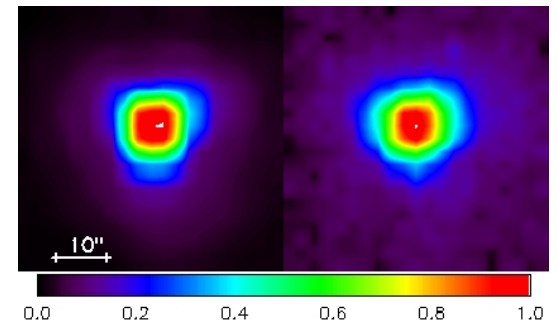
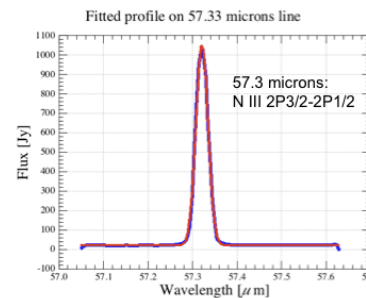
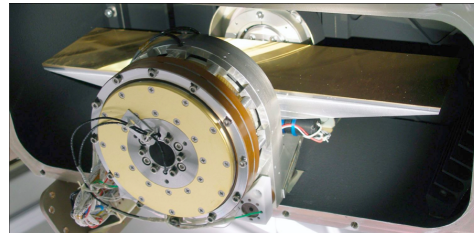
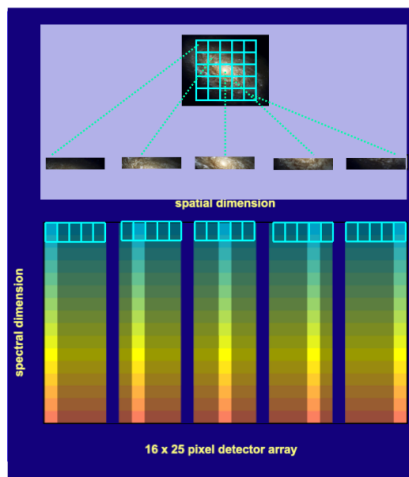


PACS Spectrometer: Overview on Calibration

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PACS Spectrometer Instrument Overview in a Nutshell

- 5×5 pixels (25 spaxels) IFU, $9''.4$ pixel FoV, $47''$ instrument FoV
- scanning grating spectrometer,
16 pixels instantaneous λ -coverage (600 – 2900 km/s)
- Operated in 3 different grating orders
(1: 102 – 220 μm , 2: 51/70 – 105 μm , 3: 51 – 73 μm)
- “Unstressed” and stressed Ge:Ga photoconductors
in “responsivity equilibrium” between thermal (curing) telescope
background and responsivity increase due to cosmic irradiation for
applied bias voltage,
monitored by constant illumination of internal calibration source
- CREs with 4 different capacitance settings for flux range coverage
- Line ($\frac{\lambda}{\Delta\lambda} = 940 - 5500$) & range spectroscopy (incl. full SED mode)
with various samplings in
 - chop/nod (3 throws)
 - unchopped (for bright extended sources) with off-position

PACS Spectrometer Calibration Issues

- **Wavelength calibration**
for all individual pixels, instrumental profile, spectral ghosts
dependence on source position inside pixel aperture
- **Spatial calibration**
PSF/beam, distortion (chopper throw), flat-field,
pointing dependence, ghosts
- **Flux calibration**
absolute flux calibration @ key wavelengths, RSRF,
internal responsivity monitoring, reproducibility,
background normalisation,
order sorting & leakage, flux linearity, capacitance scaling
- **Stability monitoring**
wavelength, flux, RSRF

PACS Spectrometer Wavelength Calibration Sources

- Full wavelength calibration: Jupiter, Saturn, water line stars (PV)
- Wavelength stability monitoring: PNe: NGC 6543
- Pointing dependence: point-like PNe: IC 2501
- Spectral ghost assessment: bright PN: NGC 7027
- Instrumental profile (PV): Neptune, Uranus

PACS Spectrometer Spatial Calibration Sources

- PSF & FF: Neptune (large rasters with fine step sizes)
- Extended PSF: Mars
- Spatial ghosts: Neptune rasters

PACS Spectrometer Flux Calibration Sources @ Key Wavelengths

Flux range (at 100 μm) and source trace matrix for spectrometer absolute flux and linearity calibration at key wavelengths. Sources are used for both chop/nod and unchopped calibration. Sources in [] are planned but not yet scheduled.

flux range (Jy)	period 1 cycle#1-15	period 2 cycle#16-30	period 3 cycle#31-45	period 4 cycle#46-60	period 5 cycle#61-75	period 6 cycle#76-90
1.00–3.00		γ Dra α Cet	α Cet	γ Dra α Cet	[γ Dra]	
3.00–10.0	α Tau(2 \times) β Peg(2 \times)	α Boo(4 \times) α Tau β Peg Thisbe	α Boo(3 \times) α Tau	α Boo(2 \times) α Tau(4 \times) Thisbe(2 \times)	[α Boo] [α Tau] [Thisbe]	
10.0–30.0		Hebe	Hygiea(3 \times) Hebe Europa(2 \times)	Hygiea Hebe Juno Europa	[Hygiea] [Hebe] [Juno] [Europa]	
30.0–100.	Vesta HD 161796(11 \times)	Pallas HD 161796(18 \times)	Pallas Vesta(3 \times) HD 161796(21 \times)	Pallas Vesta HD 161796(24 \times)	[Pallas] [Vesta] [HD 161796]	
100.–300.	Ceres(2 \times)	Ceres(2 \times) Neptune	Ceres(2 \times) Neptune(3 \times)	Ceres Neptune(2 \times)	[Ceres] [Neptune]	
>300.		Uranus(2 \times)	Uranus(3 \times) Callisto	Uranus(2 \times)	[Uranus]	

PACS Spectrometer Flux Calibration Sources for RSRF & Cross-cal with photometer

- RSRF (PV): internal CS1, Vesta, Neptune, Uranus

Flux range (at 100 μm) and source trace matrix for spectrometer absolute flux calibration of the SED mode. Sources are used for both chop/nod and unchopped calibration. Sources in [] are planned but not yet scheduled.

flux range (Jy)	period 1 cycle#1-15	period 2 cycle#16-30	period 3 cycle#31-45	period 4 cycle#46-60	period 5 cycle#61-75	period 6 cycle#76-90
10.0–30.0		Hebe Juno	Hygiea(2×) Europa	Juno Europa	[Hygiea] [Hebe] [Juno] [Europa]	
30.0–100.	Pallas Vesta	Pallas	Pallas Vesta(2×)	Pallas Vesta	[Pallas] [Vesta]	
100.–300.	Ceres Neptune	Ceres(3×) Neptune	Ceres Neptune(2×)	Ceres(2×) Neptune(2×)	[Ceres] [Neptune]	
>300.		Uranus(2×)	Uranus(2×) Callisto	Uranus(2×)	[Uranus]	