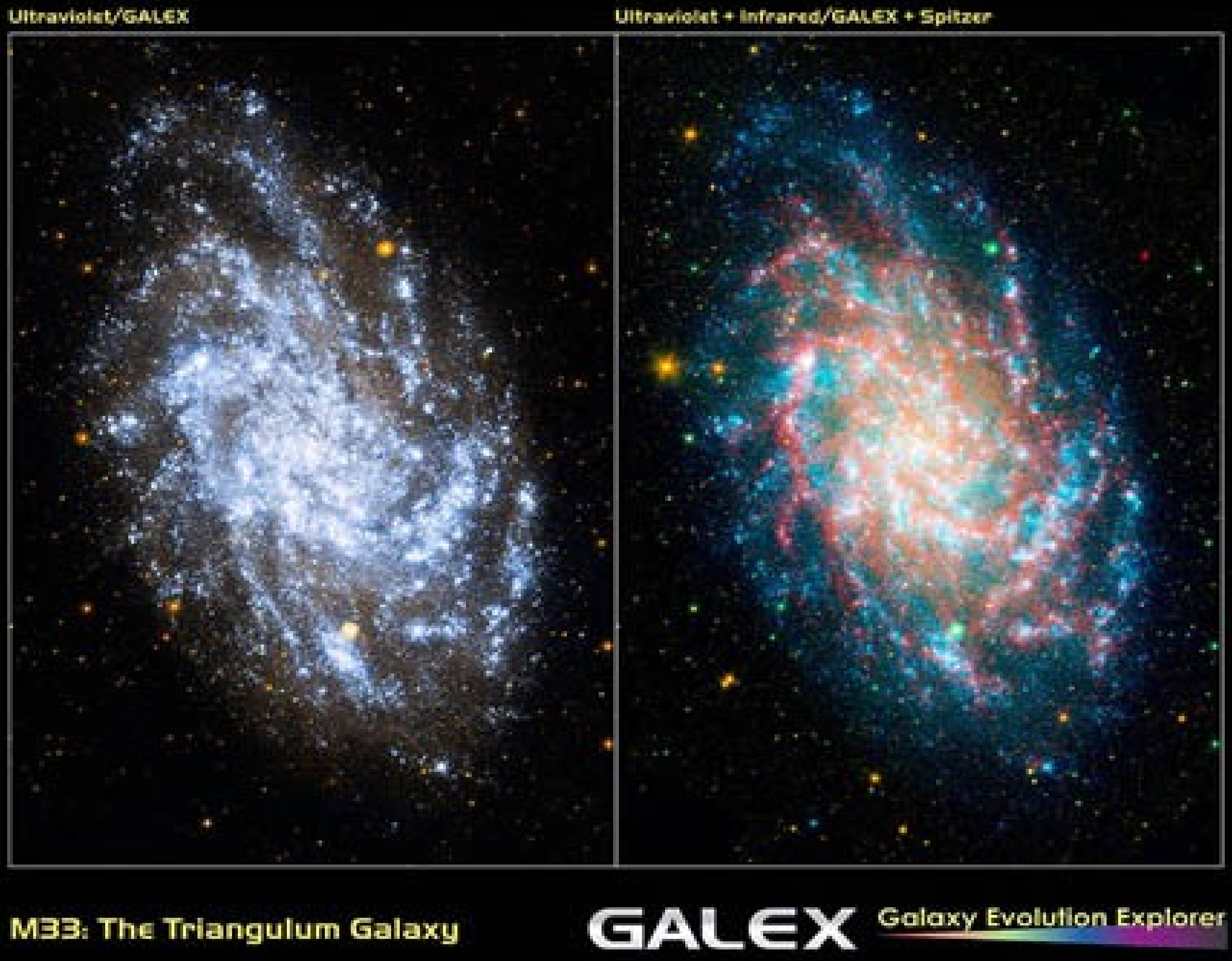
Metallicity of M33 using Planck data



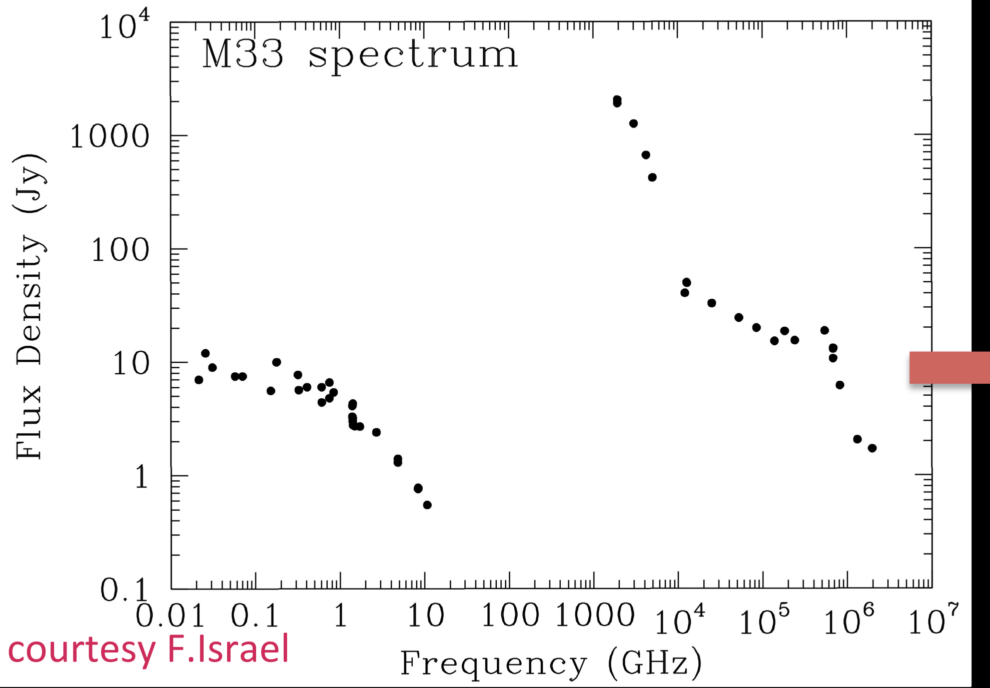
L. Fauvet
F. Israel, R. Laureijs, R. Leonardi, J. Tauber

What about M33 ?

nearby spiral Galaxy with expected low metallicity.

