

APPENDIX

A. Static Identification Results

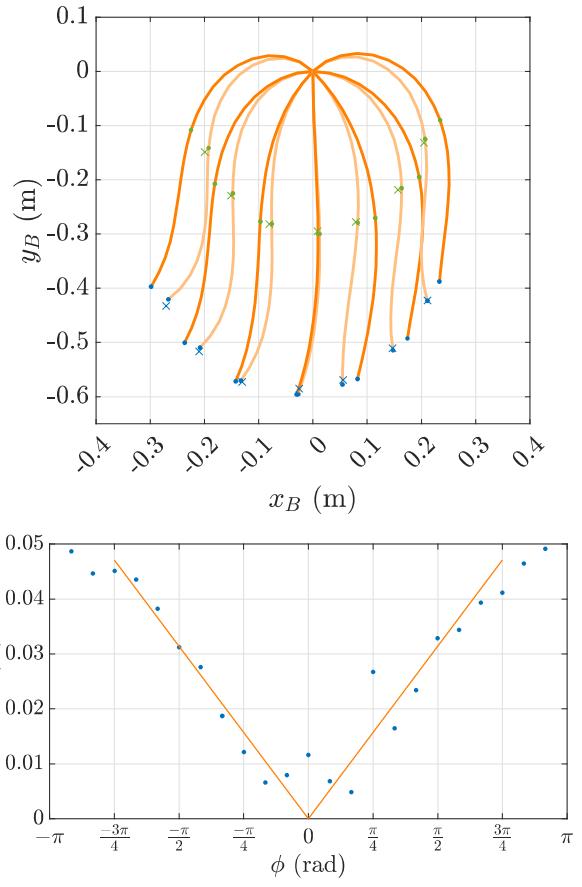
Left: Composite image showing 7 of the 23 object equilibria states used for identification.

Right, top: Cartesian plot of measured mid- and endpoints (crosses), Affine Curvature configurations extracted from these points by IK (light orange) and corresponding modelled equilibria with the identified parameters (dark orange).

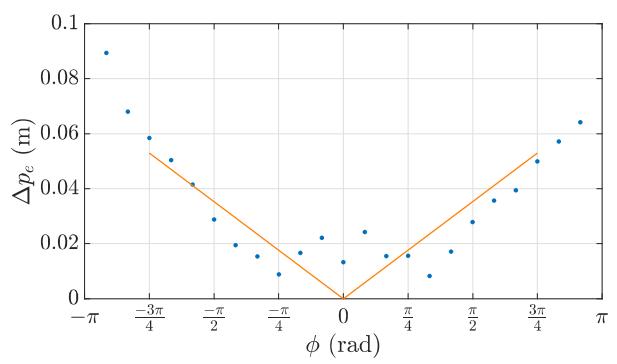
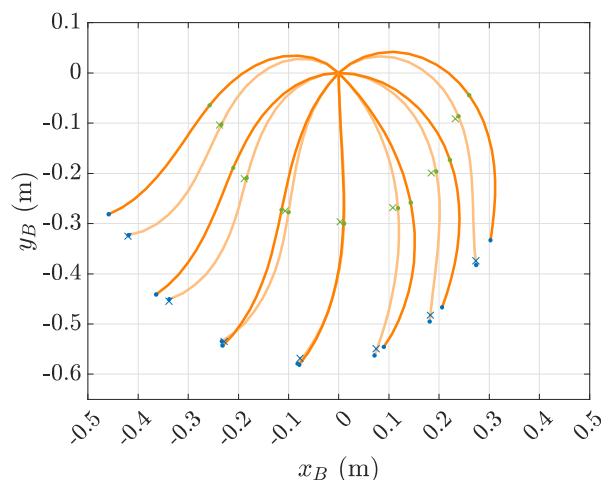
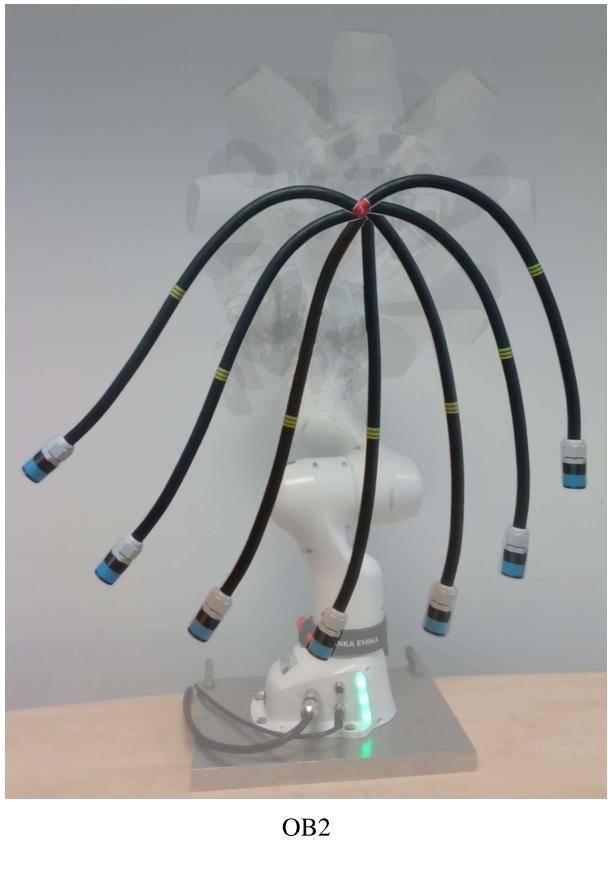
Right, bottom: Plot of error between measured and modelled endpoints against manipulator orientation, with manually determined linear fit for optimisation cost (where applicable).



OB1

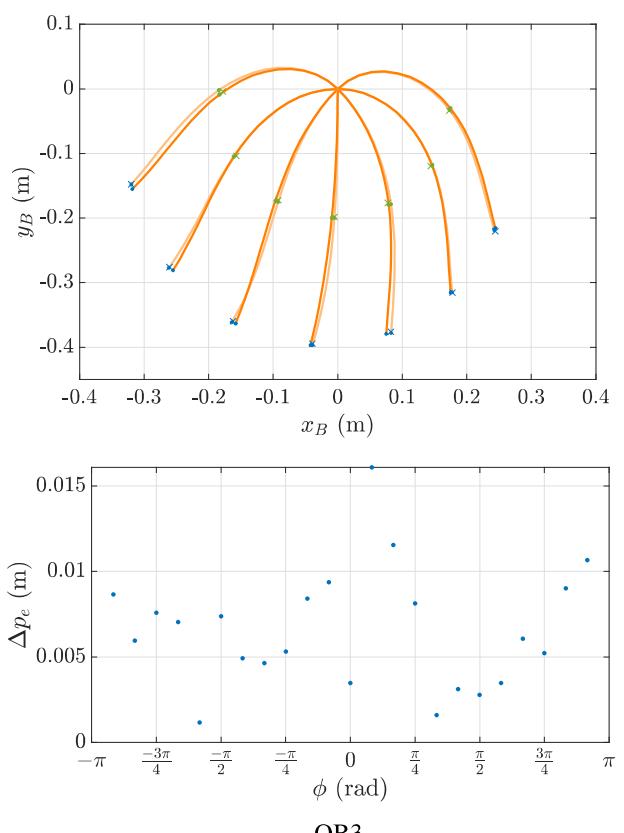


OB1



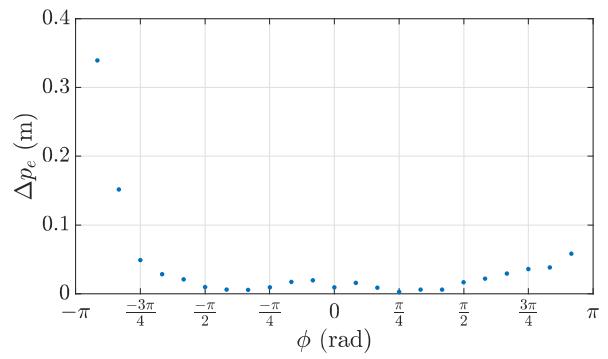
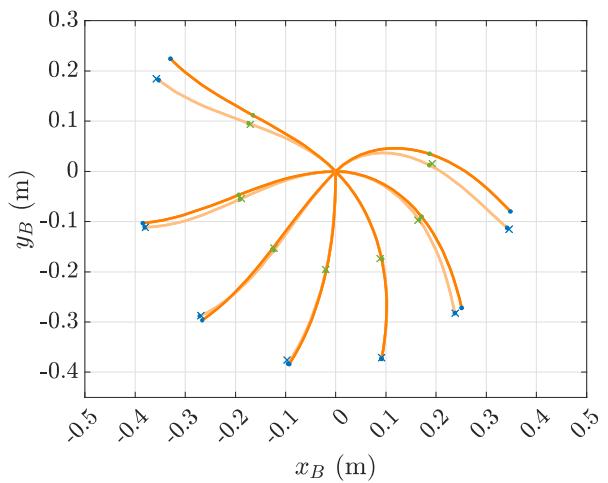


OB3





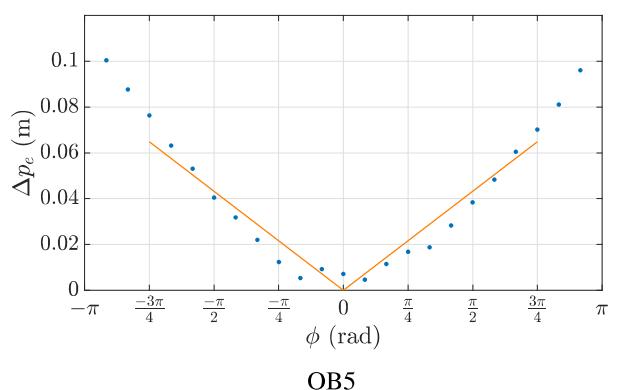
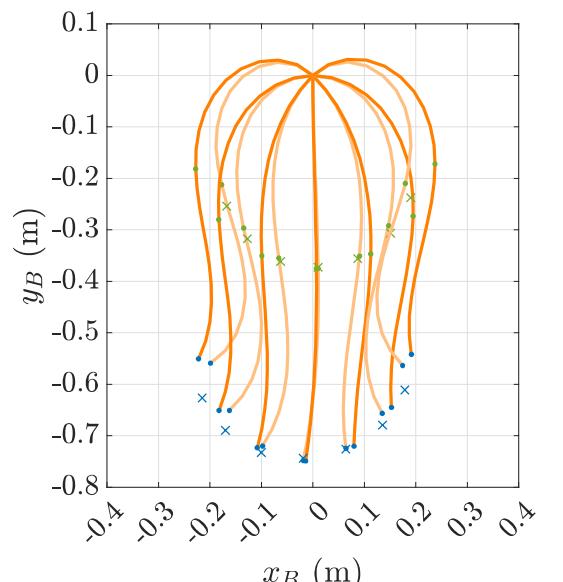
OB4



OB4

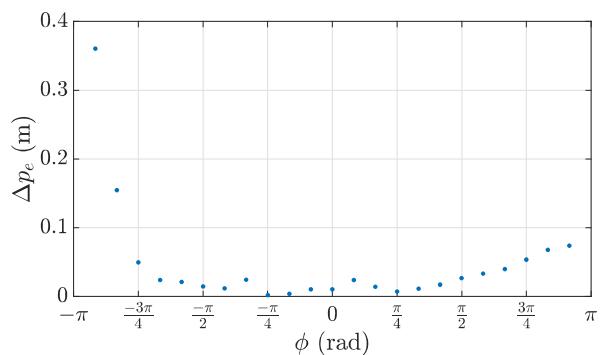
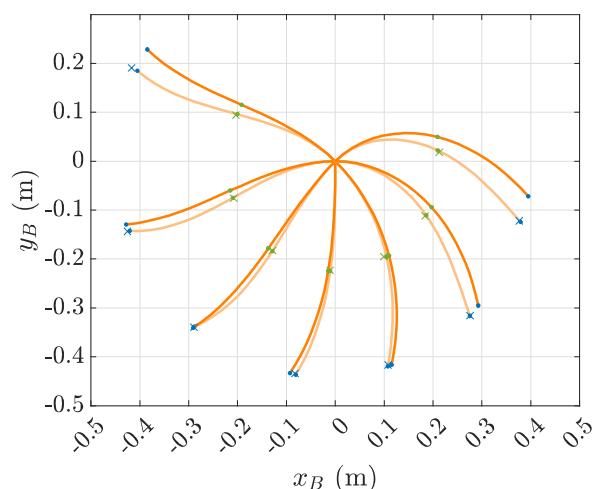


OB5





OB6



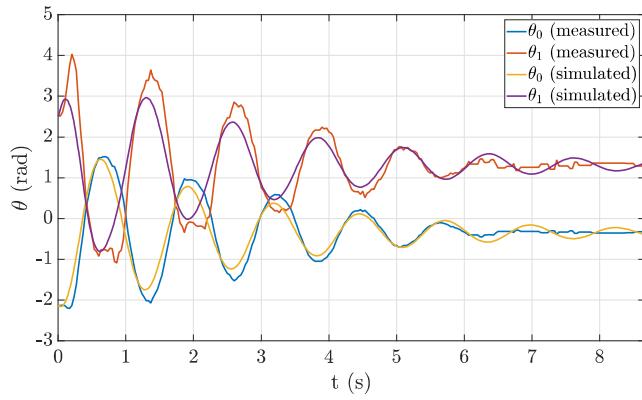
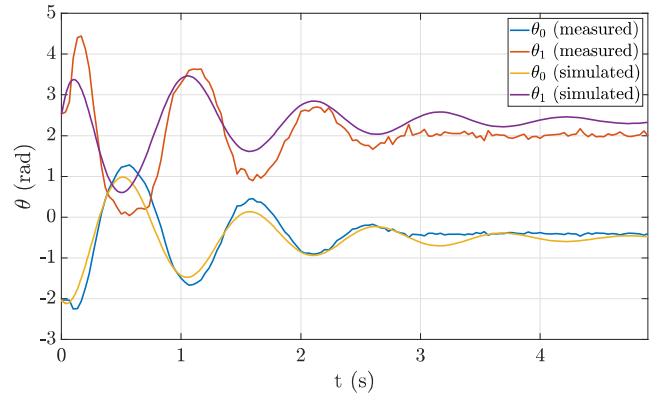
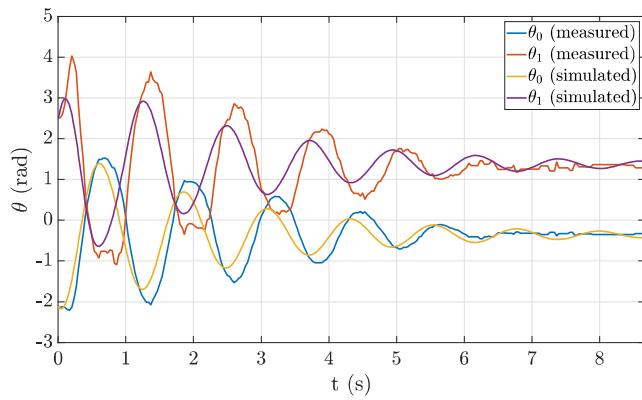
OB6

B. Dynamic Identification Results

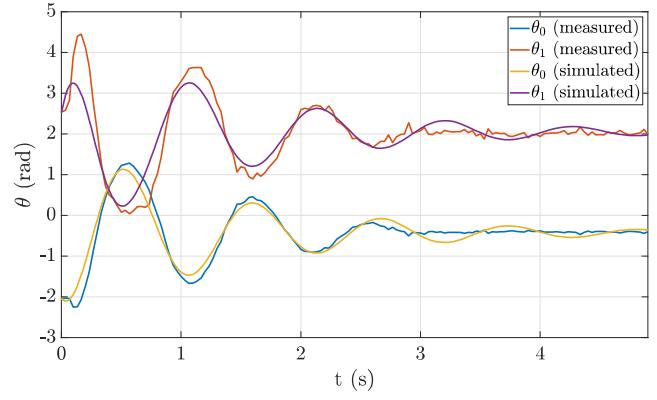
Plots of comparison between measured and simulated θ evolution.

