> Rich Neuschaefer struck a disdainful pose, poncho tossed carelessly over his shoulder, MaxBright diagonal stuffed into a low-cut holster at his waist, and lasciviously fondled the new voice-operated go-to mount he had bought to clinch the comparison. Sneering at Jay Freeman and Dave North, who were trying to find the Moon and failing, because that bright thing in the sky had ruined their dark adaptation, he spat and spoke with a scornful stare, "There are two kinds of people in this world -- those who have loaded Astro-Physics refractors and those who star-hop: You star-hop!"
>
> Freeman lifted his gaze slowly from the finder and raised a cynical eyebrow, whereupon Neuschaefer looked up to find the sky had suddenly darkened, and saw that the vast shadow obliterating the light pollution of San Jose fell from a giant Celestron 14, dust covers off and siderial drive tracking smoothly, pointed directly at him. Fidgeting nervously, he suddenly realized that the tanned leather cartridge belt that used to hold his prized, paired collection of Zeiss Abbe Orthos was now empty ... and that North had disappeared ...

Well, not quite. It began when three amateur astronomer helpers for the August 28 public night at Lick Observatory found that they planned to bring five-inch refractors from different manufacturers to set up. It took a fist full of dollars to buy even the cheapest of these -- my Meade 127 ED doublet -- and a few dollars more -- quite a few -- to obtain Dave North's new Takahashi FS 128 fluorite doublet or Rich Neuschaefer's late-model Astro-Physics 130 f/8 EDT. So the model of "The Good, the Bad, and the Ugly" was very natural when I circulated the previous quote by private EMail. But that's not how it really was.

To begin with, Neuschaefer's Astro-Physics 130 is indeed loaded, but he has not yet bought a voice-driven mounting for it. He did bring along his 155 f/7 EDF, too, though, and we all watched closely to make sure he didn't try to sneak it onto the mounting when no one was looking. Dave North didn't steal any eyepieces, or at least, I had all mine when I got home, but he was most covetous of Neuschaefer's Zeiss Abbes, and eager to try them, when we got around to swapping eyepieces in the test. And I left Harvey, my Celestron 14, at home, though I felt a considerable twinge of regret at doing so, for the seeing was certainly good enough to allow a C-14 to perform at its best.

More importantly, when word of our planned engagement got around, two more high-end five-inch refractors showed up. Robin Casady brought his nearly new Astro-Physics 130 f/6 EDF, which did have a go-to mounting (though not a voice-operated one), and Dean Linebarger showed up with

another Takahashi FS 128. That was a lot of high-end competition slumming with my lowly Meade, but I wasn't worried: Anything my telescope did well would be because of its own intrinsic superiority, and anything the others did better would merely be because of their larger apertures, by one and three millimeters. Besides, at f/9, my Meade had a longer tube length than any of the other telescopes, and since I had bought a pier extender for my Losmandy G-11 mounting, it stood taller in the saddle, er, tube rings, as well. How could I lose?

There were also a number of experienced observers at hand who did not bring five-inch telescopes. Those whom I know well included Rod Norden and Akkana Peck, but the volunteers at Lick were drawn in great part from the Hall's Valley Astronomical Group, a very active club whose members I generally do not know. Thus we had a great many qualified people wandering around looking through our telescopes.

I generally make a point of not saying who owns what equipment in my usenet postings -- I don't wish to tell whose garage might be worth breaking into (and I thank Rich, Dave, Dean, and Robin for specific permission to describe what they brought to the shoot-out). However, I think I should mention that the people present all own a tremendous amount of equipment. Each five-inch owner has at least one other telescope a good deal larger. Collectively, the group of observers who were there have at least a dozen high-end refractors (including two Astro-Physics 180 EDTs, several more Takahashis, and a couple of Vixen fluorites), a handful of Dobson-mounted Newtonians in the 12- to 20-inch aperture range, a Celestron 14 (mine), a Takahashi 9-inch Schmidt-Cassegrain, and no doubt many other fine instruments that I have either forgotten to mention or have never heard about.

I suspect this test report will be well read and will provoke controversy, so before I go into detail on what we did, I will state two of the important bottom lines, and I will repeat them later, as well:

1.) THIS WAS A TEST OF SPECIFIC TELESCOPES: We certainly did not obtain sufficient statistics to make any claims about the average quality of any of these products, and the quality control of telescope manufacturers is a subject of frequent heated controversy among amateur astronomers.

2.) DIFFERENCES AMONG THESE TELESCOPES WERE VERY SMALL: Though the majority opinion was that they were not identical in performance; nevertheless, a modest minority of the experienced observers who looked through them could detect no difference at all among all five. Furthermore, all of the telescope owners agreed that the performance difference between the best and the worst of the telescopes was less

than the performance difference obtained on any one of them by switching from a good eyepiece to a merely acceptable one.

