

Responses to reviewers for Metcalf and Flowers. Author responses in blue.

We wish to thank the reviewers for such a detailed and helpful critique of the manuscript. We've responded to each point individually below, and believe the changes have greatly improved the manuscript.

RC1: '[Comment on egusphere-2025-6263](#)', Stephen Cox, 02 Jan 2026

This manuscript describes the established procedure for design and construction of a helium measurement system for (U-Th)/He analysis using a ^3He spike and a QMS originally intended for use as an RGA. Surprisingly this has not been written up anywhere as far as I know, so this is a valuable contribution. The link to the intended use for laser ablation analysis is incidental to the content of the manuscript, so I do not address it further in the review. I limit my comments mostly to places where I think the utility of the manuscript would be improved by additional discussion, consideration of alternatives or complications, and presentation of measurements or data associated with the topic under discussion. I think there are several places where the manuscript needs such changes in order to truly serve as a blueprint for someone setting up a noble gas mass spectrometry lab without access to existing facilities, which is the goal stated in the introduction. I encourage rapid publication once these minor revisions have been considered.

Section 2.2 and other places pressures are mentioned

The only way to calculate the pressure in one of these vacuum systems is using the mass spectrometer. I think it would be instructive to include such a calculation to show how deep into UHV one really must be to make good noble gas measurements.

Author Response: This is a good point, we included the absolute line pressure in the measurement chamber as measured by the mass spectrometer.

Pumps, getters, and gauges (section 3.5)

Why these pumps? For a vacuum system dedicated to helium measurements, why choose a turbo pump with such a poor He compression ratio? And more important, why these getters? Why stray from the conventional choices, and what considerations or cautions should be given to other people building vacuum lines for noble gas analysis? Which ones are run hot and which at room temperature? How hot, and why?

Author Response: Although the compression ratio and pumping rate that Agilent quotes for their turbo pumps are lower than some other models, in our experience the actual speed of pumping out a line doesn't vary significantly between Agilent and other brands of pumps (e.g. Pfeiffer). This may have to do with the conductance of the line being the limiting factor, but we decided based on experience to not use Pfeiffer pumps and instead stick with Agilent based on

our experience using and maintaining them, cost (CU has a purchase agreement with Agilent), and communicability (in general, in my experience, communicating with Pfeiffer equipment is difficult). We added more text explaining our thought process on purchasing items.

What problems have been observed (line 214) with having a turbo pump directly connected to the vacuum line, or is this just speculative? What about the problems that arise from having the high surface area of a flexible tubing in the UHV system?

Author Response: As long as the high surface area is on the pump side of the valve the effect seems to be minimal, however future plans do include shortening many of the flex hoses including to the turbo pump. In terms of problems, when the turbo was connected directly to the frame during early line development vibrations could be felt throughout the frame. This was before the mass spectrometer was being used, but we decided to avoid the potential problem. We clarified in the text that this is not a speculative statement but we actually observed the vibrations.

Bakeout is briefly mentioned in the tank filing procedure, and bakeability is mentioned in section 2.2, but bakeout procedures and the limits imposed on hardware choices by baking probably deserve further discussion somewhere.

Author Response: Excellent point. All of the vacuum components, with the exception of the sapphire laser window, were chosen to be bakeable to 250 °C. The line was baked out using an integrated power source and temperature controller, fiberglass heating tapes, and aluminum foil. We expanded this section in the revision.

Quadrupole choices and performance claims (sections 3.6 and 6)

I agree that the Hiden 3F is a good choice for this application, but I did not learn much about it from the manuscript. The brief section 3.6 asserts that the Hiden has a higher sensitivity than "other QMSs often used in (U-Th)/He labs," but it does not show any comparison data or even state the sensitivity of the Hiden 3F or how it was determined. The summary (section 6) mentions sensitivity numbers in V/fmol that are not previously shown elsewhere in the manuscript. Sensitivity, abundance sensitivity, and detection limits are frequently conflated in QMS advertising literature. The authors should show measurement data, discuss important considerations like source configuration, measurement conditions, and duty cycle, and deconvolute volume and mass spectrometer sensitivity in the discussion of instrument choice.

