LVV-T2190

October 19, 2021

1 MTAOS add aberrations to M1M3+M2+hexapod

This notebook is used for the level 3 integration tests from test plan LVV-P81 (https://jira.lsstcorp.org/secure/Tests.jspa#/testPlan/LVV-P81) as part of test cylce LVV-C176 (https://jira.lsstcorp.org/secure/Tests.jspa#/testCycle/LVV-C176). The following tests are currently run as part of this notebook:

- LVV-T2190 (https://jira.lsstcorp.org/secure/Tests.jspa#/testCase/LVV-T2190)

Execution steps are separated by horizontal lines. Upon completion, save the notebook and its output as a pdf file to be attached to the test execution in JIRA.

Last executed by E. Dennihy 20211019

Load all the needed libraries. Get the remotes ready Code in the notebook including section: "Check the summary state of each CSC".

[1]:
```
%load_ext autoreload
%autoreload 2
```

[2]:
```
import rubin_jupyter_utils.lab.notebook as nb
nb.utils.get_node()
```

```
Patching auth into notebook.base.handlers.IPythonHandler(notebook.base.handlers.
AuthenticatedHandler) ->
IPythonHandler(jupyterhub.singleuser.mixins.HubAuthenticatedHandler,
notebook.base.handlers.AuthenticatedHandler)
```

[2]:
```
'andes05.cp.lsst.org'
```

[3]:
```
import os
import sys
import asyncio
import logging

import pandas as pd
import numpy as np

from matplotlib import pyplot as plt
```

```
from lsst.ts import salobj
from lsst.ts.observatory.control.maintel import MTCS, ComCam
from lsst.ts.observatory.control import RotType
```

```
Update leap second table
current_tai uses the system TAI clock
```

[4]:
```
logging.basicConfig(format="%(name)s:%(message)s", level=logging.DEBUG)
```

[5]:
```
log = logging.getLogger("setup")
log.level = logging.DEBUG
```

[6]:
```
domain = salobj.Domain()
```

[7]:
```
mtcs = MTCS(domain=domain, log=log)
mtcs.set_rem_loglevel(40)
```

```
mtmount: Adding all resources.
mtptg: Adding all resources.
mtaos: Adding all resources.
mtm1m3: Adding all resources.
mtm2: Adding all resources.
mthexapod_1: Adding all resources.
mthexapod_2: Adding all resources.
mtrotator: Adding all resources.
mtdome: Adding all resources.
mtdometrajectory: Adding all resources.
```

[8]:
```
await mtcs.start_task
```

```
Read historical data in 0.14 sec
Read historical data in 0.16 sec
rotation DDS read queue is full (100 elements); data may be lost
electrical DDS read queue is full (100 elements); data may be lost
zenithAngle DDS read queue is full (100 elements); data may be lost
motors DDS read queue is full (100 elements); data may be lost
```

