Slew, Track and Image taking with ComCam

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-T2290 (https://jira.lsstcorp.org/secure/Tests.jspa#/testCase/LVV-T2290)

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.

In [1]:
```
from lsst.ts import utils

# Extract your name from the Jupyter Hub
__executed_by__ = os.environ["JUPYTERHUB_USER"]

# Extract execution date
__executed_on__ = utils.astropy_time_from_tai_unix(utils.current_tai())
__executed_on__.format = "isot"

# This is used later to define where Butler stores the images
summit = os.environ["LSST_DDS_PARTITION_PREFIX"] == "summit"

print(f"\nExecuted by {__executed_by__} on {__executed_on__}."
      f"\n  At the summit? {summit}")
```

```
lsst.ts.utils.tai INFO: Update leap second table
lsst.ts.utils.tai INFO: current_tai uses the system TAI clock
Executed by b1quint on 2022-05-24T18:17:43.753.
  At the summit? True
```

Run the setup.ipnyb notebook to bring all components up and in their enabled position. Check Chronograph.

Bring ComCom online and tranistion it to EnabledState. Check Chronograph.

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

In [3]:
```
import rubin_jupyter_utils.lab.notebook as nb
nb.utils.get_node()
```

```
/tmp/ipykernel_16534/1665379685.py:2: DeprecationWarning: Call to deprecated f
unction (or staticmethod) get_node. (Please use lsst.rsp.get_node())
  nb.utils.get_node()
```

Out[3]:
```
'yagan03'
```

In [4]:
```
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
```

In [5]:
```
logging.basicConfig(format="%(name)s:%(message)s", level=logging.DEBUG)
```

In [6]:
```
log = logging.getLogger("setup")
log.level = logging.DEBUG
```

In [7]:
```
domain = salobj.Domain()
```

In [8]:
```
mtcs = MTCS(domain=domain, log=log)
mtcs.set_rem_loglevel(40)
```

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

In [9]:
```
await mtcs.start_task
```

```
MTHexapod INFO: Read historical data in 0.07 sec
MTHexapod INFO: Read historical data in 0.10 sec
```

Out[9]:
```
[None, None, None, None, None, None, None, None, None, None]
```

```
MTHexapod.electrical WARNING: tel_electrical DDS read queue is filling: 15
 of 100 elements
```

