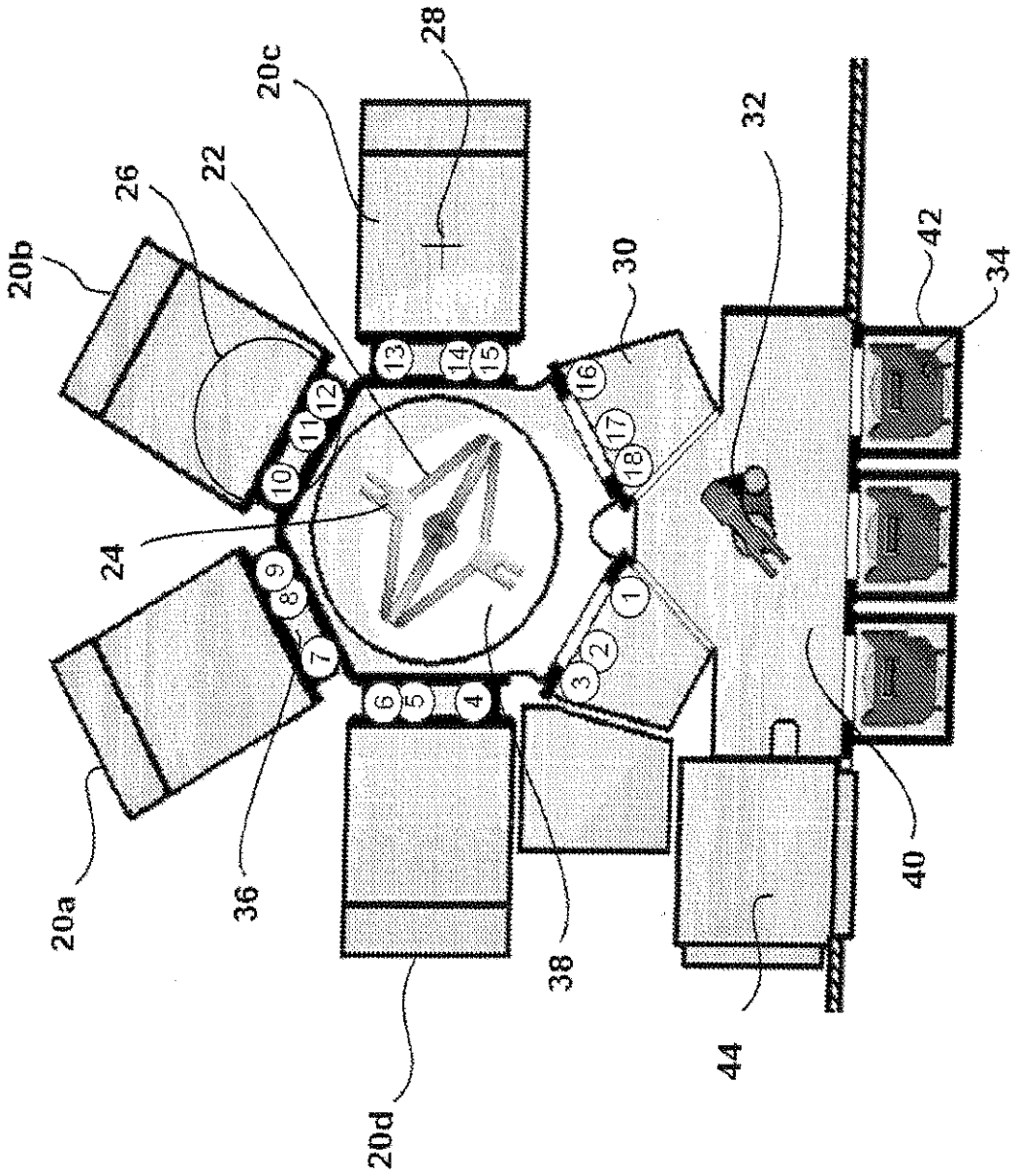

20b
26
22
20c
28
32
42
34
30
24
20a
36
38
40
44
20d
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Fig. 1

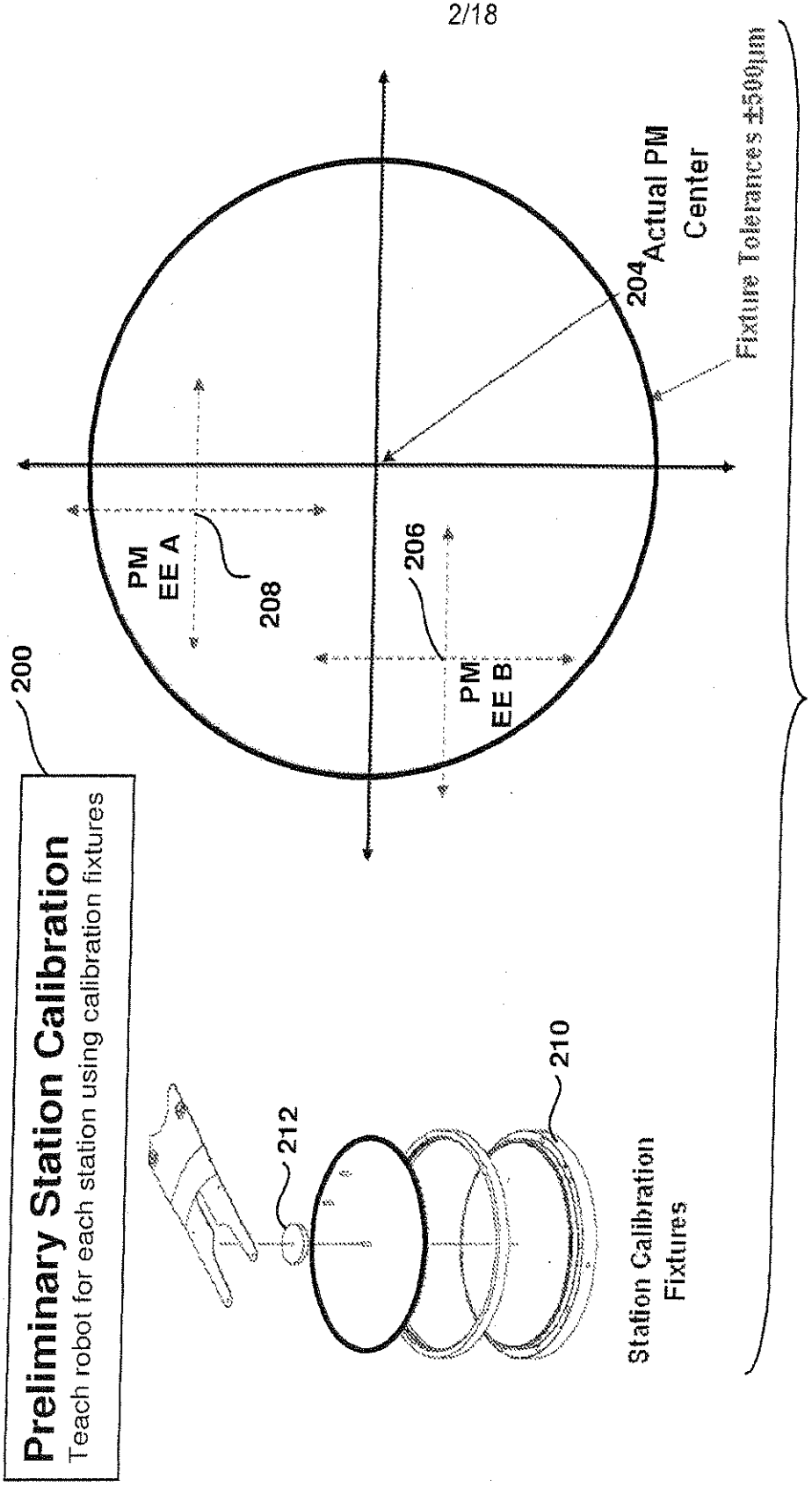

Preliminary Station Calibration
Teach robot for each station using calibration fixtures
200
Station Calibration Fixtures
210
212
PM EE B
206
PM EE A
208
204 Actual PM Center
Fixture Tolerances ±500µm

