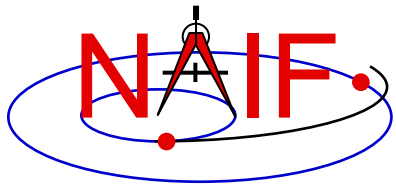


Navigation and Ancillary Information Facility

Using the Frames Subsystem

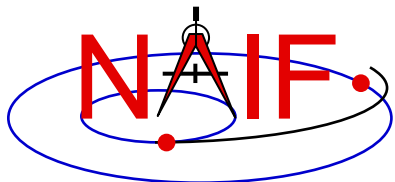
January 2020



What is the Power of Frames?

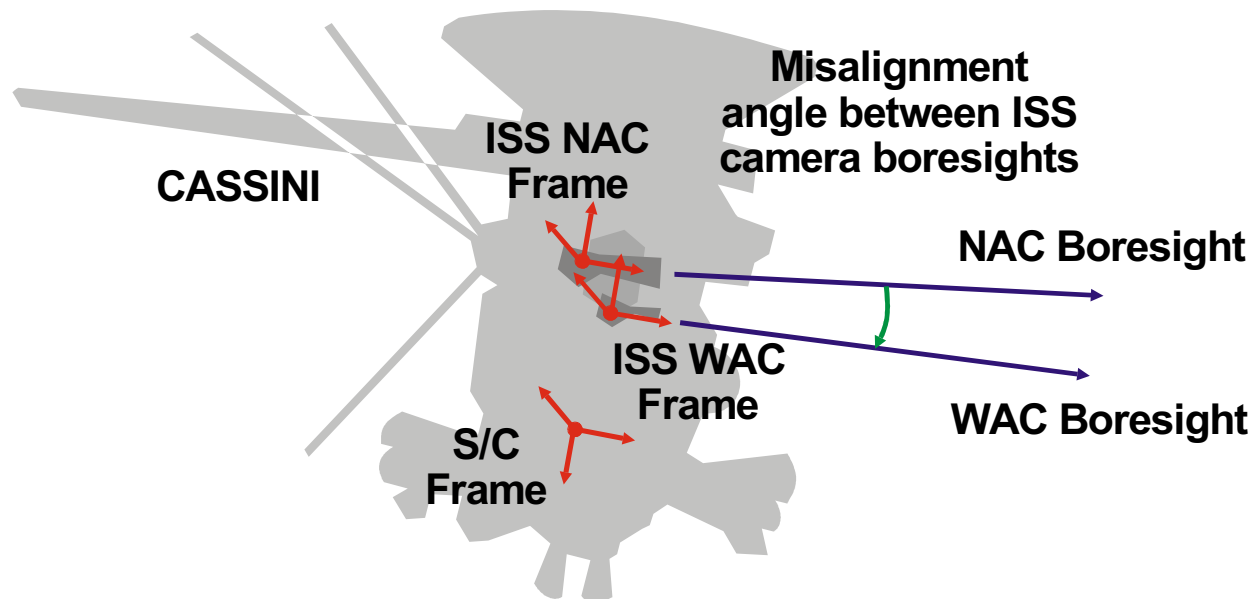
Navigation and Ancillary Information Facility

- The “power” of the Frames capability stems from the SPICE system’s ability to construct complex reference frame transformations with no programming effort required of you - the end user
 - But it’s crucial that you select and load the needed kernels
- The principal benefit from the Frames capability is obtained through the main SPK subsystem interfaces (SPKEZR and SPKPOS) and the Frames subsystem interfaces (SXFORM, PXFORM, PXFRM2)
- The remaining pages illustrate typical use of frames
- Several **VERY IMPORTANT** usage issues are mentioned in the Frames tutorial; be sure to also read that.



Offset Between Instruments

Navigation and Ancillary Information Facility



Required Kernels:

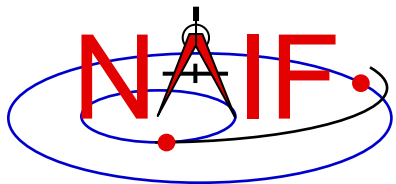
- Generic LSK
- Mission FK
- Camera IK(s)

ISS = Imaging Science System

Compute the angular separation between the Cassini ISS Narrow Angle Camera and Wide Angle Camera boresights:

