tailed look at the young stars in these galaxies. NICMOS may also make the Deep Field even deeper. As the universe expands, light from objects moving away from Earth is stretched to longer wavelengths in a phenomenon called redshift. NICMOS will be able to spot galaxies so distant that even their shortest wavelengths are redshifted into the infrared. While the most distant objects currently known in the Deep Field are at redshifts of between 4.5 and 5.5—more than 11 billion light-years away—"I think we could see objects up to [a redshift of] 14—if they exist," says Thompson. That would be equivalent to peering 12 billion years or even more into the past.

In addition to installing STIS and NICMOS, the Discovery crew will update Hubble's original tape recorder with a larger digital recorder that will allow STIS, NICMOS, WFPC2, and the Faint Object Camera to collect data simultaneously. While one instrument is pointed at a target, the other three will scan the adjacent sky for hard-to-find objects, such as brown dwarves—small, dim cousins of stars that some astronomers think make up the "dark matter" affecting the motions of galaxies. But Richard Terrile of NASA's Jet Propulsion Laboratory in Pasadena, California, says there's no telling what else these "serendipity scans" might turn up: "We can expect to be surprised. Reality always seems to be more exciting than we can predict."

–Gretchen Vogel

PLASMA PHYSICS

ITER Review Team Takes Bullish Stance

SAN DIEGO—A large team of U.S. fusion researchers last week began poring over the latest blueprints for a massive international machine designed to demonstrate fusion power and provide plasma physicists with an exciting new facility. The review of the $10 billion International Thermonuclear Experimental Reactor (ITER) was prompted by controversy over the reactor's design and the shrinking U.S. fusion budget.

The sweeping review is likely to give ITER a green light, say panel members, despite concerns that the design may not be adequate to reach the ultimate goal of a self-sustaining fusion burn. Even skeptics on the panel say they are confident that the machine can be made to work despite the thorny technical hurdles facing designers. "If it's a question of thumbs up or down, I'm definitely putting my thumbs up for ITER," says Richard Hazeltine, head of the Institute for Fusion Studies at the University of Texas, Austin, and a critic of the program. Indeed, bringing the fusion community together is a central element of the review, requested by the Department of Energy (DOE), which will examine cost, design, and objectives and is expected to take another 3 months to complete. "This is deliberately set up to make sure we don't miss anything," says John Sheffield, director for energy technology programs at DOE's Oak Ridge National Laboratory in Tennessee and chair of DOE's fusion science advisory panel, which met here last week.

Sheffield's team must wrestle with divergent opinions on the validity of theoretical models for the ITER design, including the new turbulence model proposed by two Texas researchers that raises doubts about the machine's ability to create an extended fusion reaction (*Science*, 6 December, p. 1600). Program supporters tend to downplay the debate as simply the latest example of the traditional tension between theorists, who look for reasons why a design will fail, and experimentalists, who believe they can make the design meet its goals. "We are confident ITER will work," says Paul Rutherford, a Princeton University theoretical physicist who chaired an ITER technical advisory committee that recently reviewed the detailed design. While it would be nice to have a good theoretical model, he says, "we do not see one that would compete with the current empirical model—at least, not right now."

THE COST OF ITER
(in 1997 dollars)

Category	Estimated Cost
Preconstruction	$539 million*
Construction	$8043 million
Construction Support	$1133 million
Research	$400 million
TOTAL	**$10.115 billion****
Annual Operating Cost	$500 million

* Includes personnel.
** Excludes contingency reserve and infrastructure costs.
SOURCE: RAYTHEON

For ITER's director, Robert Aymar, the problem is not with the design, but with the balance between the two camps. He complains that U.S. theoreticians have too much influence within the community.

Although the review panel seems likely to back the project, insiders say that its report will probably urge the ITER staff to make better use of both theory and existing data. "We're lacking a lot of physics," says John Lindl, scientific director of Lawrence Livermore National Laboratory's inertial-confinement fusion program. "But things can be done to resolve these issues," he adds, without delaying construction.

Reviewers also are likely to cast a skeptical eye on the machine's ultimate goal of sparking a self-sustaining fusion burn. Ignition "is slipping out of the vocabulary, [but] it's a minor retreat," says Hazeltine. Even if the machine doesn't reach ignition, ITER supporters point out, controlled fusion could still be achieved for extended periods by continuously pumping power into the chamber. Adds Nermin Uckan, who leads Oak Ridge's ITER effort, "People are being cautious about ignition. It would be nice, but it is not the end-all."

DOE officials have asked Sheffield's group to complete the study by 1 May. But even if it gives ITER a glowing report card, the United States will play no more than a minor role in ITER construction and operation. Anne Davies, who directs DOE's fusion program, told the advisory panel on 22 January that U.S. participation cannot exceed its current annual level of roughly $50 million, and that a U.S. site for ITER is out of the question. Japan's government, by contrast, recently asked the Diet for funding to study potential sites in that country, while Italy is making a bid to use European Union funding set aside for economic development to pay for at least a portion of the 60% or more of the construction costs to be borne by the host. ITER supporters hope construction can begin as early as 1998, with start-up by 2008.

But while the United States may be only a small financial actor in the project, its participation could be crucial. A U.S. pullout, warn its supporters, could spook European and Japanese politicians. With this in mind, ITER managers spent 2 days briefing the advisory panel on the painstaking engineering and science behind their 1500-page detailed design, which was completed in December. The exercise was intended to arm U.S. officials with enough information to head off attempts by financially pressed legislators to pull out of the project. "It takes a carpenter to build a house, but even a jackass can knock it down," says one advisory committee member.

ITER's advocates hope that the review will end the quiet warfare over how best to spend diminishing federal dollars on fusion. In the past, critics have argued that the project could divert money from domestic plasma research. "There was a time when there was a feeling that ITER could eat us up," says Hazeltine. "Now, we're all trying to sing the same song, since there is the possibility that plasma physics could die." That somber thought, it seems, is concentrating the minds of empiricists and theorists alike.

–Andrew Lawler