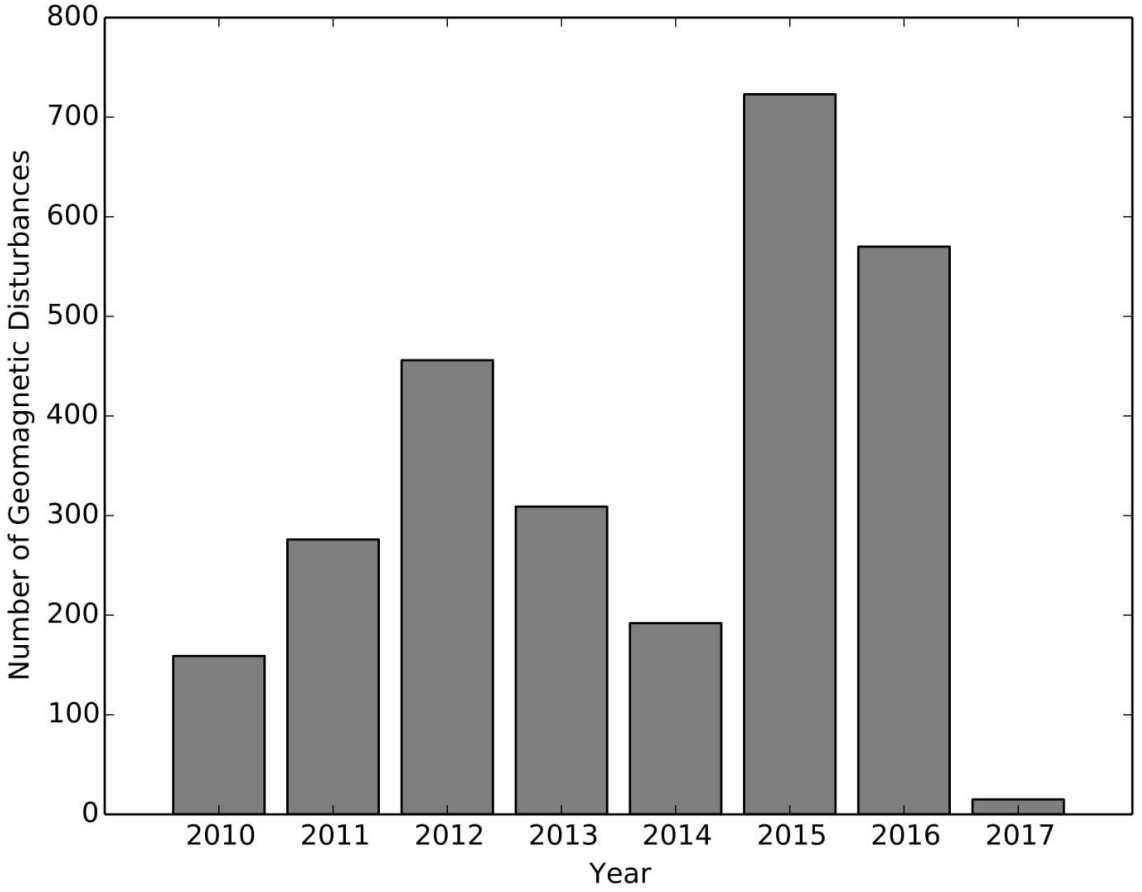
Studies of Magnetic Field Effects in Accelerator Environments and their Implications for Accelerator Performance