[8]:
```
[None, None, None, None, None, None, None, None, None, None]
```

```
electrical DDS read queue is filling: 92 of 100 elements
powerSupplyData DDS read queue is full (100 elements); data may be lost
elevation DDS read queue is full (100 elements); data may be lost
timeAndDate DDS read queue is full (100 elements); data may be lost
application DDS read queue is full (100 elements); data may be lost
temperature DDS read queue is full (100 elements); data may be lost
electrical DDS read queue is full (100 elements); data may be lost
application DDS read queue is filling: 97 of 100 elements
pidData DDS read queue is full (100 elements); data may be lost
cameraCableWrap DDS read queue is full (100 elements); data may be lost
```

```
mountStatus DDS read queue is full (100 elements); data may be lost
actuators DDS read queue is full (100 elements); data may be lost
tangentForce DDS read queue is full (100 elements); data may be lost
ccwFollowingError DDS read queue is full (100 elements); data may be lost
actuators DDS read queue is filling: 99 of 100 elements
inclinometerData DDS read queue is full (100 elements); data may be lost
azimuth DDS read queue is full (100 elements); data may be lost
mountPosition DDS read queue is full (100 elements); data may be lost
tangentEncoderPositions DDS read queue is full (100 elements); data may be lost
imsData DDS read queue is full (100 elements); data may be lost
currentTargetStatus DDS read queue is full (100 elements); data may be lost
tangentActuatorSteps DDS read queue is full (100 elements); data may be lost
hardpointMonitorData DDS read queue is full (100 elements); data may be lost
powerStatus DDS read queue is full (100 elements); data may be lost
hardpointActuatorData DDS read queue is full (100 elements); data may be lost
positionIMS DDS read queue is full (100 elements); data may be lost
position DDS read queue is full (100 elements); data may be lost
forceActuatorData DDS read queue is full (100 elements); data may be lost
netMomentsTotal DDS read queue is full (100 elements); data may be lost
accelerometerData DDS read queue is full (100 elements); data may be lost
netForcesTotal DDS read queue is full (100 elements); data may be lost
ilcData DDS read queue is full (100 elements); data may be lost
forceBalance DDS read queue is full (100 elements); data may be lost
displacementSensors DDS read queue is full (100 elements); data may be lost
axialForce DDS read queue is full (100 elements); data may be lost
appliedCylinderForces DDS read queue is full (100 elements); data may be lost
axialEncoderPositions DDS read queue is full (100 elements); data may be lost
appliedBalanceForces DDS read queue is full (100 elements); data may be lost
axialActuatorSteps DDS read queue is full (100 elements); data may be lost
appliedAzimuthForces DDS read queue is full (100 elements); data may be lost
appliedActiveOpticForces DDS read queue is full (100 elements); data may be lost
appliedAberrationForces DDS read queue is full (100 elements); data may be lost
```

Ready M1M3: Raise mirror, turn on FB, clear forces

Need to have M1M3 LUT use its inclinometer.

Ready M2: Turn on FB, clear forces

Need to have M2 LUT use its inclinometer

Get camera hexapod ready: check config; make sure LUT is on, and has valid inputs; make sure hex is at LUT position

---

Get M2 hexapod ready: check config; make sure LUT is on, and has valid inputs; make sure hex is at LUT position

---

Slew to the next target. Choose a target such that the rotator stays within a couple of degrees of its initial position. This is because the CCW is not running (MTmount in simulation mode). Start tracking.