Author Response: Excellent points. Much of the data on mass spectrometer sensitivity comes from the literature provided by the various manufacturers, and we will provide the manufacturer-quoted sensitivity for the Hiden 3F in the revision. We removed the sensitivity numbers in V/fmol in section 6.

We feel that comprehensively addressing sensitivity, abundance sensitivity, and detection limits of the Hiden and other comparable QMS's using measurement data and a thorough discussion of all the considerations are beyond the scope of this manuscript.

The specifics of the Hiden 3F and the choice of two QMS instruments also deserves additional consideration. Was this really just made because the lab already had the SRS instrument on hand? What customization was required to measure up to mass 20 in a way that affects the resolution of the He peaks, and why? Can we see said peaks? Why would these instruments have different sensitivities? Why plan to use the less sensitive one for CRH measurements?

Author Response: This section will be expanded to clarify the decision making process. The reason we chose the Hiden 3F is because it has higher sensitivity than other QMS instruments and comes with Labview drivers.

There are two main reasons that we decided to have a second QMS on the line, specifically for CRH method development. First, CRH analyses requires separate, high conductance tubing and gettering connecting the sample chamber to the mass spectrometer, and the QMS that is connected to that system can experience higher total gas loads than a typical "conventional" He line. There is some concern that regular exposure to these gas levels can raise blank levels and is a greater risk of damaging the QMS filaments. We decided therefore that especially during the developmental stage it would be beneficial to allow the Laser Ablation (Hiden) part of the line remain as clean as possible, while allowing experimentation on a less expensive system.

Second after discussions with Bruce Idleman (who developed the CRH hardware we are installing), we realized that CRH analyses require monitoring of a much larger mass range of contaminant gases than the Hiden is capable of (The Hiden has a 20 amu range). For these reasons we decided to install a relatively inexpensive SRS QMS.

We added to the discussion of these details in the revision.

UPS system (section 3.7)

Has the UPS system been tested? Section 3.7 (lines 244-246) provides a cursory mention of the backup capabilities of the UPS, but there is no test data provided. The UPS model listed in Table 1 is a consumer-grade line-interactive UPS. This type is meant for things like home computers and is typically avoided in instrument labs because they experience a delay in switching to battery power during a failure, and because the conditioning capabilities are limited compared to a double-conversion UPS. The authors should discuss this decision and show test data demonstrating that this UPS actually works to keep all of these sensitive electronics operating when stress tested.

Author Response: The UPS has been tested, the line has experienced power outages ~10 times since it began running and equipment continued running without issue for all but the longest (> 5 minutes) outage. We noted this in the revised text.

Section 3.7 also mentions that the backup compressor is on a UPS, but it doesn't list the model of either the UPS or the compressor. I wonder also if this setup has been tested. It would require a massive UPS unit to handle the inrush current of a starting air compressor motor. Lab-grade UPS systems are expensive to purchase and maintain, and even when properly maintained represent an additional point of failure. Most labs that experience long power failures frequent enough to merit this investment will also have backup generators that would make it unnecessary to back up things like air compressors and backing vacuum pumps that do not need to run constantly and that are challenging for UPS systems. If power failures are so rare that no backup generators are necessary, it's frequently better to just ensure that everything fails in the least damaging way possible when power is lost. Backing up the compressed air better than the electronics is actually detrimental in this case because you can end up having sensitive items like turbo pumps trip and fail with all of the valves still open. None of this is discussed and it really ought to be for the benefit of people operating in different situations regarding electricity reliability and building services. I think some of the decisions (consumer-grade UPS, air compressor backup) need to be reconsidered or at least defended with data.