Top: k and $\bar{\theta}$ identified from static equilibrium data; β identified from dynamic evolution data.

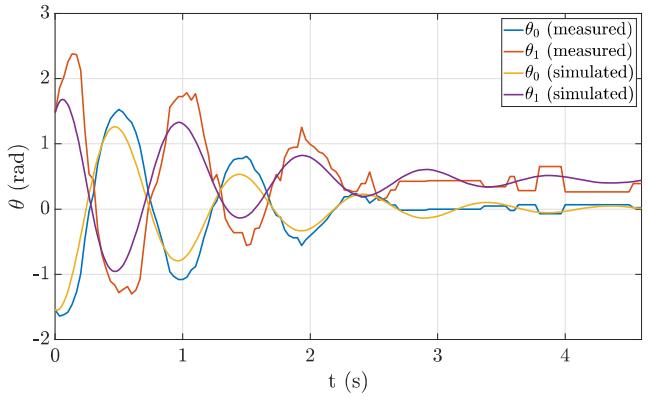
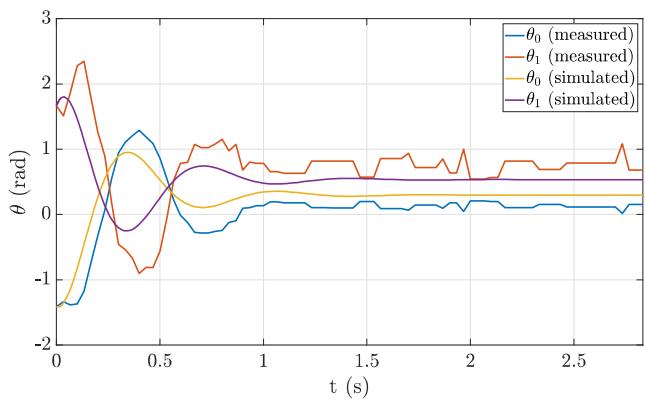
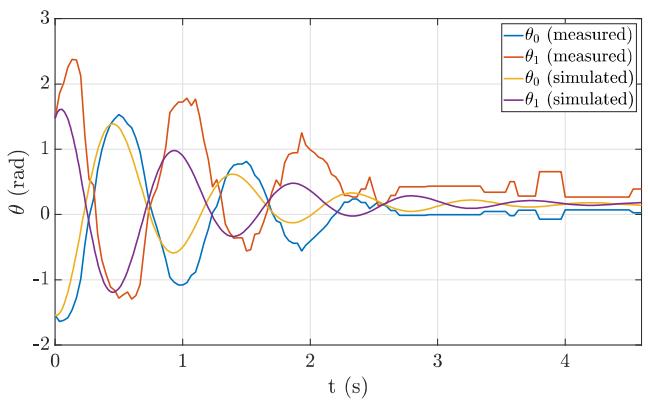
Bottom: k , $\bar{\theta}$ and β identified from dynamic evolution data.



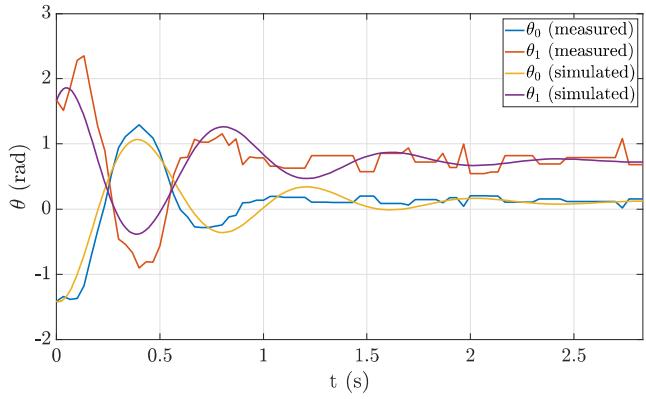
OB1



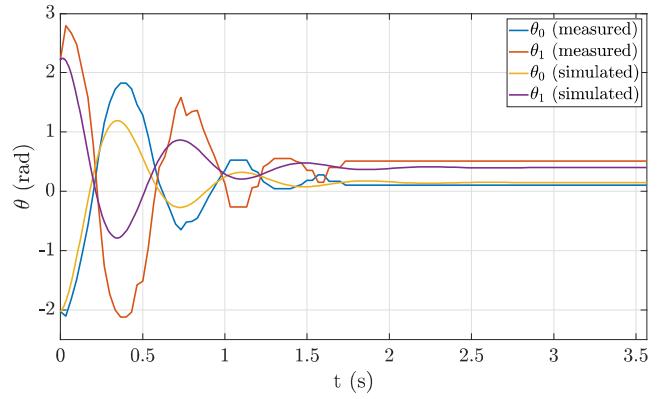
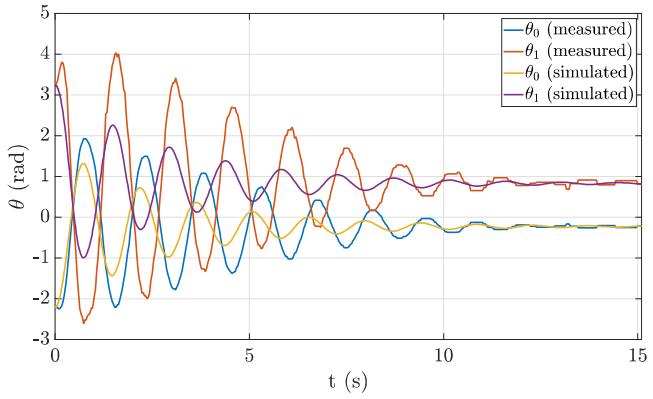
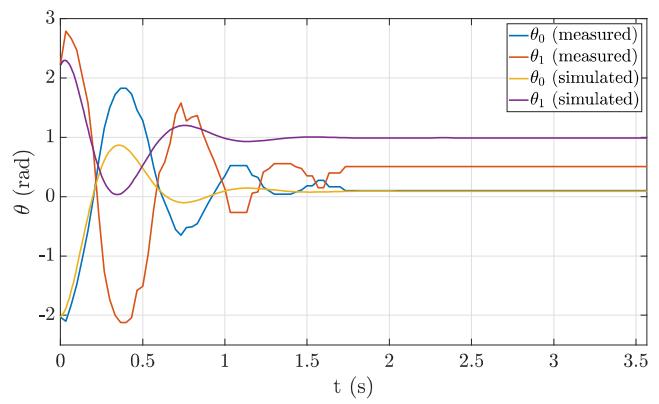
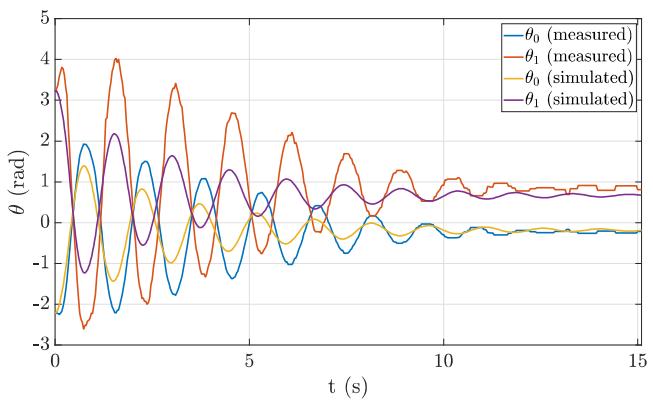
OB2



OB3



OB4

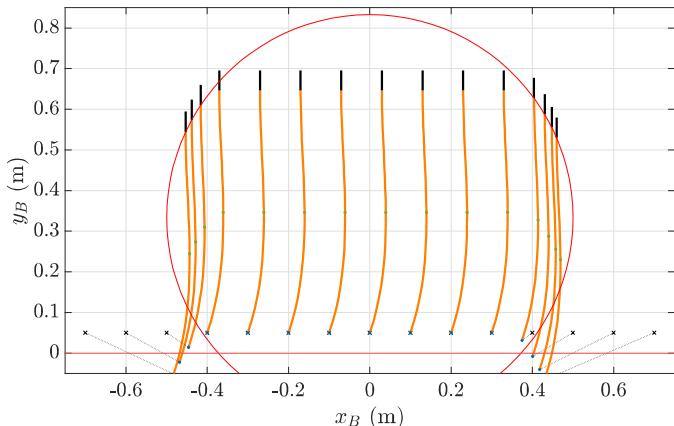


OB5

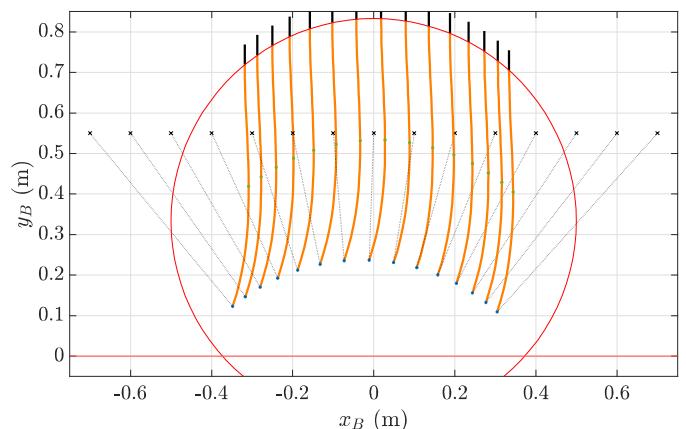
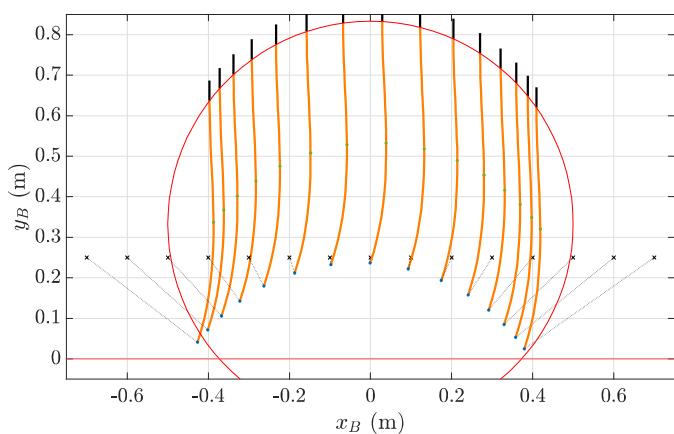
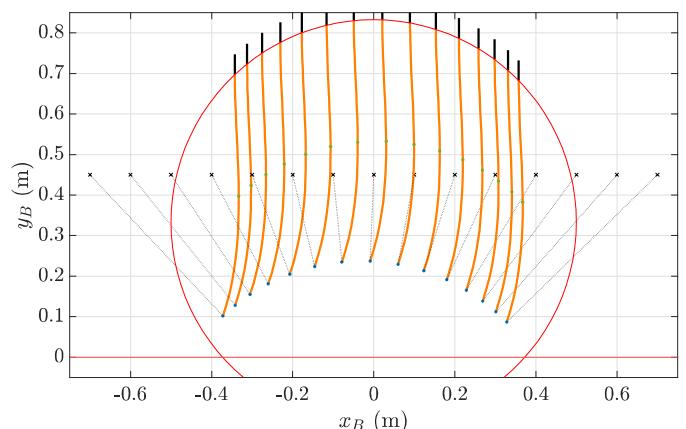
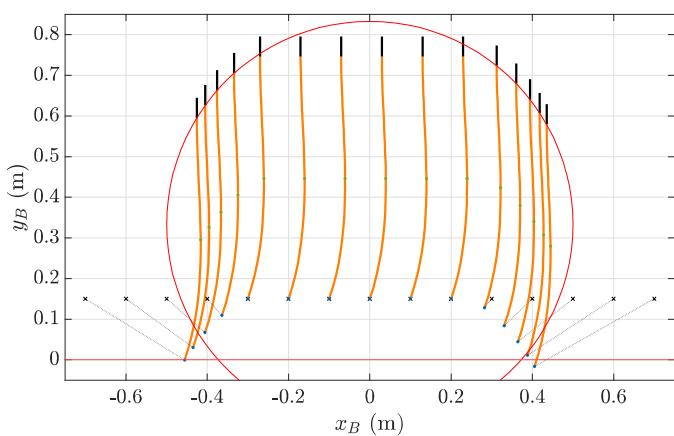
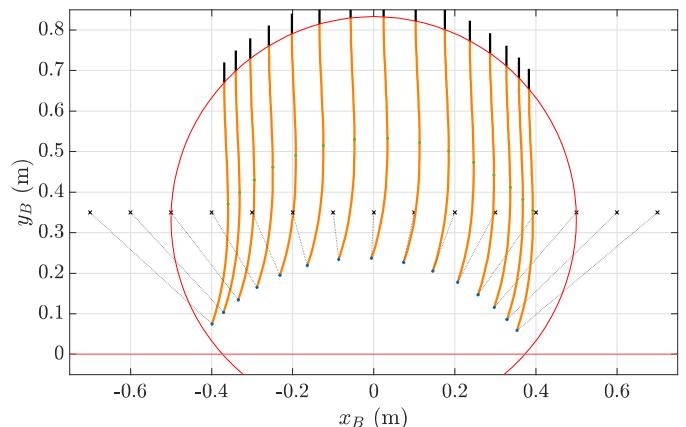
OB6

