# 1 Tuning

## 1.1 Thoughts on tuning VP

For the simulated data, the tuning to achieve acceptable consistency seemed to mainly involve $Q$ and $R$,

The tuning was mainly done on the first 5000 iterations, due to constraints in runtime. We first tuned by only looking at the odometry results, trying to get as good fit as possible on the first few thousand samples. The weakness in the odometry appeared to be long turns, where it slowly drifted resulting in an increasing off-set. This then appears to be what the laser measurements must handle. Considering that the odometry appears fairly capable of following most maneuvers, it would seem that the noise required for the laser updates should be fairly small in order to compensate for the odometry drift.

- Higher $R_1$ Less landmarks
- Trust odometry to much causes predicted position to change making it harder to make associations
- Avoid detecting same object as different
- Make sure Q is tuned so that P contains reasonable values
- High Q causes initial pose offset that stays uncorrected
- To many landmarks indicate that our position has drifted such that the same landmark is detected again
- To few landmarks indicate that we treat different landmarks as the same, either indicates drift or to high noise
- To high $\sigma_3$ introduces pose error, to low makes the system react to slowly to turns
- Hard to get NIS above lower limit while matching GNSS trajectory
- Smaller JCBB alphas increase variance in NIS and decrease number of landmarks
- Large R, overfit and NIS becomes small, few landmarks

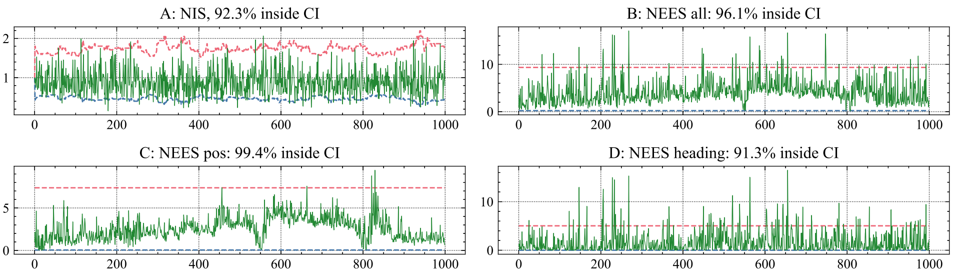


Figure 1: Consistency for simulated dataset

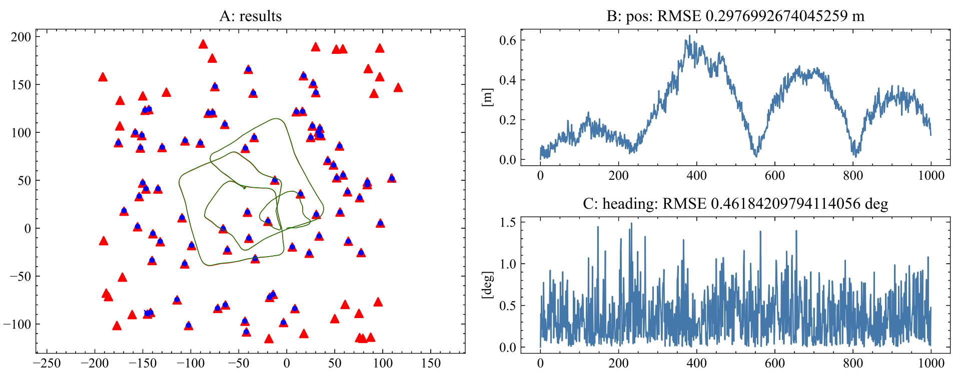


Figure 2: Result and RMSE for simulated dataset

# 2 Consistency

## 2.1 Fit to GNSS

To try to identify any significant offset between our estimates and the GNSS measurements we transformed the GNSS measurements onto our estimates. The optimal rotation was found using SVD,

$$H = \begin{bmatrix} \mathbf{Lo_{gnss}} & \mathbf{La_{gnss}} \end{bmatrix} \begin{bmatrix} \mathbf{Lo_{est}} \\ \mathbf{La_{est}} \end{bmatrix}, \quad U, S, V = SVD(H), \quad R = VU^T$$

whereas the translation was solved by OLS.

$$T = \frac{1}{N} \sum_{1}^{N} \begin{bmatrix} Lo_{gnss_i} \\ La_{gnss_i} \end{bmatrix} - \mathbf{R} \frac{1}{N} \sum_{1}^{N} \begin{bmatrix} Lo_{est_i} \\ La_{est_i} \end{bmatrix}$$

As seen in figure (blabla) the transformation is almsot negligible. It is therefore assuemd that the GNSS measurements are reasonably correct in time and place.

To compare with GNSS we computed NIS by using the odometry predictions as if we would update using GNSS. We paired a prediction with a GNSS measurement by locating the closest GNSS sample to each odometry measurement that was also within 0.01 seconds (chosen by a little trial and error) of eachother.