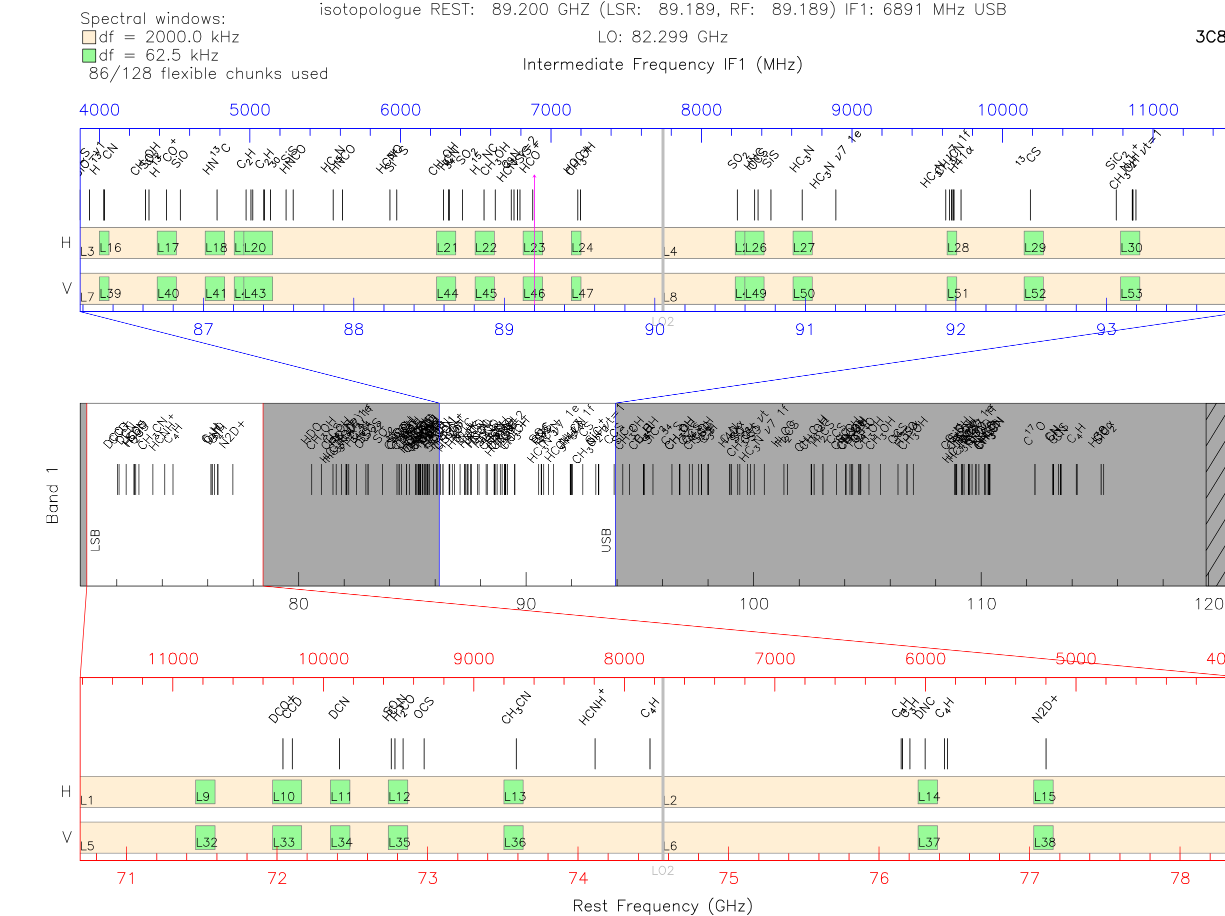
$$\widetilde{a}_{ij} = a_i \cdot a_j \cdot S$$

