TURBOJET DESIGN POINT SIMULATOR
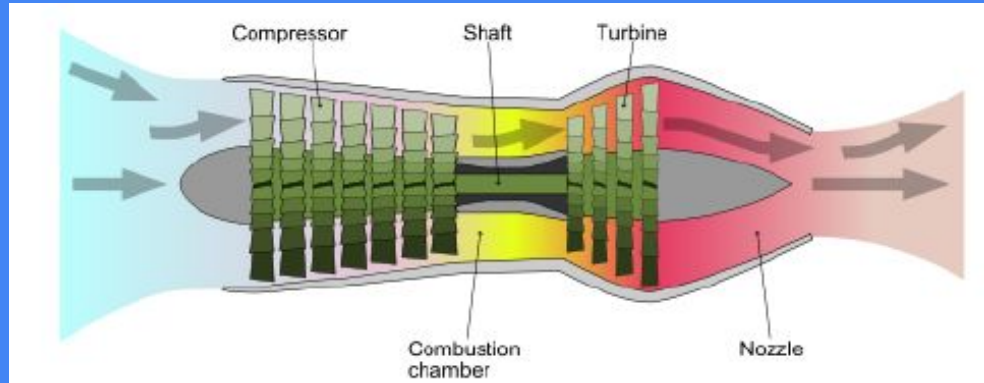
Álvaro Quispe

Initial hypotheses

-Real turbojet (pressure losses and efficiencies)

-Adapted nozzle (p9=p0)

-No mechanical losses (n_mech=1)

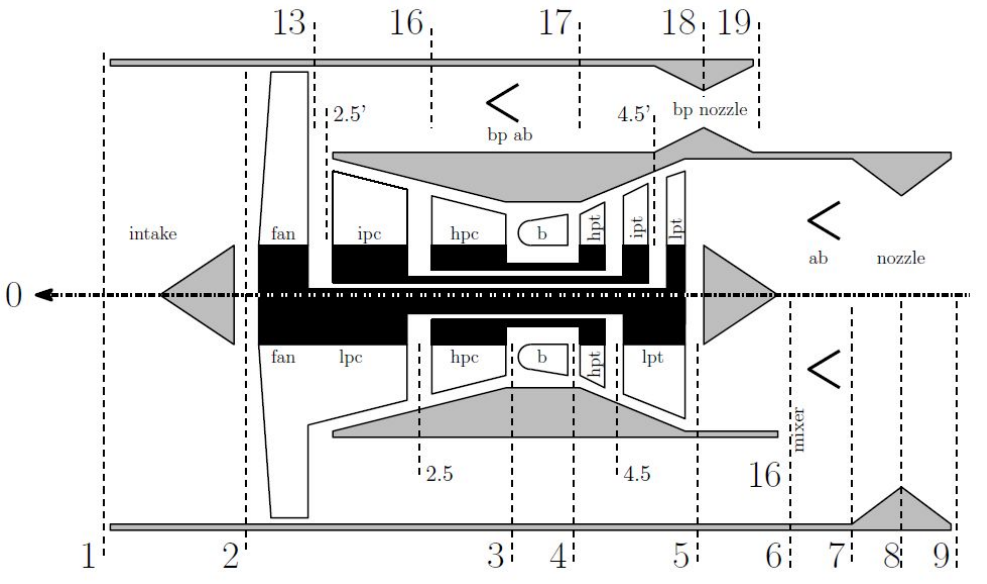-No power extraction (P=0)

-Ideal gas (Only depends on T)

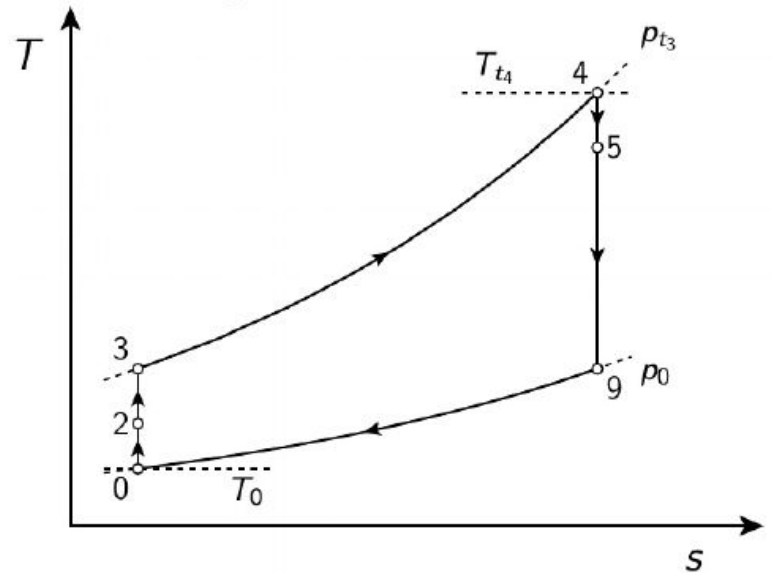# Initial hypotheses

3 main sets of solutions from different cases:

