$$\text{DFT: } X_k = \sum_{n=0}^{N-1} x_n e^{-j2\pi \frac{k}{N} n}$$

$$\text{IDFT: } x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k e^{j2\pi \frac{k}{N} n}$$

So element k corresponds to:

$$\begin{aligned}
e^{j\omega t} &= e^{j2\pi \frac{k}{N} n} = e^{j2\pi \frac{k}{N} t f_s} \\
\omega &= \frac{k}{N} 2\pi f_s \\
\omega &= \frac{k}{N} \omega_s
\end{aligned}$$

Input Matrix: $s(i, j, n)$

$$x = x_0 + i\Delta x$$

$$y = y_0 + j\Delta y$$

$$f = f_0 + n\Delta f$$

Compute Fourier Transform: $A(i, j, n) = \underset{(i,j)}{\text{DFT}_{2D}}\{s(i, j, n)\}(k_x, k_y, \omega)$

$$\begin{aligned}
k_x &= \frac{i}{N_x} \frac{2\pi}{\Delta x} \\
k_y &= \frac{j}{N_y} \frac{2\pi}{\Delta y}
\end{aligned}$$

$$\begin{aligned}
k_z &= \sqrt{4(\frac{\omega}{c})^2 - k_x^2 - k_y^2} \\
&= \sqrt{4(\frac{2\pi(f_0 + n\Delta f)}{c})^2 - (\frac{i}{N_x} \frac{2\pi}{\Delta x})^2 - (\frac{j}{N_y} \frac{2\pi}{\Delta y})^2}
\end{aligned}$$

Compute $D(i, j, n) = e^{-jk_z Z_1}$

Compute $C(i, j, n) = A(i, j, n) \times D(i, j, n)$

Need to resample for uniform k_z

$$\begin{aligned}\text{Range: MIN } k_z &= 2(\frac{\omega}{c}) = \frac{2}{c}2\pi f_0 \\ \text{MAX } k_z &= \sqrt{4(\frac{2\pi(f_0+(N-1)\Delta f)}{c})^2 - (\frac{N_x-1}{N_x}\frac{2\pi}{\Delta x})^2 - (\frac{N_y-1}{N_y}\frac{2\pi}{\Delta y})^2}\end{aligned}$$

$$\text{Interpolating } n = \frac{1}{\Delta f}(\frac{c}{2\pi}\sqrt{\frac{1}{4}(k_z^2 + (\frac{i}{N_x}\frac{2\pi}{\Delta x})^2 + (\frac{j}{N_y}\frac{2\pi}{\Delta y})^2)} - f_0)$$