In [10]:
```
comcam = ComCam(domain=domain, log=log)
```

```
setup.ComCam DEBUG: cccamera: Adding all resources.
setup.ComCam DEBUG: ccheaderservice: Adding all resources.
setup.ComCam DEBUG: ccoods: Adding all resources.
MTHexapod.application WARNING: tel_application DDS read queue is filling: 1
5 of 100 elements
MTHexapod.actuators WARNING: tel_actuators DDS read queue is filling: 24 of
100 elements
```

```
MTHexapod.actuators WARNING: tel_actuators DDS read queue is filling: 11 of 100 elements
CCHeaderService INFO: Read historical data in 0.09 sec
CCCamera INFO: Read historical data in 0.11 sec
CCCamera.logevent_focal_plane_Reb_RaftsPowerConfiguration WARNING: evt_focal_plane_Reb_RaftsPowerConfiguration DDS read queue is filling: 60 of 100 elements
CCCamera.logevent_focal_plane_Reb_timersConfiguration WARNING: evt_focal_plane_Reb_timersConfiguration DDS read queue is filling: 60 of 100 elements
CCCamera.logevent_focal_plane_SequencerConfig_DAQConfiguration WARNING: evt_focal_plane_SequencerConfig_DAQConfiguration DDS read queue is filling: 50 of 100 elements
CCCamera.logevent_focal_plane_SequencerConfig_SequencerConfiguration WARNING: evt_focal_plane_SequencerConfig_SequencerConfiguration DDS read queue is filling: 10 of 100 elements
CCCamera.logevent_focal_plane_WebHooksConfig_VisualizationConfiguration WARNING: evt_focal_plane_WebHooksConfig_VisualizationConfiguration DDS read queue is filling: 27 of 100 elements
CCCamera.logevent_heartbeat WARNING: evt_heartbeat DDS read queue is filling: 15 of 100 elements
CCCamera.logevent_image_handling_ImageHandler_DAQConfiguration WARNING: evt_image_handling_ImageHandler_DAQConfiguration DDS read queue is filling: 14 of 100 elements
CCCamera.logevent_image_handling_ImageHandler_FitsHandlingConfiguration WARNING: evt_image_handling_ImageHandler_FitsHandlingConfiguration DDS read queue is filling: 34 of 100 elements
CCCamera.logevent_image_handling_PeriodicTasks_timersConfiguration WARNING: evt_image_handling_PeriodicTasks_timersConfiguration DDS read queue is filling: 56 of 100 elements
CCCamera.logevent_image_handling_Reb_FitsHandlingConfiguration WARNING: evt_image_handling_Reb_FitsHandlingConfiguration DDS read queue is filling: 37 of 100 elements
CCCamera.logevent_quadbox_PDU_48V_QuadboxConfiguration WARNING: evt_quadbox_PDU_48V_QuadboxConfiguration DDS read queue is filling: 10 of 100 elements
CCCamera.logevent_quadbox_BFR_LimitsConfiguration WARNING: evt_quadbox_BFR_LimitsConfiguration DDS read queue is filling: 57 of 100 elements
CCCamera.logevent_quadbox_BFR_QuadboxConfiguration WARNING: evt_quadbox_BFR_QuadboxConfiguration DDS read queue is filling: 46 of 100 elements
CCCamera.logevent_quadbox_PDU_24VC_LimitsConfiguration WARNING: evt_quadbox_PDU_24VC_LimitsConfiguration DDS read queue is filling: 13 of 100 elements
CCCamera.logevent_quadbox_PDU_24VC_QuadboxConfiguration WARNING: evt_quadbox_PDU_24VC_QuadboxConfiguration DDS read queue is filling: 25 of 100 elements
CCCamera.logevent_quadbox_PDU_24VD_LimitsConfiguration WARNING: evt_quadbox_PDU_24VD_LimitsConfiguration DDS read queue is filling: 17 of 100 elements