C. Gohil

JAI, University of Oxford, Oxford, OX1 3PA, UK

Geomagnetic Storms

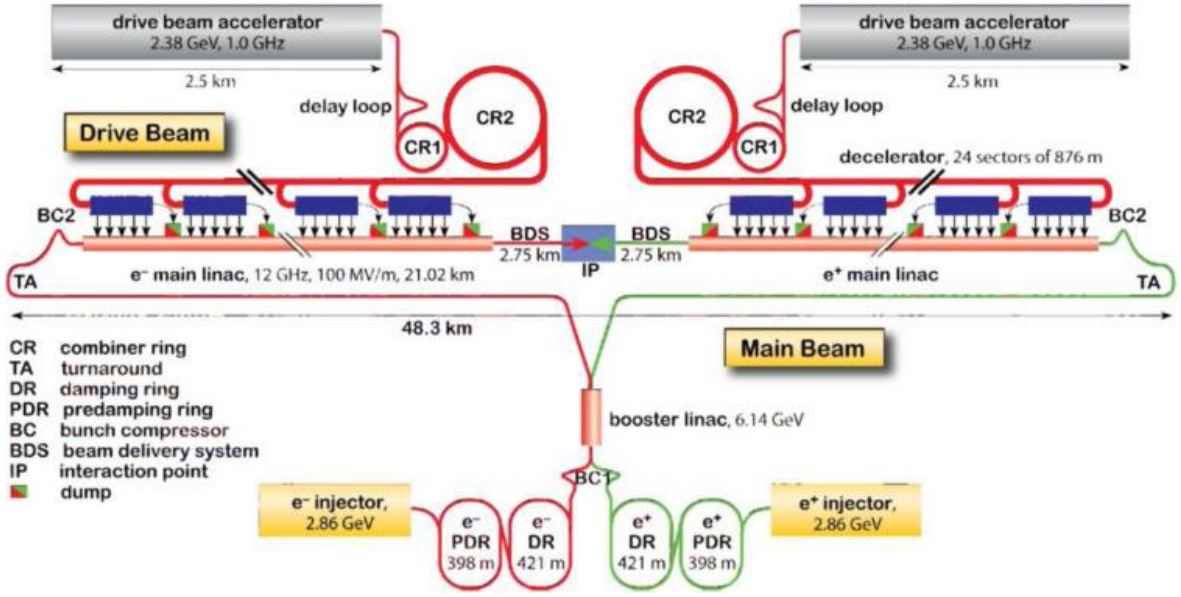
- External dynamic magnetic field source.
- Caused by solar activity.
- Characterised by the Kp-index.
- Any effect on collider performance should be correlated with the Kp-index.
- Geomagnetic storms with $Kp \geq 4$ disturb the geomagnetic field.
- Disturbances O(100 nT).



The Compact Linear Collider (CLIC) and the Large Hadron Collider (LHC)

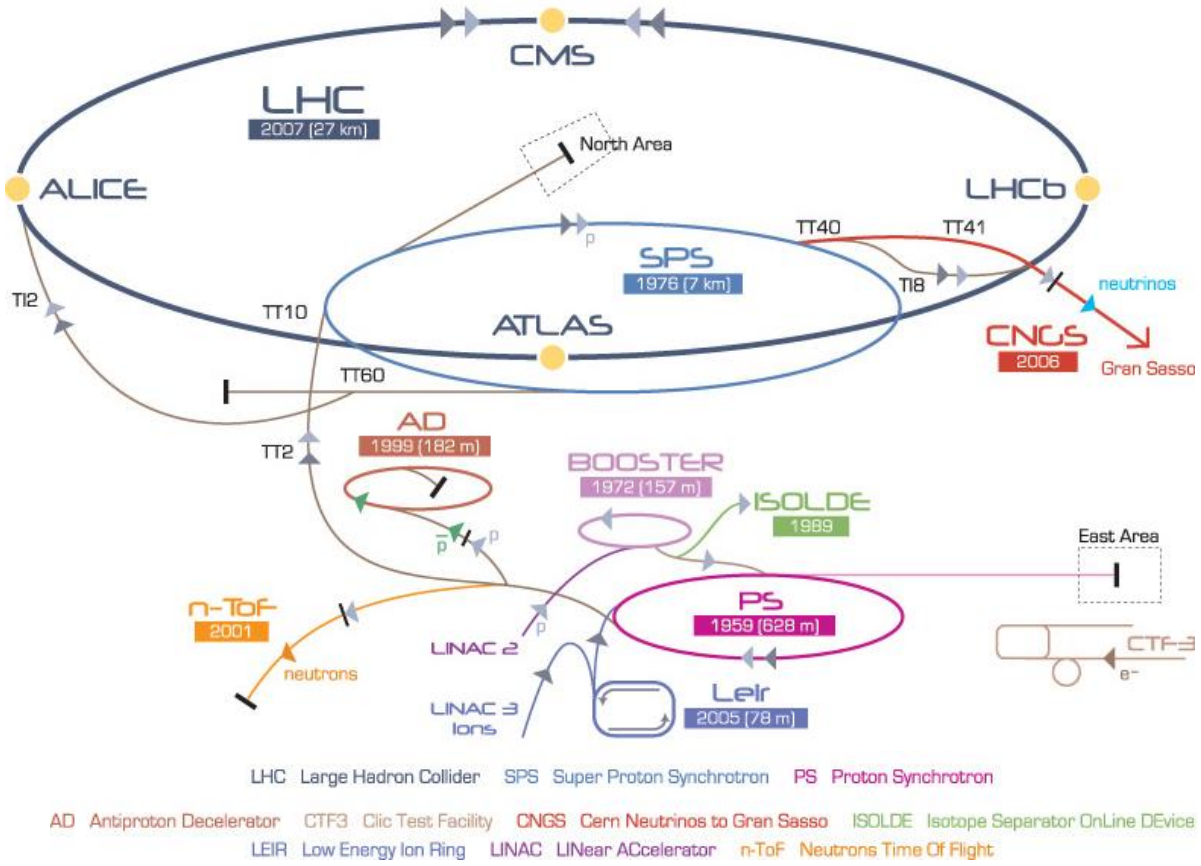
CLIC:

