

ILC-CLIC LET Beam Dynamics Workshop (CERN, 23-25 June 2009)

# **Measurements of stray magnetic fields at Fermilab.**

*Dmitri A. Sergatskov*

das@fnal.gov

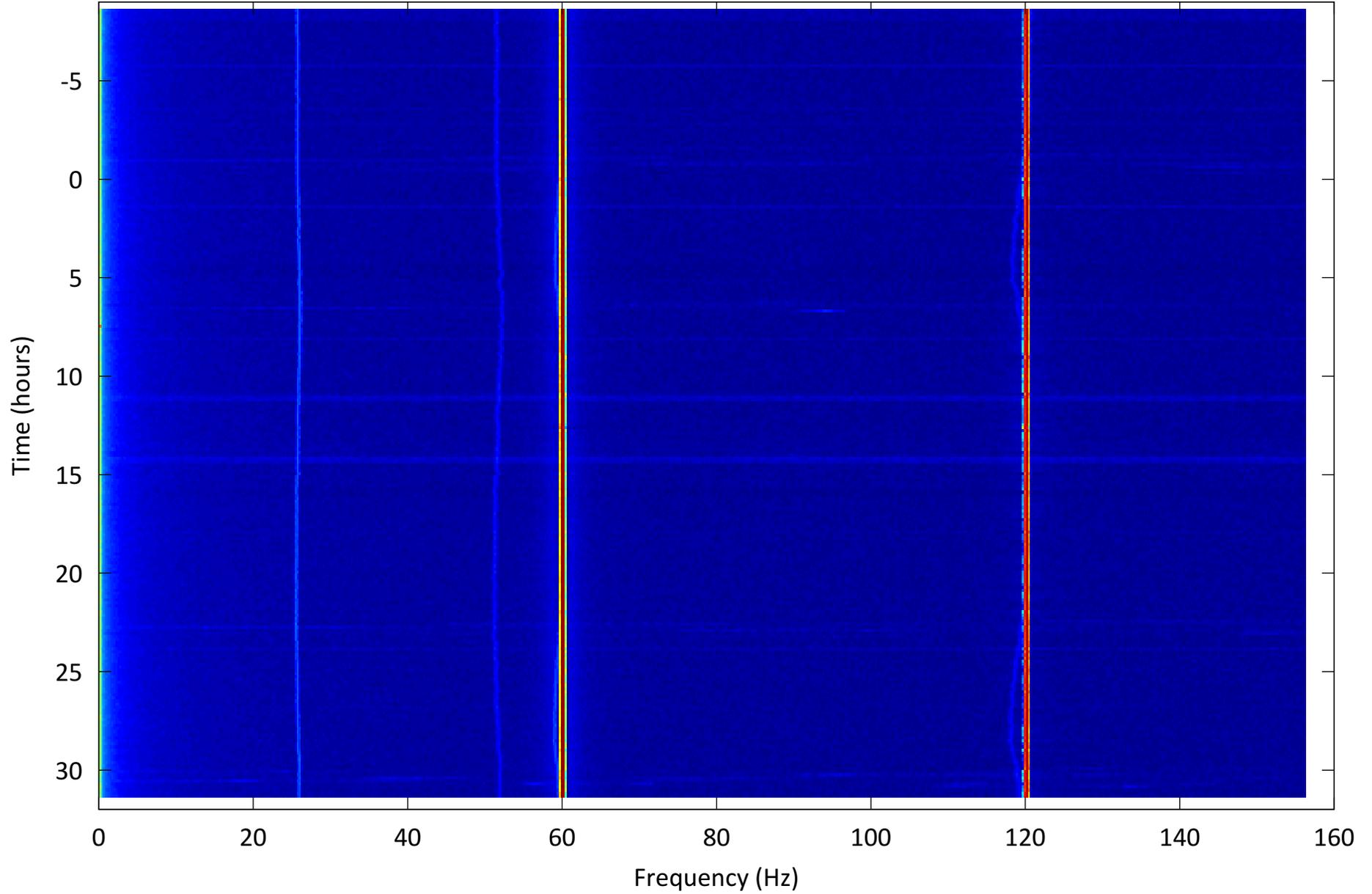
# Magnetic fields

- Commercial superconducting solenoid – **10 Tesla (1 e+1)**
- Earth magnetic field -- **50 micro-Tesla (5 e-5)**
- Cell phone – **100 nano-Tesla (1 e-7)**
- **ILC-RDR requirement – 10 nano-Tesla (1 e-8)**
- Beating human heart -- **~ 10 pico-Tesla (1 e-11)**