IRAS + ISO + Spitzer

SED

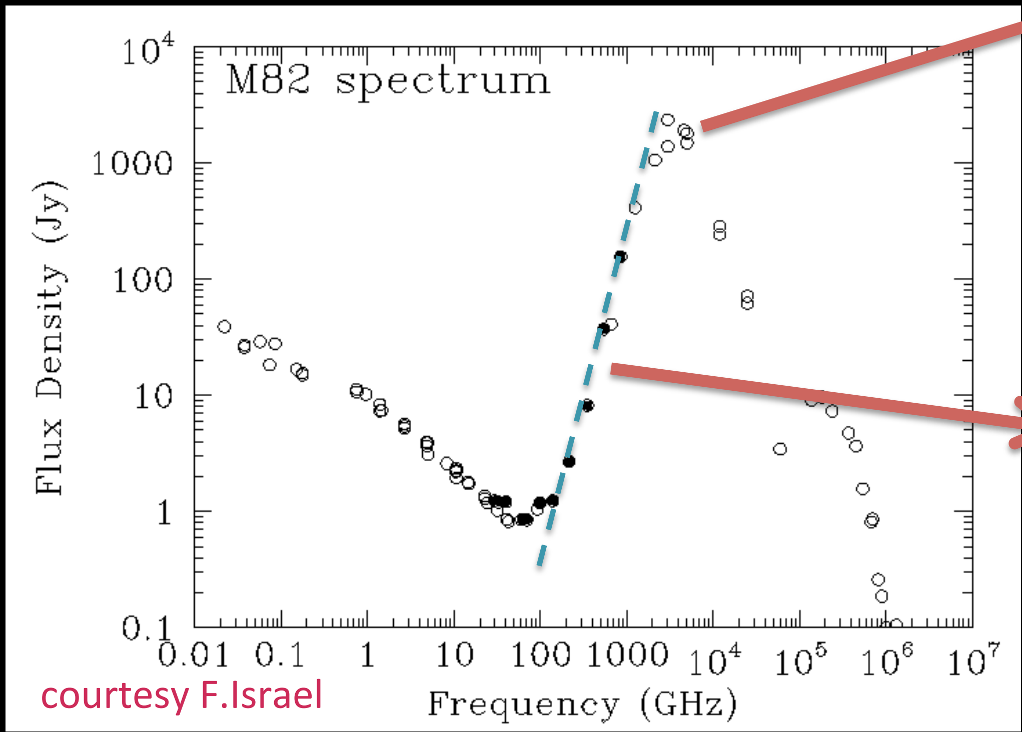


courtesy F.Israel

Submm continuum to be determined ...

SED and dust characteristics

Submm continuum : dominated by thermal dust emission



courtesy F.Israel

peak of the black body : constraint on the dust grain temperature.

➔ information on the surrounding medium.

slope : constraint on β which could be an indicator of the metallicity.

➔ nature of the dust grains.