Proposed 3 TeV linear e^+e^- collider.



LHC:

13 TeV circular pp collider.



Luminosity

$$L = \frac{N_1 N_2 f N_b}{4\pi\sigma_x\sigma_y}$$

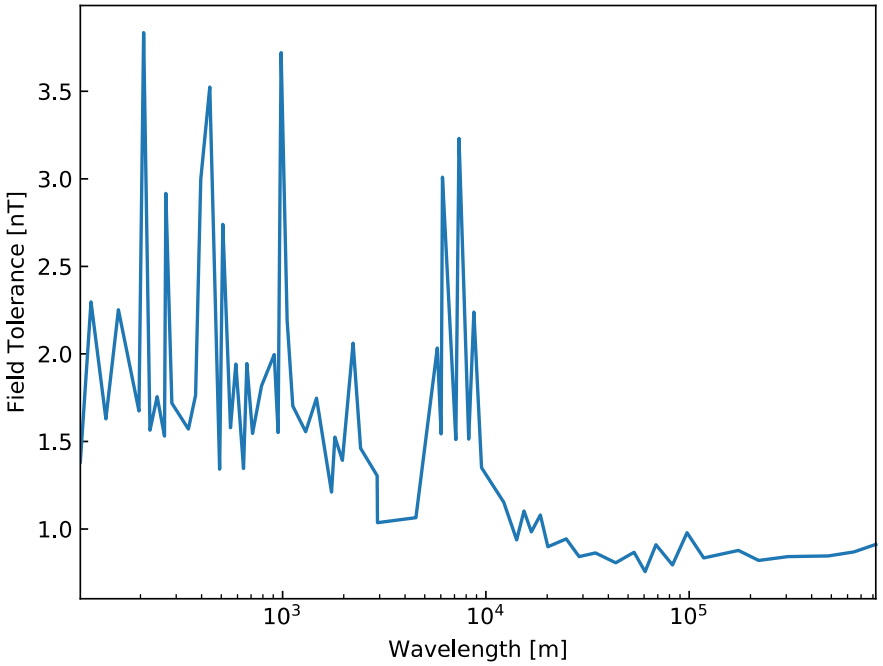
- $N_{1,2}$ = number of particles in each bunch.
- f = repetition or revolution frequency.
- N_b = number of bunches.
- $\sigma_{x,y}$ = horizontal and vertical beam sizes.

