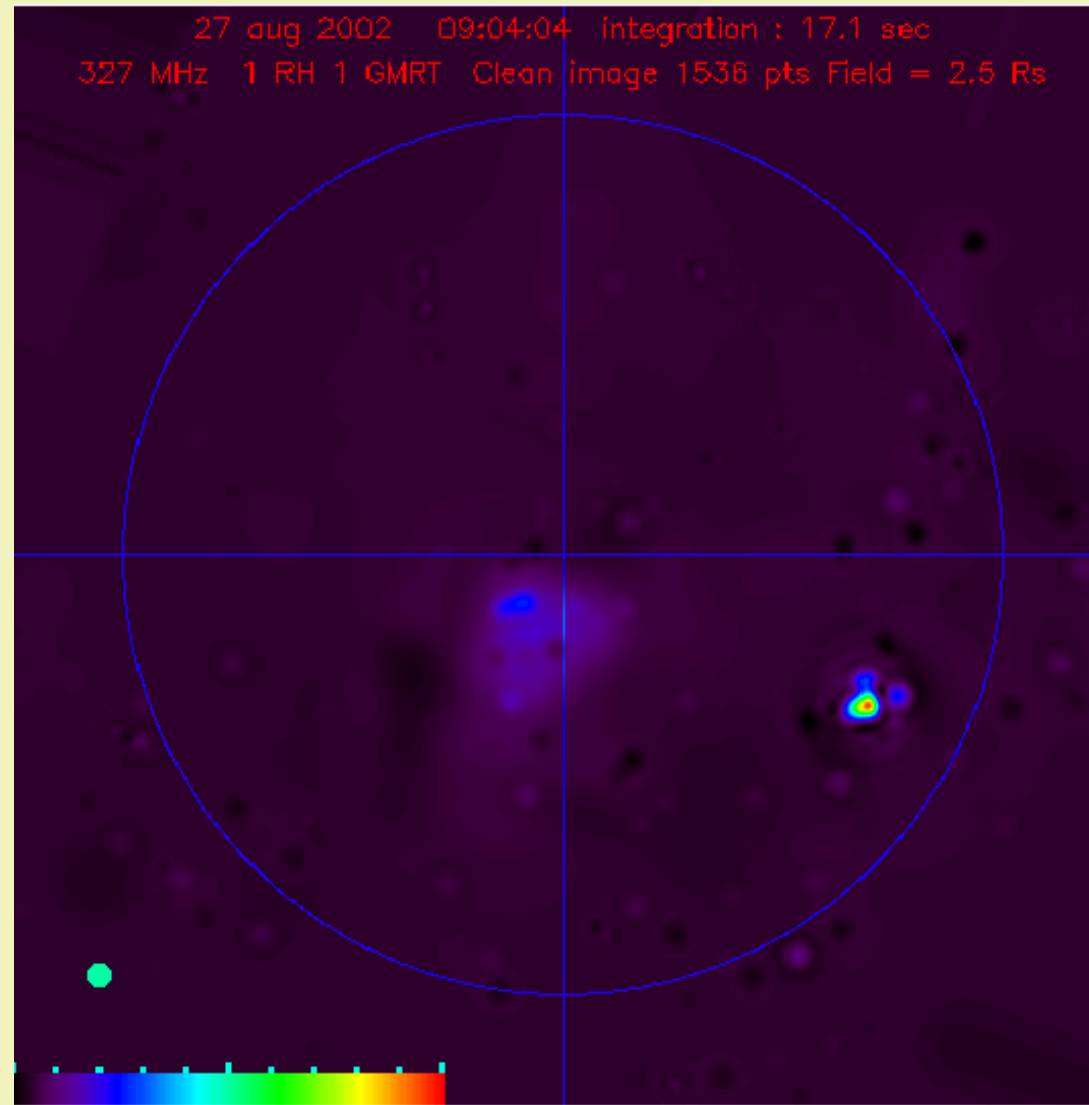


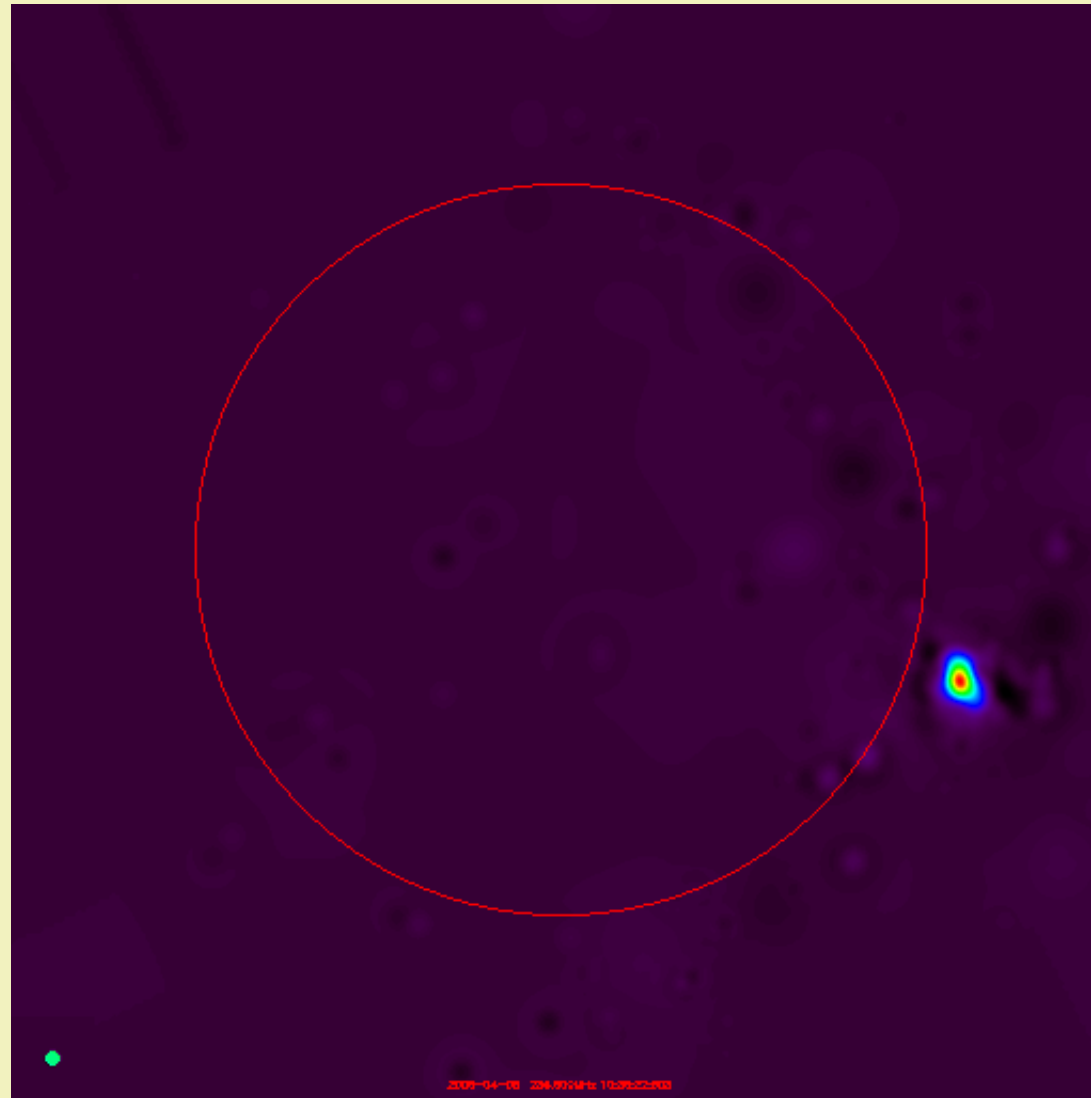
# **Electron acceleration in solar noise storms**

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- Observational motivation: Hi dynamic range, hi resolution snapshot maps of the solar corona (GMRT + NRH) (*Mercier et al. 2005*)
- Noise storms: ubiquitous sites of long-lasting (hours-days) quasi-continuous **electron acceleration**.
- Only sites of electron acceleration outside of violent events such as flares.
- Wideband ( $\sim 50 - 300$  MHz), brightest at around 150 MHz.

