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 2022-05-10T18:29:53.070.
  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_39821/1665379685.py:2: DeprecationWarning: Call to deprecated f
unction (or staticmethod) get_node. (Please use lsst.rsp.get_node())
  nb.utils.get_node()
```

Out[3]:
```
'yagan04'
```

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 0.04 sec
MTHexapod INFO: Read historical data in 0.05 sec
```

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

```
MTHexapod.electrical WARNING: tel_electrical DDS read queue is filling: 13
 of 100 elements
MTHexapod.application WARNING: tel_application DDS read queue is filling: 2
0 of 100 elements
MTHexapod.actuators WARNING: tel_actuators DDS read queue is filling: 20 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.
```

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

```
MTHexapod.electrical WARNING: tel_electrical DDS read queue is filling: 10
 of 100 elements
MTHexapod.application WARNING: tel_application DDS read queue is filling: 1
1 of 100 elements
MTHexapod.actuators WARNING: tel_actuators DDS read queue is filling: 10 of
100 elements
CCHeaderService.logevent_logMessage ERROR: evt_logMessage DDS read queue is
full (100 elements); data may be lost
```

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.ENABLED: 2>]
setup.ComCam DEBUG: [ccheaderservice]::[<State.ENABLED: 2>]
setup.ComCam DEBUG: [ccoods]::[<State.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
    (113.44976196, -39.67568848)>
Target 2: <ICRS Coordinate: (ra, dec) in deg
    (113.04599281, -42.34133775)>
Target 3: <ICRS Coordinate: (ra, dec) in deg
    (106.46675687, -41.34687836)>
Target 4: <ICRS Coordinate: (ra, dec) in deg
    (107.05614704, -39.08309618)>
```

```
MTHexapod.electrical WARNING: tel_electrical DDS read queue is filling: 74
 of 100 elements
MTHexapod.electrical ERROR: tel_electrical DDS read queue is full (100 elem
ents); data may be lost
MTRotator.rotation ERROR: tel_rotation DDS read queue is full (100 element
s); data may be lost
MTM1M3.powerSupplyData ERROR: tel_powerSupplyData DDS read queue is full (1
00 elements); data may be lost
MTHexapod.application WARNING: tel_application DDS read queue is filling: 7
4 of 100 elements
MTRotator.motors ERROR: tel_motors DDS read queue is full (100 elements); d
ata may be lost
MTHexapod.application ERROR: tel_application DDS read queue is full (100 el
ements); data may be lost
MTHexapod.actuators WARNING: tel_actuators DDS read queue is filling: 73 of
100 elements
MTRotator.electrical ERROR: tel_electrical DDS read queue is full (100 elem
ents); data may be lost
MTM1M3.pidData ERROR: tel_pidData DDS read queue is full (100 elements); da
ta may be lost
MTHexapod.actuators ERROR: tel_actuators DDS read queue is full (100 elemen
ts); data may be lost
MTRotator.ccwFollowingError ERROR: tel_ccwFollowingError DDS read queue is
 full (100 elements); data may be lost
MTM1M3.inclinometerData ERROR: tel_inclinometerData DDS read queue is full
 (100 elements); data may be lost
MTM1M3.imsData ERROR: tel_imsData DDS read queue is full (100 elements); da
ta may be lost
MTM1M3.hardpointMonitorData ERROR: tel_hardpointMonitorData DDS read queue
 is full (100 elements); data may be lost
MTM1M3.hardpointActuatorData ERROR: tel_hardpointActuatorData DDS read queu
e is full (100 elements); data may be lost
MTM1M3.forceActuatorData ERROR: tel_forceActuatorData DDS read queue is ful
l (100 elements); data may be lost
MTM1M3.accelerometerData ERROR: tel_accelerometerData DDS read queue is ful
l (100 elements); data may be lost
MTM1M3.logevent_forceActuatorWarning ERROR: evt_forceActuatorWarning DDS re
ad queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedThermalForces ERROR: evt_appliedThermalForces DDS re
ad queue is full (100 elements); data may be lost
```