C. Feedforward Control Solutions for Endpoint Positioning

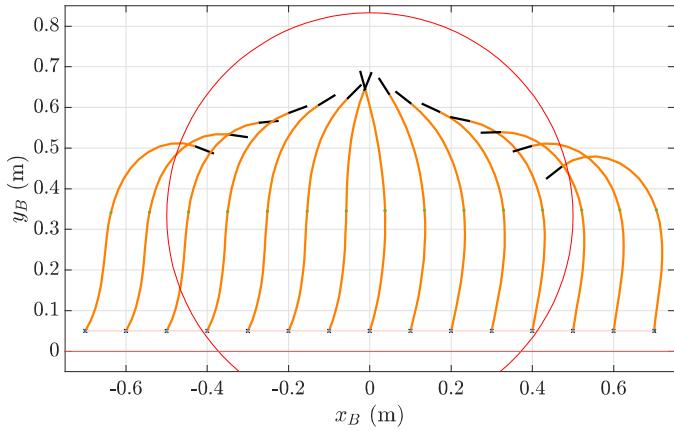
OB1, Model-free Reference



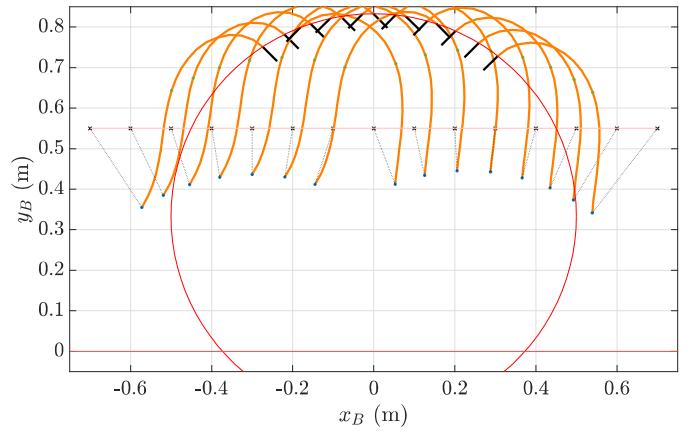
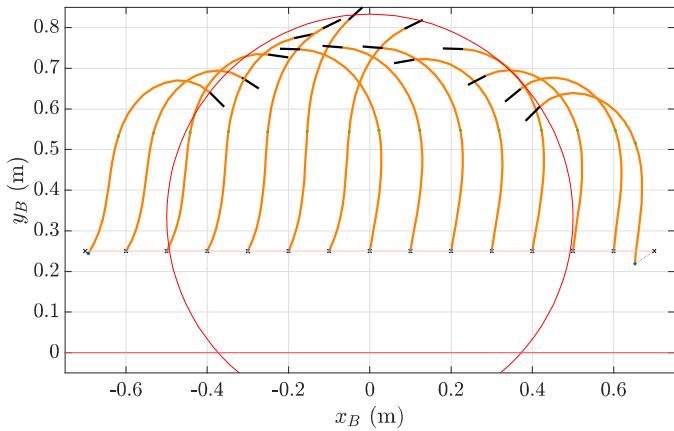
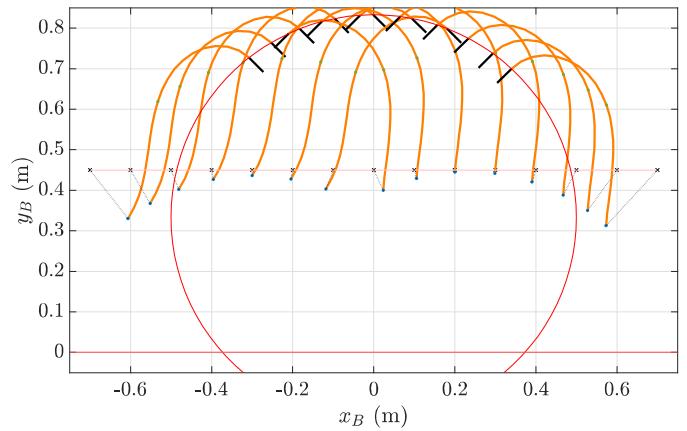
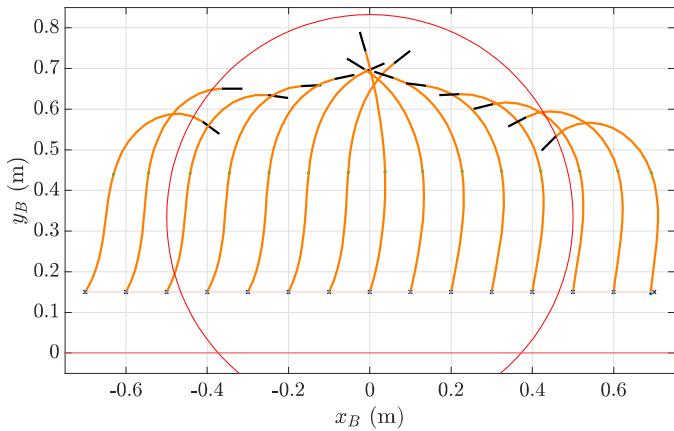
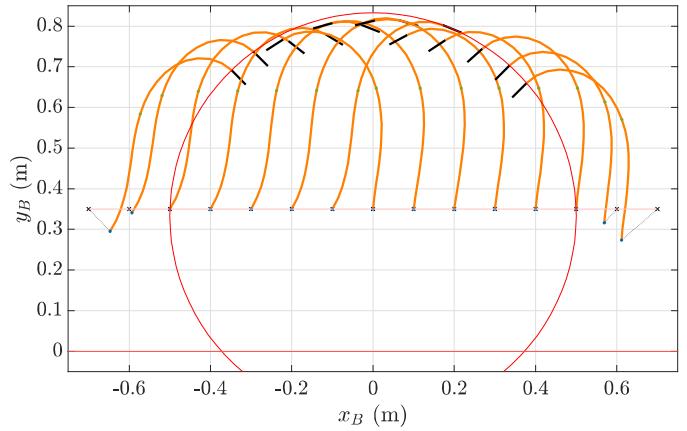
OB1, Model-free Reference Continued



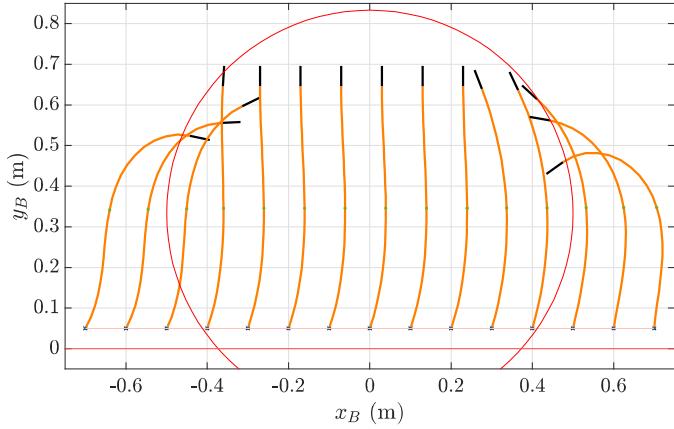
OB1, Cost On Δp_e



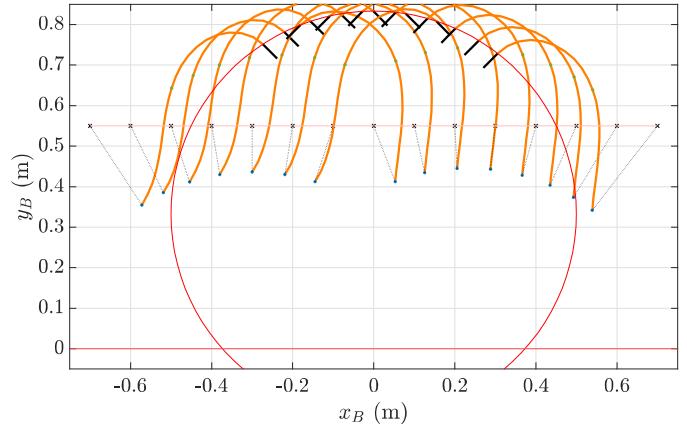
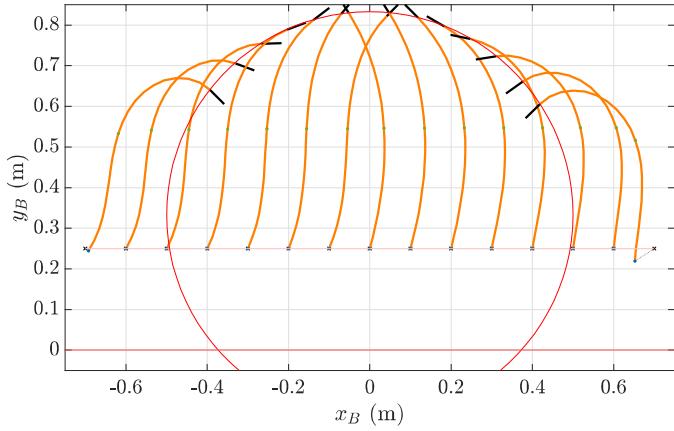
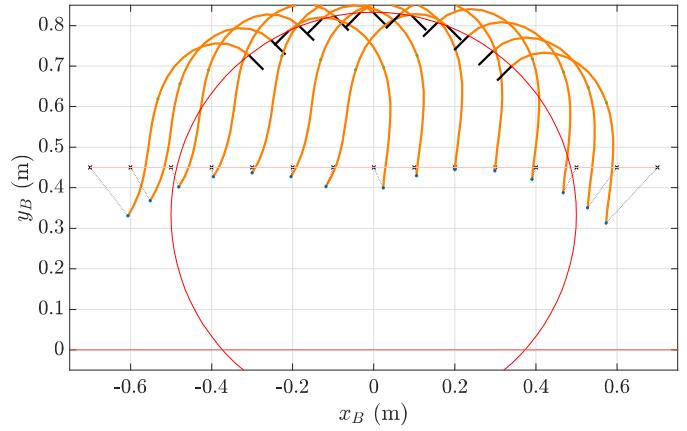
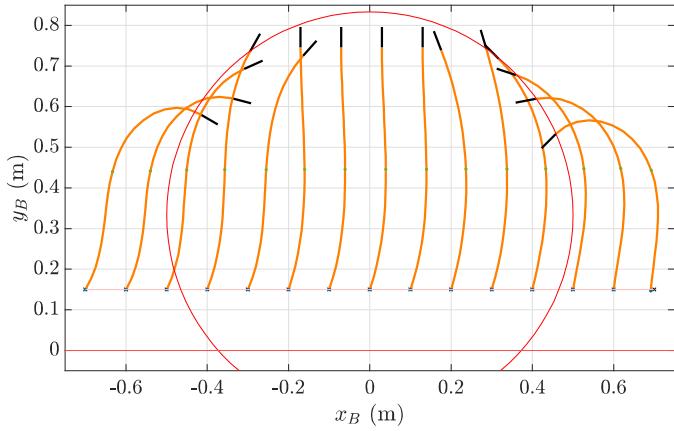
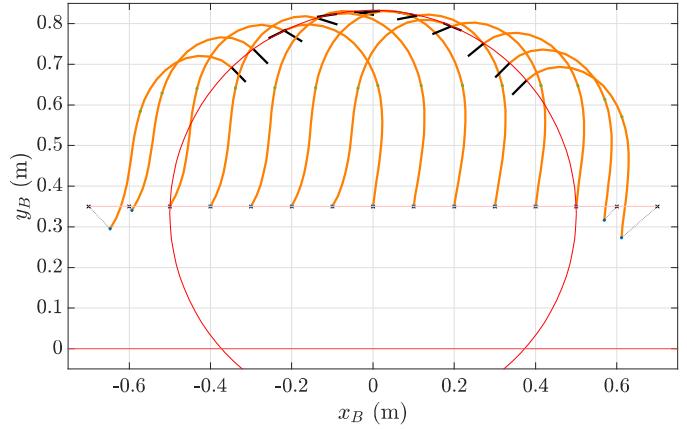
OB1, Cost On Δp_e Continued