[10]:
```
target = await mtcs.find_target(el=60, az=120, mag_limit=9)
print(target)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astroquery/simbad/core.py in _parse_result(self,␣
 ↪result, resultclass, verbose)
   1052                 return None
-> 1053             resulttable = self.last_parsed_result.table
   1054             if len(resulttable) == 0:

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astroquery/simbad/core.py in table(self)
    191             self.bytes = BytesIO(self.data.encode('utf8'))
--> 192             tbl = votable.parse_single_table(self.bytes, pedantic=False
    193             self.__table = tbl.to_table()

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/io/votable/table.py in␣
 ↪parse_single_table(source, **kwargs)
    184
--> 185     votable = parse(source, **kwargs)
    186

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/utils/decorators.py in wrapper(*args, **kwarg
    534
--> 535             return function(*args, **kwargs)
    536

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/io/votable/table.py in parse(source, columns,
 ↪invalid, verify, chunk_size, table_number, table_id, filename, unit_format,␣
 ↪datatype_mapping, _debug_python_based_parser)
    165             _debug_python_based_parser=_debug_python_based_parser) as␣
 ↪iterator:
--> 166         return tree.VOTableFile(

    167             config=config, pos=(1, 1)).parse(iterator, config)
```

```
/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/io/votable/tree.py in parse(self, iterator,␣
 ↪config)
   3573             if start:
-> 3574                 tag_mapping.get(tag, self._add_unknown_tag)(
   3575                     iterator, tag, data, config, pos)

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/io/votable/tree.py in _add_resource(self,␣
 ↪iterator, tag, data, config, pos)
   3484         self.resources.append(resource)
-> 3485         resource.parse(self, iterator, config)
   3486

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/io/votable/tree.py in parse(self, votable,␣
 ↪iterator, config)
   3285             if start:
-> 3286                 tag_mapping.get(tag, self._add_unknown_tag)(
   3287                     iterator, tag, data, config, pos)

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/io/votable/tree.py in _add_table(self,␣
 ↪iterator, tag, data, config, pos)
   3231         self.tables.append(table)
-> 3232         table.parse(iterator, config)
   3233

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/site-packages/astropy/io/votable/tree.py in parse(self, iterator,␣
 ↪config)
   2451
-> 2452             for start, tag, data, pos in iterator:
   2453                 if start:

ValueError: 7:115: no element found

During handling of the above exception, another exception occurred:

TableParseError                           Traceback (most recent call last)
<ipython-input-10-e6e87ac0f177> in <module>
----> 1 target = await mtcs.find_target(el=60, az=120, mag_limit=9)
      2 print(target)

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/contro /
 ↪base_tcs.py in find_target(self, az, el, mag_limit, mag_range, radius)
   1401
   1402         if target is None:
```

```
-> 1403             target = await self.find_target_simbad(
   1404                 az=az, el=el, mag_limit=mag_limit, mag_range=mag_range,
 ↪radius=radius
   1405             )

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/contro
 ↪base_tcs.py in find_target_simbad(self, az, el, mag_limit, mag_range, radius)
   1451         loop = asyncio.get_event_loop()
   1452
-> 1453         result_table = await loop.run_in_executor(
   1454             None, customSimbad.query_criteria, criteria
   1455         )

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li
 ↪python3.8/concurrent/futures/thread.py in run(self)
     55
     56         try:
---> 57             result = self.fn(*self.args, **self.kwargs)
     58         except BaseException as exc:
     59             self.future.set_exception(exc)

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li
 ↪python3.8/site-packages/astroquery/simbad/core.py in query_criteria(self,␣
 ↪*args, **kwargs)
    488         verbose = kwargs.pop('verbose', False)
    489         result = self.query_criteria_async(*args, **kwargs)
--> 490         return self._parse_result(result, SimbadVOTableResult,␣
 ↪verbose=verbose)
    491
    492     def query_criteria_async(self, *args, **kwargs):

/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li
 ↪python3.8/site-packages/astroquery/simbad/core.py in _parse_result(self,␣
 ↪result, resultclass, verbose)
   1056         except Exception as ex:
   1057             self.last_table_parse_error = ex
-> 1058             raise TableParseError("Failed to parse SIMBAD result! The␣
 ↪raw "
   1059                                   "response can be found in "
   1060                                   "self.last_response, and the error in "

TableParseError: Failed to parse SIMBAD result! The raw response can be found i␣
 ↪self.last_response, and the error in self.last_table_parse_error. The␣
 ↪attempted parsed result is in self.last_parsed_result.
 Exception: 7:115: no element found
```