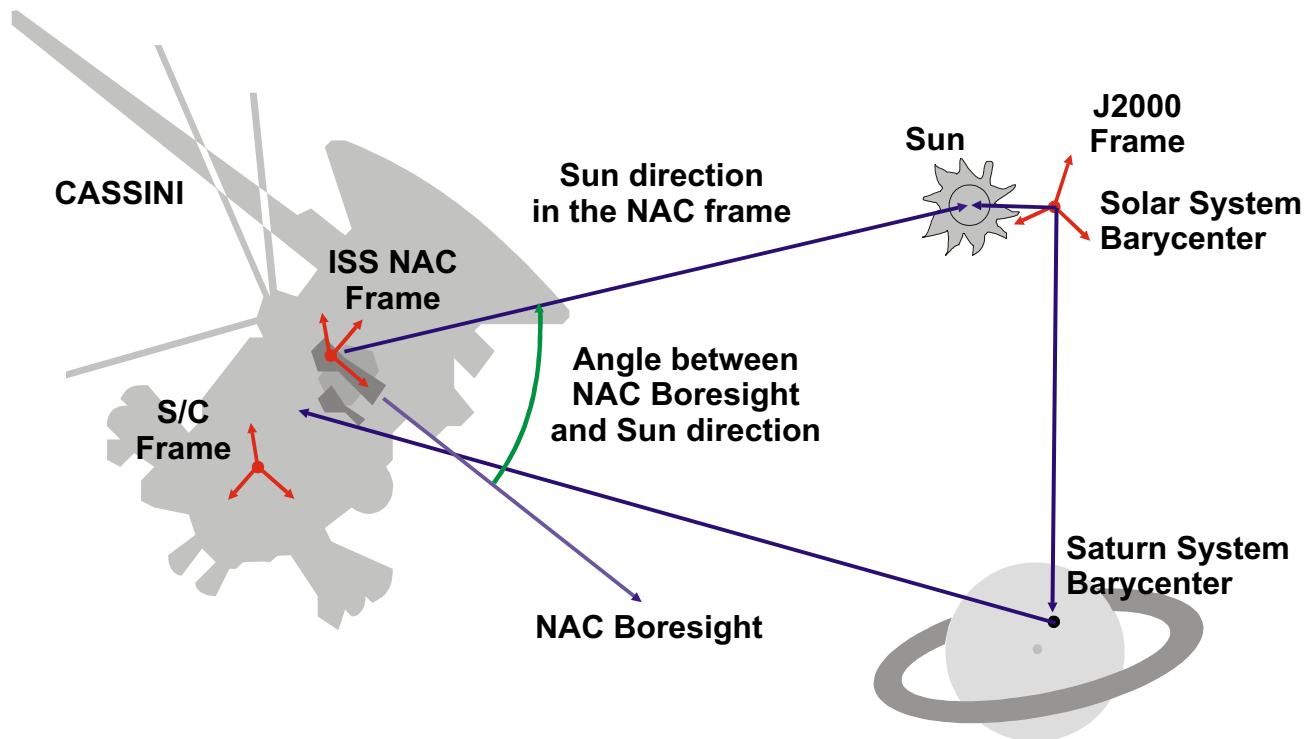
```
C Retrieve the matrix that transforms vectors from NAC to WAC frame
CALL PXFORM( 'CASSINI_ISS_NAC', 'CASSINI_ISS_WAC', ET, MAT )
C Transform NAC boresight to WAC frame and find separation angle
CALL MXV ( MAT, NAC_BORESIGHT_nac, NAC_BORESIGHT_wac )
ANGLE = VSEP( NAC_BORESIGHT_wac , WAC_BORESIGHT_wac )
```

Fortran
example



Angular Constraints

Navigation and Ancillary Information Facility



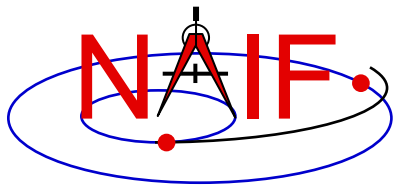
Required Kernels:

- Generic LSK
- Mission FK
- Spacecraft SCLK
- Camera IK
- Planetary Ephemeris SPK
- Spacecraft SPK
- Spacecraft CK

Check whether the angle between the camera boresight and the direction to the Sun is within the allowed range:

