Observing Extended Source with the Herschel SPIRE FTS

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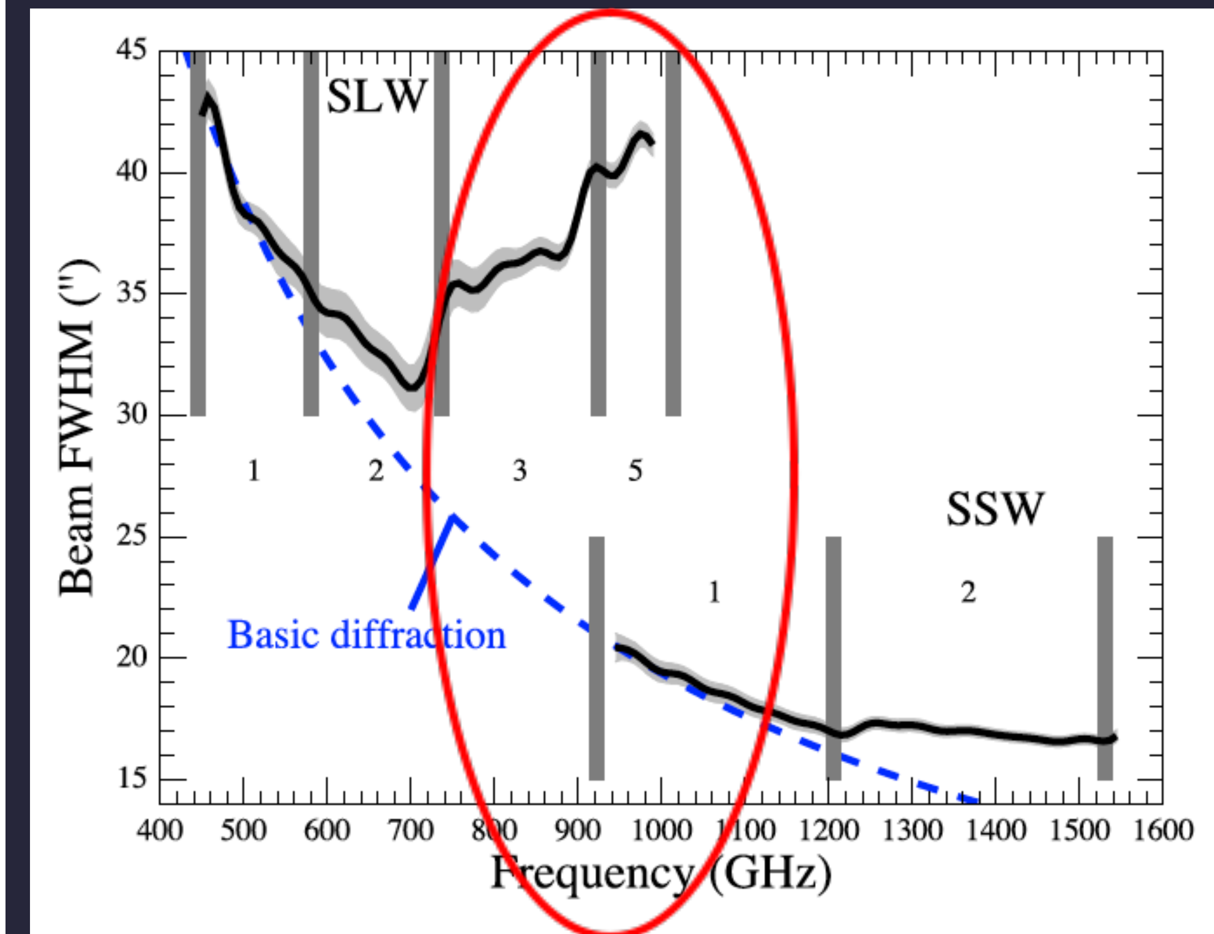
All contents are from Wu et al. 2013 (to be submitted soon!)