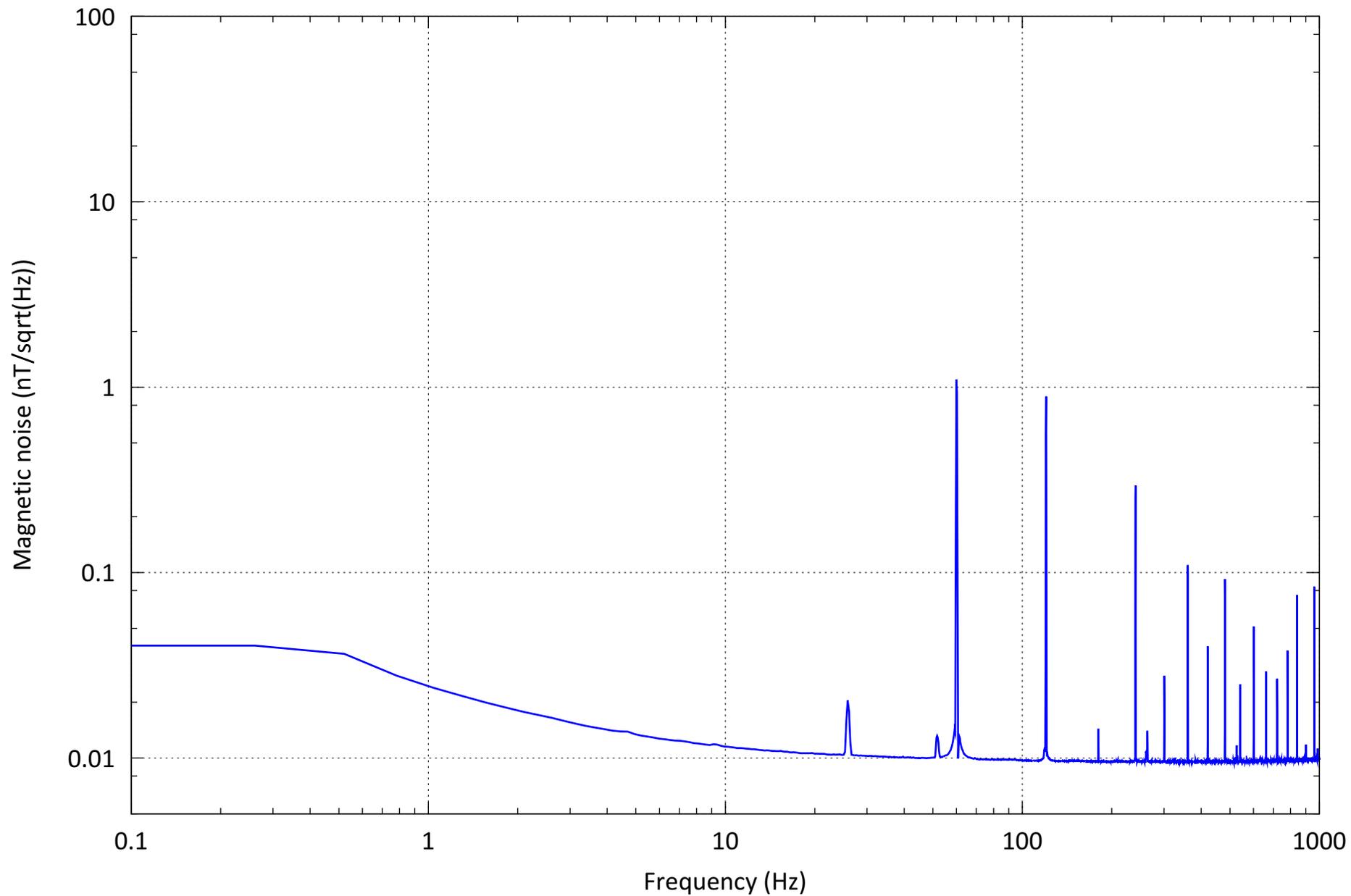
# Data-taking hardware

- Use 3-axis fluxgate magnetometer (Bartington Mag-03MC-100)
  - +/- 0.1mT full scale (+/- 10V output),
  - DC to 3 kHz bandwidth
  - ~10 pT/sqrt(Hz) noise
- 24-bit DAQ card (National Instruments)

