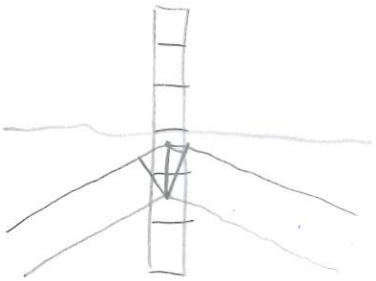
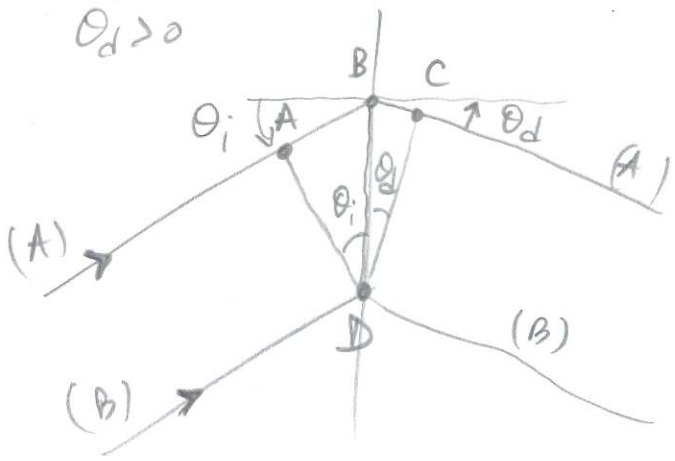
TD : Bragg Grating as a temperature sensor

1)





$$\Delta\varphi = \varphi(A) - \varphi(B) = \frac{2\pi}{\lambda}(AB + BC) = \frac{2\pi}{\lambda}(\Lambda \sin\theta_i + \Lambda \sin\theta_d)$$

$$(\text{Condition de résonance}) = \frac{2\pi\Lambda}{\lambda}(\sin\theta_i + \sin\theta_d)$$

Il y a interférences constructives si $\Delta\varphi = 2p\pi = \frac{2\pi\Lambda}{\lambda}(\sin\theta_i + \sin\theta_d)$

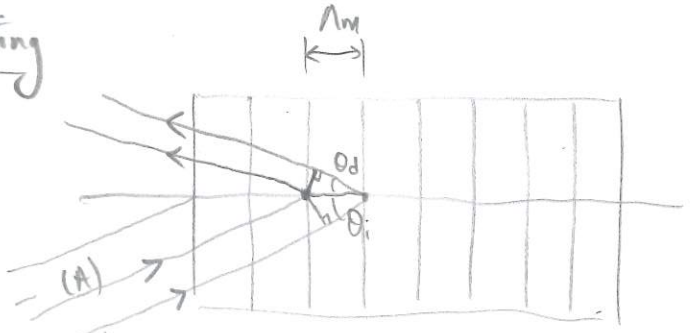
D'où $\boxed{p\lambda = \Lambda(\sin\theta_i + \sin\theta_d)}$

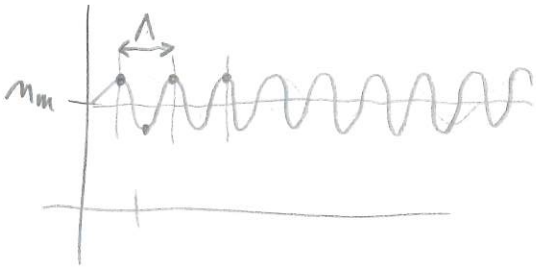
p est l'ordre de diffraction

En pratique $\theta_i = 0$

de sorte que l'on aura un maximum d'énergie pour $\sin\theta_d^{(p)} = \frac{p\lambda}{\Lambda}$ soit $\boxed{\theta_d = \text{Arcsin}\left(\frac{p\lambda}{\Lambda}\right)}$

2) Thick grating





$\theta_d = \theta_i = \theta$

$$\Delta\varphi = \varphi(B) - \varphi(A) = \frac{2\pi}{\lambda} \cdot 2n_m(\Lambda\cos\theta)$$

condition de résonance (interférences constructives) : $\frac{2n_m\Lambda\cos\theta}{\lambda} = p$

$p=1 \Rightarrow \boxed{\lambda_B = 2n_m\Lambda\cos\theta}$ Relation de BRAGG (longueur d'onde de Bragg)

$$FWHM = \frac{\lambda_B^2}{2n_m L}$$

3) $\theta = 0 \Rightarrow \boxed{\lambda_B} = 2 \cdot 1{,}475 \cdot 0{,}29 \cdot 10^{-6} = \underline{0{,}855\ \mu m}$

$\boxed{FWHM} = \frac{\lambda_B^2}{2n_m L} = \frac{(8{,}55 \cdot 10^{-6})^2}{2 \cdot 1{,}475 \cdot 8 \cdot 10^{-3}} = \underline{3{,}1\ nm}$

4) $\lambda_B = 2 n_m \Lambda$

$$\frac{\partial \lambda_B}{\partial T} = 2\left(\frac{\partial n_m}{\partial T}\Lambda + n_m \frac{\partial \Lambda}{\partial T}\right)$$

$$= \frac{\lambda_B}{n_m}\frac{\partial n_m}{\partial T} + \frac{\lambda_B}{\Lambda}\frac{\partial \Lambda}{\partial T}$$

soit $$\boxed{\frac{1}{\lambda_B}\frac{\partial \lambda_B}{\partial T} = \frac{1}{n_m}\frac{\partial n_m}{\partial T} + \frac{1}{\Lambda}\frac{\partial \Lambda}{\partial T}}$$

5) On réécrit cette expression sous la forme $\Delta\lambda_B = \lambda_B \underbrace{\left(\frac{1}{n_m}\frac{\partial n_m}{\partial T} + \frac{1}{\Lambda}\frac{\partial \Lambda}{\partial T}\right)}_{\xi} \Delta T$

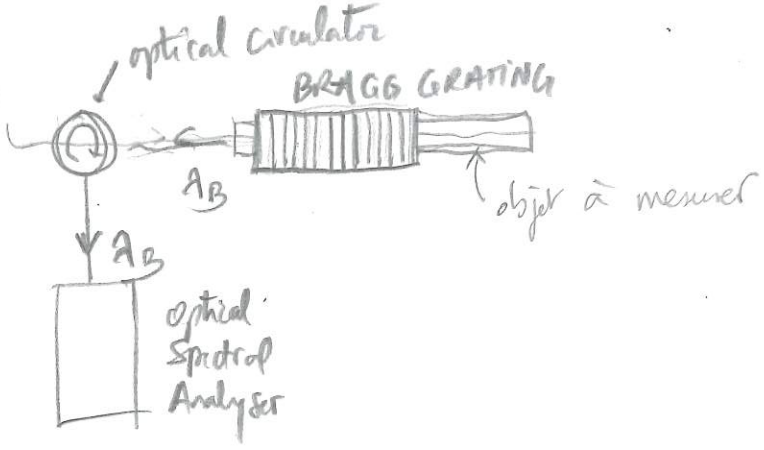
$\lambda_B = 2 n_m \Lambda = 2 . 1{,}41 . 0{,}55 = 1{,}551\ \mu m$

$\Delta\lambda_B = \lambda_B . 8{,}9\, 10^{-6} . 2{,}5$

$= 1{,}55 . 10^{-6} . 8{,}9 . 10^{-6} . 22$

$$\boxed{\Delta\lambda \leq 0{,}3\ nm}$$

6)



7°) Nécessité de mettre un collimateur en espace libre entre le circulateur et le FBG