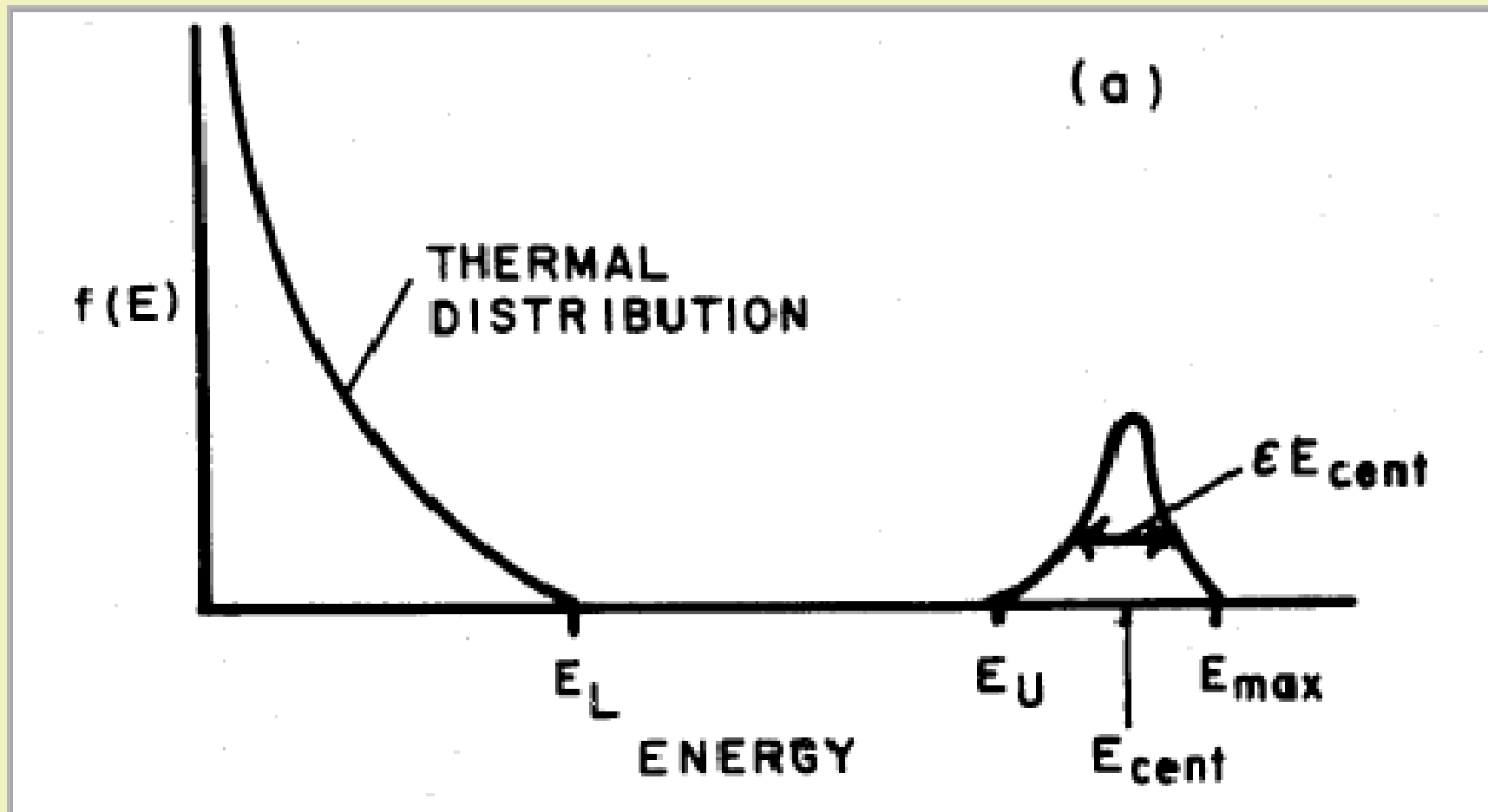


17 sec snapshot. 327 MHz, Resol.  $49''$ , **rms dyn range 283.**



02 sec snapshot. 236 MHz, Resol.  $29''$ , **rms dyn range 447.**

- Improved lower limit on source size (smallest observable source in the corona)
- **Our immediate concern:** Firm upper limit on  $T_b \rightarrow$  emission mechanism  $\rightarrow$  electron acceleration
- Specifically: what is the power budget for the electron acceleration process? How does it compare w/ the power in observed radiation?
- Starting point: electron acceleration, anisotropy in velocity and/or physical space



