July 31, 2025

Understanding SQZ Mode-mismatch

Interim Presentation

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Project Goal and Roadmap

Problem:

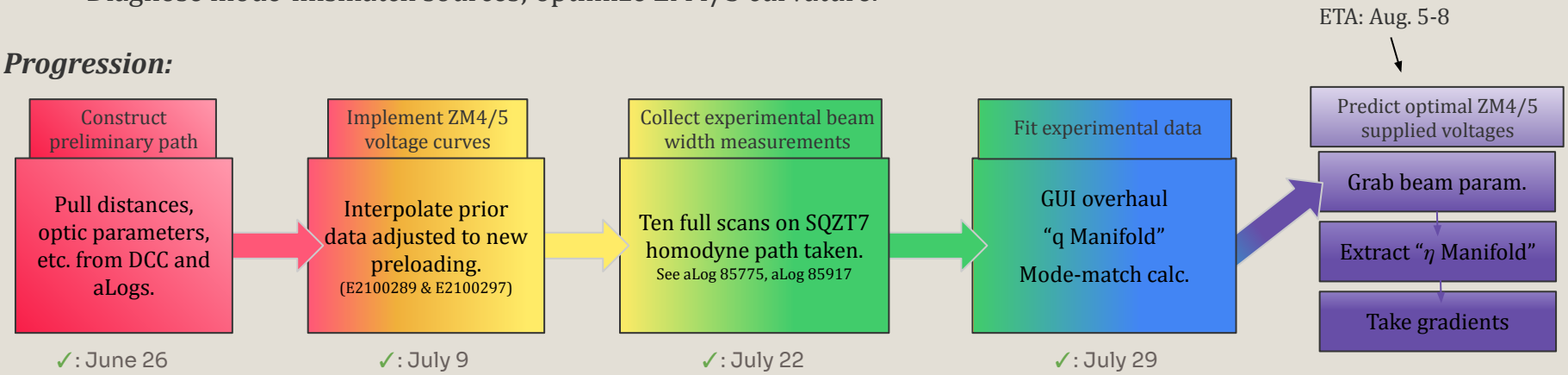
Mode-mismatch from SQZ may account for unexplained losses, we want to minimize such behavior.

Project outcomes:

Characterize beam from SQZ → OMC.

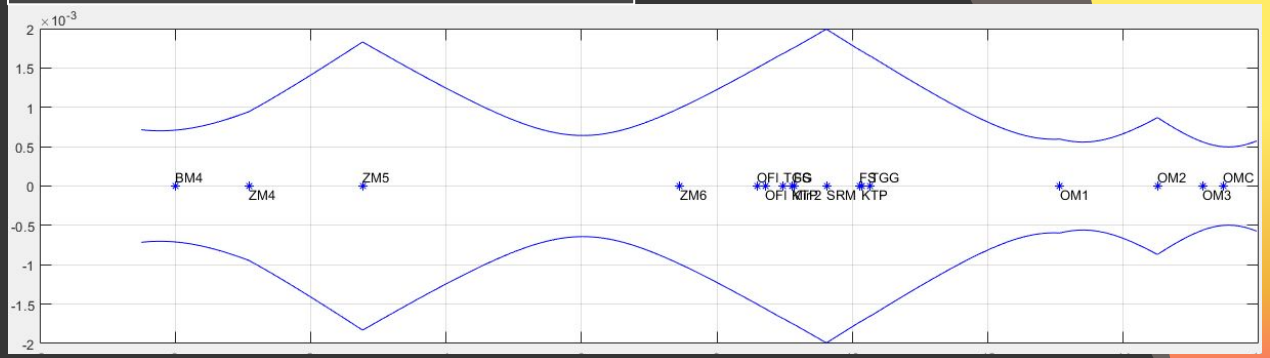
Diagnose mode-mismatch sources; optimize ZM4/5 curvature.

