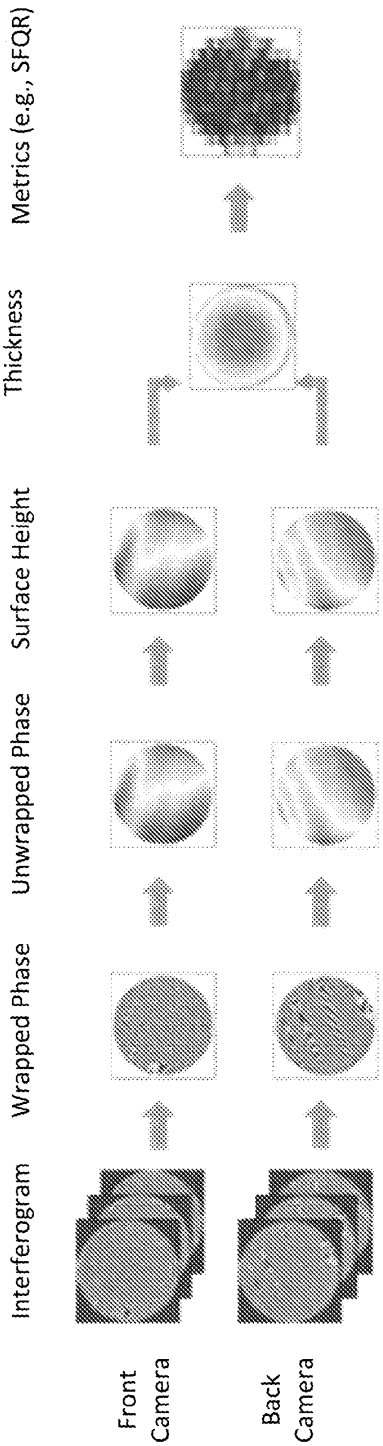


FIG. 1
(PRIOR ART)

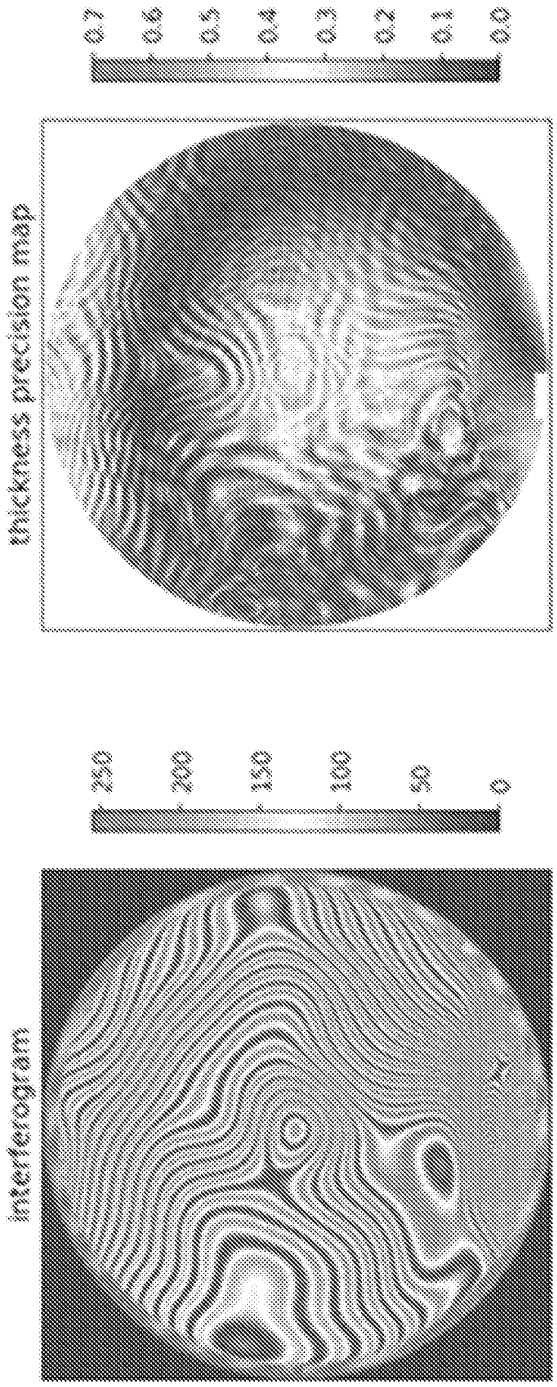


FIG. 2
(PRIOR ART)