Fig. 2

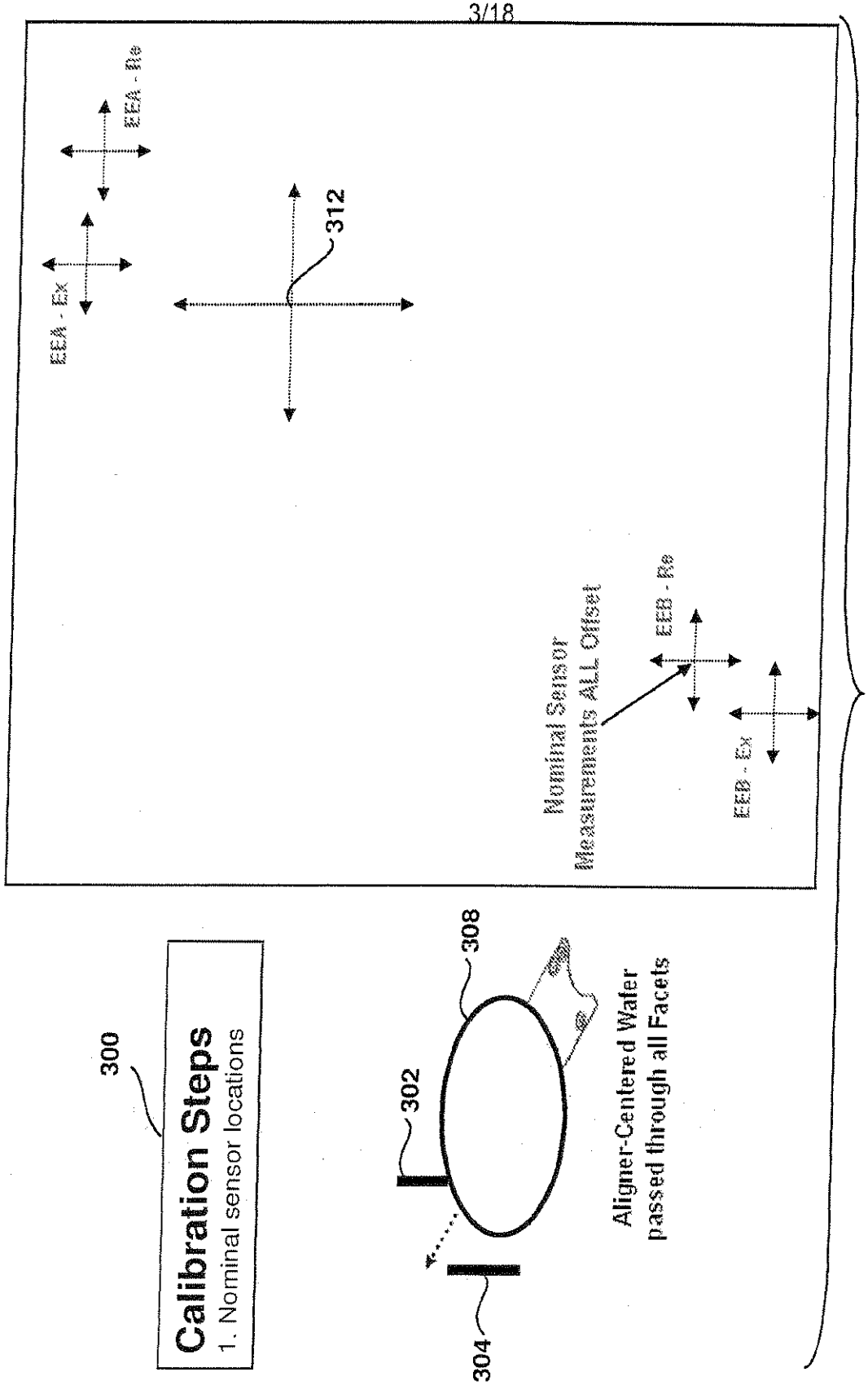
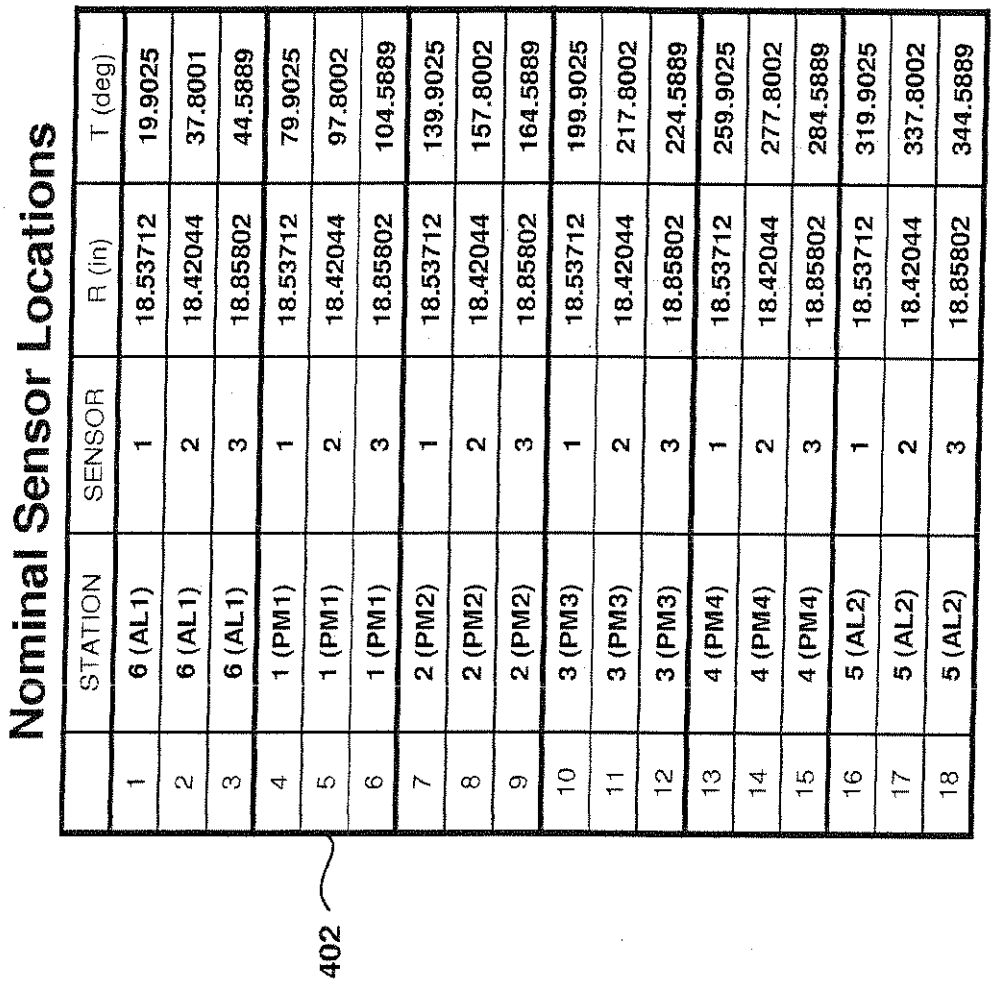

Calibration Steps
1. Nominal sensor locations
300
Aligner-Centered Wafer
passed through all Facets
302
304
308
312
Nominal Sensor
Measurements ALL Offset
EEA - Ex
EEA - Re
EEB - Ex
EEB - Re

Fig. 3

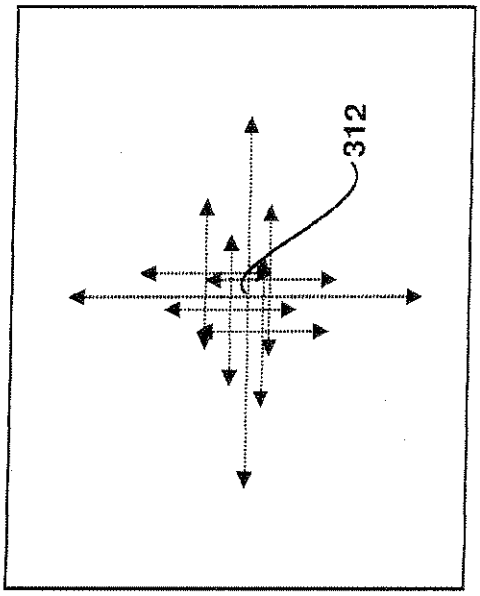


Nominal Sensor Locations

	STATION	SENSOR	R (in)	T (deg)
1	6 (AL1)	1	18.53712	19.9025
2	6 (AL1)	2	18.42044	37.8001
3	6 (AL1)	3	18.85802	44.5889
4	1 (PM1)	1	18.53712	79.9025
5	1 (PM1)	2	18.42044	97.8002
6	1 (PM1)	3	18.85802	104.5889
7	2 (PM2)	1	18.53712	139.9025
8	2 (PM2)	2	18.42044	157.8002
9	2 (PM2)	3	18.85802	164.5889
10	3 (PM3)	1	18.53712	199.9025
11	3 (PM3)	2	18.42044	217.8002
12	3 (PM3)	3	18.85802	224.5889
13	4 (PM4)	1	18.53712	259.9025
14	4 (PM4)	2	18.42044	277.8002
15	4 (PM4)	3	18.85802	284.5889
16	5 (AL2)	1	18.53712	319.9025
17	5 (AL2)	2	18.42044	337.8002
18	5 (AL2)	3	18.85802	344.5889