[11]:
```
await mtcs.slew_object('HD130642', rot_type=RotType.PhysicalSky, rot=1.9)
```

```
Object HD130642 not in internal catalog. Querying Simbad.
Slewing to HD130642: 14 50 34.1030 -40 23 24.014
Setting rotator physical position to 1.9 deg. Rotator will track sky.
Stop tracking.
Sending slew command.
Scheduling check coroutines
process as completed…
Monitor position started.
Waiting for Target event from mtmount.
mtmount: <State.ENABLED: 2>
mtptg: <State.ENABLED: 2>
mtaos: <State.ENABLED: 2>
mtm1m3: <State.ENABLED: 2>
mtm2: <State.ENABLED: 2>
mthexapod_1: <State.ENABLED: 2>
mthexapod_2: <State.ENABLED: 2>
mtrotator: <State.ENABLED: 2>
mtdome: <State.ENABLED: 2>
mtdometrajectory: <State.ENABLED: 2>
Wait for mtmount in position events.
Wait for dome in position event.
Wait for rotator in position event.
Wait for MTMount elevation in position event.
MTMount elevation in position: False.
Wait for MTMount azimuth in position event.
MTMount azimuth in position: False.
Mount target: private_revCode: 261ad639, private_sndStamp: 1634658315.337845,
private_rcvStamp: 1634658315.3387032, private_seqNum: 3428, private_identity:
MTMount, private_origin: 51871, private_host: 0, elevation: 64.21573548552142,
elevationVelocity: 0.0030811213906859172, azimuth: 121.36597839331272,
azimuthVelocity: 0.0017835598376159036, taiTime: 1634658315.393264, trackId: 1,
tracksys: SIDEREAL, radesys: ICRS, priority: 0
mtrotator not in <State.ENABLED: 2>: <State.FAULT: 3>
```

```
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
<ipython-input-11-1a34c3a0c84e> in <module>
----> 1 await mtcs.slew_object('HD130642', rot_type=RotType.PhysicalSky, rot=1.9)

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/
↪base_tcs.py in slew_object(self, name, rot, rot_type, dra, ddec, offset_x,␣
↪offset_y, az_wrap_strategy, time_on_target, slew_timeout)
    402         self.log.info(f"Slewing to {name}: {object_table['RA']}␣
↪{object_table['DEC']}")
    403
--> 404         await self.slew_icrs(
    405             ra=object_table["RA"],
```

```
    406             dec=object_table["DEC"],

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/
↪base_tcs.py in slew_icrs(self, ra, dec, rot, rot_type, target_name, dra, ddec␣
↪offset_x, offset_y, az_wrap_strategy, time_on_target, slew_timeout,␣
↪stop_before_slew, wait_settle)
    578             )
    579
--> 580         await self.slew(
    581             radec_icrs.ra.hour,
    582             radec_icrs.dec.deg,

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/
↪base_tcs.py in slew(self, ra, dec, rotPA, target_name, frame, epoch, equinox,␣
↪parallax, pmRA, pmDec, rv, dRA, dDec, rot_frame, rot_track_frame, rot_mode,␣
↪az_wrap_strategy, time_on_target, slew_timeout, stop_before_slew, wait_settle␣
↪offset_x, offset_y)
    750
    751         try:
--> 752             await self._slew_to(
    753                 getattr(self.rem, self.ptg_name).cmd_raDecTarget,
    754                 slew_timeout=slew_timeout,

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/
↪maintel/mtcs.py in _slew_to(self, slew_cmd, slew_timeout, offset_cmd,␣
↪stop_before_slew, wait_settle, check)
    255                 )
    256
--> 257         await self.process_as_completed(self.scheduled_coro)
    258
    259     async def wait_for_inposition(

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/
↪remote_group.py in process_as_completed(self, tasks)
   1134             except Exception as e:
   1135                 await self.cancel_not_done(tasks)
-> 1136                 raise e
   1137             else:
   1138                 await self.cancel_not_done(tasks)

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/
↪remote_group.py in process_as_completed(self, tasks)
   1131         for res in asyncio.as_completed(tasks):
   1132             try:
-> 1133                 ret_val = await res
   1134             except Exception as e:
   1135                 await self.cancel_not_done(tasks)
```

```
/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-0.7.0/li /
 ↪python3.8/asyncio/tasks.py in _wait_for_one()
    617             # Dummy value from _on_timeout().
    618             raise exceptions.TimeoutError
--> 619         return f.result()  # May raise f.exception().
    620
    621     for f in todo:

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/contro /
 ↪remote_group.py in check_component_state(self, component, desired_state)
    481             if state != desired_state:
    482                 self.log.warning(f"{component} not in {desired_state!r} ␣
 ↪{state!r}")
--> 483                 raise RuntimeError(
    484                     f"{component} state is {state!r}, expected␣
 ↪{desired_state!r}"
    485                 )

RuntimeError: mtrotator state is <State.FAULT: 3>, expected <State.ENABLED: 2>
```

[12]:
```
await mtcs.set_state(salobj.State.ENABLED, components=["mtptg"])
```

```
[mtptg]::[<State.FAULT: 3>, <State.STANDBY: 5>, <State.DISABLED: 1>,
<State.ENABLED: 2>]
All components in <State.ENABLED: 2>.
```

