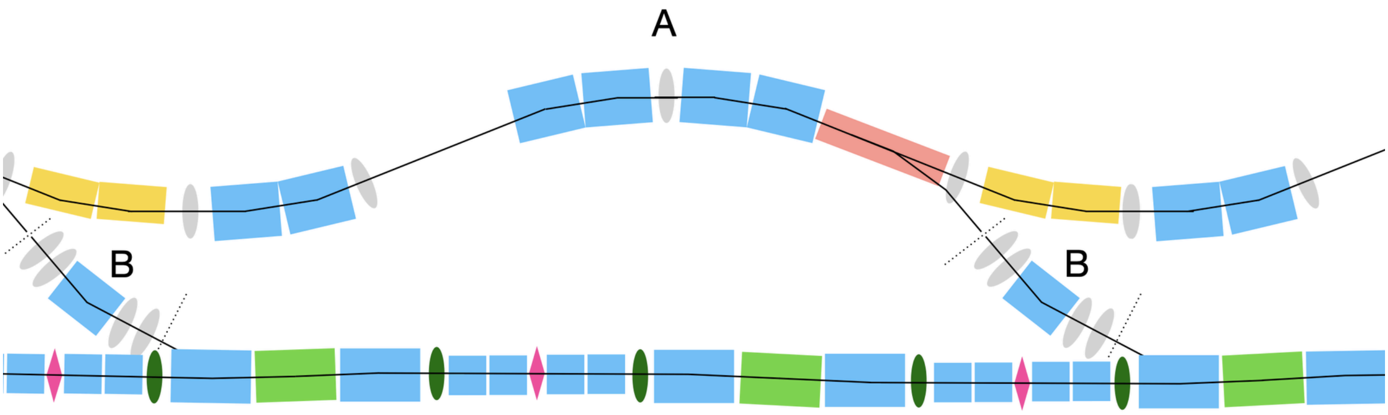
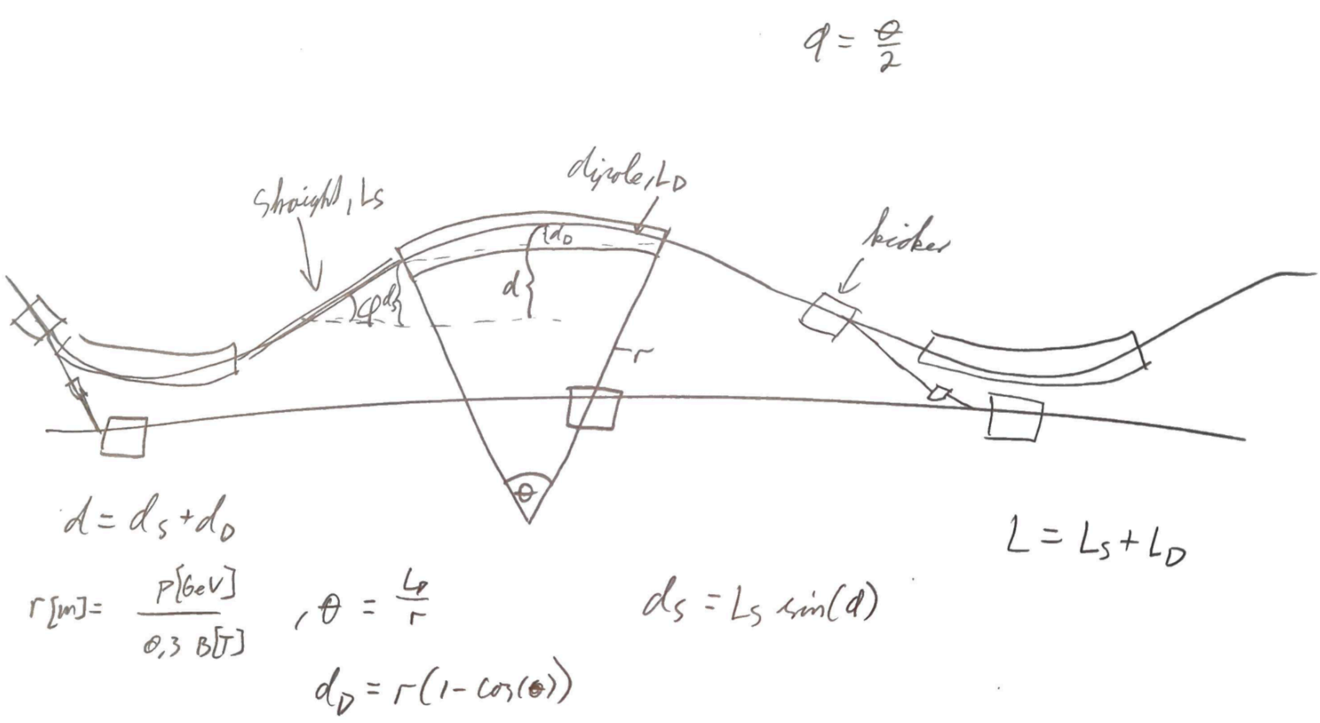
The oscillating chicane

Current design:



🧡 =Kicker, 💙 =Dipole, 💛 =septum magnets, 💚 =PWFA, 💗 =Plasma lens



Assume maximum B-field of 1.2 T.

