MEASUREMENTS OF STRAY MAGNETIC FIELDS AT CERN FOR CLIC

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INTRODUCTION

- Stray magnetic fields (SMFs) are **external dynamic magnetic fields**. These lead to:
  - A beam-beam offset at the interaction point.
  - Emittance growth.
- Simulations show the Compact Linear Collider (CLIC) [1] is sensitive to SMFs **O(nT)** [2].
- Sources of SMFs are classified as:
  - **Natural** - e.g. Earth's magnetic field. Discussed in [3].
  - **Environmental** - Man-made objects that are not elements of CLIC.
  - **Technical** - Elements of CLIC.

MAGNETIC FIELD SENSOR

- A commercial 3-axis fluxgate magnetometer (Mag-13Z [4]) was used for measurements.
- Specifications:

Technical Parameter	Value	Unit
Frequency range	0-1	kHz
Noise level (at 1 Hz)	< 7	pT/√Hz
Resolution (24-bit DAQ)	6	pT
Magnetic field range	±100	μT

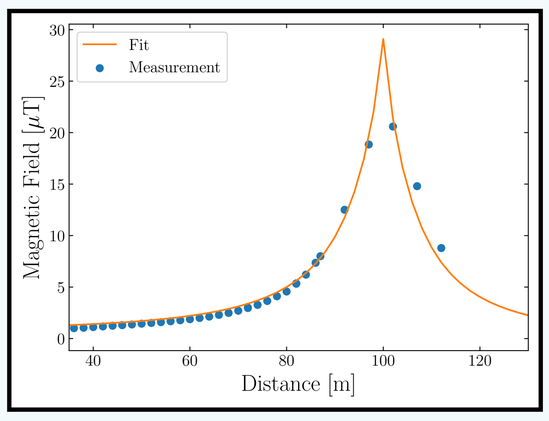
- The Mag-13Z was used with a 24-bit National Instruments DAQ (NI 9238).

ENVIRONMENTAL SOURCES

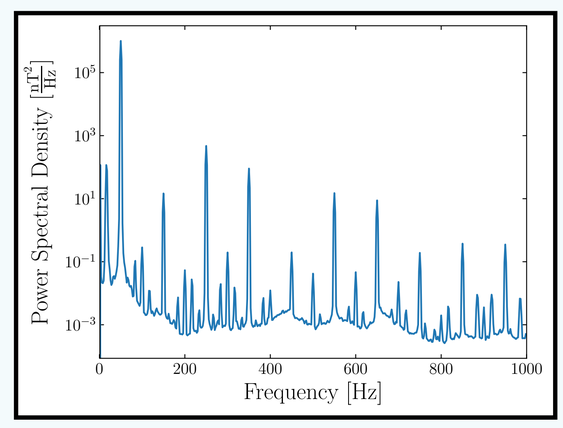
- **The Proton Synchrotron (PS):**
  - A regular pattern was observed in the magnetic fields near the PS.
  - Modelled as a ring of 100 equally spaced dipoles:

$$\boldsymbol{B}(\rho_i) = \frac{C_1}{(\rho_i + C_2)^3}\left\{\frac{3}{2}\hat{\boldsymbol{\rho}}_i - \hat{\boldsymbol{z}}\right\}$$

$$B(r) = \left|\sum_i \boldsymbol{B}(\rho_i)\right|$$

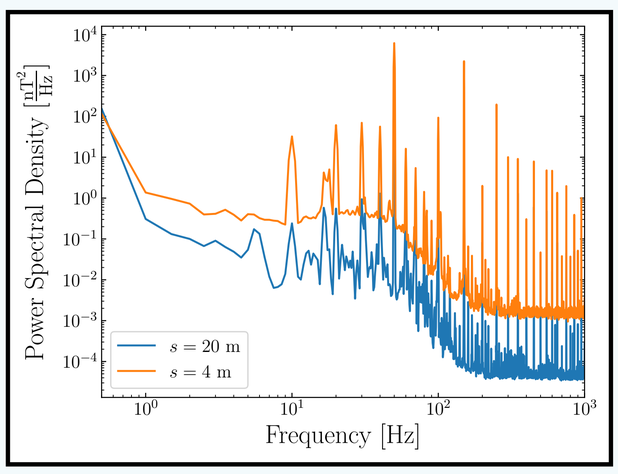


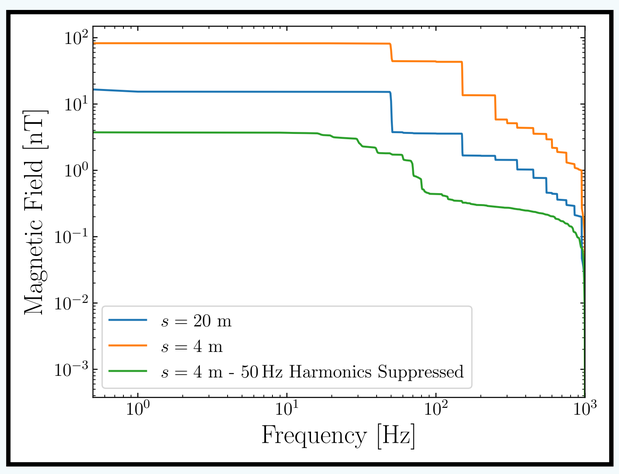
- **The Electrical Grid:**
  - The magnetic field directly under power lines on the CERN site was measured:
  - Load is domestic consumption in Switzerland.
  - Largest contributions are from odd harmonics of 50 Hz.



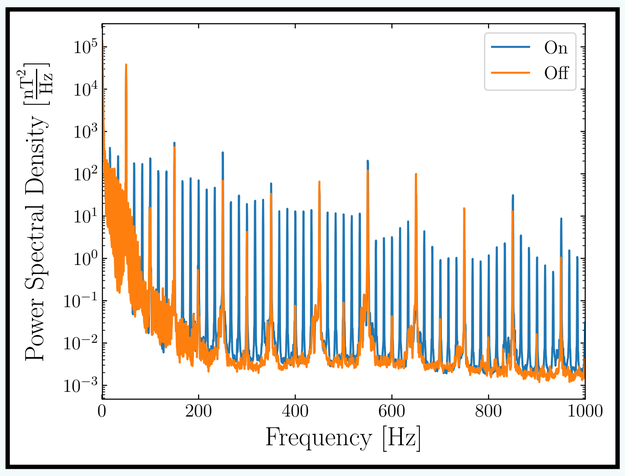
TECHNICAL SOURCES

- **CERN Linear Electron Accelerator for Research:**
  - Represents a CLIC-like beamline.
  - Measurements are without beam and RF.
  - ~5 nT remains with 50 Hz harmonics suppressed.





- **XBOX-3 Test Stand:**
  - Performs R&D on CLIC accelerating cavities [5].
  - Klystrons and modulators were operating at 16.7 Hz.
  - 16.7 Hz harmonics in the spectrum are due to the modulator recharging.
  - In CLIC the modulator will be operating at 50 Hz.



CONCLUSIONS

- Several environmental and technical sources have been identified and measured.
- SMFs at 50 Hz and harmonics appear static because the repetition rate of the beam is 50 Hz.
  - Majority of SMFs from the electrical grid and modulators are suppressed.
- The SMFs measured at CLEAR can be effectively mitigated with passive shielding [6].

REFERENCES

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