[13]:
```
await mtcs.set_state(salobj.State.DISABLED, components=["mtrotator"])
```

```
Unable to transition mtrotator to <State.DISABLED: 1> NoneType: None
.
Traceback (most recent call last):
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-
scipipe-0.7.0/lib/python3.8/site-packages/lsst/ts/salobj/csc_utils.py", line
161, in set_summary_state
    await cmd.start(timeout=timeout)
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-
scipipe-0.7.0/lib/python3.8/site-
packages/lsst/ts/salobj/topics/remote_command.py", line 483, in start
    return await cmd_info.next_ackcmd(timeout=timeout)
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-
scipipe-0.7.0/lib/python3.8/site-
packages/lsst/ts/salobj/topics/remote_command.py", line 201, in next_ackcmd
    raise base.AckError(msg="Command failed", ackcmd=ackcmd)
lsst.ts.salobj.base.AckError: msg='Command failed', ackcmd=(ackcmd
private_seqNum=1668971306, ack=<SalRetCode.CMD_FAILED: -302>, error=1,
result='Failed: You must use the clearError command or the engineering user
interface to clear a rotator fault.')
```

```
The above exception was the direct cause of the following exception:

Traceback (most recent call last):
  File "/opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-
scipipe-0.7.0/lib/python3.8/site-packages/lsst/ts/salobj/csc_utils.py", line
163, in set_summary_state
    raise RuntimeError(
RuntimeError: Error on cmd=cmd_standby, initial_state=3: msg='Command failed',
ackcmd=(ackcmd private_seqNum=1668971306, ack=<SalRetCode.CMD_FAILED: -302>,
error=1, result='Failed: You must use the clearError command or the engineering
user interface to clear a rotator fault.')
```

```
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
<ipython-input-13-d08f96a05d0c> in <module>
----> 1 await mtcs.set_state(salobj.State.DISABLED, components=["mtrotator"])

~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/contro
 ↪remote_group.py in set_state(self, state, settings, components)
    789
    790         if error_flag:
--> 791             raise RuntimeError(
    792                 f"Failed to transition {failed_components} to "
    793                 f"{salobj.State(state)!r}."

RuntimeError: Failed to transition ['mtrotator'] to <State.DISABLED: 1>.
```

[14]:
```
await mtcs.rem.mtrotator.cmd_clearError.set_start()
```

[14]:
```
<ddsutil.MTRotator_ackcmd_55ad33c7 at 0x7f25d05b4f10>
```

[15]:
```
await mtcs.set_state(salobj.State.ENABLED, components=["mtrotator"])
```

```
[mtrotator]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <State.ENABLED: 2>]
All components in <State.ENABLED: 2>.
```

[16]:
```
await mtcs.slew_object('HD130642', rot_type=RotType.PhysicalSky, rot=1.9)
```

```
Slewing to HD130642: 14 50 34.1030 -40 23 24.014
Setting rotator physical position to 1.9 deg. Rotator will track sky.
Stop tracking.
Sending slew command.
Scheduling check coroutines
process as completed…
Monitor position started.
```

```
Waiting for Target event from mtmount.
mtmount: <State.ENABLED: 2>
mtptg: <State.ENABLED: 2>
mtaos: <State.ENABLED: 2>
mtm1m3: <State.ENABLED: 2>
mtm2: <State.ENABLED: 2>
mthexapod_1: <State.ENABLED: 2>
mthexapod_2: <State.ENABLED: 2>
mtrotator: <State.ENABLED: 2>
mtdome: <State.ENABLED: 2>
mtdometrajectory: <State.ENABLED: 2>
Wait for mtmount in position events.
Wait for dome in position event.
Wait for rotator in position event.
Wait for MTMount elevation in position event.
MTMount elevation in position: False.
Wait for MTMount azimuth in position event.
MTMount azimuth in position: False.
Mount target: private_revCode: 261ad639, private_sndStamp: 1634658482.9436533,
private_rcvStamp: 1634658482.944432, private_seqNum: 3430, private_identity:
MTMount, private_origin: 51871, private_host: 0, elevation: 64.73130304560961,
elevationVelocity: 0.003070940626995347, azimuth: 121.67538931164354,
azimuthVelocity: 0.0019097821426265127, taiTime: 1634658482.9988043, trackId: 2,
tracksys: SIDEREAL, radesys: ICRS, priority: 0
MTMount azimuth in position: True.
[Tel]: Az = +119.852[  +1.8]; El = +060.925[  +3.8] [Rot]: +001.179[  +0.0]
[Dome] Az = +000.000; El = +000.000
Dome azimuth in position.
Dome elevation in position.
MTMount elevation in position: True.
Got True
Rotator in position.
```