	Luminosity ($cm^{-2}s^{-1}$)
CLIC	6×10^{34}
LHC	10^{34}

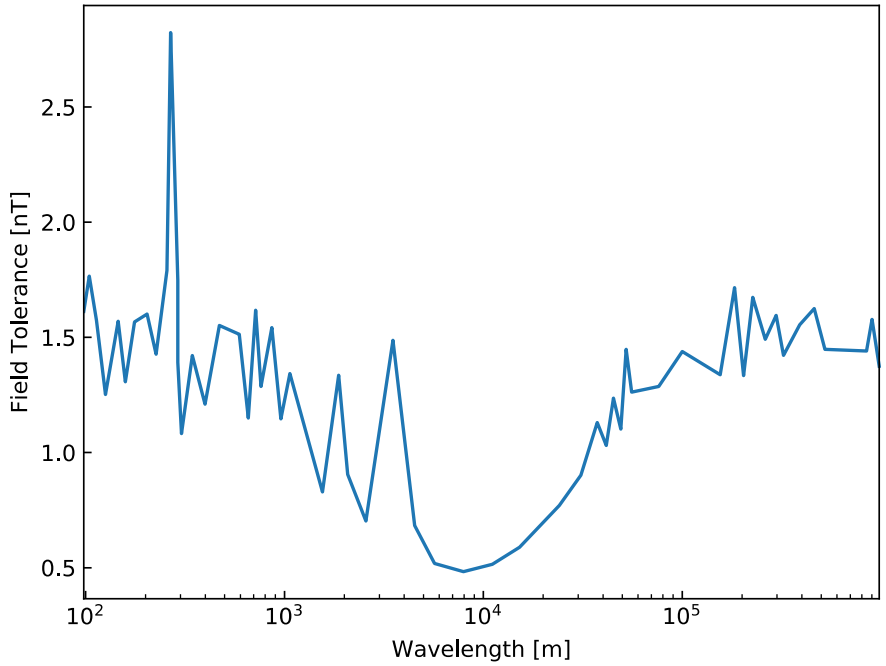
CLIC Simulations

- Simulations were done by J. Snuverink *et al*.
- They show the magnetic field strength that leads to a 2% loss in luminosity.

