

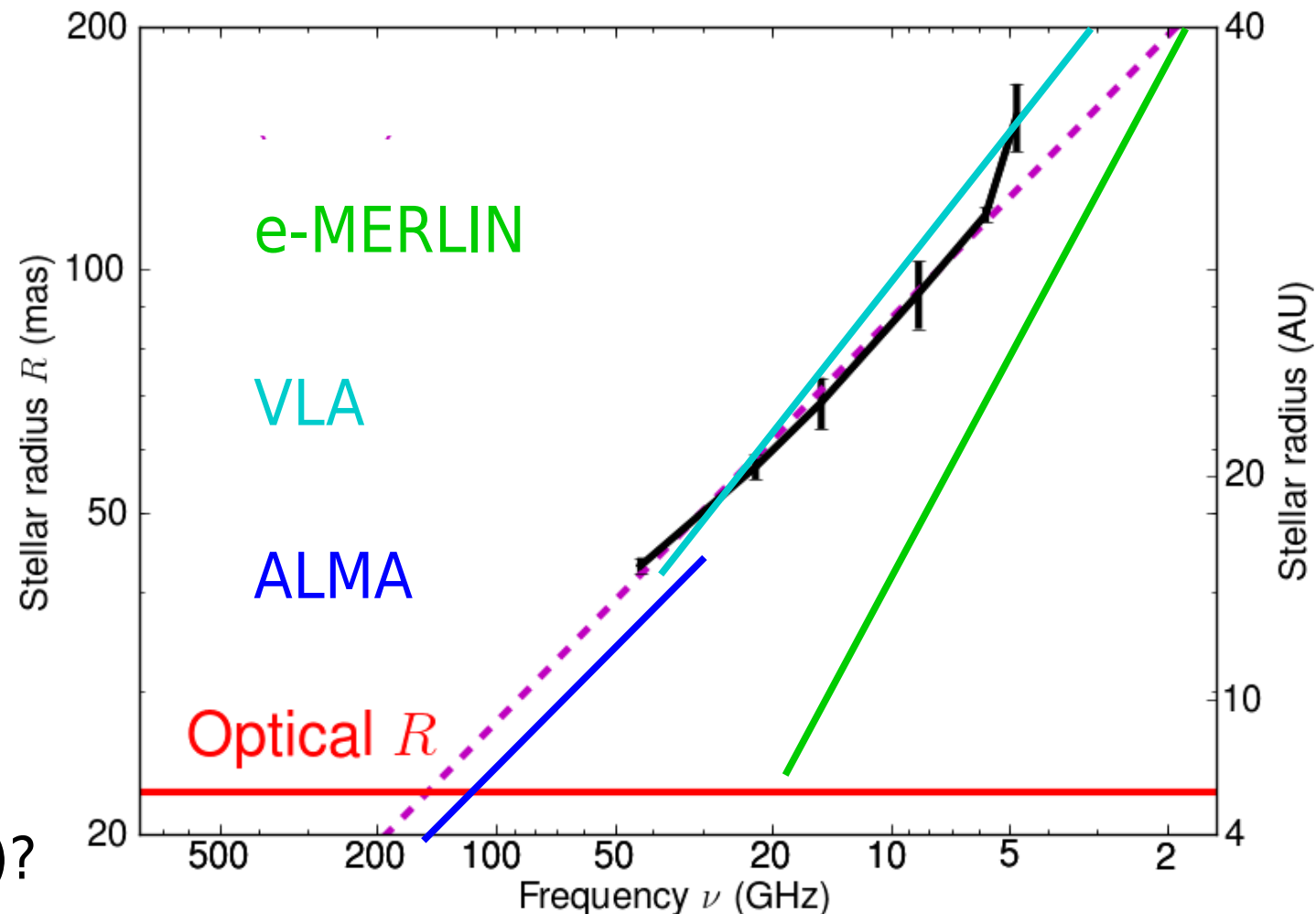
# Radio observations

- **Variability: monitoring continuum**
- Total flux density (imaging not required)
  - Changes up to 25% in a few months seen at  $\lambda > 1\text{cm}$ 
    - Why not at 0.7 cm?
- Need to detect  $\sim 10\%$  changes -  $2\%$  *peak* sensitivity
  - **0.7-20 cm**: only VLA is sensitive enough to be efficient
    - How long for? How often?
- Concurrent optical/IR monitoring - AAVSO/FOEV?
  - Good project for university somewhere (clear!)?
- **mm-wave  $\sim 86\text{ GHz}$** : maybe LMT?
- **Sub-mm**: APEX? but  $\sim 5\text{-hr}$  to reach sensitivity

# Resolving the star

- Radio continuum surface at  $\tau_\lambda \sim 3$ ;  $R_* \sim 54.3\lambda_{\text{cm}}^{0.35}$ 
  - Shorter wavelengths see deeper, smaller layers

- Do spots trace rising (falling?) clumps?
- Or radiative disturbances?
- Coordinated (pulsation)?
- Individual variability (convection/bulk turbulence/associated radiative effects)?