(shielded box) magnetic noise spectrogram



(Zero box) magnetic noise spectrogram. 2009.06.18



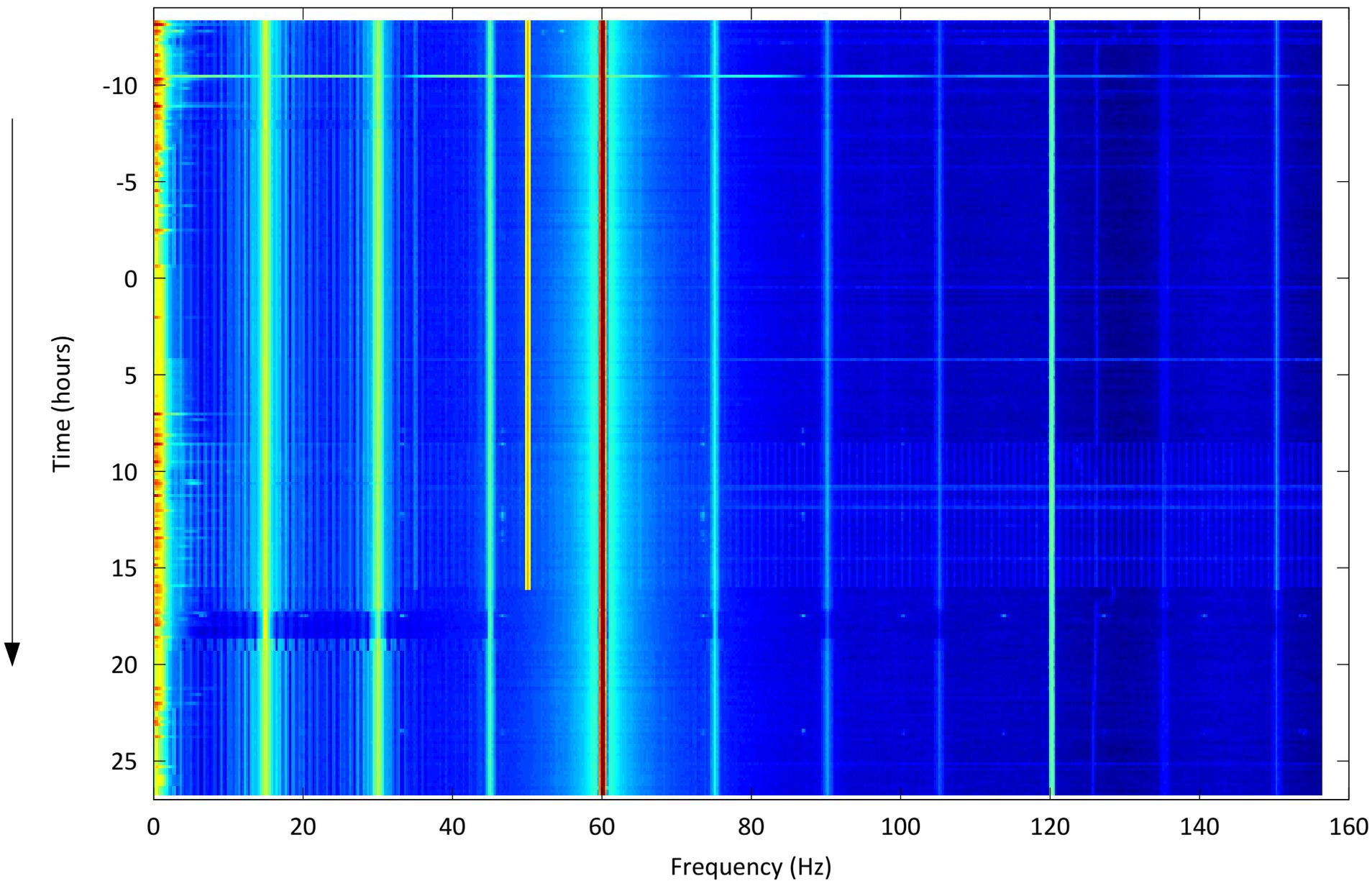
# Fermilab data

- Take data at **A0** experimental hall with 8 MW working klystron -- worst case?
- Take data inside the office building (Industrial Central Building at Fermilab) – best case?
- Look for day/night and workday/holiday variability.



