OSCAR simulations update

Phase images in the single arm lock

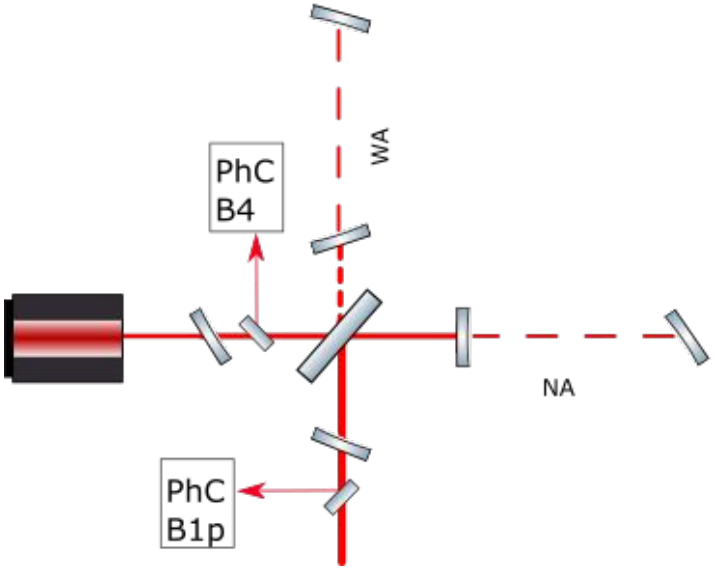
R. Cabrita, J. Degallaix, J. v. Heijningen

Optical ITF tuning meeting 22 November 2022

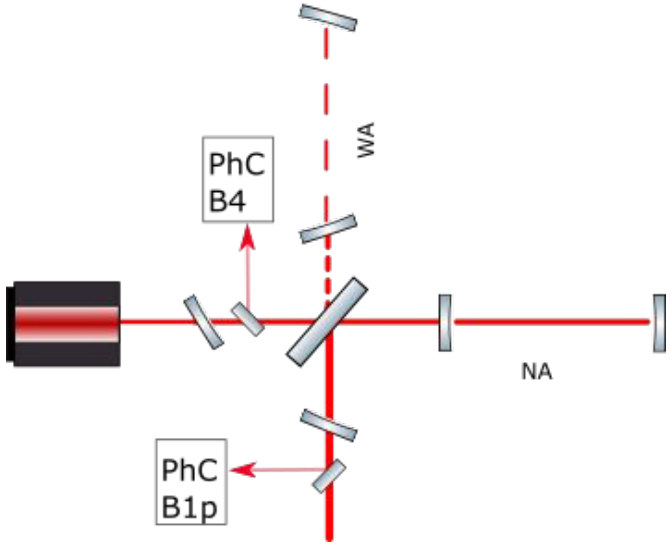
ricardo.cabrita@uclouvain.be

Phase Camera (PhC) measurement 1st April - refresher

- Measure reflected input beam - single bounce



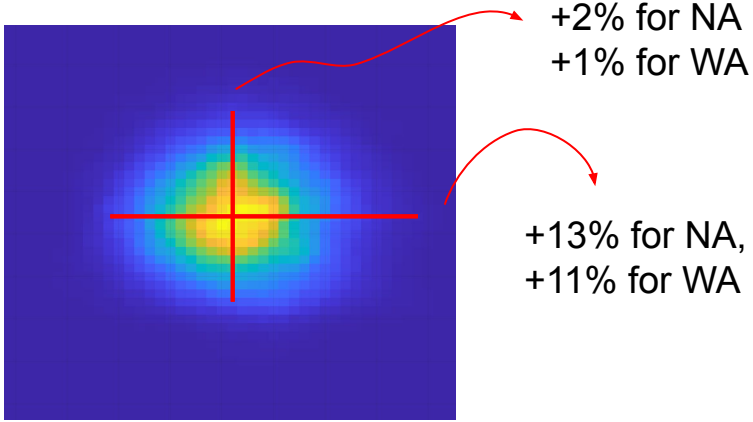
- Measure beam reflected from locked arm cavity.