Progression:

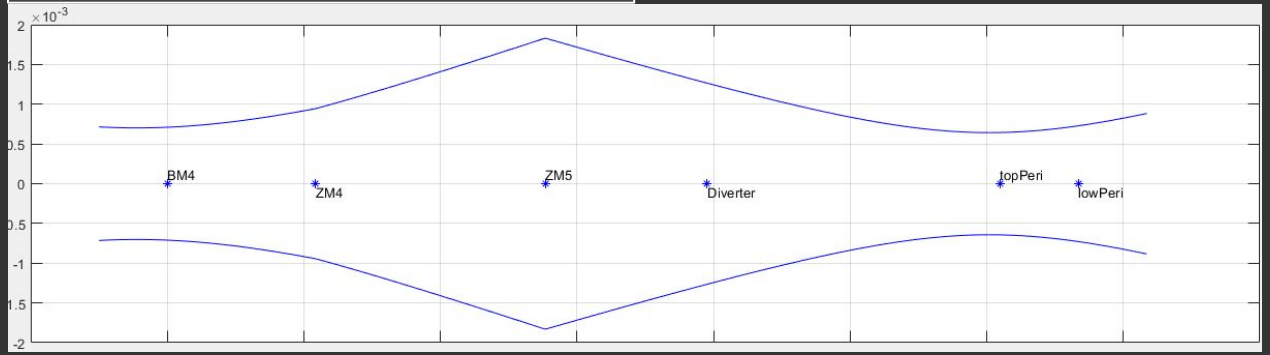


Version 1: *alm_SQZsim.m*

Beam width from SQZ to OMC



Beam width from SQZ to SQZT7



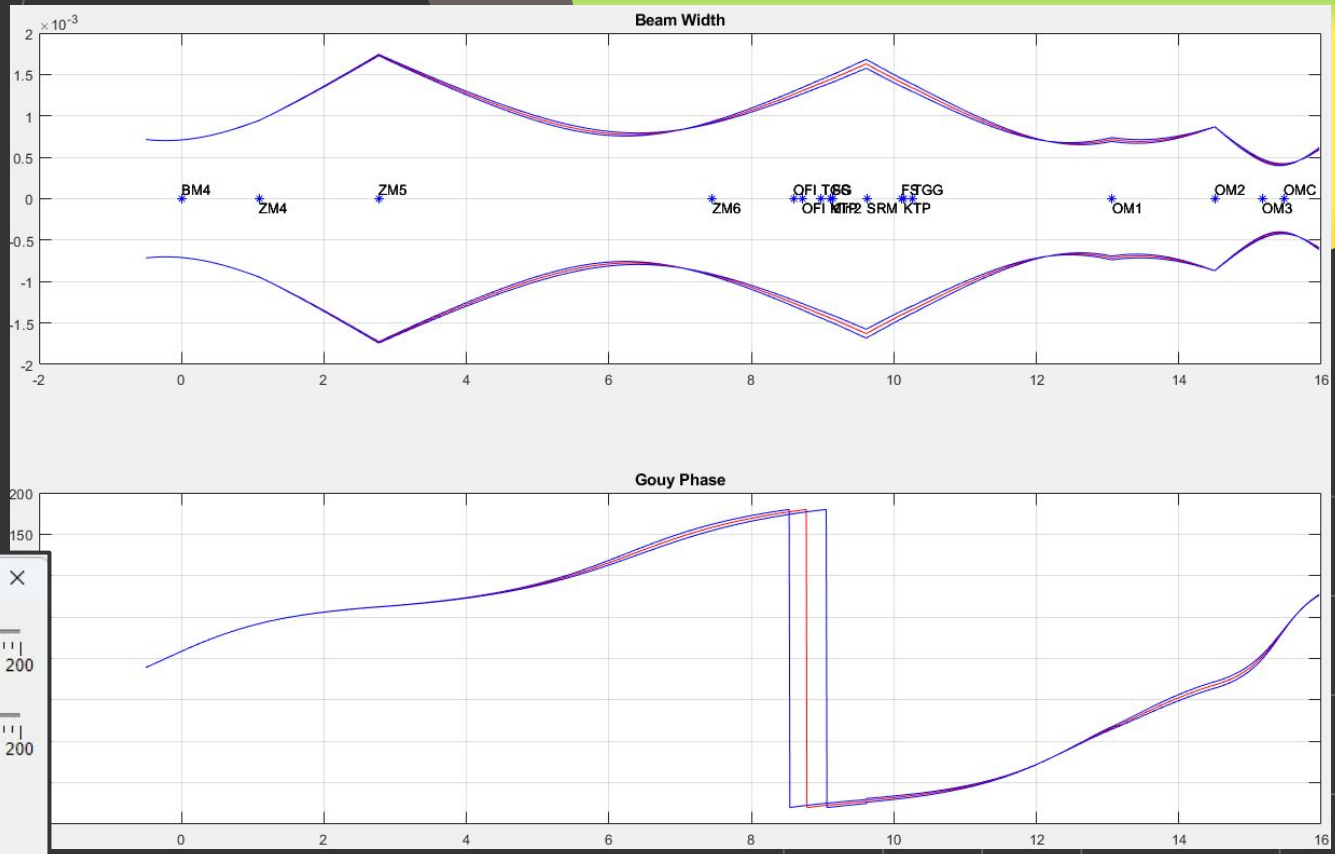
All measurement sources are documented in the respective Matlab scripts.