strong degeneracy between β and T.

Why do we need Planck data ?

- data currently available not enough to constrain -> peak wavelength : Td
  -> Rayleigh-Jean slope : β

- β and T not independents : requires accurate fit on both.

- PCCS (Planck Catalogue of Compact Sources) ?

➔ contains compact sources ~ few arcmin.

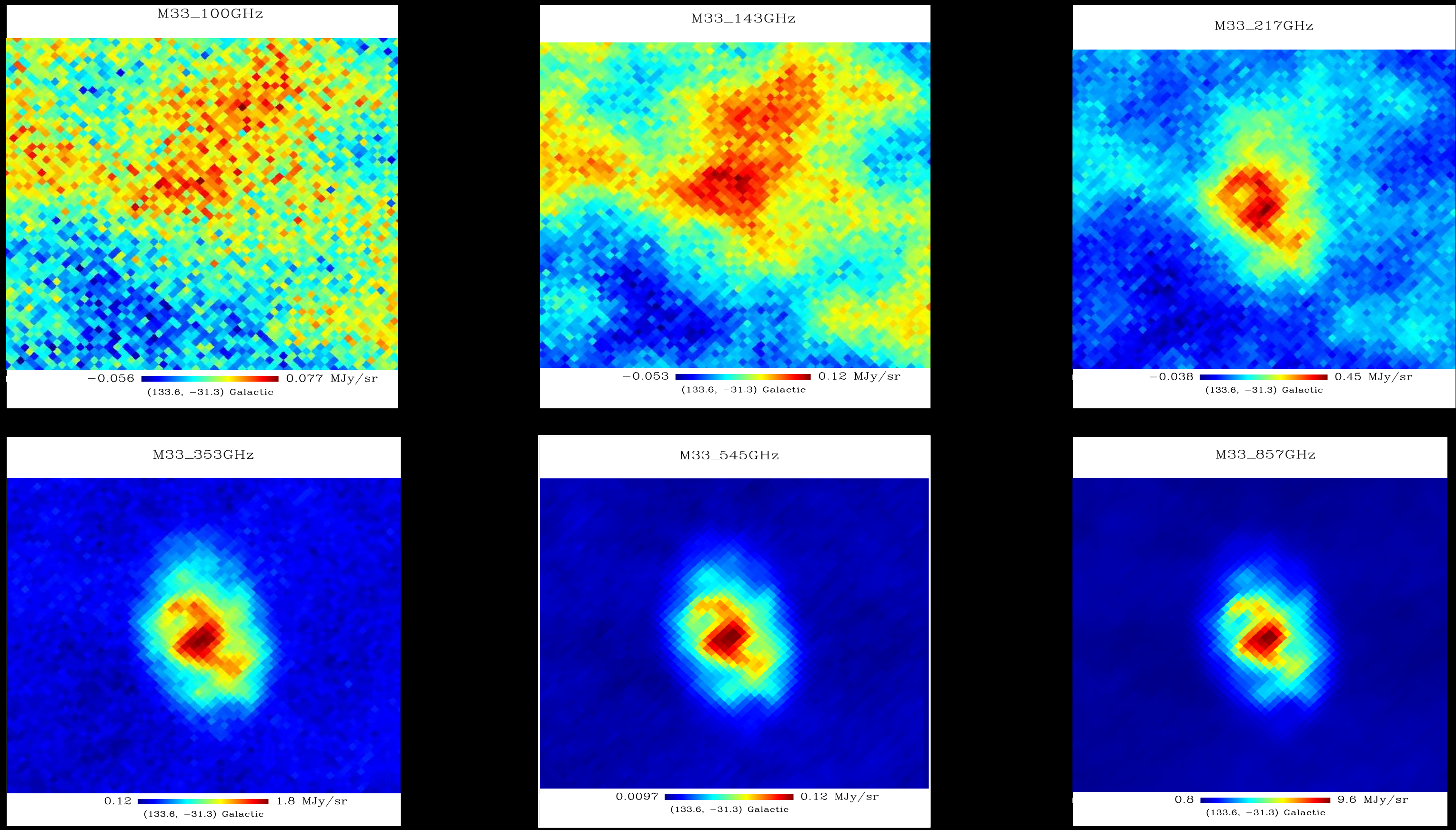
➔ more accuracy needed to solve a specific extended source like M33.