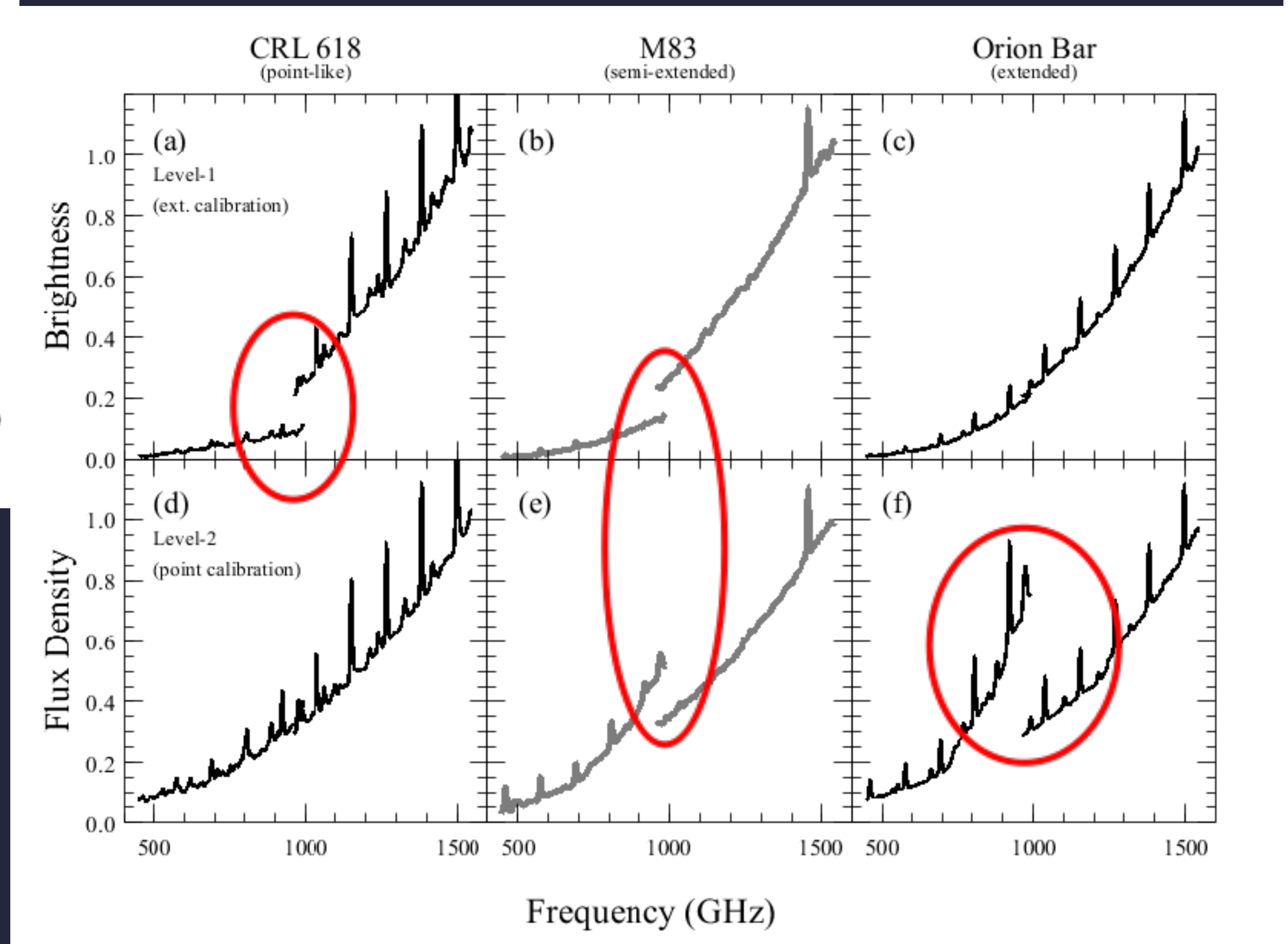
R. Wu[1], E. T. Polehampton[2,3], M. Etxaluze[4], G. Makiwa[3], D. A. Naylor[3], C. Salji[2,5], B. M. Swinyard[3,6], M. Ferlet[2], M. H. D. van der Wiel[3], A. J. Smith[11], T. Fulton[3,11], M. J. Griffin[8], J.-P. Baluteau[9], D. Benielli[9], R. Hopwood[7], P. Imhof[3,11], T. Lim[2], N. Lu[12], P. Panuzzo[1] C. Pearson[2], S. Sidher[2], I. Valtchanov[10]

Outline

- How do source-beam coupling appear?
- How to correct for source light profile?
- What about the beam efficiency?
- What can we learn from the defect?
- Two examples: M82 and Sgr B2
- Conclusion

