What actually is ATONA?

ATONA is a revolutionary Faraday amplifier system designed for use in isotope ratio mass spectrometers.

It does away with the high gain resistor used in traditional Faraday amplifier systems, instead using a patented, capacitor-based technology, resulting in far superior performance. The noise level is significantly lower and more stable than traditional Faraday systems, and the linear dynamic range is orders of magnitude wider. Furthermore, it has far better gain stability and Tau decay that is so swift it is almost unmeasurable. There is no performance compromise, it's easy to set up, and it's easy to use.

How is it that the noise level is so low?

Much of the noise associated with Faraday detectors comes from the amplification circuit. This can be decreased by using a very high gain resistor in the amplification system. But these high gain resistor systems are hugely compromised, exhibiting lengthy calibration times, long Tau decay issues, and the inability to measure larger ion beams. ATONA uses a completely different amplification system that removes the major source of electronic noise, so it's inherently a much less noisy system, with all the benefits that brings to your analysis, and none of the compromises.

Why doesn't the gain drift?

The gain stability of ATONA is remarkable. One user has observed less than 10ppm of gain calibration drift over a period of three years, unheard of with traditional resistor-based Faradays. Why so stable? Simply put it is due to the inherent stability of the electronics and hardware that underpin ATONA. In traditional Faraday systems the weak link regarding stability is the need to use high gain resistors; these components are significantly affected by environmental changes such as temperature fluctuations. ATONA does not utilise such resistors.

Is ATONA easy to set up?

Absolutely! One of the most tangible benefits of the ATONA system is that it requires no setup. If you've used mass spectrometers equipped with Faraday detectors then you can use ATONA; the amplification system is essentially invisible to the user. For many isotope ratio applications, the wide dynamic range of ATONA is enough to negate the need to switch over to ion counting detectors for low abundance isotopes or small ion beams, meaning that setting up an analytical method can be made even easier.

Does ATONA require special Faraday detectors in order to operate?

No, it doesn't. The technology contained in ATONA is all in the amplification circuit, not the Faraday collectors themselves. We still use the same Faraday collectors that we've used at Isotopx since the company was started. These are extremely hardy and very few have ever been replaced, even if we include the legacy systems built prior to the formation of Isotopx.

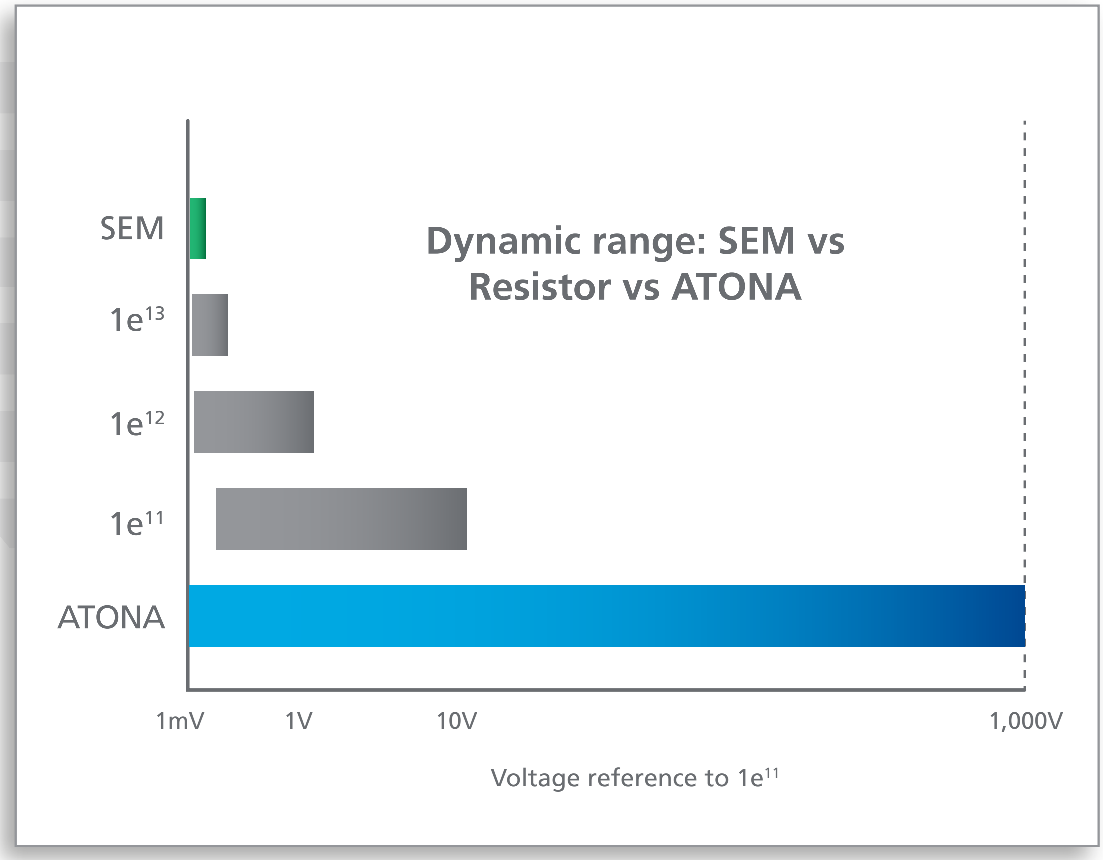
Does ATONA require specialized environmental conditions to achieve its performance?