Yet truth is in the details, so here they are:

Our primary job during the evening was to show celestial objects to the guests at Lick's public night. Thus our comparison tests got going slowly, but on the other hand, the telescopes had plenty of time to settle in thermally -- it was a lovely evening, with shirt-sleeve temperatures all night long, and a strong temperature inversion (it got a good deal colder as we drove back down the mountain later on). Furthermore, we all had plenty of time to familiarize ourselves with each other's equipment.

I had always been curious how obvious the performance disadvantage of my Meade's relatively simple and inexpensive ED-glass achromatic objective was, in side by side testing with better designs, so one of the first tests I wanted was a check of color correction on a bright star. Dave North had set up his Takahashi FS 128 next to me, and we both happened to have 9 mm Vixen Lanthanum eyepieces in use -- the long eye relief and moderate magnification made them very useful for the guests' observing, so I suggested we both point our telescopes at Vega. The Vixen LVs sometimes have noticeable lateral color, so we were careful to keep the star well centered in the field. Vega itself was near the zenith at the time.

The difference was quite obvious: The Takahashi showed a little glow around the bright star, as one usually sees from the combined effects of atmospheric and optical-surface scattering, but it was of the same color as Vega itself. The Meade showed a glow that was noticeably larger and brighter, and was of a hue considerably more violet than the star alone. With that data in mind, I walked over to Rich Neuschaefer's Astro-Physics 130 f/8 and asked to look at Vega. I didn't bring the Lanthanum eyepiece with me -- Rich was using an 8 mm Brandon at the time. Vega showed no trace of violet under these conditions -- the star looked neither better nor worse than in the FS 128. I wasn't surprised, for I had looked at bright stars in Rich's telescope before.

Later in the evening -- to get a little ahead of myself -- Rich compared the view of Jupiter in my 127 ED with that in his Astro-Physics 130, using a 10 mm Zeiss Abbe Orthoscopic in both telescopes, looking specifically for color at the edge of the planet. He reported that my ED showed more.

As the evening wore on, Jupiter cleared the trees at the east side of the Lick parking lot. (We had set up on the east side of the main

building, to keep out of the wind, if there had been any, but there wasn't.) It was a showpiece object, and very popular with the public, and we all spent large amounts of time with it in the field of view. Several of the telescope owners were also very experienced lunar and planetary observers -- I know for sure that Rich and Dave are -- and one of the most common reasons for buying a high-performance refractor is to obtain excellent views of the Moon and the planets, so we ended up doing most of our test comparisons with Jupiter as the subject.

The seeing was good enough, and Jupiter high enough, that these instruments were limited by their own optical performance rather than by seeing, for a significant amount of the time. In any ten-second view of the planet, odds were good that there would be a second or two of breathtaking quality, during which such details as festoons and spots in the equatorial zone, or delicate scalloping at the edges of the bands, jumped out in crystal clarity. We all independently settled on magnifications between about 125x and about 175x as providing the best views -- less did not show all the detail, and more reduced the apparent brightness of the planet's cloud tops to the point where many of the low-contrast features became harder to see.

(I had one interesting seeing problem. By coincidence, Robin had set up below my line of sight to Jupiter. My seeing varied in inverse proportion to the number of people lined up to look through his telescope -- warm air rising from their bodies, in the calm conditions of the evening, was enough to cause a noticeable loss of image clarity in my telescope. The problem went away, within seconds, every time they all went away.)

One problem emerged relatively soon: Image quality varied noticeably with the eyepiece that was in use. The variation was not enormous -- differences between telescopes and between eyepieces were both small -- but it was there. For example, I found that when I compared my Meade 127 ED, using a Meade 7 mm Research-Grade Orthoscopic eyepiece, to Dean's Takahashi FS 128, using a 7 mm Nagler, the views were about equal. Yet when Dean borrowed an 8 mm Brandon, or a Takahashi 7.5 mm, or a 16 mm Zeiss Abbe Orthoscopic with a 2x Barlow, his image became better than mine. My own telescope also delivered a better image when I used a borrowed Takahashi 7.5 mm eyepiece.

The effect of eyepiece choice on performance created a problem with the tests: We couldn't just compare the telescopes with the same eyepieces, because the different telescope focal lengths resulted in different magnifications, which obviously affected what we saw. Yet if we juggled eyepieces to achieve closely similar magnifications, how would we know whether any differences in performance came from

the telescopes or the eyepieces?