Author Response: Good points. The line is designed to fail safely. As the reviewer mentioned, the ultimate goal is to protect the equipment during long power outages. All of the valves are normally closed, and the valve manifold depressurizes when it loses power, so all of the valves will shut in this situation. There is also a valve between the turbo and scroll pumps that closes when the scroll pump is turned off and protects the turbo pump from a rapid influx of atmosphere. In our experience, the Jimbochron can catastrophically lose power but retain ultra-high vacuum conditions without user intervention. Because an industrial grade UPS system is prohibitively expensive and our building does not have backup generators, our goal was to provide enough backup to handle the (more common) small interruptions (< 1 min), and just accept that longer interruptions may result in a lost analysis.

We determined that backing up the air is critical because our building compressed air supply went through a period of time where the pressure was dropping below ~80 PSI regularly and unpredictably. Although the valves are supposed to operate with pressures as low as 50 psi according to the Swagelok specs, we found the response uneven, with some operating normally and others not opening at all until the pressure was > 90 psi. This was the main reason we added the backup system in the first place. In terms of the danger of compressed air being backed up longer than the power, the Festo valve manifold releases pressure when it loses power, so even with ample compressed air the valves will all default to closed when power is eventually lost.

We added text to explain these points in the revision.

Communications section about valves (section 4.1)

Considering and ordering new hardware from Festo is a pretty annoying experience even for experienced lab operators because of the impenetrable product codes and massive catalog, so I think this is once instance where more detail would actually be helpful to some readers. The setup of the connections and the manifold model are not included, nor are the considerations that went into those choices described. I think a "USB to ribbon cable" probably leaves out a step or omits that this is some proprietary USB to serial converter that then terminates in a ribbon cable.

Author Response: Good point, we included this information in the revision.

Also, "PCB Board" is redundant.

Author Response: Good catch, we fixed this in the revision.

Labview code (section 4.2)

The Labview section states that Labview is "affordable" due to the University of Colorado's site license, and the code is described as "open." I think it is important to disclose that Labview requires very expensive licenses that are not available as part of large site licenses to all potential users of publicly funded research, and I would argue that Labview (or "G") code that requires a proprietary IDE cannot really be considered open. That aside, the manuscript states that the code is provided through Github but this repository isn't actually linked. And I think Geochronology either requires or strongly encourages putting code in a repository that provides a doi rather than just providing a link to a dynamic resource like Github.

Author Response: This is an important distinction that we will clarify in the revision. We were distinguishing between code that cannot be modified (what we called "closed") and code that can be modified (what we called "open"), as opposed to distinguishing between platforms that do not cost money to use. Our frustration with existing equipment has primarily been our inability to modify the software at all.

We believe that LabView is the most useful option for our lab, both based on in-house expertise and cost, however we do understand it requires a license to use. National Instruments does provide a version of LabView they call "LabView Community Edition" which is free for non-commercial use and compatible with Windows, Mac, and Linux operating systems. While this doesn't get around the proprietary nature of LabView it does make it widely available. National Instruments' claim is that the Community Edition is fully functional, but we will test the software using that version for the revisions.

Thank you for the reminder about the Geochronology requirements, we will make sure the code is both available and properly referenced.

Sections 5.1-5.5

I don't think the "3T" and "4T" tanks are defined anywhere before the manuscript just starts using them.

Author Response: Good catch, this is remedied.

The manuscript cites a couple examples of isotope dilution in very different contexts but not any of the examples of this exact procedure being used for decades in other labs, which oddly implies that this technique is new. It is a fair point that someone ought to have published it a long time, so maybe there is not much to cite. I think it would be reasonable to cite some previous work using the procedure even if they don't describe it in detail, and/or mention how well established this is.

Author Response: We certainly did not intend to imply that we are inventing isotope dilution and added references to emphasize this.

Why not show some data? It would probably be easier for an unfamiliar reader to understand the discussion if it referred to some measurement plots.

Author Response: That is a good suggestion, showing the real data of how the volumes were determined could be useful for readers. We think this could be demonstrated easily with a table of measurements, which added a table of data showing one of these experiments to the manuscript.

Choose one of cc or mL to use for volumes throughout.

Author Response: We standardized this.

Quantitative discussion of the uncertainties in the volume calibrations would be valuable. The assertions in lines 375-377 in particular deserve some data behind them.