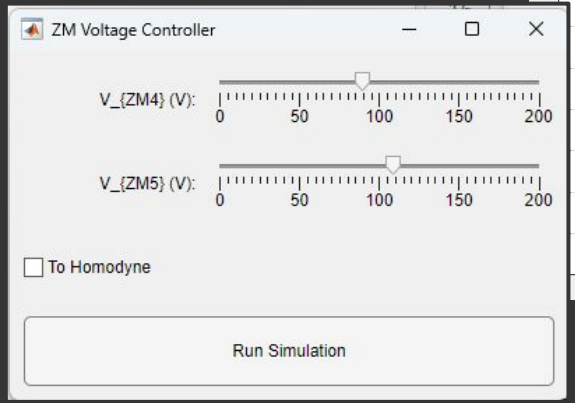
https://git.ligo.org/leendert.schrader/alm-beam-simulation-for-sqz

Version 2: *SQZ_simulation_gui.m*

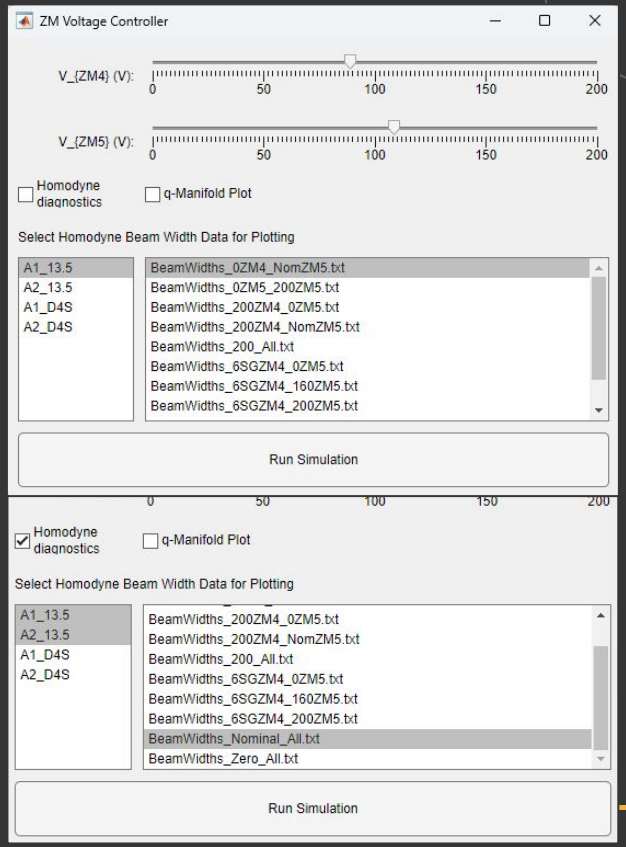
- Liberal estimates of ZM4/5 RoC error.