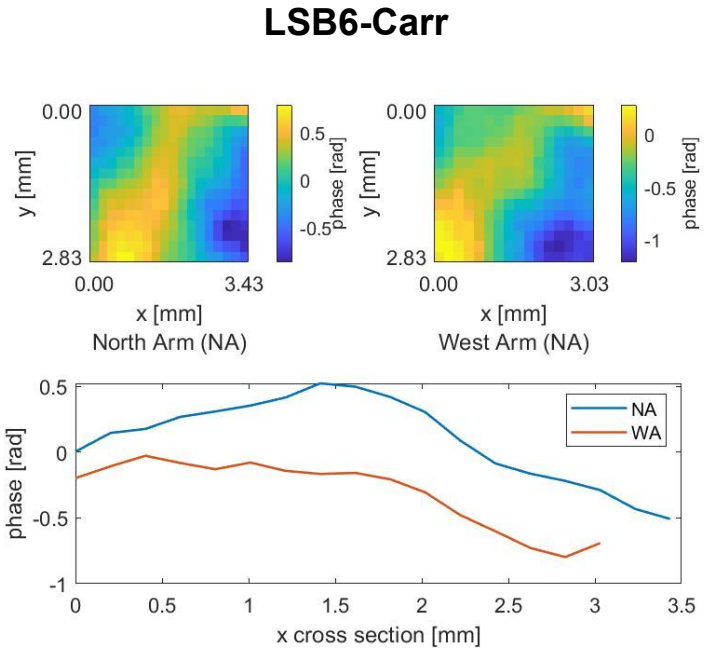
Phase camera data should be the same if mode matching is perfect

Phase camera measurement 1st April - refresher

Carrier reflected beam size ratio



Reflected beam phase information (when arm is locked)

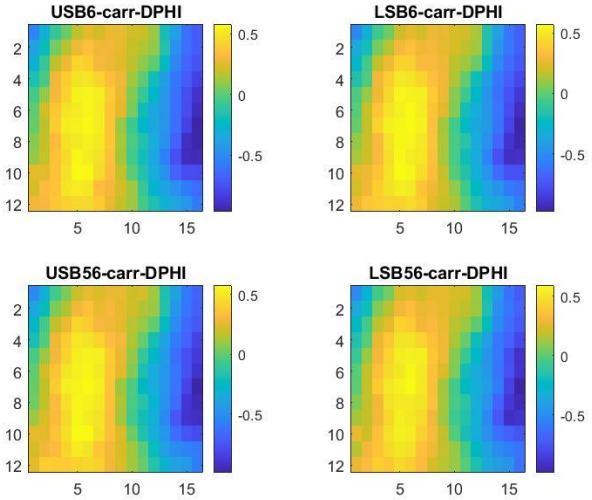


- Larger reflected beam when locked, points to an **input beam that is smaller than nominal**
  - Need to understand astigmatism
- Concave cross section could point to **larger input beam wavefront curvature than nominal**
  - Need to understand phase features

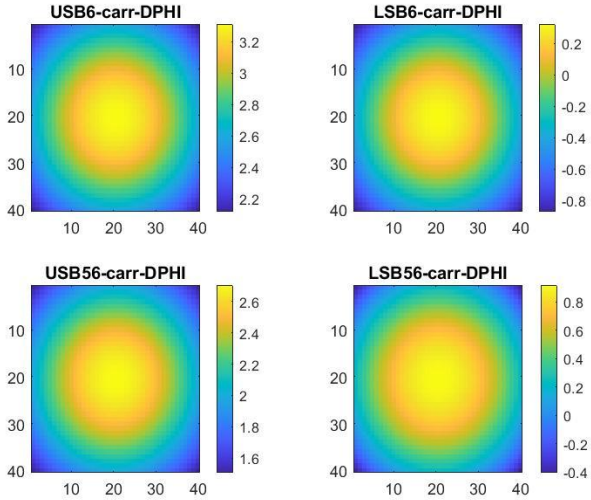
Phase camera measurement 1st April - refresher

Context: Check if phase deformation could be caused by tilting of cavity mirrors

Data measured on-site (1 April)