# Resolving continuum

- $R_{\star} \sim 150 \text{ mas @ } 20\text{cm? to } \sim 22 \text{ mas @ } <1.3 \text{ mm?}$
- $R_{\text{spot}} \leq 0.3 R_{\star}$  (if spot size scales with disc)
- Disc fully resolved, spots at least partly by:
  - e-MERLIN 20cm, 5cm; e-MERLIN(+VLA) 1.3cm
  - ?VLA+LLAMA 7mm? (Disc by VLA alone)
  - ALMA long baselines at sub-mm  $\lambda$
- Stagger observations to test propagation of disturbances from deeper (short  $\lambda$ ) to higher layers?
- Detect dust in dense wind close to star
  - Resolve formation radius ( $\sim 80 \text{ mas}$ )? What is best  $\lambda$  ?

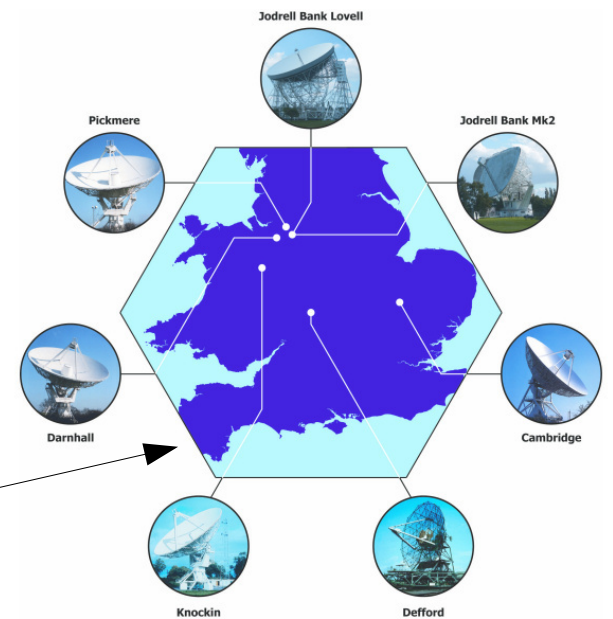


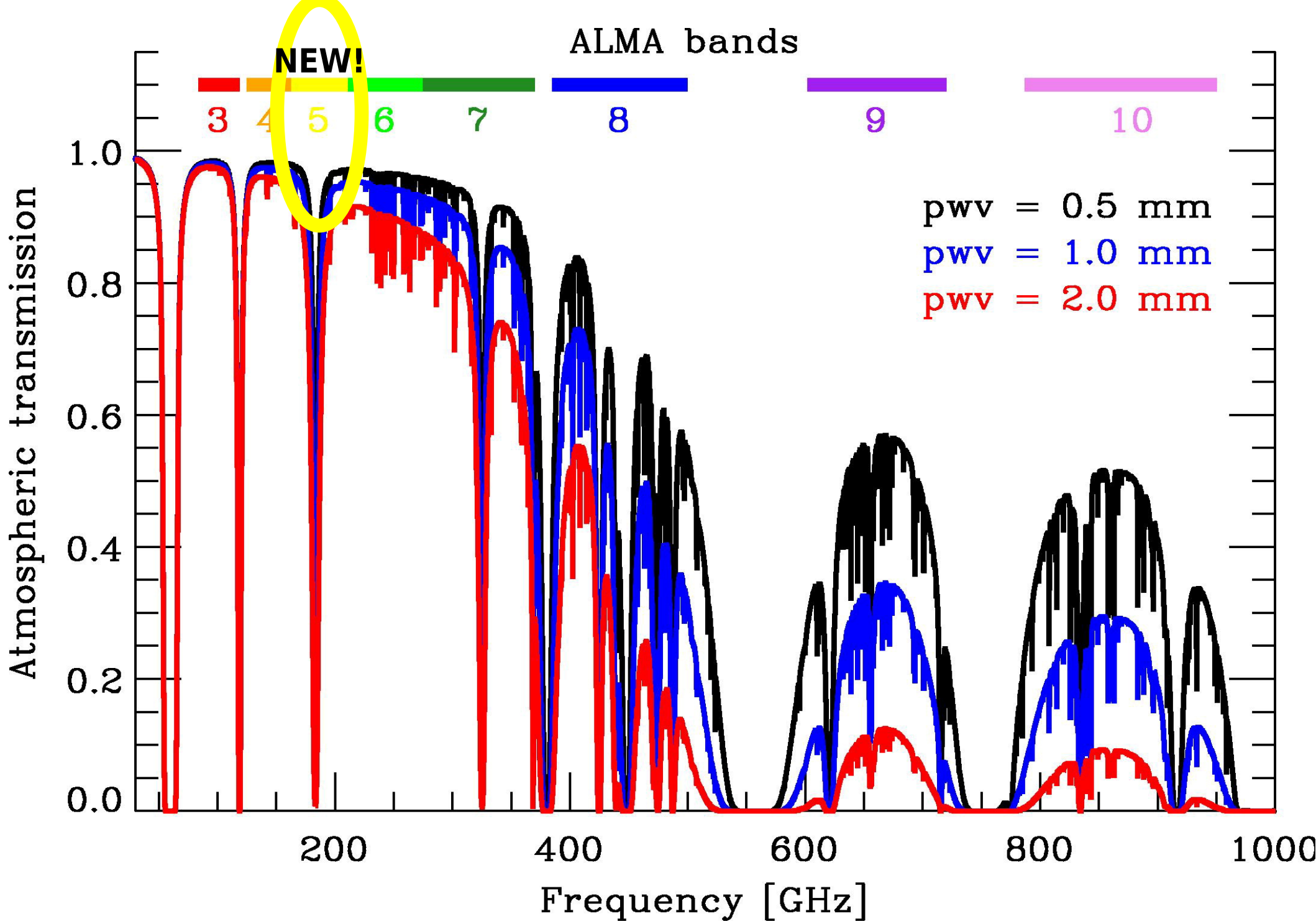
# Line searches and imaging

- IRAM 30-m - lovely results from Duthu
  - ALMA follow-up?
- NOEMA - large-scale mosaics e.g. CO?
- APEX ( $\lambda$  2-0.8 mm)
  - Band 5 - 183 GHz water maser + SiO in same band
  - CO ladder? SiO ladder/other masers?
    - $v>0$  likely to be maser, especially if narrow/bright
- Monitoring (APEX, IRAM 30-m, OSO (but far N))
  - SiO masers, compact thermal lines?
- Predictions for dust-related lines (Ti\*? Al\*?)
  - Anything within ALMA sensitivities?

# capabilities (for Dec 7<sup>o</sup>)

- 1.3-1.7, 4-8, 21-26 GHz wavebands ( $\leq 2$ -GHz bw)
  - 250 - 20 mas angular resolution
  - 10  $\mu$ Jy 3- $\sigma$  sensitivity in 12 hr at 4-8 GHz (full bw)
    - 40-mas resolution
  - Other bands  $\sim 20$   $\mu$ Jy continuum sensitivity
  - Spectral line: 15-40 mJy in 0.1 km/s
  - Full polarization
- Deadlines each Spring
- Joint observations with EVN/Global VLBI
  - <http://www.e-merlin.ac.uk>
  - Hope to add Goonhilly for better N-S coverage







# ALMA GUESSES for C5

- Up to 16 km baselines for all? most? frequencies?
  - (Currently 12.6 to 3.7 km at 3 to 0.3 mm)
- Full polarization (calibration of circular not official?)
- Large programs (>50 hr, probably standard modes only), spectral scans and surveys, multi-configs
