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STATUS OF OAK RIDGE NATIONAL LABORATORY
FUSION ACTIVITIES

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Joint Fusion Power Coordinating Committee
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MASTER

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MWR

ORNL FUSION PROGRAM
1985 BUDGET - \$60 MILLION

- CONFINEMENT EXPERIMENTS
 - ISX-B (TOKAMAK) → ATF-1 (STELLERATOR)
 - EBT-S → EBS (?)
 - STX (?)

- THEORY

- ATOMIC PHYSICS

- SHIELDING

- TECHNOLOGY DEVELOPMENT
 - SUPERCONDUCTING MAGNETS
 - PELLET INJECTION
 - RF PLASMA HEATING
 - MATERIALS

- FUSION ENGINEERING DESIGN CENTER

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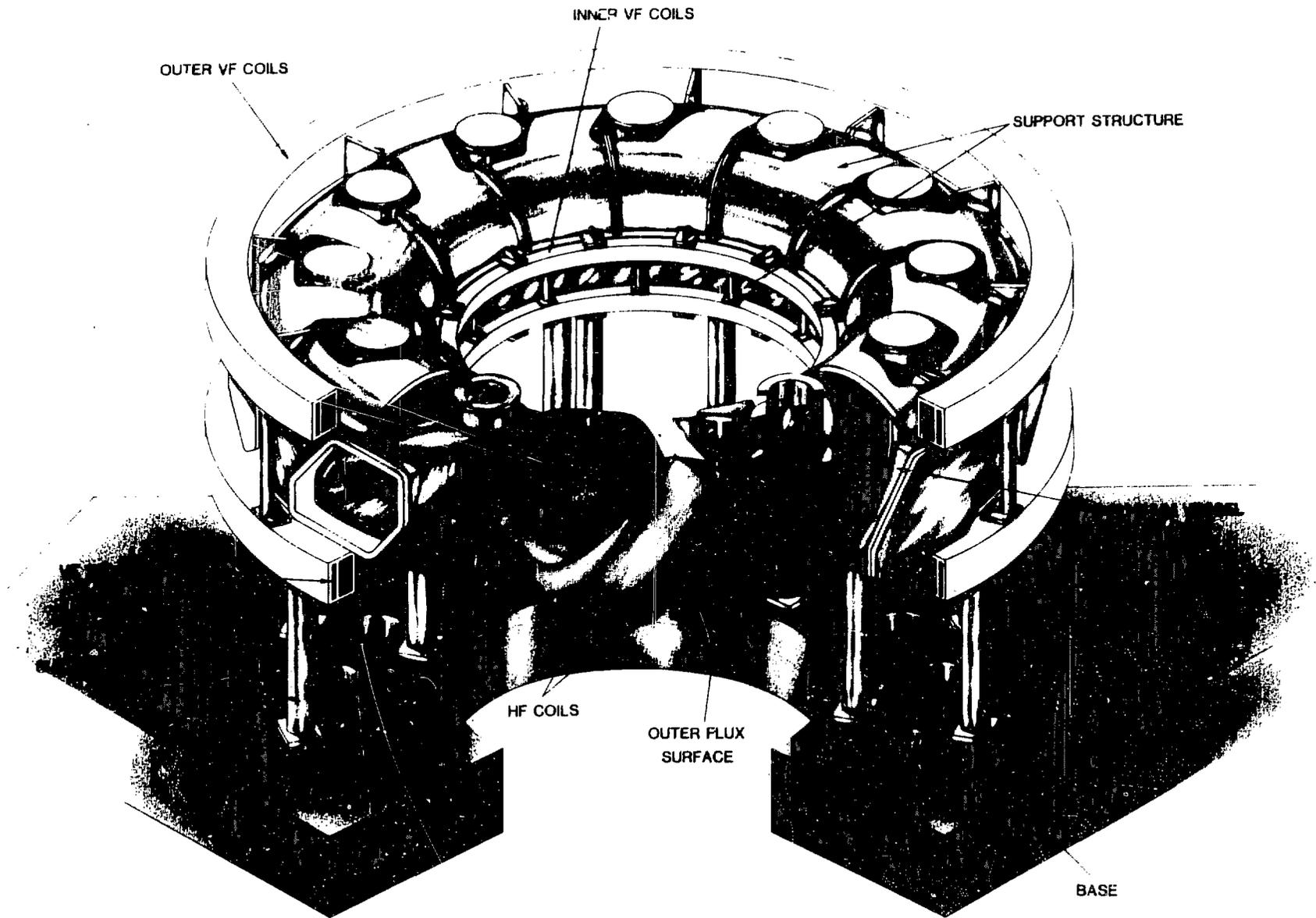
ADVANCED TOROIDAL FACILITY (ATF)