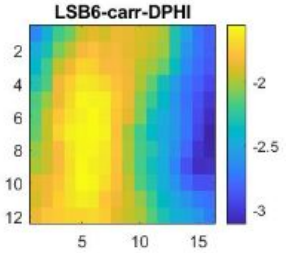


Simulation with comparable pure mode mismatch

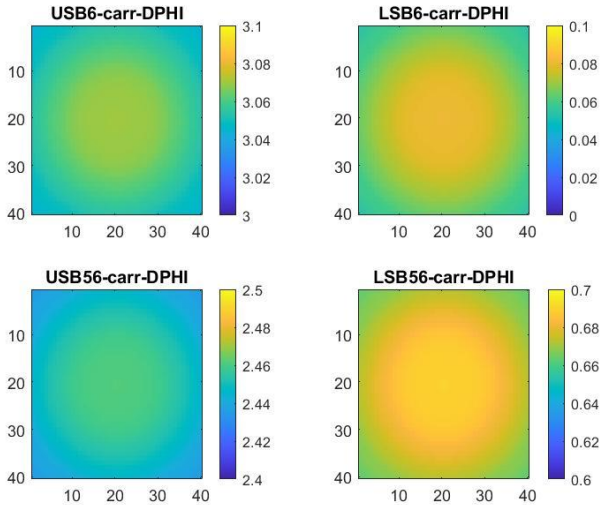


Cavity mirror tilt impact on phase images

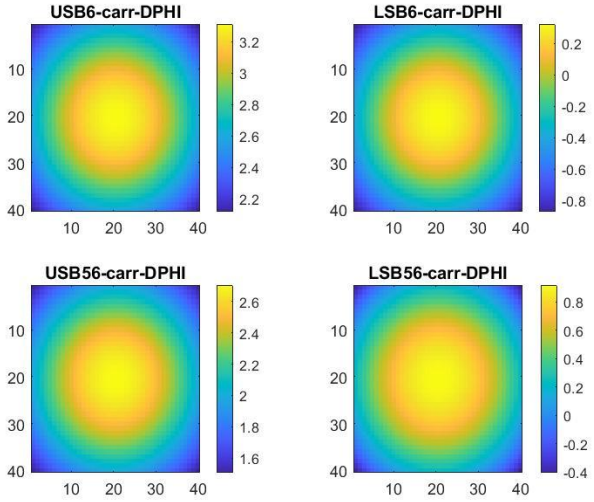
Context: Check if phase deformation could be caused by tilting of cavity mirrors



Without mode mismatch



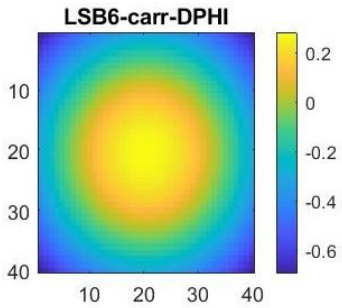
Simulation with comparable pure mode mismatch



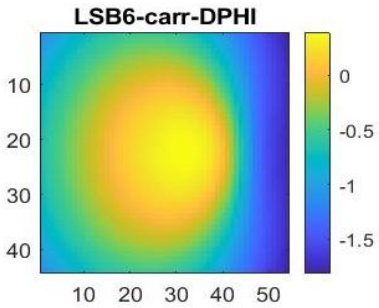
Tilt in x direction of end mirror

Simulation: arm cavity, with some mismatch and tilt (in x direction) of end mirror