CCCamera.logevent_quadbox_PDU_24VD_QuadboxConfiguration WARNING: evt_quadbox_PDU_24VD_QuadboxConfiguration DDS read queue is filling: 16 of 100 elements
CCCamera.logevent_quadbox_PDU_5V_LimitsConfiguration WARNING: evt_quadbox_PDU_5V_LimitsConfiguration DDS read queue is filling: 51 of 100 elements
CCCamera.logevent_quadbox_PeriodicTasks_timersConfiguration WARNING: evt_quadbox_PeriodicTasks_timersConfiguration DDS read queue is filling: 23 of 100 elements
```

```
CCCamera.logevent_raftsDetailedState WARNING: evt_raftsDetailedState DDS re
ad queue is filling: 65 of 100 elements
CCCamera.logevent_rebpower_PeriodicTasks_timersConfiguration WARNING: evt_r
ebpower_PeriodicTasks_timersConfiguration DDS read queue is filling: 15 of
 100 elements
CCCamera.logevent_rebpower_Reb_LimitsConfiguration WARNING: evt_rebpower_Re
b_LimitsConfiguration DDS read queue is filling: 55 of 100 elements
CCCamera.logevent_vacuum_Cold2_CryoconConfiguration WARNING: evt_vacuum_Col
d2_CryoconConfiguration DDS read queue is filling: 37 of 100 elements
CCCamera.logevent_vacuum_Cold2_LimitsConfiguration WARNING: evt_vacuum_Cold
2_LimitsConfiguration DDS read queue is filling: 11 of 100 elements
CCCamera.logevent_vacuum_Cryo_CryoconConfiguration WARNING: evt_vacuum_Cryo
_CryoconConfiguration DDS read queue is filling: 10 of 100 elements
CCCamera.logevent_vacuum_Cryo_CryoconConfiguration WARNING: evt_vacuum_Cryo
_CryoconConfiguration DDS read queue is filling: 10 of 100 elements
CCCamera.logevent_vacuum_Cryo_LimitsConfiguration WARNING: evt_vacuum_Cryo_
LimitsConfiguration DDS read queue is filling: 15 of 100 elements
CCCamera.logevent_vacuum_IonPumps_CryoConfiguration WARNING: evt_vacuum_Ion
Pumps_CryoConfiguration DDS read queue is filling: 37 of 100 elements
CCCamera.logevent_vacuum_IonPumps_LimitsConfiguration WARNING: evt_vacuum_I
onPumps_LimitsConfiguration DDS read queue is filling: 11 of 100 elements
CCCamera.logevent_vacuum_VacPluto_DeviceConfiguration WARNING: evt_vacuum_V
acPluto_DeviceConfiguration DDS read queue is filling: 15 of 100 elements
CCCamera.logevent_vacuum_PeriodicTasks_timersConfiguration WARNING: evt_vac
uum_PeriodicTasks_timersConfiguration DDS read queue is filling: 10 of 100
 elements
CCCamera.logevent_vacuum_Rtds_DeviceConfiguration WARNING: evt_vacuum_Rtds_
DeviceConfiguration DDS read queue is filling: 15 of 100 elements
CCCamera.logevent_vacuum_Turbo_LimitsConfiguration WARNING: evt_vacuum_Turb
o_LimitsConfiguration DDS read queue is filling: 42 of 100 elements
CCCamera.logevent_vacuum_VQMonitor_CryoConfiguration WARNING: evt_vacuum_VQ
Monitor_CryoConfiguration DDS read queue is filling: 14 of 100 elements
CCCamera.logevent_vacuum_VQMonitor_LimitsConfiguration WARNING: evt_vacuum_
VQMonitor_LimitsConfiguration DDS read queue is filling: 10 of 100 elements
CCHeaderService.logevent_heartbeat WARNING: evt_heartbeat DDS read queue is
filling: 42 of 100 elements
CCCamera.logevent_vacuum_Rtds_LimitsConfiguration WARNING: evt_vacuum_Rtds_
LimitsConfiguration DDS read queue is filling: 57 of 100 elements
CCHeaderService.logevent_largeFileObjectAvailable WARNING: evt_largeFileObj