➔ especially : gradient expected between the center similar to MW and the arms similar to the LMC.

combined use of
Planck data + SPIRE + PACS to conclude

Method (1/3)

data used : 2013 Planck public data release of HFI 100 – 857 GHz

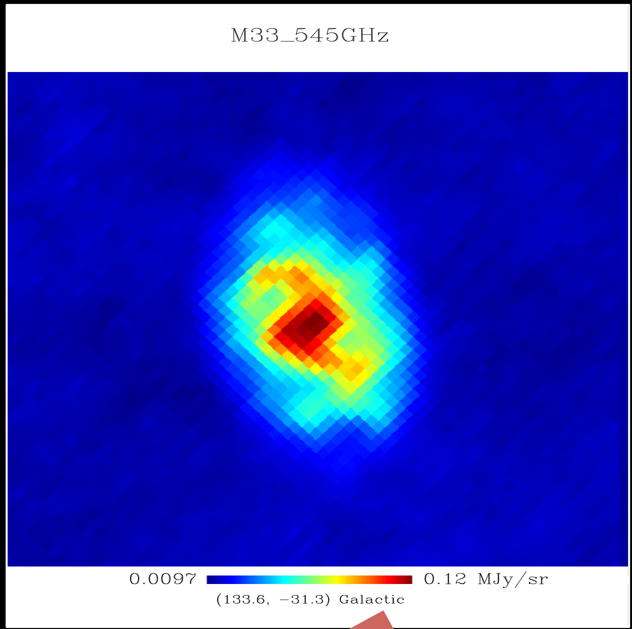


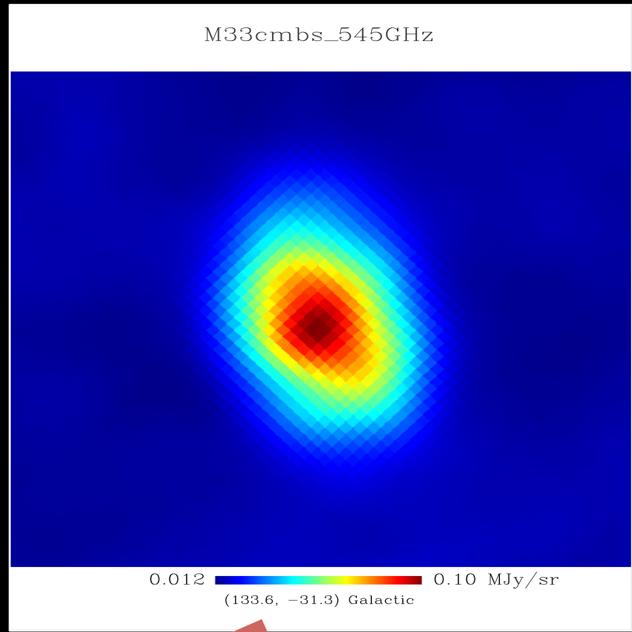
2 complementary approaches :

➔ full galaxy [square patch of 30 arcmin^2].