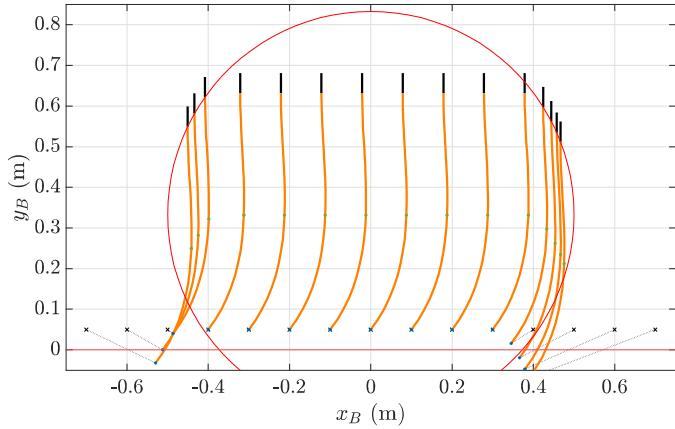
OB1, Cost On Δp_e and $|\phi|$



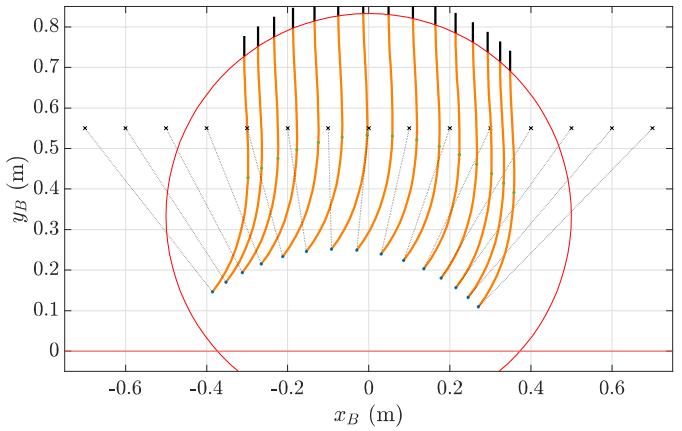
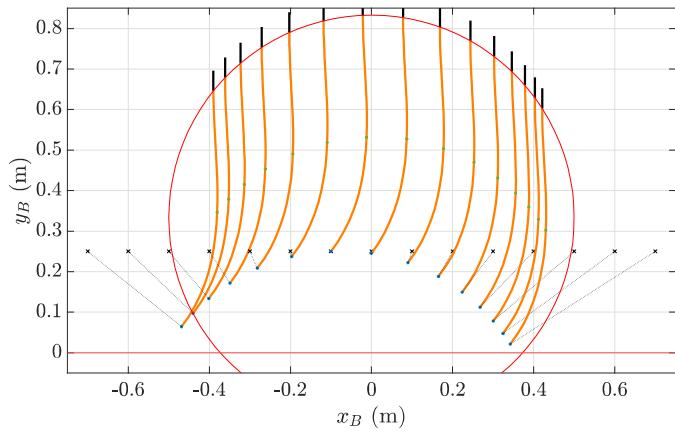
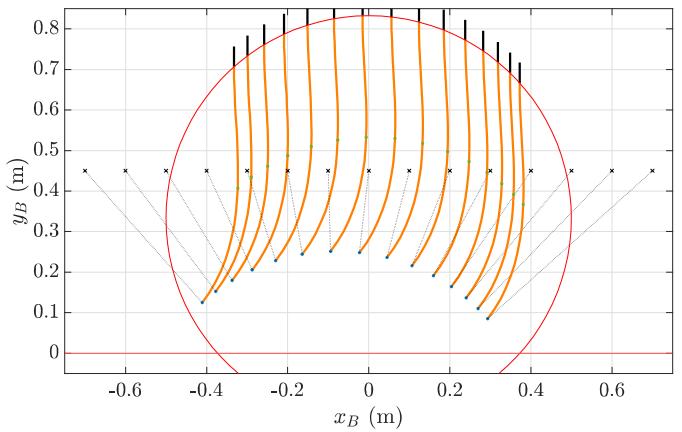
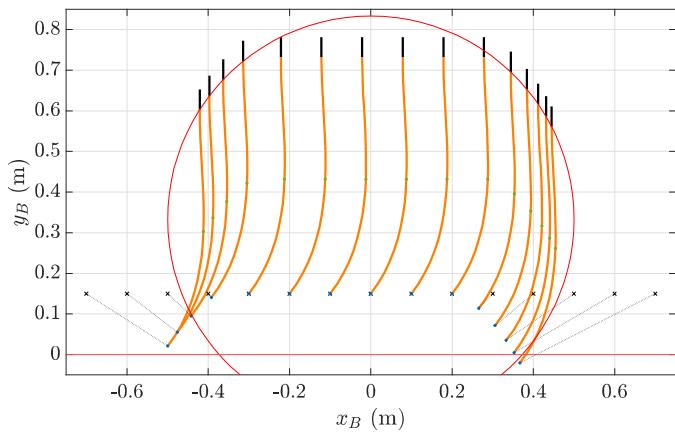
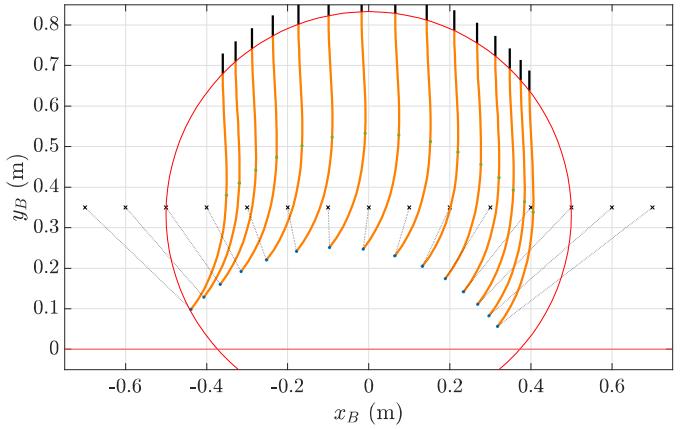
OB1, Cost On Δp_e and $|\phi|$ Continued



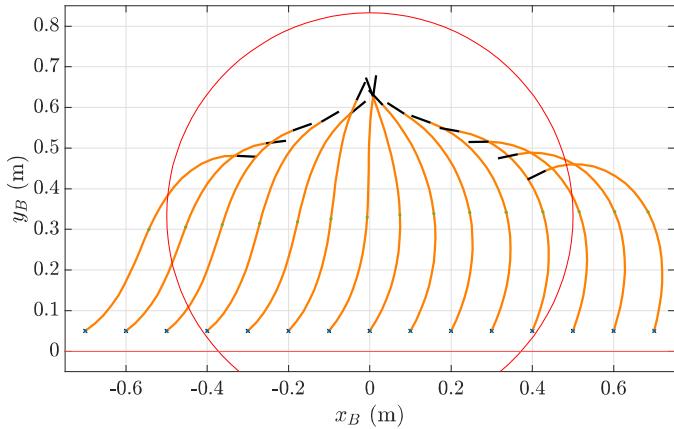
OB2, Model-free Reference



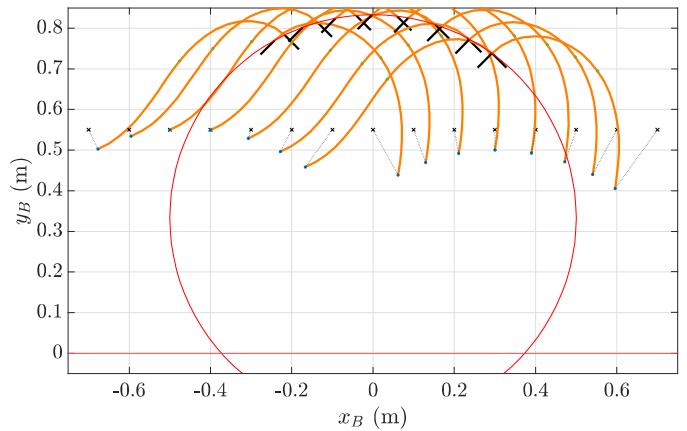
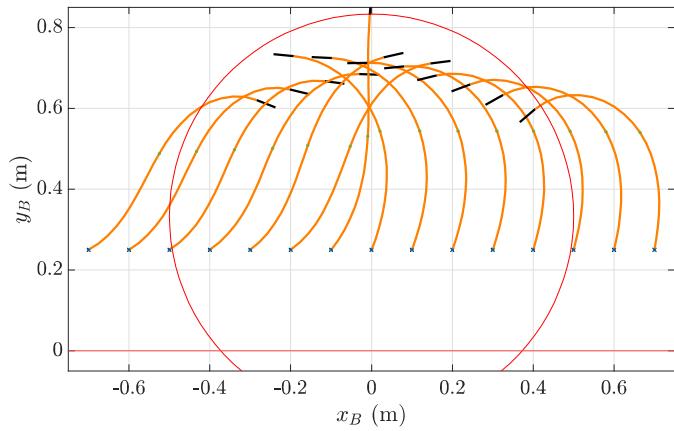
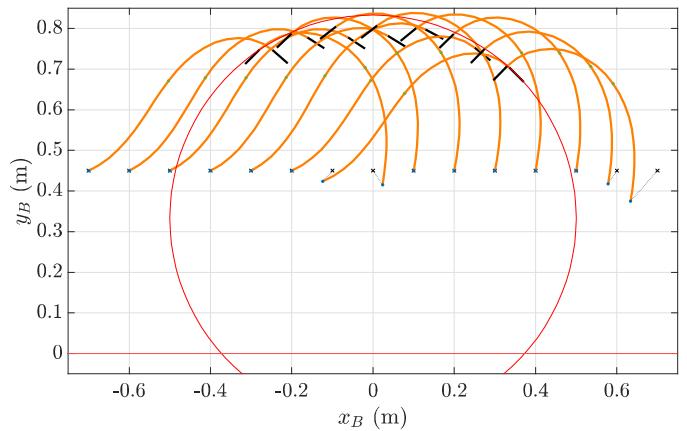
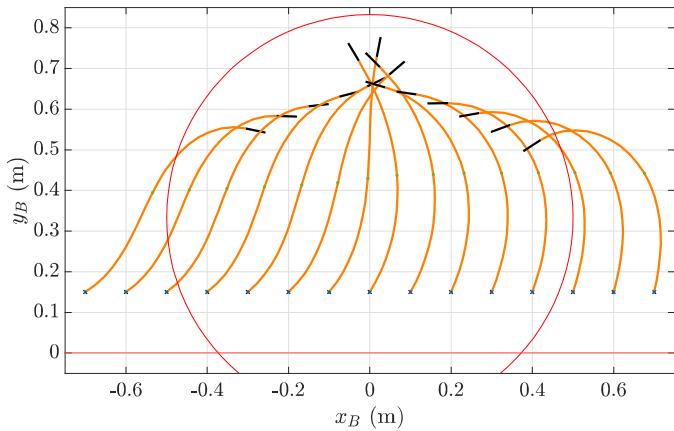
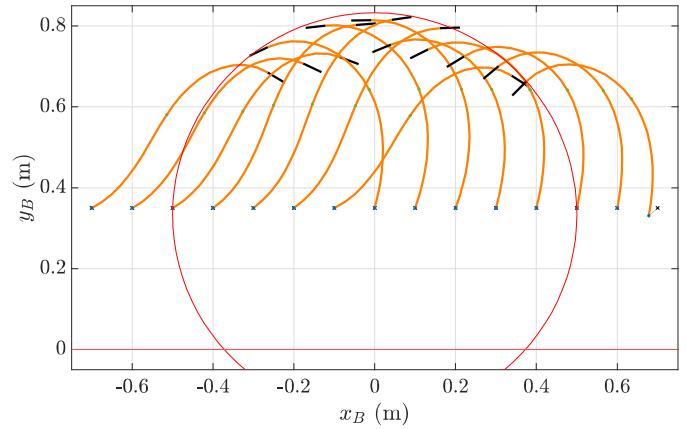
OB2, Model-free Reference continued



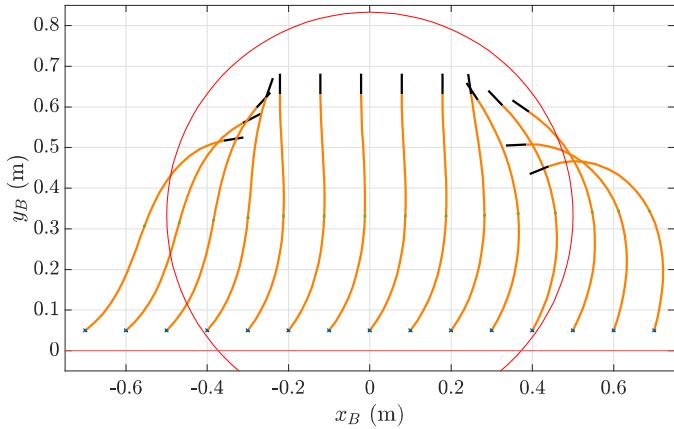
OB2, Cost On Δp_e



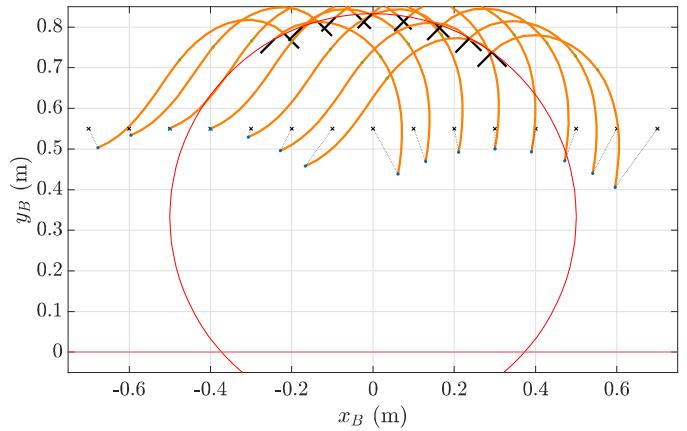
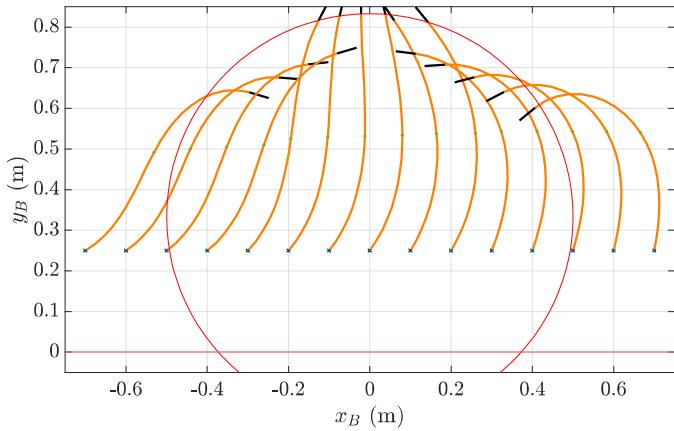
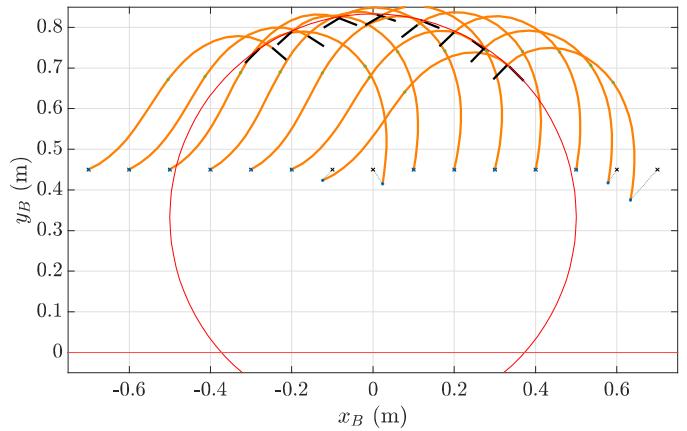
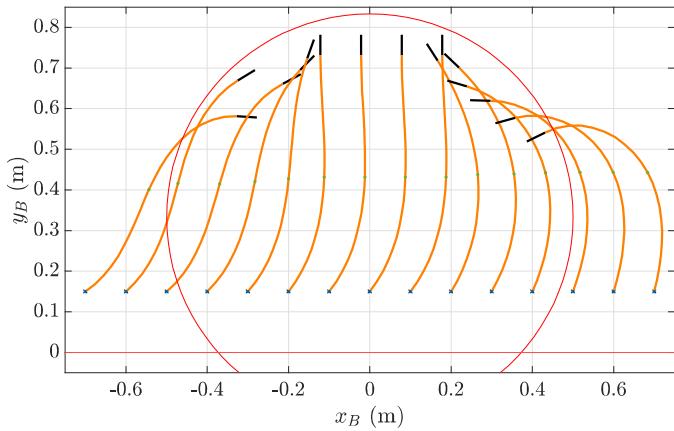
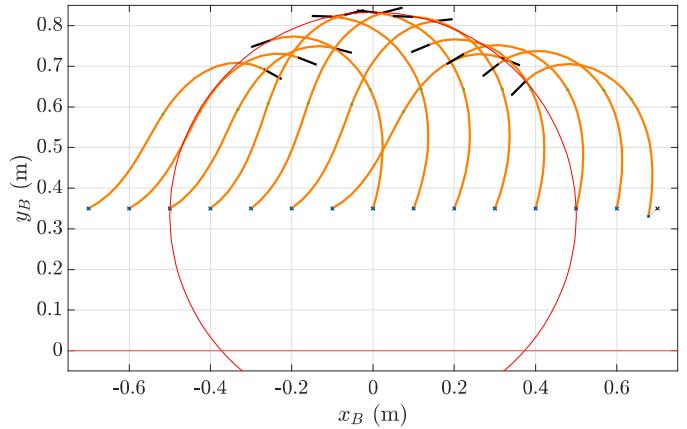
OB2, Cost On Δp_e Continued