Source-beam Coupling





An indication of the source distribution

Derivation of Correction

Forward coupling efficiency:
(Ulich & Haas 1976)

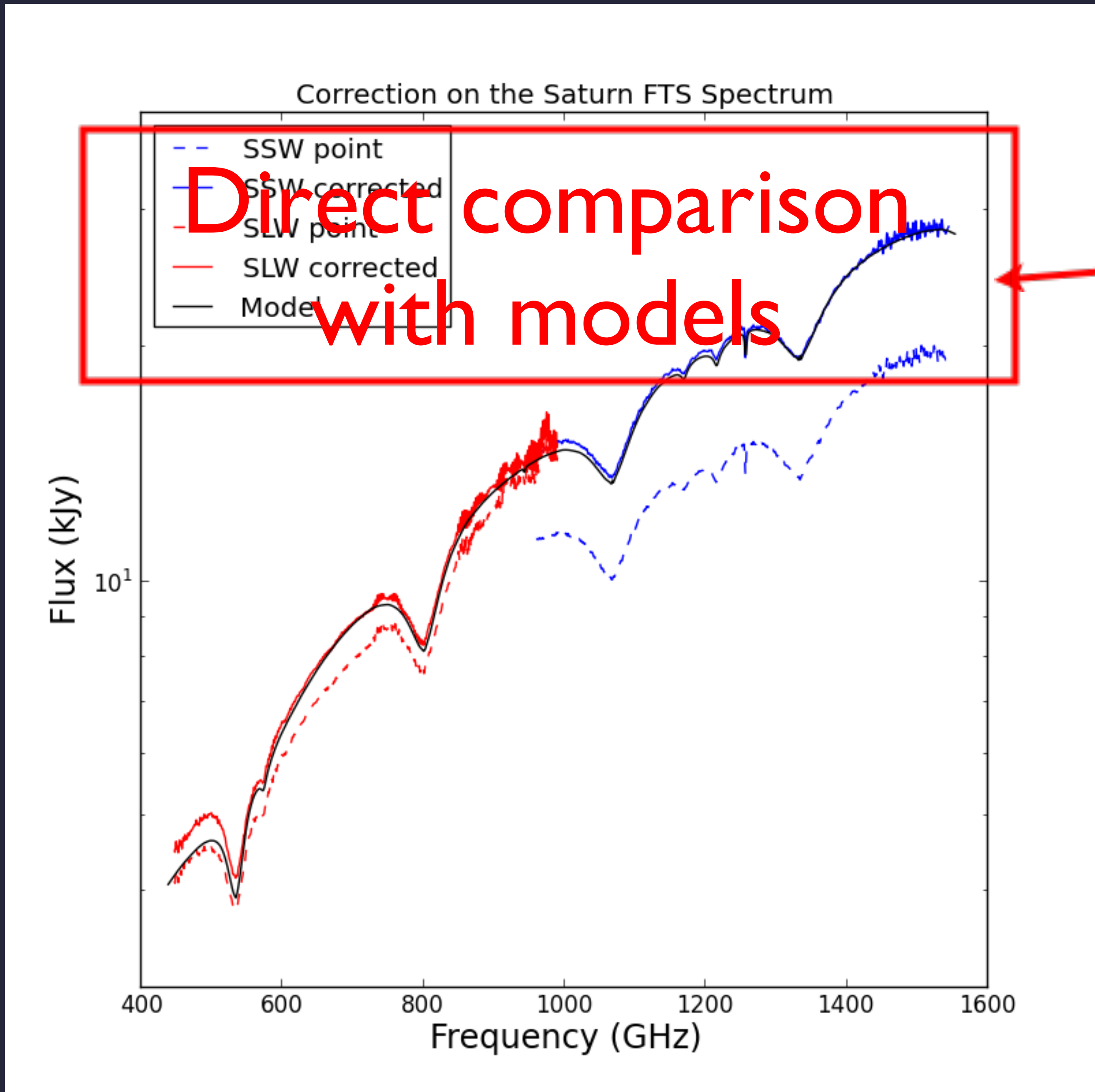
$$\eta_f = \frac{\iint_{2\pi} P_\nu(\Psi - \Omega_0)\, D_\nu(\Psi)\, \mathrm{d}\Psi}{\iint_{2\pi} P_\nu(\Psi)\, \mathrm{d}\Psi}$$