“Gap” distribution

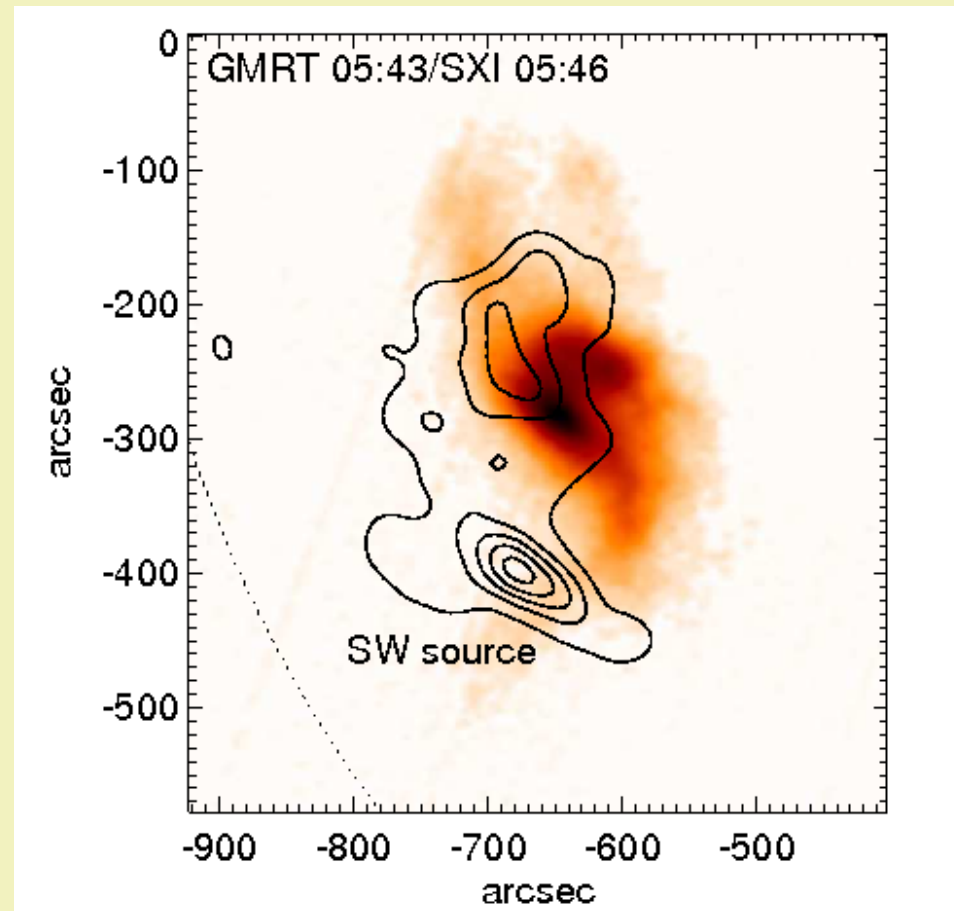
- **1** Electrons accelerated to form nonthermal population
- **2** Anisotropy in electron distribution → (induced)  
Langmuir/UH waves (like Cerenkov emission)
- **3** Langmuir/UH waves + low-freq waves → observed emission

**These 3 stages → coherent “plasma emission” process. All hi- $T_b$  meter/decameter  $\lambda$  emission (not only noise storms)**