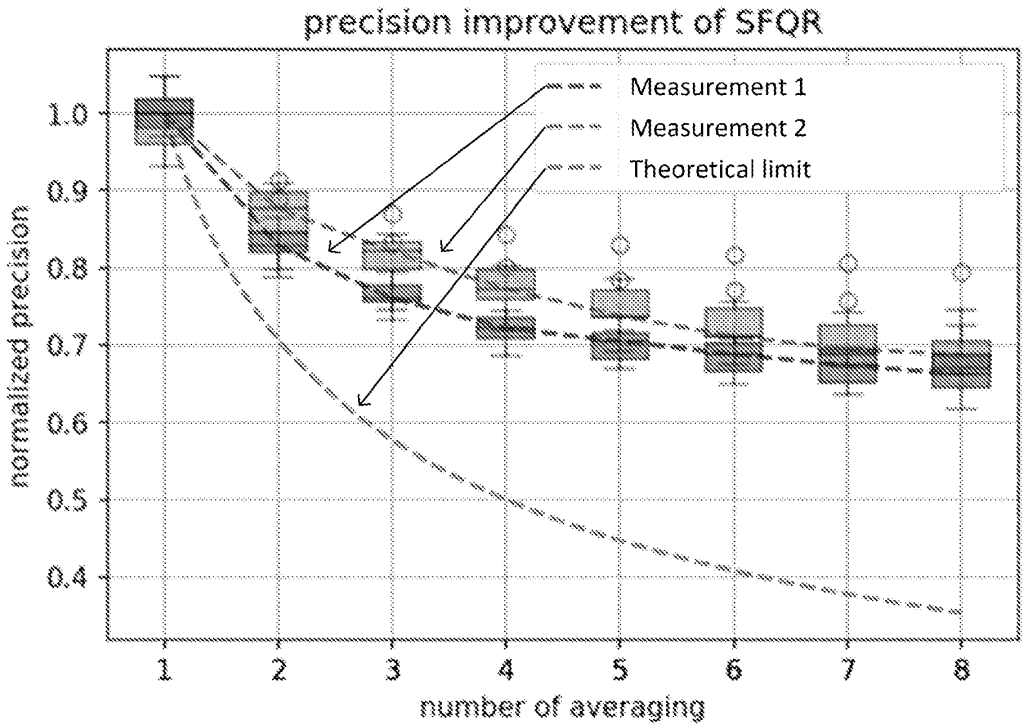


FIG. 3
(PRIOR ART)

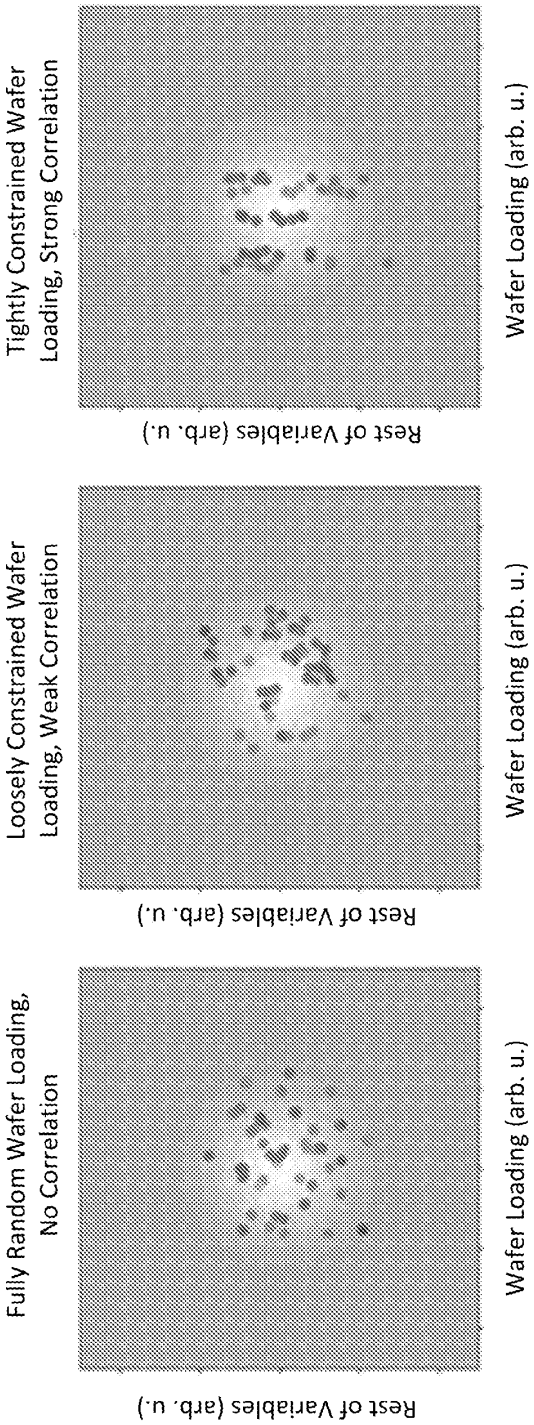

Fully Random Wafer Loading, No Correlation
Loosely Constrained Wafer Loading, Weak Correlation
Tightly Constrained Wafer Loading, Strong Correlation
Wafer Loading (arb. u.)
Rest of Variables (arb. u.)

