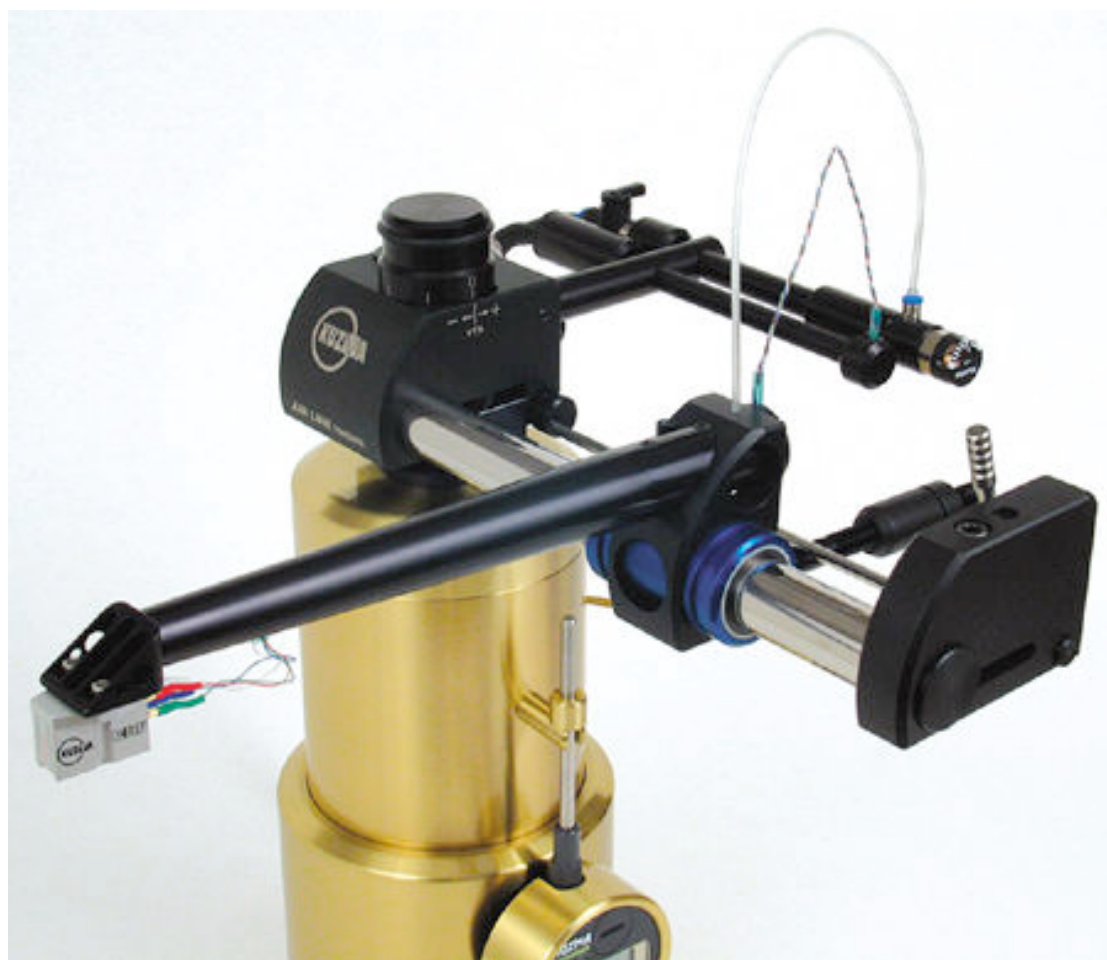


# Stereophile

## Kuzma Air Line tonearm

Michael Fremer, August, 2004

The lacquers from which LPs are pressed are cut in a straight line, and that's how the LP groove should be traced. Even when set up perfectly, a pivoted arm describes an arc across the disc surface, maintaining tangency to the groove at only two points on that arc. Yet despite numerous attempts at building and selling linear-tracking tonearms, few remain on the market, and most are fraught with technical problems. Linear-tracking arms can be anything *but* linear, committing more sins of geometry as they meander across the record surface than do their pivoted brethren.



One problem facing designers of linear arms is how to drag the arm's mass laterally across the record surface. Another is how to route the wires from the sliding arm to a fixed termination point without impeding the arm's freedom of movement. Noisy, tweaky, motor-driven servo systems have been used on a number of linear designs both ambitious (Rabco, Goldmund, B&O) and low-tech (plastic turntables from many mainstream manufacturers). But even the best of these require the *loss* of tangency to signal the servo correction system to move the arm along the track. The

correction inevitably overshoots or undercorrects to some degree; the result is an arm that wiggles its way across the record, creating potentially greater tracking errors—and more of them—than you'll find with a properly set-up pivoted arm. The ideal is for the cartridge's cantilever to maintain perpendicularity to a radial line drawn across the grooves. This can probably never be achieved by servo-type linear designs, even if, from afar, they look as if they are, and even if many audiophiles remain loyal enthusiasts.