---

add 1um of z7 to the system via OFC

Compare the corrections sent vs forces and position changes applied. This is currently done in a separate notebook.

[17]:
```
wavefront_errors = np.zeros(19)
```

[18]:
```
wavefront_errors[3] += 1.0 # add1 um to z7
```

[19]:
```
await mtcs.rem.mtaos.cmd_addAberration.set_start(wf=wavefront_errors,␣
↪timeout=10)
```

[19]:
```
<ddsutil.MTAOS_ackcmd_8e276e56 at 0x7f257b5ff730>
```

This command primes the corrections, the issueCorrection command is needed to actually command

them to be sent

[20]:
```
await mtcs.rem.mtaos.cmd_issueCorrection.start(timeout=60.)
```

[20]:
```
<ddsutil.MTAOS_ackcmd_8e276e56 at 0x7f25d0746c10>
```

Make plots using telemetry from each component to verify the changes in the DOFs. This step does not currently involve running any commands in this notebook. This step must be verified using a separate noteboook.

---

reset the corrections using the resetCorrection command

Compare the corrections sent vs forces and position changes applied (these are all expected to be zero). This is currently done in a separate notebook or on Chronograf.

[21]:
```
await mtcs.rem.mtaos.cmd_resetCorrection.start()
```

[21]:
```
<ddsutil.MTAOS_ackcmd_8e276e56 at 0x7f2583978790>
```

[22]:
```
await mtcs.rem.mtaos.cmd_issueCorrection.start(timeout=60.)
```

[22]:
```
<ddsutil.MTAOS_ackcmd_8e276e56 at 0x7f2583d7eeb0>
```

---

add 2um of z7 to the system via OFC

Compare the corrections sent vs forces and position changes applied. This is currently done in a separate notebook or on Chronograf.

[23]:
```
wavefront_errors[3] = 2.0 # add 2.0 um of z7
```

[24]:
```
await mtcs.rem.mtaos.cmd_addAberration.set_start(wf=wavefront_errors,␣
↪timeout=10)
```

[24]:
```
<ddsutil.MTAOS_ackcmd_8e276e56 at 0x7f25d0304820>
```

[25]:
```
await mtcs.rem.mtaos.cmd_issueCorrection.start(timeout=60.)
```

[25]:
```
<ddsutil.MTAOS_ackcmd_8e276e56 at 0x7f2519683dc0>
```

Check that the corrections in step 10 are twice of those in step 7. This step does not currently involve running any commands in this notebook. This step must be verified using a separate noteboook.

Wrap up. Put each component to the following states: mtaos –> standby m1m3 –> lower mirror –> standby m2 –> standby camera hex –> standby m2 hex –> standby

[ ]:
```
await mtcs.set_state(salobj.State.STANDBY, components=["mtaos"])
```

[ ]:
```
await mtcs.lower_m1m3()
```

[ ]:
```
await mtcs.set_state(salobj.State.STANDBY, components=["mtm1m3"])
```

[ ]:
```
await mtcs.set_state(salobj.State.STANDBY, components=["mtm2"])
```

[ ]:
```
await mtcs.set_state(salobj.State.STANDBY, components=["mthexapod_1"])
```

[ ]:
```
await mtcs.set_state(salobj.State.STANDBY, components=["mthexapod_2"])
```

[ ]:
```
await mtcs.standby()
```