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# A note on the limitations of ZUPTs and the implications on sensor error modeling

Presentation at IPIN 2012 (121114)

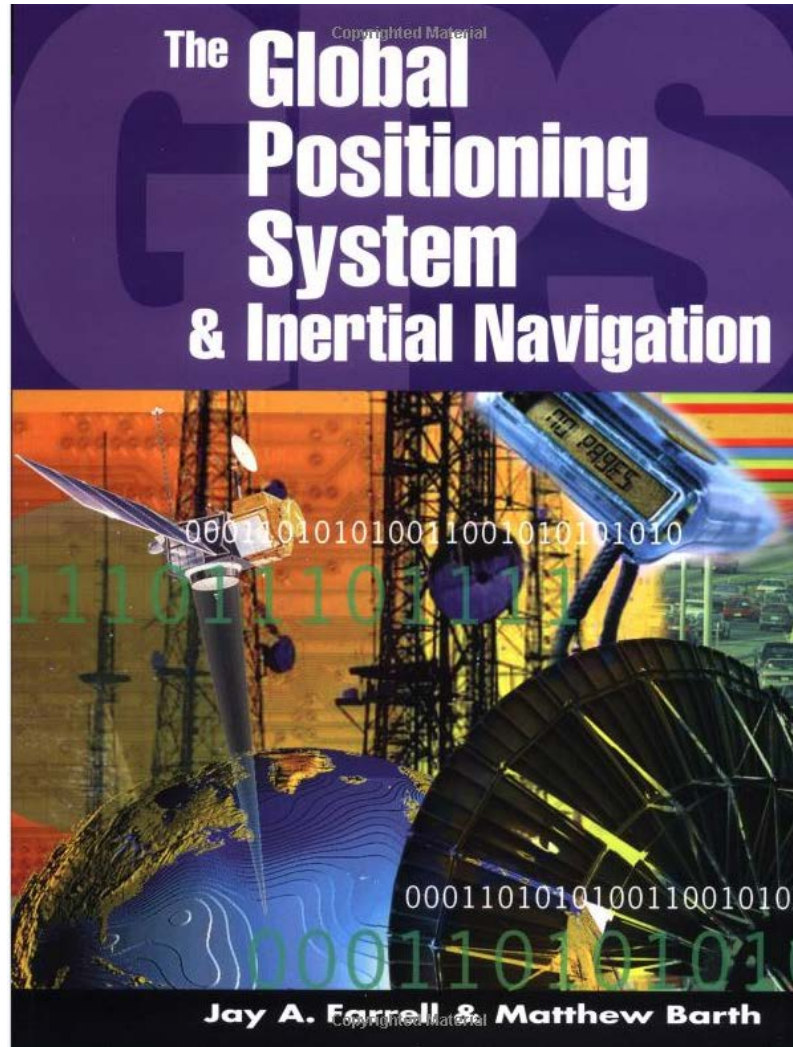
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# Error comes from ...