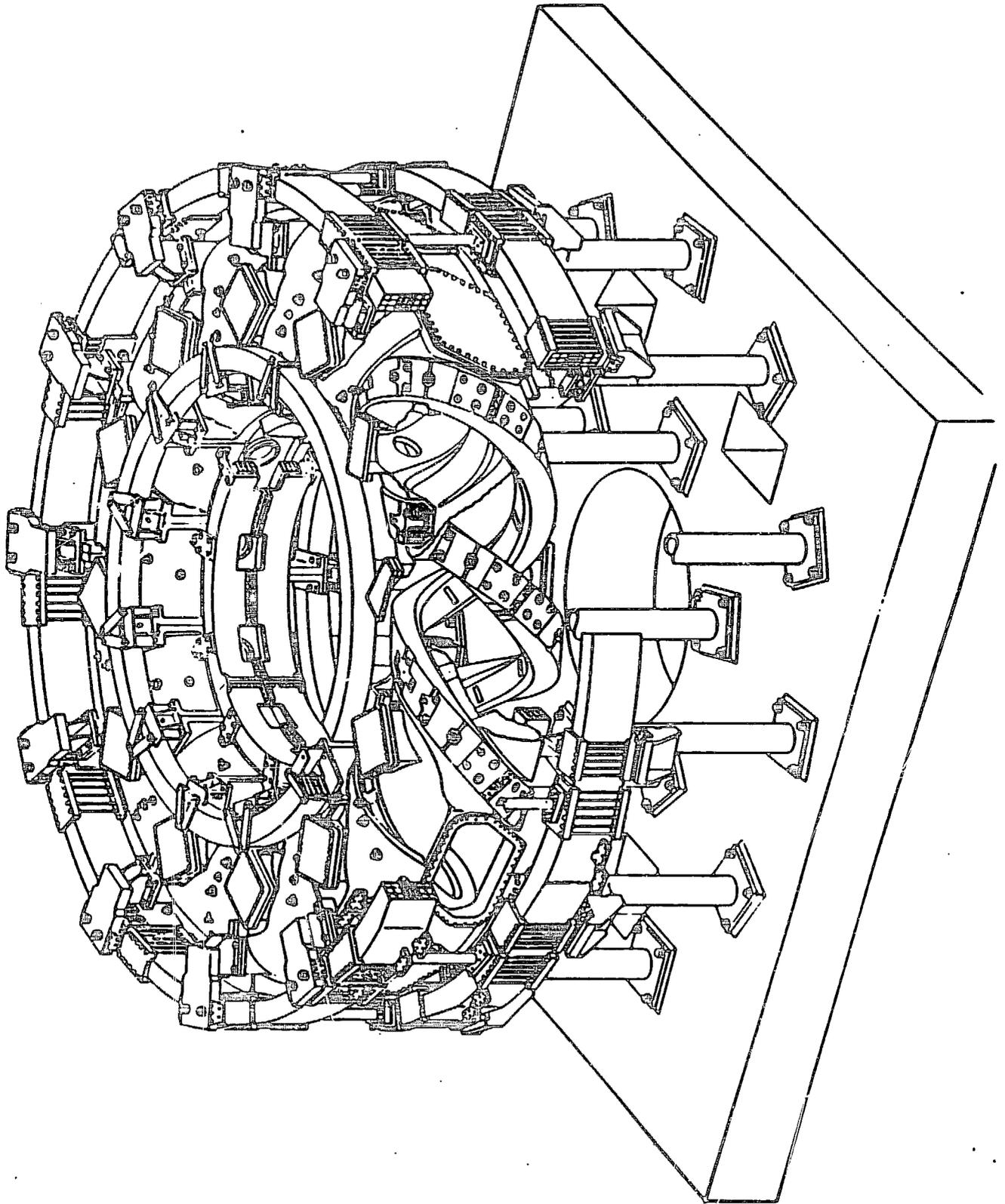
- MODERATE-ASPECT-RATIO TORSATRON
 - ASPECT RATIO 7, $\ell = 2$, $M = 12$
 - MAJOR RADIUS 2.1 m, MINOR RADIUS 0.3 m
 - $B_0 = 2$ T for 5 sec, 1 T STEADY STATE
 - PREDICTED $\beta > 8\%$