ectAvailable DDS read queue is filling: 47 of 100 elements
CCHeaderService.logevent_logMessage WARNING: evt_logMessage DDS read queue
 is filling: 21 of 100 elements
CCHeaderService.logevent_logMessage WARNING: evt_logMessage DDS read queue
 is filling: 67 of 100 elements
CCCamera.logevent_vacuum_Cold1_CryoconConfiguration WARNING: evt_vacuum_Col
d1_CryoconConfiguration DDS read queue is filling: 57 of 100 elements
CCHeaderService.logevent_largeFileObjectAvailable WARNING: evt_largeFileObj
ectAvailable DDS read queue is filling: 53 of 100 elements
CCCamera.logevent_summaryState WARNING: evt_summaryState DDS read queue is
 filling: 14 of 100 elements
CCCamera.logevent_startReadout ERROR: evt_startReadout DDS read queue is fu
ll (100 elements); data may be lost
```

```
CCCamera.logevent_startIntegration ERROR: evt_startIntegration DDS read que
ue is full (100 elements); data may be lost
CCCamera.logevent_shutterDetailedState WARNING: evt_shutterDetailedState DD
S read queue is filling: 91 of 100 elements
CCCamera.logevent_rebpower_Rebps_LimitsConfiguration WARNING: evt_rebpower_
Rebps_LimitsConfiguration DDS read queue is filling: 57 of 100 elements
CCCamera.logevent_quadbox_REB_Bulk_PS_QuadboxConfiguration WARNING: evt_qua
dbox_REB_Bulk_PS_QuadboxConfiguration DDS read queue is filling: 57 of 100
 elements
CCCamera.logevent_quadbox_PDU_48V_LimitsConfiguration WARNING: evt_quadbox_
PDU_48V_LimitsConfiguration DDS read queue is filling: 57 of 100 elements
CCOODS INFO: Read historical data in 0.49 sec
CCCamera.logevent_imageReadoutParameters ERROR: evt_imageReadoutParameters
 DDS read queue is full (100 elements); data may be lost
CCCamera.logevent_focal_plane_Segment_LimitsConfiguration WARNING: evt_foca
l_plane_Segment_LimitsConfiguration DDS read queue is filling: 60 of 100 el
ements
CCCamera.logevent_focal_plane_Reb_RaftsLimitsConfiguration WARNING: evt_foc
al_plane_Reb_RaftsLimitsConfiguration DDS read queue is filling: 60 of 100
 elements
CCCamera.logevent_focal_plane_Reb_RaftsConfiguration WARNING: evt_focal_pla
ne_Reb_RaftsConfiguration DDS read queue is filling: 60 of 100 elements
CCCamera.logevent_focal_plane_Reb_LimitsConfiguration WARNING: evt_focal_pl
ane_Reb_LimitsConfiguration DDS read queue is filling: 60 of 100 elements
CCCamera.logevent_focal_plane_Reb_HardwareIdConfiguration WARNING: evt_foca
l_plane_Reb_HardwareIdConfiguration DDS read queue is filling: 60 of 100 el
ements
CCCamera.logevent_focal_plane_RebTotalPower_LimitsConfiguration WARNING: ev
t_focal_plane_RebTotalPower_LimitsConfiguration DDS read queue is filling:
 60 of 100 elements
CCCamera.logevent_focal_plane_Raft_RaftTempControlStatusConfiguration WARNI
NG: evt_focal_plane_Raft_RaftTempControlStatusConfiguration DDS read queue
 is filling: 60 of 100 elements
CCCamera.logevent_focal_plane_Raft_RaftTempControlConfiguration WARNING: ev
t_focal_plane_Raft_RaftTempControlConfiguration DDS read queue is filling:
 60 of 100 elements
CCCamera.logevent_focal_plane_Raft_HardwareIdConfiguration WARNING: evt_foc
al_plane_Raft_HardwareIdConfiguration DDS read queue is filling: 16 of 100
 elements
```

