

Gas in protoplanetary discs



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On behalf of the GASPS Team (PI: Bill Dent)

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Discs are sites of planet formation



Dissipation of abundant gas when disc evolves:

- limits timescale for giant planet formation
- controls dynamics of planetary bodies during formation
- determines final architecture of a planetary system

Gas makes up 99% of disc mass, but difficult to observe.
=> Not too much known about gas evolution

But brightest lines lie in Far-IR!

Earlier gas disc observations



- UV spectra H, C and some metals in inner regions
- Hot inner few AU discs: near-IR CO and H₂O
- 12.8 μm line of [NeII] was detected by Spitzer (but only ionised component close to star)
- Cooler, outer disc: (sub)mm lines of CO and other molecules

But Far-IR lines trace disc radii 5 to 500 AU !

GASPS: the Goals



- Trace gas *and* dust in the planet formation region of discs across an extensive parameter space
- Provide measurement of the *gas* dissipation timescale, to compare with the *dust* dissipation time
- Evolutionary link between protoplanetary and debris discs
- Provide input for disc chemistry models
- Provide an extensive database of observations and models with long-lasting legacy value

GASPS in a nutshell



- ~ 250 sources
- ~ 450 hours
- Mainly gas line scans, some photometry
- Large modelling effort to interpret observations
- Auxiliary data obtained to support interpretation
- Providing an archive for future gas disc studies

The Dent grid: 300000 disc models



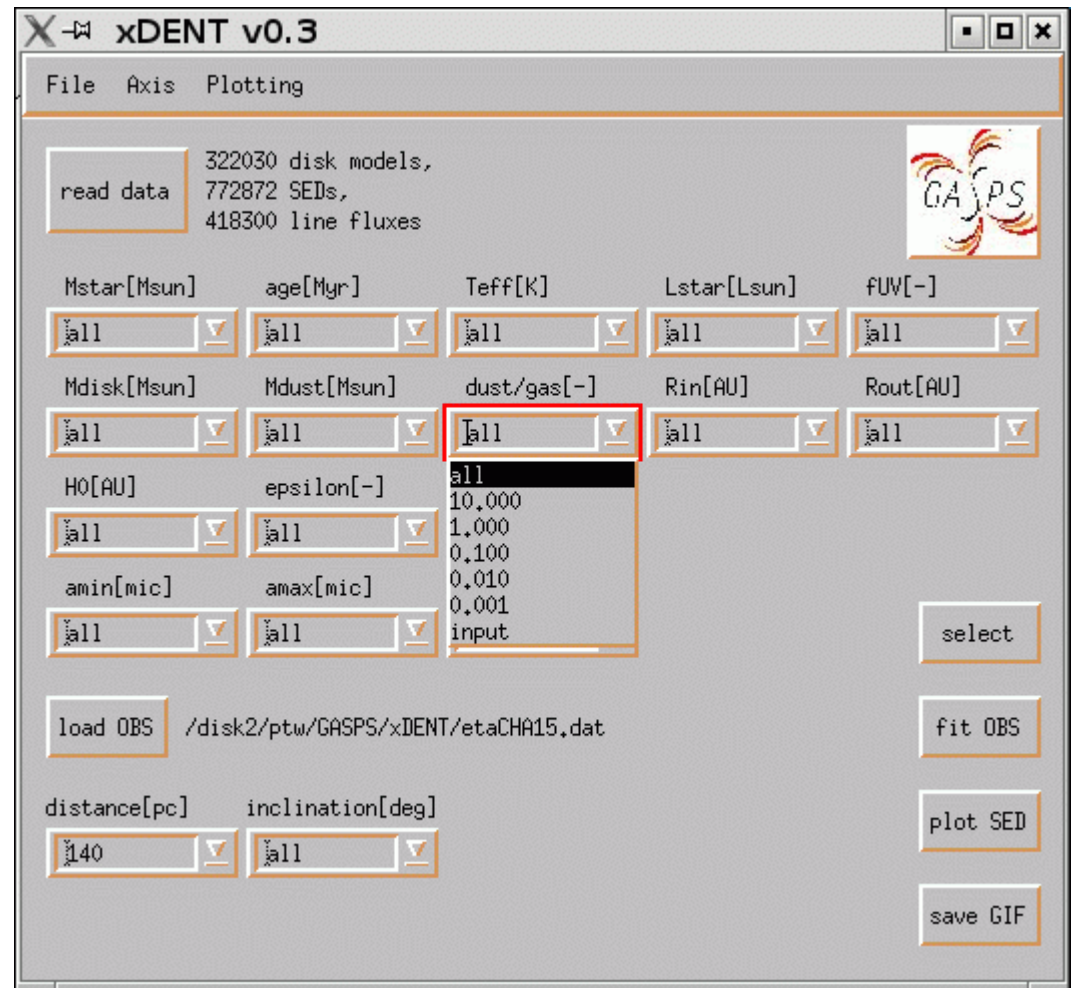
ProDiMo:

thermo-chemical disc code
(2D radiative transfer,
chemistry, ice formation,...)

MCFOST:

3D continuum and line
radiative transfer code

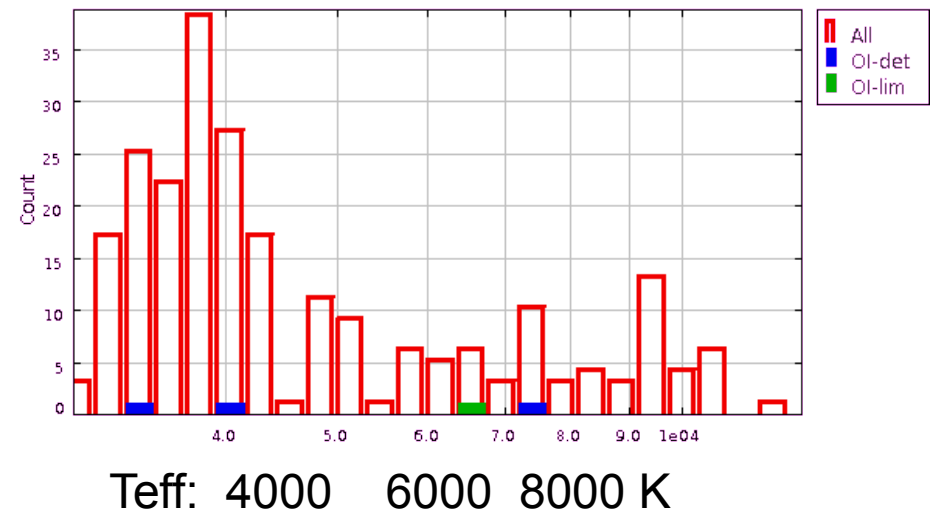
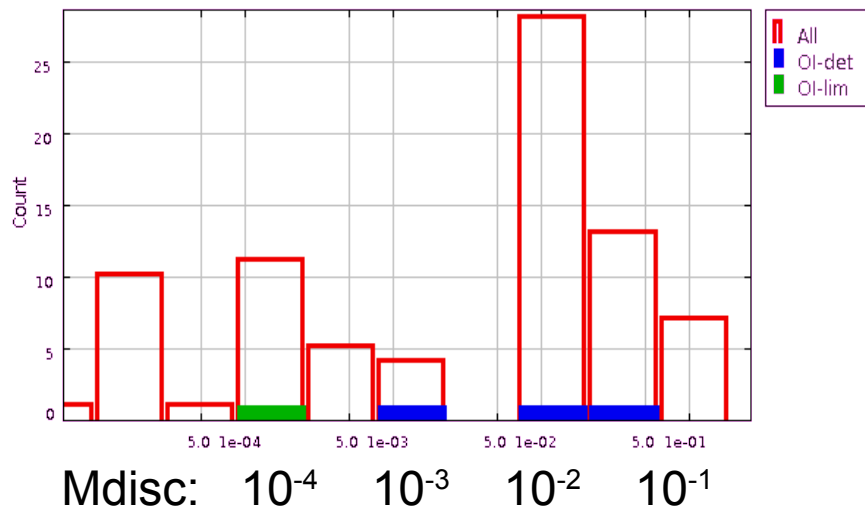
Woitke et al. (2009)



Target Selection



- Located in nearby star formation regions:
Taurus, BPMG, ϵ Cha, Tuc Hor, Upper Sco + HAeBe stars
- Measured submm fluxes, H α , near-IR photometry
- Wide range of dust disc M, sp. type, Lx, age, acc. rate