It doesn't. The ATONA electronics boards containing the capacitor networks are temperature and pressure controlled, as they often are with resistor-based Faraday amplifiers. But that's it; there is no need for a special laboratory environment in order to use the ATONA system.

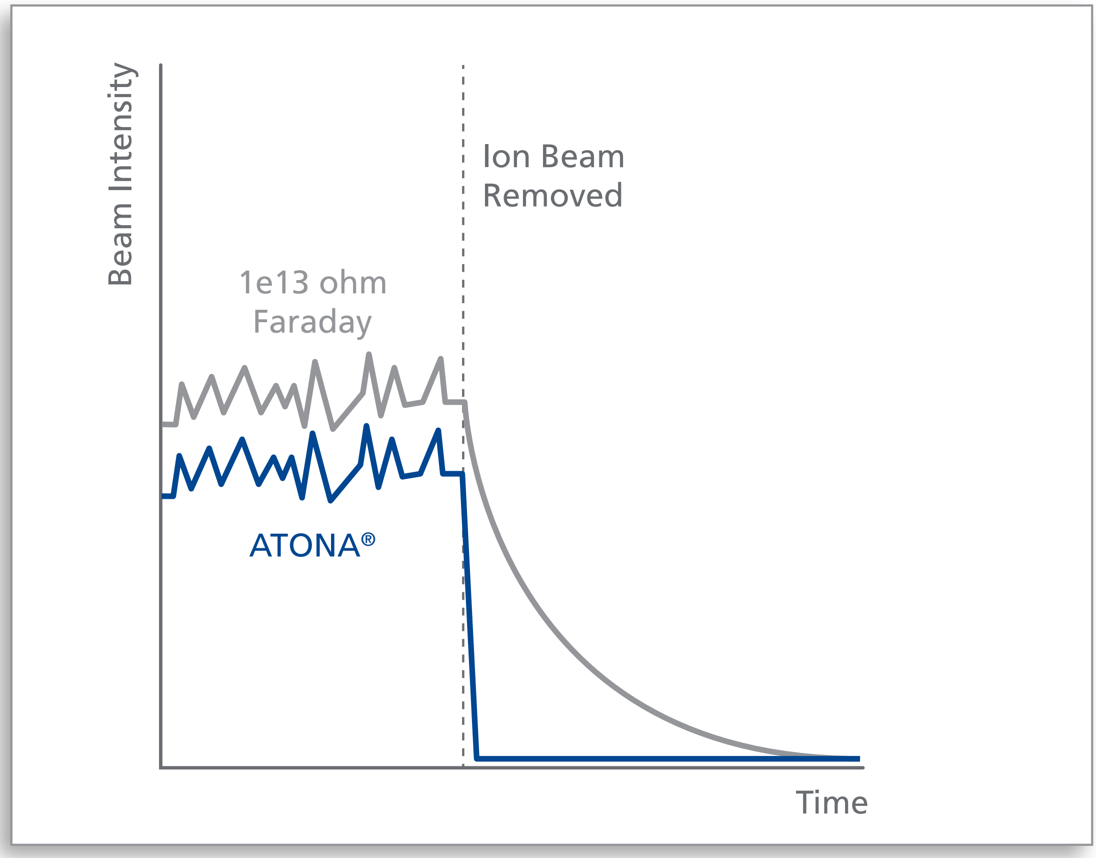
Does ATONA require any amplifier switching to achieve the huge dynamic range?

No, it doesn't. This is one of the benefits of ATONA that's hardest to get to grips with, as it's such a big change from traditional resistor-based Faraday amplifier systems. When using a traditional system, you need to choose the gain of your amplifier according to the size of the ion beam you'll measure, meaning that you require some prior knowledge about the analyte concentration in your samples. This adds a degree of complexity to method setup and offers plenty of scope for putting the wrong ion beam into a sensitive detector and saturating it, causing delays.