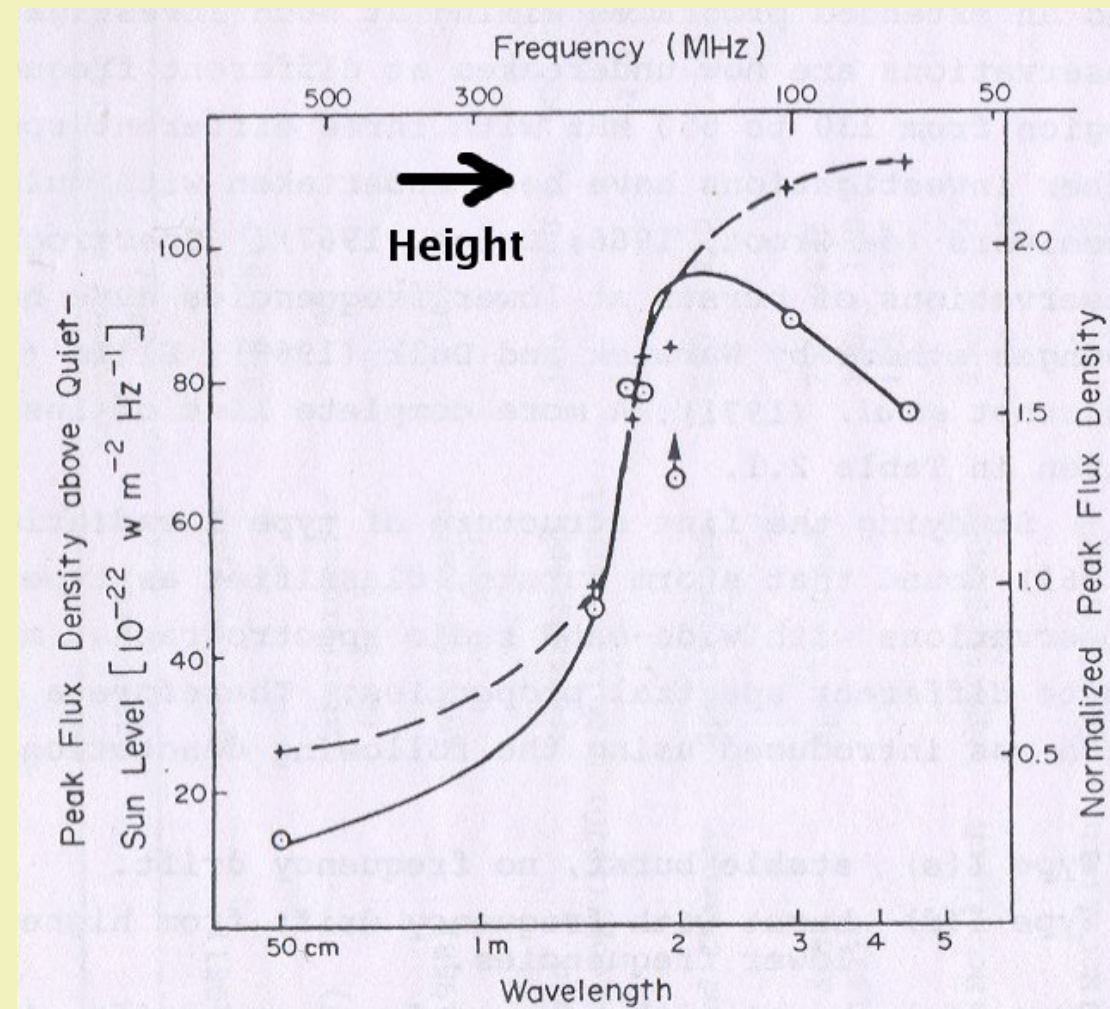
- Generic 2nd order Fermi electron accel process → nonthermal electrons

- Self-consistently combine req. of accel proc w/ req on nonthermal electron number (the gap needs to be sufficiently “empty” to spawn intense Langm wave population)
- **Rough** estimate of emission vol  $V$  ( $\sim 10^{30}$  cm<sup>3</sup>)
- Calculate  $L_{\text{in}}$  (erg s<sup>-1</sup>) to nonthermal electrons.
- Compare with  $L_{\text{out}}$  in observed radiation to calculate efficiency  $\eta \equiv L_{\text{out}}/L_{\text{in}}$
- **Rough** estimate:  $L_{\text{out}} \sim 10^{17}\text{--}10^{18}$  erg s<sup>-1</sup>
- $\eta < 10^{-6}$  (Subramanian & Becker 2006)