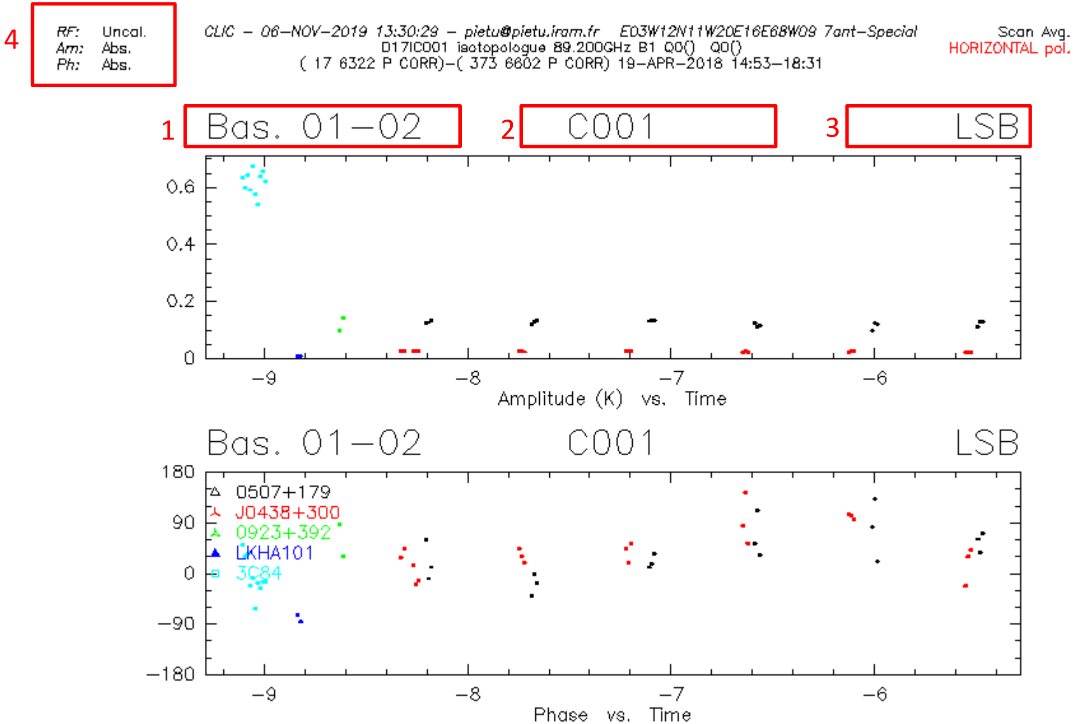
$n + 2$

$$(spectralwindow, sideband, baseline)$$

$$(channel, sideband, baseline)$$

$channel$


Spectral windows:
df = 2000.0 kHz
df = 62.5 kHz
86/128 flexible chunks used
isotopologue REST: 89.200 GHZ (LSR: 89.189, RF: 89.189) IF1: 6891 MHz USB
LO: 82.299 GHz
Intermediate Frequency IF1 (MHz)
3C8
Band 1
LSB
USB
LO2
H
V
Rest Frequency (GHz)


4
RF: Uncal.
Am: Abs.
Ph: Abs.
CLIC – 06–NOV–2019 13:30:29 – pietu@pietu.iram.fr E03W12N11W20E16E68W09 7ant–Special
D17IC001 isotopologue 89.200GHz B1 Q0() Q0()
(17 6322 P CORR)–(373 6602 P CORR) 19–APR–2018 14:53–18:31
Scan Avg.
HORIZONTAL pol.
1
Bas. 01–02
2
C001
3
LSB
0.6
0.4
0.2
0
–9
–8
–7
–6
Amplitude (K) vs. Time
Bas. 01–02
C001
LSB
180
90
0
–90
–180
0507+179
J0438+300
0923+392
LKHA101
3C84
–9
–8
–7
–6
Phase vs. Time