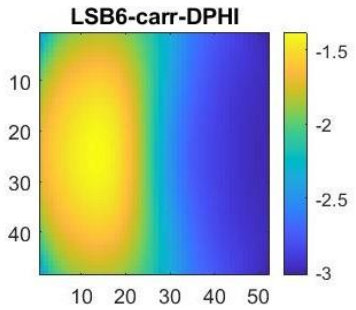
No tilt



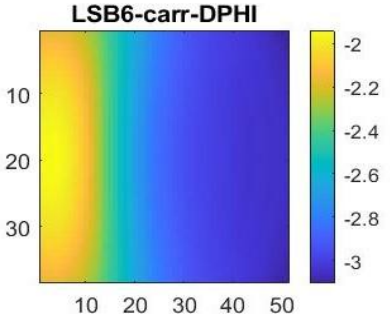
0.5 urad tilt



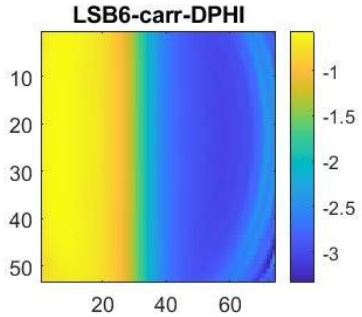
1.4 urad tilt

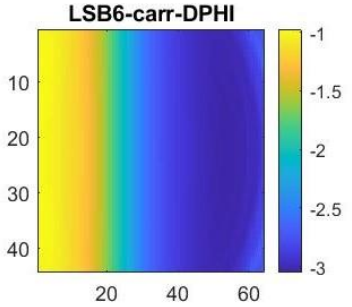


1.5 urad tilt



No mode mismatch

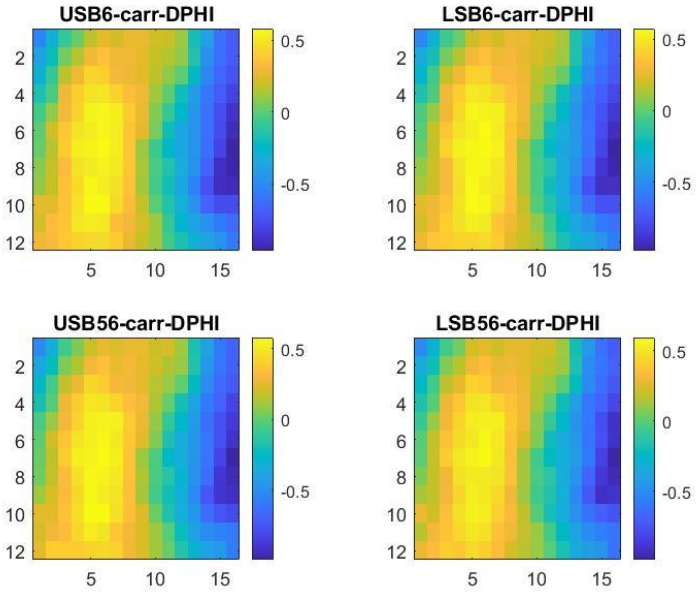




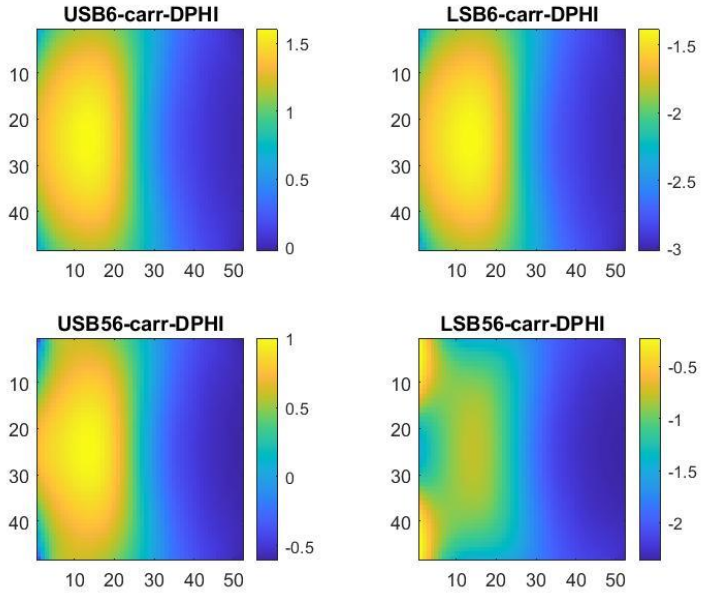
Tilt in x direction of end mirror - comparison

Simulation: “Perfect interferometer”, with some mismatch and tilt (in x direction) of end mirror

Data form NA lock (1 april)



