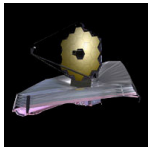

# 3671 - Radio Jet Feedback in the Nearby Spiral Galaxy M58

Cycle: 2, Proposal Category: GO

**INVESTIGATORS**


| *Name* | *Institution* |
|---|---|
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**OBSERVATIONS**

| *Folder* | *Observation* | *Label* | *Observing Template* | *Science Target* |
|---|---|---|---|---|
| M58 IFU and MRS | | | | |
| | 1 | M58 IFU | NIRSpec IFU Spectroscopy | (1) M-58 |
| | 2 | M58 MRS | MIRI Medium Resolution Spectroscopy | (2) M-58-MRS |
| | 3 | M58 MRS Off | MIRI Medium Resolution Spectroscopy | (3) M-58-MRS-OFF |
| M58 Imaging | | | | |
| | 4 | M58 MIRI IM | MIRI Imaging | (1) M-58 |
| | 9 | M58 NIRCAM IM | NIRCam Imaging | (1) M-58 |

**ABSTRACT**

We propose MIRI MRS and imaging, NIRSpec IFU, and NIRCam imaging observations of radio jet feedback on the kpc-scale molecular disk of nearby spiral galaxy M58. This is the most luminous nearby example where a low-power radio jet is having an enormous impact on the physical state of molecular gas in the central regions of a spiral galaxy, heating a large fraction of it to 200-3000K. We will spatially and kinematically resolve the jet-ISM interactions at a scale of 10 pc and determine what fraction of the molecular and ionized gas is heated in place and what fraction is entrained

in an outflow. This will also yield the molecular and ionized gas outflow rates, which we will compare to the AGN accretion rate and nuclear star formation rates to determine how significant these processes are in regulating both. While confined to the central disk and bulge, AGN jet feedback can potentially have an impact on the recycling of gas and star formation in the larger disk of the galaxy. Crucially, an up-close look at the jet feedback process will greatly improve our understanding of both how efficiently it operates and the potential impact of more powerful jets in radio galaxies and quasars on the global gas content and star formation at high redshift, where it will not be possible to examine the details jet feedback process at such high spatial resolution.

**OBSERVING DESCRIPTION**

We use NIRSpec IFU with G235H/F170LP and G395H/F290LP; and MIRI MRS for spectroscopic mapping the wavelength range 1.7-25 microns, to cover the full series of accessible H2 pure rotational and rovibrational lines and PAH features. A large array of ionized gas lines will be used to characterize ionized outflows driven by the radio jet. Leakcal observations are needed to remove MSA print-through since the MSA FOV lands on the bright disk of the host galaxy. We take concurrent MIRI imaging to help with astrometric registration. MRS off observations are required to be taken in an noninterruptible sequence with the MRS observations to enable accurate background subtraction. NIRCam and MIRI imaging of the H2, PAH, and adjacent continuum bands will give a broader context for AGN feedback across the galaxy bulge and bar and higher resolution on the nucleus to help interpret the IFU observations.

**Fixed Targets**

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | M-58 | RA: 12 37 43.5220 (189.4313417d)<br>Dec: +11 49 5.50 (11.81819d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |
| *Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Pointing moved 1" north and 1" east to put the AGN away from the edge of the IFU and MRS FOV.*<br>*Category=Galaxy*<br>*Description=[Active galactic nuclei]*<br>*Extended=YES* | | | | |
| (2) | M-58-MRS | RA: 12 37 43.5220 (189.4313417d)<br>Dec: +11 49 5.50 (11.81819d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |
| *Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Pointing moved 1" north and 1" E to put the AGN away from the edge of the IFU and MRS FOV.*<br><br>*02/04/2024 - I linked the M-58-MRS-OFF target as the background of this observation, following the suggestion of Mike Engesser. Thank you! I also marked the source as Extended.*<br>*Category=Galaxy*<br>*Description=[Active galactic nuclei]*<br>*Extended=YES* | | | | |
| (3) | M-58-MRS-OFF | RA: 12 37 53.4990 (189.4729125d)<br>Dec: +11 50 12.60 (11.83683d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |
| *Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*<br><br>*02/04/2024 - Background position changed, just to try to take advantange of the MIRI imager targeting the galaxy while the MRS take the exposure. I didn't put PA constrains, to avoid possible limitations in the scheduling.*<br>*Category=Galaxy*<br>*Description=[Active galactic nuclei]* | | | | |

## Observation

**Proposal 3671, Observation 1: M58 IFU** Tue Jun 11 01:00:20 GMT 2024

**Diagnostic Status: Warning**

Observing Template: NIRSpec IFU Spectroscopy

## Diagnostics

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | M-58 | RA: 12 37 43.5220 (189.4313417d)<br>Dec: +11 49 5.50 (11.81819d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Pointing moved 1" north and 1" east to put the AGN away from the edge of the IFU and MRS FOV.*
*Category=Galaxy*
*Description=[Active galactic nuclei]*
*Extended=YES*