\

$$A_{ij}(t)$$

$$1/S$$

$$\sqrt{J_i * J_j}$$

$$A_{ij}(t)/\sqrt{J_i * J_j}$$

$$B_{,ijk}$$

$$b_{ik}$$

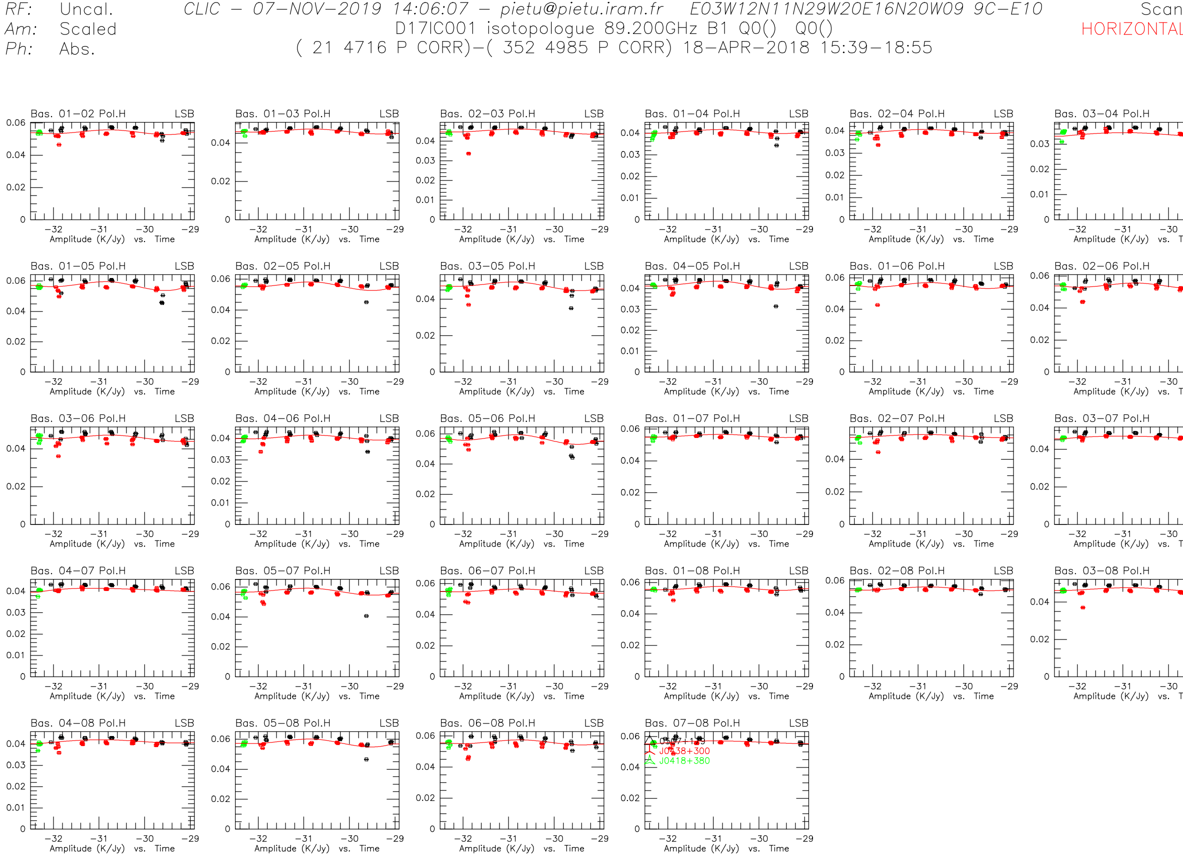
$$B_{ijk} = b_{ik} b^*_{jk}$$

α

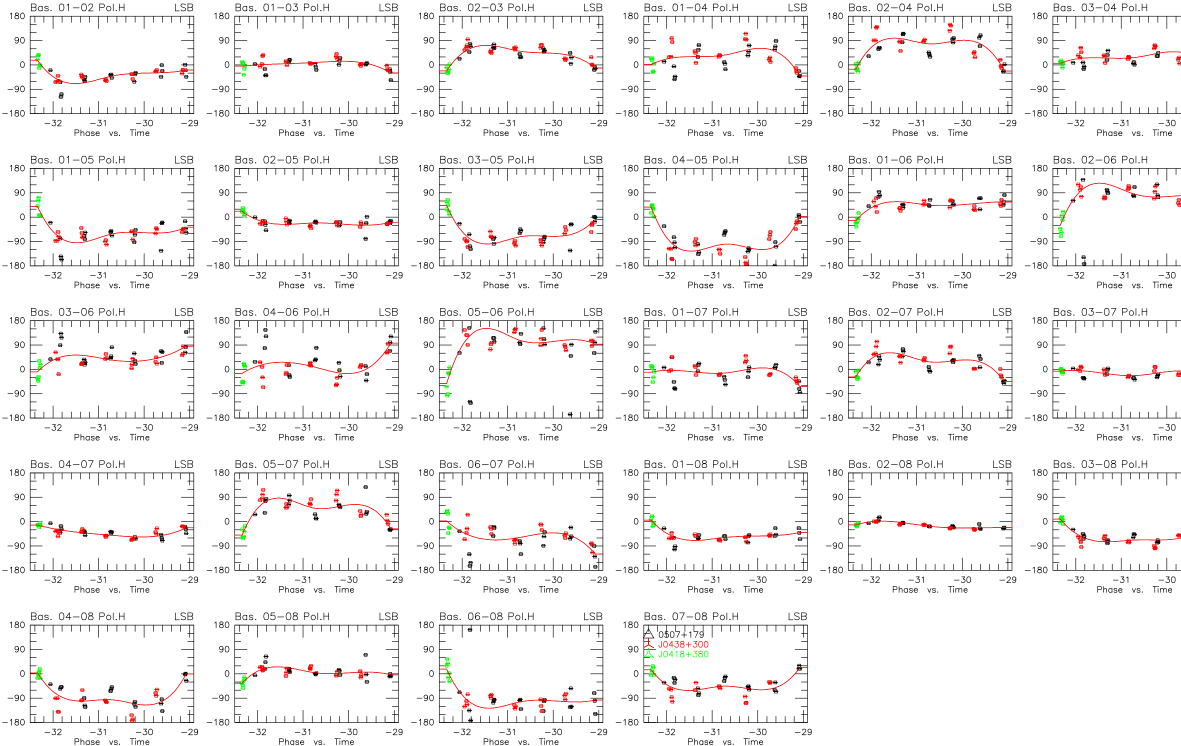
$$G_{ij}(t)$$

$$g_i(t)$$

$$G_{ij}(t) = g_i(t) g_j^*(t)$$


RF: Uncal.
Am: Scaled
Ph: Abs.
CLIC – 07-NOV-2019 14:06:07 – pietu@pietu.iram.fr
E03W12N11N29W20E16N20W09 9C-E10
D17IC001 isotopologue 89.200GHz B1 Q0() Q0()
(21 4716 P CORR)-(352 4985 P CORR) 18-APR-2018 15:39-18:55
Scan
HORIZONTAL
Bas. 01-02 Pol.H LSB
Bas. 01-03 Pol.H LSB
Bas. 02-03 Pol.H LSB
Bas. 01-04 Pol.H LSB
Bas. 02-04 Pol.H LSB
Bas. 03-04 Pol.H
Bas. 01-05 Pol.H LSB
Bas. 02-05 Pol.H LSB
Bas. 03-05 Pol.H LSB
Bas. 04-05 Pol.H LSB
Bas. 01-06 Pol.H LSB
Bas. 02-06 Pol.H
Bas. 03-06 Pol.H LSB
Bas. 04-06 Pol.H LSB
Bas. 05-06 Pol.H LSB
Bas. 01-07 Pol.H LSB
Bas. 02-07 Pol.H LSB
Bas. 03-07 Pol.H
Bas. 04-07 Pol.H LSB
Bas. 05-07 Pol.H LSB
Bas. 06-07 Pol.H LSB
Bas. 01-08 Pol.H LSB
Bas. 02-08 Pol.H LSB
Bas. 03-08 Pol.H
Bas. 04-08 Pol.H LSB
Bas. 05-08 Pol.H LSB
Bas. 06-08 Pol.H LSB
Bas. 07-08 Pol.H LSB
Amplitude (K/Jy) vs. Time
J0438+300
J0418+380