BDS

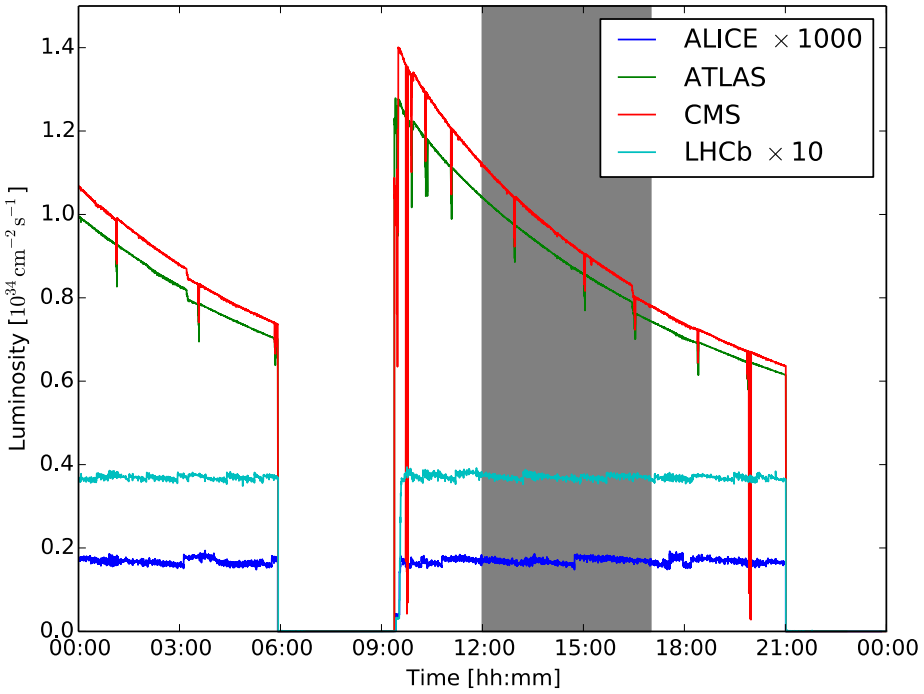


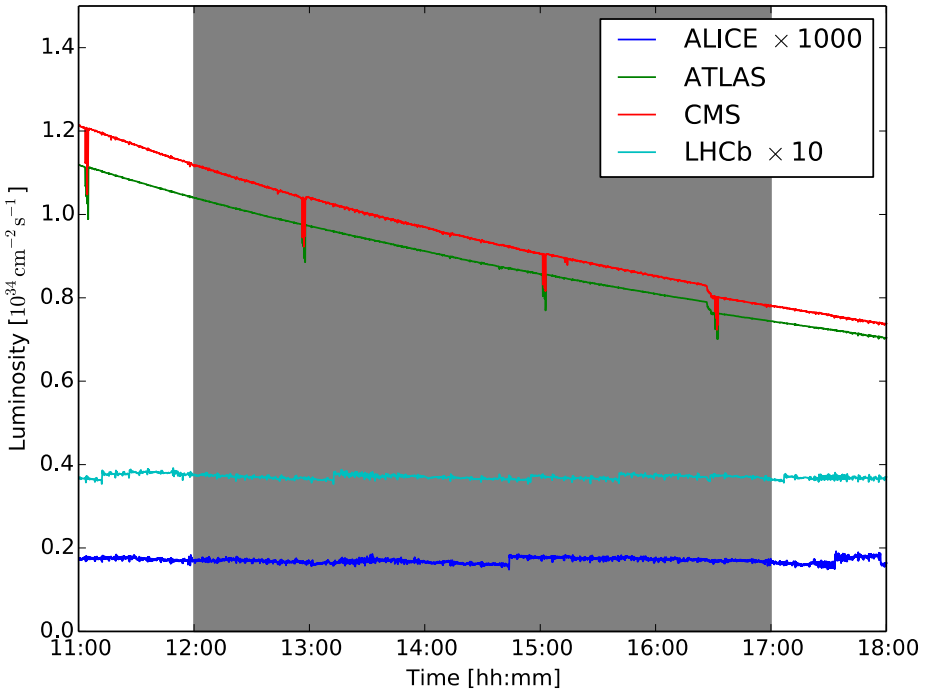
Main LINAC



- Geomagnetic disturbances cause magnetic field variations O(100 nT).