FIG. 4

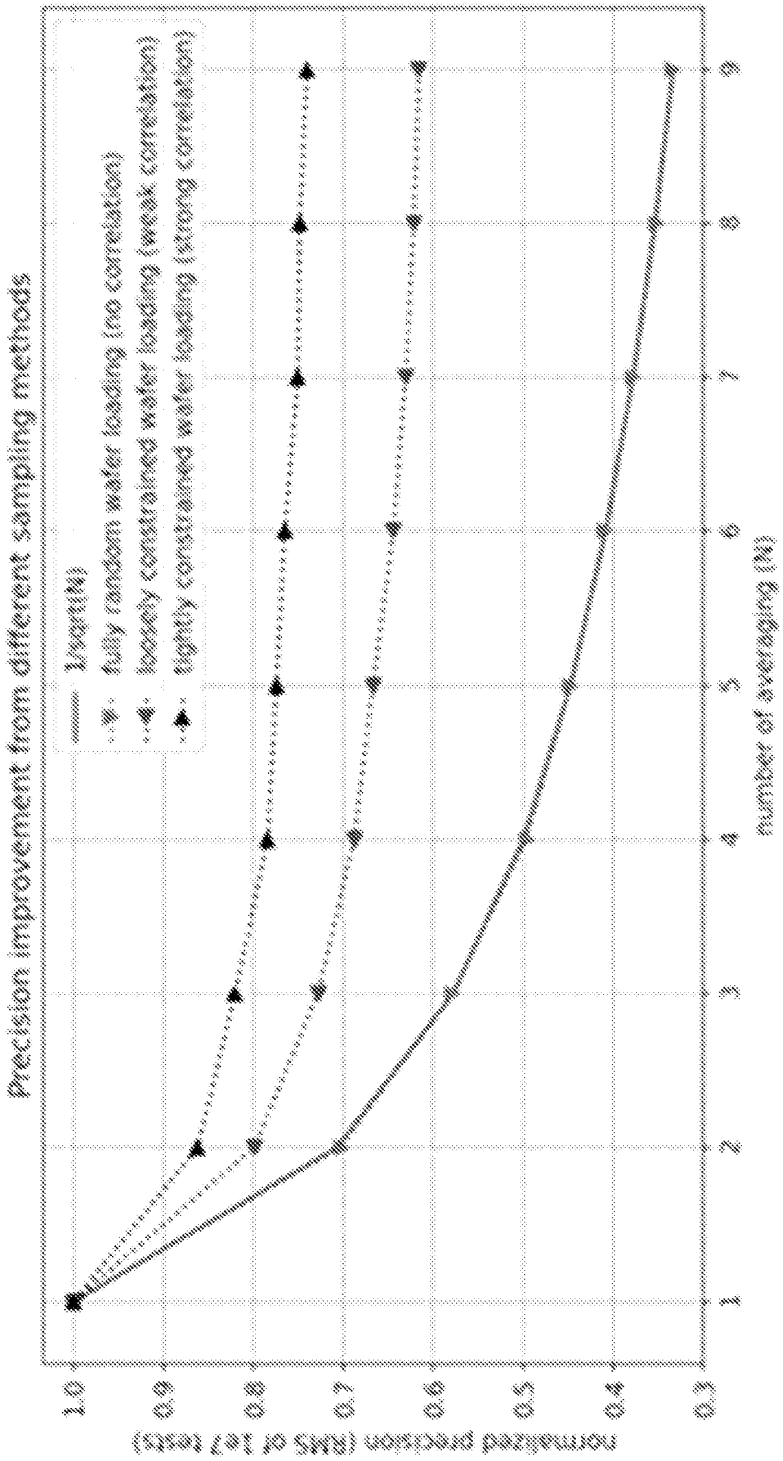

Precision improvement from different sampling methods
1/sqrt(N)
fully random water loading (no correlation)
loosely constrained water loading (weak correlation)
tightly constrained water loading (strong correlation)
normalized precision (RMS of 1e7 tests)
number of averaging (N)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1
2
3
4
5
6
7
8
9