Author Response: Some of this is easy to demonstrate, for example the problem with larger pipettes and the tank pressures required to deliver the appropriate amount of He for each analysis. The problem with manufacturing pipettes that are too small is based on discussions with Tim Becker who designed and manufactured these pipettes. We added language to this section to clarify the point.

It is difficult to assess Table 3 without seeing the measurement data, but it seems like some optimistic assumptions might have been made about the relative accuracy of the manometric pressure measurements, especially at the low end of the scale. These decisions, and the measurements themselves, ought to be shown and discussed.

Author Response: The propagation of uncertainties is shown in Figure 4. We therefore think the source of the numbers in Table 3 is clear. We better emphasized this in the text, but have no

other way currently to evaluate the accuracy of the capacitance manometer beyond manufacturer provided data.

Are the tanks not cylindrical? Surely the volume of large cylindrical tanks could be measured more accurately with a ruler than with the procedure described here. Alternatively, just fill them with water and weigh them.

Author Response: We considered this, however the tanks in their final construction include getters in the volume which we would not want to get wet. We clarified in the text why we did not use the approach of filling with water and weighing.

Summary (section 6)

Why would more vacuum pumps improve the pumpdown time? It's hard to imagine this is limited by pumping speed.

Author Response: Thanks for the opportunity to clarify: The main reason it would help with pumpdown speed is that it would allow segments of the line to be pumped while others are still being used for an analysis. We have tried to optimize this as much as possible, but a second pumping set up would allow for more things to happen concurrently. We clarified this.

As mentioned above the sensitivity calculations need a lot more data and context and should not appear for the first time in the summary section. Same goes for the background measurement. And what about comparison to sector mass specs and other setups than just the Alphachron?

Author Response: Thank you for these comments. We decided not to compare the machine to sector based mass spectrometers because we consider them to be different scales of instrumentation. While the extraction line could be the same the cost and infrastructure required are different enough that we don't think it fits in this contribution. We do hope that this contribution helps encourage others to describe their systems.

RC2: '[Comment on egusphere-2025-6263](#)', Bjarne Friedrichs, 18 Mar 2026

The manuscript “Technical Note: Design, construction, automation, and calibration of a low-volume He measurement line optimized for laser-ablation analyses” by James R. Metcalf and Rebecca M. Flowers is well-written and documents important aspects of custom-building such an intricate instrument. I enjoyed reading the manuscript and generally agree with the thorough comments Stephen Cox posted earlier. The manuscript is a valuable resource both for people who consider building their own He line but also for people interested in the details of the analytical concepts, and I can happily recommend publication after minor revisions.

My below specific comments and few technical corrections are organized per section, focusing on where I believe the reader could benefit most from some additional details or explanations.

In section 1, the word “plasma” is missing (line 26).

Author Response: Thank you, this was fixed.

In section 2.2, it is correctly stated that “it is good practice to minimize the line volume exposed to atmosphere during sample loading to preclude adsorption of atmospheric gas to internal surfaces” (lines 116-117). However, the Jimbochron design implies exposing the entire process side manifold to atmospheric gases during evacuation after sample change, which could be avoided by additionally connecting the scroll pump between valve 6 and the sample chamber (as it is done in the Alphachron® design). Does this design decision extend the time required to reach UHV pressure suitable for analysis relative to the Alphachron®?

Author Response: Good point. We decided against adding a valve between because it is geometrically awkward to position properly with the sample holder unless we added significant extra tubing. We agree it would be better, however the pumpdown time for the current set up is not noticeably different than for the Alphachron.

In section 2.3, it is stated that “after analysis, the valves to the vacuum pumps are opened and the gas is pumped away in preparation for the next sample” (lines 145-146). Are both ion and turbo pumps used at this stage? Otherwise, it should be singular (“the valve to the ion pump”, or “a valve” with an explanation given, e.g., in section 3.5).

Author Response: Yes, the turbo pump is used first until the gas levels are sufficiently reduced, at which point the pumping is shifted to the ion pump. We clarified this language.