➔ 3 restricted area : center, West and East arms.

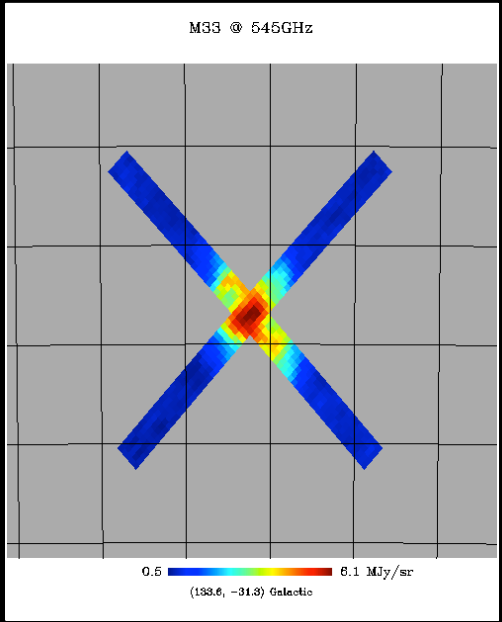
Method (2/3) : full galaxy photometry



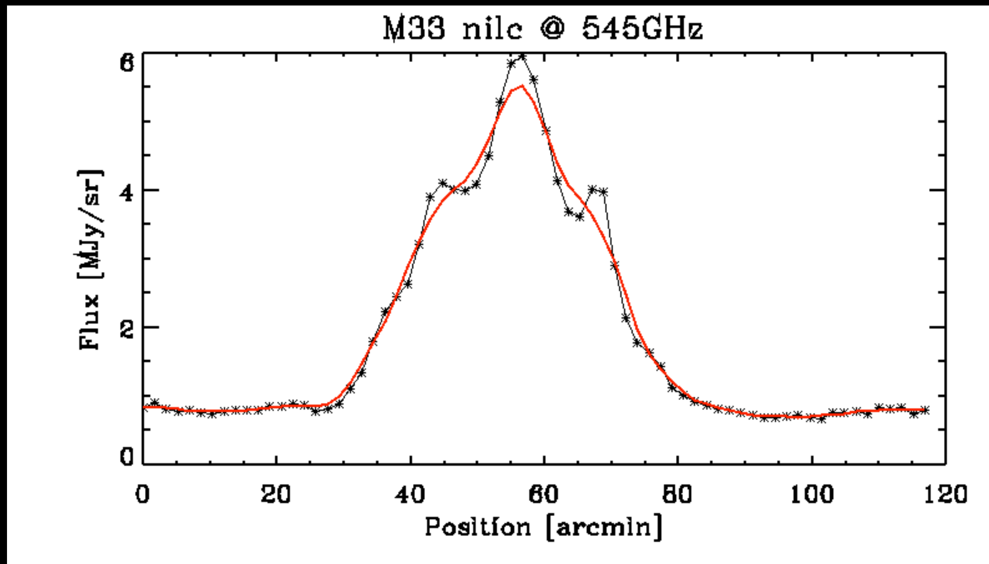


- convolution with 100 GHz channel beam (10arcmin).
- subtraction of CMB.
- removal of the galactic foreground.
- calculation of the flux associated to each patch.