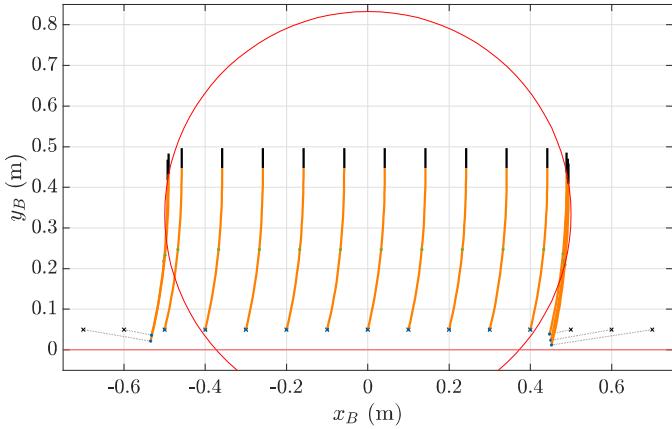
OB2, Cost On Δp_e and $|\phi|$



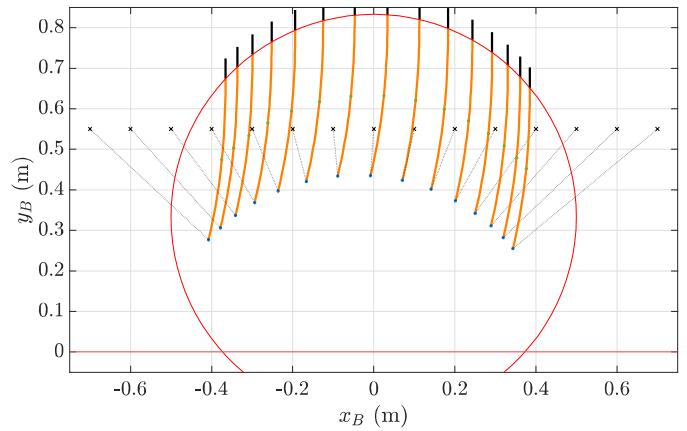
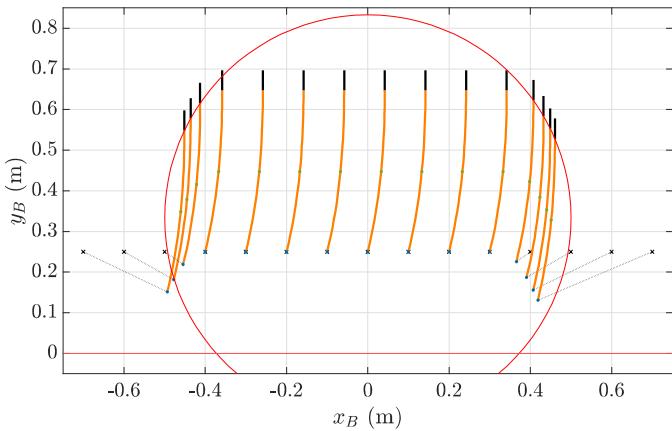
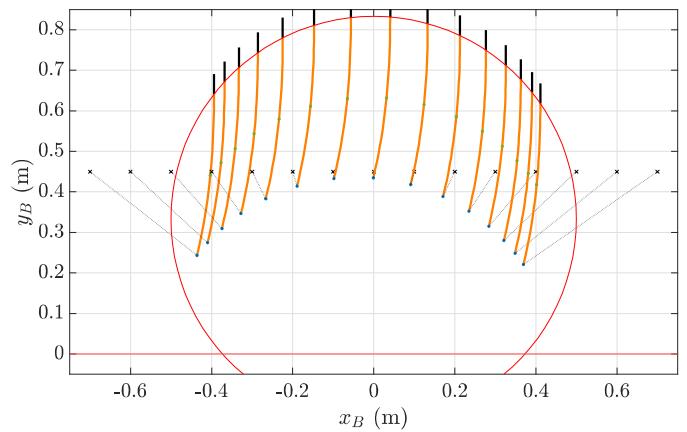
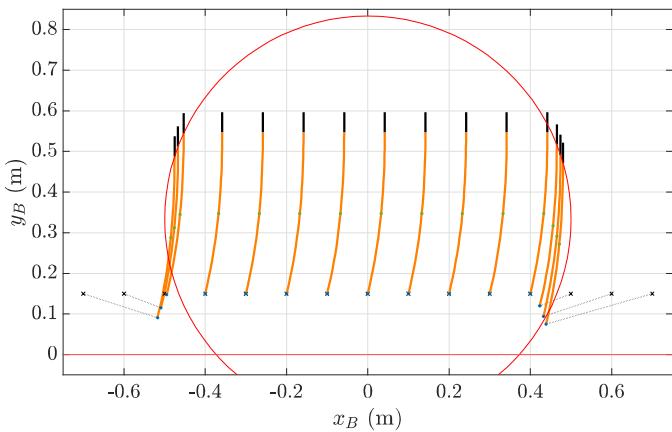
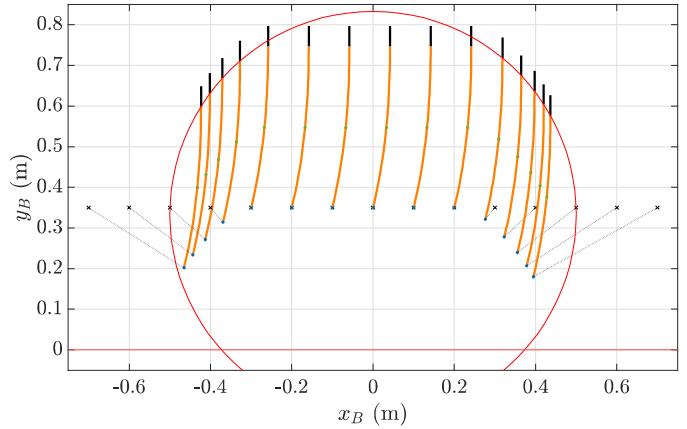
OB2, Cost On Δp_e and $|\phi|$ Continued



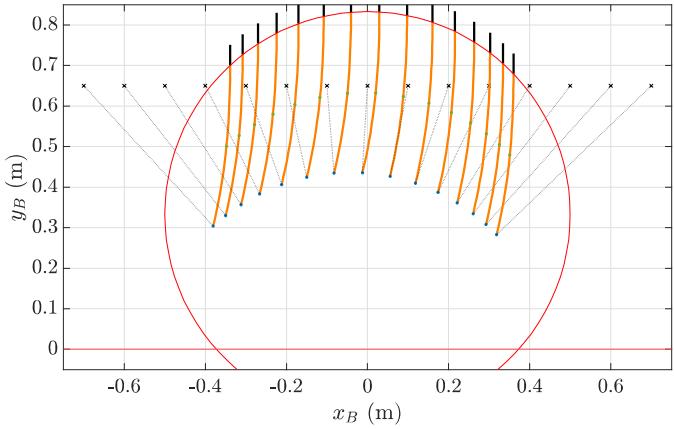
OB3, Model-free Reference



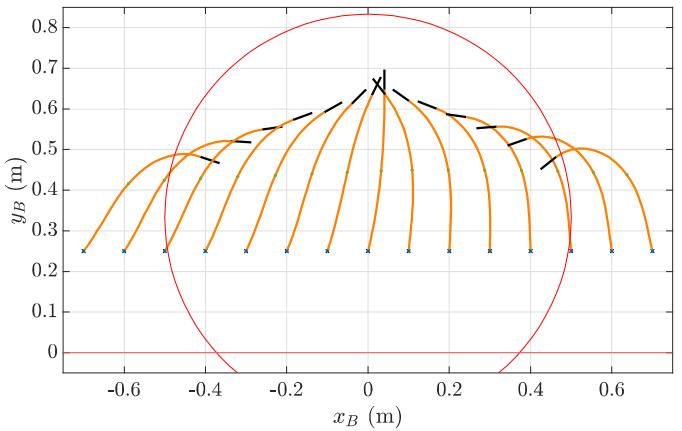
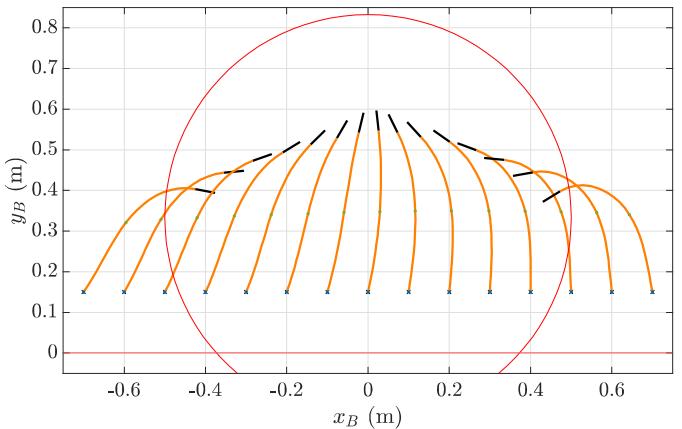
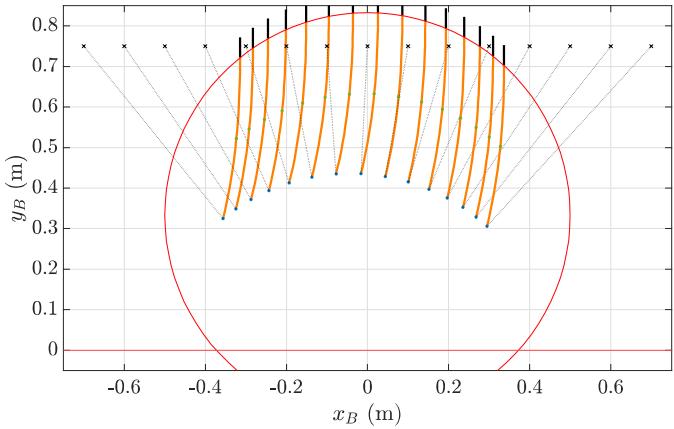
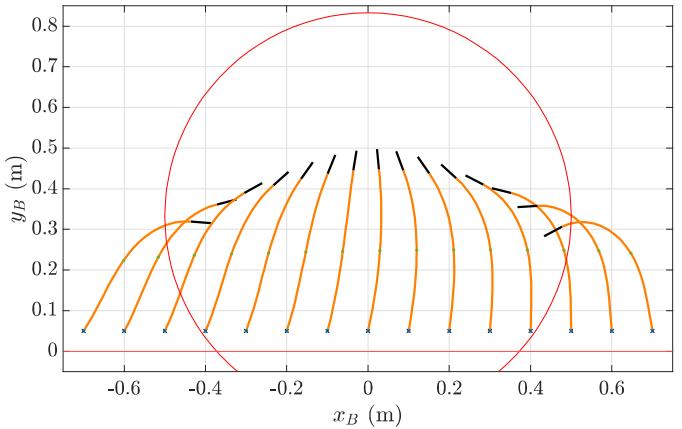
OB3, Model-free Reference Continued