```
MTM1M3.logevent_appliedStaticForces ERROR: evt_appliedStaticForces DDS read queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedForces ERROR: evt_appliedForces DDS read queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedElevationForces ERROR: evt_appliedElevationForces DDS read queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedCylinderForces ERROR: evt_appliedCylinderForces DDS read queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedBalanceForces ERROR: evt_appliedBalanceForces DDS read queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedAzimuthForces ERROR: evt_appliedAzimuthForces DDS read queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedActiveOpticForces ERROR: evt_appliedActiveOpticForces DDS read queue is full (100 elements); data may be lost
MTM1M3.logevent_appliedAberrationForces ERROR: evt_appliedAberrationForces DDS read queue is full (100 elements); data may be lost
```

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 will 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: 0.82
setup.MTCS DEBUG: Wait for MTRotator in position event.
setup.MTCS DEBUG: 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: 1652207481.9886744, private_rcvStamp: 1652207481.9888825, private_seqNu
m: 3, private_identity: MTMount, private_origin: 6655, elevation: 57.608003
25930995, elevationVelocity: 0.0032001206621281226, azimuth: 117.5161531508
8713, azimuthVelocity: 0.0005231699490735734, taiTime: 1652207482.0460913,
 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 DEBUG: [Tel]: Az = +000.001[+117.5]; El = +090.000[ -32.4] [Ro
t]: +000.823[  -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 INFO: MTRotator in position: True.
setup.MTCS DEBUG: MTRotator in position True. Waiting settle time 3.0s
setup.MTCS DEBUG: [Tel]: Az = +041.813[ +75.7]; El = +069.114[ -11.5] [Ro
t]: +002.039[  +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 = +087.079[ +30.4]; El = +057.647[  -0.0] [Ro
t]: +002.020[  -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 3.0
s
setup.MTCS DEBUG: [Tel]: Az = +117.526[  -0.0]; El = +057.666[  -0.0] [Ro
t]: +002.001[  -0.0] [Dome] Az = +000.000; El = +000.000
```

Out[15]:
```
(<ICRS Coordinate: (ra, dec) in deg
    (113.44976196, -39.67568848)>,
 <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.
Target 1 exposure: [2022051000001]
```

Slew to target_2:

In [18]:
```
await mtcs.slew_icrs(ra=target_2.ra, dec=target_2.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: 1.59
setup.MTCS DEBUG: Wait for MTRotator in position event.
setup.MTCS DEBUG: 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: False.
setup.MTCS DEBUG: Wait for MTMount azimuth in position event.
setup.MTCS DEBUG: MTMount azimuth in position: False.
setup.MTCS DEBUG: Mount target: private_revCode: bdcb00ba, private_sndStam
p: 1652207960.9576013, private_rcvStamp: 1652207960.9578118, private_seqNu
m: 2360, private_identity: MTMount, private_origin: 6655, elevation: 59.034
07499973334, elevationVelocity: 0.0030251595702639553, azimuth: 123.0300608
1226663, azimuthVelocity: 0.0011733040492971148, taiTime: 1652207961.01653,
trackId: 2, tracksys: SIDEREAL, radesys: ICRS, priority: 0
setup.MTCS INFO: MTRotator in position: False.
setup.MTCS INFO: MTMount elevation in position: True.
setup.MTCS DEBUG: MTMount elevation in position True. Waiting settle time
 3.0s
setup.MTCS INFO: MTMount azimuth in position: True.
```

```
setup.MTCS DEBUG: MTMount azimuth in position True. Waiting settle time 3.0
s
setup.MTCS DEBUG: [Tel]: Az = +117.655[  +5.4]; El = +058.022[  +1.0] [Ro
t]: +001.587[  -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 INFO: MTRotator in position: True.
setup.MTCS DEBUG: MTRotator in position True. Waiting settle time 3.0s
```

Out[18]:
```
(<ICRS Coordinate: (ra, dec) in deg
     (113.04599281, -42.34133775)>,
 <Angle 1.9 deg>)
```

