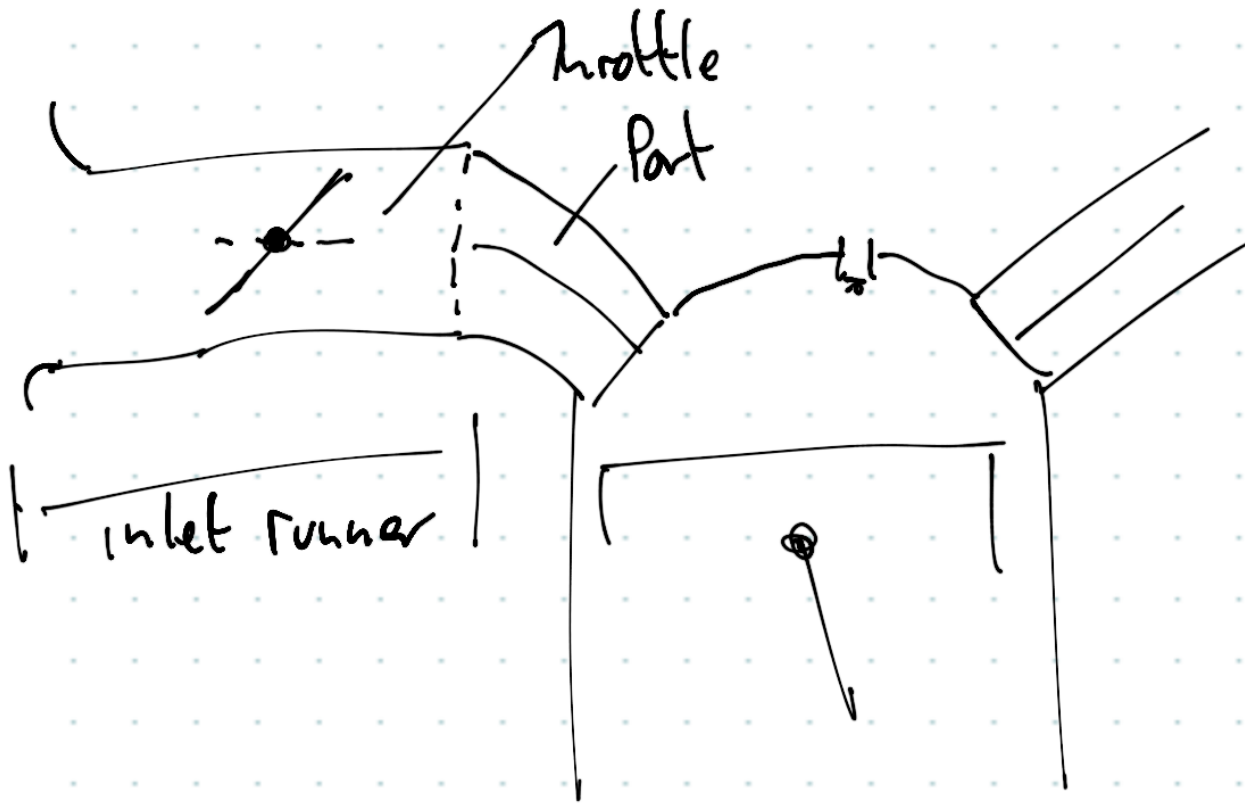


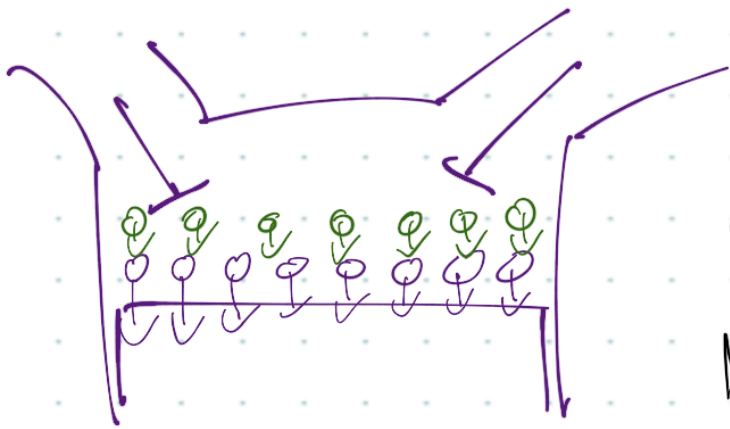
Inlet Pulse Tuning



$$S = R + L - R \cos \theta - L \cos \phi$$

$$\text{Velocity} = \frac{\partial S}{\partial t}$$

Generally the Greatest velocity is at 80°
 The best Suction in the engine occurs at peak velocity. This is when the air moves the fastest



The piston causes a layer of molecules to move down

Movement of the second layer

Creates a localised vacuum. This partial vacuum or 'suction pulse' moves up and out of the cylinder.