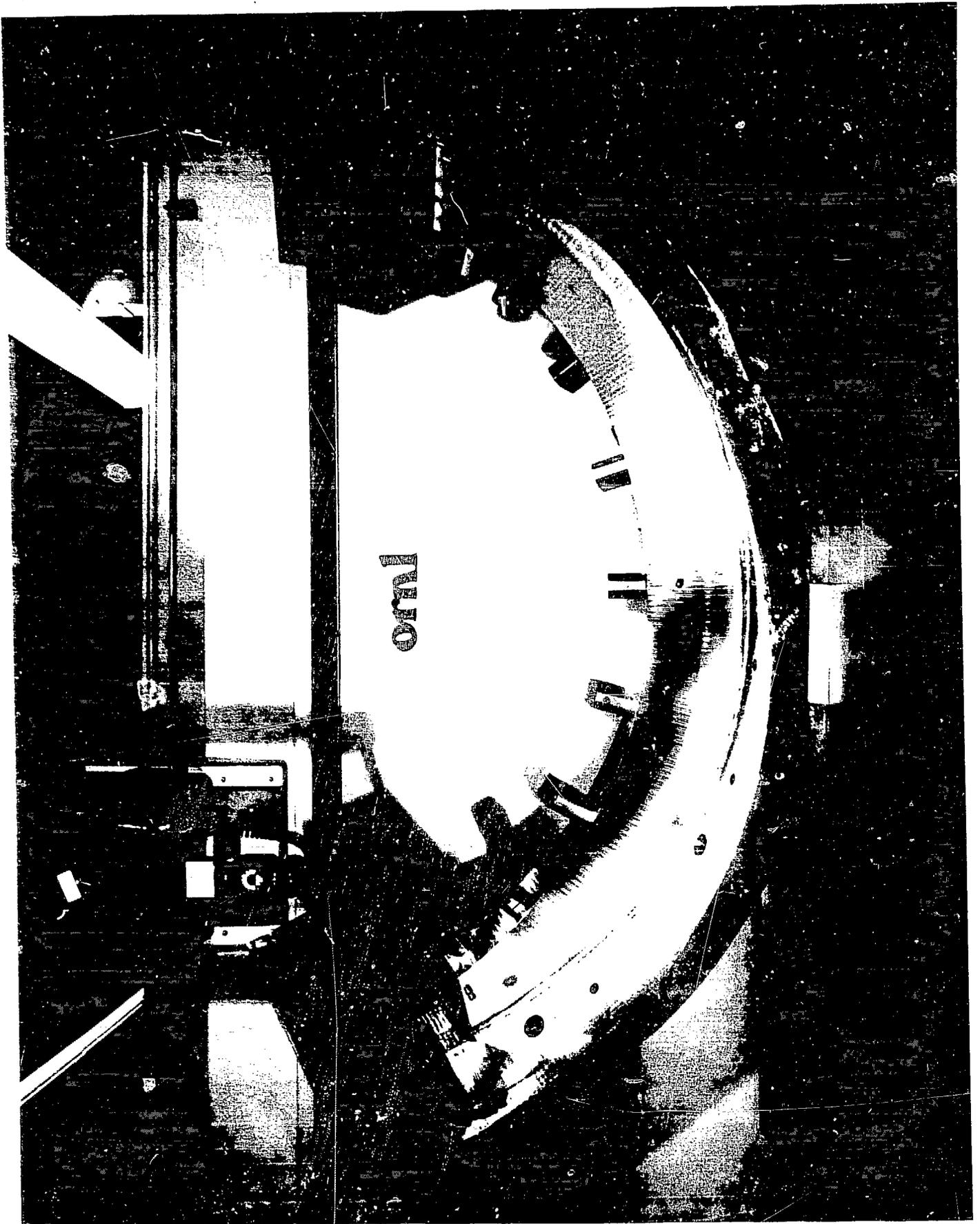
- FLEXIBLE
 - GOOD HEATING AND DIAGNOSTICS ACCESS
 - VARIETY OF PLASMA CONFIGURATIONS CAN BE STUDIED, INCLUDING HELICAL AXIS