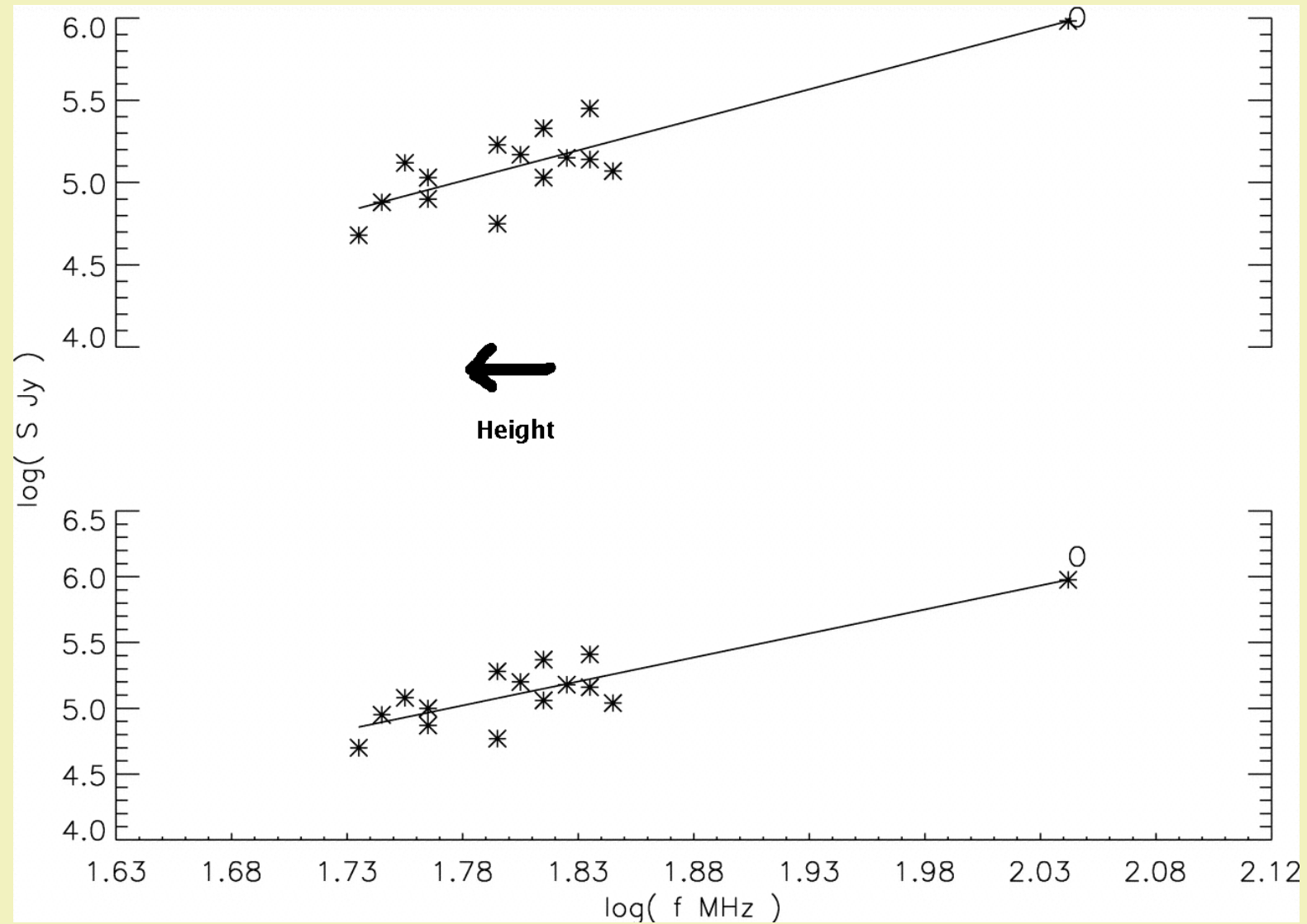
- Better estimate from hi- $T_b$  post-flare decimetric continuum (GMRT, 1060 MHz, Nov 17 2001)
- $10^{-8} > \eta > 10^{-9}$



But on looking closer..