With ATONA that simply doesn't happen. The ATONA amplifier system can handle really large ion beams (1,000 volts or more) with no saturation delay. And when you want to measure a tiny beam (sub-millivolts) on the same Faraday detector, the 1,000-volt beam decays to background count rates in a fraction of a second. There really is nothing else quite like it.



Huge dynamic range



Zero Tau decay time

Does the ATONA system require more regular calibrations to achieve low noise levels?

Absolutely not! Baseline noise levels for ATONA-based detectors are significantly lower than those of resistor-based detectors. And even better, the stability of the baseline noise is excellent over significant periods of time. The detector gain calibration is equally stable, again over long periods of time. The baseline and gain stability performance of ATONA means that detector calibrations are required less frequently. Typically, users of our instruments equipped with ATONA systems perform far fewer baseline noise and gain stability measurements, meaning more time is devoted to taking measurements.

Is ATONA quick to gain calibrate?

Much quicker. The reason why is very simple. The 1e13 Ohm amplifier-based Faraday detector systems can only use a small calibration current to avoid saturating the amplifier, which means a lengthy calibration time. ATONA does not have this limitation, so calibrations are much quicker, allowing you to get on with your measurements sooner.

How quick is the Tau decay, and why is it so quick?

It's so quick we can hardly measure it! Large (i.e. >10V) ion beams decay to less than 10ppm of the original beam size in under 10 milliseconds on removal of the signal. In practice, this means that you can switch from very high to extremely low signals on a given collector almost instantaneously, and scan over huge peaks from baseline on the low mass side to baseline on the high mass side with no delays from signal decay. So for practical purposes the tau decay time is zero. Why so quick? It's because a resistor-based system with a high gain resistor suffers from capacitive issues, meaning that built-up charge can take time to decay. Anyone who has ever saturated a 1e13 Ohm resistor-based detector will know how painful this can be. ATONA uses a completely different system – there is no high gain resistor so no capacitive issues.

What's the smallest beam you can put on an ATONA detector?

At the lower end, you can get useable data from beams well below 1 mV (62,500 counts per second). In fact, some users are taking data with beams down to 100 mV or below (6,250 cps). With a Zeptona detector, an evolution of ATONA typically placed behind the main ATONA Faraday array, it's possible to get 1% signal precision with beams down to just 1,500 cps, normally only achievable with the use of ion counting detectors.

And what about the biggest?

The ATONA amplifier system can handle really large ion beams (1,000V or more) with no detrimental effects and no saturation delay. In fact, it's likely that any beam size limitations are due to the mass spectrometer rather than the ATONA detector.

Do you have to be careful with large ion beams when using the ATONA system?

Absolutely not! As mentioned above, ATONA can handle huge ion beams without causing the Tau decay issues that are well documented for higher gain resistor-based Faraday amplifier systems. With the ATONA system, you can scan across the whole mass range without fear of saturating any of the Faraday detectors. This is particularly useful for applications where the intensity of an ion beam may vary rapidly.

Do you need to change the gain of the resistor for this huge dynamic range?

No. This is a key benefit of ATONA. The huge dynamic range is available all the time, with no user intervention. There is no need to change gains, change resistors or switch amplifiers. It's always on, and always ready.

Can it work with short integration times?

It can! ATONA is typically used for integration times around 5-20 seconds, common in many isotope ratio measurements. However, it can also be used for much shorter integration times such as laser ablation MC-ICP-MS analysis, where integration times are typically around 100ms. A technical note to describe how the noise level varies with integration times is available separately.

Is it reliable?

It is. The ATONA system does not require the hyper-sensitive high gain resistors used in other Faraday systems used for small ion beams, so is inherently more rugged and reliable. There is no user maintenance required, and as we already mentioned, calibrations are quicker and less frequent. We use long-life Faraday detectors that come with a ten year guarantee, although failures are vanishingly rare.

What do users think about it?

They like it! There is a wealth of data already published by our ATONA users, and at least two review papers that discuss the analytical capabilities of ATONA. Have a look at Mixon et al (https://doi.org/10.1016/j.chemgeo.2022.120753) to read about the suitability of ATONA for noble gas measurements. Check out Szymanowski et al (https://doi.org/10.1039/d0ja00135j) to read how ATONA works for U-Pb geochronology using TIMS.

Is ATONA available on all Isotopx products?

Yes! The current range of products at Isotopx is the Phoenix TIMS, the NGX noble gas MS and the SIRIX stable isotope ratio MS. All are equipped with ATONA as standard. Our intention is that all future products will be similarly equipped.

How can I find out more?

Please get in touch with us (sales@isotopx.com) and we'll be happy to discuss your specific requirements.

Excellence in Mass Spectrometry