FIG. 5

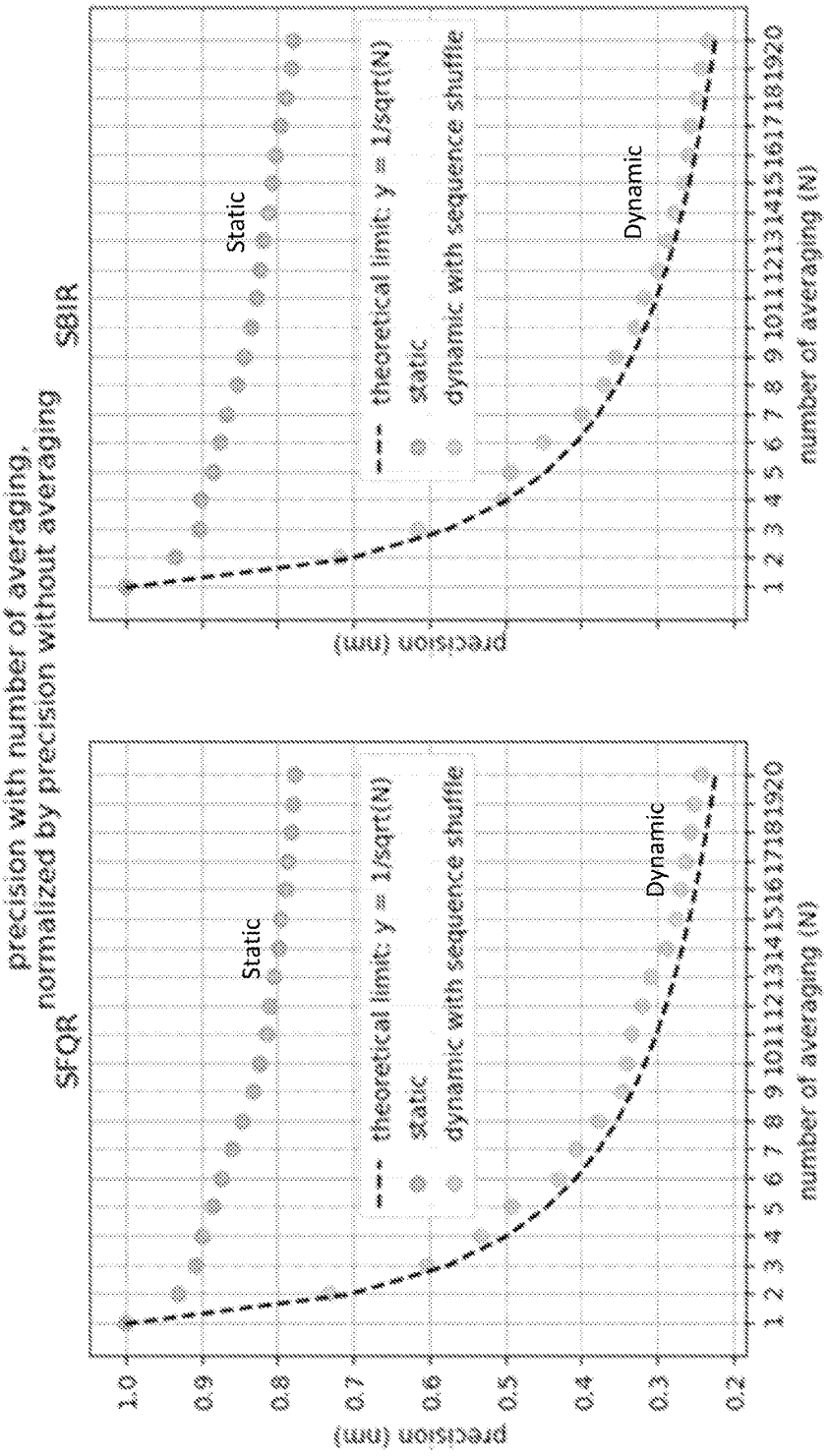

precision with number of averaging,
normalized by precision without averaging
SQR
SBR
precision (nm)
number of averaging (N)
theoretical limit: y = 1/sqrt(N)
static
dynamic with sequence shuffle
Static
Dynamic
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