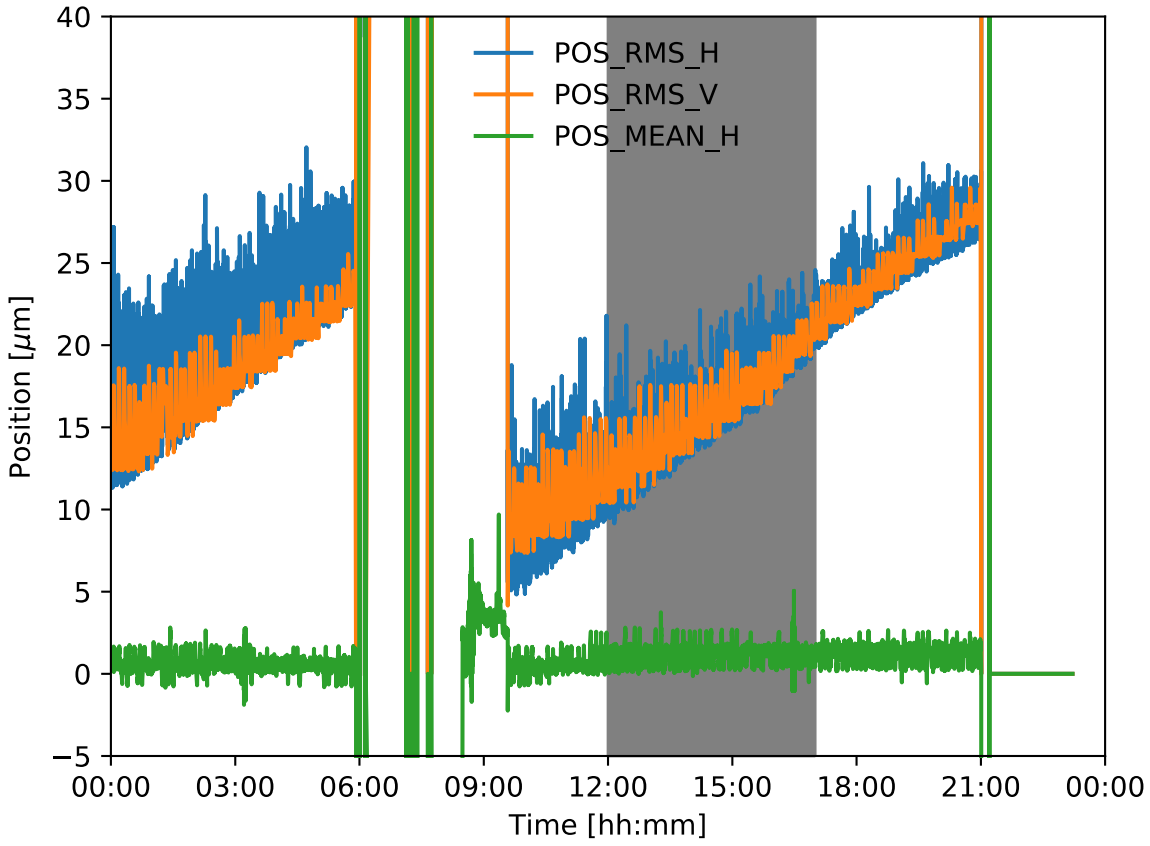
LHC Luminosity





- Luminosity of the 4 LHC detectors on the 25th October, 2016.
- Grey areas are Kp=6.3.

LHC Beam Size



- LHC beam sizes on the 25th October, 2016.
- Grey areas are Kp=6.3.
- Each BPM measures a closed orbit position.
- The precision of the BPMs in the LHC is 5 microns.
- Fluctuations are O(5 microns).

POS_RMS	Root-mean-square of the BPM Measurements
POS_MEAN	Mean of the BPM measurements

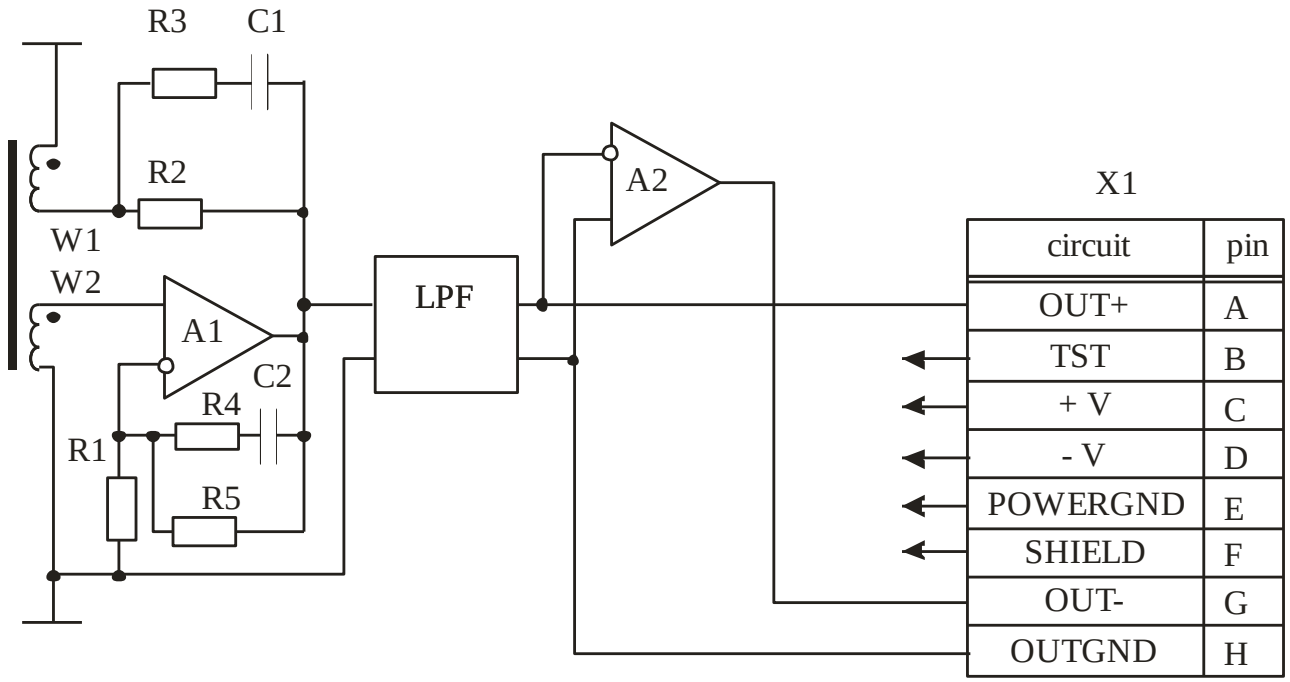
Future Work

Stray Magnetic Fields

- Geomagnetic disturbances represent one kind of external dynamic magnetic field (stray field).
- Other stray field sources specific to CLIC are:
  - The drive beam.
  - Near by equipment, e.g. RF systems, vacuum systems, power cables.
  - External sources, e.g. railways, power lines.
- Measurements of stray fields at CERN are planned.