402

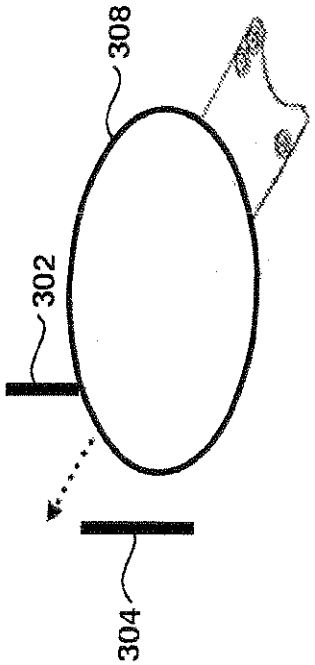
Fig. 4



500

Calibration Steps

2. Generate Offset Table



Aligner-Centered Wafer passed through all Facets

Fig. 5A

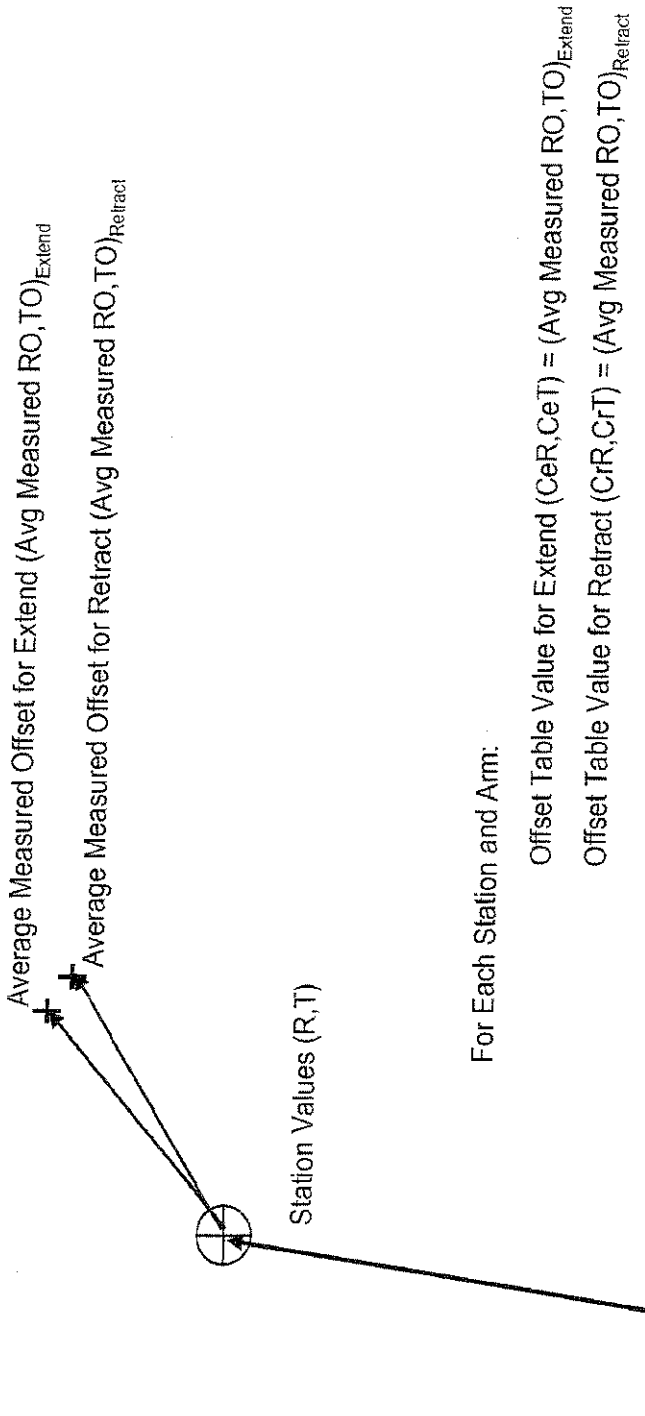

Average Measured Offset for Extend (Avg Measured RO,TO)Extend
Average Measured Offset for Retract (Avg Measured RO,TO)Retract
Station Values (R,T)
For Each Station and Arm:
Offset Table Value for Extend (CeR,CeT) = (Avg Measured RO,TO)Extend
Offset Table Value for Retract (CrR,CrT) = (Avg Measured RO,TO)Retract
Robot Home (0,0)

Fig. 5B

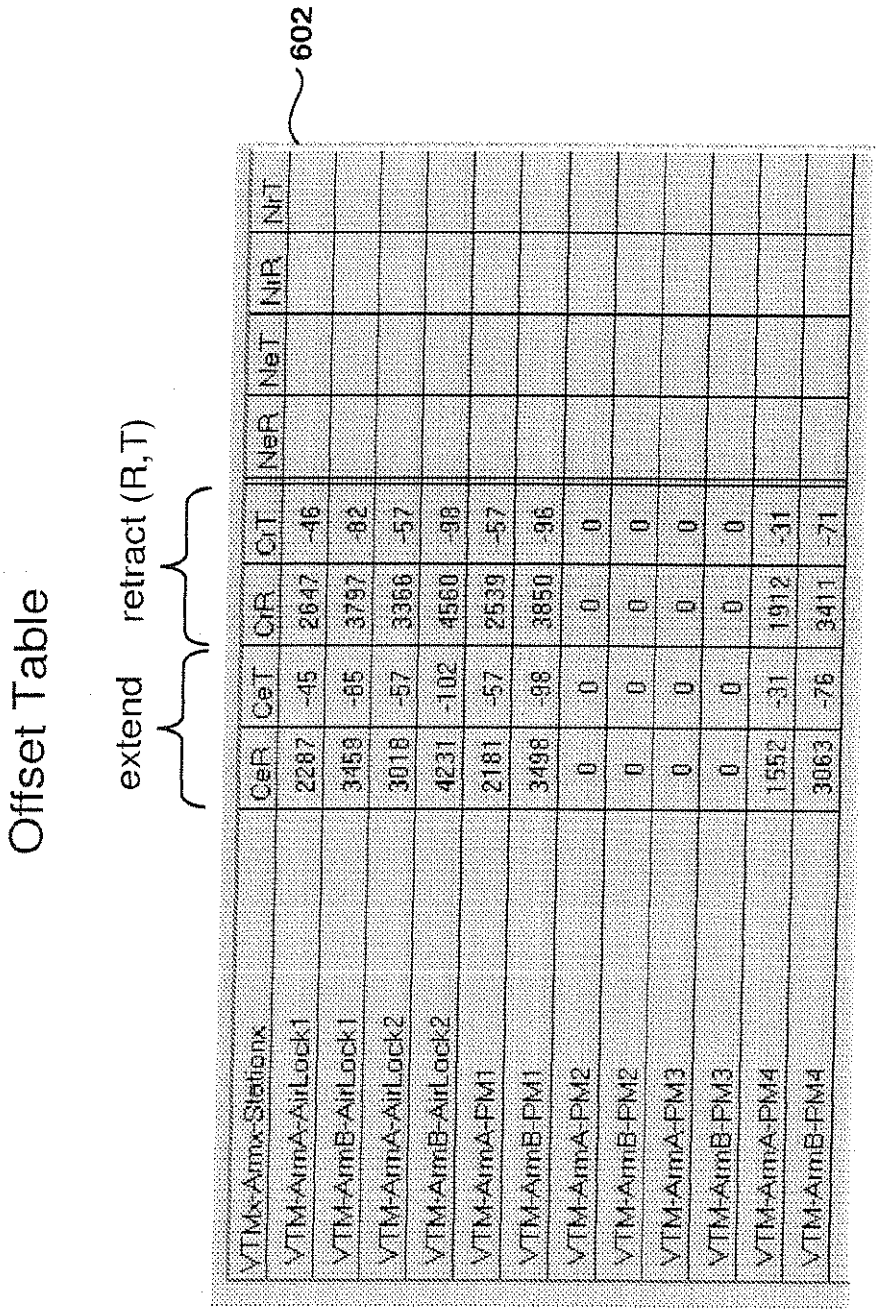

Offset Table
extend
retract (R,T)
602
VTMx-Amx-Stationx
CeR
CeT
CrR
CrT
NeR
NeT
NrR
NrT
VTM-AmA-AirLock1
2287
-45
2647
-46
VTM-AmB-AirLock1
3459
-65
3797
-82
VTM-AmA-AirLock2
3018
-57
3366
-57
VTM-AmB-AirLock2
4231
-102
4560
-93
VTM-AmA-PM1
2181
-57
2539
-57
VTM-AmB-PM1
3498
-98
3850
-96
VTM-AmA-PM2
0
0
0
0
VTM-AmB-PM2
0
0
0
0
VTM-AmA-PM3
0
0
0
0
VTM-AmB-PM3
0
0
0
0
VTM-AmA-PM4
1552
-31
1912
-31
VTM-AmB-PM4
3063
-76
3411
-71

