EQUATIONS

1. n (p,t)dp = $\left(\frac{a(t_L)}{a(t)}\right)^3 n(pt, t_L)d(p_L)$

$$=\left(\frac{a(t_L)}{a(t)}\right)^3 \frac{4\pi g p_L^2 dp_L}{(2\pi h)^3} \frac{1}{e^{[(\sqrt{p_L^2+m^2}-\mu_4)/kT_d]} \pm 1}$$

2. $z_0 = \frac{60}{(2\varepsilon_r)^{0.5}} \ln[1 + \frac{4h}{w'}\{\left(\frac{14+\frac{8}{\varepsilon_r}}{11}\right)\left(\frac{4h}{w'}\right) + \sqrt{\left(\frac{14+\frac{8}{\varepsilon_r}}{11}\right)^2 \left(\frac{4h}{w'}\right)^2 + \pi^2 \frac{1+\frac{1}{\varepsilon_r}}{2}}$

Where

$$w' = w + \left(\frac{1+\frac{1}{\varepsilon_r}}{2}\right)\left(\frac{t}{\pi}\right)\ln\left(\frac{4e}{\left(\frac{t}{h}\right)^2 + \left(\frac{\frac{1}{\pi}}{\frac{w}{t}+1.1}\right)^2}\right)$$

And ,

$$\varepsilon_{eff} = \begin{cases} \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\left(1+\frac{12h}{w}\right)^{-0.5} + 0.04\left(1-\frac{w}{h}\right)^2\right) \\ \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1+\frac{12h}{w}\right)^{-0.5} \end{cases}$$