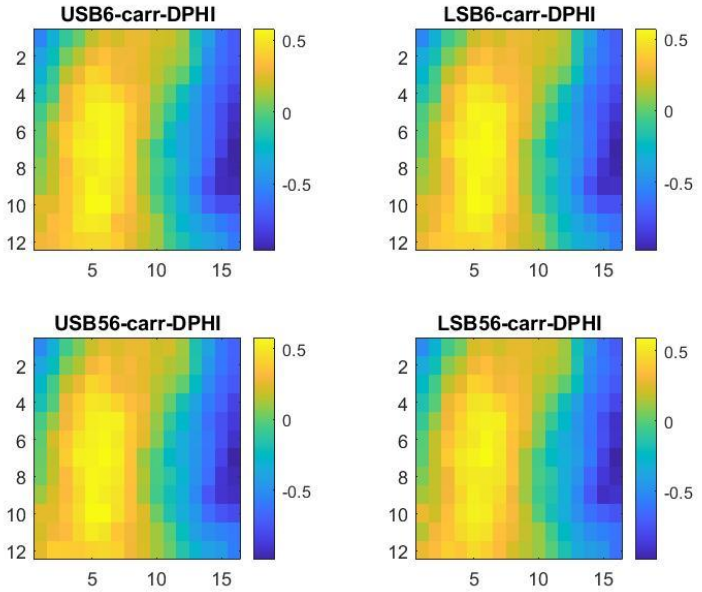
1.4 urad tilt



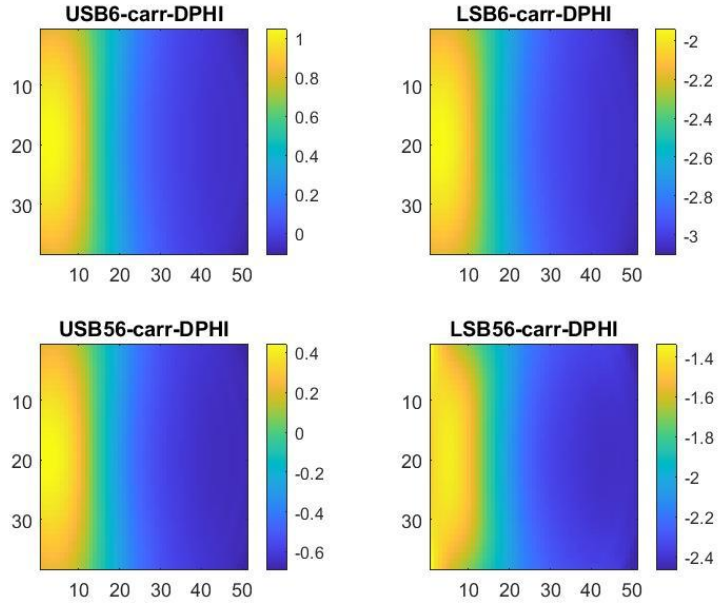
Tilt in x direction of end mirror - comparison

Simulation: “Perfect interferometer”, with some mismatch and tilt (in x direction) of end mirror

Data form NA lock (1 april)