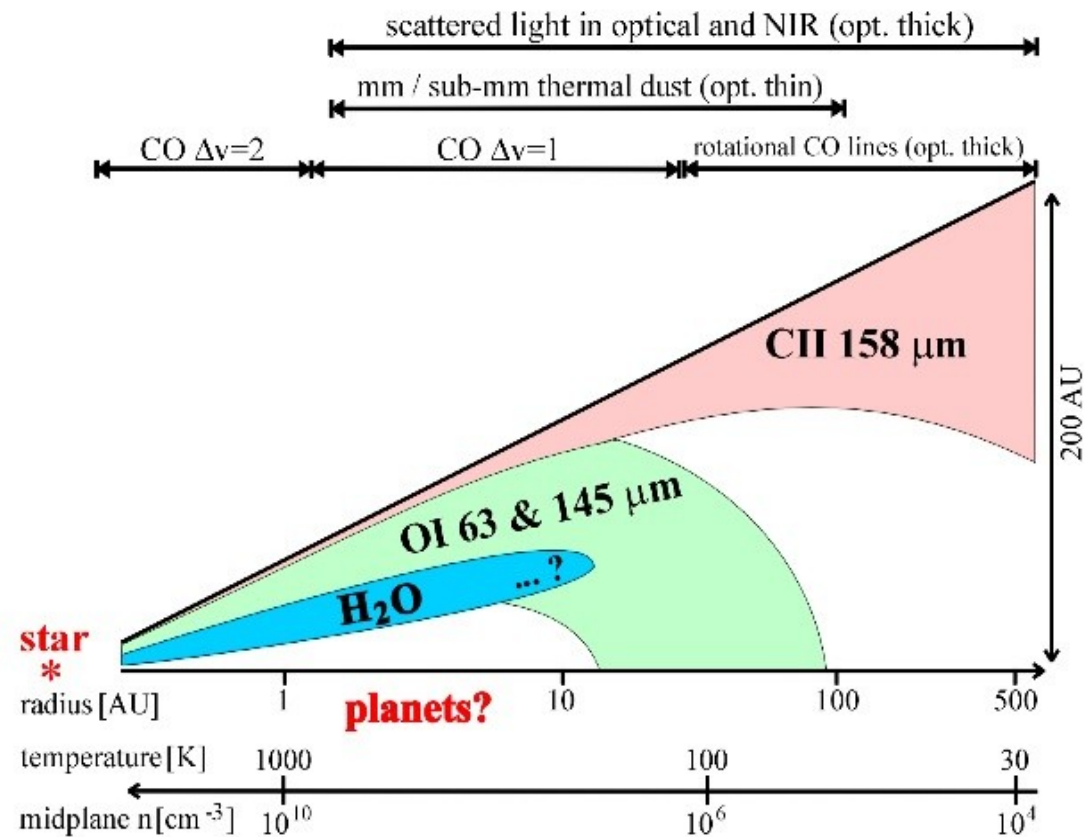
Blue: targets with OI-63um detections
Green: target with OI-63um upper limit

Different gas transitions trace different regions



Stellar irradiation & disc M determine size radiating region

Lower disc M: more photo-dissociation and ionisation



GASPS: Observations



- [OI] at 63.2 and 145.5 micron
- [CII] at 157.7 micron
- H₂O and CO at various wavelengths

Phase I: PACS line-scan [OI]63 and [CII]158 for all targets

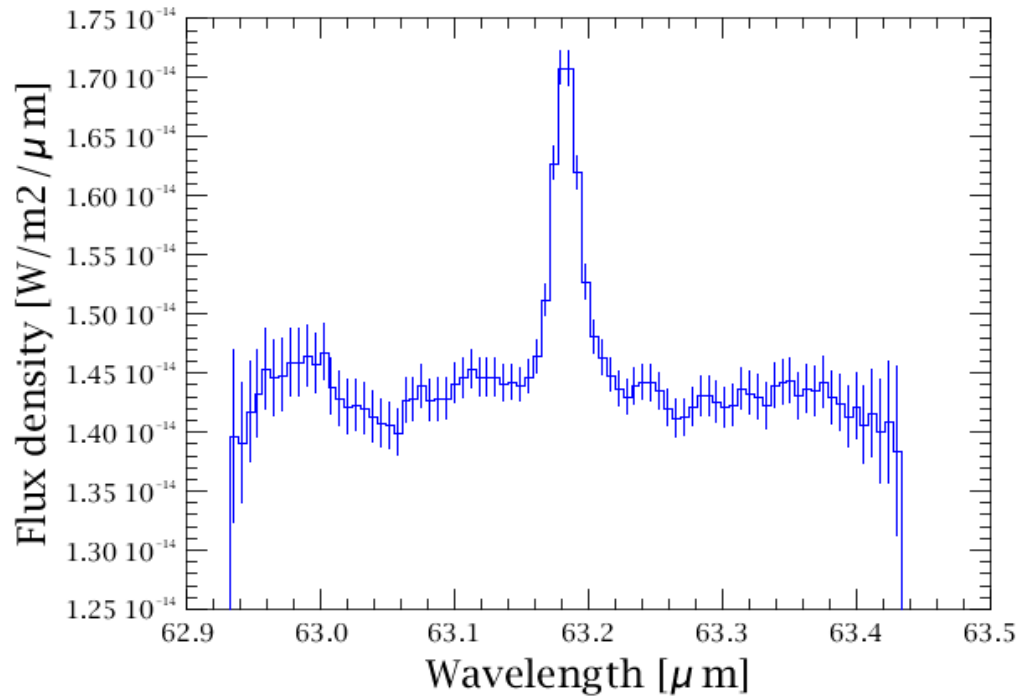
Phase II: PACS range-scan for most promising targets