In section 3.2, it is stated that “the main skeleton of the Jimbochron consists of ¼” internal diameter (ID), electro-polished, stainless-steel tubing and manifolds” (lines 178-179), whereas the Alphachron® skeleton consists of ¼” outer diameter (OD) tubing. Therefore, the decision for wider tubes seems contradictory to the goal “to precisely measure very small (~fmol) amounts of 4He [...] by minimizing the line volume” as stated in the abstract, which might warrant some explanation of this decision. Furthermore, it is stated that “components made with multiple VCR® flanges can be more difficult to seal than ConFlat® flanges, owing to the torque

introduced while tightening the seals. VCR® seals were only used to connect components that are regularly replaced or where space considerations made ConFlat® seals overly difficult to access” (lines 187-190). I can follow the latter reason but would be curious about (an) example(s) for components that are regularly replaced.

Author Response: Thank you for noticing this. The ¼” ID is a typo, it should read ¼” OD.

This statement regarding VCR fittings was be removed. It largely addressed conditions encountered during the development and testing phase of the build, and really isn’t relevant to the final configuration.

In section 3.5, it is stated that “future expansion plans include the addition of more pumps to allow for greater flexibility in gas handling” (line 217). I am wondering which use case would require more pumps (even plural!) and could not be done with extra connections but here I would be happy to learn more after the modifications only. However, the Sorb-AC® getter listed in this section (line 220) is missing in Table 1 so that it remains unclear where it is used, and this should be amended.

Author Response: Good catch, thank you. We clarified where the Sorb-AC getter is being used in the text and in Figure 1.

Section 3.6 requires more detail. (Why) is a dedicated QMS for CRH experiments beneficial or even required? Why would one not just use the more sensitive main QMS for this application as well? Also, the benefit of the Hiden 3F® being “approximately an order of magnitude more sensitive than other QMSs often used in (U-Th)/He labs” (line 232) should be proven with data, probably in a dedicated additional section before the summary presenting and discussing at least gas standard and blank reproducibility of the Jimbochron itself and, ideally, relative to the Alphachron® that is referred to often.

Author Response: As noted above the sensitivity estimates come from manufacturer provided data, and we do not have direct comparisons with other machines. The rationale for two QMS’s is also discussed above, and modified the text to better explain.

Section 5 was the most difficult for me to follow upon the first read as different aspects are spread over several sub-sections. For example, it is stated in section 5.2 that “following [...] volume measurements, the tanks were filled with isotopically pure ³He or ⁴He to the target tank pressures” (lines 385-386), but these numbers are specified in section 5.5 (lines 483-486) only. I am wondering whether section 5 could benefit from some restructuring (although I find it hard to suggest specific changes) or at least more cross-references.

Author Response: Thank you for the recommendation, we added and clarified text to make it easier to follow.

In section 5.1, it is stated that “isotopically pure ^3He is readily available” (line 327). I am not aware of any source, so this might be worthwhile information to add. The sentence introducing the term “tank depletion” (line 335) misses an “and”. The sentence stating that “calculating the tank depletion rate requires knowledge of only the volume of the pipette and the tank” (lines 343-344) should use the plural “volumes”.

Author Response: Excellent point. Our ^3He supplier is Sigma Aldrich, and while expensive the volume of ^3He required is low enough that one purchase will easily last decades for even a busy analysis line. We will include the source information in the text. Additionally, this was written prior to the closure of the Strait of Hormuz and resultant restrictions on the global He supply, although primarily the problem is for ^4He , we removed the term “readily available.”

There are two sections numbered as 5.2. After adjustment and potentially restructuring, all cross-references should be checked.

Author Response: Thank you, we fixed this mistake.

The wording “using the standard objects in expansion experiments to calibrate the volume of a vacuum chamber (a known volume)” (lines 380-381) confused me, as a literally “known volume” would not need to be calibrated. I would prefer a term such as “calibration volume” (used in the abstract and Introduction) or “reference volume”, in which case several text passages, figures, and tables would need to be updated. An easier alternative could be to specify “termed as ‘known volume’ hereafter” in the brackets, but that would leave the inconsistency with earlier paragraphs. Furthermore, the concept of expansion experiments could be explained briefly here, and/or it could be referred to the respective sections. Also, why was an extra vacuum chamber connected for these calibrations instead of using the sample chamber?