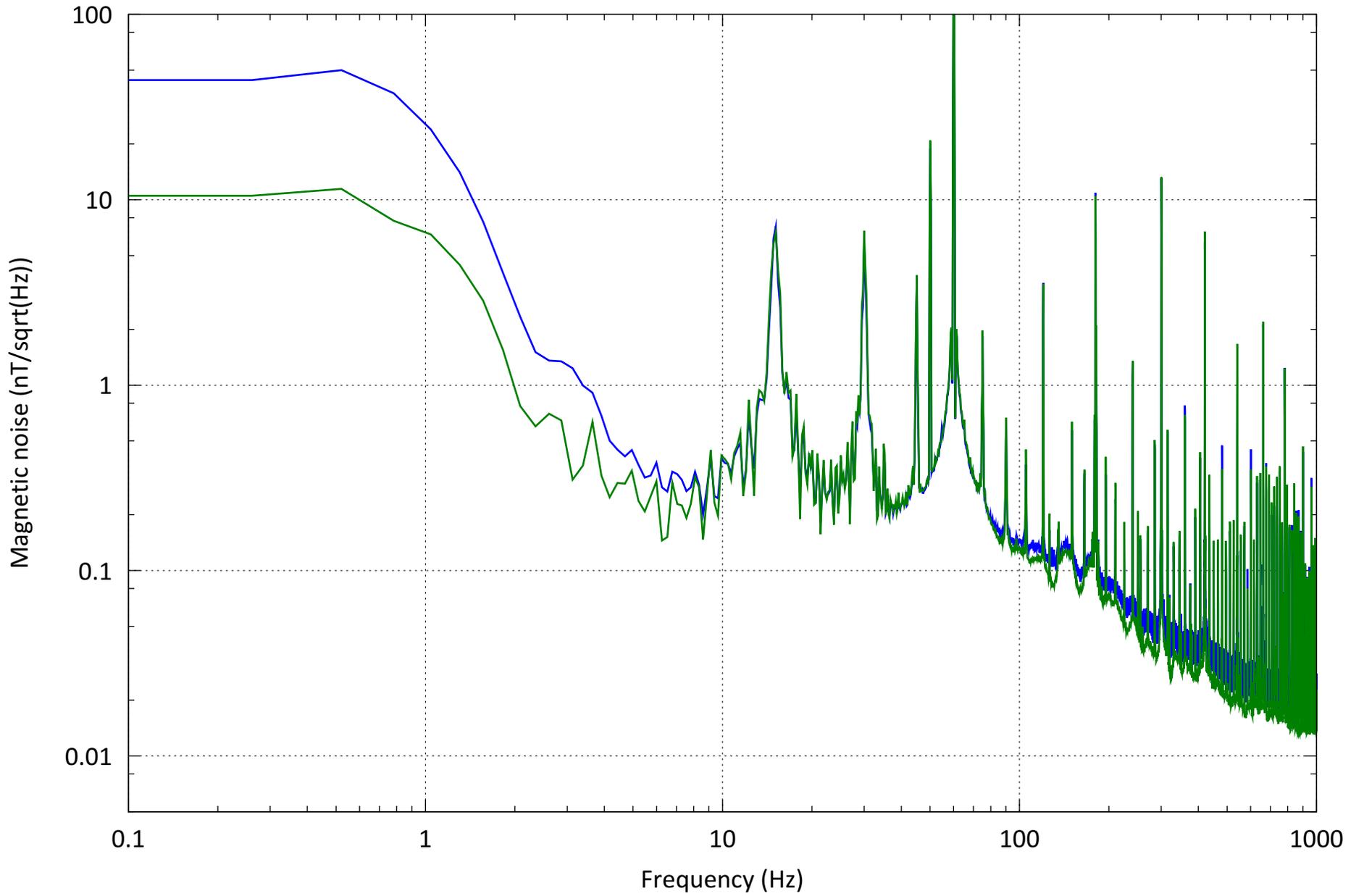
“A0” experimental hall.