Fig. 6

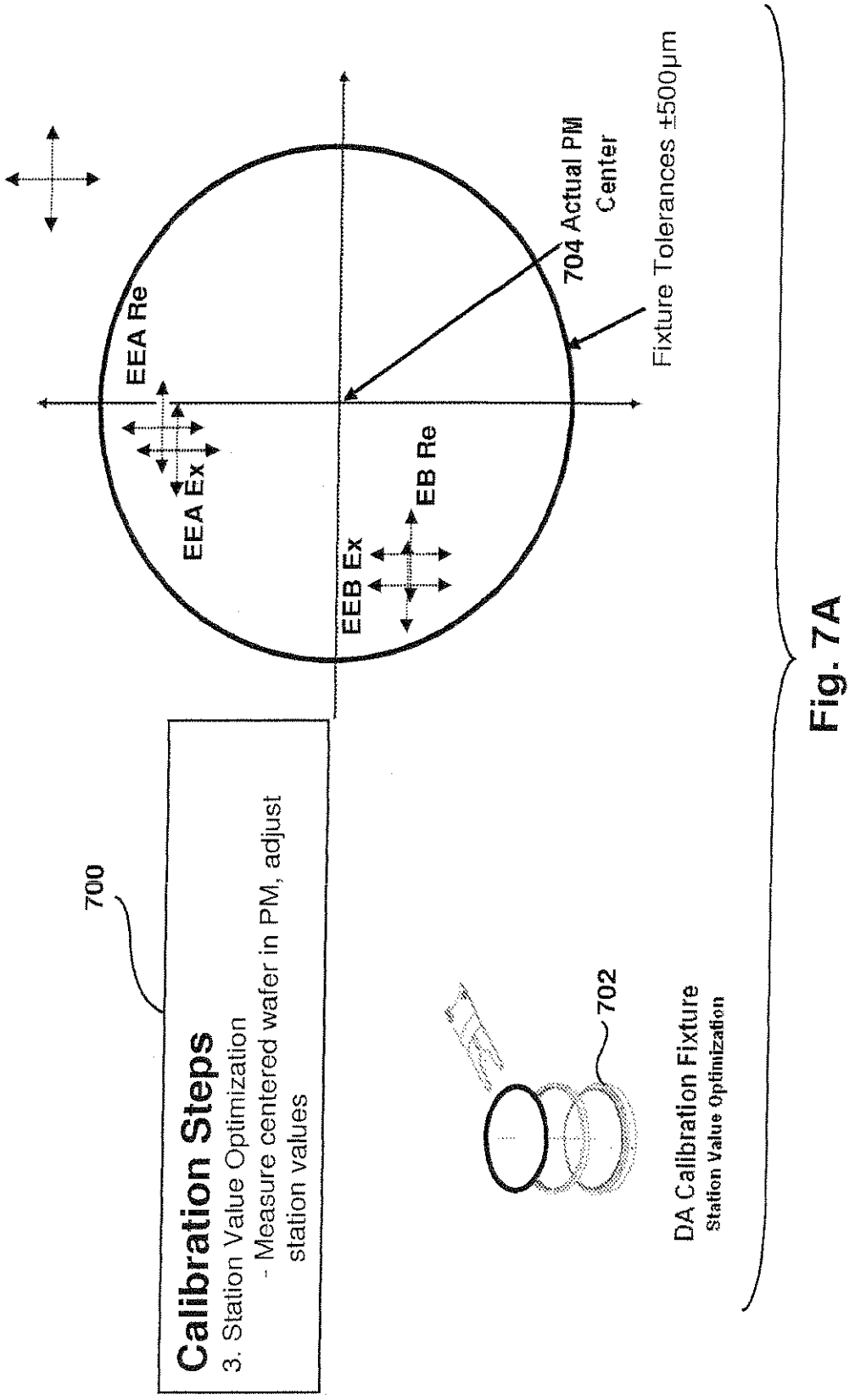

Calibration Steps
3. Station Value Optimization
- Measure centered wafer in PM, adjust station values
700
EEA Re
EEA Ex
EEB Ex
EB Re
704 Actual PM Center
Fixture Tolerances ±500µm
702
DA Calibration Fixture
Station Value Optimization