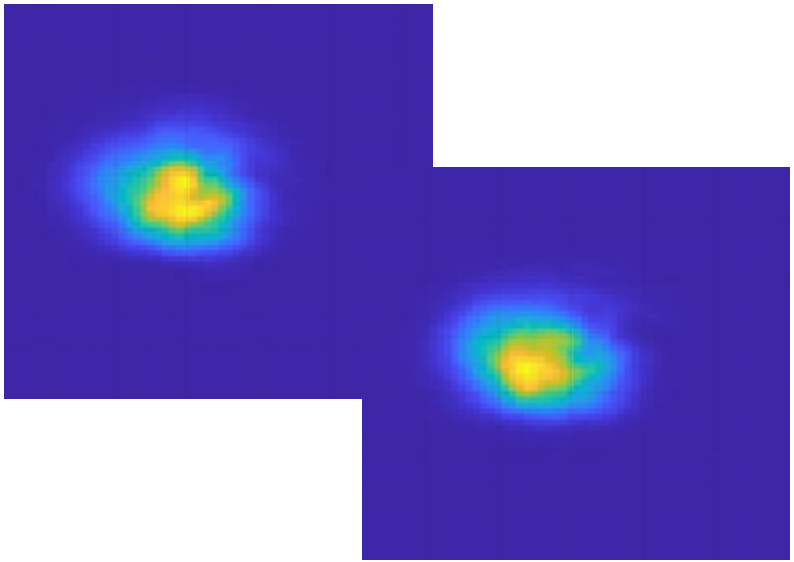
1.5 urad tilt



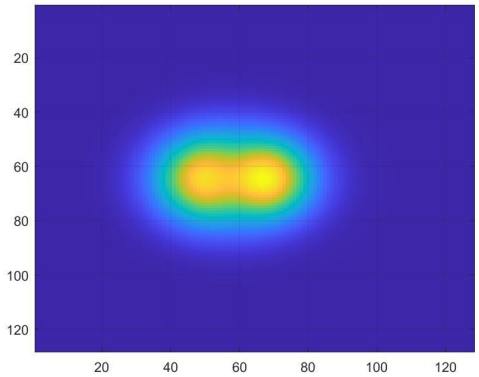
Tilt in x direction of end mirror - carrier comparison

Simulation: “Perfect interferometer”, with some mismatch and tilt (in x direction) of end mirror

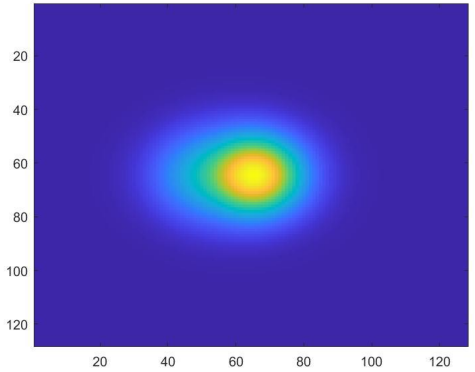
Data form NA lock (1 april - 2 examples)



sim. 1.4 urad tilt



sim. 1.5 urad tilt

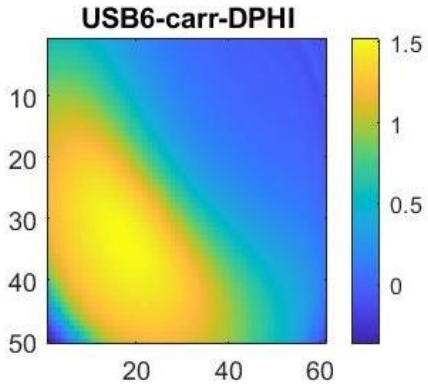


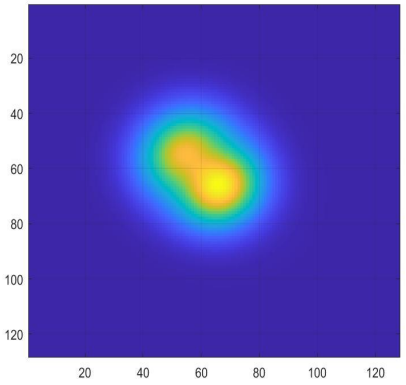
This could also explain the increased astigmatism in x direction when cavity is locked

Tilt in x/y direction of end mirror

Simulation: “Perfect interferometer”, with some mismatch and tilt (in x and y direction) of end mirror

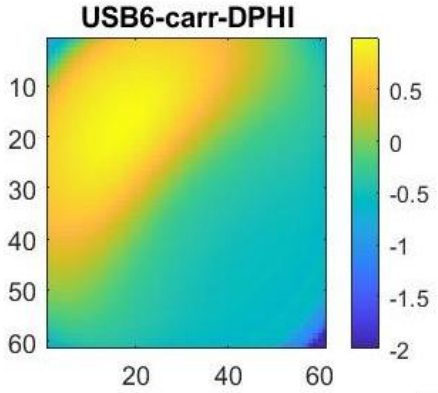
1 urad in x, 1 urad in y

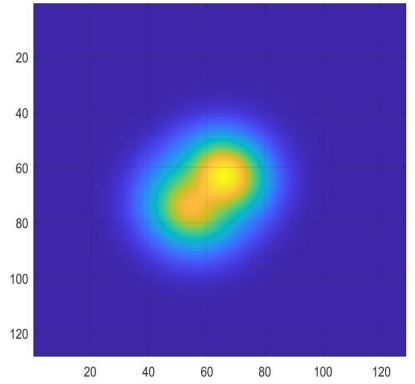




This rotation of the beam was not observed in the measured data!