(A0) magnetic noise spectrogram. 2009.04.10



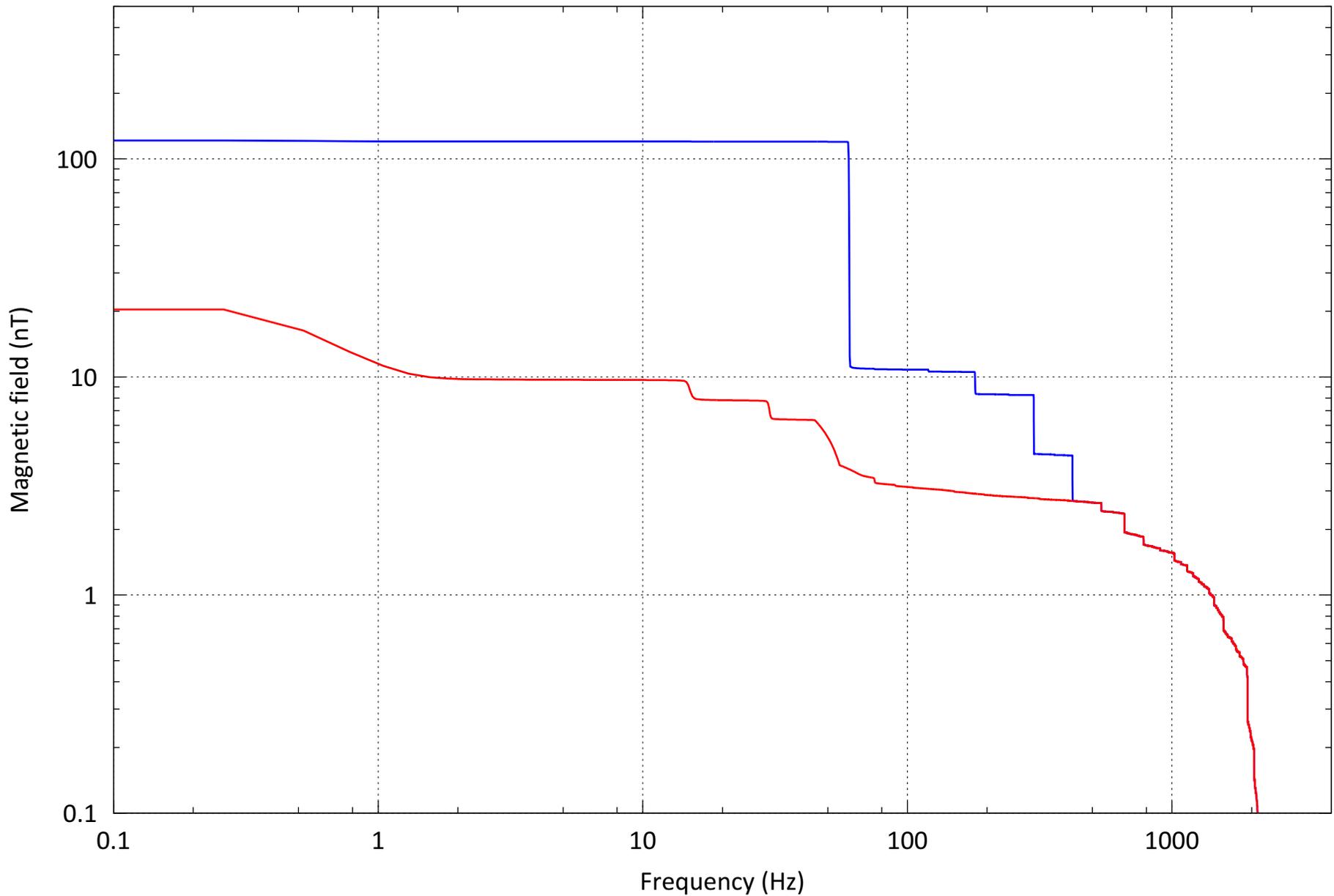
"0" on time axis: 00:00 on 2009.04.10 (Friday)

(A0) magnetic noise spectrum. 2009.04.09 (day/night)



