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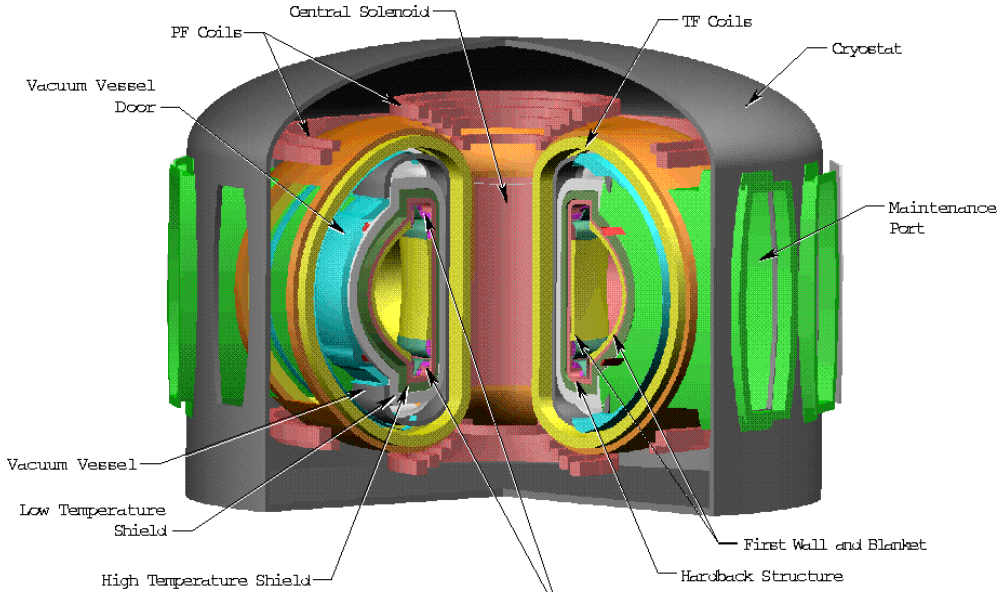
Advanced design studies for power systems and next generation experiments

"While the U.S. fusion program has been restructured from fusion energy development to innovation-driven research focused on fusion's scientific foundations, we must preserve our long term energy option. The restructuring process has created opportunities to explore cost-effective pathways to this vision, with steps that are more affordable, deliver an improved fusion product, and provide the greatest return on investment of federal research funds."
Dr. N. Anne Davies, Associate Director, Office of Fusion Energy Sciences, Department of Energy

Advanced design studies guide fusion research and development toward attractive and achievable fusion power systems, and provide critical technical information for major program decision points. This research has increased in value with the expanded focus on innovation in the U.S. fusion program.

Conceptual design of commercial fusion facilities is essential in guiding fusion research and development, and in focusing the fusion program on the development of useful products. Conceptual design studies ensure that all physics and technology aspects can be integrated within the constraints imposed by physics, materials, and technology to produce a system that is both economically and environmentally attractive, as well as technologically feasible.

The advanced design studies also provide a forum for "roll-back" planning. Most research in this area is performed under the umbrella of the national power plant studies program, which involves scientists from most major universities, national laboratories and industry active in fusion research.



ARIES-RS Power Plant

ARIES

The ARIES series of power plant studies guide fusion research towards a viable product. The ARIES-RS is a conceptual design of a 1000 Megawatt electric commercial power plant based on a reversed-shear tokamak plasma. It is hailed as an attractive vision for fusion with a reasonable extrapolation from both physics and technology.

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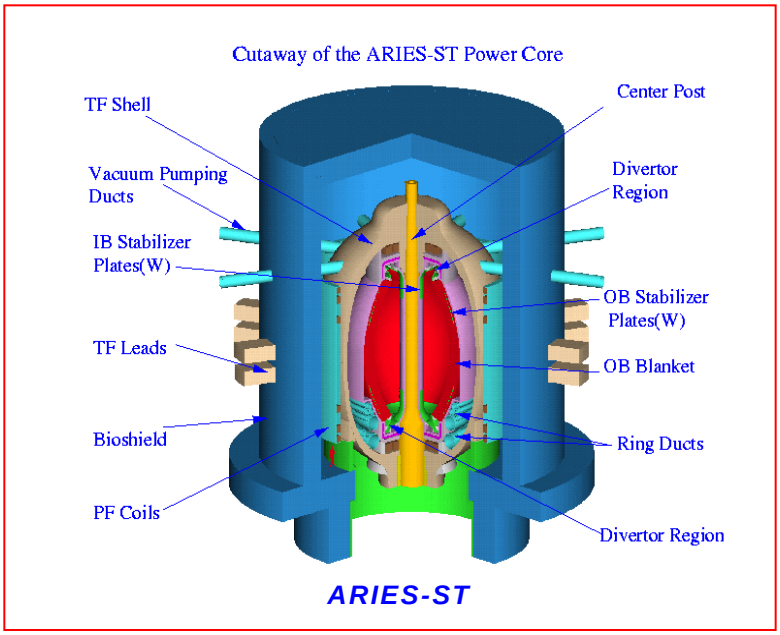
The ARIES-ST is an innovative design that considers a combination of materials to address performance goals. The study identified key directions for spherical torus research. The study indicates that a 1000-Megawatt electric spherical torus power plant is comparable in size and cost to an advanced tokamak power plant.



Next Step Options

Burning plasma experiments, as well as technology and material testing facilities, provide data to support critical program decisions. This research links broad national and international interests in fusion development, and explores options with substantial variation in performance, cost, and technology requirements.

These studies also provide a forum for "roll-forward" planning. More innovative, yet integrated approaches are needed to make the challenge of fusion energy more tractable.

Within the VLT infrastructure a Next Step Options study was commissioned to evaluate lower-cost candidates for a burning plasma experiment through a modular pathway.

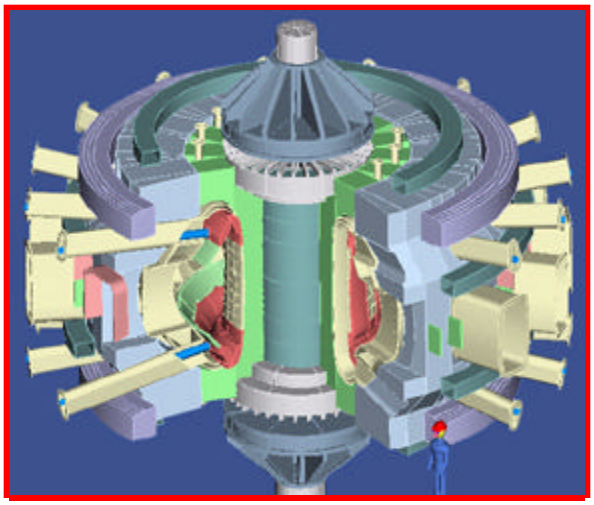


Illustration of Fusion Ignition Research Experiment (FIRE) for Next Step Options

Development of fusion as a commercial product is a grand challenge, in part for technical reasons, in part due to limited resources, and in part due to competition from other options. Strategic planning and forecasting studies help develop criteria describing what fusion must do to be successful in the global market place.

Socioeconomic studies of fusion's role in a sustainable global energy strategy address the potential of fusion to resolve worldwide energy issues such as greenhouse gases and sustainable economic development, as highlighted in the Rio and Kyoto Agreements. Studies of fusion non-electric applications (or co-generation) help develop potential new clients and new products for fusion. It is the advanced design activity that leads the search for development paths for fusion to minimize the cost and risk, as well as compress the timetable for realizing fusion power systems.