FIG. 6

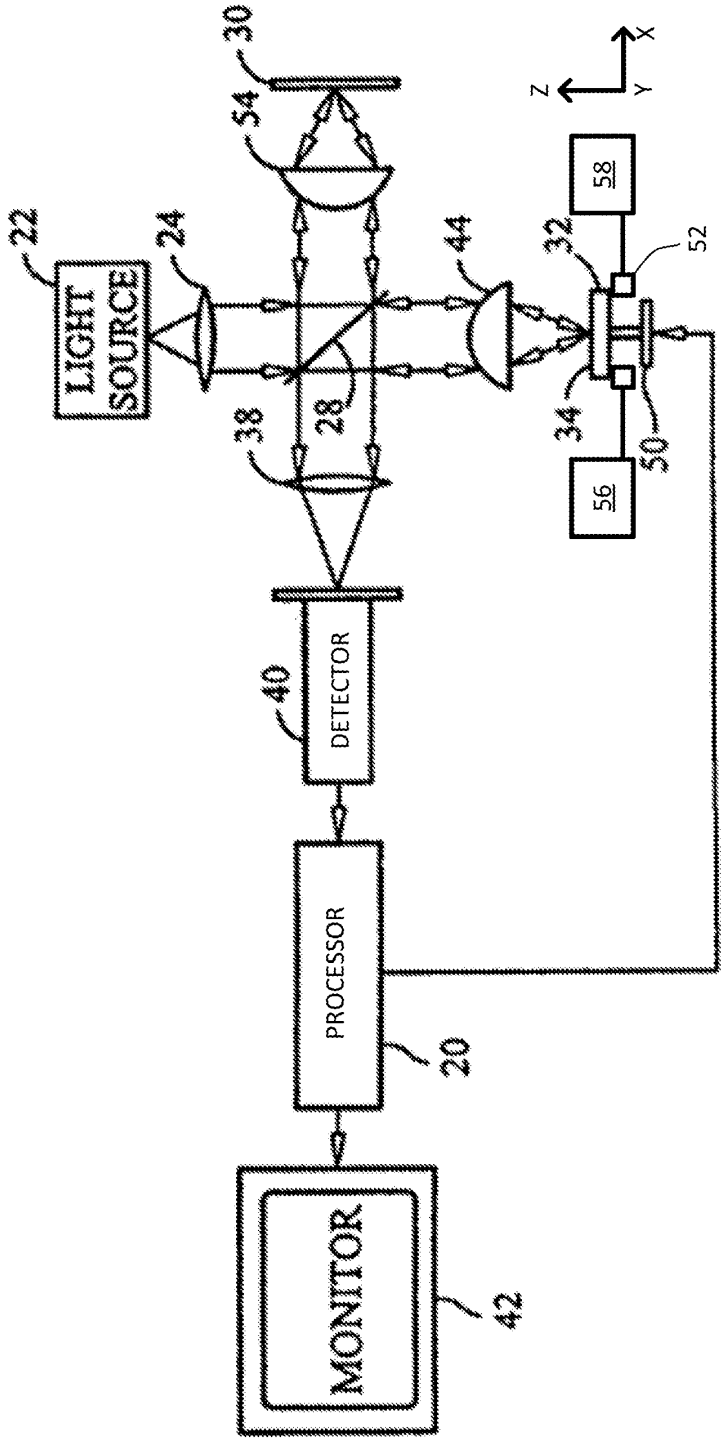

30
54
Z
X
Y
58
22
24
44
32
52
LIGHT SOURCE
38
28
34
50
56
40
DETECTOR
PROCESSOR
20
MONITOR
42

FIG. 7

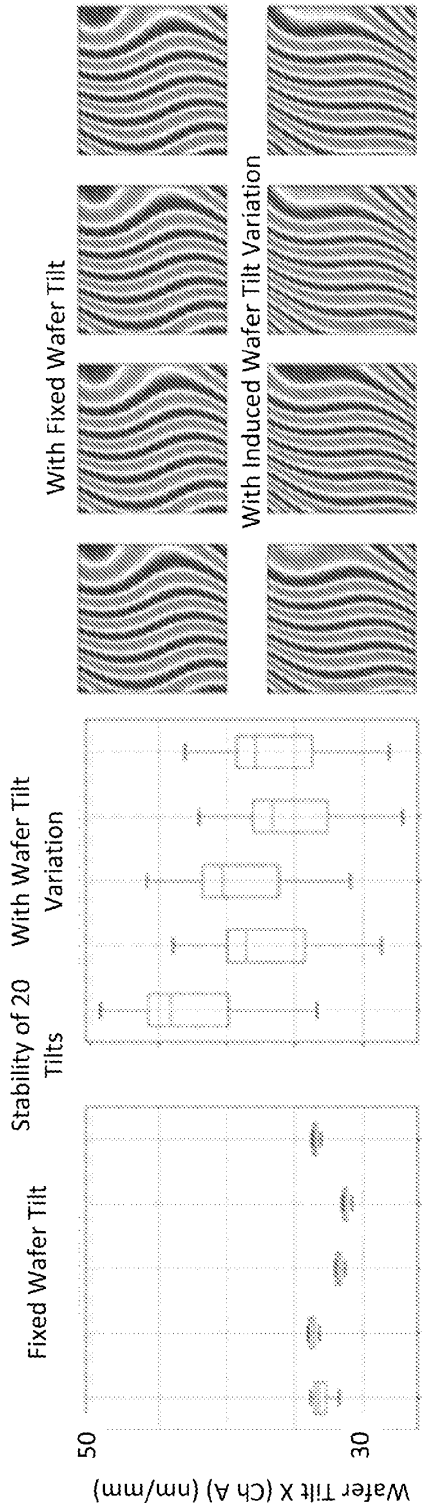

Wafer Tilt X (Ch A) (nm/mm)
50
30
Fixed Wafer Tilt
Cycle (1 to 5)
Stability of 20 Tilts
With Wafer Tilt Variation
Cycle (1 to 5)
With Fixed Wafer Tilt
With Induced Wafer Tilt Variation