The fix was to do lots of eyepiece swapping. We compared the same telescope with different eyepieces, and different telescopes with the same eyepiece, and different telescopes with different eyepieces, till a consensus emerged. A little to everyone's surprise, there was considerable agreement on results. I attempted to poll everyone involved in the testing before I wrote the next few paragraphs, and I hope I am not misrepresenting anyone's views, but I believe all participants will see this report in one place or another, and I will happily report if any of them subsequently disagree -- or they may well say so themselves.

First, no one could detect any difference in performance among the two Takahashi FS 128s, the Astro-Physics 130 mm f/8 EDT, and the Astro-Physics 130 mm f/6 EDF: As far as we could tell, these four telescopes all delivered identical planetary performance while looking at Jupiter. People who wish to argue about performance differences between Astro-Physics triplets and Takahashi fluorite doublets will find no grist for their mill in our experience.

Second, a majority of the experienced telescope users present, including all five owners of the five-inch refractors under test, agreed that the Meade 127 ED delivered images that were slightly softer, or slightly less contrasty, or slightly less crisp, than those of the other four telescopes. The Meade is mine, and I expect I made more comparisons involving it than anyone else, but nevertheless, it is difficult to describe just how and in what respect its images were lacking. I certainly could not identify any feature or hint of a feature that I could see in one of the other telescopes, that I could not see in the Meade. Perhaps it was that I could not see those features quite as often in the Meade, or that it was more difficult to do so. The difference was small and subtle. Yet I would say that it was certainly there.

Notwithstanding, a few experienced users, notably Rod Norden, could detect no difference at all between any of the five telescopes tested. Rod kept saying that his favorite telescope was the one he had just looked through, and that he could find all the features he had seen in any one telescope, in any other. These persons, however, were in the minority. (Incidentally, I am not including the opinions of the general public -- Lick's non-amateur-astronomer guests for the evening -- in these results. Most of them looked with great curiosity, and several made sharp and insightful comments about the telescopes, but a large proportion were neither informed nor experienced.)

Third, the perceived differences in telescope performance were indeed small. I didn't know how to quantify them, and after a little thinking suggested that at least we could say that the difference was about the same as we got in any one telescope by switching from a good eyepiece to a merely acceptable one, and people agreed. That comparison isn't particularly quantitative, either, but readers of this report are perhaps more likely to be in a position to compare eyepieces than to compare high-end refractors, so putting the conclusion in those terms does make it more widely understandable.

There was also something close to consensus on eyepieces. The most common opinion was that the best eyepieces present were Zeiss Abbe Orthoscopics -- the newest, 1.25-inch barrel models, recently sold in limited quantity in the United States by Astro-Physics. The only "complaint" about these was that they didn't come in enough focal lengths -- most everybody wanted a 7 or 8 mm for the Jupiter viewing; Zeiss offered nothing between 6 and 10. However, the 16 mm worked well with a 2x Barlow (and I regrettably did not think to ask which manufacturer's Barlow was in use). Tied for second were Vernonscope's Brandons and Takahashi's line. My Meade 7 mm Research-Grade Orthoscopic was third (though I noticed later that it was dirty). The Vixen Lanthanums and a couple of Naglers were each separately inferior to all of the others, though I don't believe anyone compared Naglers to Lanthanums directly.

A couple of people also compared Rich Neuschaefer's MaxBright diagonal with more conventional mirror diagonals, and found the MaxBright produced notably less scattering in the image. I heard at least one person state that he planned to order a MaxBright on the basis of that comparison.

After we had all looked at Jupiter to our hearts' content, I suggested doing formal star testing, and even pointed my Meade at a bright star with a high-power eyepiece, to demonstrate its less than perfect star test (which I have reported in a previous internet posting). There was little interest in star testing, however -- and that sort of makes sense, though the part of me that wants to be scrupulously complete about gathering data, is uneasy. The sense is, that we had just completed exhaustive testing of these telescopes in one of their specific intended uses -- looking at fine, low-contrast planetary detail -- with convincing results. It might have been nice to see whether those results were reflected in star testing, but to do so would more nearly have served as a check on the validity of star testing than have provided additional information on what was most important about the telescopes' performance.

So we called it quits, and packed up.

I said before, that I would repeat two particularly important bottom lines, and I will now do so, word for word:

1.) THIS WAS A TEST OF SPECIFIC TELESCOPES: We certainly did not obtain sufficient statistics to make any claims about the average quality of any of these products, and the quality control of telescope manufacturers is a subject of frequent heated controversy among amateur astronomers.

2.) DIFFERENCES AMONG THESE TELESCOPES WERE VERY SMALL: Though the majority opinion was that they were not identical in performance; nevertheless, a modest minority of the experienced observers who looked through them could detect no difference at all among all five. Furthermore, all of the telescope owners agreed that the performance difference between the best and the worst of the telescopes was less than the performance difference obtained on any one of them by switching from a good eyepiece to a merely acceptable one.