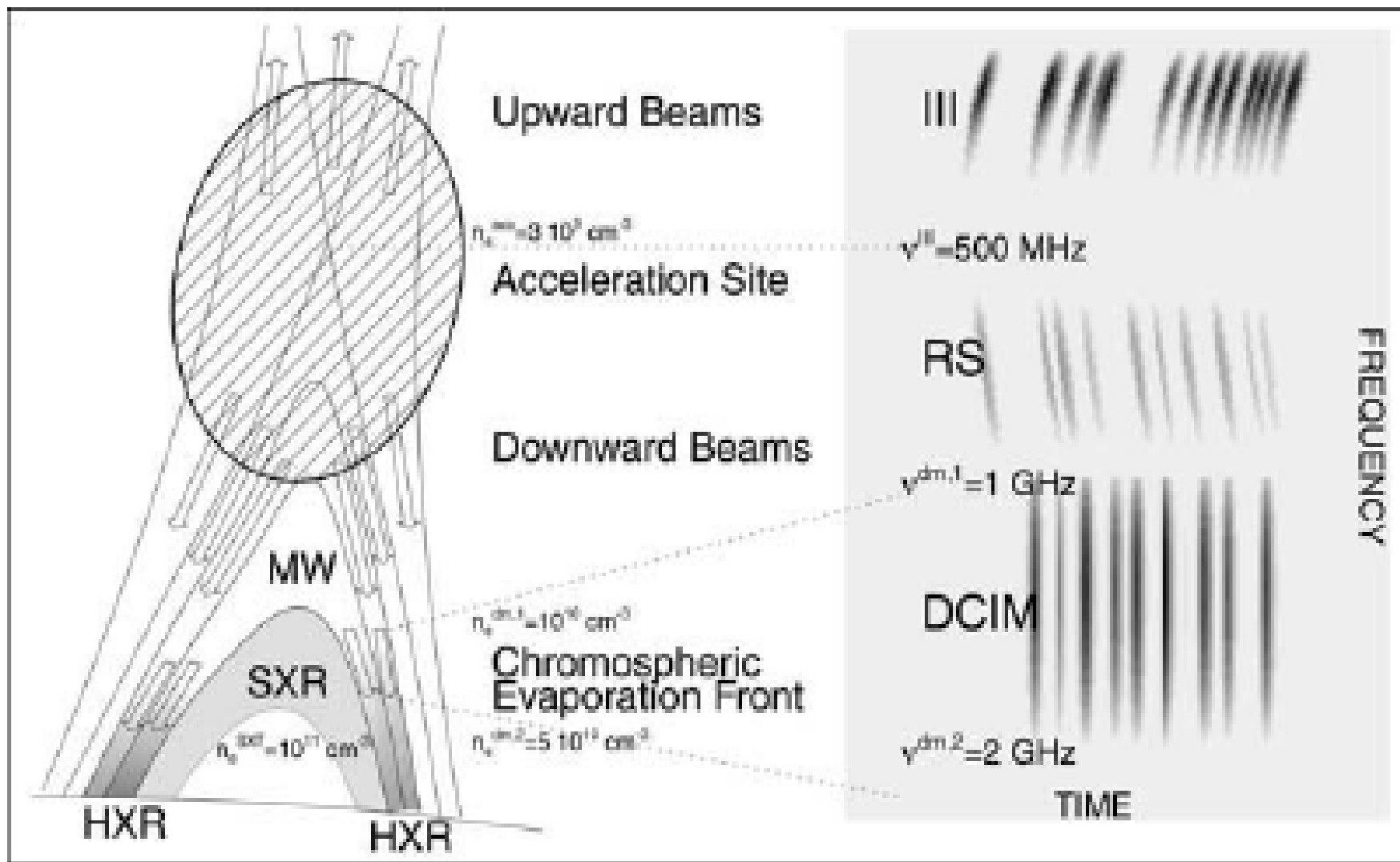


Smerd (1964)



Shanmuga Sundaram & Subramanian (2004)

- There seems to be an “optimum height” (corresp to  $\sim 150$  MHz layer) at which obs noise storm intensity is highest.
- Is it because there is an optimum height for electron acceleration? (Current theory predicts  $L_{\text{in}} \downarrow$  w/  $\uparrow$  frequency; i.e., only one side of the “hat”)
- Density  $\downarrow$  w/  $\uparrow$  height, so (Coulomb collisional) losses  $\downarrow$ , but so does reservoir of electrons available for acceleration.
- So maybe there is an optimum height at which the nonthermal electron power is maximized



Aschwanden & Benz (1997)

- There also seems to be an “optimum”/primary energy release height for flares, at the  $\sim 5 - 600$  MHz level (which is why 610 MHz flare observations w/ GMRT are important!)
- If electron acceleration in noise storms are a “milder” version of that in flares, maybe understanding one can lead to a better understanding of the other.