Fig. 7A

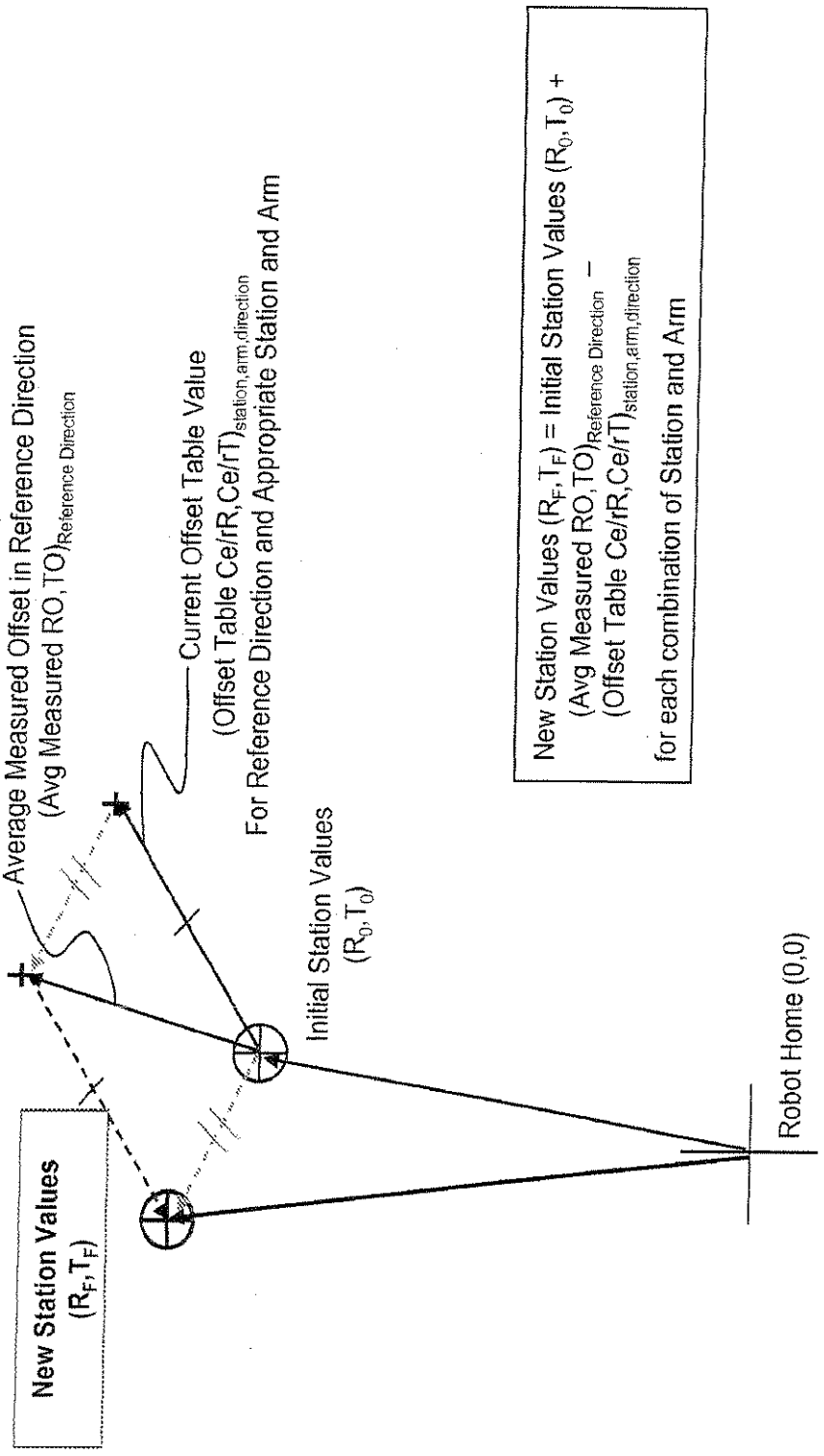
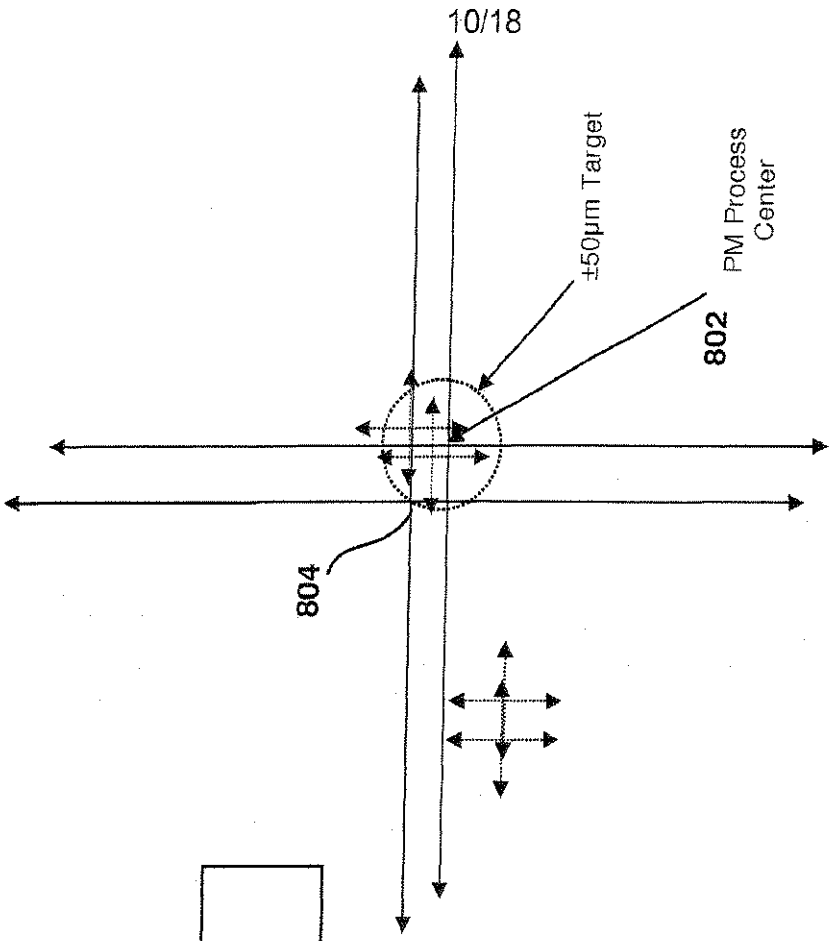

New Station Values
(R_F, T_F)
Average Measured Offset in Reference Direction
(Avg Measured $RO,TO)_{Reference\ Direction}$
Current Offset Table Value
$(Offset\ Table\ Ce/rR,Ce/rT)_{station,arm,direction}$
For Reference Direction and Appropriate Station and Arm
Initial Station Values
(R_0, T_0)
Robot Home (0,0)
New Station Values (R_F, T_F) = Initial Station Values (R_0, T_0) +
(Avg Measured $RO,TO)_{Reference\ Direction}$ −
$(Offset\ Table\ Ce/rR,Ce/rT)_{station,arm,direction}$
for each combination of Station and Arm

Fig. 7B


±50µm Target
PM Process Center
802
804

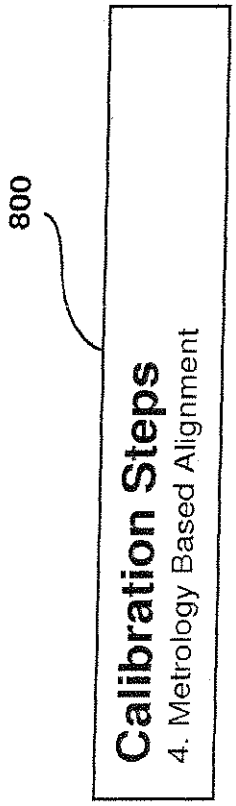
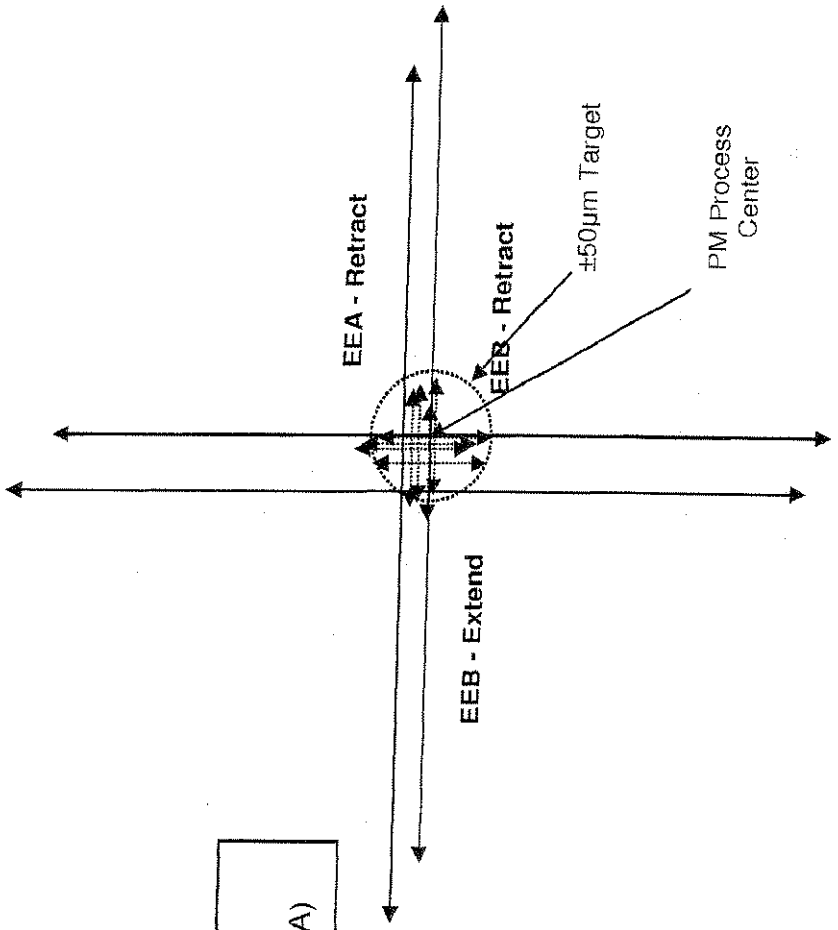