- DIFFICULT CONSTRUCTION
 - HELICAL COILS ± 1 mm
 - STEADY STATE MAGNETIC FIELDS

- STATUS
 - FABRICATION IN PROGRESS
 - COST ~\$20 MILLION
 - SCHEDULED COMPLETION OCTOBER 1986 (BUT TIGHT)





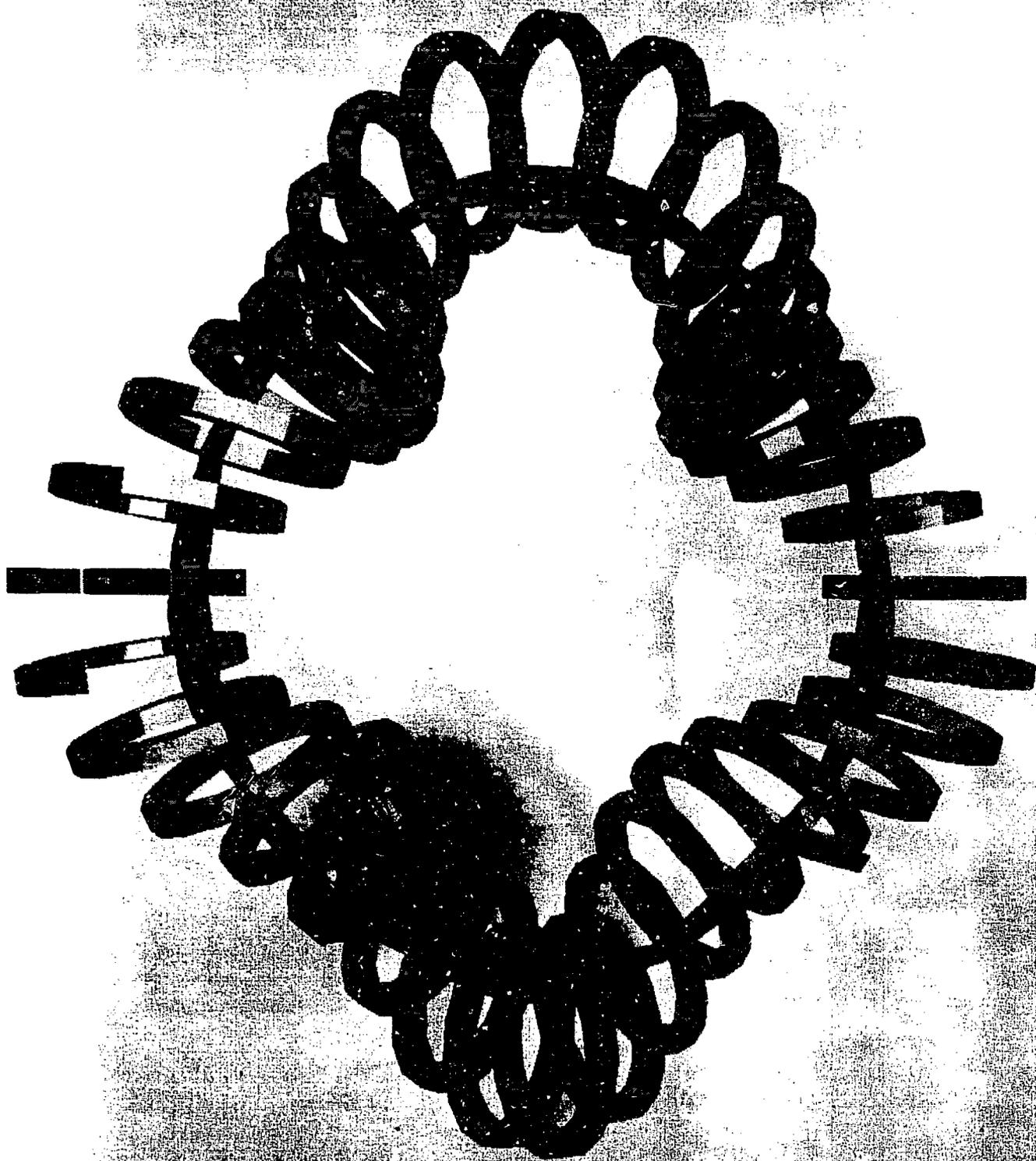


**A PROTOTYPE SEGMENT FOR THE ATF HELICAL
FIELD COIL HAS BEEN ASSEMBLED**



FLEXIBLE HELIAC

- ORNL-DEVELOPED FLEXIBLE HELIAC FORMS BASIS FOR SPANISH TJ-II
 - ADDITION OF $\nu = 1$ HELICAL HARD CORE TO HELIAC
 - ALLOWS INDEPENDENT CONTROL OF TRANSFORM AND MAGNETIC WELL
- MODEST SIZE
 - MAJOR RADIUS 1.5 m
 - AVERAGE PLASMA RADIUS 0.25 m