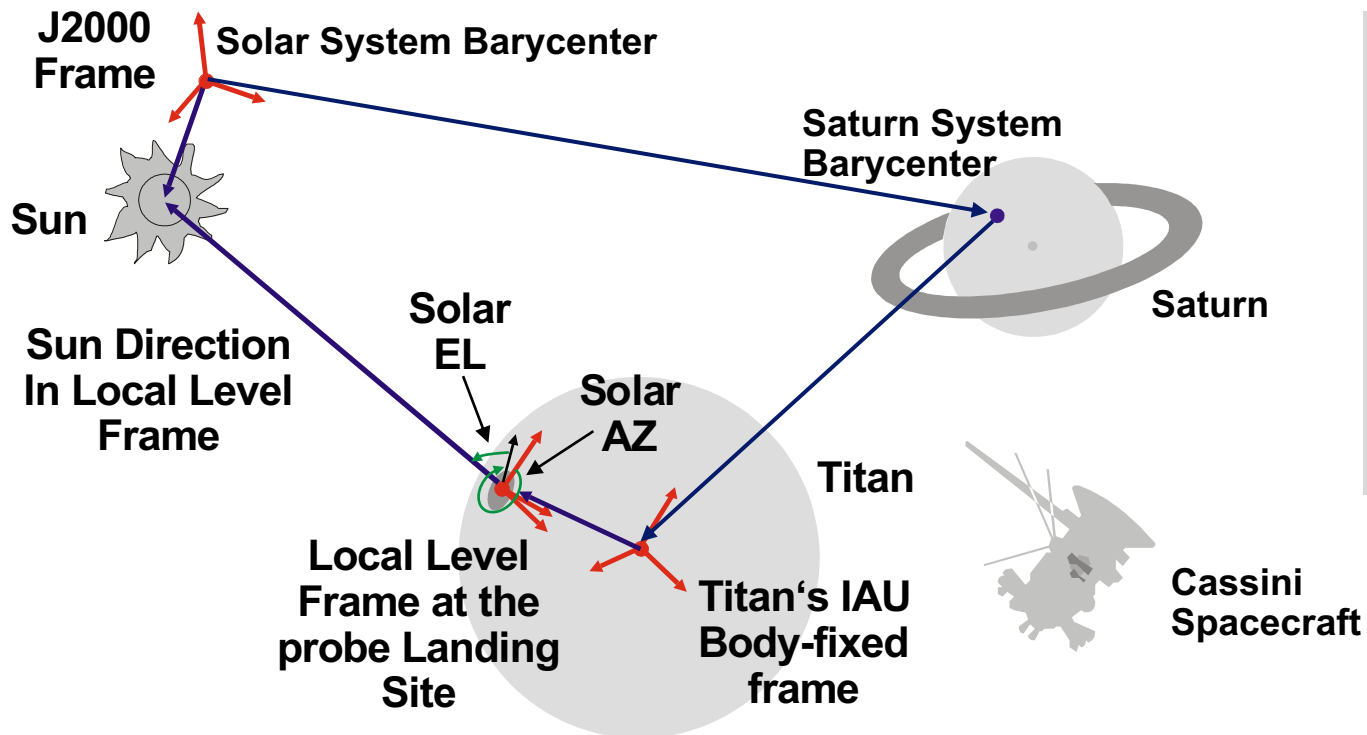
```
CALL SPKPOS( 'SUN', ET, 'CASSINI_ISS_NAC', 'LT+S', 'CASSINI', SUNVEC, LT )
ANGLE = VSEP( NAC_BORESIGHT_nac, SUNVEC )
IF ( ANGLE .LE. CONSTRAINT ) WRITE(*,*) 'WE ARE IN TROUBLE!'
```

Fortran example



Angles at the Surface

Navigation and Ancillary Information Facility



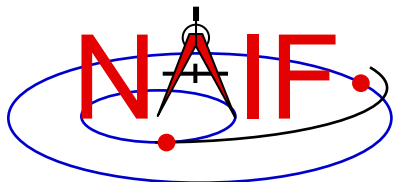
Required Kernels:

- Generic LSK
- Generic PCK
- Mission FK
- Planetary Ephemeris SPK
- Satellite Ephemeris SPK
- Landing Site SPK