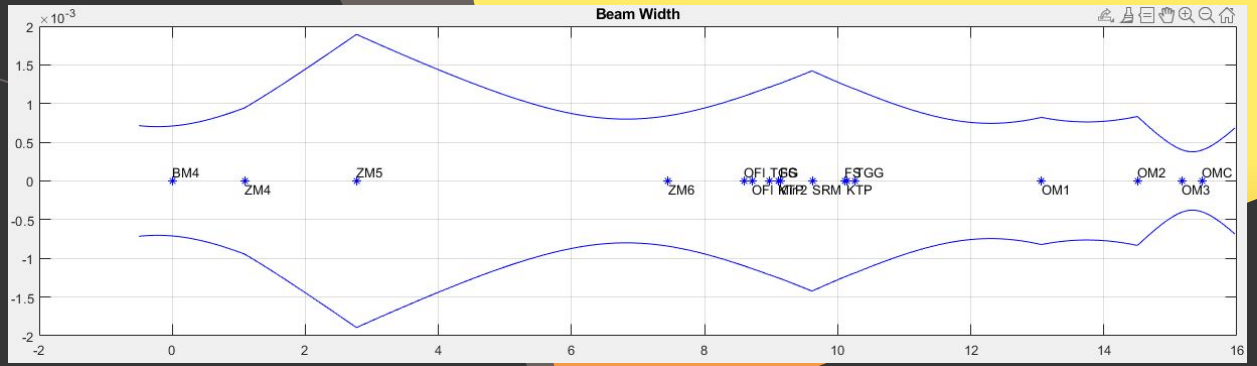
- Needed full range data on ZM4/5 to check accuracy rigorously.





Version 3: *SQZ_simulation_v3.m*



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Voltage to ZM4 = 89.2; Est. ZM4 RoC = -10.3591
Voltage to ZM5 = 109; Est. ZM5 RoC = 3.8832