Each step needs time for things to elapse
There is a lag between the piston movement and the pressure change in the inlet.

We need to use this to our advantage

Full lift (M.O.P) is generally 110° ATDC

30° After V_{max} (Piston)
max opening

We assume that Air V_{max} at the valve occurs at M.O.P

you want the valve fully open when air is the fastest

The Vacuum effect is basically a Suction pulse

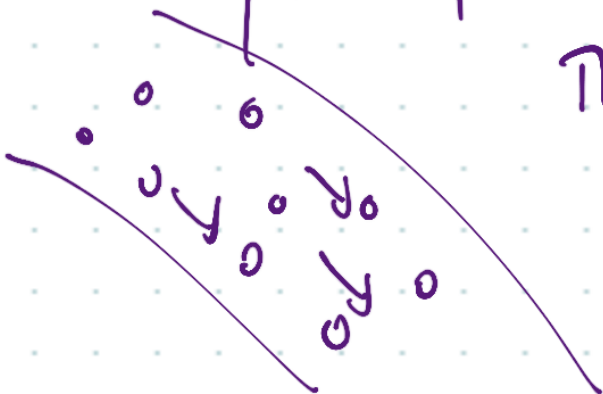
The Suction pulse is $\therefore$ the strongest at M.O.P.

This suction pulse moves back up the intake system at the speed of sound.

Eventually the suction pulse reaches the trumpet. At this point there is an 'In Rush' of air. This is effectively a positive pressure pulse.

Ideally, the positive and negative pulse ≈ 0.1 Bar

The +ve pulse moves back at the speed of sound



It takes a certain time for the -ve
to leave and return as a +ve

$$T = \frac{2L}{330}$$

L = Runner length Speed of Sound : 330m/s

As the pulse is moving, the crank is rotating
and the valve returning to its seat.
lets look at a race car.