Method (3/3) : photometry of restricted area

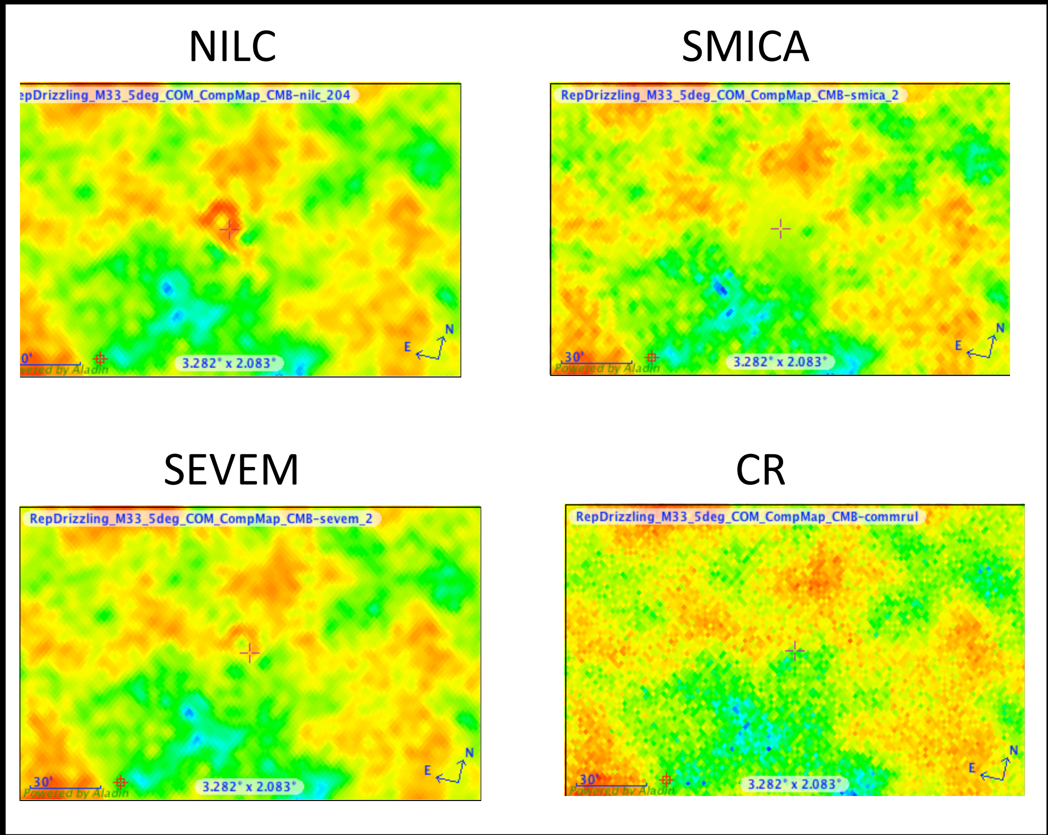


- fixed 5 arcmin resolution (30-353 GHz) :average value over the width of the size.
- selected 3 positions along the slice running over the major axis of the galaxy
- west and east arm at 4kpc from center



- constant background subtraction (uncertainties of ½ difference of foregrounds in West and East arms)
- CMB removal

CMB removal and other uncertainties



4 CMB removal method

all show differences at M33 center

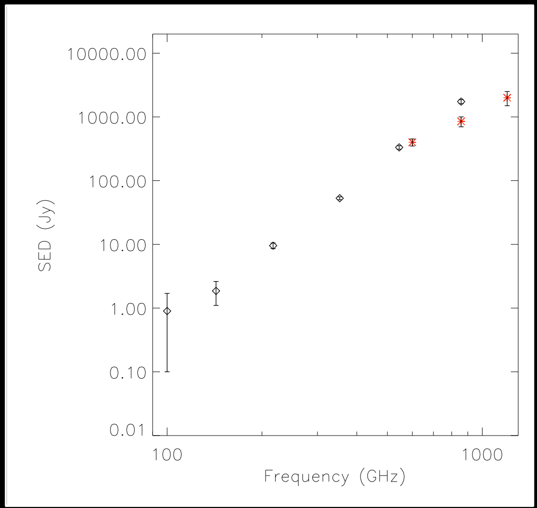
➔ value on M33 position not reliable

➔ to be take into account as an uncertainty.

Other uncertainties :

- foreground removal based on average calculation : existing gradient?
- instrumental noise