1. Measurement errors
  2. Modeling errors
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# The origin



# Estimating sensor errors

- By position updates

$$\int (\boldsymbol{\omega} + \mathbf{e}_\omega) dt = \boldsymbol{\theta}$$

$$\iint \mathbf{R}_\theta (\mathbf{a} + \mathbf{e}_a) dt dt = \mathbf{p}$$

- By (zero-) velocity updates

$$\int (\boldsymbol{\omega} + \mathbf{e}_\omega) dt = \boldsymbol{\theta}$$

$$\int \mathbf{R}_\theta (\mathbf{a} + \mathbf{e}_a) dt = \mathbf{v}$$

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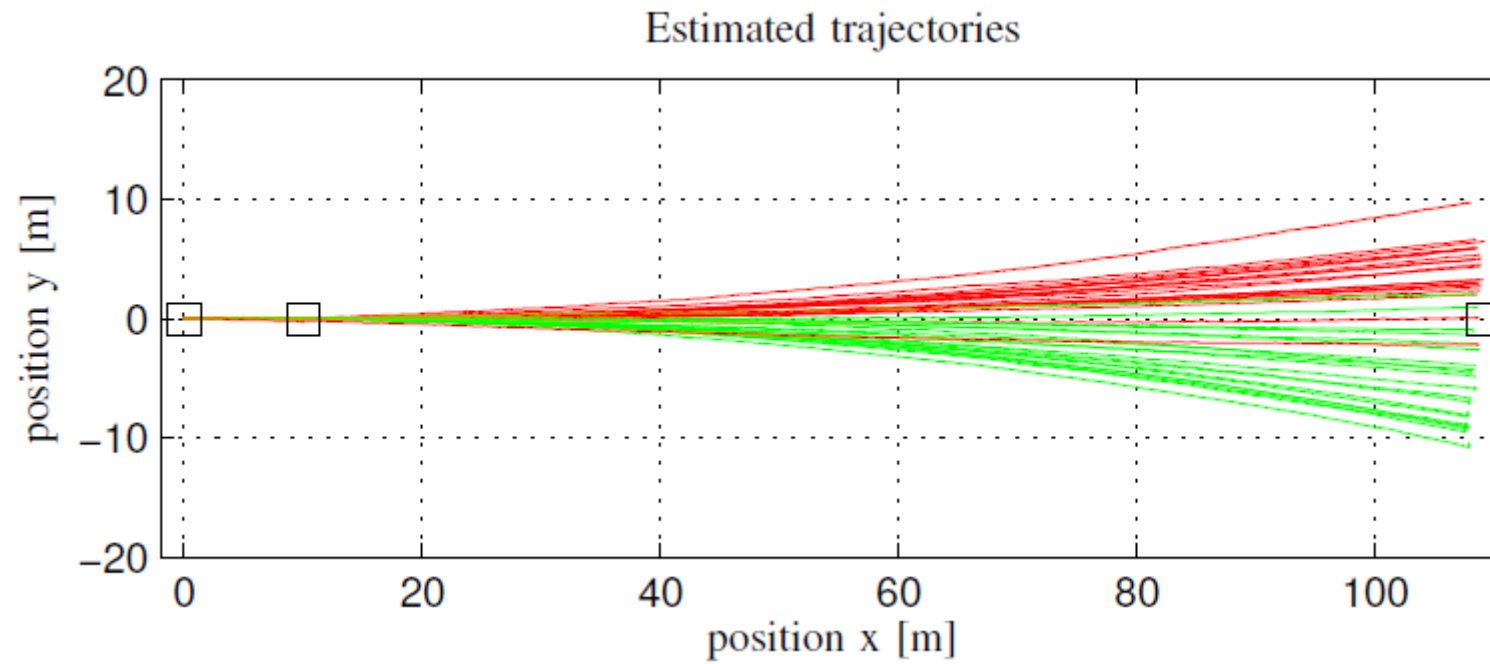
# Quantify modeling errors

- Why? Its not for certain that sensor errors are dominant in relation to modeling errors
- Data collected with OpenShoe Units