 - COST ~\$15 MILLION
- STATUS
 - PLANNED FOR CONSTRUCTION IN MADRID BY JEN
 - OPERATE IN EARLY 1989



ELMO BUMPY SQUARE (EBS)

- EBS IS REARRANGEMENT OF EBT INTO SQUARE
 - USES 16 EBT MIRROR COILS
 - ADDS 8 HALF-SIZE COILS IN EACH CORNER
 - COST ~\$4 MILLION, CONSTRUCTION TIME ~2 YEARS

- CHANGES IN PAST YEAR
 - REDUCED TO 5 CAVITIES (FROM 6) PER SIDE
 - REDESIGNED CAVITIES, CORNERS, AND PUMPING SYSTEMS
TO REDUCE COST

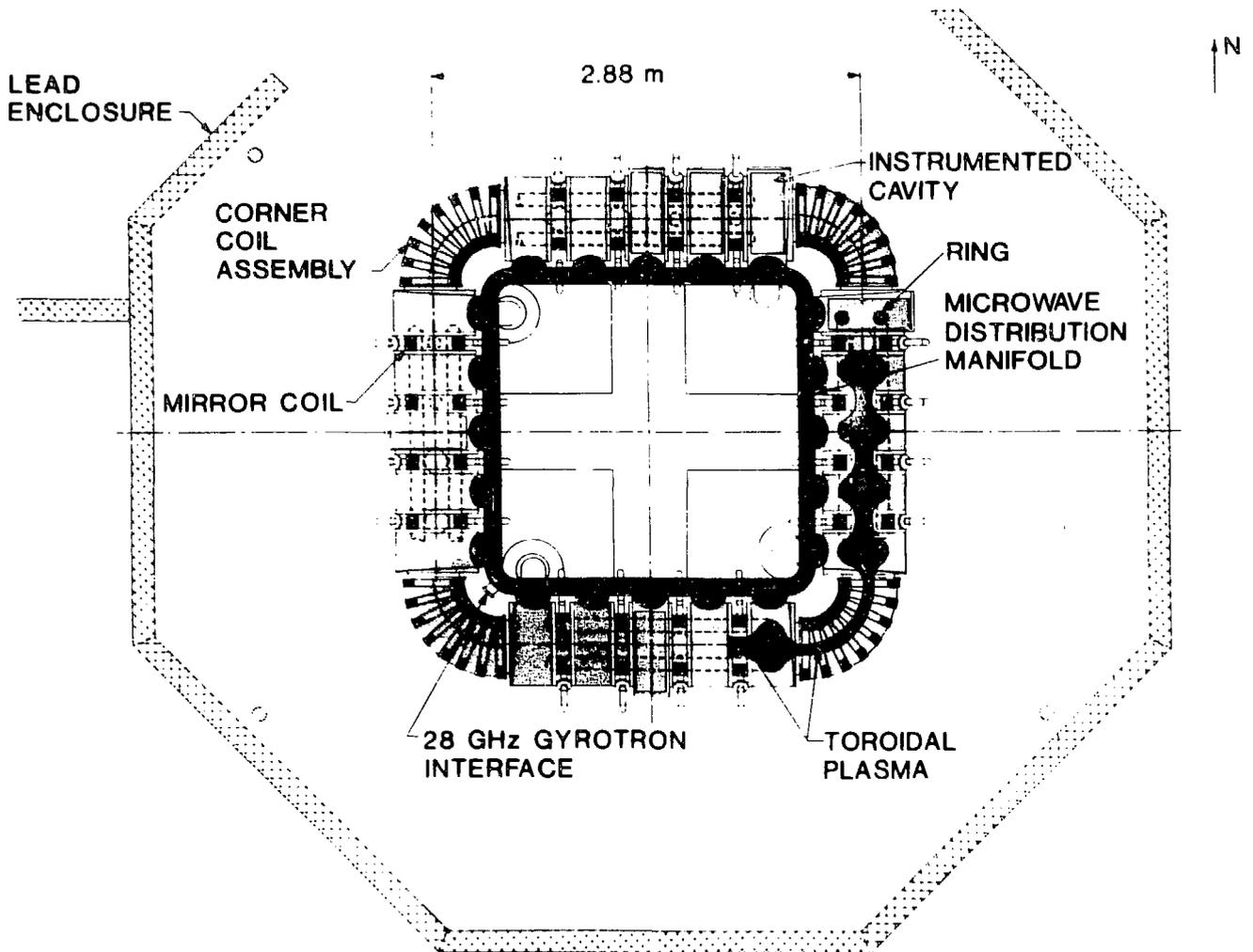
- STATUS
 - PROPOSAL SUBMITTED TO DOE
 - COMMITTEE REVIEW IN OCTOBER
 - DECISION EXPECTED IN DECEMBER