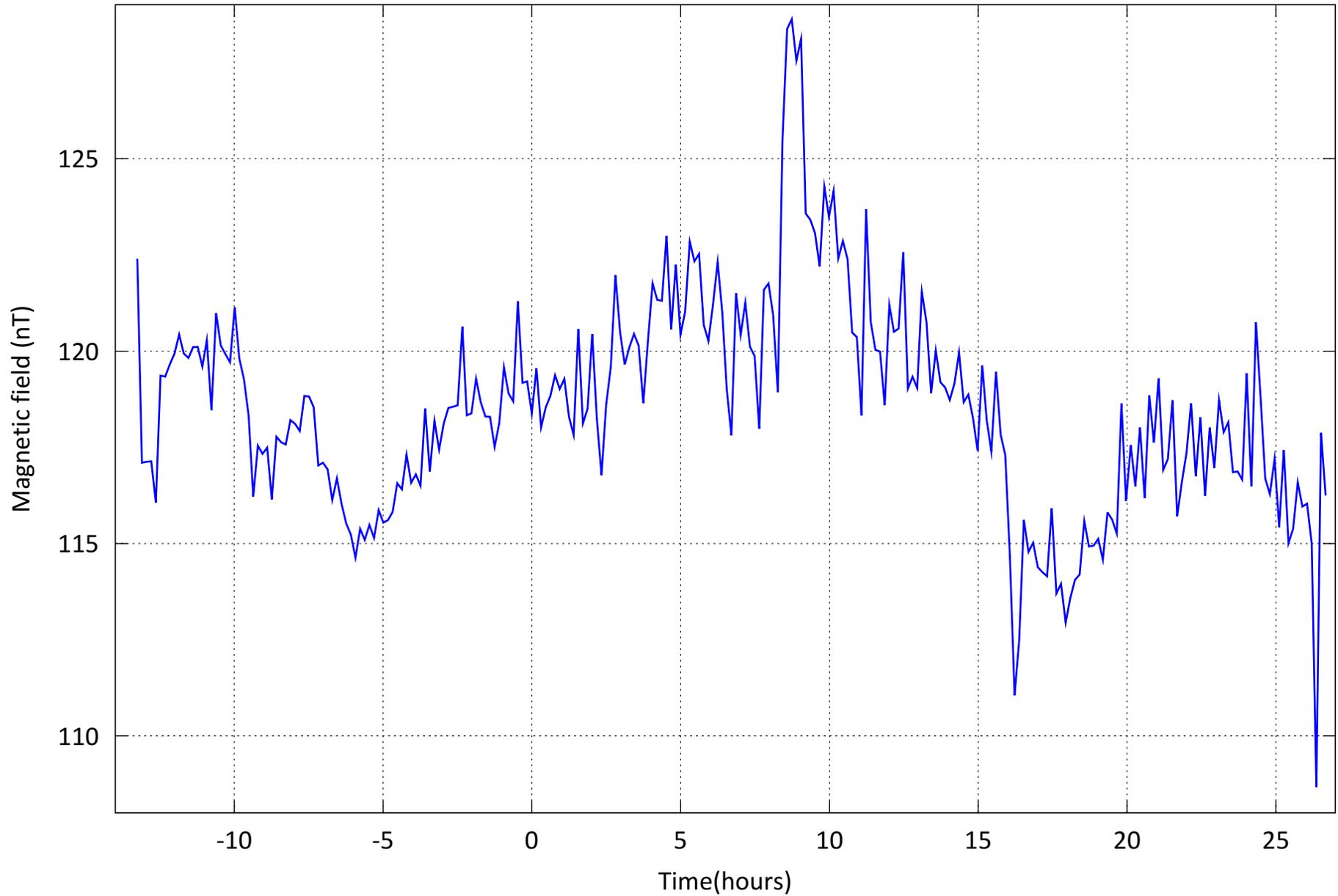
11am (blue) vs 11pm (green) noise.