An upgraded iteration of the Souther linear-tracking arm, built and currently marketed by Clearaudio, uses a different scheme. A very short, low-mass rod rides on wheels along a pair of low-friction quartz rails. Discussion of the design tradeoffs is best left to a full review, but I remain skeptical about this arm's ability to maintain true tangency to the grooves as it rides the rails.

The virtually frictionless air-bearing designs originally produced by Maplenoll and Eminent Technology were both designed by Eminent's Bruce Thigpen. In these arms, the bearing is fixed; it's the rail that moves, with the armtube attached to it. Eminent still sells its ET2 arm; a heavily modified edition of the original Maplenoll design can be found on Walker Audio's Proscenium Gold turntable.

Finally, a number of air-bearing designs use a fixed rail and move the bearing, which has the considerable advantage of moving a far lower mass across the record surface. Included among these are the Versa Dynamics and Forsell (neither any longer in production), and the Airtangent, Rockport, V.Y.G.E.R., and, now, the Kuzma Air Line. These designs vary in bearing mechanics and air flow, as well as in overall build quality and ergonomics.

**Imitation, flattery, hot air** What Franc Kuzma's Air Line arm (\$8000) lacks in originality is more than made up for in its superb execution, high build quality, and Kuzma's innovative upgrades to what must have been his obvious inspiration: Andy Payor's Rockport tonearms. The Air Line is in some ways even more practical and easier to use than the Rockport Series 6000, which I reviewed in the May 1996 *Stereophile* (Vol.19 No.5).

Like the pivot bearing of a conventional tonearm, the air bearing of a linear-tracking arm must be free to move in the vertical and horizontal planes, and not at all in any other. Too tight a tolerance and you restrict movement, too loose and you end up with sloppy geometry. The goal is for the arm and cartridge to track across the record with perfect tangency to the groove and zero play fore and aft.

Though Kuzma's air bearing superficially resembles the Rockport 6000's, it's a fundamentally different design. Kuzma uses what's called a porous-wall air bearing in which pressurized air flows through thousands of tiny holes. Rockport uses a groove-compensated bearing, which has lateral grooves in the bearing wall.

Kuzma supplies a remarkably quiet Sil-Air oil-cooled compressor and a sophisticated and effective system for removing both the water that's

squeezed out of the compressed air, and any oil that might otherwise get sprayed into the system. The compressor is capable of running at around 12 bar (ca 120psi), but air bearings don't need nearly that much pressure. The Air Line's porous-wall bearing operates at around 4 bars (ca 60psi), or around four times the Rockport's pressure. However, that doesn't mean the Kuzma bearing is four times stiffer than the Rockport's, or even as stiff. There are too many variables involved to draw a blanket conclusion like this.

The Sil-Air pump is far quieter than the one Rockport supplied with the 6000, but because it includes an air reservoir and pressure-sensing system, it emits a rather loud hiss, like an air brake's, after the compressor has refreshed the reservoir and shuts off. The shutoff can send a noise spike through the AC; I was advised to use a line separate from the one my audio system was plugged into. Kuzma told me that a fix is in the works, but the hiss means you need to locate the compressor out of audible range. Fortunately, you don't need to visit the compressor to turn it off, or even to keep tabs on the pressure. Closing a small valve on the arm maintains air pressure, which effectively keeps the compressor shut down. A neat little gauge built into the end of the air-carrier rod, which runs parallel to the bearing rail, tells you if the bearing is sufficiently pressurized.

**A question of damping** The one glaring omission in the Air Line's design is a damping trough. A linear design—even one using a stationary rail—must laterally move a large mass. The grooves of most LPs are not concentric because of pressing inconsistencies, which means the groove is constantly shifting the tonearm's mass back and forth. Because the stylus is at the end of a spring mechanism (the cantilever's suspension), if you use a cartridge with too high a compliance—too floppy a spring—you can have the tail wagging the dog, in that the motion of the groove spiral will move the cantilever from its central position. The risk is then that with a frictionless bearing the stylus might be slammed from one groove wall to the other

I discussed this in my May 1996 review of the Rockport Series 6000:

"In conventional pivoted arms the arm/cartridge system moves vertically *and* horizontally around a common point; thus, horizontal and vertical effective masses are very similar. In linear trackers there is a big difference between the effective vertical and horizontal masses. Being a pivoted system in the vertical axis, a linear tracker's effective vertical mass is low because it consists of the relatively short armtube and cartridge. Horizontal mass is much larger: it includes the entire arm/sleeve assembly as well as the cartridge, all of which must be carried across the record and which do not benefit from being a pivoted system.