Author Response: Thank you, we were trying to differentiate between what we called a “known volume”, which is the chamber we could use for expansion experiments, and the items we used to determine the volume of the “known volume.” These terms have been clarified and defined better.

We decided to create an extra chamber for the calibrations for two reasons. First, the laser sample chamber was not available at the time of line construction (COVID restrictions meant the line was built before the laser could be delivered and installed), and second we wanted a volume that was portable, so if we decided to use it on other vacuum lines it would be easy to transport.

It is stated that “the amount of ^4He in the calibration shot can be calculated directly from the tank and pipette volumes and the pressure the tank was filled with, or can be determined using an external standard” (lines 369-370) which apparently was done ultimately (“We checked our metrologically-determined volumes with volumes that we constrained using our existing calibrated He line.”, lines 384-385, and “Our existing, calibrated He line enabled us to check our volume measurements (Table 4). The pipette volumes determined metrologically as described

above matched those yielded by calibration with our existing line, but the tank volume measurements were slightly too small. [...] We ultimately adopted the tank volumes yielded by cross-calibration with our existing line.”, lines 473-481). The procedure that was actually used for calibrating the Jimbochron’s tank volumes by means of the Alphachron® should be specified and the uncertainty adopted for the tank volumes / reference shots stated.

Author Response: We understand why this section was not clear, and added text to better clarify the process.

Why were so many different items used for the volume calibration? Were the results consistent between the different items but just not with the external Alphachron® calibration? How big was the discrepancy between tank volumes calculated based on filling pressures and external Alphachron® calibration?

Author Response: We used a variety of items for the volume calibration to test the repeatability of the process and the capacitance manometer.

The discrepancies were not that large, but we will clarify that we used an average of the results from these items in the final numbers.

In section 5.4, it is stated that “the volume of the pipettes, for example, were measured 3-6 times using different loading pressures, with the resultant 2s SE on volume determinations <0.2%” (lines 450-451), but Table 3 lists 2s SE values for the pipette volumes corresponding to 0.3% (twice) and 0.5%, so these numbers need to be double-checked and adjusted.

Author Response: Thank you for catching this, the figures are now consistent.

In section 5.5, it is stated that “in preparation for tank filling, the tanks, pipettes, and line were first baked at ~200°C for ~24 hours while being pumped by both turbo and ion pumps to ensure as evacuated a volume and as low a pressure as possible” (lines 488-489). Is there a housing for the line or was it wrapped with heating wires? It might be nice to add which materials were used, how much of them was required, and whether / on which occasions baking the line is repeated in operation.

Author Response: Good point, we used heating tapes connected to a temperature controller this process, and included the details about these products. So far we have not had to bake out parts of the line again, even when loading samples we have been able to pump down to appropriate running conditions within a few hours (similar to our experience with the Alphachron.)

In section 6, the summary, it is stated that “sensitivity estimates of the Jimbochron indicate that it is approximately 2 orders of magnitude more sensitive than the lab’s Alphachron He line” (lines 511-512) whereas in section 2.1, it is stated that “as explained in more detail in Sect. 3.6, the Jimbochron uses a QMS that is approximately an order of magnitude more sensitive than

the QMS on our existing Alphachron® He system” (lines 88-90), which seems contradictory at first. If an order of magnitude improvement was achieved by the QMS selection and another order of magnitude improvement by other design and/or component decisions, this should be described and discussed more thoroughly. These numbers should be consistent and comprehensible in all occurrences (including the abstract). It would also be good if such an important statement could be backed up with data, probably in an additional section before the summary as suggested above.

Author Response: Direct comparisons of different lines are difficult, so we will remove the measurements from the text. As noted above we will remove this statement in the summary about the Jimbochron being two orders of magnitude more sensitive than the Alphachron, and include manufacturer provided sensitivity information.