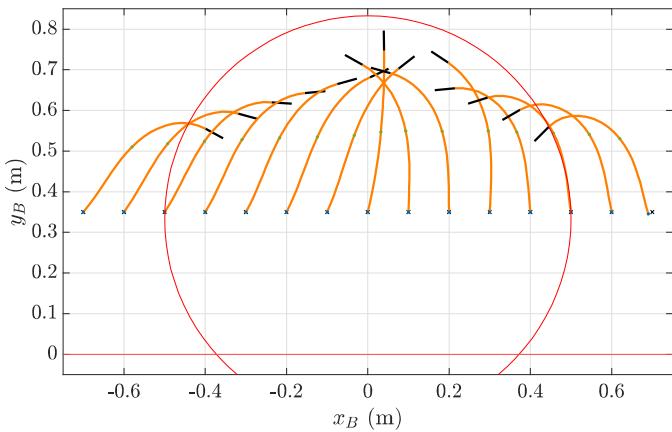
OB3, Model-free Reference Continued



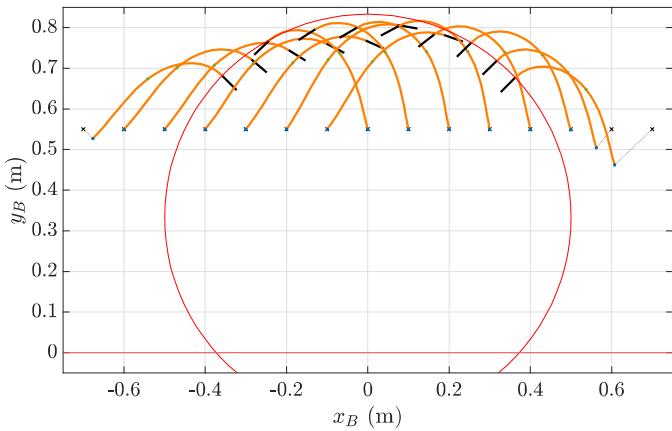
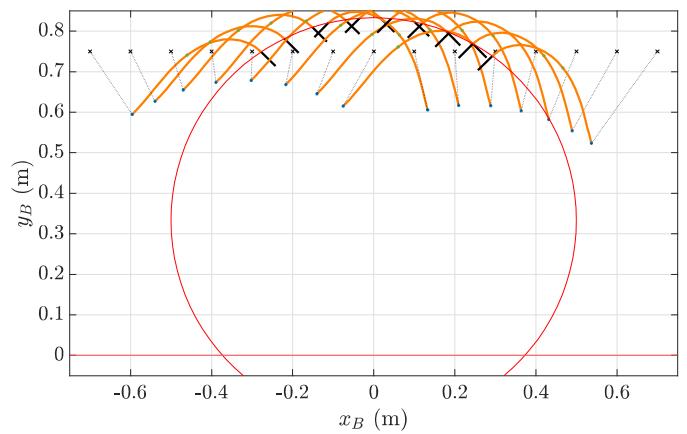
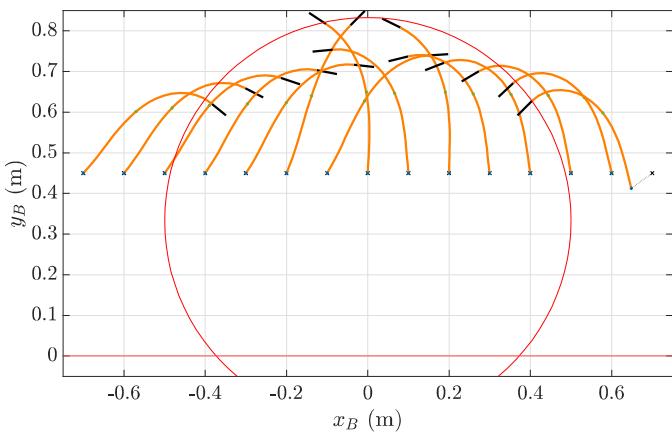
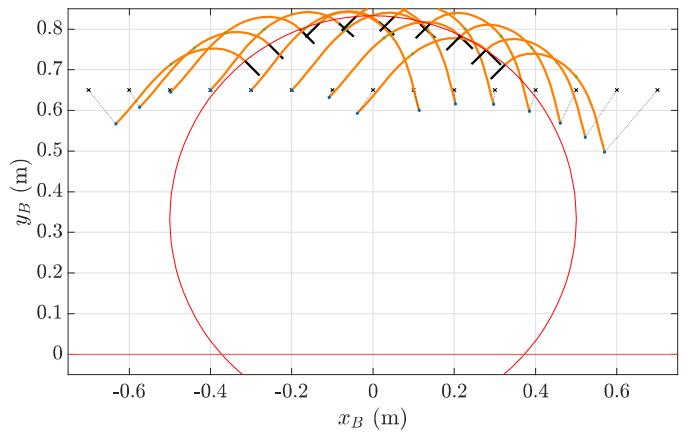
OB3, Cost On Δp_e



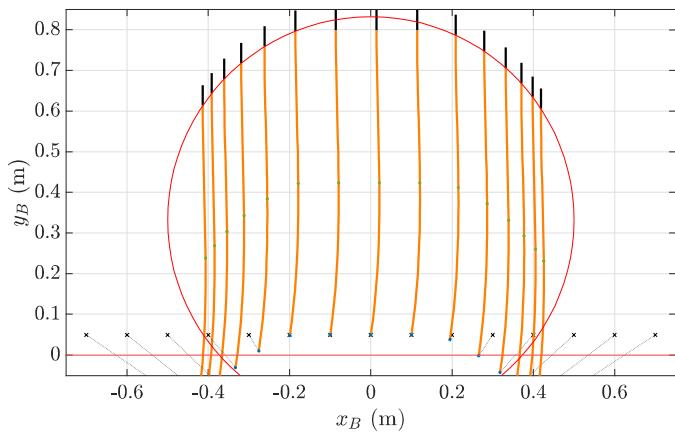
OB3, Cost On Δp_e Continued



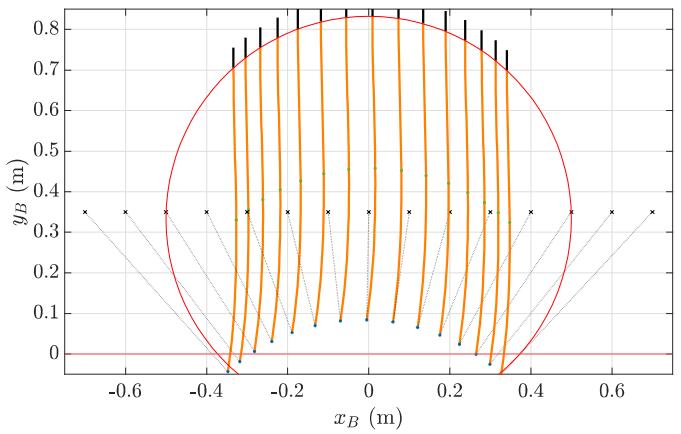
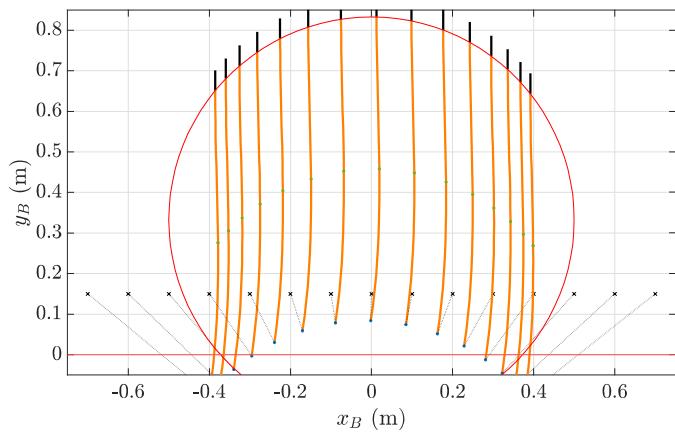
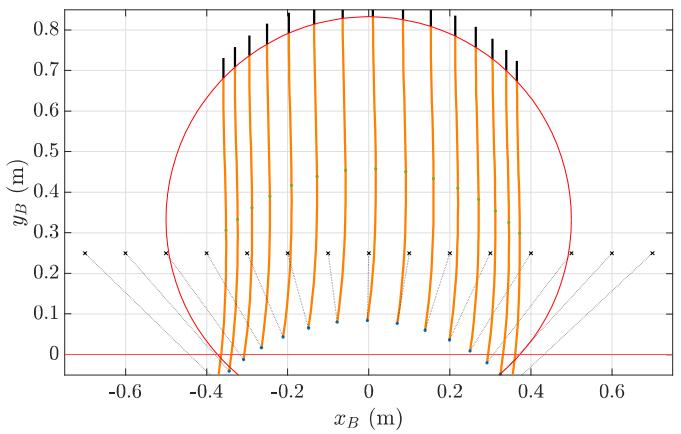
OB3, Cost On Δp_e Continued



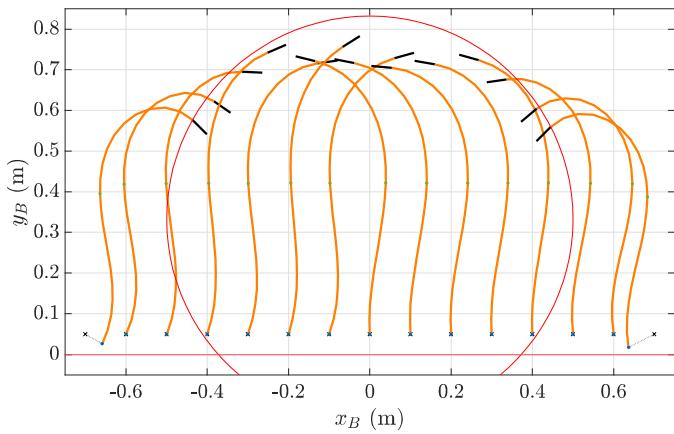
OB5, Model-free Reference



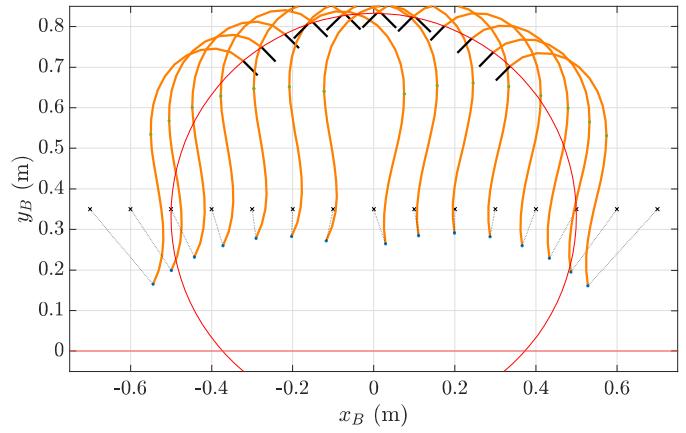
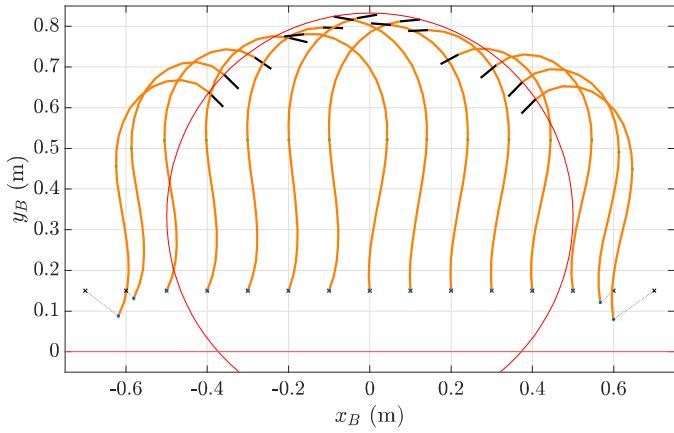
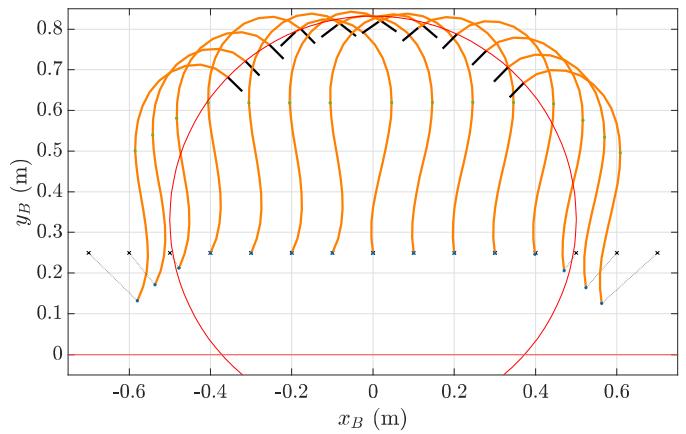
OB5, Model-free Reference Continued



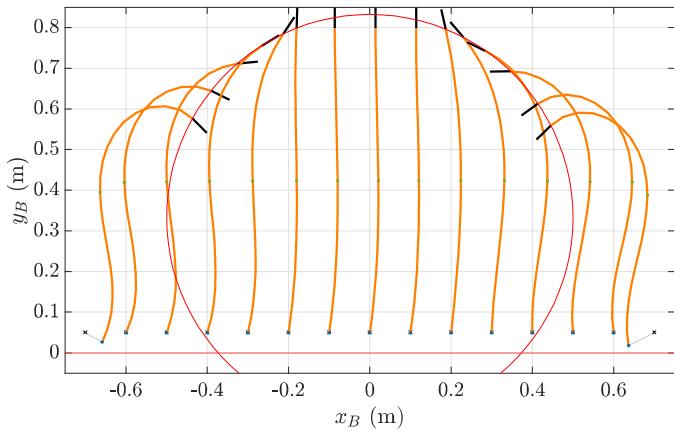
OB5, Cost On Δp_e



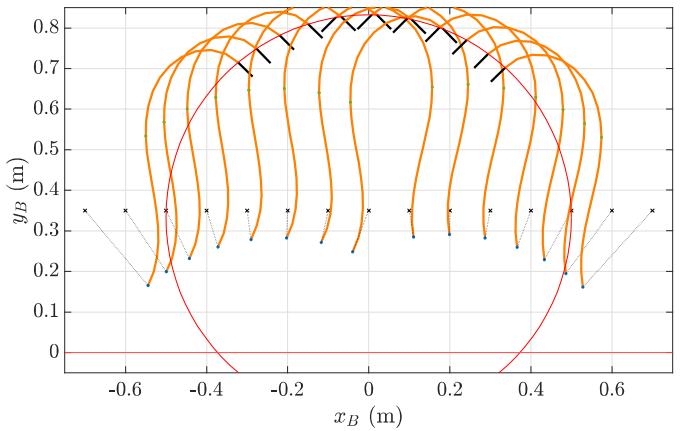
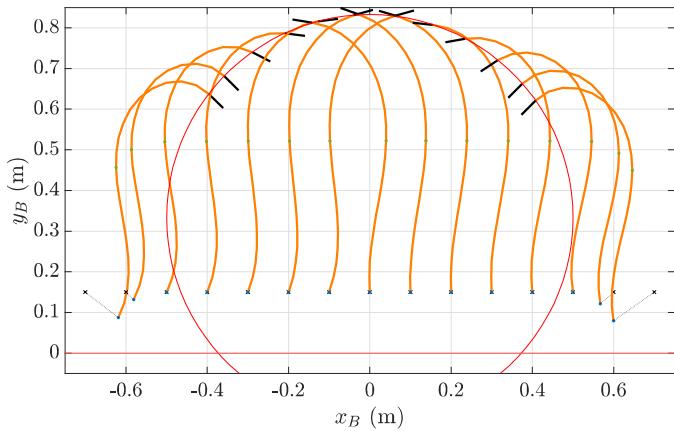
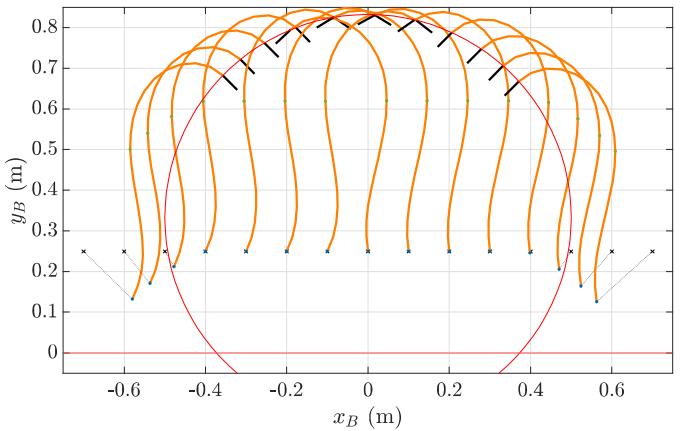
OB5, Cost On Δp_e Continued