"Hang a small weight on the end of a spring and it bounces at a fairly high frequency over a short distance. Put a bigger weight on the spring and the rate of movement slows while the excursion length increases. The high mass of a linear-tracking arm in the horizontal axis can create a very nasty low-frequency resonance. The eccentricities due to the off-center pressing of virtually every LP made will excite this resonance as the system moves

back and forth trying to track the shifting groove.

"In any arm/cartridge system, the arm should hold steady while the cantilever remains free to extract information from the groove. If the two were dancing partners, the cantilever would 'lead' and the arm would follow. In an undamped high-mass system the 'tail' (arm) begins to wag the dog (cantilever). Unwanted cantilever movement creates unwanted electrical output. In addition, any electrical output created with the coils uncentered in the magnetic gap is nonlinear, thus making it virtually impossible for the cartridge to act as a linear transducer, which is its job. Cantilevers can actually snap in undamped linear-tracking systems....In my opinion, a linear-tracking arm without damping is simply not viable if the goal is a 'reverse machine tool' accurately tracing what's in the groove."

It is thus inexplicable to me that Kuzma, a designer who, by every indication, clearly understands all of these issues, chose to omit a damping trough, which wouldn't have been all that difficult to implement. It's like not including shock absorbers in an automobile. While using a low-compliance cartridge will mitigate this problem to some degree (and using a cartridge of low compliance and relatively high mass is mandatory with the Kuzma), I believe the problem still exists.

**Setup** Installing and setting up the Air Line was relatively easy. The massive main housing terminates in a large threaded bolt that's compatible physically and geometrically with the circular cutout used for many pivoted designs. An armboard cut for the Morch arm worked fine once the hole's diameter had been increased. The small-diameter air hose, which is stiff but still sufficiently flexible to allow it to be dressed, attaches to the arm via a push-lock connector.

Kuzma provides a straight run of cable from the cartridge clips to a set of Bullet RCA plugs at the end of an ample length of high-quality interconnect. As with the Rockport, the thin tonearm wire is fixed in an arc to minimize interference with arm movement.

Kuzma supplies a straight-line protractor, attached to a paper jig, that makes it easy to establish a radial line before you lock down the arm mount. From there, mounting the cartridge and setting its overhang, VTF, VTA, and azimuth are fast and easy. However, establishing an initial reference VTA, with the axis of the tonearm parallel to the record surface, would be considerably easier if Kuzma would scribe a straight line on the side of the tapered armtube, as SME does.

The rigid headshell is slotted for setting overhang, a locking threaded counterweight on a long shaft sets VTF, a dual-scale, precision-locking threaded VTA adjustment smoothly raises and lowers the main housing (and lets you know exactly where you've set it), and a worm-gear mechanism similar to what Herb Papier designed for his Tri-Planar arm permits precise adjustment of azimuth. Setting up the Air Line couldn't have been more easy or reassuring: the settings *lock* into place.

The tapered armtube attaches to a massive machined aluminum block that completely encircles the air bearing. A sure-feel cam-actuated rod applies the cueing mechanism, which lets you precisely stop the arm's travel at any height within its adjustment range.

Everything about the execution of this well-crafted design screams rigidity, security, and repeatability. It's everything the cumbersome air-bearing arm that came with the V.Y.G.E.R. Atlantis turntable wasn't (see "Analog Corner," July 2003).

Like any air-bearing arm, the Air Line *must* be used on a level, stable platform. The lack of both friction and damping, combined with high horizontal moving mass, means the arm's stability and thus tracking effectiveness depend on its being absolutely level. Any slight deviation will pitch the arm in the direction of the slope. I used the "balancing plateau" on the *Cardas Sweep Record* to level my Sounds of Silence Vibraplane active isolation platform, and found it extremely difficult to keep the stylus from sliding in one direction or the other. Soggily sprung turntables need not apply.

Once set up, the Air Line was a pleasure to use, though the active Vibraplane tends to shift slightly over time; I had to level it often. Even then, occasionally at the end of an LP side the Air Line would slide into the record weight and then careen back across the record surface. Keep that in mind if you think you can get away with a less than ultra-stable, level platform.