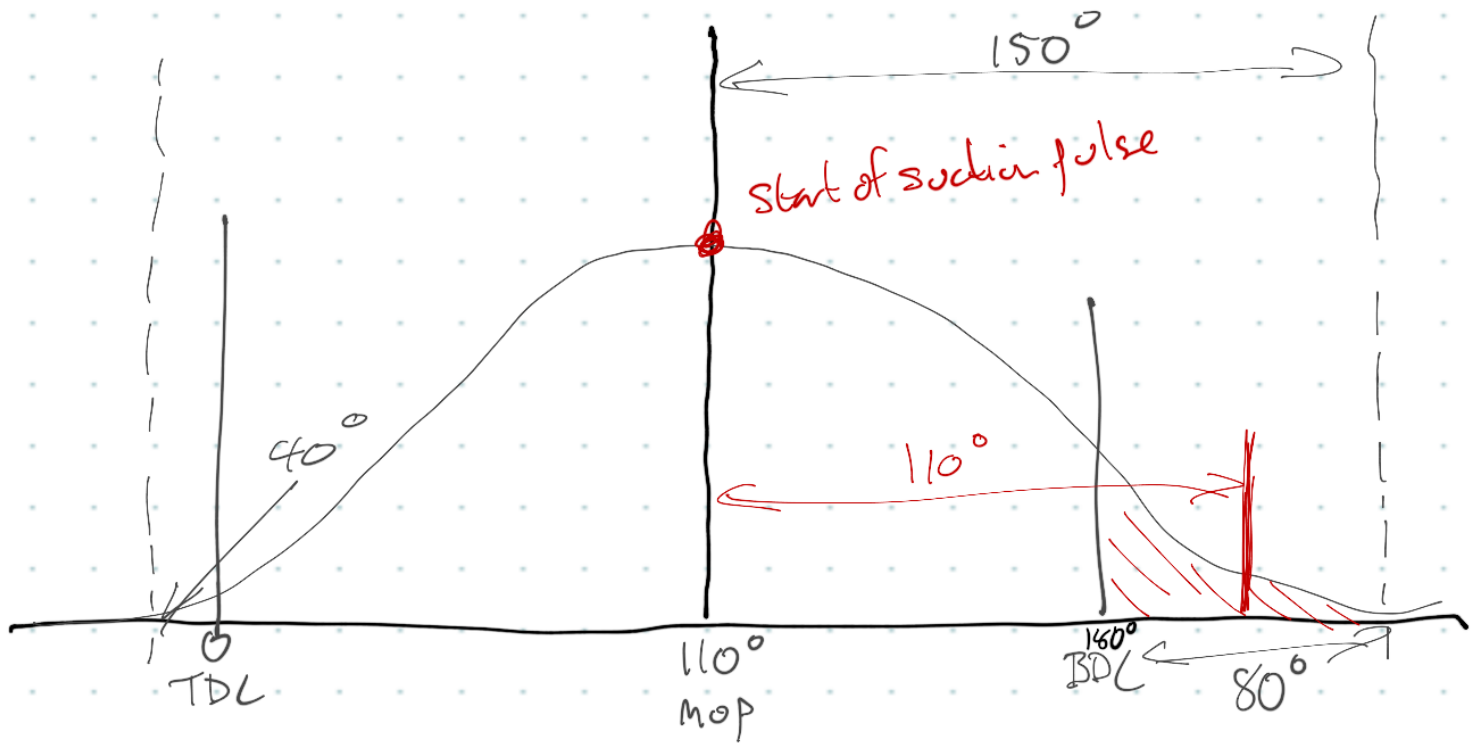
Assume 300° duration

Inlet opens 40° BTDC

Inlet close 80° ABDC

Duration $40 + 180 + 80 = 300^\circ$

M.O.P = 110°



we want the +ve pulse back in the rect area
to reduce -ve flow / flow reversal

So how long does it take for the crank to
move to 110° to match the pulse?

$$\text{MOP} \rightarrow 220^\circ \quad (110 + 110)$$

So to get things at the right time we
need the time for the crank to turn

$$110^\circ = \frac{24}{330} \quad (\text{RPM Dependent})$$

So Time for 1 Rev = $\frac{60}{\text{RPM}}$ Seconds

So Time for 360° = $\frac{60}{\text{RPM}}$ Seconds

Time for 110° = $\frac{110}{360} \times \frac{60}{\text{RPM}}$ Seconds

So we need

Pulse timing = Time for 110° Crank rotation

So $\frac{2L}{330} = \frac{110}{360} \times \frac{60}{\text{RPM}}$

Example best tuning : @ 10,000 RPM

$$L = \frac{330}{2} \times \frac{110}{360} \times \frac{60}{10,000}$$

$$L = 300 \text{ mm}$$

At 6000 RPM this is $\sim 500\text{mm}$

At 2000 RPM we get $\sim 1.6\text{m}$

These lengths may be impractical in practice

These pulses are reflected and repeated in the pipe, so we could take advantage of 'higher harmonics'

The aim of the final harmonic, be that 1st, 2nd or 3rd is to return a +ve pulse to reduce flow reversal and give the best cylinder pressure.

$$\text{Time for Second Harmonic} = 2 \times \frac{2L}{330}$$

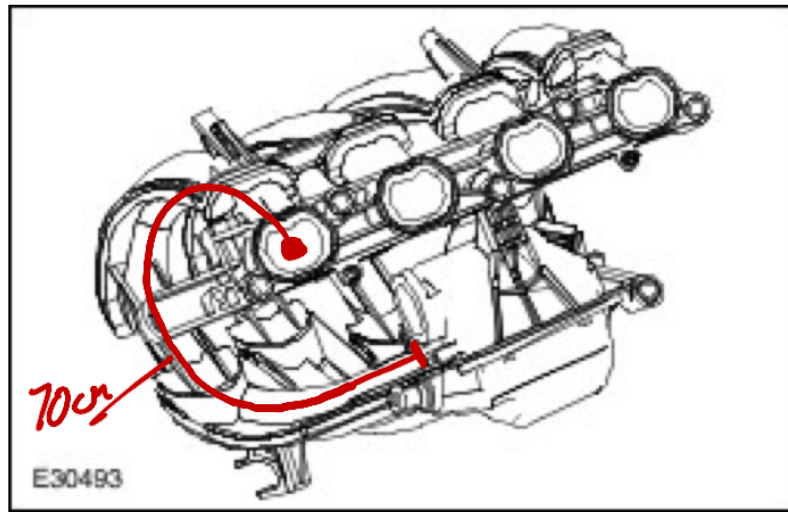
$$\text{Time for } N^{\text{th}} \text{ harmonic} = N \times \frac{2L}{330}$$

Ford Sigma 1600 :