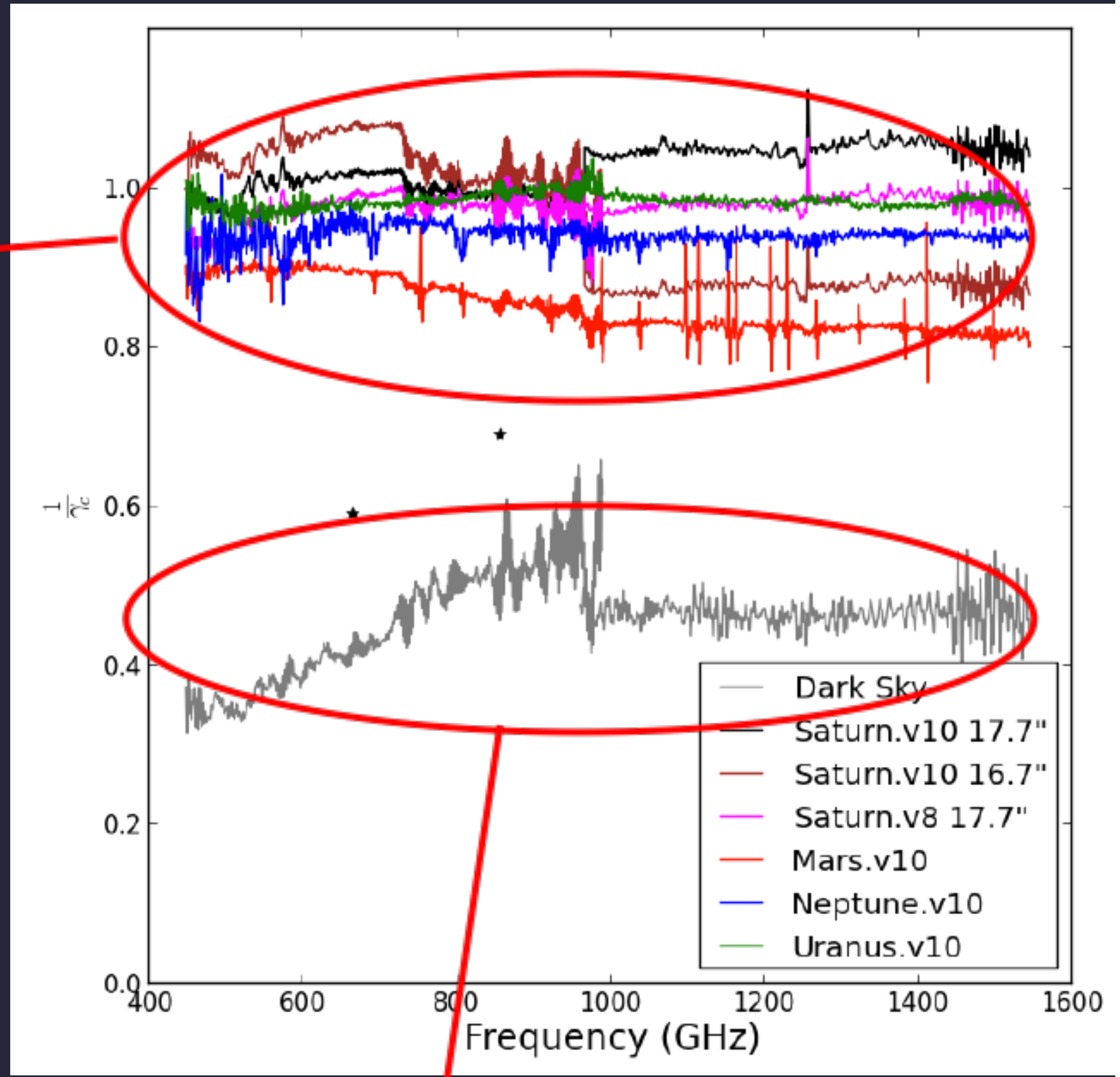
$$F_s = \begin{cases} I_{ext} \cdot \dfrac{\eta_c(\nu, \Omega_{source})}{\eta_c(\nu, \Omega_{beam})} \dfrac{\Omega_{source}}{\eta_f(\nu, \Omega_{source})} \\ F_{point} \cdot \eta_c(\nu, \Omega_{source}) \dfrac{\Omega_{source}}{\eta_f(\nu, \Omega_{source})\, \Omega_{beam}(\nu)} \end{cases}$$