-From the programmed script

-From handmade computation with tables and interpolations

-From handmade computation assuming calorically perfect gas and no bleed
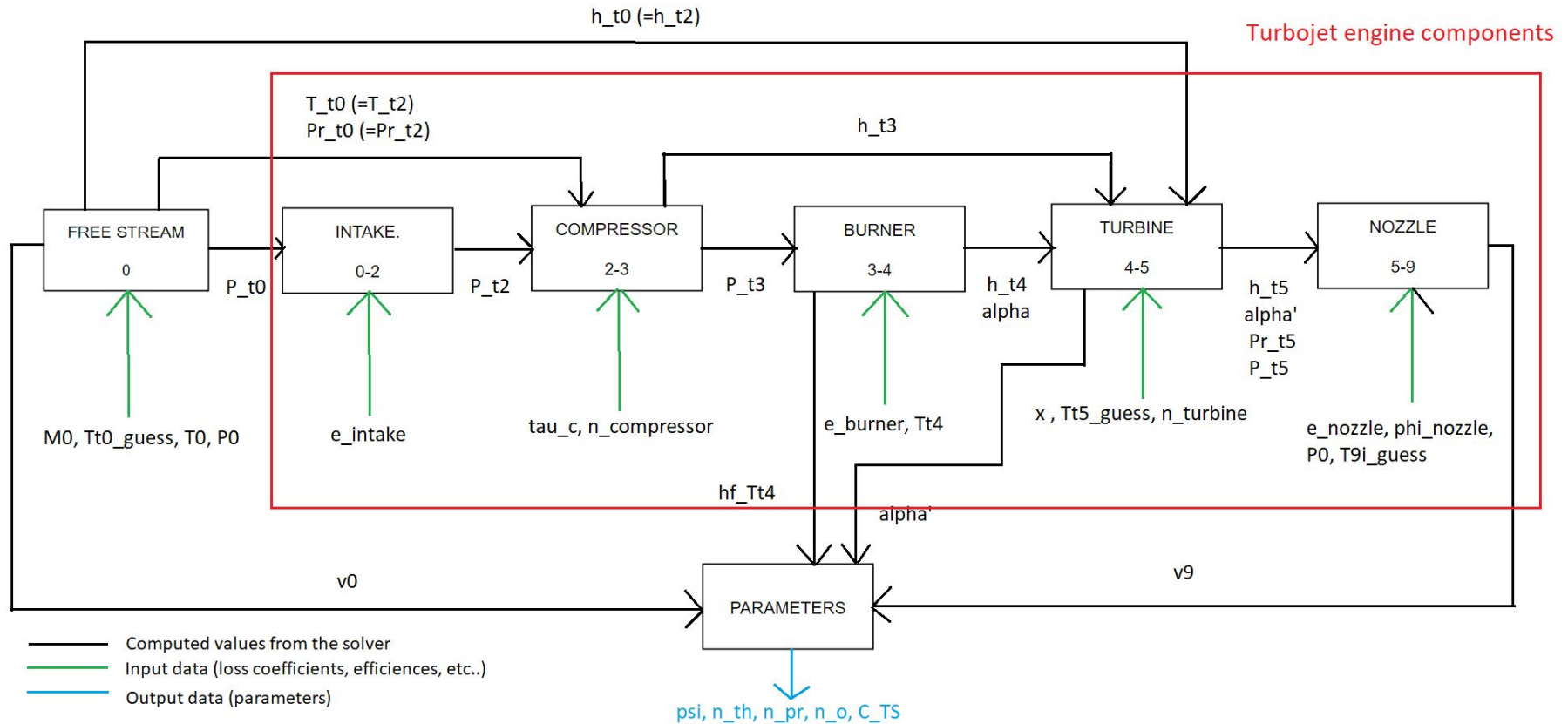
Engine diagram