800
Calibration Steps
4. Metrology Based Alignment

Fig. 8

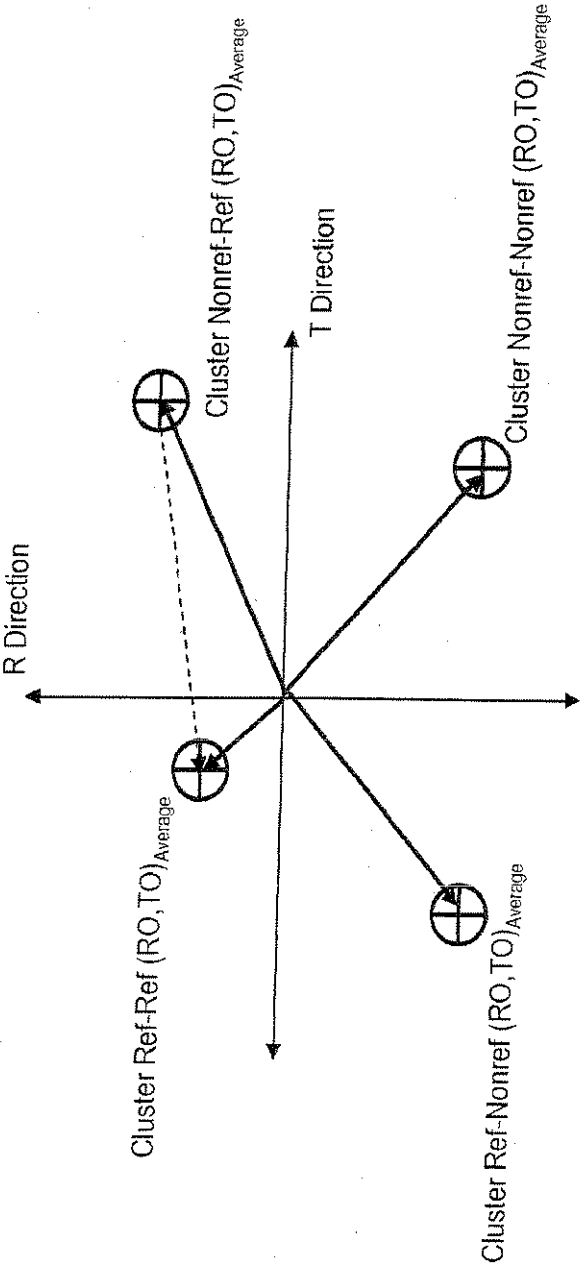


Calibration Steps

5. Fine tuning operation (arm swapping with DA)

Fig. 9A

Wafers placed using Dynamic Alignment III Compensation during extend
Wafers picked and measured using Dynamic Alignment III during retract



New Offset Table Retract Values $(NrR,NrT)_{Ref\ Arm}$ = Current Offset Table Retract Values $(CrR,CrT)_{Ref\ Arm}$ + Cluster Ref-Ref $(RO,TO)_{Average}$

New Station Values Nonref Arm (R_F, T_F) = Current Stn Values (R_0, T_0) – Cluster Nonref-Ref $(RO,TO)_{Average}$ + Cluster Ref-Ref $(RO,TO)_{Average}$

New Offset Table Retract Values for $(NrR,NrT)_{Nonref\ Arm}$ = Current Offset Table Retract Values $(CrR,CrT)_{Nonref\ Arm}$ + Cluster Nonref-Nonref $(RO,TO)_{Average}$

Fig. 9B

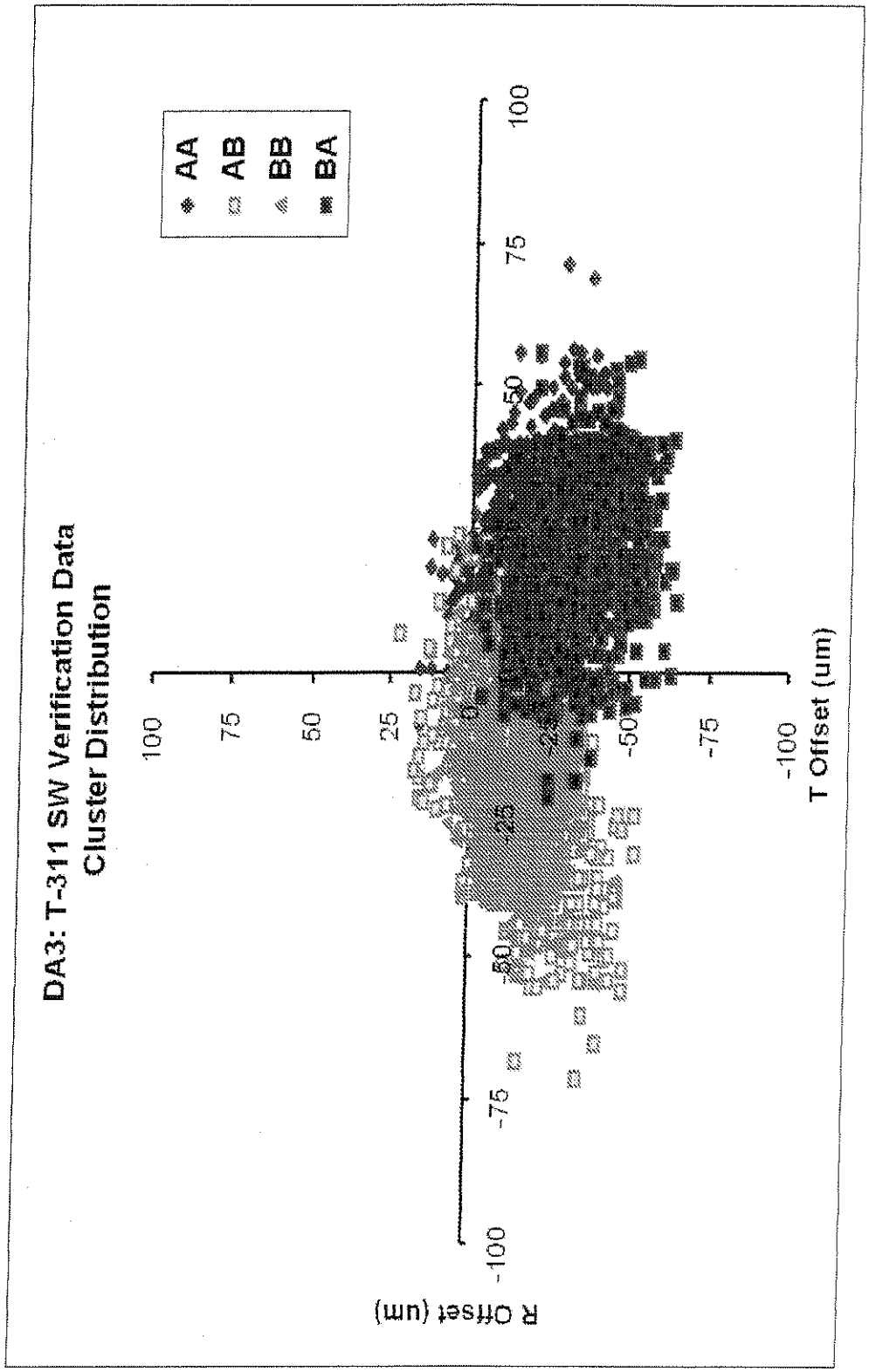

DA3: T-311 SW Verification Data
Cluster Distribution
AA
AB
BB
BA
R Offset (um)
T Offset (um)
100
75
50
25
-25
-50
-75
-100