The two intrinsic calibration schemes from the pipeline (I_{ext}: extended; F_{point}: point-like)

Beam coupling efficiency

Beam coupling efficiency η_c:





$$\frac{F_{point}}{I_{ext} \cdot \Omega_{beam}}$$

Up to $\theta_D = 18''$

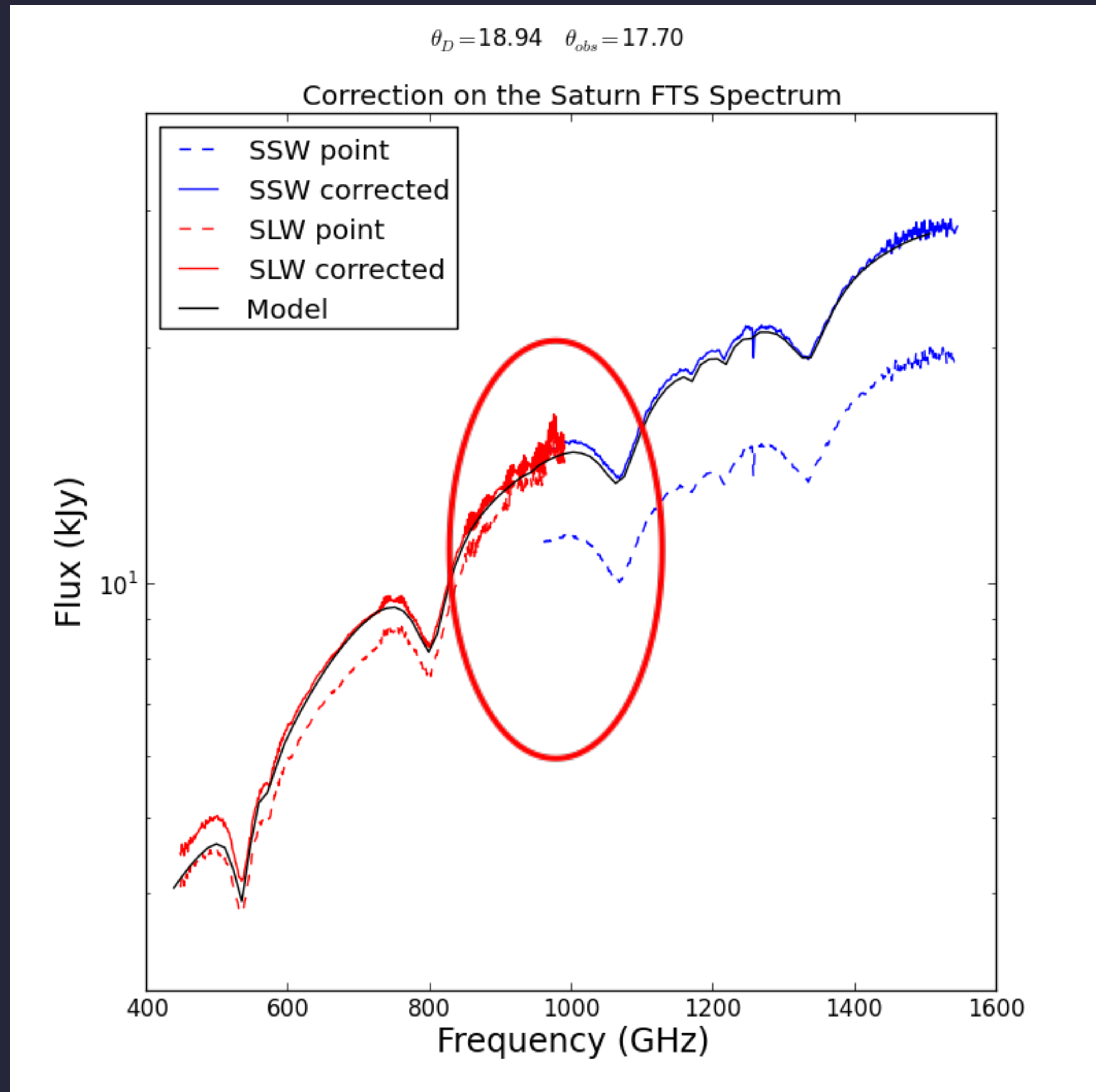
Correction works well!