Engine layout and notation


Ideal turbojet cycle

Solver flowchart diagram

Comparison between the different computations

|	ψ [m/s]	η_th	η_pr	η_o	C_TS[Kg/s/N]
Solver solution	451.4	0.567	0.740	0.42	3.50*(10^-5)
Handmade with tables	464	0.589	0.734	0.43	3.41*(10^-5)
Handmade with calorically perfect gas	430.46	0.58	0.732	0.425	3.7*(10^-5)

psi vs delta_Tc (Fixed MO)

- +Tt4 → More compression available (zeroes are further)
- +Tt4 → Optimal point for max thrust is displaced to the right(more compression) and it increases
- +M0 → + ram compression → - less compression from turbomachinery
- +M0 → Optimal point decreases
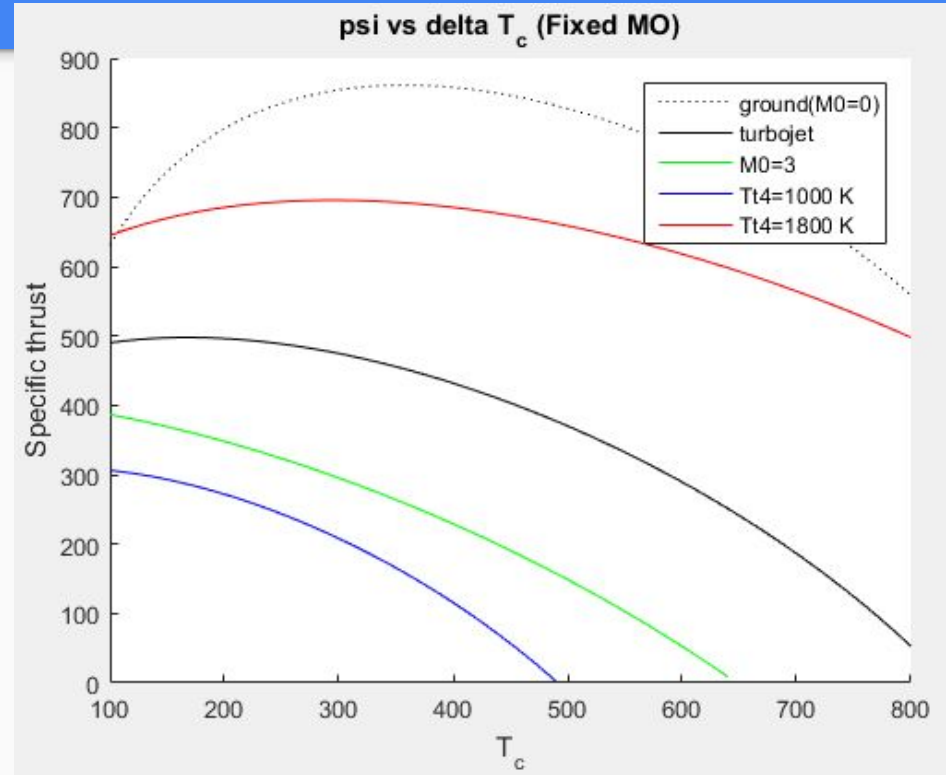
C_TS vs delta_Tc (Fixed M0)