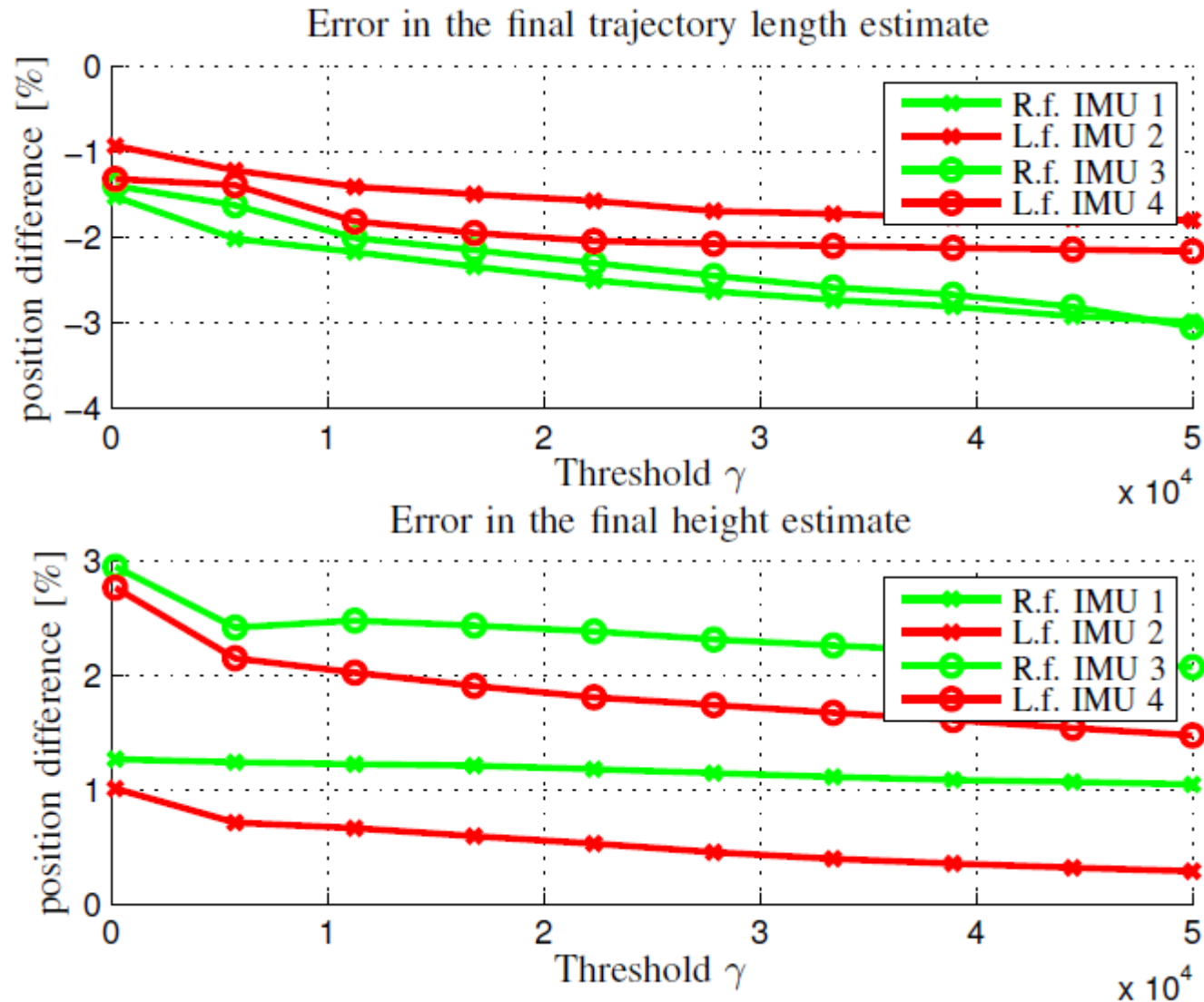
(<http://www.openshoe.org>)