(A0) Integrated magnetic field. 2009.04.10



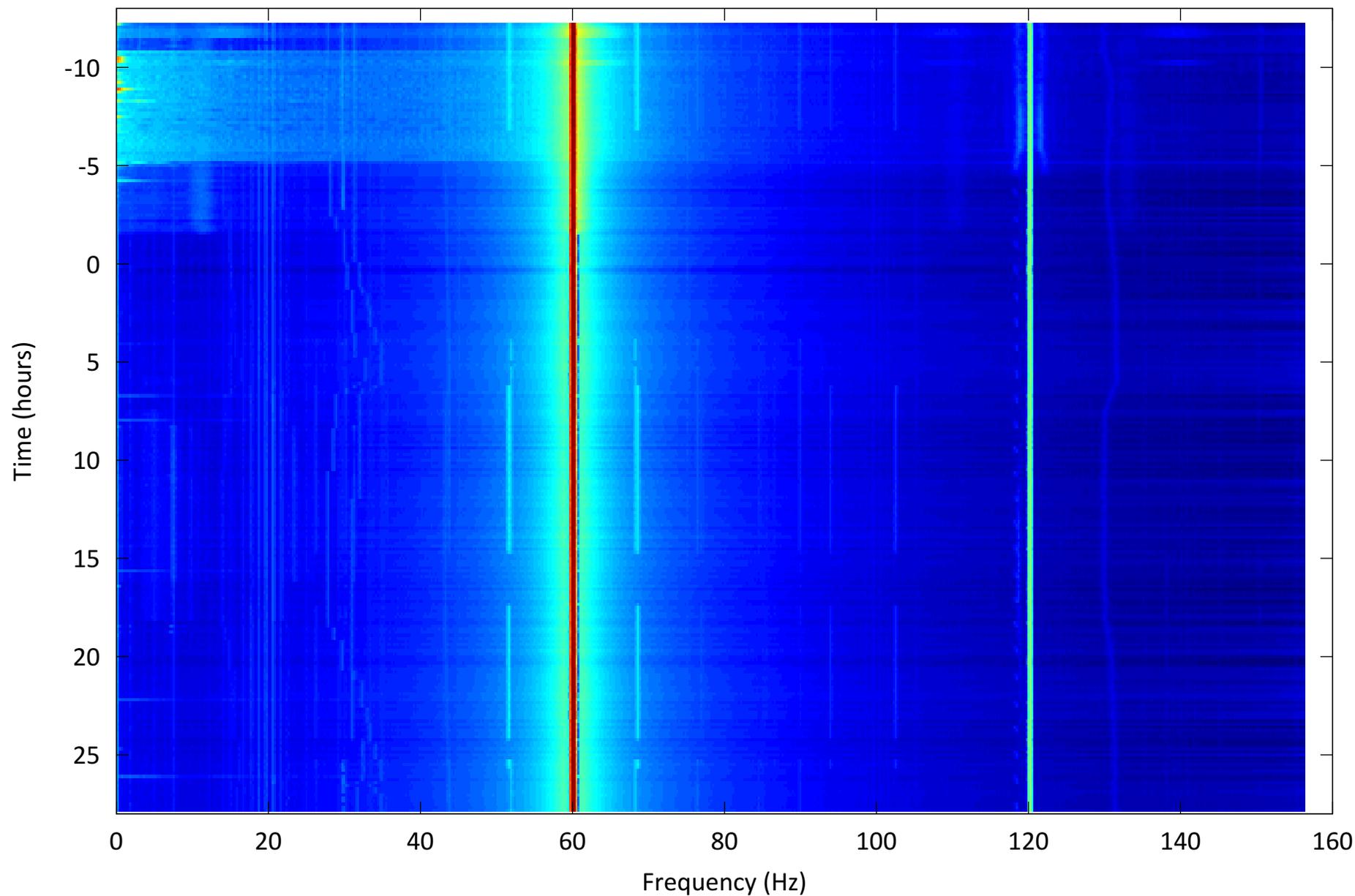
RMS integrated, 24h-averaged noise spectrum. Blue – original, red – with 50 Hz, and 60Hz and its harmonics removed.