In [11]:
```
comcam.set_rem_loglevel(40)
```

In [12]:
```
await comcam.start_task
```

Out[12]:
```
[None, None, None]
```

In [13]:
```
await comcam.enable()
```

```
setup.ComCam INFO: Enabling all components
setup.ComCam DEBUG: Expand overrides None
setup.ComCam DEBUG: Complete overrides: {'cccamera': '', 'ccheaderservice':
'', 'ccoods': ''}
setup.ComCam DEBUG: [cccamera]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <
State.ENABLED: 2>]
```

```
setup.ComCam DEBUG: [ccheaderservice]::[<State.STANDBY: 5>, <State.DISABLE
D: 1>, <State.ENABLED: 2>]
setup.ComCam DEBUG: [ccoods]::[<State.STANDBY: 5>, <State.DISABLED: 1>, <St
ate.ENABLED: 2>]
setup.ComCam INFO: All components in <State.ENABLED: 2>.
```

Find four targets separated by 5° in azimuth and elevation in a square pattern around az = 120° and el = 60° and rotator angle at PhysicalSky and 1.8°.

At this position, the rotator stays within a couple of degrees of its initial position. This is because the CCW is not running (MTmount in simulation mode).

target_1 -> az = 117.5^o, el = 57.5^o
target_2 -> az = 122.5^o, el =57.5^o
target_3 -> az = 122.5^o, el=62.5^o
target_4 -> az = 117.5^o, el = 62.5^o

In [14]:
```
target_1 = mtcs.radec_from_azel(az=117.5, el=57.5)
target_2 = mtcs.radec_from_azel(az=122.5, el=57.5)
target_3 = mtcs.radec_from_azel(az=122.5, el=62.5)
target_4 = mtcs.radec_from_azel(az=117.5, el=62.5)

print(f"Target 1: {target_1}\n"
      f"Target 2: {target_2}\n"
      f"Target 3: {target_3}\n"
      f"Target 4: {target_4}\n")
```

```
WARNING: AstropyDeprecationWarning: Transforming a frame instance to a frame c
lass (as opposed to another frame instance) will not be supported in the futur
e.  Either explicitly instantiate the target frame, or first convert the sourc
e frame instance to a `astropy.coordinates.SkyCoord` and use its `transform_to
()` method. [astropy.coordinates.baseframe]
astroquery WARNING: AstropyDeprecationWarning: Transforming a frame instanc
e to a frame class (as opposed to another frame instance) will not be suppo
rted in the future.  Either explicitly instantiate the target frame, or fir
st convert the source frame instance to a `astropy.coordinates.SkyCoord` an
d use its `transform_to()` method.
Target 1: <ICRS Coordinate: (ra, dec) in deg
    (124.60208155, -39.65485164)>
Target 2: <ICRS Coordinate: (ra, dec) in deg
    (124.1695968, -42.3204616)>
Target 3: <ICRS Coordinate: (ra, dec) in deg
    (117.5928972, -41.32490233)>
Target 4: <ICRS Coordinate: (ra, dec) in deg
    (118.18266814, -39.06121743)>

MTHexapod.electrical WARNING: tel_electrical DDS read queue is filling: 13
 of 100 elements
MTHexapod.application WARNING: tel_application DDS read queue is filling: 1
4 of 100 elements
MTHexapod.actuators WARNING: tel_actuators DDS read queue is filling: 13 of
100 elements
```

Slew to target 1:

In [15]:
```
await mtcs.slew_icrs(ra=target_1.ra, dec=target_1.dec, rot_type=RotType.Physica
```

```
setup.MTCS DEBUG: Setting rotator physical position to 1.9 deg. Rotator wil
l track sky.
setup.MTCS DEBUG: Wait 5.0s for rotator to settle down.
setup.MTCS DEBUG: Workaround for rotator trajectory problem. Moving rotator
to its current position: -0.10
setup.MTCS DEBUG: Wait for MTRotator in position event.
setup.MTCS DEBUG: MTRotator in position: True.
setup.MTCS DEBUG: MTRotator already in position. Handling potential race co
ndition.
setup.MTCS INFO: MTRotator in position: False.
setup.MTCS INFO: MTRotator in position: True.
setup.MTCS DEBUG: MTRotator in position True. Waiting settle time 5.0s
setup.MTCS DEBUG: Sending slew command.
setup.MTCS DEBUG: Scheduling check coroutines
setup.MTCS DEBUG: process as completed...
setup.MTCS DEBUG: Monitor position started.
setup.MTCS DEBUG: Waiting for Target event from mtmount.
setup.MTCS DEBUG: mtmount: <State.ENABLED: 2>
setup.MTCS DEBUG: mtptg: <State.ENABLED: 2>
setup.MTCS DEBUG: mtaos: <State.ENABLED: 2>
setup.MTCS DEBUG: mtm1m3: <State.ENABLED: 2>
setup.MTCS DEBUG: mtm2: <State.ENABLED: 2>
setup.MTCS DEBUG: mthexapod_1: <State.ENABLED: 2>
setup.MTCS DEBUG: mthexapod_2: <State.ENABLED: 2>
setup.MTCS DEBUG: mtrotator: <State.ENABLED: 2>
setup.MTCS DEBUG: mtdome: <State.ENABLED: 2>
setup.MTCS DEBUG: mtdometrajectory: <State.ENABLED: 2>
setup.MTCS DEBUG: Wait for mtmount in position events.
setup.MTCS DEBUG: Wait for dome in position event.
setup.MTCS DEBUG: Wait for MTRotator in position event.
setup.MTCS DEBUG: MTRotator in position: True.
setup.MTCS DEBUG: MTRotator already in position. Handling potential race co
ndition.
setup.MTCS DEBUG: Wait for MTMount elevation in position event.
setup.MTCS DEBUG: MTMount elevation in position: True.
setup.MTCS DEBUG: MTMount elevation already in position. Handling potential
race condition.
setup.MTCS DEBUG: Wait for MTMount azimuth in position event.
setup.MTCS DEBUG: MTMount azimuth in position: True.
setup.MTCS DEBUG: MTMount azimuth already in position. Handling potential r
ace condition.
setup.MTCS DEBUG: Mount target: private_revCode: bdcb00ba, private_sndStam
p: 1653416441.1041849, private_rcvStamp: 1653416441.1044898, private_seqNu
m: 1, private_identity: MTMount, private_origin: 28805, elevation: 57.57703
074674596, elevationVelocity: 0.003200267188023725, azimuth: 117.5110944152
7043, azimuthVelocity: 0.0005195871470016742, taiTime: 1653416441.1631935,
 trackId: 1, tracksys: SIDEREAL, radesys: ICRS, priority: 0
```

```
setup.MTCS INFO: MTMount elevation in position: False.
setup.MTCS INFO: MTMount azimuth in position: False.
setup.MTCS INFO: MTRotator in position: False.
setup.MTCS INFO: MTRotator in position: True.
setup.MTCS DEBUG: MTRotator in position True. Waiting settle time 3.0s
setup.MTCS DEBUG: [Tel]: Az = +000.001[+117.5]; El = +089.999[ -32.4] [Rot]: -000.097[  -0.0] [Dome] Az = +000.000; El = +000.000
setup.MTCS DEBUG: Dome azimuth in position.
setup.MTCS DEBUG: Dome elevation in position.
setup.MTCS DEBUG: [Tel]: Az = +043.959[ +73.6]; El = +068.020[ -10.4] [Rot]: +002.021[  -0.0] [Dome] Az = +000.000; El = +000.000
setup.MTCS INFO: MTMount elevation in position: True.
setup.MTCS DEBUG: MTMount elevation in position True. Waiting settle time 3.0s
setup.MTCS DEBUG: [Tel]: Az = +085.090[ +32.4]; El = +057.618[  +0.0] [Rot]: +002.002[  +0.0] [Dome] Az = +000.000; El = +000.000
setup.MTCS INFO: MTMount azimuth in position: True.
setup.MTCS DEBUG: MTMount azimuth in position True. Waiting settle time 3.0s
setup.MTCS DEBUG: [Tel]: Az = +117.521[  +0.0]; El = +057.638[  +0.0] [Rot]: +001.984[  +0.0] [Dome] Az = +000.000; El = +000.000
```

Out[15]:
```
(<ICRS Coordinate: (ra, dec) in deg
    (124.60208155, -39.65485164)>,
 <Angle 1.9 deg>)
```