ELMO BUMPY SQUARE

REARRANGEMENT OF ELMO BUMPY TORUS

- SUBSTANTIALLY REDUCED LOSSES
- RINGS TO GIVE AVERAGE WELL
- FLEXIBILITY TO TEST AND OPTIMIZE

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RECENT ADVANCES IN BUMPY TOROID SCIENCE

- DETERMINED STRUCTURE OF THE ENERGY FLOW IN EBT AND EBS
 - QUANTIFICATION OF MAJOR PARASITIC LOSSES (EBT)
 - REDUCTION OF THESE BY DRIFT ORBIT OPTIMIZATION (EBS)
- COMPLETED ANALYSIS OF FIELD AND PROBE DATA FOR RINGS IN STRAIGHT MIRROR
 - REAFFIRMATION OF REVERSAL OF AVERAGE FIELD GRADIENT BY RINGS
- DETERMINED STRATEGY FOR TESTING RING-PLASMA STABILITY THEORY
 - REDUCED FIELD (18GHZ RINGS) TO INCREASE BETA
 - HIGHER BETA RINGS TO INCREASE RING-PLASMA COUPLING
- REWORKED EBS DESIGN FOR COST EFFICIENCY
 - REDUCED NUMBER OF MIRRORS PER SIDE TO MINIMUM NEEDED
 - DETERMINED ALTERNATIVE CORNER COIL DESIGNS FOR POWER SAVINGS

SPHERICAL TORUS EXPERIMENT (STX)

- SMALL, LOW-ASPECT-RATIO TOKAMAK
 - ASPECT RATIO, 1.7
 - MAJOR RADIUS 0.45 m, MINOR RADIUS 0.27 m
 - BEAM HEATED
 - NATURAL ELONGATION (~1.8)
 - B_T 0.5 T
 - I_p 0.9 MA
- NEW PARAMETER SPACE REGION LEADS TO:
 - $\beta \sim 20\%$
 - DISCRIMINATORY TEST FOR SCALING LAWS
 - STRONGLY PARAMAGNETIC PLASMA
 - HIGH PLASMA CURRENT FOR GIVEN q_{edge}
 - OSCILLATING MAGNETIC FIELD CURRENT DRIVE (?)

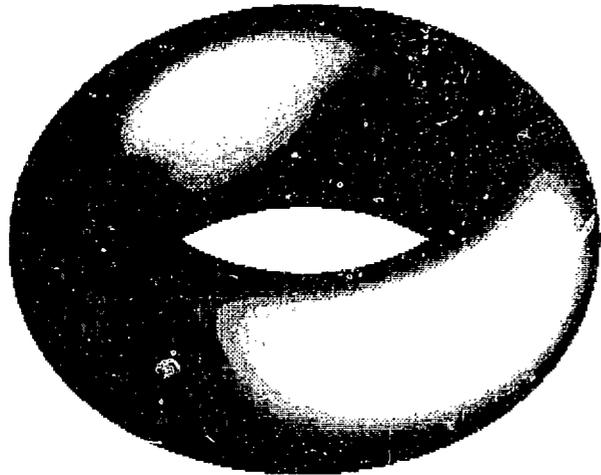
SPHERICAL TORUS EXPERIMENT (STX)