Photometry calculation

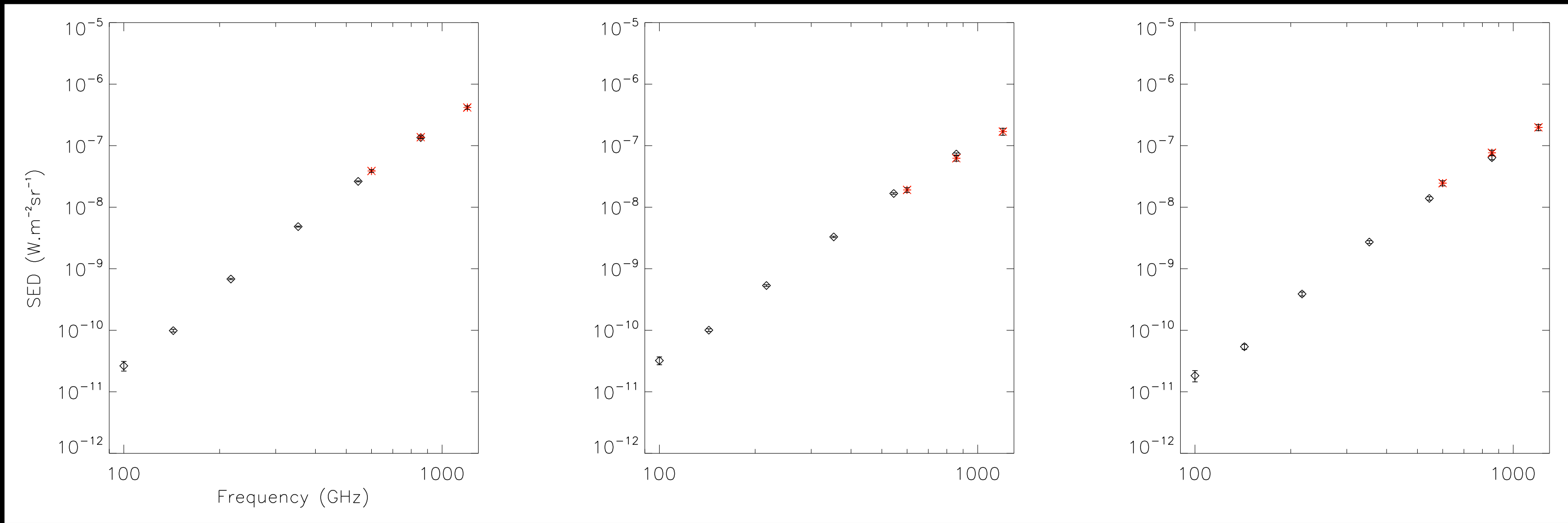


- ◆ Planck HFI
- ◆ SPIRE (total flux [Kramer et al 2011])

• consistency of both set but bias du to calibrations and beam correction on SPIRE data have to be take into account for the all galaxy photometry .

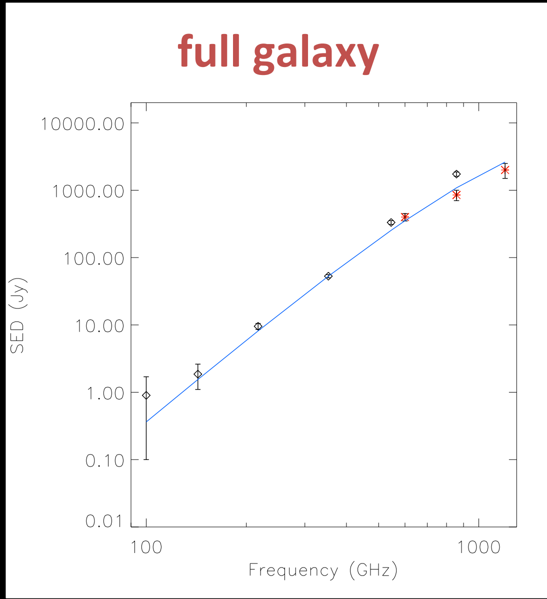
• on restricted area : error bares to be improved.

• power law behaviour.