Size estimate

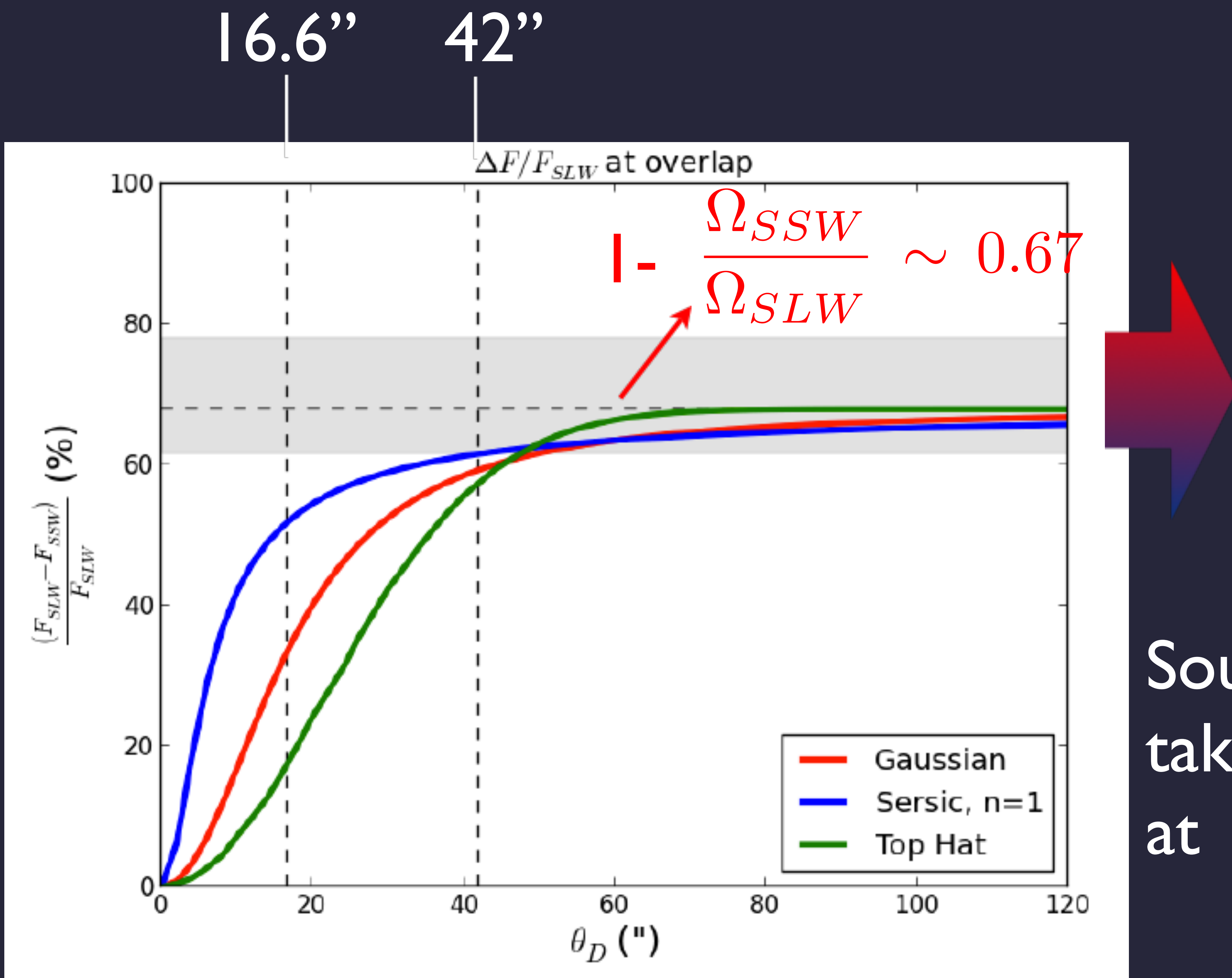
$$\chi^2(\theta_D) = \sum_i \frac{F_{SLW}(\nu_i, \theta_D) - F_{SSW}(\nu_i, \theta_D)}{\sigma_{SLW}(\nu_i)^2 + \sigma_{SSW}(\nu_i)^2}$$