## Template

| TA Method |
|---|
| NONE |

## Mosaic

| Rows | Columns | Row Overlap % | Column Overlap % | Row shift (deg) | Column shift (deg) | Tile Order |
|---|---|---|---|---|---|---|
| 2 | 2 | 10.0 | 10.0 | 0.0 | 0.0 | DEFAULT |

## Dithers

| # | Dither Type | Size | Starting Point | Number of Points | Points |
|---|---|---|---|---|---|
| 1 | CYCLING | SMALL | 1 | 4 | |

## Spectral Elements

| # | Grating/Filter | Readout Pattern | Groups/Int | Integrations/Exp | Leakcal | Dither | Autocal | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | G235H/F170LP | NRSIRS2RAPID | 10 | 1 | false | true | NONE | 4 | 4 | 641.911 | |
| 2 | G235H/F170LP | NRSIRS2RAPID | 10 | 1 | true | true | NONE | 4 | 4 | 641.911 | |
| 3 | G395H/F290LP | NRSIRS2RAPID | 10 | 1 | false | true | NONE | 4 | 4 | 641.911 | |
| 4 | G395H/F290LP | NRSIRS2RAPID | 10 | 1 | true | true | NONE | 4 | 4 | 641.911 | |

## Observation

**Proposal 3671, Observation 2: M58 MRS** Tue Jun 11 01:00:20 GMT 2024

**Diagnostic Status: Warning**

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[M58 MRS Off (Obs 3)]

## Diagnostics

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (2) | M-58-MRS | RA: 12 37 43.5220 (189.4313417d)<br>Dec: +11 49 5.50 (11.81819d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Pointing moved 1" north and 1" E to put the AGN away from the edge of the IFU and MRS FOV.*

*02/04/2024 - I linked the M-58-MRS-OFF target as the background of this observation, following the suggestion of Mike Engesser. Thank you! I also marked the source as Extended.*
*Category=Galaxy*
*Description=[Active galactic nuclei]*
*Extended=YES*

## Acquisition

| # | Target |
|---|---|
| 1 | NONE |

## Template

| AcqFilter | Primary Channel | Simultaneous Imaging | Imager Subarray | Grating Wheel Direction |
|---|---|---|---|---|
| | All MRS | YES | FULL | NEUTRAL |

## Mosaic

| Rows | Columns | Row Overlap % | Column Overlap % | Row shift (deg) | Column shift (deg) | Tile Order |
|---|---|---|---|---|---|---|
| 2 | 2 | 10.0 | 10.0 | 0.0 | 0.0 | DEFAULT |

## Dithers

| # | Dither Type | Optimized For | Direction |
|---|---|---|---|
| 1 | 4-Point | EXTENDED SOURCE | NEGATIVE |

**Spectral Elements**

| # | Wavelength Range | Detector | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | IMAGER | F1130W | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 1 | LONG(C) | MRSLONG | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 1 | LONG(C) | MRSSHORT | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 2 | | IMAGER | F770W | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 2 | MEDIUM(B) | MRSLONG | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 2 | MEDIUM(B) | MRSSHORT | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 3 | | IMAGER | F560W | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 3 | SHORT(A) | MRSLONG | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 3 | SHORT(A) | MRSSHORT | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |

**Special Requirements**

Aperture PA Range 30 to 120 Degrees (V3 30.0 to 120.0)
Aperture PA Range 210 to 300 Degrees (V3 210.0 to 300.0)

Group Observations 2, 3, Non-interruptible

## Observation

**Proposal 3671, Observation 3: M58 MRS Off** Tue Jun 11 01:00:20 GMT 2024

**Diagnostic Status: Warning**

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [M58 MRS (Obs 2)]

## Diagnostics

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (3) | M-58-MRS-OFF | RA: 12 37 53.4990 (189.4729125d)<br>Dec: +11 50 12.60 (11.83683d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*

*02/04/2024 - Background position changed, just to try to take advantange of the MIRI imager targeting the galaxy while the MRS take the exposure. I didn't put PA constrains, to avoid possible limitations in the scheduling.*
*Category=Galaxy*
*Description=[Active galactic nuclei]*

## Acquisition

| # | Target |
|---|---|
| 1 | NONE |

## Template

| AcqFilter | Primary Channel | Simultaneous Imaging | Imager Subarray | Grating Wheel Direction |
|---|---|---|---|---|
| | All MRS | YES | FULL | NEUTRAL |

## Mosaic

| Rows | Columns | Row Overlap % | Column Overlap % | Row shift (deg) | Column shift (deg) | Tile Order |
|---|---|---|---|---|---|---|
| 2 | 2 | 10.0 | 10.0 | 0.0 | 0.0 | DEFAULT |