1 urad in x, -1 urad in y

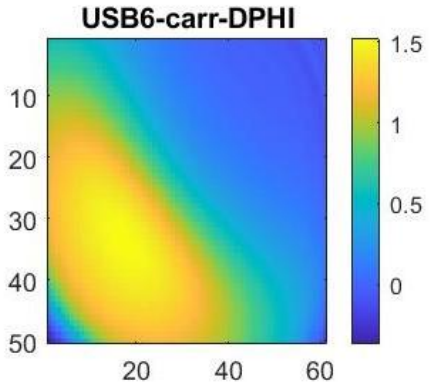




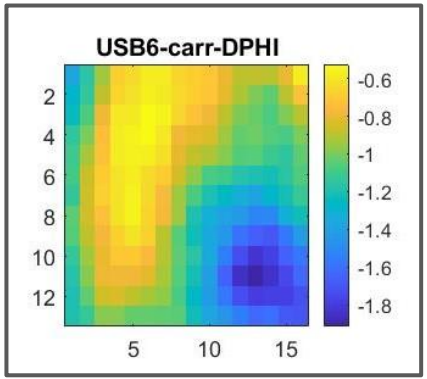
Tilt in x/y direction of end mirror

Simulation: “Perfect interferometer”, with some mismatch and tilt (in x and y direction) of end mirror

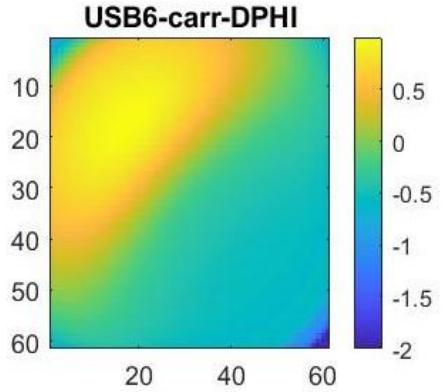
1 urad in x, 1 urad in y



WA lock



1 urad in x, -1 urad in y



This rotation of the beam was not observed in the measured data!

Summary

- End mirror tilt in x direction could explain phase image “elongation” and astigmatism in intensity image
  - Need to understand simulated carrier image - how it evolves with increasing tilt
  - Check how carrier shape looks just with tilt - can we disentangle the two ?

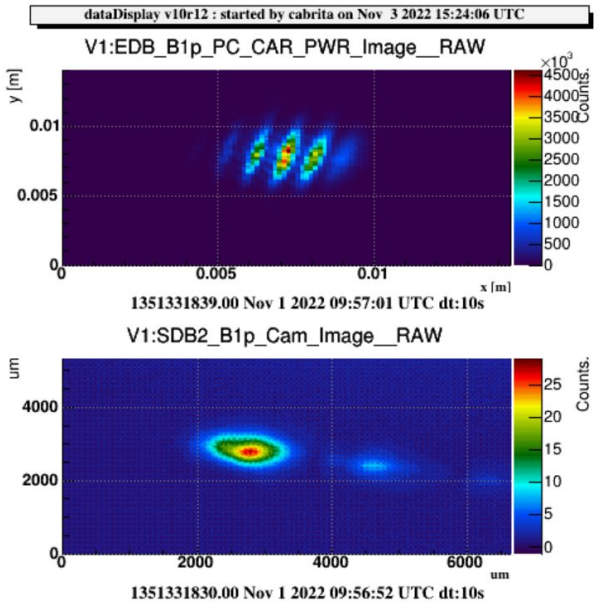
- End mirror tilt in both x and y direction rotates beam - this was not observed with the measured data.