+ PACS Photometry at 70 and 170 micron

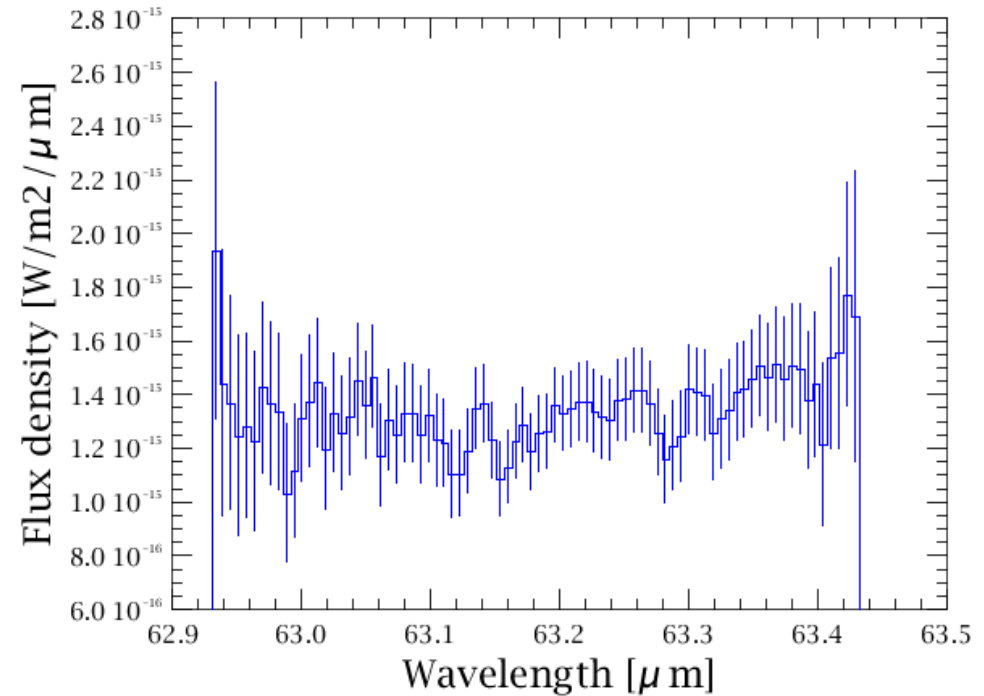
The [OI] 63 micron line



A5V_8Myr OI_63 12



F5_12Myr OI_63 12

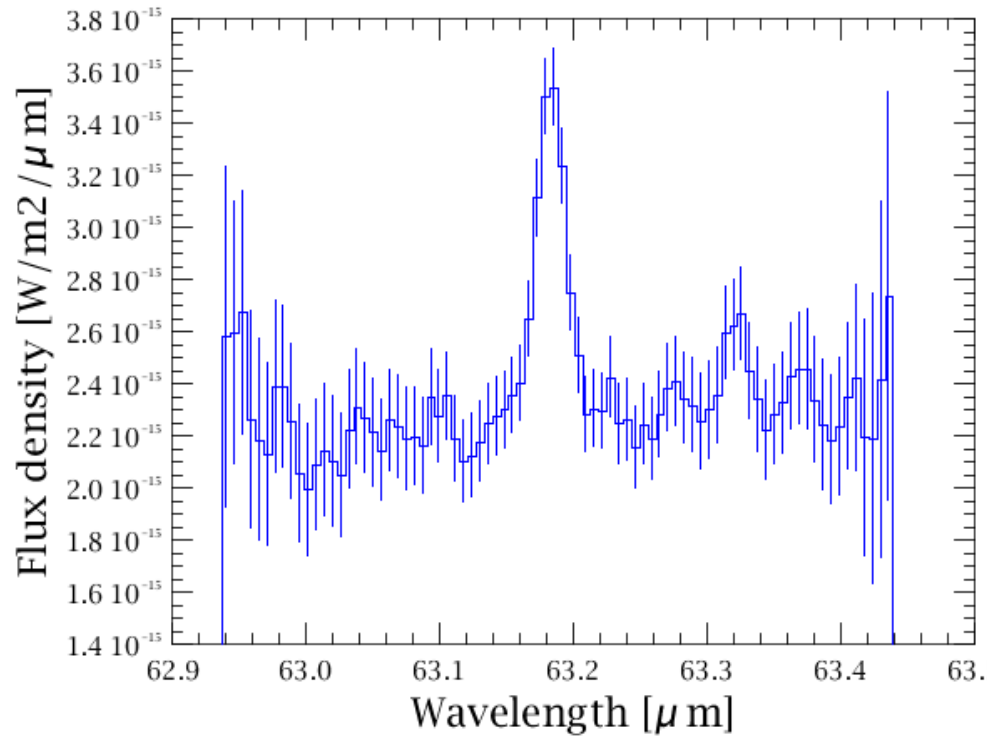


Data Reduction by G. Matthews, C. Howard and B. Vandenbussche

