EDGES MEMO #415

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**
**HAYSTACK OBSERVATORY**
**WESTFORD, MASSACHUSETTS 01886**

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*Telephone:* 617-715-5533

To: EDGES group
From: Alan E.E. Rogers
Subject: Re-examination of potential sites for global 21-cm systems

1] Galactic noise – memo 20

While minimum Galactic noise is desirable a change in Galactic noise with LST allows a check on instrument calibration and observations from different hemispheres is useful in the confirmation that the observed absorption signal is global.

2] Proximity of FM radio stations – memos 54, 311

The presence of micromeorites which produce ionized regions at about 100 km altitude upon entry is worldwide and a minimum of about 10 FM radio stations within 2000 km of the 21-cm antenna is desirable. This criteria is met at the MRO site in Western Australia but not at the site in Oregon used for a test of the EDGES-3 prototype – see memo 310. Also see José Miguel Jáuregui's talk at the 21-cm workshop at McGill for world maps of FM radio stations

http://www.physics.mcgill.ca/global21cm2019/talks/Jauregui.pdf

FM radio in the Karoo limits at the low frequency end of the HERA array and Western Australia was chosen for the low frequency band of the SKA based on a comparison of RFI at the 2 sites.

3] Solar activity and Sporadic E

RFI at low frequencies can also be enhanced by "Sporadic E" propagation. A good example of this is in memo 400 which shows the spectra of digital TV and FM radio seen at the site in Devon island at 75.5deg N. While the presence solar activity limits EDGES data at all sites during the day it appears in recent EDGES-3 data from the MRO that the solar activity may also indirectly producing Sporadic E enhancement of the FM signals and amateur radio beacon signals as discussed in memo 404. Another example of sporadic E is in Figure 1 which shows the enhancement of the FM signal at night. The major concern now is that Sporadic E may be a major limit for global 21-cm observations at all sites through all seasons both day and night until solar activity starts to decrease as we move to the next minimum in the solar cycle. However we should see reduced activity at night in the winter at all sites. A big question for which I have not yet been able to find a definitive reference is whether there is significant Sporadic E in winter. The paper "The global climatology of the intensity of the ionospheric sporadic *E* layer" by Bingkun Yu, Xianghui Xue, Xin'an Yue, Chengyun Yang, Chao Yu, Xiankang Dou, Baiqi Ning, and Lianhuan Hu https://acp.copernicus.org/articles/19/4139/2019/ uses wind shear theory which predicts that nighttime in the winter should have a low occurrence of sporadic E. While some events in the arctic winter reported are by Kirkwood, S., 2007 in *Advances in Space Research*, *40*(6), pp.751-757. These are produced by Solar Proton events and solar proton events are relatively infrequent and don't occur every day. Kirkwood, S., 2015, report echoes from heights of 55–80 km

(polar mesosphere winter echoes, PMWE) on 60 % of all winter days (from March to October) in the antarctic.

https://www.diva-portal.org/smash/get/diva2:816169/FULLTEXT01.pdf

4] Other considerations for a site

While a large lake was used for SARAS observations was used for 21-cm observations the use of vertical polarization results in a higher antenna gain at low elevations which makes the system more sensitive to the ionosphere. A large flat area like that at the EDGES site at the MRO allows for a large ground plane which reduces the beam chromaticity and results in very low loss. Power line noise and noise from LED and florescent lights are potential sources of RFI and need to be sufficiently far away from the antenna – see memo 383. Strong power noise from high voltage lines can be reflected by Sporadic E and micrometeorites so that ideally a site should be at least 2000 km from these noisy high voltage lines like those which have been mapped by the LWA – see Obenberger et al. https://doi.org/10.1029/2020RS007169