Estimated size is ~6% larger

A hint of source light profile



Size estimate limitation

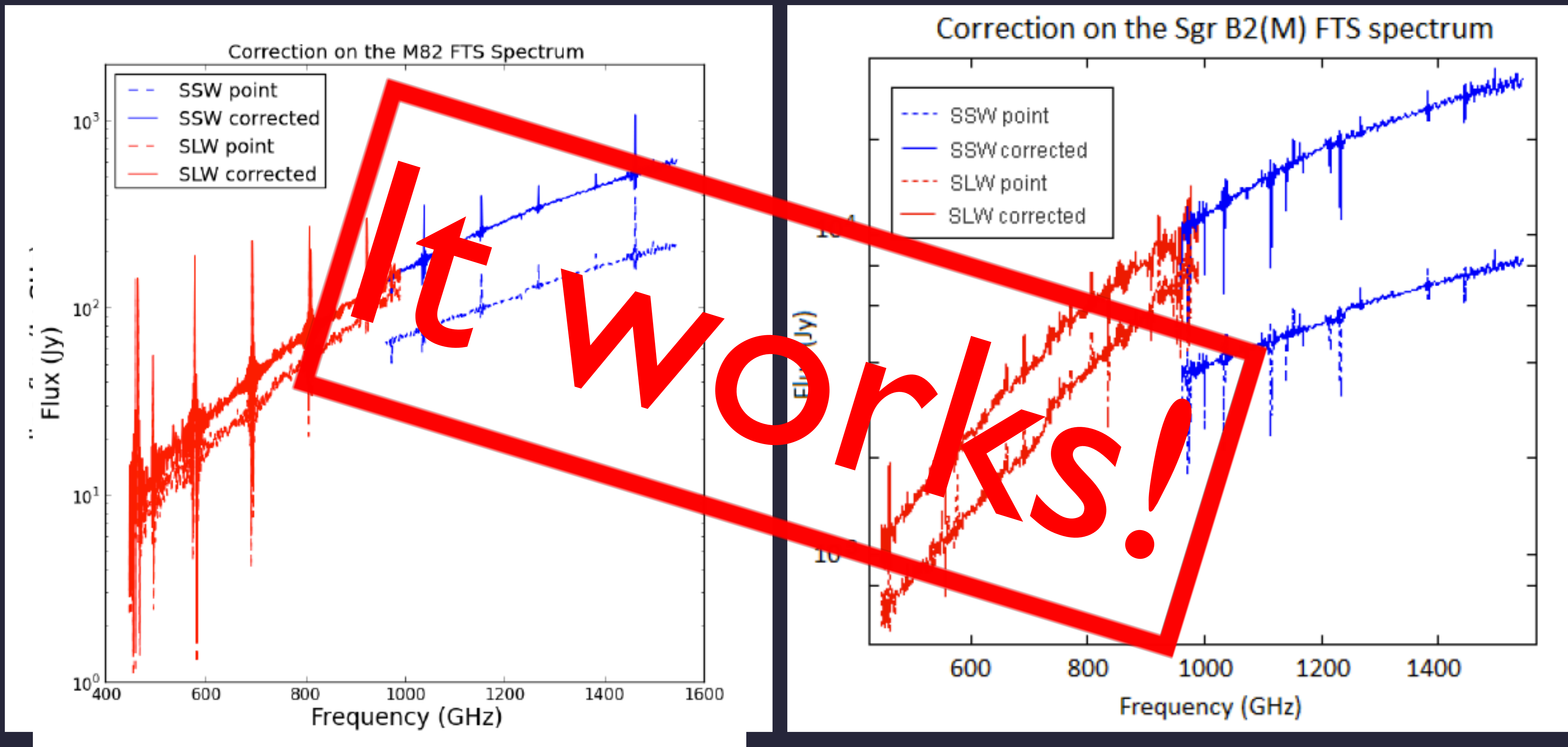


Uncertainty due to η_c

Sources can be taken as extended at $\theta_D > 42''$

M82 and Sgr B2

M82 | Sgr B2



(Etxaluze et al. 2013)

Conclusion

- Source-beam coupling creates a visible discontinuity from SSW to SLW.
- Spectra can be corrected by assuming a light profile of source.
- For small sources (<18”) , $\eta_c \sim 1$, larger sources are uncertain.
- The discontinuity can be used to estimate the source geometry.
- The correction works well on M82 and Sgr