FIG. 8

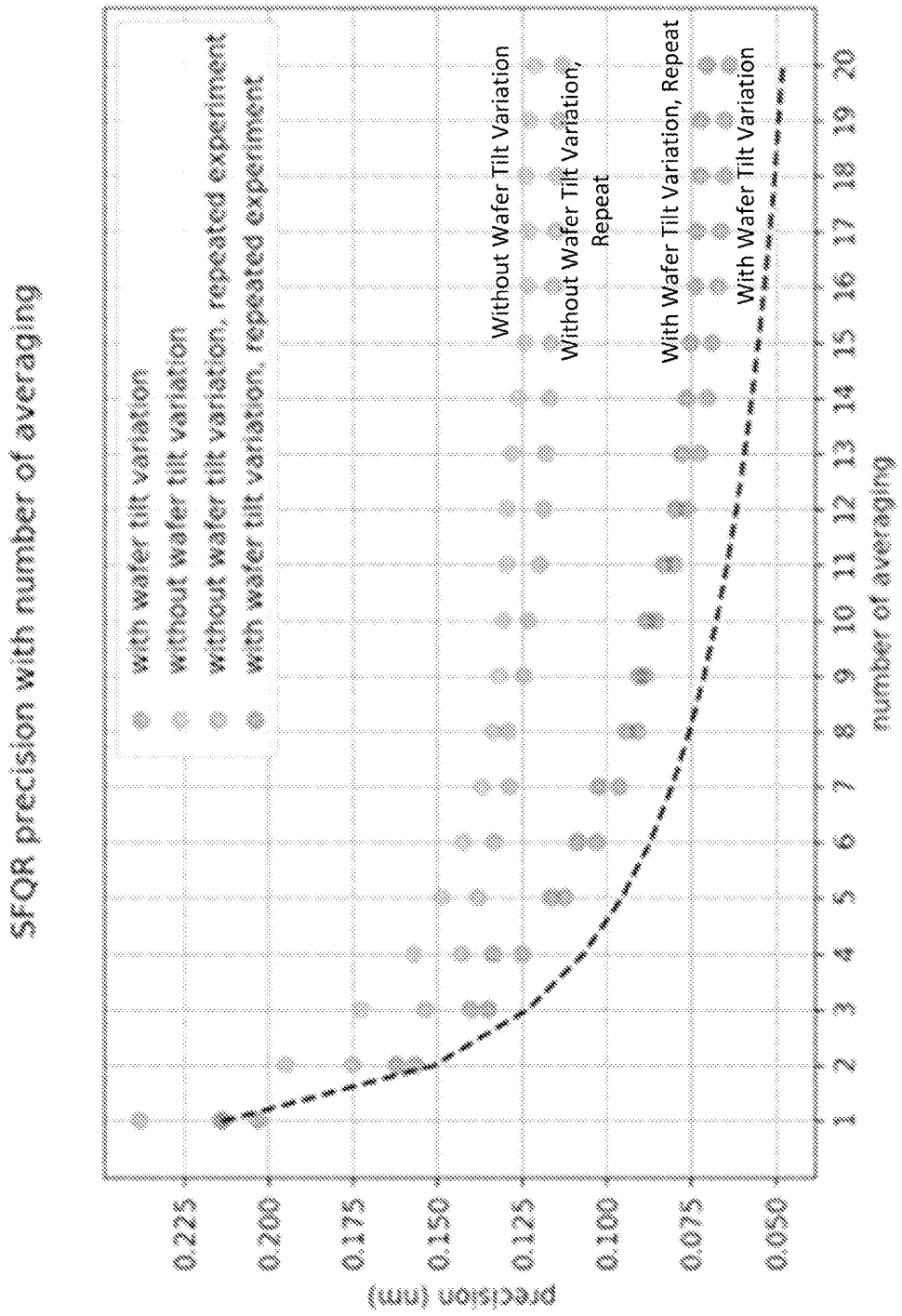

sFOR precision with number of averaging
with wafer tilt variation
without wafer tilt variation
without wafer tilt variation, repeated experiment
with wafer tilt variation, repeated experiment
Without Wafer Tilt Variation
Without Wafer Tilt Variation, Repeat
With Wafer Tilt Variation, Repeat
With Wafer Tilt Variation
precision (nm)
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
number of averaging
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