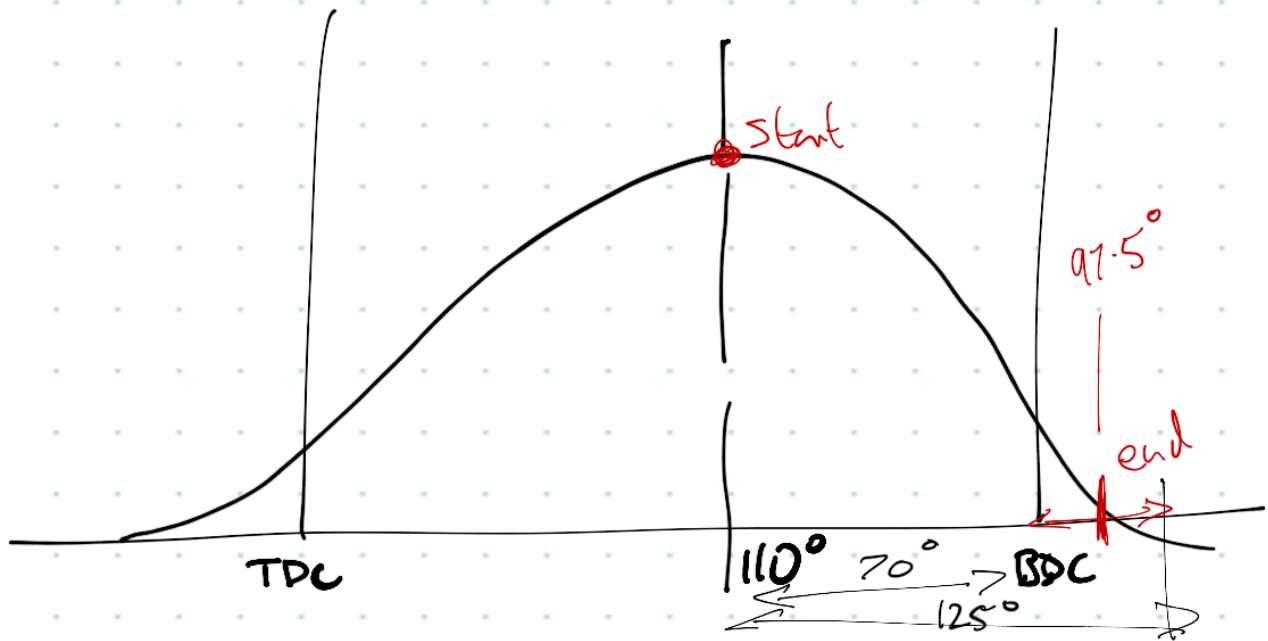
Sigma plastic manifold

Duration $\sim 250^\circ$

M.O.P - 110°



Intake length = 70 cm



$$125^\circ - 70^\circ = 55^\circ \longleftrightarrow$$

So we know $70 + \frac{55}{2} = 97.5^\circ$

So now we can calculate things :

The time taken for the pulse to travel from Valve to Entry and back N times

$$T = \frac{2NL}{330}$$

This time must be equal to the time for the Crank to turn from full lift, to half way between BDC and closing (Red line)

$$\text{Time for crank} = \frac{97.5}{360} \times \frac{60}{\text{RPM}} = N \times \frac{2L}{330}$$

So

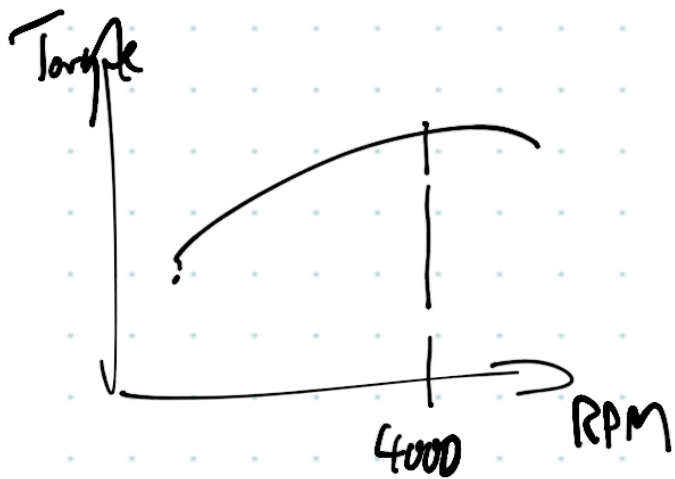
$$\text{RPM} = \frac{330}{2NL} \times \frac{97.5}{360} \times 60$$

$N = 1 \rightarrow 3830 \text{ RPM}$

$N = 2 \rightarrow 1915 \text{ RPM}$

$N = 3 \rightarrow 1277 \text{ RPM}$

$N = 4 \rightarrow 957 \text{ RPM}$



Signa max torque is at
4000 RPM —

Ford are tuning for torque