Particularly, it is concluded that “the minimum 4He blanks measured in both machines are similar (~ 0.04 fmol). However, for the same gas volume, the Jimbochron yields a larger signal to noise ratio with lower uncertainties on repeated measurements and more consistent and reproducible blank measurements” but a presentation of these data and the analytical parameters (especially dwell times) is missing.

Author Response: We understand the confusion with these statements, however we stress that they are meant to be approximate, and that strict comparisons are difficult considering all of the variables that can affect sensitivity. We removed these approximate comparisons from the text to avoid confusion.

Lastly, rough estimates of the material price and working hours that went into designing, building, and testing the Jimbochron might be valuable for (future) labs to trade off custom-building against commercially available instruments.

Author Response: This was something we debated and I can see the merit. The numbers would be both pre-tariff and based on CU purchasing agreements, however we now provide a rough estimate of the total cost of materials. The total working hours are not easily tabulatable and are highly individualized, so we prefer not to attempt to report these numbers

RC3: '[Comment on egusphere-2025-6263](#)', William Guenther, 25 Mar 2026

This manuscript is a welcome addition to the technical literature as, to my knowledge, there is no comparable text anywhere that summarizes and steps through all of the requirements needed (at this level of detail) to build a noble gas extraction and measurement line. It is certainly appropriate as a Geochronology Technical Note and can be published after a few items are added to the text. To that end, I have a few comments for improvements:

1) There is not enough discussion or comparison between the QMS options in the current draft of the manuscript, which limits its impact somewhat and is a missed opportunity. Given that this manuscript will be one of the few available resources for folks that might want to build a new line, I strongly suggest that the authors do a deeper dive on these choices. Specifically, plots showing direct comparisons between measurements made on the Hiden 3F vs. SRS vs. the Alphachron's QMS (which I assume is a Pfeiffer QMG220?) are needed here. Also, my understanding has always been that the lower limits on ^4He measurements are inherently blank-limited and not sensitivity-limited. Some explicit demonstration and comparison (as plots) that disentangles the blank vs. sensitivity issue would be really helpful. Fundamentally, I do not completely understand from the current and somewhat limited discussion why the Hiden 3F is required when you could use the (cheaper) Pfeiffer QMG220 instead, given that blank levels are largely dictated by the line design (I am happy to be disabused of this notion by the way!).

Author Response: As noted above we modified the discussion of the QMS selection.

2) It's great that the code is available for download and modification, but please include a link to the GitHub repository in the text at line 281 for ease of access. It would also be appropriate to archive the most recent stable version at OSF or Zenodo and share that doi.

Author Response: Good point, we made sure the software is properly linked and referenced.

3) In several places, there is a reference to the potential use of this line for continuous ramped heating. A crucial aspect of getting CRH to work on a line is the conductance, which is partially a function of the inner diameter of the tubing. Have the authors confirmed that they have the necessary conductance for this technique? If so, can they elaborate on that within the text and tables? This would be appropriate around line 178 where the internal diameter of the tubing is mentioned, and as an item list in table 1 (i.e. what are tubing diameters used on the line?). The authors list the ID of their tubing as 0.25", but what I gather from discussions with Bruce Idleman is that 0.75" is required (this might be the OD but regardless, a wider ID than 0.25"), so I'm a little skeptical that the design will work. Again, as this manuscript is in part a really nice summary of "how to build a line", which I expect a number of readers will use in this fashion, I think it is important to be clear about whether CRH is feasible with this specific set-up.

Author Response: You are correct. Our understanding is that for CRH we will need to add an additional, larger diameter (higher conductance) patch from a sample chamber to the SRS QMS, complete with the additional robust gettering system CRH requires. We decided to include

it on the same line because the CRH set up could also be used for traditional, full grain degassing measurements using the same gas processing system and QMS as the in-situ measurements, meaning we'd have 3 potential measurement options on one line. However, because we have not completed and tested this aspect of the line, we don't want to speculate too much on what the final design would be. We clarified this in the text.