To maximize the delay, we want the drivers to travel straigth as little as possible. The maximum delay is achived with the dipoles at the top and bottom of the oscillations, and as steep an angle as possible between the delay chicane straight section, and the main beamline.

We have for the length of one half oscillation (the space between one stage to the next):

$$L = L_S + L_D$$

The radius of the bending magnet is

$$r[\mathrm{m}] = \frac{P[\mathrm{GeV}]}{0.3B[\mathrm{T}]}$$

which is 5.56 m in the case of a 2 GeV beam. And the bedning angle is

$$\theta = \frac{L_D}{r}.$$

The total amplitude is the amplitude of the dipole turn, and the "height" of the Straight section.
The height of the straight section is

$$d_S = \frac{L_S}{2}\sin(\phi),$$

where ϕ is the angle of the straight section compared to he main beamline.
The height of the dipole is

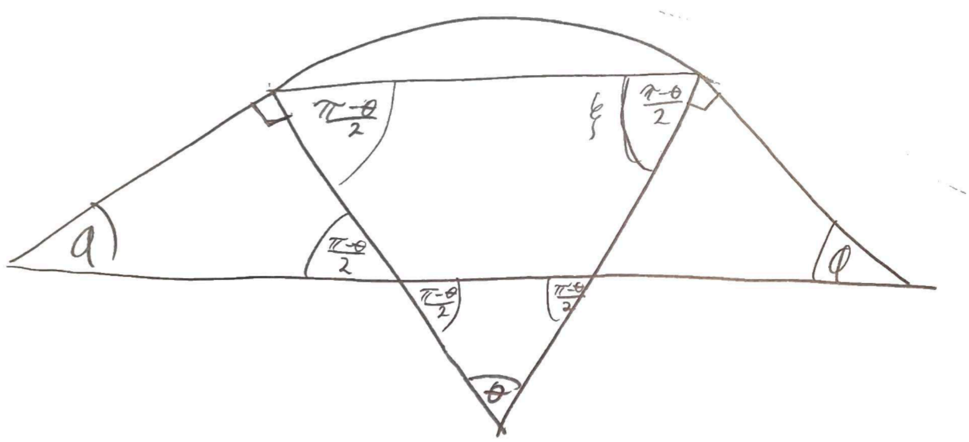
$$d_D = r(1 - \cos(\frac{\theta}{2}))$$

We can connect phi to theta by

$$\frac{\pi}{2} + \frac{\pi - \theta}{2} + \phi = \pi \qquad 2\xi + \theta = \pi$$

$$\pi - \frac{\theta}{2} + \phi = \pi \qquad \xi = \frac{\pi - \theta}{2} \checkmark$$

$$\frac{\theta}{2} = \phi$$



which shows that

$$\phi = \frac{\theta}{2}$$

We now have the formula for the "amplitude" which is

$$d_{tot} = r(1 - \cos(\frac{\theta}{2})) + \frac{L_S}{2}\sin(\frac{\theta}{2})$$

Now we got to find the theta that gives 75% of the mainline to dipoles (filling factor), and the subsequent L_S. Then we have the total length of the delay chicane and can calculate the delay.

For 75% filling we have $L_S = \frac{L_D}{3}$
We also have that the straight component of the delay chicane is as long as the stage which is 7 m (assumed for now).
Then

$$2r\sin(\frac{\theta}{2}) + L_S\cos(\frac{\theta}{2}) = L_{stage}$$

where the first term is the length og the straight part of the dipole, and the second term is the parallel part of the straight section (parallel to the main beamline).
Substituting θ with $\frac{L_D}{r}$, and L_D with $3L_S$ gives

$$2r\sin(\frac{3L_S}{2r}) + L_S\cos(\frac{3L_S}{2r}) = L_{stage}$$

which can be solved for L_S.
With the current parameters, $L_S = 1.87$ m, which would make $L_D = 5.61$ m, and the delay 0.48 m.
This delay equates to 1.6 ns per stage, I.e 3.2 ns from one stage to the one after the next one.

This would make $d_{tot} = 1.79$ m, which allready seems too big for IR12.