(A0) 60Hz amplitude variation ( $\pm 5$ Hz). 2009.04.10



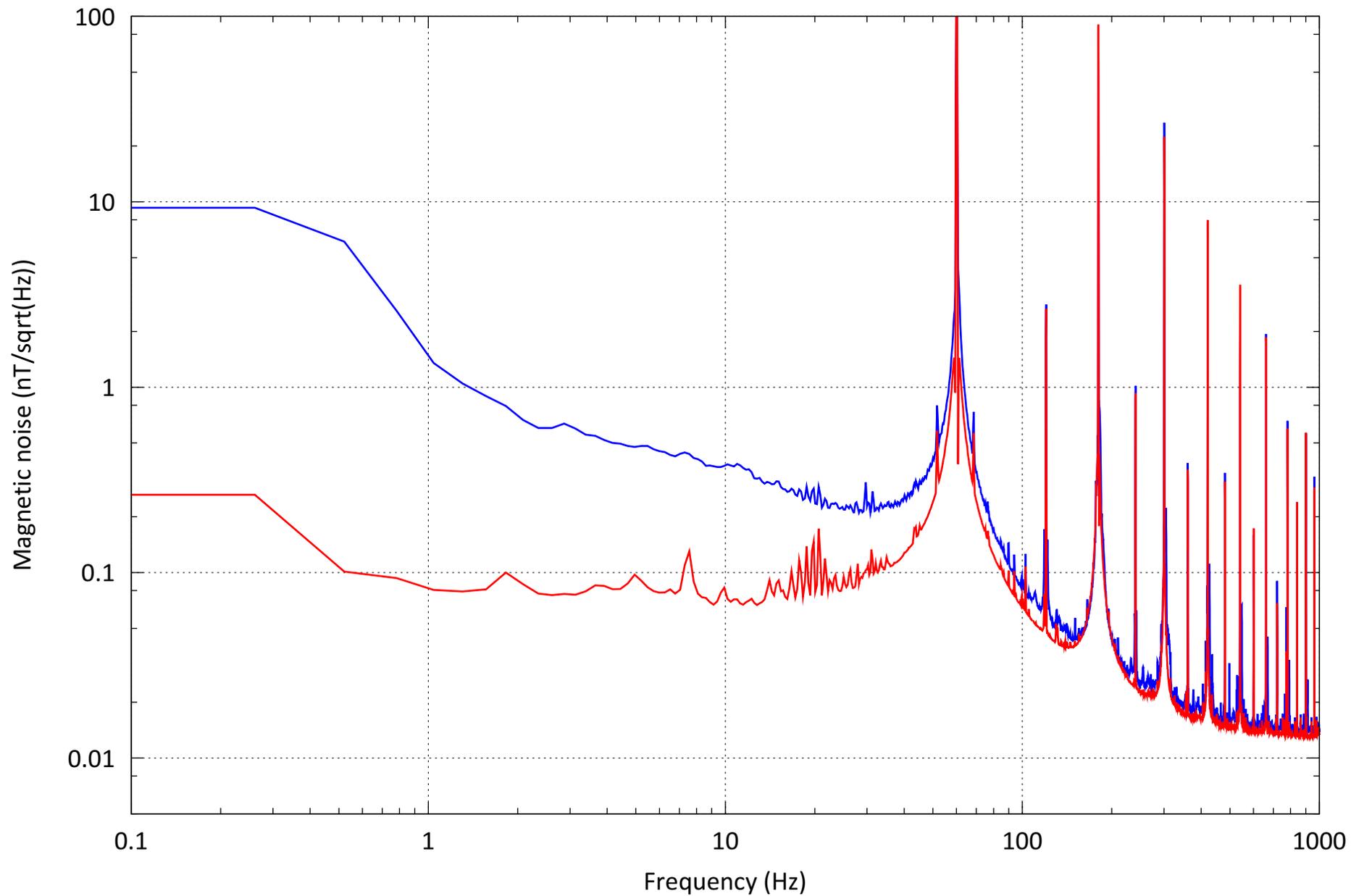
60Hz signal shows weak, if any, 24-hours periodicity. Surprise?

(ICB office) magnetic noise spectrogram. 2009.06.20



“0” on time axis -- 2009.06.20 00:00am (Saturday)

(ICB office) magnetic noise spectrum. 2009.06.19/20 (Friday/Saturday)



Blue – Friday, red -- Saturday

# Conclusions

- Human activity seems to result in broadband noise increase in 0 to ~80 Hz range. Its origin is not understood.
- Amplitude of 60 Hz remains fairly stable (+/- 5%) throughout the day.
- Required 10 nT rms field attainable only marginally.
- Need more data (different locations)!
- Need to look at shielding options (mumetal shield? soft-iron RTML pipe? )