FIG. 9

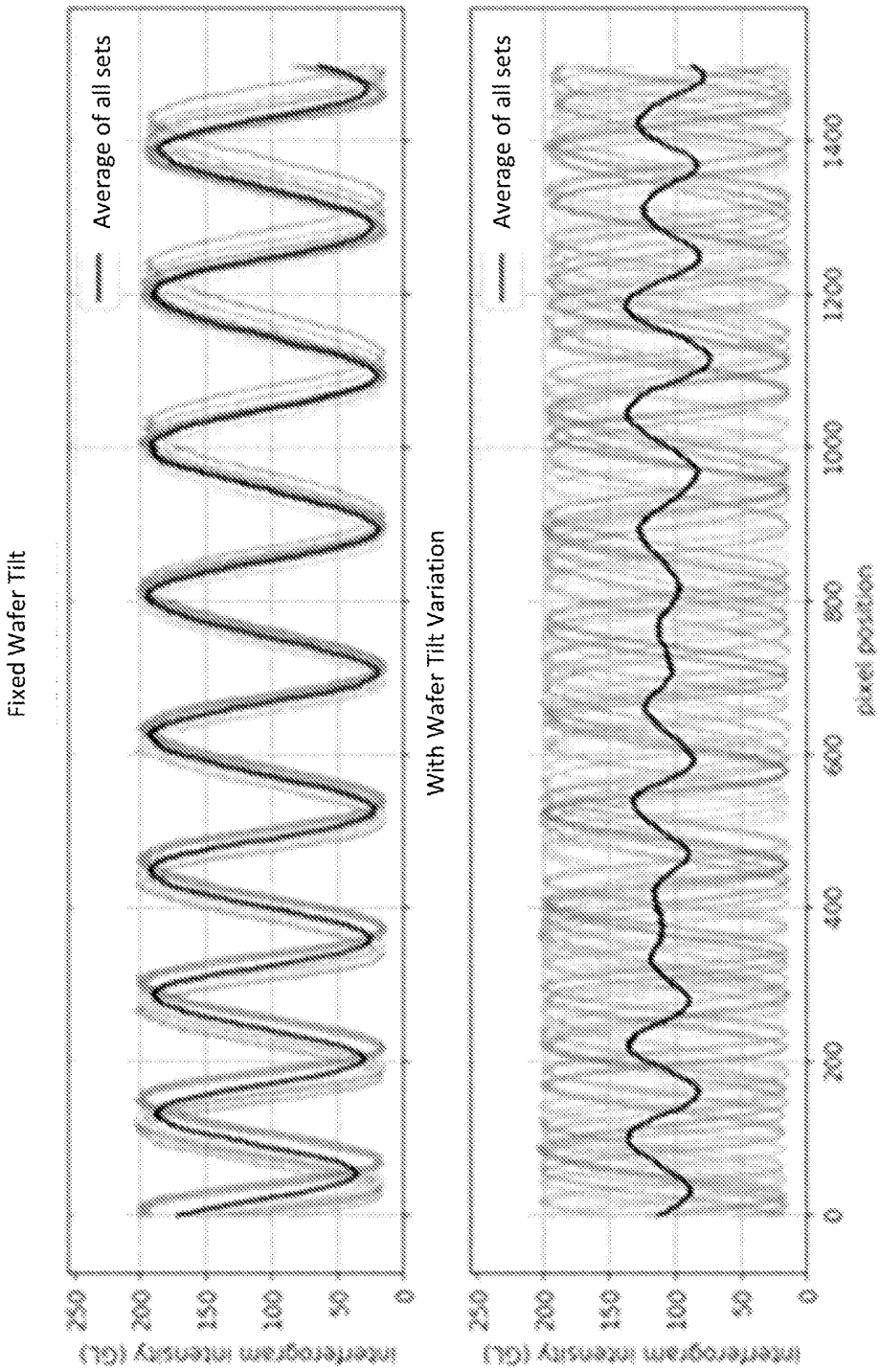

Fixed Wafer Tilt
With Wafer Tilt Variation
Average of all sets
Average of all sets
interferogram intensity (DL)
interferogram intensity (DL)
pixel position
0
200
400
600
800
1000
1200
1400
0
50
100
150
200
250