OB5, Cost On Δp_e and $|\phi|$



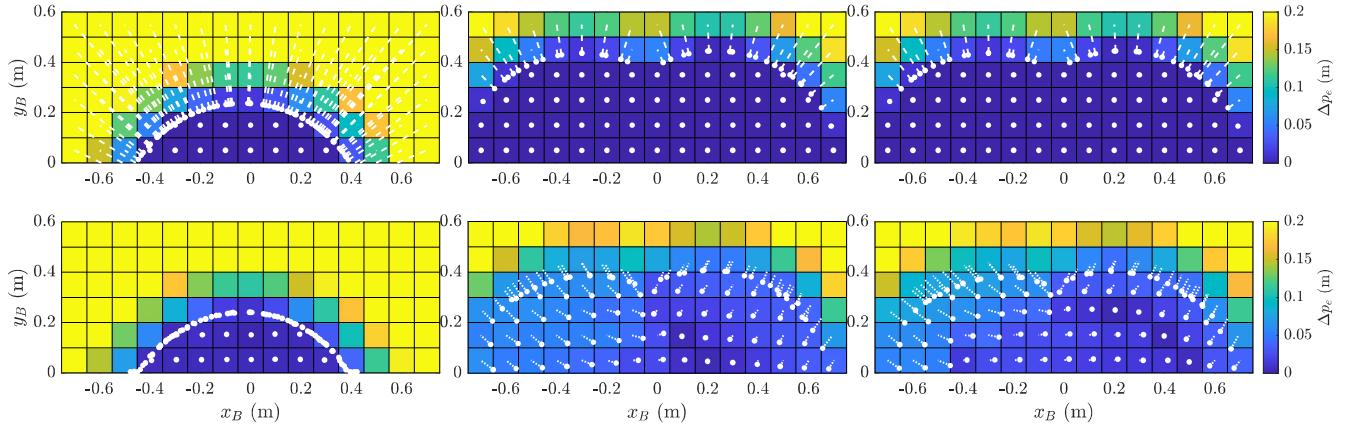
OB5, Cost On Δp_e and $|\phi|$ Continued



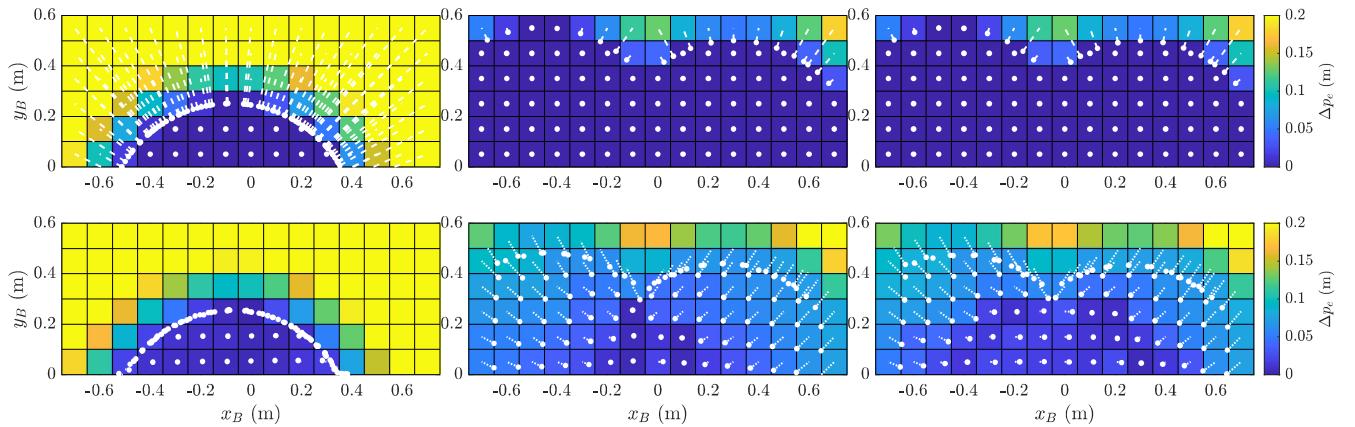
D. Endpoint Error Visualisations

Top rows: Error from goal to modelled endpoint (colour). Modelled endpoints plotted, lines drawn from goal to modelled endpoints.

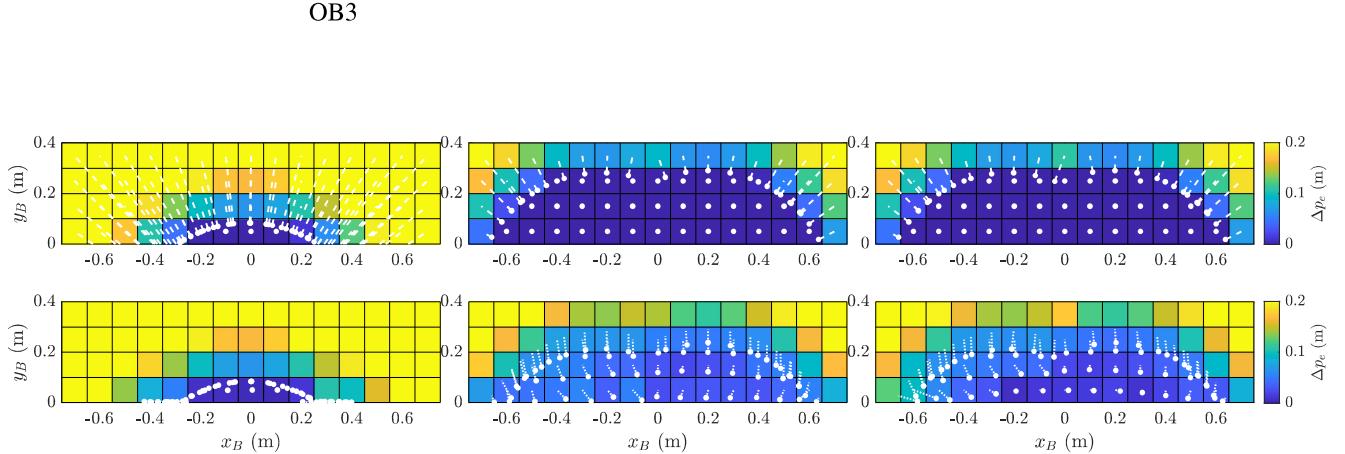
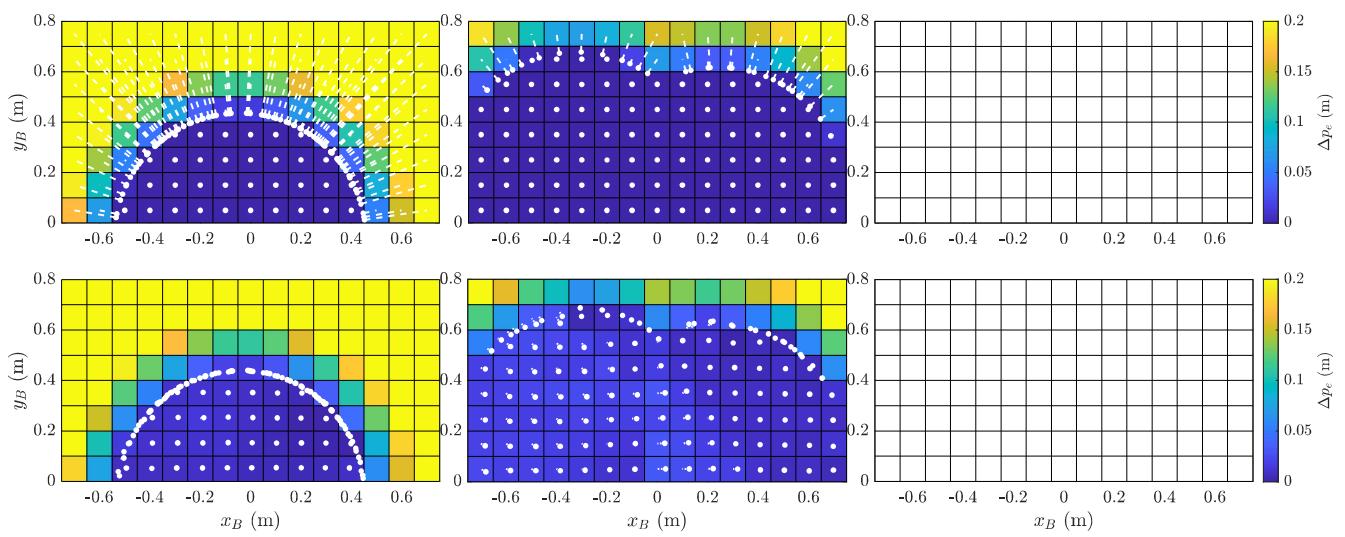
Bottom rows: Error from goal to measured endpoint (colour). Measured endpoints plotted, lines drawn from modelled endpoints to measured endpoints.