RF: Uncal. CLIC – 07-NOV-2019 14:04:27 – pietu@pietu.iram.fr E03W12N11N29W20E16N20W09 9C-E10 Scan
Am: Abs. D17IC001 isotopologue 89.200GHz B1 Q0() Q0() HORIZONTAL
Ph: Abs. (21 4716 P CORR)-(352 4985 P CORR) 18-APR-2018 15:39-18:55



$$\widetilde{A_{ij}} = a_i a_j \left(I + Q\cos(2\chi) + U\sin(2\chi)\right)$$

χ

I, Q, U, V

$$P = \frac{\sqrt{Q^2+U^2}}{I}$$

$\Delta\tau$

$$\phi = \pm 2\pi \Delta \tau \nu_{IF1}$$

土

$$\frac{\pi}{2}$$

$$P_{sky}$$

P_{hot}

$$T_{hot}$$

$$(T_{hot} + T_{rec}) \times \frac{P_{sky}}{P_{hot}} - T_{rec} = \eta_f \times Airmass \times \tau_{zenith} + (1 - \eta_f) \times T_{ground}$$

$$\tau_g = \frac{\mathbf{b.s}}{c}$$

$$\mathbf{b} = (X_{ij}, Y_{ij}, Z_{ij})$$

$$\mathbf{s} = (\cos h \cos \delta, -\sin h \cos \delta, \sin \delta)$$

ϕ_{ijk}

$$2\pi\tau_g\nu_{RF}$$

$$\frac{2\pi}{\lambda}\mathbf{b}.\mathbf{s}$$

$$\frac{2\pi}{\lambda_k} \left(X_{ij} \cos h \cos \delta - Y_{ij} \sin h \cos \delta + Z_{ij} \sin \delta \right)$$

$\cos(El)$

$> 2d^2/\lambda$

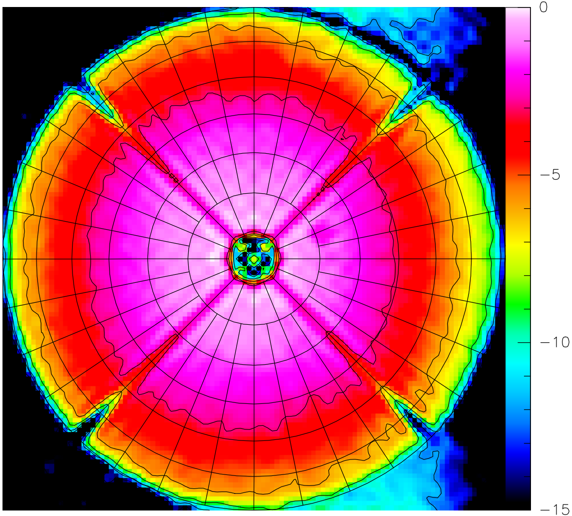
30−sep−2019−holo−r1

RF: Fr.(B) *CLIC − 19−NOV−2019 10:01:36 − pietu@pietu.iram.fr − Ant 10 − N05N13W12W09E10E04W05N02N09*
Am: Rel.(B) 3C454.3 9D scans 6011 to 6085 30−SEP−2019 23:23UT El: 56.00
Ph: Rel.(B)

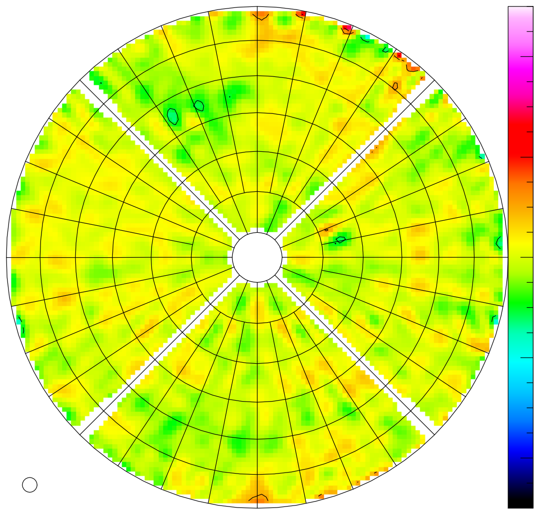
rms Pha.
01−09 4.82
02−09 3.75
03−09 14.35
04−09 13.36
05−09 10.87
06−09 10.26
07−09 11.02
08−09 8.17