FIG. 10

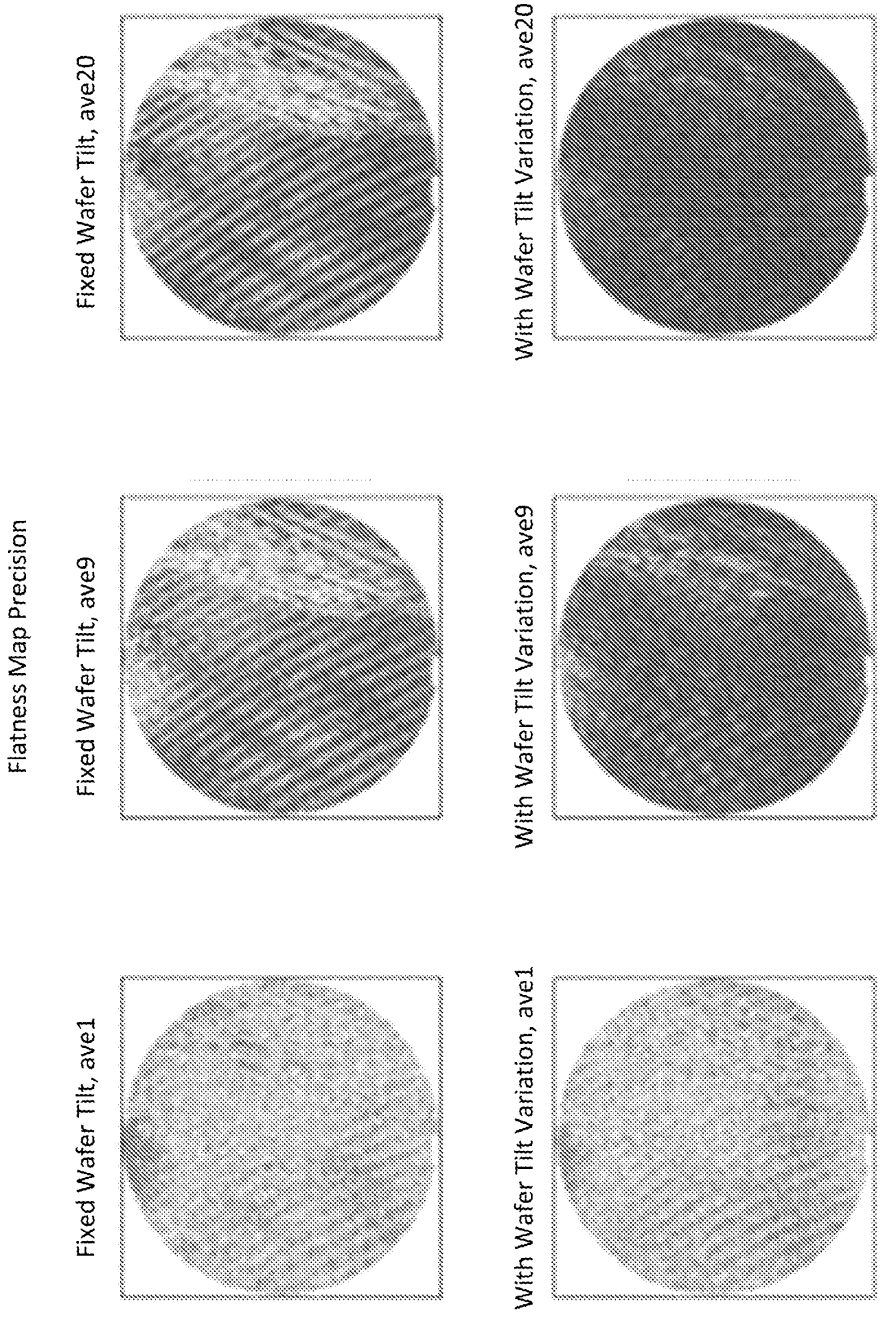

Flatness Map Precision
Fixed Wafer Tilt, ave20
With Wafer Tilt Variation, ave20
Fixed Wafer Tilt, ave9
With Wafer Tilt Variation, ave9
Fixed Wafer Tilt, ave1
With Wafer Tilt Variation, ave1

FIG. 11

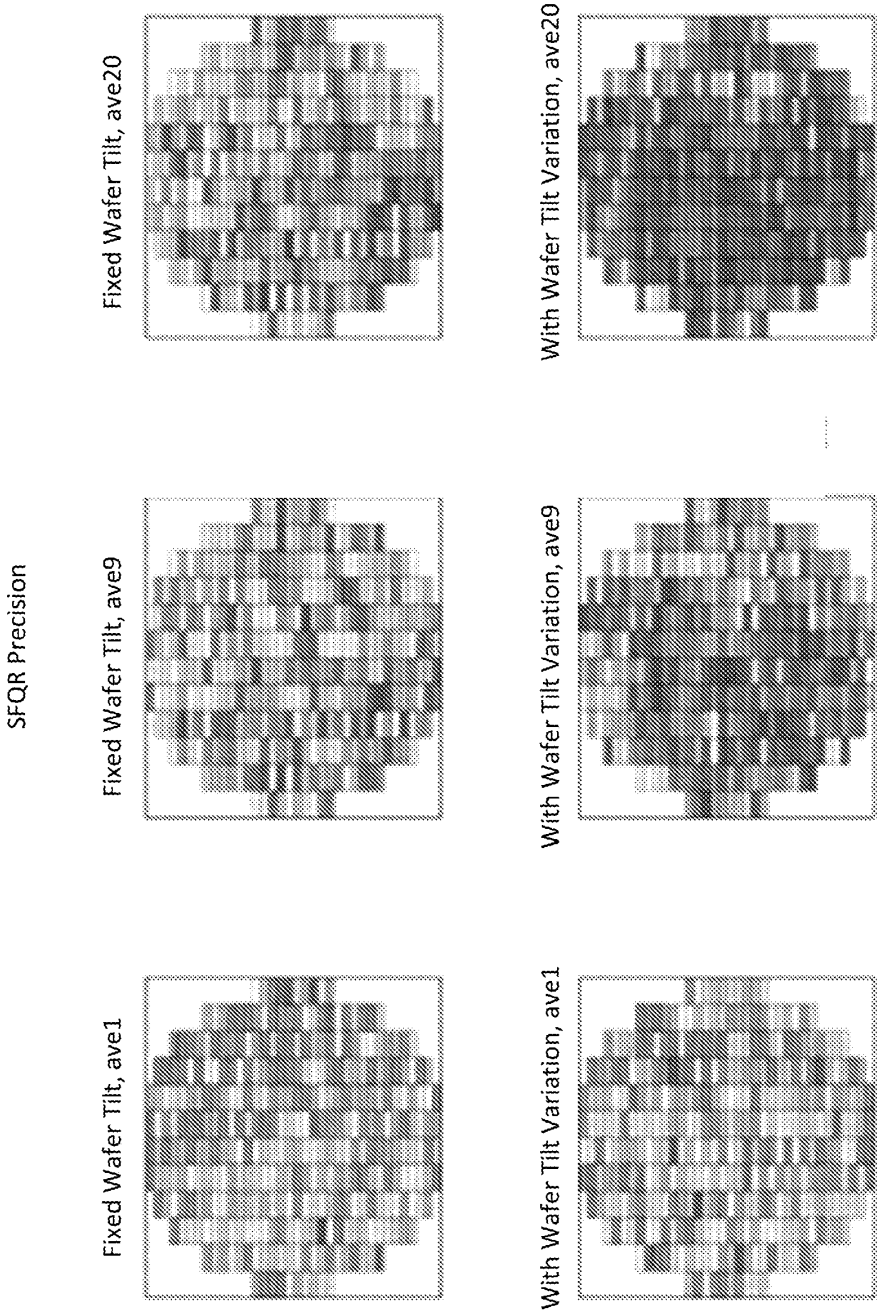

SFQR Precision
Fixed Wafer Tilt, ave20
With Wafer Tilt Variation, ave20
Fixed Wafer Tilt, ave9
With Wafer Tilt Variation, ave9
Fixed Wafer Tilt, ave1
With Wafer Tilt Variation, ave1

FIG. 12