Once on target_1 and tracking, take an image with ComCam

In [16]:
```
exp1 = await comcam.take_object(15)
print(f"Target 1 exposure: {exp1}")
```

```
setup.ComCam DEBUG: Generating group_id
setup.ComCam DEBUG: imagetype: OBJECT, TCS synchronization not configured.
```

```
---------------------------------------------------------------------------
TimeoutError                              Traceback (most recent call last)
File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/base_camera.py:1122, in BaseCamera._handle_snaps(self, camera_exposure)
   1121 try:
-> 1122     exp_id = await self.next_exposure_id()
   1123 except asyncio.TimeoutError:

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/base_camera.py:1223, in BaseCamera.next_exposure_id(self)
   1212 """Get the exposure id from the next endReadout event.
   1213
   1214 Await for the next `camera.evt_endReadout` event, without flushing,
   (...)
   1221     Exposure id from next endReadout event.
   1222 """
-> 1223 end_readout = await self.camera.evt_endReadout.next(
   1224     flush=False, timeout=self.long_long_timeout
   1225 )
   1226 # parse out visitID from filename
   1227 # (Patrick comment) this is highly annoying

File /opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/read_topic.py:645, in ReadTopic.next(self, flush, timeout)
    644     self.flush()
--> 645 return await self._next(timeout=timeout)

File /opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-3.0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/read_topic.py:659, in ReadTopic._next(self, timeout)
    658     self._next_task = asyncio.Future()
--> 659 return await asyncio.wait_for(self._next_task, timeout=timeout)

File /opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-3.0.0/lib/python3.8/asyncio/tasks.py:501, in wait_for(fut, timeout, loop)
    500         await _cancel_and_wait(fut, loop=loop)
--> 501         raise exceptions.TimeoutError()
    502 finally:

TimeoutError:

During handling of the above exception, another exception occurred:

RuntimeError                              Traceback (most recent call last)
Input In [16], in <cell line: 1>()
----> 1 exp1 = await comcam.take_object(15)
      2 print(f"Target 1 exposure: {exp1}")

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/base_camera.py:389, in BaseCamera.take_object(self, exptime, n, n_snaps, group_id, test_type, reason, program, sensors, note, checkpoint, **kwargs)
    322 """Take a series of object images.
    323
    324 Object images are assumed to be looking through an open dome at the
   (...)
    384 discouraged (and will result in a warning message).
    385 """
    387 self.check_kwargs(**kwargs)
```

```
--> 389 return await self.take_imgtype(
    390     imgtype="OBJECT",
    391     exptime=exptime,
    392     n=n,
    393     n_snaps=n_snaps,
    394     group_id=group_id,
    395     test_type=test_type,
    396     reason=reason,
    397     program=program,
    398     sensors=sensors,
    399     note=note,
    400     checkpoint=checkpoint,
    401     **kwargs,
    402 )

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/base_camera.py:923, in BaseCamera.take_imgtype(self, imgtype, exptime, n, n_snaps, n_shift, row_shift, group_id, test_type, reason, program, sensors, note, checkpoint, **kwargs)
    905     await checkpoint(f"Expose {n} {imgtype}")
    907 camera_exposure = CameraExposure(
    908     exp_time=exptime if imgtype != "BIAS" else 0.0,
    909     shutter=imgtype not in ["BIAS", "DARK"],
   (...)
    920     note=note,
    921 )
--> 923 return await self.expose(camera_exposure=camera_exposure)

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/base_camera.py:1030, in BaseCamera.expose(self, camera_exposure)
   1021     elif (
   1022         bool(camera_exposure.shutter)
   1023         and camera_exposure.exp_time < self.min_exptime
   1024     ):
   1025         raise RuntimeError(
   1026             f"Minimum allowed open-shutter exposure time "
   1027             f"is {self.min_exptime}. Got {camera_exposure.exp_time}."
   1028         )
-> 1030     exp_ids = await self.handle_take_images(camera_exposure=camera_exposure)
   1032 return exp_ids

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/base_camera.py:1051, in BaseCamera.handle_take_images(self, camera_exposure)
   1037 """Handle take images command.
   1038
   1039 Parameters
   (...)
   1047     List of exposure ids.
   1048 """
   1050 if camera_exposure.image_type not in self._stuttered_imgtype:
-> 1051     return await self._handle_take_images(camera_exposure=camera_exposure)
   1052 else:
   1053     return await self._handle_take_stuttered(camera_exposure=camera_exposure)

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/control/base_camera.py:1078, in BaseCamera._handle_take_images(self, camera_ex
```

```
posure)
   1076 exp_ids = []
   1077 for _ in range(camera_exposure.n):
-> 1078     exp_ids += await self._handle_snaps(camera_exposure)
   1080 return exp_ids

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/
control/base_camera.py:1124, in BaseCamera._handle_snaps(self, camera_exposur
e)
   1122         exp_id = await self.next_exposure_id()
   1123     except asyncio.TimeoutError:
-> 1124         raise RuntimeError(
   1125             "Timeout waiting for endReadout event. "
   1126             f"Expected {camera_exposure.n_snaps} got {len(exp_ids)}."
   1127         )
   1129     exp_ids.append(exp_id)
   1131 return exp_ids

RuntimeError: Timeout waiting for endReadout event. Expected 1 got 0.
```

```
MTHexapod.electrical WARNING: tel_electrical DDS read queue is filling: 15
 of 100 elements
```

```
MTHexapod.application WARNING: tel_application DDS read queue is filling: 1
5 of 100 elements
```

```
MTHexapod.actuators WARNING: tel_actuators DDS read queue is filling: 15 of
100 elements
```