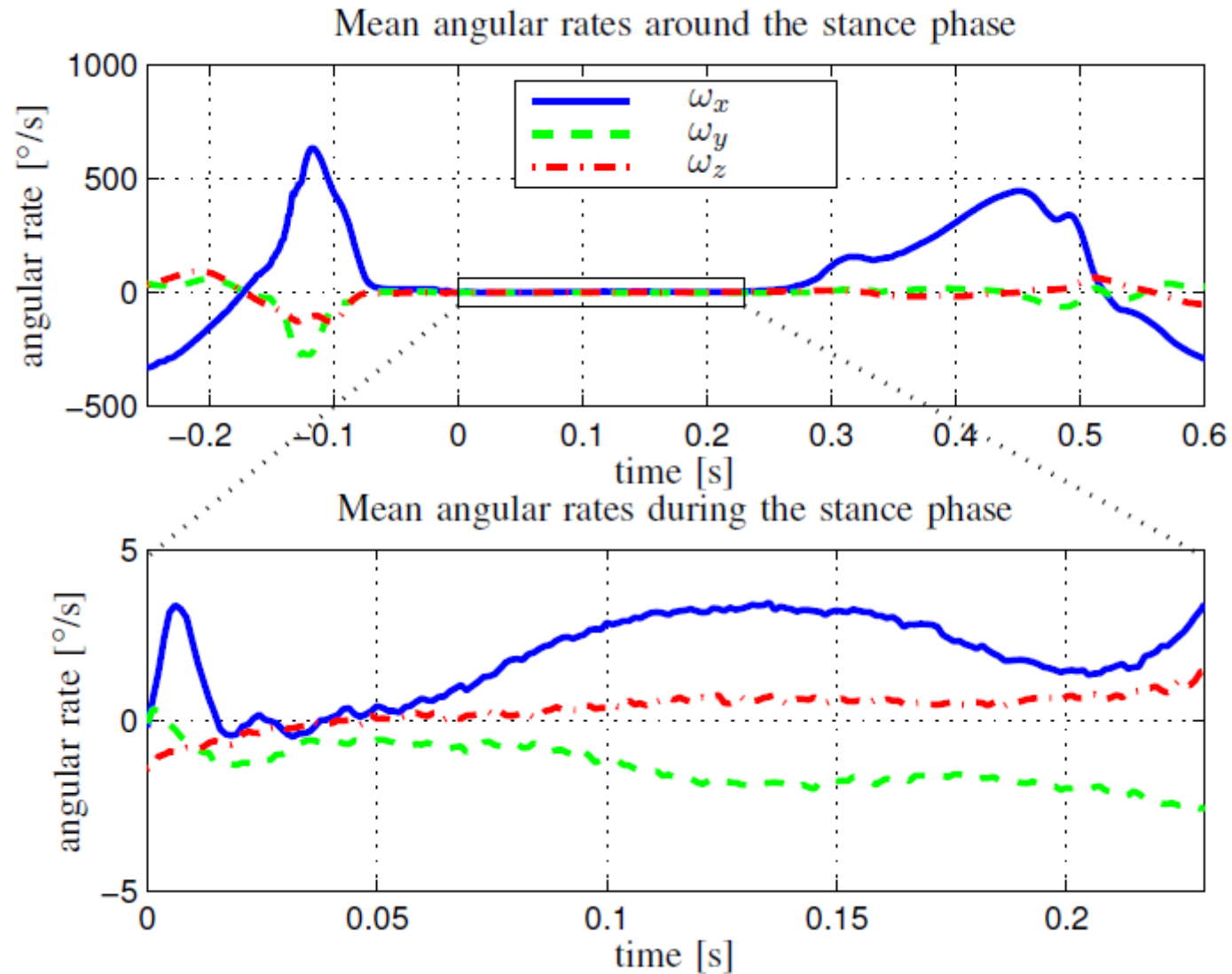
# Systematic heading error



# Systematic height and distance error

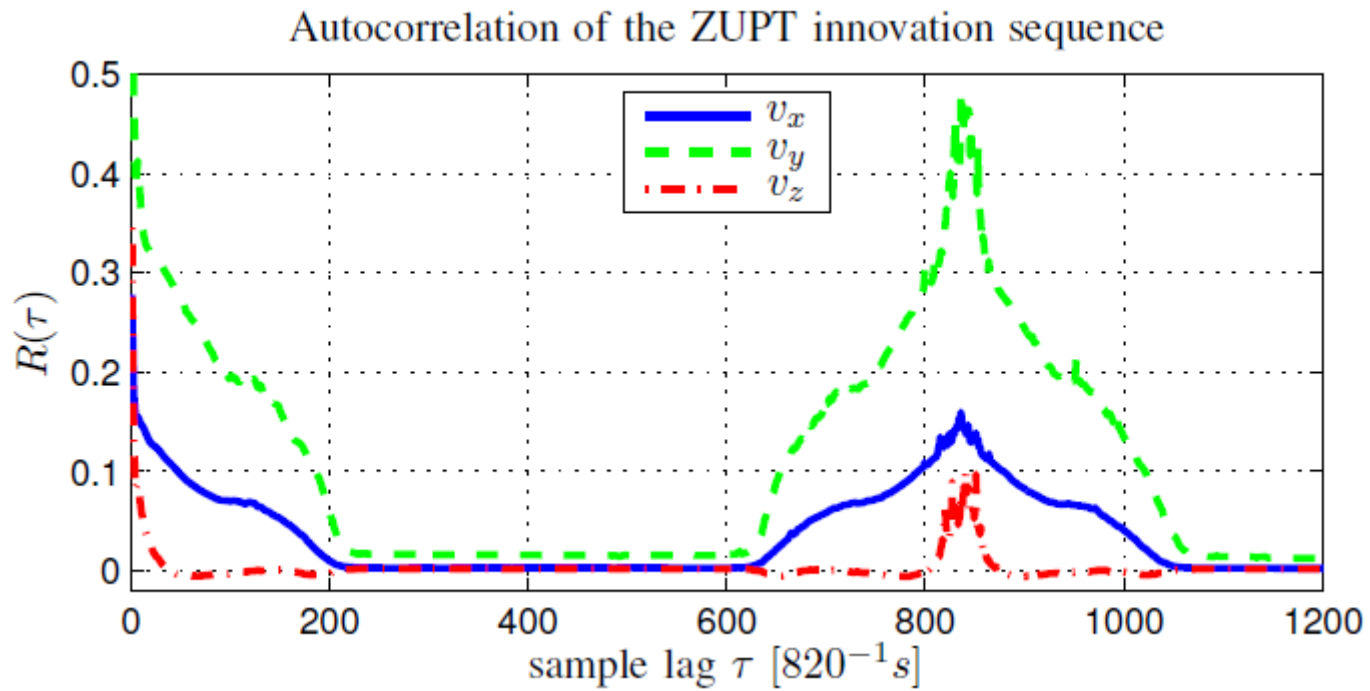


# The zero velocity assumption

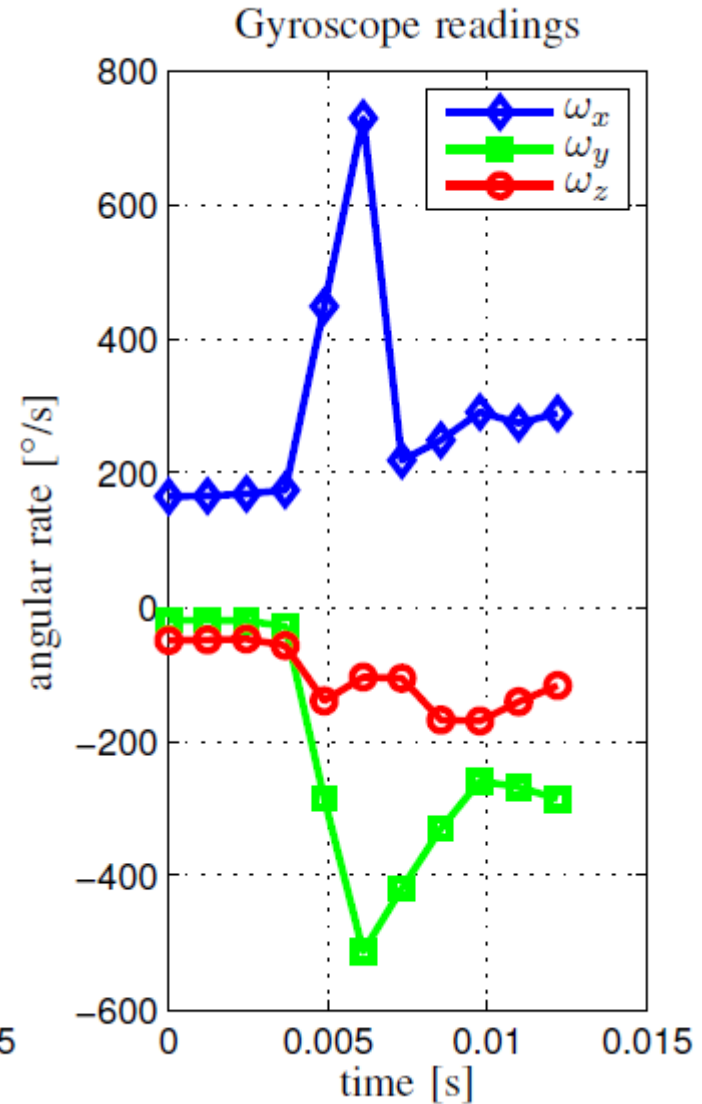
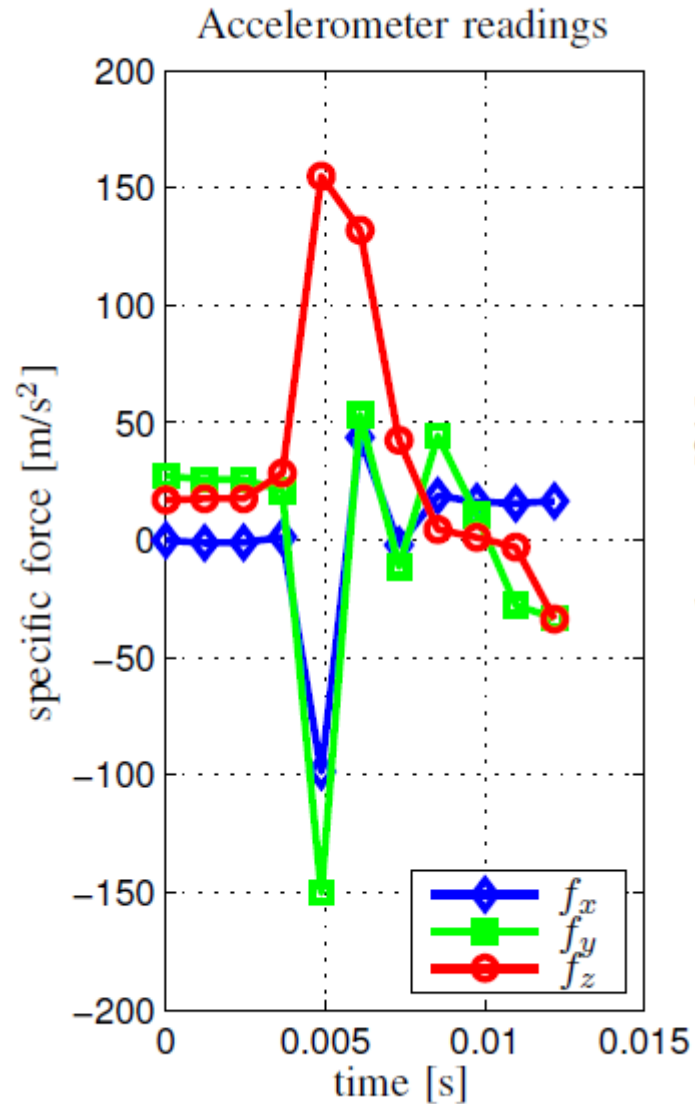




# Innovation sequence



# Finite bandwidth



# Summary

- The situation for estimating systematic sensor errors with ZUPTs is poor
  - A multitude of systematic errors which are not due to systematic sensor errors
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## Conclusion

- There are significant modeling errors in the system in addition to sensor errors

## Implication

- Be careful when combining ZUPTs and sensor error modeling
  - Improved motion models rather than improved error models
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The end