## Dithers

| # | Dither Type | Optimized For | Direction |
|---|---|---|---|
| 1 | 4-Point | EXTENDED SOURCE | NEGATIVE |

Proposal 3671 - Observation 3 - Radio Jet Feedback in the Nearby Spiral Galaxy M58

**Spectral Elements**

| # | Wavelength Range | Detector | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | IMAGER | F1130W | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 1 | LONG(C) | MRSLONG | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 1 | LONG(C) | MRSSHORT | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 2 | | IMAGER | F770W | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 2 | MEDIUM(B) | MRSLONG | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 2 | MEDIUM(B) | MRSSHORT | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 3 | | IMAGER | F560W | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 3 | SHORT(A) | MRSLONG | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |
| 3 | SHORT(A) | MRSSHORT | | FASTR1 | 30 | 1 | 1 | Dither 1 | 4 | 4 | 333.005 | |

**Special Requirements**

Group Observations 2, 3, Non-interruptible

## Observation

**Proposal 3671, Observation 4: M58 MIRI IM** Tue Jun 11 01:00:20 GMT 2024

**Diagnostic Status: Warning**

Observing Template: MIRI Imaging

*Comments: 02/04/2024 - Dither patter changed to Cycling (Start point 5, pattern LARGE) following the suggestion of Mike Engesser. Thank you!*

## Diagnostics

(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | M-58 | RA: 12 37 43.5220 (189.4313417d)<br>Dec: +11 49 5.50 (11.81819d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Pointing moved 1" north and 1" east to put the AGN away from the edge of the IFU and MRS FOV.*
*Category=Galaxy*
*Description=[Active galactic nuclei]*
*Extended=YES*

## Template

| Subarray |
|---|
| FULL |

## Dithers

| # | Dither Type | Starting Point | Number of Points | Points | Starting Set | Number of Sets | Optimized For | Direction | Pattern Size |
|---|---|---|---|---|---|---|---|---|---|
| 1 | CYCLING | 5 | 4 | | 1 | 1 | | | LARGE |

## Spectral Elements

| # | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F770W | FASTR1 | 10 | 1 | 1 | Dither 1 | 4 | 4 | 111.002 | |
| 2 | F1000W | FASTR1 | 10 | 1 | 1 | Dither 1 | 4 | 4 | 111.002 | |
| 3 | F1130W | FASTR1 | 20 | 1 | 1 | Dither 1 | 4 | 4 | 222.003 | |
| 4 | F1280W | FASTR1 | 20 | 1 | 1 | Dither 1 | 4 | 4 | 222.003 | |

## Special Requirements

Group Observations 4, 9, Non-interruptible

## Observation

**Proposal 3671, Observation 9: M58 NIRCAM IM** Tue Jun 11 01:00:20 GMT 2024

**Diagnostic Status: Warning**

Observing Template: NIRCam Imaging

Coordinated Parallel Template(s): MIRI Imaging

## Diagnostics

(Visit 9:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | M-58 | RA: 12 37 43.5220 (189.4313417d)<br>Dec: +11 49 5.50 (11.81819d)<br>Equinox: J2000 | Epoch of Position: 2015.5 | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Pointing moved 1" north and 1" east to put the AGN away from the edge of the IFU and MRS FOV.*
*Category=Galaxy*
*Description=[Active galactic nuclei]*
*Extended=YES*

## Template

| NIRCam Imaging | MIRI Imaging |
|---|---|
| Module: B | Subarray: FULL |
| Subarray: FULL | |

## Dithers

| # | Primary Dither Type | Primary Dithers | Dither Size | Subpixel Positions | Coordinated Parallel Subpixel Selector | Dither Direct Images Primes |
|---|---|---|---|---|---|---|
| 1 | INTRAMODULE | 4 | | 1 | NIRCam Only | NO_DITHERING |

## Spectral Elements

| NIRCam Imaging | Short Filter | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Dithers | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F212N | F300M | BRIGHT1 | 5 | 1 | 4 | 4 | 386.524 | |
| 2 | F212N | F300M | BRIGHT1 | 5 | 1 | 4 | 4 | 386.524 | |
| 3 | F200W | F335M | BRIGHT1 | 5 | 1 | 4 | 4 | 386.524 | |
| 4 | F200W | F335M | BRIGHT1 | 5 | 1 | 4 | 4 | 386.524 | |

## Spectral Elements

| MIRI Imaging | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F770W | FASTR1 | 10 | 1 | 1 | | 4 | 4 | 111.002 | |
| 2 | F1000W | FASTR1 | 10 | 1 | 1 | | 4 | 4 | 111.002 | |
| 3 | F1130W | FASTR1 | 20 | 1 | 1 | | 4 | 4 | 222.003 | |
| 4 | F1280W | FASTR1 | 20 | 1 | 1 | | 4 | 4 | 222.003 | |

| Special Requirements | |
|---|---|
| | No Parallel Attachments<br><br>Group Observations 4, 9, Non-interruptible |