**Sound** Though the original Rockport Series 6000 tonearm received a deservedly gushing review, over time it became apparent that its low-frequency extension and solidity were not as good as the Graham 2.2's or the Immedia RPM2's. The 6000's relatively low vertical effective mass put its resonant frequency above the ideal 8-12Hz region with moving-coil cartridges of average weight and typically low compliance, causing the bass to begin rolling off prematurely. Andy Payor solved the problem on the System III Sirius arm—see my [analogsourcereviews/review in August 2000](#)—by adjusting the mass so that the arm's fundamental resonant frequency would be compatible with a wider range of cartridges.

Before switching from the Graham 2.2 to the Kuzma Air Line on the Simon Yorke turntable, I played a number of bass-heavy LPs. Judging by the Air Line's relatively long, massive, tapered armtube, I didn't think I'd run into the same bass problem. I didn't, but when I measured the horizontal resonant frequency using a few typical MC cartridges, it was very low—around 5Hz—making Kuzma's choice to omit damping all the more puzzling.

That said, and when all conditions were ideal, the Air Line's top-to-bottom performance was absolutely stunning, and comparable, as best as I can compare, to the Rockport arm on the Sirius. When you hear a *true* linear tracker for the first time, you'll know it—the absence of the etchy, pinched character present in all pivoted arms is among the most obvious differences. You're not really aware of it when listening to the best pivoted

arms, but when it's gone, what a difference!

The Air Line's dramatic, solid, three-dimensional spatial presentation was very similar to that of the Rockport 6000, which I'd reviewed with a VPI TNT turntable. The Kuzma's bottom-end performance, however, was far more robust—going from the Graham 2.2 to the Air Line, nothing was lost in bass extension, and much was gained in bass texture and harmonic detail.

When I played the Beatles' "Baby You're a Rich Man" (from a true stereo pressing of *Magical Mystery Tour*, German Apple SHZE 327) with the Air Line after hearing it with the Graham 2.2, I was struck by the enormous overall improvement in the naturalness of transient attack and subsequent decay. The handclaps were far less brittle and far more solid, fleshy, three-dimensional, and convincing. The bass wasn't more extended, but it was more complex physically and harmonically, particularly the attacks—I could feel McCartney plucking the strings in a fundamentally different and more revealing way. Front-to-back imaging was far more pronounced and more naturally conveyed. Lennon's voice, usually somewhat thin and wispy, was *there*, with a fleshy physical presence so convincing I thought I might be able to reach out and touch his face.

Ultra-black backgrounds; enormous, airy, startlingly stable soundstages; palpable images perfectly placed and sized; ear-popping harmonic, dynamic, and transient complexity—I could blather on about the Air Line's convincingly natural performance and brilliant overall balance. I'd rather just get to the point: In every playback parameter I was able to delineate, the Kuzma Air Line's presentation was staggeringly better than that of any other arm I've auditioned—with the exception of the one included with the \$70,000 Rockport System III Sirius.

**Conclusions** When all playback conditions are ideal, the Kuzma Air Line is one of the top two tonearms I've ever heard. Some engineers, like Tim Sheridan of Lorien Consultants Group, who was employed for many years by Professional Instruments, of Minneapolis, the world's leading manufacturer of air bearings and supplies Rockport with its groove-compensated bearings, feel that there are theoretical problems with a porous-wall bearing. Whatever issues the Kuzma's porous-wall bearing might have introduced, I didn't hear them. However, the Air Line's large horizontal mass and its lack of a damping trough mean that eccentric LPs and any deviation from absolute horizontality will create physical and sometimes audible playback problems.

With the exceptions of some vintage LPs, such as original Blue Notes, and Classic Records' SV-P Quiex pressings, the groove areas of records are "dished"—that is, they slope downward from the outer lip and upward toward the label area. During playback of most LPs, even when the Air Line is absolutely dead level and on an ultra-stable platform, the arm will track biased on the inner groove on the way down, and biased on the outer groove on the way up. Add an off-center spindle hole—which most LPs have, to one degree or another—and you have a playback situation of

complex dynamics that, for reasons I don't understand, Franc Kuzma has failed to address. (I expect to read his spirited reply in "Manufacturers' Comments.") With the addition of a damping trough, the Air Line could very well be the finest tonearm ever built.

### **Sidebar 1: Specifications**

**Description:** Air-bearing, linear-tracking tonearm. VTA continuously adjustable during play. Optimal cartridge weight: <9gm. **Dimensions:** Effective length: 184mm. Effective arm mass: 13gm vertical. Weight: 4.5 lbs. **Serial number of unit reviewed:** Not noted. **Price:** \$8000.