



 **Compact,
hybrid bearing
Turbopumps**

HiPace® 2300

- High pumping speeds for both light and heavy gases
- High gas throughputs, even for heavy gases
- High process integrity

Are you looking for a
perfect vacuum solution?
Please contact us:

Pfeiffer Vacuum, Inc. • USA
T 800-248-8254
F 603-578-6550
contact@pfeiffer-vacuum.com

www.pfeiffer-vacuum.com



than Mach 3. The event resulted in an involuntary free fall that in all probability began at a speed much greater than Mach 1. The pilot, Bill Weaver, survived his high-speed free fall; his reconnaissance system officer, Jim Zwyer, did not.

Alan Spero

(alanspero@earthlink.net)
Thermal Storage Systems Inc
Ramona, California

■ **The discussion** about Felix Baumgartner's fall to Earth gives an interesting analysis of a hair-raising event. A similar historical feat that few may know about involves the return of the early Soviet cosmonauts.

In the race into space, the Soviets sent Yuri Gagarin and his colleagues in the Vostok program into orbit without having confidence they could bring them back in one piece. Their solution, which they kept secret for many years, was to have the cosmonauts eject from their reentering capsule at an altitude of 7 km and parachute to the ground. Valentina Tereshkova, the first woman in space and part of the Vostok program, was chosen for the job in part because she was a member of a parachuting club.

So while Baumgartner started his jump essentially at rest, Gagarin and colleagues started with a big initial velocity. Stories about the 2012 jump got me wondering just how fast the cosmonauts were going. I've posted my analysis at <http://allthingsnuclear.org/skydiving-from-a-reentering-spaceship>.

David Wright

(dwright@ucsusa.org)
Union of Concerned Scientists
Cambridge, Massachusetts

■ **Colino, Barbero, and Tapiador reply:**

We thank Alfonso Gañán-Calvo, Alan Spero, and David Wright for their careful, detailed comments on our Quick Study. Gañán-Calvo's point about sonic sheets is pertinent; it shows that the topic is too subtle to be judiciously covered in the limited space of a Quick

Study. We thank him for expanding on it for PHYSICS TODAY readers. Also, because the real flow structure was unknown, we simplified the plots: The offending panel b of the figure, for which "downstream" is incorrectly used instead of "upstream," is obviously not a precise depiction of the aerodynamics but a sketch intended for a wide audience. For a discussion of such issues as low-intensity shock waves around the suit and the complex flow patterns that expansion waves, shocks, and turbulence form past a body—downstream—at transonic or supersonic regimes, see the more detailed treatment given in references 1–3.

Spero and Wright bring attention to two other free falls that we think can hardly be compared with Baumgartner's. The SR-71 pilot and reconnaissance system officer could have experienced a fall with a presumably horizontal, probably supersonic initial speed. Nevertheless, it is hard to tell without ejection trajectory data, fall dynamics details, or any other information except the tragic outcome.

We also know little about the jumps associated with the Vostok program. Neither example can be compared with the jump by Baumgartner—or even the one by Joseph Kittinger in 1960—not only because the two jumpers began their descent at nearly zero speed but especially because precise speed and location measurements were available. Indeed, we should thank the Red Bull Stratos project for making such quality data available.

References

1. J. M. Colino, A. J. Barbero, *Eur. J. Phys.* **34**, 841 (2013).
2. R. A. Granger, *Fluid Mechanics*, Dover (1995), chap. 15.
3. S. F. Hoerner, *Fluid Dynamic Drag: Practical Information on Aerodynamic Drag and Hydrodynamic Resistance*, Hoerner (1958).

Jose M. Colino

(josemiguel.colino@uclm.es)

Antonio J. Barbero

(antonio.barbero@uclm.es)

Francisco J. Tapiador

(francisco.tapiador@uclm.es)

University of Castilla-La Mancha, Spain

Letters and commentary are encouraged and should be sent by email to ptletters@aip.org (using your surname as the Subject line), or by standard mail to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842. Please include your name, work affiliation, mailing address, email address, and daytime phone number on your letter and attachments. You can also contact us online at <http://contact.physicstoday.org>. We reserve the right to edit submissions.

Correction

October 2014, page 12—The first sentence in the second paragraph under the subhead "Cosmic foil" should read, "The team's search turned up 20 impact craters, including the one shown in figure 2." The majority of craters were identified manually. ■