Stray Field Sensor

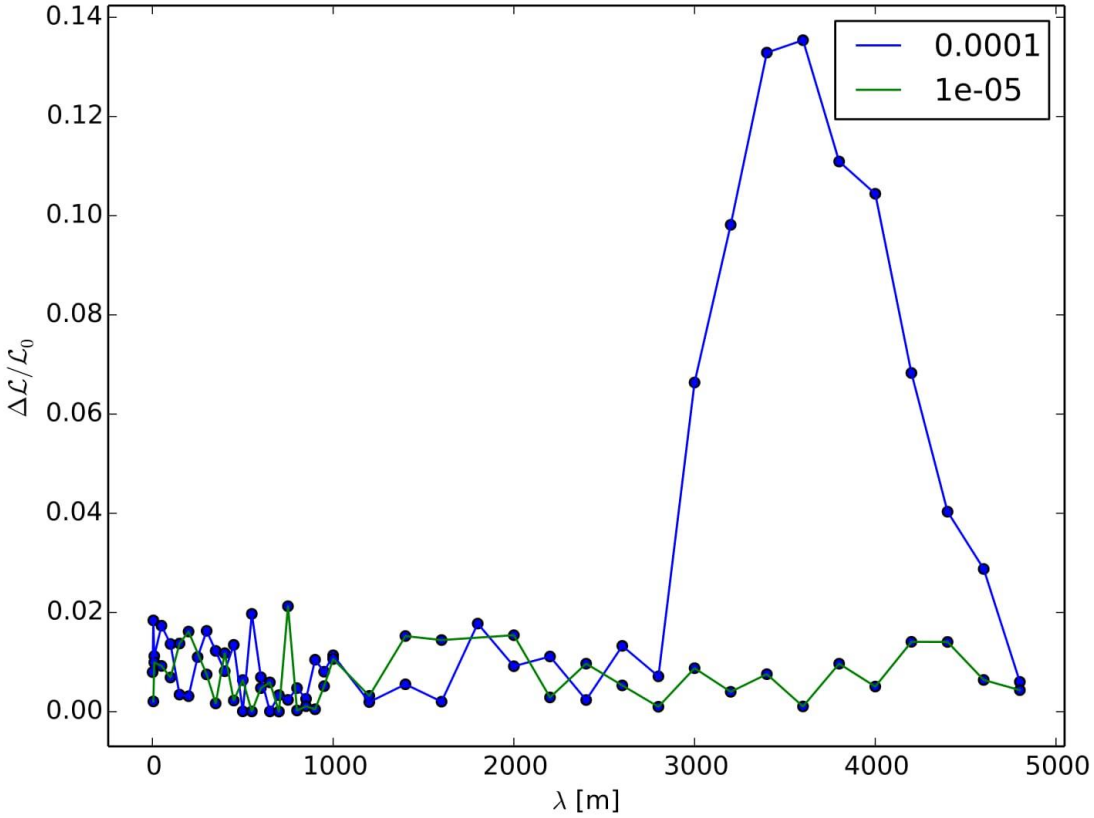
LEMI-144 induction magnetometer



Simplified functional diagram

Further Simulations

- The simulations done by J. Snuverink examined the 3 TeV design.
- Looking at the RTML transfer line sensitivity of the 380 GeV design.
- Stray fields with amplitudes less than 0.1 mT do not disturb the collider performance.



Future Measurements and Simulations

- A measurement campaign at ELANA is planned.
- With this data more detailed simulations of stray fields can be written.
- From the results of the simulations mitigation techniques for the effects of the stray fields will be developed.

Thank You.

Questions?