



soon hopes to announce a second, \$4 million donation for science. Such funds are needed, he says, to offset declining support for science by Congress.

Small predicts that the brouhaha will subside once the plan is fleshed out, and that he and the scientists will eventually see eye to eye. "Everybody wants the Smithsonian to do well," he says. —ELIZABETH PENNISI

MISSILE DEFENSE

SDI Redux Has One Element Critics Like

Be careful what you ask for, goes an old proverb, because you may get it. Last week, that warning came true for scientists long skeptical of a Star Wars-style weapons system. President George W. Bush's vision for a nuclear missile defense system, outlined in a speech at the National Defense University, contains a concept they advocate—but only as part of a most costly and ambitious scheme that they vehemently oppose.

Bush has embraced the idea of shooting down hostile missiles during their initial ascent into space. The approach, known as boost-phase intercept, is based on the fact that the bright flame of a burning rocket, viewed against the cold background of space, provides a much clearer target than would a weapon later in flight. But Bush made it clear that boost-phase defense would supplement, rather than replace, other antimissile weapons. The Pentagon, Bush said, has been instructed to examine "all available technology and basing modes for effective missile defenses that could protect our deployed forces, our friends, and our allies."

It's the broad scope of the president's plans—along with his dismissal of the 1972 Anti-Ballistic Missile (ABM) Treaty and preliminary cost estimates for missile defense that range into the hundreds of billions of dollars—that troubles many scientists. Bush declared that "today's most urgent threat" is posed by a small number of missiles in the hands of "some of the world's least responsible states ... for whom

terror and blackmail are a way of life." But the skeptics believe that the Administration has other foes in mind. "They want to counter China and get a start on Russia," says Richard Garwin, a senior science fellow at the Council on Foreign Relations and a member of a 1998 commission on ballistic missile threats chaired by current Defense Secretary Donald Rumsfeld.

According to Garwin, boost-phase defense is far more likely to work than other missile defense schemes. The Pentagon already has satellites in orbit that routinely detect missile launches on Earth, 40,000 kilometers away. The missile's flame would appear 1600 times brighter to a ground- or sea-based sensor linked to a boost-phase interceptor, he notes, while the job of shooting it down would become incomparably more difficult once the rocket stopped firing and the plume disappeared. In addition, nuclear tipped, balloon-shrouded weapons sailing through space are likely to be accompanied by a host of identical-looking decoys. The string of failures in U.S. tests

3 to 4 minutes. As a result, boost-phase interceptors could not reach missiles launched from the interior of large nations such as Russia or China. (Space-based systems are conceivable, but decades away.)

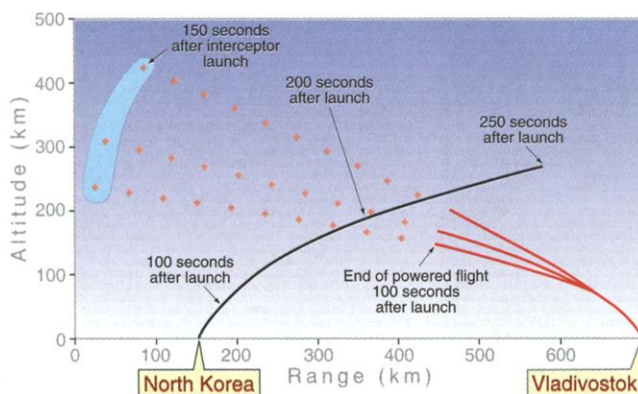
"That's good news, because it means you can be reassuring towards those two countries," says Michael O'Hanlon of the Brookings Institution in Washington, D.C., at a briefing held the day after Bush's speech. In contrast, interceptors could be parked just outside the borders of "rogue states" such as North Korea and Iraq. O'Hanlon believes that such defenses, while banned by the letter of the ABM Treaty, are consistent with its spirit.

The issue's shifting terrain has led some arms control advocates to worry that support for any form of missile defense will help the Bush Administration in its quest for a more ambitious system. "I struggle with that question," says Brookings's Ivo Daalder, who supports a boost-phase defense system but opposes Bush's effort to "junk the ABM Treaty."

However, even boost-phase intercepts are a long way from being a mature technology.

Philip Coyle, a former director of operational test and evaluation at the Defense Department, says that the technical limitations of a boost-phase defense will become more obvious on closer scrutiny. One problem is the need to react with extreme speed. "You have got to get warning from a satellite back through a command-control system—Cheyenne Mountain—and then out to a Navy ship or a land-based intercept system in a couple of minutes," says Coyle, who now works for the Center for Defense Information in Washington, D.C. "This is not a process where the president or the secretary of defense is going to be involved. There won't be time for that in the boost phase."

These and other problems are likely to be raised in a report by an American Physical Society (APS) panel now being convened. A 1987 APS panel was very critical of the directed energy weapons—lasers, particle beams, and other technologies—that were once part of former President Ronald Reagan's Strategic Defense Initiative (*Science*, 1 May 1987, p. 509). The panel should finish its work early next year. —DANIEL CHARLES
Daniel Charles writes from Washington, D.C.



Target practice. This plot shows a North Korean missile being intercepted shortly after launch, a feat much more difficult for midflight weapons like this failed U.S. test (inset).

to date of such midrange weapons provides a hint of the difficulty of the task.

Paradoxically, the limited geographic range of boost-phase defense renders it even more attractive to Garwin and other arms control advocates. No interceptor could catch up to a ballistic missile launched from a site thousands of kilometers away, because the boost phase of a missile's trajectory lasts only