- High compressions (both ram or from the compressor) and low Tt4 make the CTS tend to infinity.This is because the Tt3 is near the Tt4 so no thrust is generated, which makes the CTS go to infinity.
- The other way around, when ram compression(ground) or high Tt4, can make the CTS decrease.
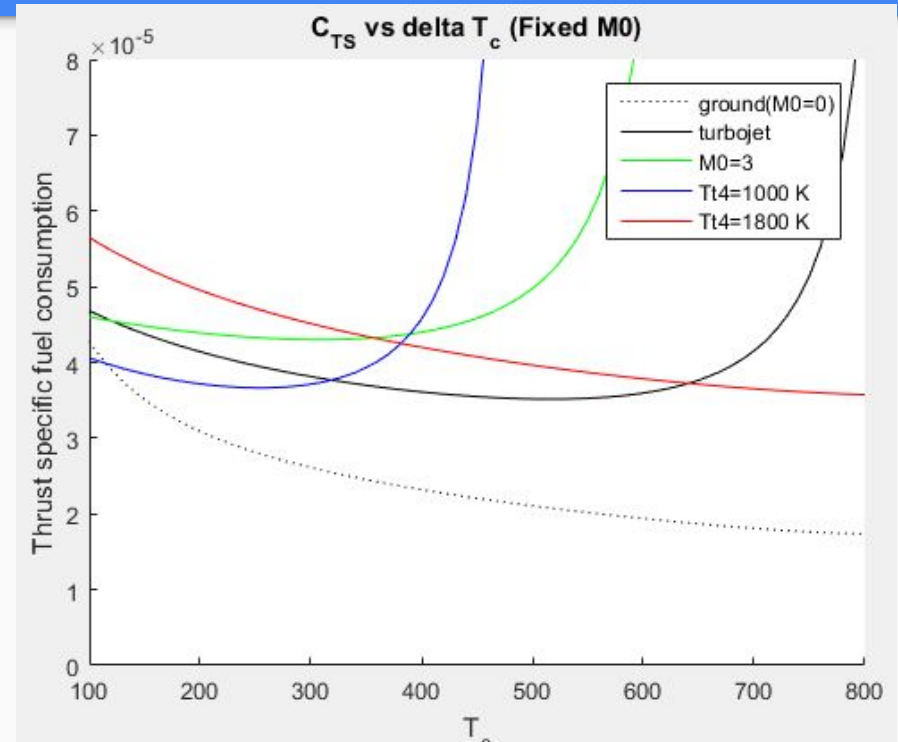
psi vs M0 (Fixed delta_Tc)

- Max thrust at ground M0=0 then decrease
- Decreasing Tc decreases maximum thrust compared to the nominal turbojet, but at higher M0 keeps higher values.
- Increasing Tc may decrease maximum thrust(depends on Tc)
- +Tt4 → increases thrust

psi vs M0 (Fixed delta T_c)
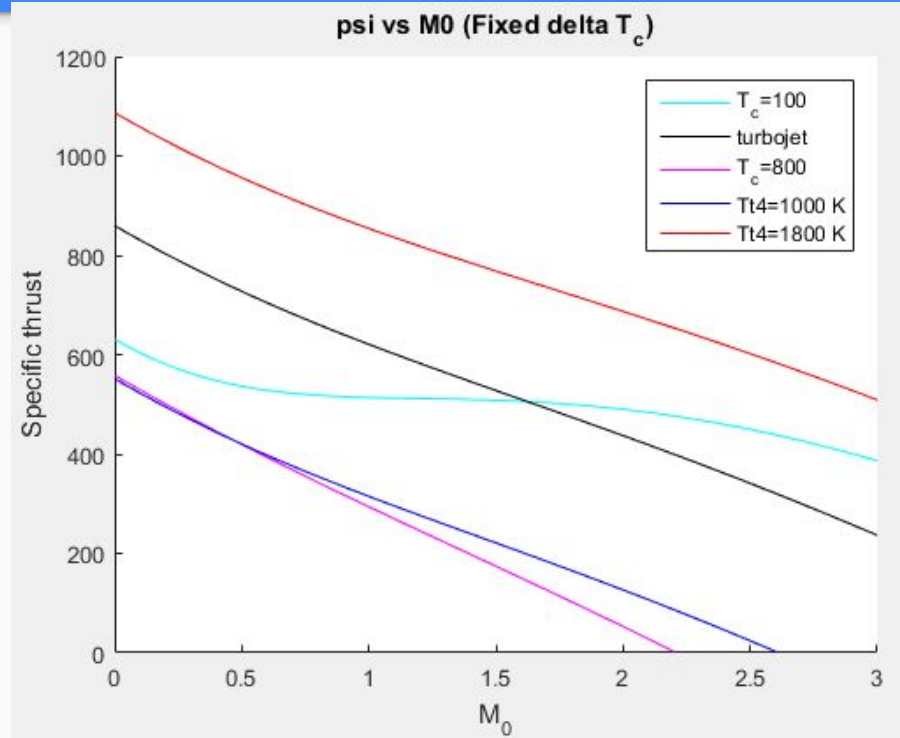
C_TS vs M0 (Fixed delta Tc)

-M0 increases along → ram compression increases → This makes that the Tt3 at the compressor output increase towards Tt4, thus making the specific thrust decrease and the CTS increase.

-This effect is carried out to infinity when we increase the compression from turbomachinery or we decrease the Tt4(maximum of the cycle) as we can see with the purple and blue lines.