In [17]:
```
await mtcs.stop_tracking()
```

```
setup.MTCS DEBUG: Stop tracking.
```

```
---------------------------------------------------------------------------
AckError                                  Traceback (most recent call last)
Input In [17], in <cell line: 1>()
----> 1 await mtcs.stop_tracking()

File ~/auto-op-env-packages/ts_observatory_control/python/lsst/ts/observatory/
control/base_tcs.py:1116, in BaseTCS.stop_tracking(self)
   1112 """Task to stop telescope tracking."""
   1114 self.log.debug("Stop tracking.")
-> 1116 await getattr(self.rem, self.ptg_name).cmd_stopTracking.start(
   1117     timeout=self.fast_timeout
   1118 )

File /opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-3.
0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/remote_command.py:485, i
n RemoteCommand.start(self, data, timeout, wait_done)
    481 cmd_info = CommandInfo(
    482     remote_command=self, seq_num=seq_num, wait_done=wait_done
    483 )
    484 self.salinfo._running_cmds[seq_num] = cmd_info
--> 485 return await cmd_info.next_ackcmd(timeout=timeout)

File /opt/lsst/software/stack/conda/miniconda3-py38_4.9.2/envs/lsst-scipipe-3.
0.0/lib/python3.8/site-packages/lsst/ts/salobj/topics/remote_command.py:195, i
n CommandInfo.next_ackcmd(self, timeout)
    193     ackcmd = await self._wait_task
    194     if ackcmd.ack in self.failed_ack_codes:
--> 195         raise base.AckError(msg="Command failed", ackcmd=ackcmd)
    196     return ackcmd
    197 except asyncio.TimeoutError:

AckError: msg='Command failed', ackcmd=(ackcmd private_seqNum=2042880307, ack=
<SalRetCode.CMD_FAILED: -302>, error=6612, result='Rejected : command not allo
wed in current state')
```

Slew to target_2:

In [ ]:
```
await mtcs.slew_icrs(ra=target_2.ra, dec=target_2.dec, rot_type=RotType.Physica
```

Once on target_2 and tracking, take an image with ComCam

In [ ]:
```
exp2 = await comcam.take_object(15)
print(f"Target 1 exposure: {exp2}")
```

Slew to target_3

In [ ]:
```
await mtcs.slew_icrs(ra=target_3.ra, dec=target_3.dec, rot_type=RotType.Physica
```

Once on target_3 and tracking, take an image with ComCam

In [ ]:
```
exp3 = await comcam.take_object(15)
print(f"Target 1 exposure: {exp3}")
```

Slew to target 4

In [ ]:
```
await mtcs.slew_icrs(ra=target_4.ra, dec=target_4.dec, rot_type=RotType.Physica
```

Once on target_4 and tracking, take an image with ComCam

In [ ]:
```
exp4 = await comcam.take_object(15)
print(f"Target 4 exposure: {exp4}")
```

Stop tracking to prevent hitting the Rotator soft limit.

In [ ]:
```
await mtcs.stop_tracking()
```

Use ComCam recent images CCS to ensure that the images were taken (http://ccs.lsst.org/RecentImages/comcam.html).

Query the butler to verify that the images are there and check the metadata. This step must be verified using a separate noteboook.

Wrap Up and Shut Down

This cell is not currently included as part of the test execution, but included here as needed to shutdown the systems

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

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

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

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

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

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

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

In [ ]:
```
await comcam.standby()
```