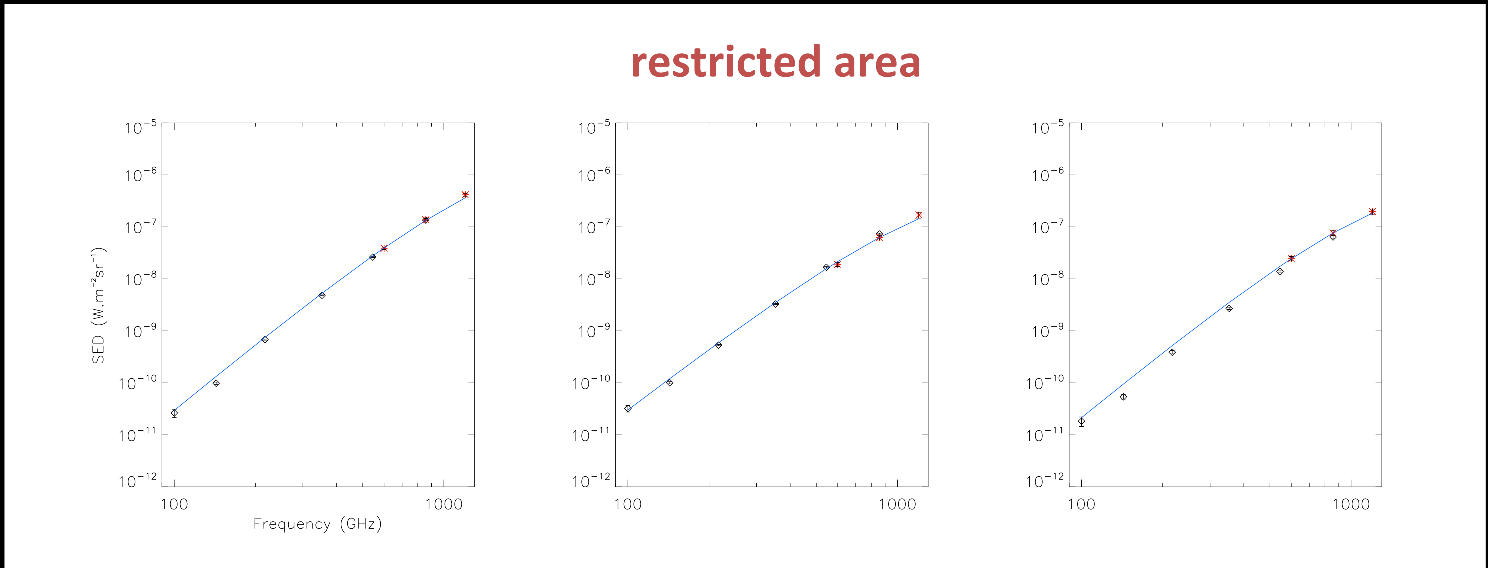


Fit with modified black body

$$F(\nu,\beta_d,T_d) = (\frac{\nu}{\nu_0})^{\beta_d}\frac{exp^{\frac{h\nu_0}{kT_d}}-1}{exp^{\frac{h\nu}{kT_d}}-1}$$



X^2 min based comparison method



Preliminary results

ν (GHz)	Parameter	Center	West arm	East arm	full M33
217 to 545	β_d	1.34 ± 10^{-3}	1.23 ± 0.02	1.36 ± 0.05	1.31 ± 0.16
217 to 857 (+spire)	β_d	1.33 ± 10^{-3}	1.02 ± 0.01	1.13 ± 5.10^{-3}	1.42 ± 0.11
217 to 545	T_d	23.55 ± 10^{-3}	23.88 ± 0.01	19.72 ± 0.08	22.98 ± 0.22
217 to 857 (+spire)	T_d	23.67 ± 2.10^{-3}	21.38 ± 0.02	19.92 ± 0.06	23.72 ± 0.15

Starburst, AGN (high metallicity galaxies)
➔ β = 1.68 ± 0.06

Low metallicity dwarf galaxies [Kramer 2011]
➔β = 1.08 ± 0.12

MW : 1.63 ± 0.3 [Planck 2013 results XXXI]

M33 ➔ β≈ 1.30 (based only on Planck) on average : medium metallicity

Conclusions and work ahead …

- good consistency between Planck and SPIRE (bias due to calibration to be corrected)

- preliminary results : M33 in between high and low metallicity
will study of separate area shows different behaviour ?

TO BE DONE …

- LFI data to be used : flat slope at low frequencies?
- PACS data to be add : improvement of constraint on T

- better estimation of the uncertainties

- calibration Herschel/Planck to be understood.

- color correction factor to be apply.

- contamination by radio continuum (synchrotron and free-free) to be estimated

- extension of the work to NGC6822 (another low metallicity galaxy)