Fig. 10

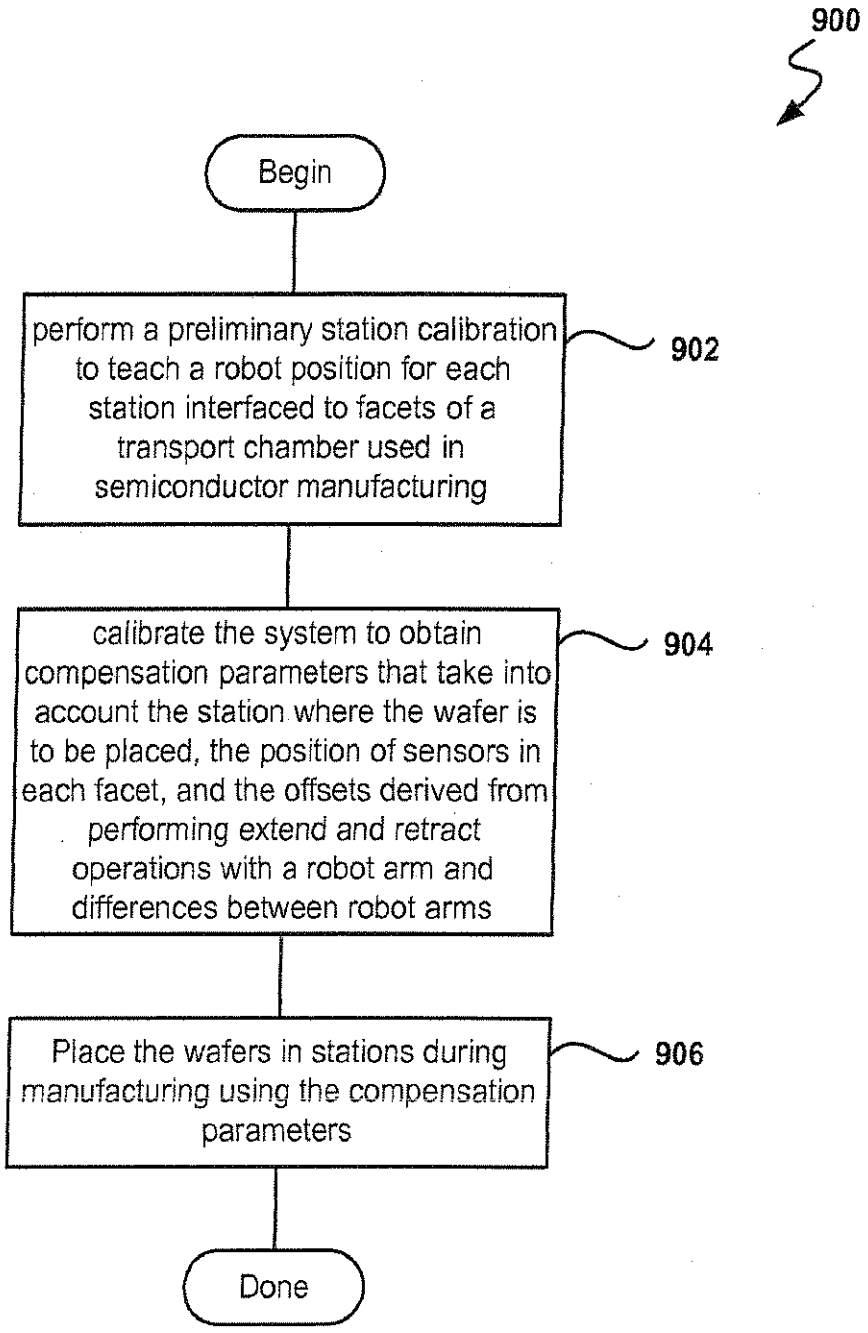

900
Begin
perform a preliminary station calibration to teach a robot position for each station interfaced to facets of a transport chamber used in semiconductor manufacturing
902
calibrate the system to obtain compensation parameters that take into account the station where the wafer is to be placed, the position of sensors in each facet, and the offsets derived from performing extend and retract operations with a robot arm and differences between robot arms
904
Place the wafers in stations during manufacturing using the compensation parameters
906
Done

Fig. 11A

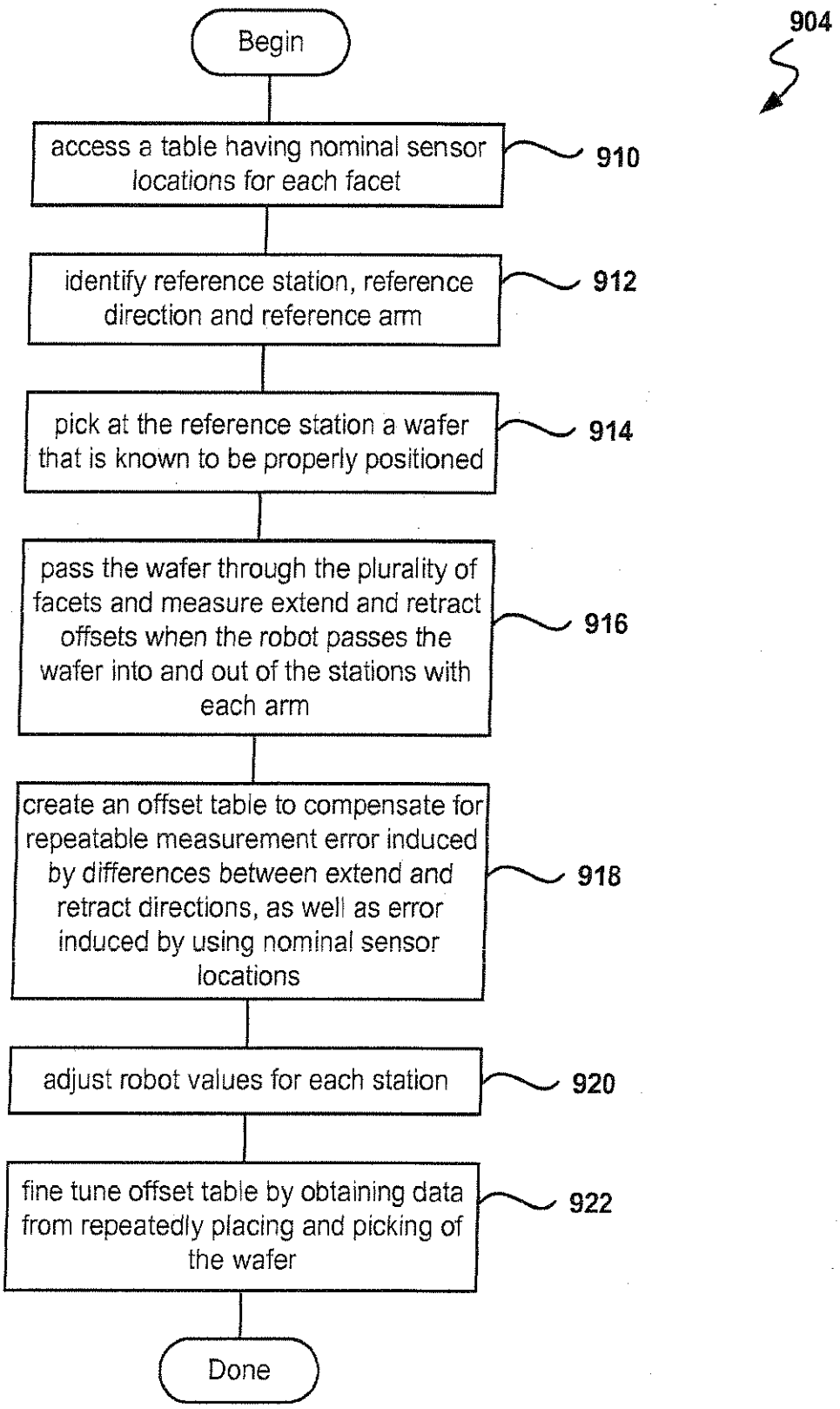

904
Begin
access a table having nominal sensor locations for each facet
910
identify reference station, reference direction and reference arm
912
pick at the reference station a wafer that is known to be properly positioned
914
pass the wafer through the plurality of facets and measure extend and retract offsets when the robot passes the wafer into and out of the stations with each arm
916
create an offset table to compensate for repeatable measurement error induced by differences between extend and retract directions, as well as error induced by using nominal sensor locations
918
adjust robot values for each station
920
fine tune offset table by obtaining data from repeatedly placing and picking of the wafer
922
Done