Once on target_2 and tracking, take an image with ComCam

In [19]:
```
exp2 = await comcam.take_object(15)
print(f"Target 1 exposure: {exp2}")
```

```
setup.ComCam DEBUG: Generating group_id
setup.ComCam DEBUG: imagetype: OBJECT, TCS synchronization not configured.
Target 1 exposure: [2022051000002]
```

Slew to target_3

In [20]:
```
await mtcs.slew_icrs(ra=target_3.ra, dec=target_3.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: 1.86
setup.MTCS DEBUG: Wait for MTRotator in position event.
setup.MTCS DEBUG: 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: 1652207998.7070796, private_rcvStamp: 1652207998.707261, private_seqNum:
3114, private_identity: MTMount, private_origin: 6655, elevation: 64.143238
54903515, elevationVelocity: 0.0030098154124093683, azimuth: 123.4766862002
5146, azimuthVelocity: 0.002002500116641052, taiTime: 1652207998.7659419, t
rackId: 3, tracksys: SIDEREAL, radesys: ICRS, priority: 0
setup.MTCS INFO: MTMount azimuth in position: False.
setup.MTCS INFO: MTMount elevation in position: False.
setup.MTCS DEBUG: [Tel]: Az = +123.077[  +0.4]; El = +059.149[  +5.0] [Ro
t]: +001.861[  -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 INFO: MTMount azimuth in position: True.
setup.MTCS DEBUG: MTMount azimuth in position True. Waiting settle time 3.0
s
setup.MTCS INFO: MTMount elevation in position: True.
setup.MTCS DEBUG: MTMount elevation in position True. Waiting settle time
 3.0s
setup.MTCS DEBUG: No new in position event in the last 3.0s. Assuming MTRot
ator in position.
setup.MTCS DEBUG: MTRotator in position True. Waiting settle time 3.0s
```

Out[20]:
```
(<ICRS Coordinate: (ra, dec) in deg
    (106.46675687, -41.34687836)>,
 <Angle 1.9 deg>)
```

Once on target_3 and tracking, take an image with ComCam

In [21]:
```
exp3 = await comcam.take_object(15)
print(f"Target 1 exposure: {exp3}")
```

```
setup.ComCam DEBUG: Generating group_id
setup.ComCam DEBUG: imagetype: OBJECT, TCS synchronization not configured.
Target 1 exposure: [2022051000003]
```

Slew to target 4

In [22]:
```
await mtcs.slew_icrs(ra=target_4.ra, dec=target_4.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: 1.76
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: 1652208036.4064116, private_rcvStamp: 1652208036.4066315, private_seqNu
m: 3867, private_identity: MTMount, private_origin: 6655, elevation: 64.351
75979607912, elevationVelocity: 0.0031791154004733773, azimuth: 118.2334614
6277294, azimuthVelocity: 0.0014506959229717929, taiTime: 1652208036.4652,
 trackId: 4, tracksys: SIDEREAL, radesys: ICRS, priority: 0
setup.MTCS INFO: MTMount azimuth in position: False.
setup.MTCS INFO: MTMount elevation in position: False.
```

```
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 = +123.542[  -5.3]; El = +064.262[  +0.1] [Ro
t]: +001.761[  +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 INFO: MTMount azimuth in position: True.
setup.MTCS DEBUG: MTMount azimuth in position True. Waiting settle time 3.0
s
setup.MTCS DEBUG: No new in position event in the last 3.0s. Assuming MTRot
ator in position.
setup.MTCS DEBUG: MTRotator in position True. Waiting settle time 3.0s
```

Out[22]:
```
(<ICRS Coordinate: (ra, dec) in deg
    (107.05614704, -39.08309618)>,
 <Angle 1.9 deg>)
```

Once on target_4 and tracking, take an image with ComCam

In [23]:
```
exp4 = await comcam.take_object(15)
print(f"Target 1 exposure: {exp4}")
```

```
setup.ComCam DEBUG: Generating group_id
setup.ComCam DEBUG: imagetype: OBJECT, TCS synchronization not configured.
Target 1 exposure: [2022051000004]
```

Stop tracking to prevent hitting the Rotator soft limit.

In [24]:
```
await mtcs.stop_tracking()
```

```
setup.MTCS DEBUG: 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()
```