Compute solar azimuth and elevation at the Huygens probe landing site

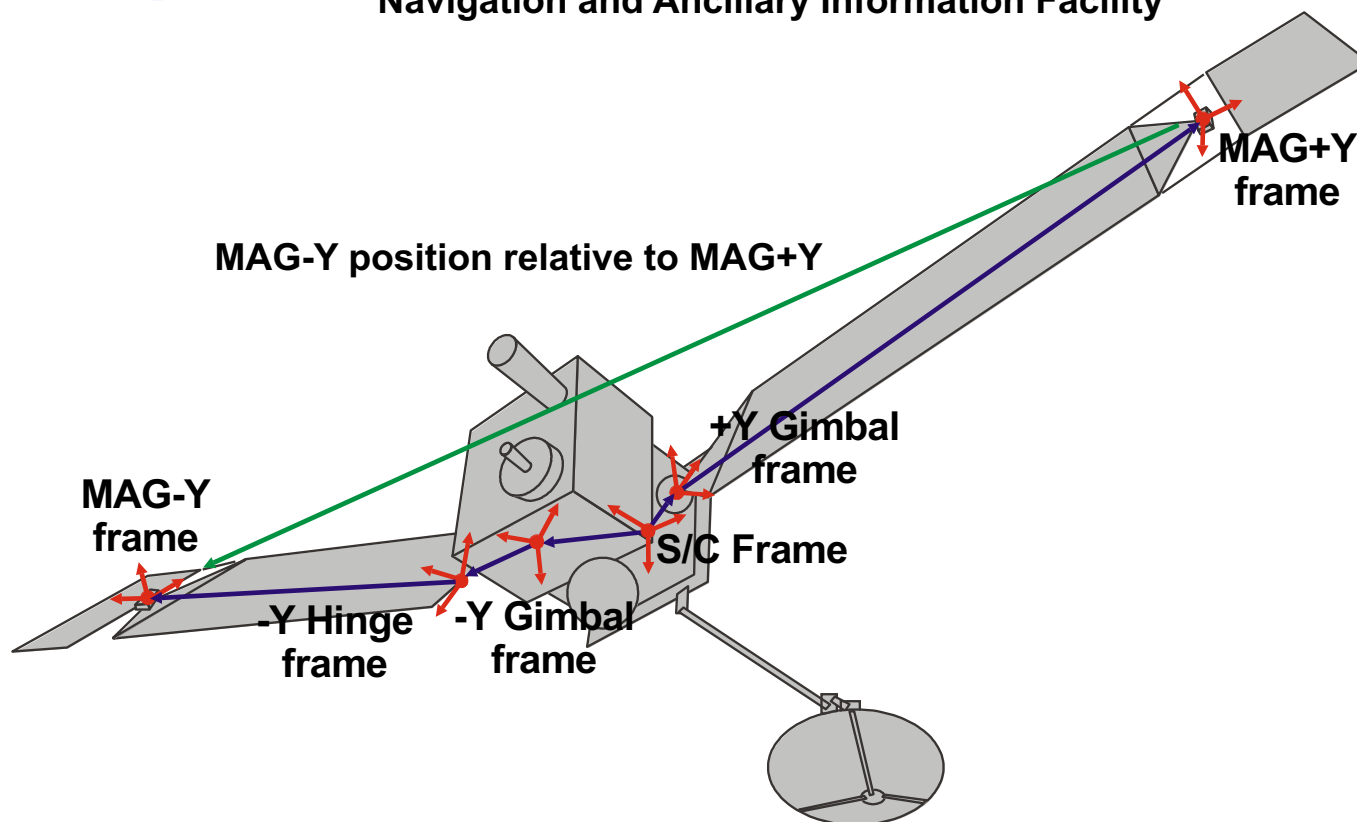
```
CALL SPKPOS ('SUN', ET, 'HUYGENS_LOCAL_LEVEL', 'LT+S', 'HUYGENS_PROBE', SUNVEC, LT)
CALL RECLAT(SUNVEC, R, AZIMUTH, ELEVATION)
ELEVATION = -ELEVATION
IF (AZIMUTH .LT. 0.D0) THEN
    AZIMUTH = AZIMUTH + TWOPI()
ENDIF
```

Fortran
example



Relative Position of Sensors

Navigation and Ancillary Information Facility



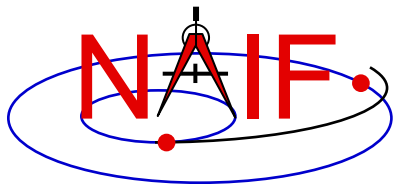
Required Kernels:

- Generic LSK
- Mission FK
- Structure Locations SPK
- Spacecraft SCLK
- Solar Array CK

Find the position of one MGS MAG sensor with respect to the other in the MGS s/c frame. Also find the relative orientation of the sensors:

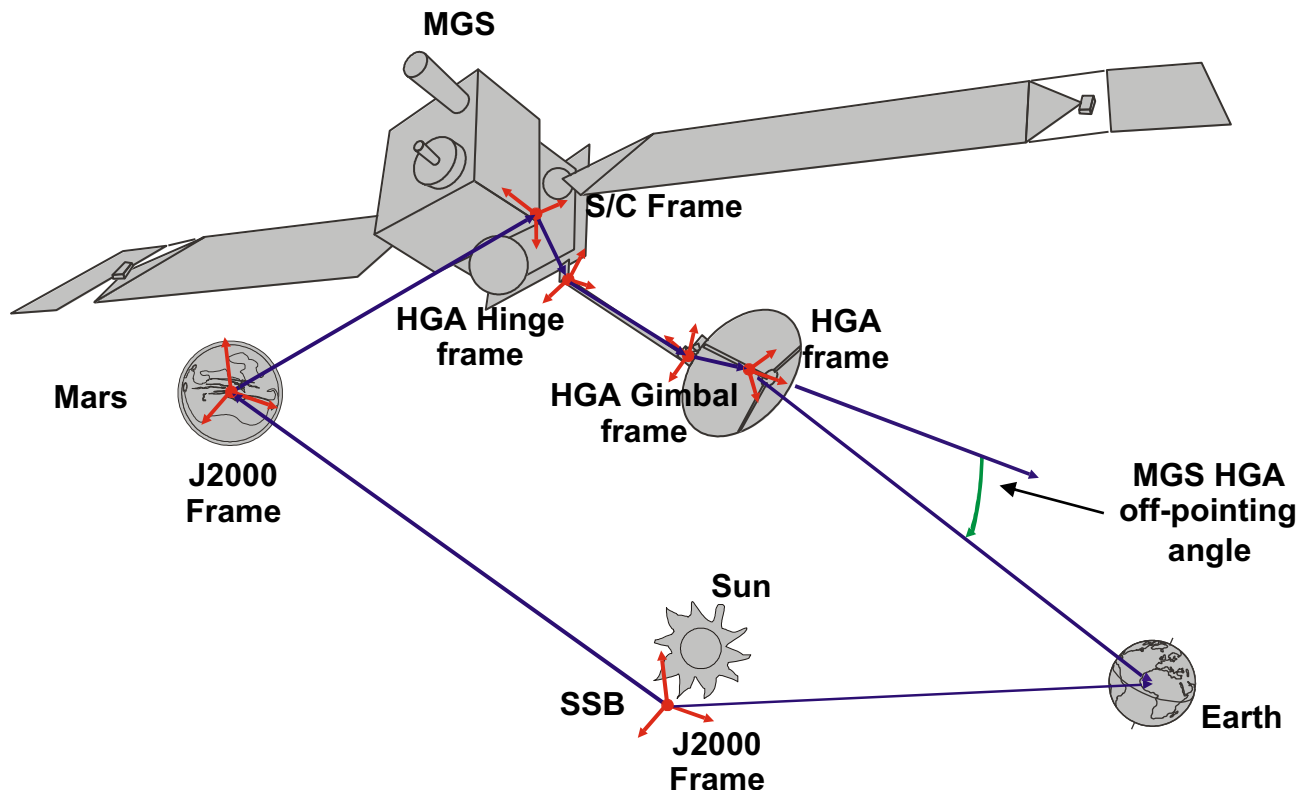
```
CALL SPKEZR('MGS_MAG-Y', ET, 'MGS_SPACECRAFT', 'NONE', 'MGS_MAG+Y', STATE, LT)  
CALL PXFORM('MGS_MAG+Y_SENSOR', 'MGS_MAG-Y_SENSOR', ET, MAT)
```

Fortran
example



Manipulators - 1

Navigation and Ancillary Information Facility



Required Kernels:

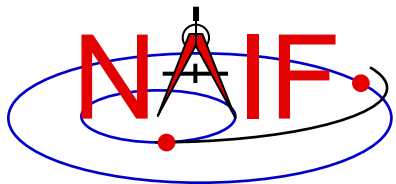
- Generic LSK
- Mission FK
- Spacecraft SCLK
- HGA IK
- Structure Locations SPK
- Planetary Ephemeris SPK
- Spacecraft SPK
- Spacecraft CK
- HGA CK

HGA = High Gain Antenna

Compute the angle between the direction to Earth and the MGS HGA boresight:

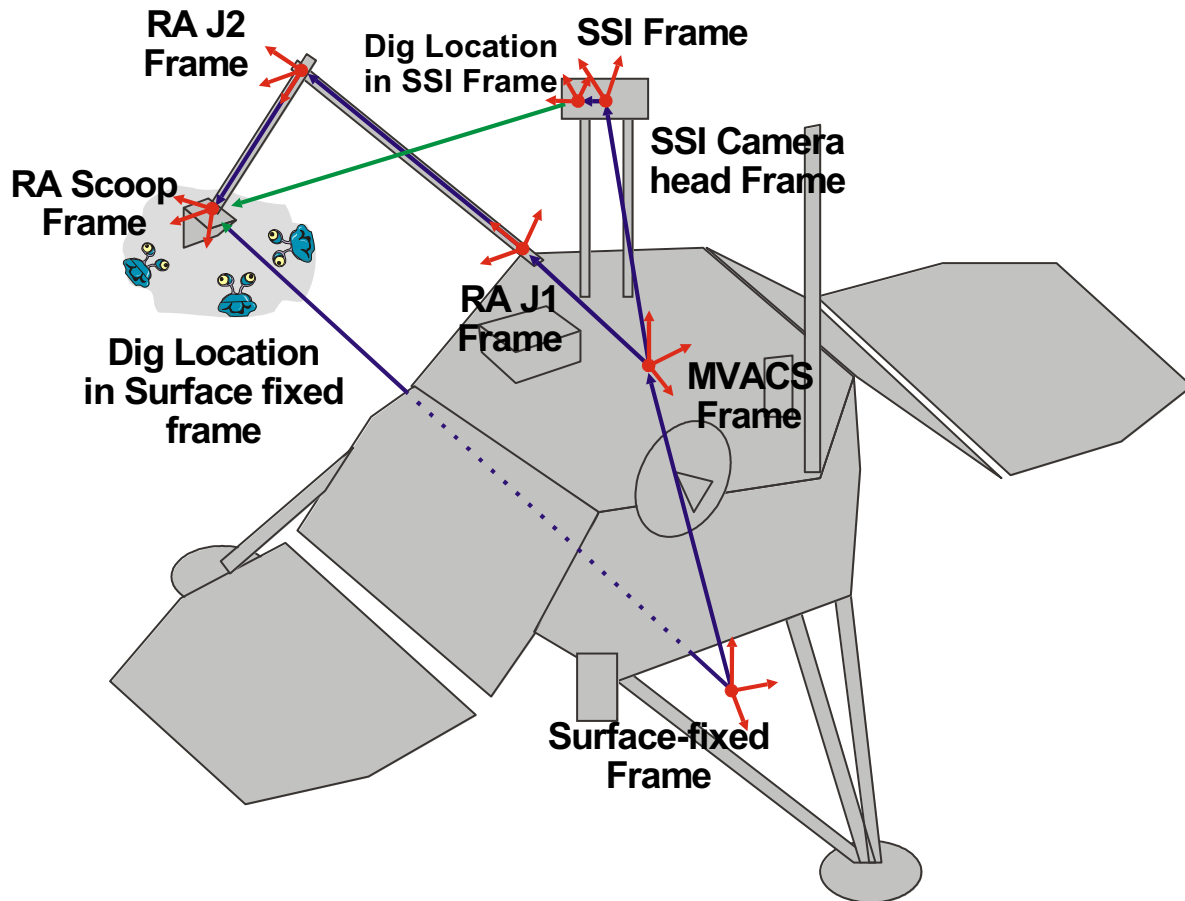
```
CALL SPKEZR( 'EARTH', ET, 'MGS_HGA', 'LT+S', 'MGS', EARTH_STATE, LT )
ANGLE = VSEP( HGA_BORESIGHT, EARTH_STATE )
```

Fortran
example



Manipulators - 2

Navigation and Ancillary Information Facility



Required Kernels:

- Generic LSK
- Mission FK
- Lander SCLK
- Structure Locations SPK
- Lander SPK
- Lander CK
- SSI CK
- RA CK

Compute the soil digging location in the MPL surface-fixed and camera left eye frames:

```
CALL SPKEZR( 'MPL_RA_SCOOP', ET, 'MPL_SURFACE_FIXED', 'NONE', 'MPL_SURF', ST1, LT )
CALL SPKEZR( 'MPL_RA_SCOOP', ET, 'MPL_SSI_LEFT', 'NONE', 'MPL_SSI', ST2, LT )
```

Fortran example