Reeferee #1

1.

The manuscript does not clearly contrast its method with standard compensation coil techniques used in cold atom experiments. How does this approach compare to three-axis compensation coil setups typically used in ultracold atom systems?

So far three-axis compensation coils have not been used to compensate noise at high magnetic field. They have been used more to compensate for ambiental noises, while our approach uses a single compensation coil to compensate for both current noise and external noise.
No need to add informations on this in the intro. Possibility to adjust the intro to make it clearer.

2.

The authors claim their method is simple and effective, but they do not discuss its potential drawbacks. Are there frequency ranges or experimental conditions where it fails? What are the trade-offs compared to direct PID feedback on the main coil current?

BW set to be optimized for the noise he have.

3.

The manuscript reports an impressive stability level (~64 microG rms), but it is unclear whether this is sufficient for the most sensitive precision experiments, such as narrow-line optical clocks or quantum sensing. What is the fundamental limit of this method?

Direct limtations are the sensor and the reference (this may be ubgraded). Precision of the sensor may be better doing more tuns. We could add a comment when we give all the numbers of noises (table in the paper). Limits come also from mechanical and thermal instabilities: we do not compensate for them.

4.

The authors describe using additional small coils to cancel unwanted mutual induction effects, but the method for optimizing these coils is vague. How precisely was mutual induction cancellation tuned? Could this lead to unintended effects over time?

Accuracy for mutual induction compensation is in a few % (we do like 10 turns for the coil and then the fine adjustments for different frequencies are obtained by adding(removing half a turn). Typical BW from 1 to 1 kHz.
Be more explicit on the procedure for the compensation of induction: modulation of the big coils current + monitoring of the voltage in the compensation circuit. Maybe add also a comment on the fact that if the indiction is not well compensated we see more noise in the voltage output signal.

5.

The manuscript states that a nearby gaussmeter was used to compensate for external field drifts. However, the effectiveness of this compensation may depend on the spatial variation of the ambient field. How well does the external field at the gaussmeter position correlate with the field at the atom location?

It may be better to state in the text that at first we compensate for 50 Hz and then we take care of ambient noise. (+ footnote on the fact that correlations to ambient noise were not too much sensitive to the gaussmeter position)

6.

The study provides data over a two-hour timescale, but many cold atom experiments require stability over much longer durations (e.g., several days). Have the authors tested long-term drift, and how does it compare to passive shielding approaches?

Modify a bit the sentence in the conclusions (no need to change it a lot). Noise can be further reduced if one improves mechanical and thermal stability. Mechanical and thermal stability are indeed not corrected at all and so this can also be seen as a drawback of our comensation strategy.

7.

The authors mention that their compensation system had to be moved to another room to avoid interference from radio-frequency (RF) fields used in the experiment. Does this imply the method is sensitive to RF noise? How would it perform in experiments that require in-situ electronics?

Be more explicit in saying that the most sensitive element to RF was the main power supply.

8.

The optimal gain for the compensation circuit is set by minimizing sensitivity to a small intentional offset. However, a 1% uncertainty is reported. How does this impact

the final field stability? Would an adaptive tuning method improve performance?

The final gain is set up to a 1% of uncertainity, however this is sufficient to not limit the overall efficiency at the end. One might do better if necessary.

Referee #2

The manuscript presents an electronic technique which enhances the stability of the magnetic field produced by a commercial 20A current source, by comparing the current sensed with a current transducer with a stable current reference, and feeding forward a correction signal to a much smaller (and hence more agile) auxiliary coil. Stability is shown to be enhanced by repeated Ramsey measurements of the total bias field.

The work will be interesting to researchers in cold atom, and potentially some other, areas of research where relatively heavy currents (several amps and above) are required to produce substantial bias fields on the mT scale. The work is appropriate for Rev Sci Instrum, and should be suitable for publication if some clarifications and additional details can be provided.

As written the initial section is hard to follow, because the presentation (and indeed the experiment) combines what appears to be feedforward correction of current source errors, with a separate feedforward compensation of ambient field, while elsewhere using language which suggests that a feedback controller has been implemented. This could be clarified by using the terms "feedforward" and "feedback", rather than drawing a distinction between PID control and P-only control. The authors should make clear that the initial discussion is entirely about stabilizing the current of the HighFinesse supply, and only later is an external field sensor added to the system to effect an additional stabilization of the field realised by the stabilized current flowing in the coils. Because the fluxgate field sensor is remote from the coils, it too generates a feedforward correction signal (presumably of ambient fields due to distant sources), and is not (much) affected by the coils. Hence there is no 'feedback' in the system, necessitating precision tuning of gains to achieve accurate cancellation, but avoiding the challenge of loop-shaping a feedback controller.

The description of the noise spectrum of the bias coils as "broad below 1kHz" is vague. Conventional terms for broadband noise include "white", "pink", "red", "blue" etc for power spectral densities with various slopes. Alternatively, a noise power spectral density estimate could be presented.

Once it is understood by the reader that the core idea here is to impress upon a commercial current source, the remarkable and unanticipatedly low noise and high stability of the LEM current sensor, the question does arise as to why this cannot be achieved by feedback to the analog control input of the current source. This is answered in footnote 27, but this should be in the main text.

It is also incorrect to say that the subtraction of currents at the input to a transimpedance amplifier "avoids the addition of electronic noise". While current-mode signal processing such as this is elegant, and Kirchoff's law is exact, the Johnson (current) noise of the 100ohm resistor, and the 1kOhm transimpedance add to the current fluctuation signal from the LEM sensor, as does the input-referred current noise of the opamp. The basic parameters of the 17kHz notch filter should be given.

One innovation that should be of interest to workers in the field is the cancellation of mutual inductance between the primary and auxiliary coils, by the addition in series of an additional pair of coupled coils, one to each supply. However, the explanation of this does not explain whether the cancellation of mutual inductance was obtained at a single frequency, or at multiple frequencies, or which frequency(ies) were tested. It should also explain between which two points the oscillating voltage was measured.

Finally, when discussing the compensation of external magnetic noise, the authors note that 50Hz and harmonic fields are not well cancelled due to their variation between the location of the fluxgate sensor and the atoms. The authors may have the recent demonstration of feedforward cancellation of 50Hz and harmonics by in-situ measurement of the line harmonic time series by a continuous dispersive measurement on the cold atoms themselves (Phys. Rev. Applied 22, 024047, 2024).

1.

Instroduce the noise compensation method as a "feedforward" method.

"The authors should make clear that the initial discussion is entirely about stabilizing the current of the HighFinesse supply, and only later is an external field sensor added to the system to effect an additional stabilization of the field realised by the stabilized current flowing in the coils."

I believe it would be clearer indeed if in the final paragraph of the intro we add a sentence like: In the following sections, we first describe the stabilization of HighFinesse current. This is followed by the characterization of the performance doing ramsey spectoscopy. In section IV there will be additional stabilization of the ambien filed...

2.

"The description of the noise spectrum of the bias coils as "broad below 1kHz" is vague."

Add more precice sectription of the noise spectrum in the range 0 to 1kHz.

3.

Footnote 27 should be in the main text.

4.

"It is also incorrect to say that the subtraction of currents at the input to a transimpedance amplifier "avoids the addition of electronic noise" josephson noise 0.3 microG Josephson noise 10% lower then sensitivity

"The basic parameters of the 17kHz notch filter should be given." T shape notch

look at reference 31 in paper Phys. Rev. Applied 22, 024047, 2024

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