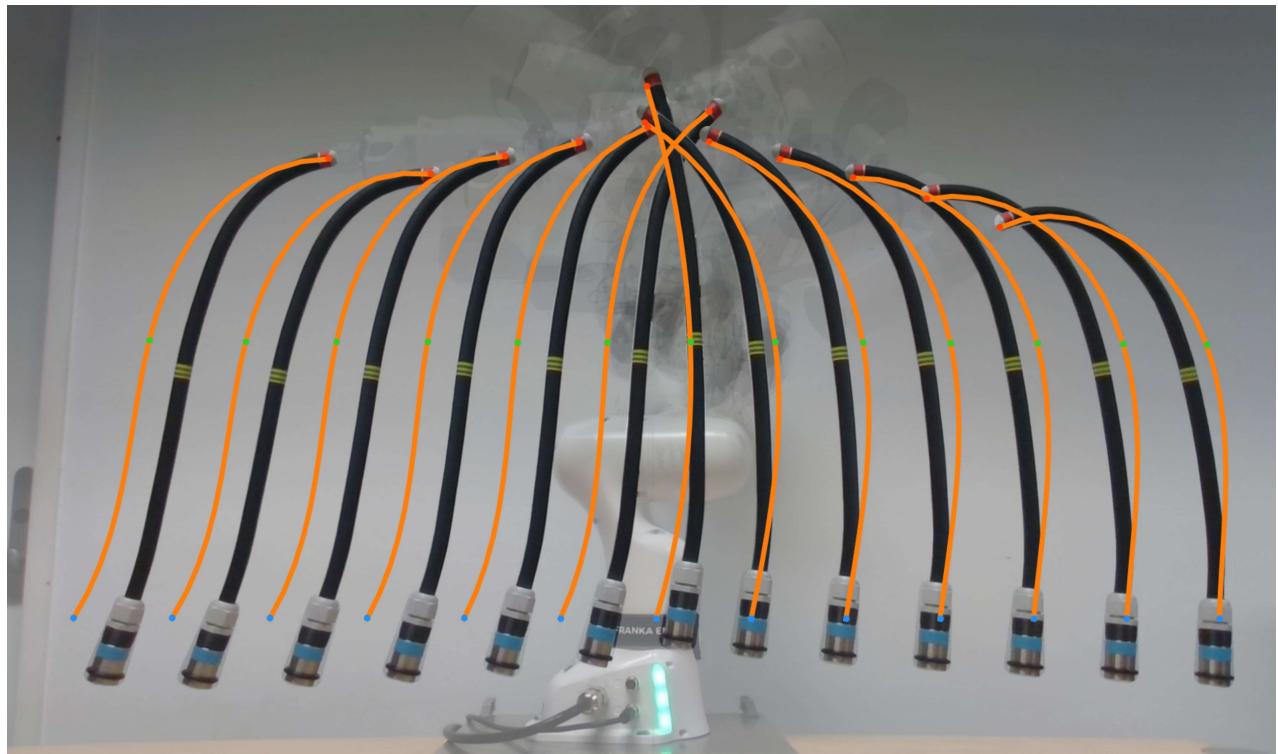
OB1



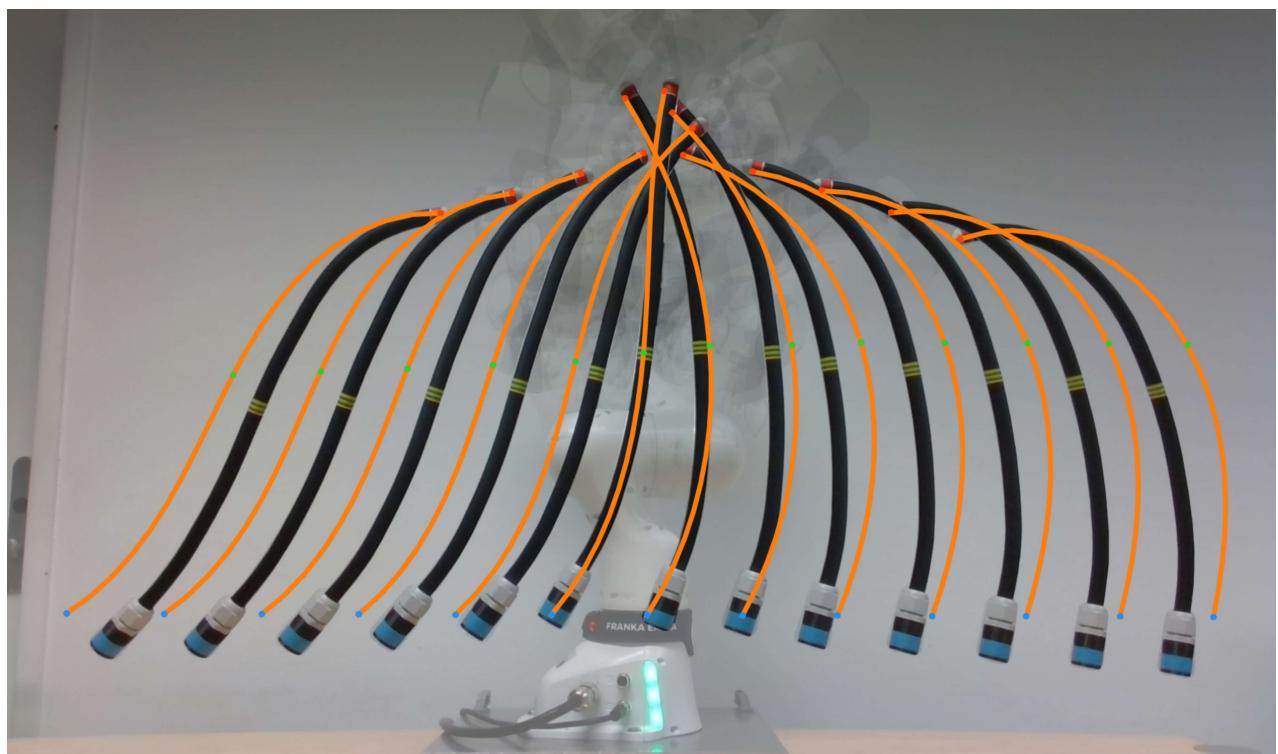
OB2



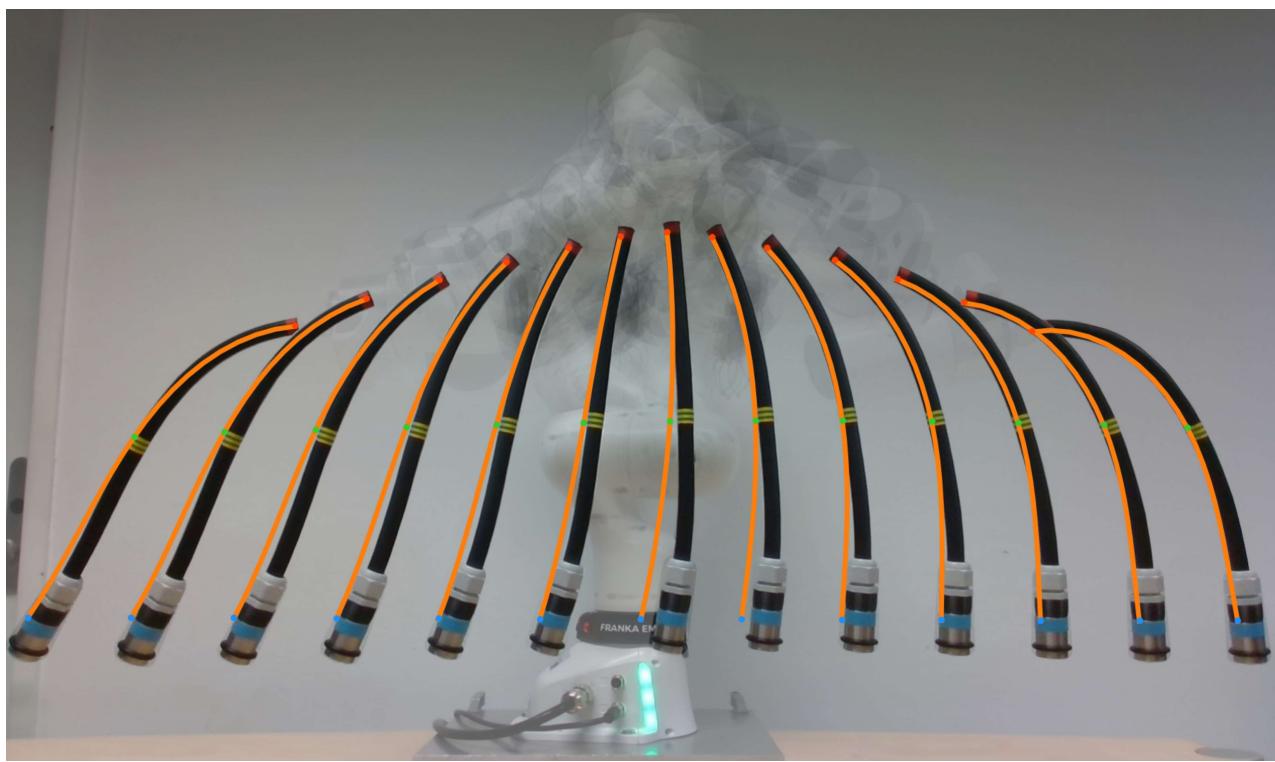
E. Endpoint Positioning Solution and Measurement Overlays



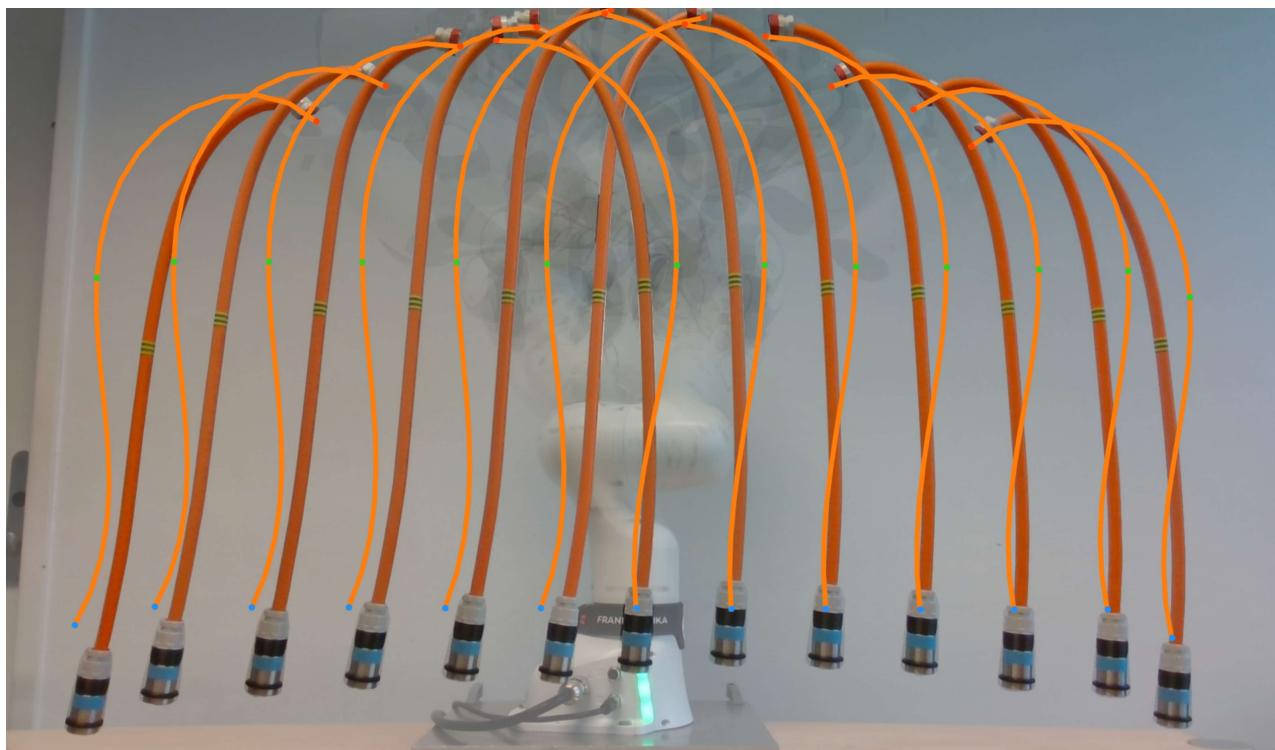
OB1



OB2



OB3



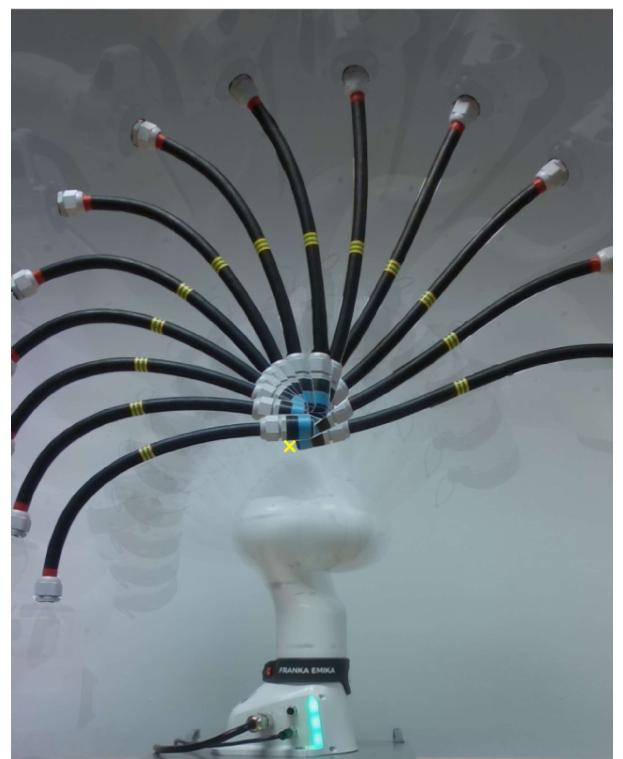
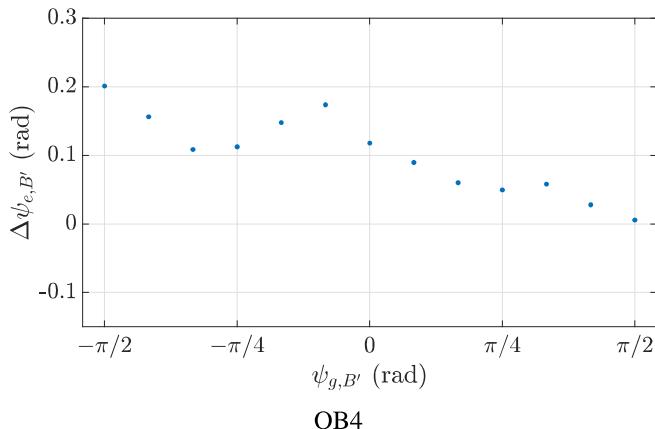
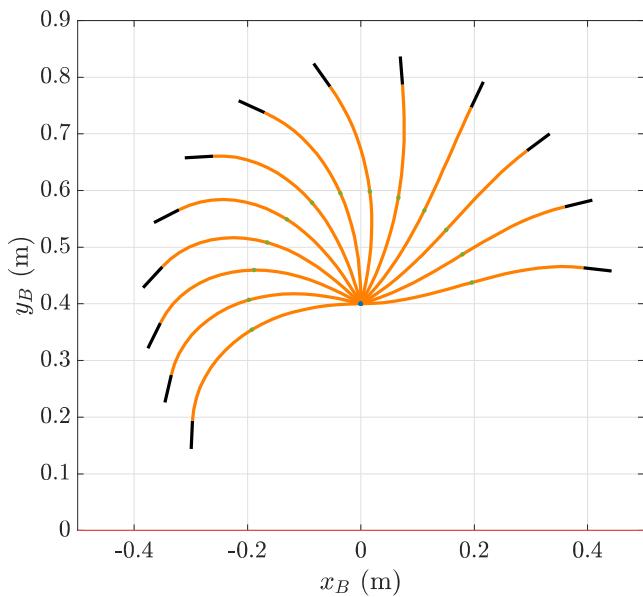
OB5

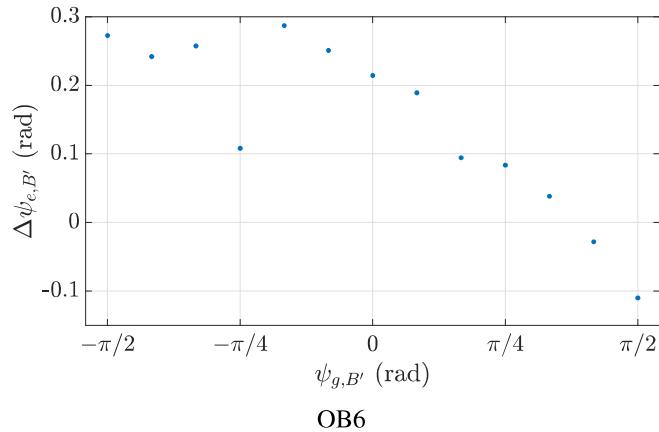
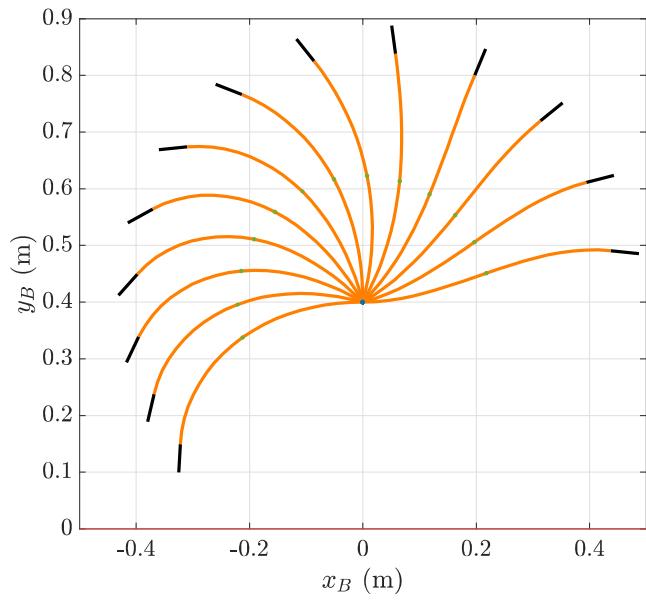
F. Feedforward Control of Endpoint Orientation Results

Left, top: Solutions for endpoint orientation goals.

Left, bottom: Measured error to goal orientation.

Right: Composite image of the measured object states with desired endpoint position marked.





OB6



OB6