Edge taper = 19.05x 16.49 dB − offset X= −0.39 Y= −0.13 m
Focus offsets (X,Y,Z) = −0.71 −1.40 0.12 mm; Astigmatism = 20.4 μm (52.0deg.)
Phase rms (unweighted)= 0.101 (weighted)= 0.097 radians
Surface rms (unweighted)= 33.63 − (weighted)= 31.09 μm
η_A(82.000 GHz) = 0.737; η_A(230.0 GHz) = 0.692; η_A(345.0 GHz) = 0.632
S/T(82.000 GHz)= 21.179 Jy/K; S/T(230GHz)= 22.573 Jy/K; S/T(345 GHz)= 24.720 Jy/K
η_I=0.744 −η_S=0.862 −η_P(82.000 GHz)=0.991 −η_P(230 GHz)=0.930 −η_P(345 GHz)=0.849
Rms/ring: 27.6 29.3 26.5 33.4 31.0 37.8

Amplitude (back view)
−15.000 to 0.000 by 3.000



Normal errors (back view)
−500.000 to 500.000 by 100.000



$$(\xi, \eta)$$

$$r = \sqrt{\xi^2 + \eta^2}$$

f

$\phi_1(\xi, \eta)$

a

$$\phi_2(\xi, \eta)$$

$b\xi$

$\phi_3(\xi, \eta)$

$c\eta$

$\phi_4(\xi, \eta)$

$$\delta z \left(1 - \frac{1 - \frac{r^2}{4f^2}}{\sqrt{\frac{r^2}{f^2} + (1 - \frac{r^2}{4f^2})^2}} \right)$$

$\phi_5(\xi, \eta)$

$$\delta x \frac{\xi}{f} \left(1 - \frac{1}{\sqrt{\frac{r^2}{f^2} + \left(1 - \frac{r^2}{4f^2}\right)^2}} \right)$$

$\phi_6(\xi, \eta)$

$$\delta y \frac{\eta}{f} \left(1 - \frac{1}{\sqrt{\frac{r^2}{f^2} + \left(1 - \frac{r^2}{4f^2}\right)^2}} \right)$$

$\phi_7(\xi, \eta)$

$$a_+ \frac{\xi^2 - \eta^2}{2f^2}$$

$\phi_8(\xi, \eta)$

$$a \times \frac{2\xi\eta}{2f^2}$$

a

b

c

$$\delta x$$

δy

δz

a_+

$a_{\times}$

O

$$\psi_a$$

$$\psi_a = \frac{\arctan\left(a_\times, a_+\right)}{2}$$

η_A

η_I

$$\eta_A$$

$$\frac{|\int_A A(\xi,\eta)\exp(i\phi(\xi,\eta))d\xi d\eta|^2}{\pi r^2\int_A A(\xi,\eta)^2 d\xi d\eta}$$

η_I

$$\frac{|\int_A A(\xi,\eta)d\xi d\eta|^2}{\pi r^2 \int_A A(\xi,\eta)^2 d\xi d\eta}$$

$$J = \frac{2k}{\eta_A \pi r^2}$$

$$\delta p = \delta\phi \times \frac{\lambda}{4\pi} \times \sqrt{1 + \frac{r^2}{4f^2}}$$

$$\phi_j - \phi_i$$

ϕ_i

τ_g

$$\frac{\mathbf{b.s}}{c}$$

$$\frac{1}{c}\left(X_{ij}\cos h\cos\delta - Y_{ij}\sin h\cos\delta + Z_{ij}\sin\delta\right)$$

$$F_{rest}^{ref}$$

v

$$F_{IF}^{ref}$$

$$F_{rest}$$

$$F_{topo}$$

$$F_{topo} = F_{rest}\left(1 + \delta - \frac{v}{c}\right)$$

δ

$$F_{IF} = \pm(F_{topo} - F_{LO1})$$

$$F_{IF} = \pm \left(F_{rest} \left(1 + \delta - \frac{v}{c} \right) - F_{LO1} \right)$$