  - Discuss with ARCs the most efficient strategies
- Schedule of configs. may be longest in S. summer?
  - High freq/long baselines prefer nighttime observing
- Cont: 0.02-0.04-0.5 mJy at 3.5-0.85-0.45 mm/30 min
- Line: 2.8-3.3-30 mJy in 1 km/s

# Current plans

- Kervella ALMA Cycle 3 data being worked on
- e-MERLIN 5 cm O'Gorman/Richards
  - Applied for 5, 1.3 cm for 2017
- Next VLA deadline 2017 Feb 1 B-array
  - Do we want to start monitoring?
  - A-array deadline 2017 Aug 1
    - Will apply for 22-GHz to combine with e-MERLIN
- Next ALMA deadline spring 2017 (line and cont. together)
  - Follow up Duthu SiO maser? 183 GHz H<sub>2</sub>O maser?
  - Band 9 or 10 if longest baselines offered (5-10 mas resolution)
- APEX 183 GHz and SiO lines in Band 5?



# What should be ALMA priorities?

- Current max. baseline restrictions at shorter  $\lambda$ 
  - Issues for weather, calibrators, pipeline (self-cal OK!)
- Large programs - do we need them?
  - Currently, spectral scans not allowed in large progs
- Band 1 (30-50+GHz) under construction
- Band 2 or 2+3 (67-86 or 67-116GHz) under development
- LLAMA few 100 km baselines (intermediate ALMA-GMVA)
- Calibration of circular polarisation
- Increasing volume of delivered/archived cubes - is this useful?
  - Or is reprocessing for science always needed?
    - Do you prefer smaller, maybe faster products?
  - ALMA still provides all calibration

# Feedback

- Monitoring e.g. every month or two
  - Likely to be possible within +/-week
  - Total flux OK, not fussy about config?
  - Want to resolve spots? Possibly get e.g. 15-mas resolution on 5-16 km baselines at Bands 10-7, over ~3 configurations - ~3 months?
    - Ideally go from 5 km baselines at B10 first, to track disturbances moving out into longer wavelength regions and relationship with gas (line) plumes
- Coordinate with IR, optical, e-MERLIN/VLA, SOFIA
- Larger sample of RSG?