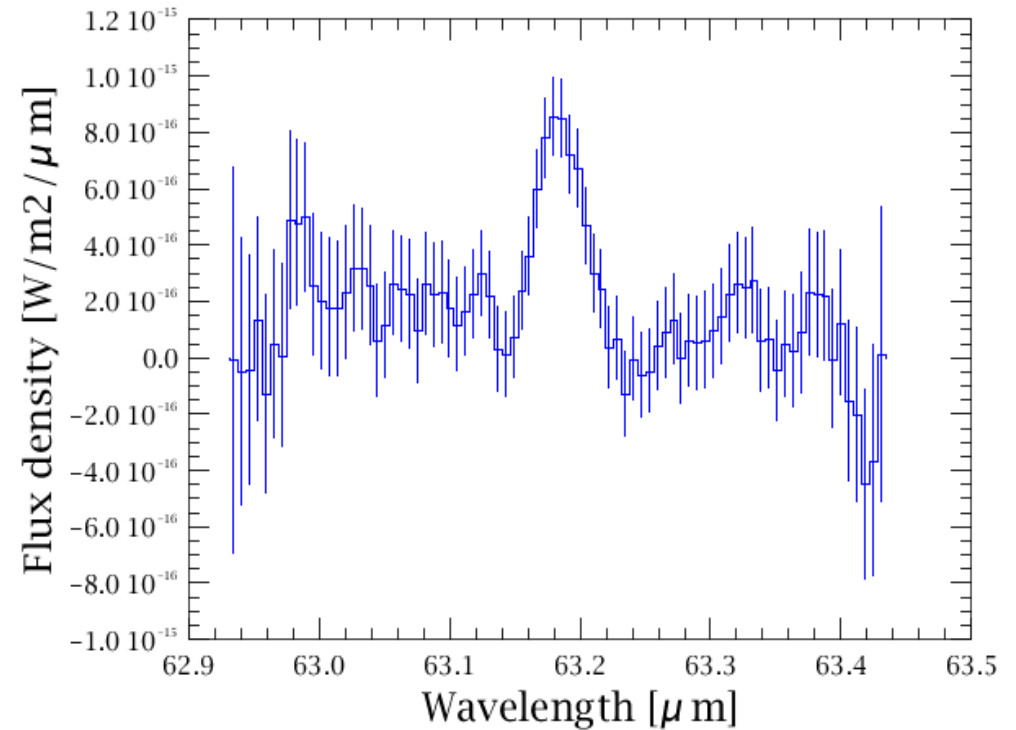
The [OI] 63 micron line



K6_10Myr OI_63 12



M2_8Myr OI_63 12



Data Reduction by G. Matthews, C. Howard and B. Vandenbussche

[OI]63 micron line flux

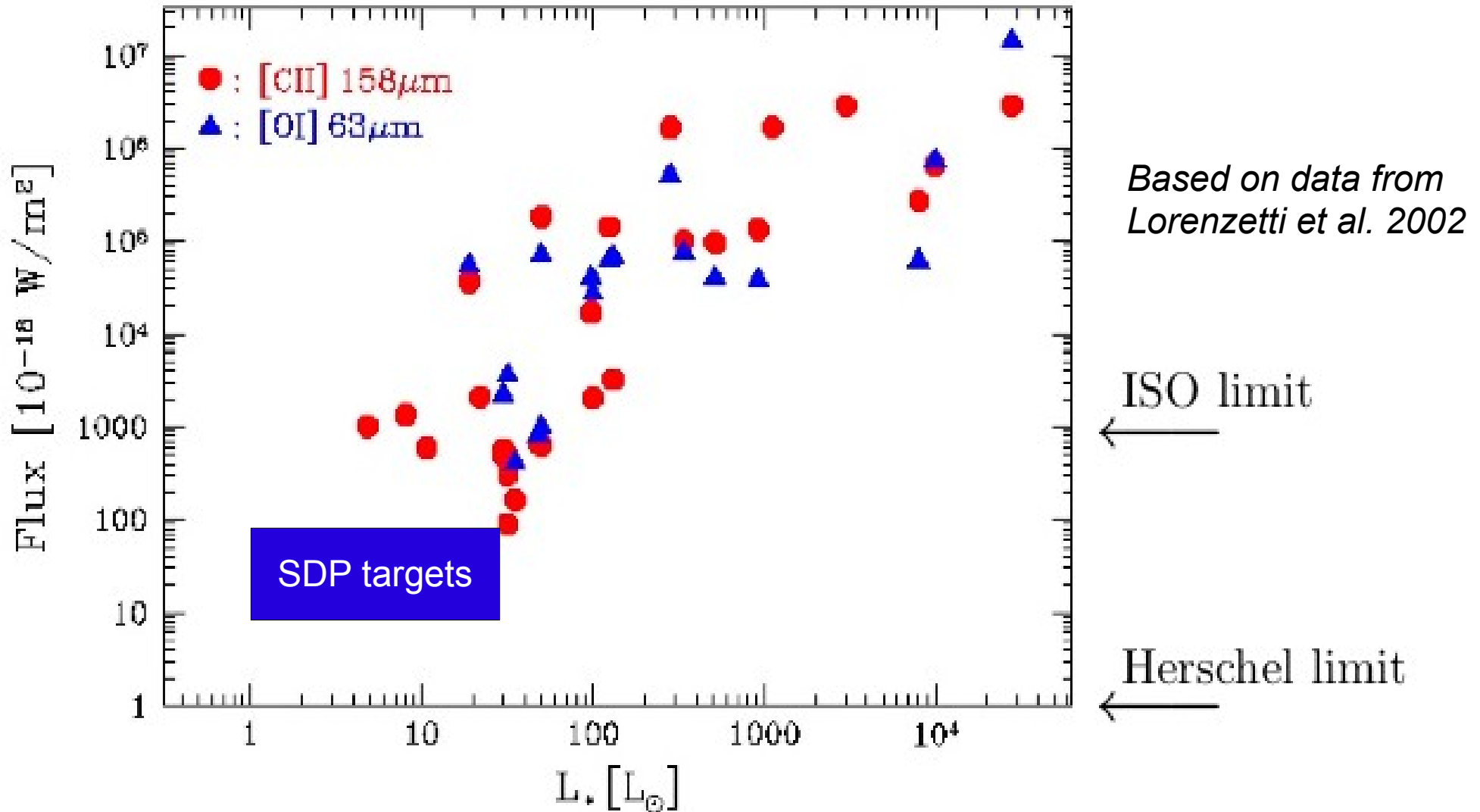


Herbig Ae	A5	8 Myr	6.7 E-17 W/m ²
CTTS	K6	10 Myr	3.3 E-17 W/m ²
CTTS	M2	8 Myr	2.9 E-17 W/m ²
Debris disc	F5	12 Myr	< 3.3 E-18 W/m ²

=> in agreement with model predictions

50% error max., to be revised downwards

[OI]63 micron line: comparison with ISO observations





More to come soon...