$$F_{LO1} = F_{rest}^{ref}\left(1 + \delta - \frac{v}{c}\right) \mp F_{IF}^{ref}$$

$$F_{LO1}$$

$$F_{IF}(j,k)$$

$$(k - i_{IF}(j)) * \delta F_{topo} + F_{IF}^{0}(j)$$

$$F_{rest}(j,k)$$

$$(k - i_{rest}(j)) * \delta F_{rest} + F^0_{rest}(j)$$

$$\delta F_{topo}$$

$$\delta F_{topo} = \delta F_{rest}\left(1 + \delta - \frac{v}{c}\right)$$

n_{ch}

$$i_{IF}$$

$$F_{IF}^{0}$$

i_{ref}

$$F^0_{rest}$$

$$\delta F_{rest}$$

P

T

K_p

$$P = K_p T$$

K_c

$$\widetilde{A_{ij}} = K_p T_{ij}$$

$$T_{ij}$$

P_{hot}

$$K_p\left(T_{hot}+T_{rec}\right)$$

$$P_{cold}$$

$$K_p\left(T_{cold}+T_{rec}\right)$$

P_{sky}

$$K_p \left(T_{sky} + T_{spill} + T_{rec} + T_a\right)$$

$$C_{ii}$$

$$K_c\left(T_{sky}+T_{spill}+T_{rec}+T_a\right)$$

$$|C_{ij}|$$

K_cT_a

$$|C_{ij}|$$

$$C_{ii}$$

$$T_{sky} + T_{spill} + T_{rec}$$

$$T_{rec} = \frac{P_{cold}T_{hot} - P_{hot}T_{cold}}{P_{hot} - P_{cold}}$$

$$T_{sky} = (T_{hot} + T_{rec}) \frac{P_{sky}}{P_{hot}} - T_{rec} - T_{spill}$$

$$T_{emi}$$

$$T_{emi} = \frac{T_{sky}}{\eta_f}$$

$$T_{emi,s}^{atm}$$

$T_{emi,i}^{atm}$

$\tau_{atm,s}$

$\tau_{atm,i}$

$$T_{emi} - \frac{T_{emi,s}^{atm} + g_{im} T_{emi,i}^{atm}}{1 + g_{im}}$$

$$T_{sys,s}$$

$T_{sys,i}$

$$T_{sys,s} = \frac{e^{\tau_s}\left(T_{hot} - T_{sky} - T_{spill}\right)\left(1 + g_{im}\right)}{\eta_f} \frac{P_{sky}}{P_{hot} - P_{sky}}$$

$$T_{sys,i} = \frac{e^{\tau_i}\left(T_{hot} - T_{sky} - T_{spill}\right)\left(1 + \frac{1}{g_{im}}\right)}{\eta_f} \frac{P_{sky}}{P_{hot} - P_{sky}}$$

$$T_{sky} + T_{spill} = (1 - \eta_f) \left(\frac{T^{atm}_{emi,s} + g_{im} T^{atm}_{emi,i}}{1 + g_{im}} \right) + \eta_f T_{ground}$$

$$C_{ijk}$$

$$T_{ijk}$$

$$T_{ijk} = \frac{C_{ijk}}{\sqrt{C_{iik}C_{jjk}}}\sqrt{T_{sys}(i)T_{sys}(j)}$$

$$K_c$$

T_{cal}

T_i

ν_1

ν_2

ν_3

$$\nu^2$$

$$T_{triple} = \frac{1-\left(\frac{\nu_1}{\nu_2}\right)^2}{1-\left(\frac{\nu_2}{\nu_3}\right)^2}\left(T_2 - T_3\left(\frac{\nu_2}{\nu_3}\right)^2\right) - \left(T_1 - T_2\left(\frac{\nu_1}{\nu_2}\right)^2\right)$$

(u, v)