Target Overlap = 0.95681
>>
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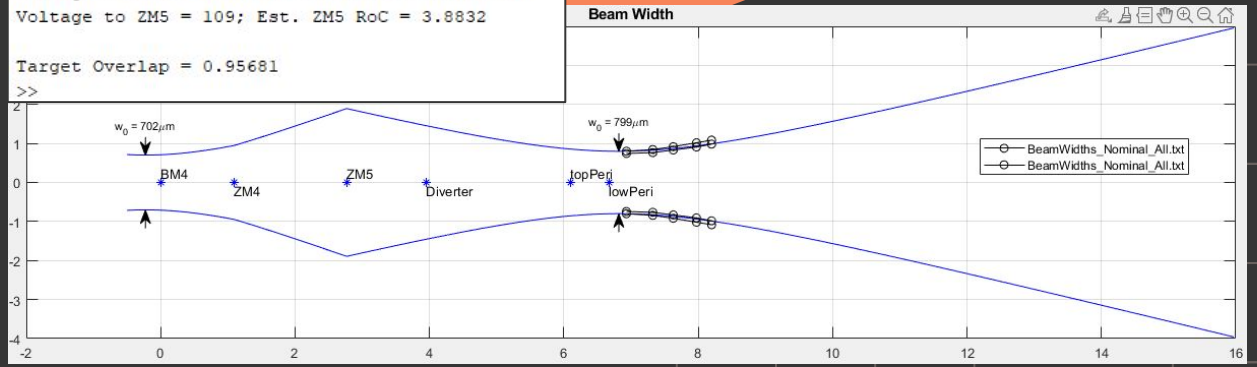
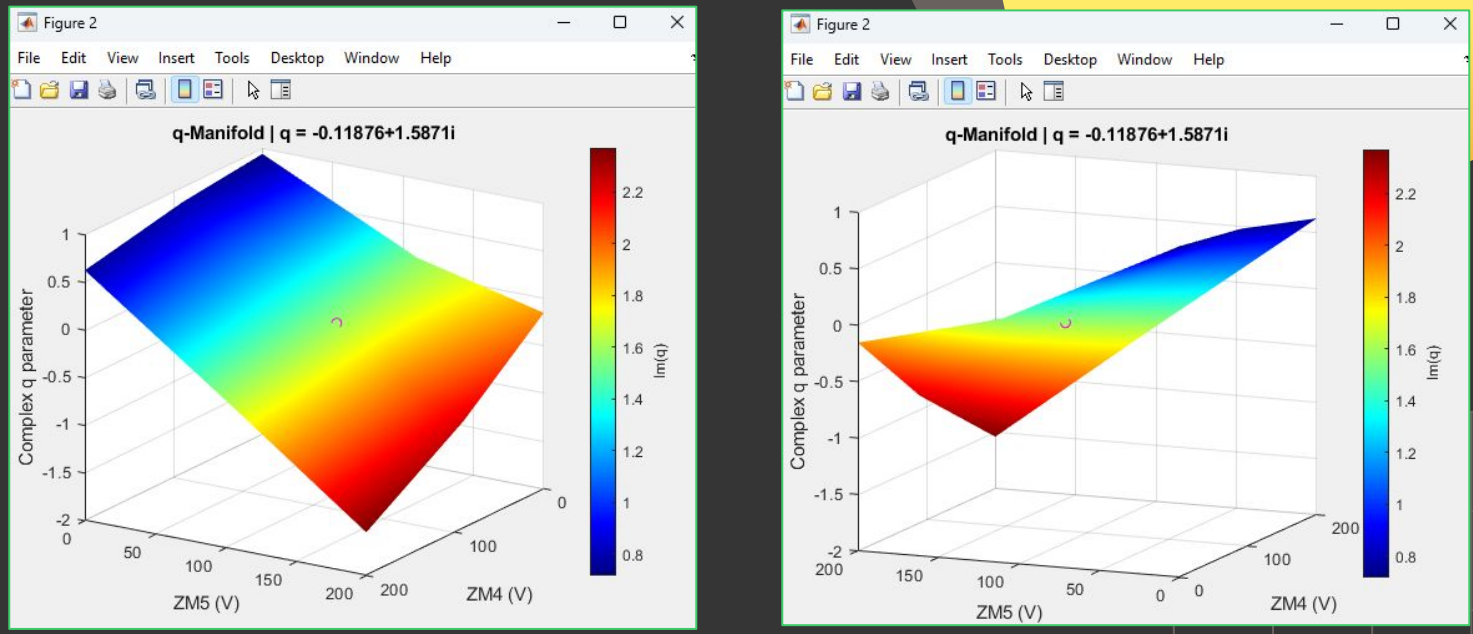


Version 3: *SQZ_simulation_v3.m, q-Manifold*

Q: How do we calculate mode overlap?
A: Macro-level interpolation of SQZT7 data.

q Manifold with Nominal Voltages



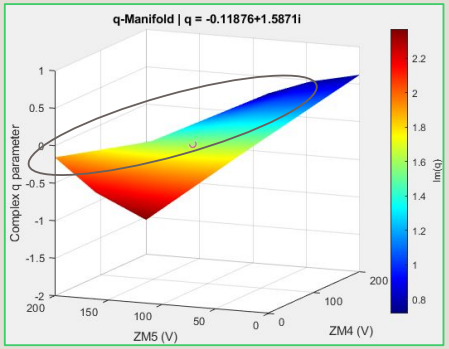
Using this method, we need only input voltages.
We back-propagate this q value to obtain ZM4/5 curvatures.

Next Steps

Current Issue:

ZM4/5 curvature calculations collapse at “extreme” voltage combinations.

Why? Nonlinearity and perturbations in ZM4.



What comes next?

1. Need a second q manifold for vertical width measurements.

2. Build “η manifold”, a plot of mode-match efficiency w.r.t. q manifold. Yields mode-match maxima, and thus optimal V_{ZM4}, V_{ZM5}.

(hypothetical η manifold)