Fig. 11B

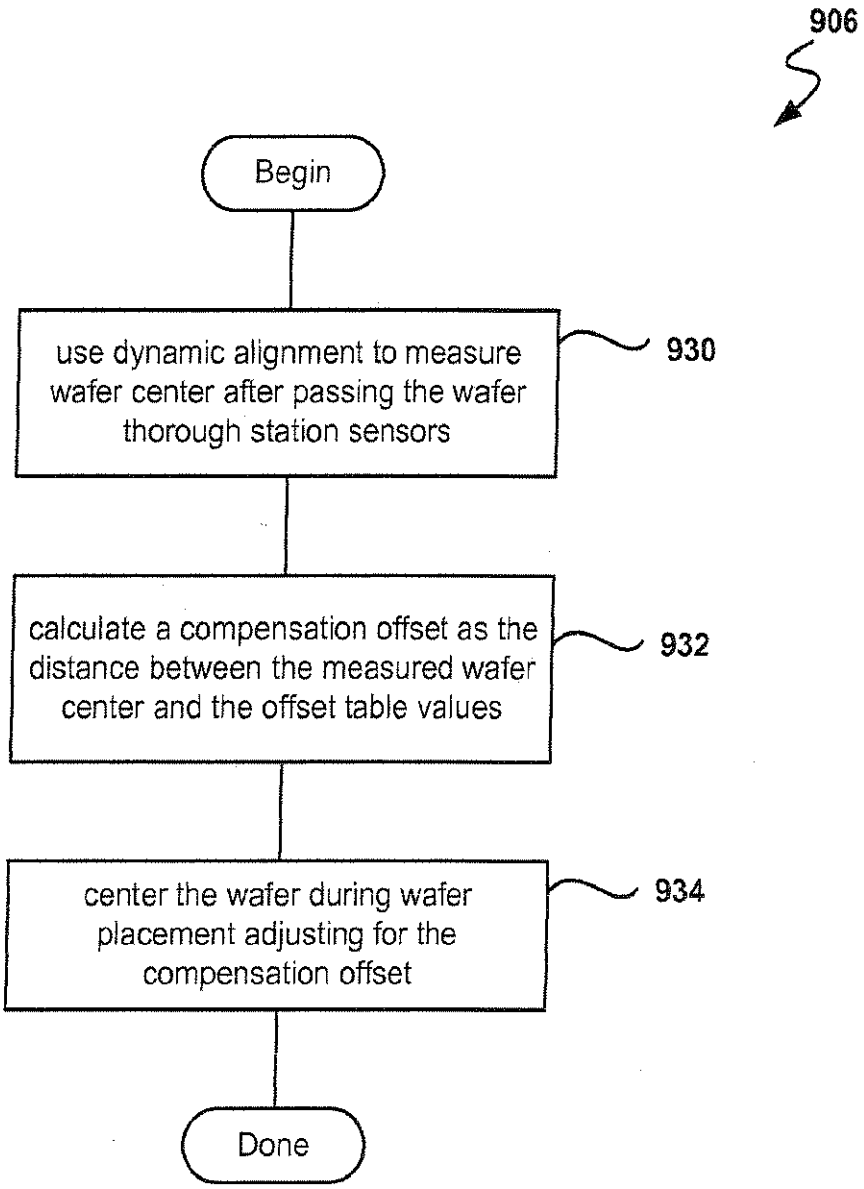

906
Begin
use dynamic alignment to measure wafer center after passing the wafer thorough station sensors
930
calculate a compensation offset as the distance between the measured wafer center and the offset table values
932
center the wafer during wafer placement adjusting for the compensation offset
934
Done

Fig. 11C

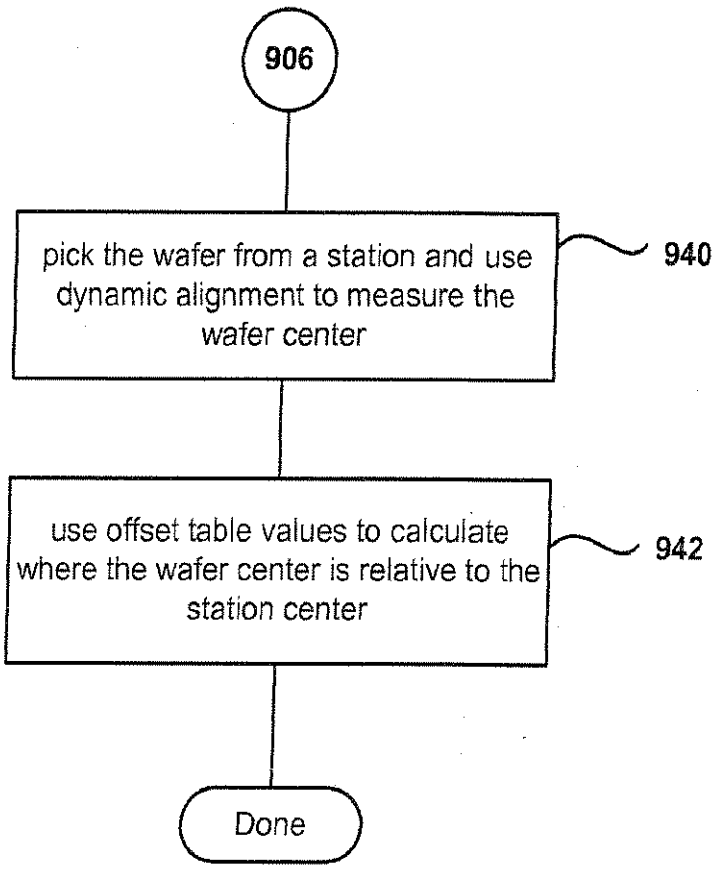

906
pick the wafer from a station and use dynamic alignment to measure the wafer center
940
use offset table values to calculate where the wafer center is relative to the station center
942
Done

Fig. 11D

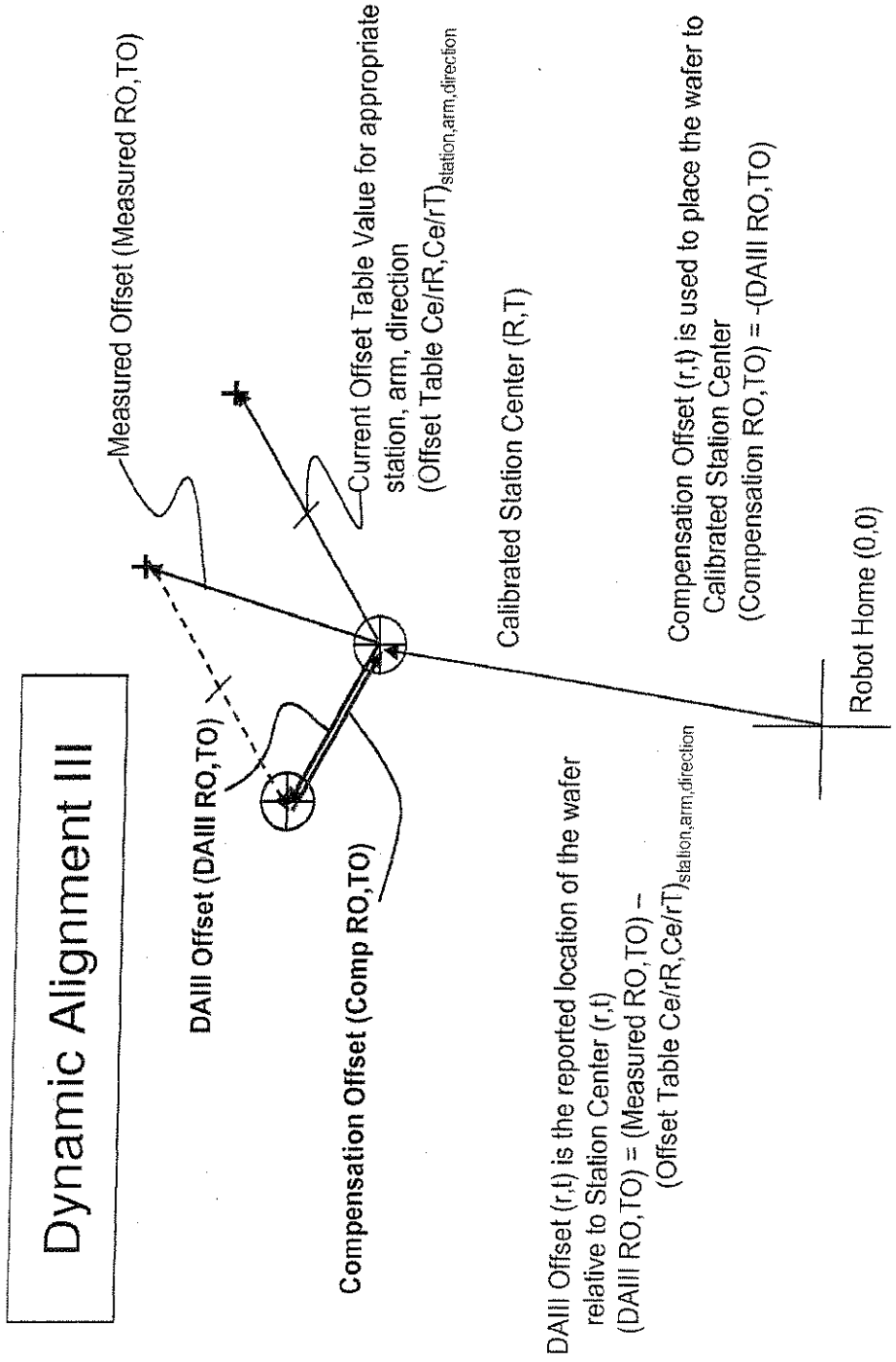

Dynamic Alignment III
Measured Offset (Measured RO,TO)
DAIII Offset (DAIII RO,TO)
Compensation Offset (Comp RO,TO)
Current Offset Table Value for appropriate station, arm, direction (Offset Table Ce/rR,Ce/rT)station,arm,direction
Calibrated Station Center (R,T)
Compensation Offset (r,t) is used to place the wafer to Calibrated Station Center (Compensation RO,TO) = -(DAIII RO,TO)
Robot Home (0,0)
DAIII Offset (r,t) is the reported location of the wafer relative to Station Center (r,t) (DAIII RO,TO) = (Measured RO,TO) – (Offset Table Ce/rR,Ce/rT)station,arm,direction

Fig. 12