There is one final bottom line:

3.) APERTURE WINS. Remember, this test was conducted at Lick observatory. At the end of the evening, we all went inside and had a look at Jupiter through the 36-inch refractor. This instrument was loafing -- its 55 mm Plossl eyepiece delivered 316x and an exit pupil nearly 3 mm in diameter -- one we associate more commonly with looking at galaxies and emission nebulae than at planets. Even at f/19, a three-foot conventional doublet has a lot of secondary color, and although the seeing was very good, it was not perfect for such a large instrument. Nevertheless, the 36-inch blew us all away. Features only hinted at in our puny five-inch instruments were shown clearly and with lots of detail in the big refractor. How humbling, to be reminded that the best of our modern, high-tech, high-end instruments was barely qualified to replace the finder on this century-old leviathan.

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This is an addendum to the report on comparison testing of high-end 5-inch refractors, that I posted on usenet newsgroup "sci.astro.amateur" with the title, "The Good, the Bad, and the Ugly -- high-end refractor shoot-out". I seek here to summarize a few additional matters that came up in discussions during the following week.

First, the original test was primarily a comparison of optical quality. The observers did not much discuss mechanical features of the

instruments, and our original report, that we could not distinguish any performance differences among four of the telescopes -- two Takahashi FS 128s, an Astro-Physics 130 f/8 EDT, and an Astro-Physics 130 f/6 EDF -- was, as stated, an assertion of equality of optical performance only.

In the absence of discussion among ourselves, I have no consensus to convey, about the mechanical features of the telescopes. However, I think it fair to say that there were no obvious lackings in any of them. I did not see any, and I am sure that someone would have hollared if there had been a real problem. Also, several of us were separately impressed by the very compact size of the Astro-Physics 130 f/6 EDF, and by its whizzy (in both figurative and literal senses) new Astro-Physics GOTO mounting. Several of us were also impressed that such a relatively fast telescope delivered the same optical performance as high-end telescopes of the same aperture and slower focal ratio.

There was a long discussion of whether we had used adequate magnification. Our observations of Jupiter were for the most part at 125x to 175x, and several readers of the original report independently wondered whether we should have used more. We all certainly had plenty of higher magnifications available, both via shorter focal-length eyepieces and via Barlow lenses, and though several of us tried it -- I had my Meade 127 ED up to 285x briefly, and Dave North used 200x on his Takahashi FS 128 for a while -- we each independently settled on some magnification in the range stated. Communications from several of the observers (but not all chose to report) stated that (a) seeing was indeed very good, (b) the magnifications ultimately selected showed more detail on Jupiter than did higher ones, and (3) the problem seemed to be that higher magnification reduced the apparent brightness of some low-contrast features, so much as to make them more difficult to see.

As an indication of seeing quality, I might add that if I had been observing double stars or the Moon, I would have used more than 167x on my Meade 127 ED -- I would have used 228X or perhaps 285x. I did briefly star-test the Meade that evening, using 285x on beta Pegasi, so I have a good idea of what the seeing was like, when determined by the classic method of looking at the diffraction pattern of a bright star: The Airy disc and a couple of diffraction rings were always visible. They were steady for perhaps ten percent of the time, and the rings slowly wavered at other times.

I received several reports from experienced observers who had occasionally used a good deal more magnification on Jupiter, with 5-inch aperture, to good effect. Dave North has done so, as has Rich Neuschaefer, and several usenet posters had, as well. A thoughtful discussion then ensued, of what goes into making one magnification

better than another, but it is beyond the scope of the telescope comparison. The point for our shoot-out was, that we carefully selected magnifications to show the most detail, in good seeing: We were evaluating the telescopes as they were being given an excellent chance to do the kind of observation for which we had for the most part bought them -- to show fine planetary detail.

In the original report, I mentioned that I had not thought to ask what Barlow lenses were in use. Rich Neuschaefer subsequently informed me that the one he used was a Celestron "silver" 2x Barlow, almost as short as a "shorty". This unit is vintage early 1990s, and is not the more recent Celestron "Ultima" Barlow. Rich didn't know the model number. He reported (and I noticed while observing) that this Barlow works very well with his Brandon, Takahashi, and Zeiss Abbe Orthoscopic eyepieces.

Many amateur astronomers have strong opinions about the relative merits of different manufacturers' optics. Thus I close by stating once again that when observing Jupiter in very good conditions, differences in optical performance between four of these telescopes -- the two Astro-Physics units and the two Takahashis -- were undetectable during comparisons by half a dozen or more experienced observers, and that the difference between any of those four telescopes and the Meade was less than the difference obtained in any of the telescopes, by switching between a good eyepiece (say, Brandon) and a merely acceptable one (say, Vixen Lanthanum LV).