- Need to simulate tilt in input mirror to see what is the impact

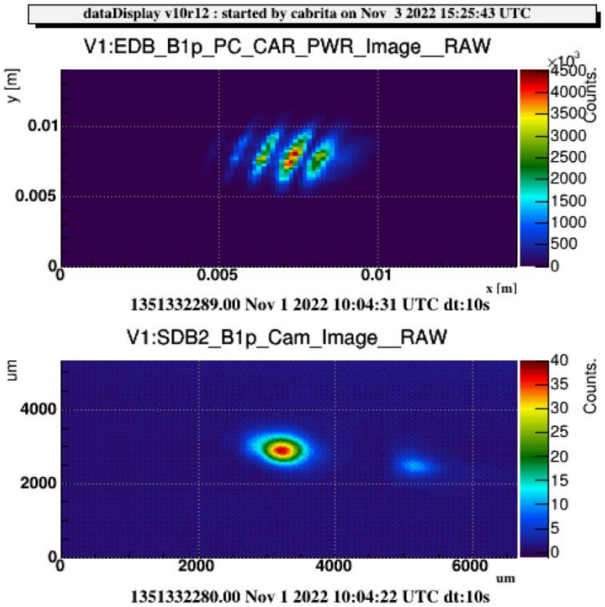
- Would be interesting to re-do the measurement in the new working point we have now - also because the measurement on the 1st of April was quite noisy
  - Cannot re-do the measurement because of fringe pattern on B1p (single bounce)

Extra - single bounce shape in B1p (Nov. 1st)

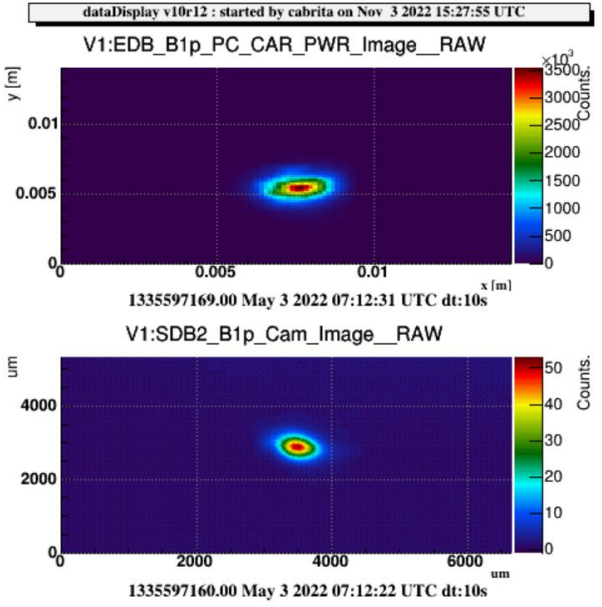
WI single bounce



NI single bounce

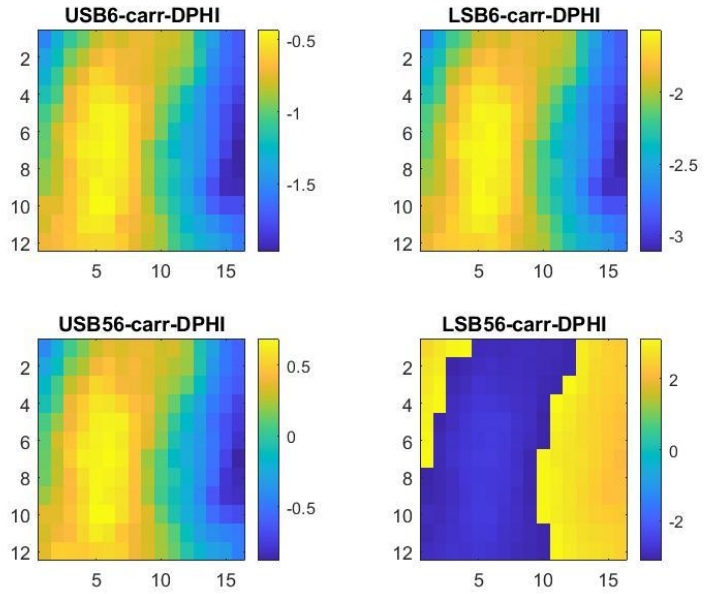


May 2 NI single bounce



Extra slide - phase unwrapping

Data form NA lock (1 april)



Data form NA lock (1 april - unwrapped)