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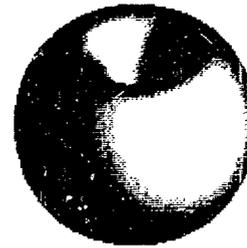
- CONSTRUCTION
 - UTILIZES EXISTING HEATING SYSTEM
 - COST ~\$6 MILLION
 - DESIGN AND CONSTRUCTION TAKE ~2-1/2 YEARS

- STATUS
 - PROPOSAL SUBMITTED TO DOE
 - COMMITTEE REVIEW IN SEPTEMBER
 - DECISION EXPECTED IN DECEMBER

TOROIDAL PLASMAS APPARENTLY LIKE
TO BE SPHERICAL



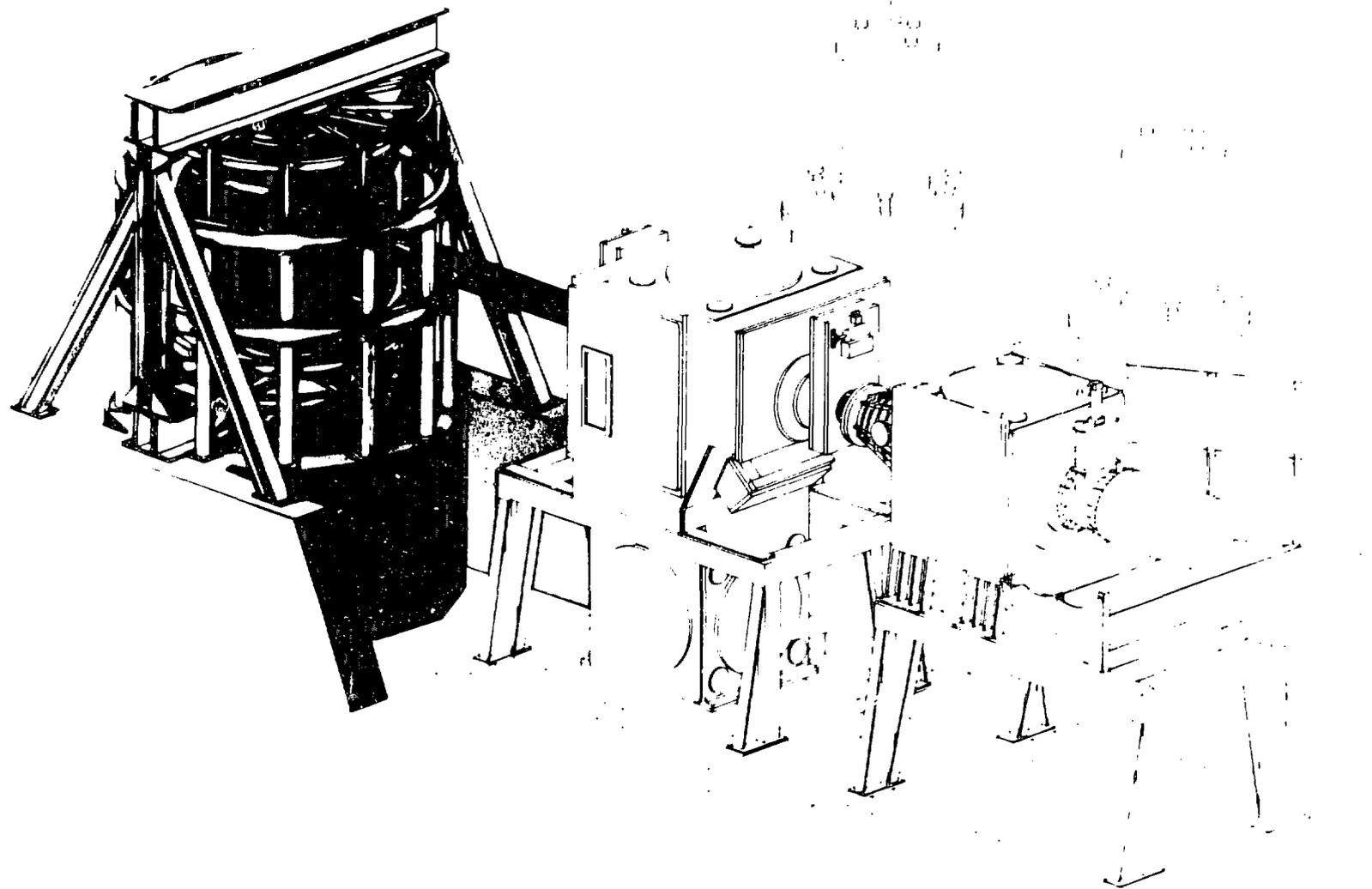
CONVENTIONAL TOKAMAK
PLASMA



SPHERICAL TORUS
PLASMA

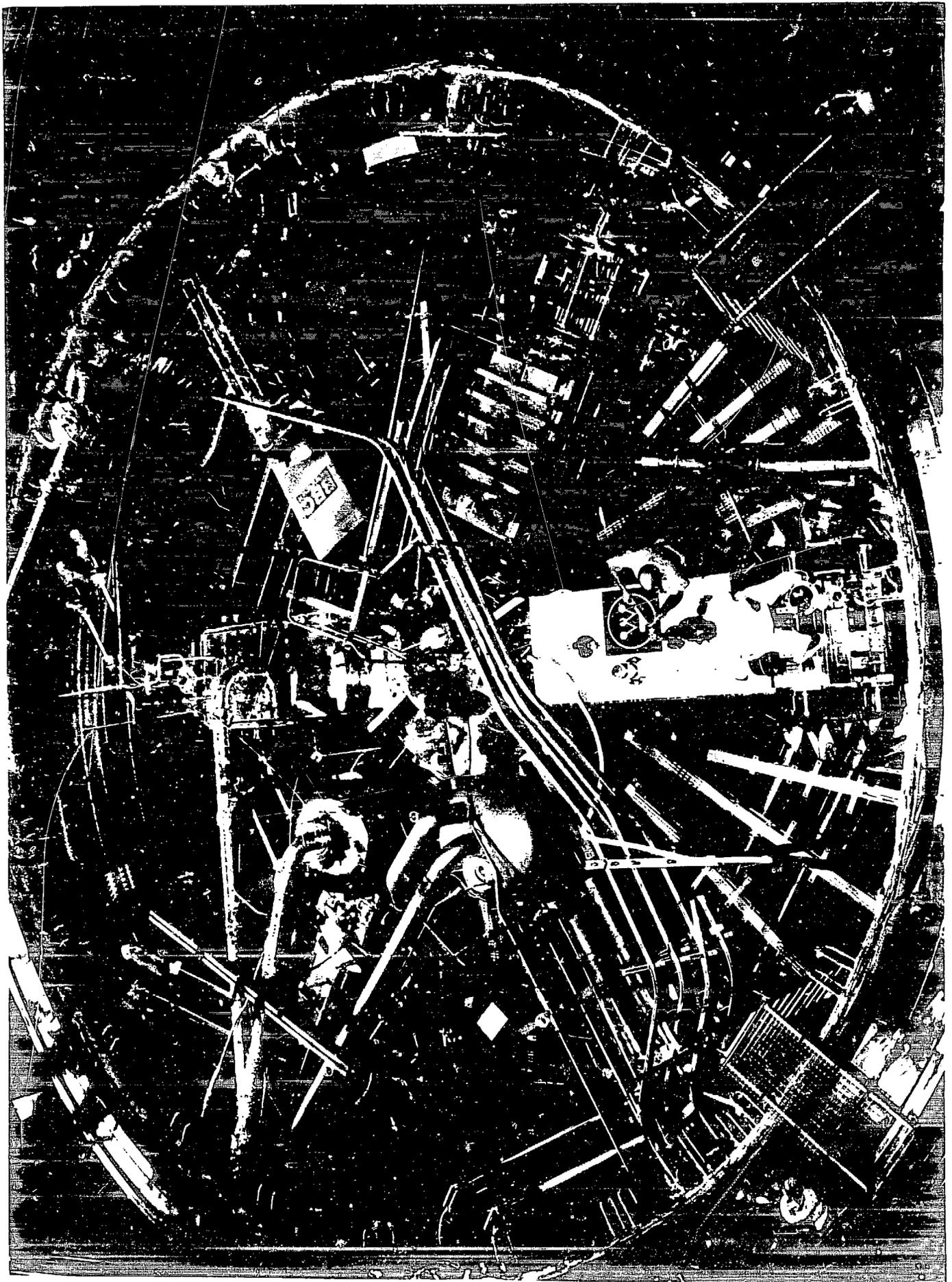
MAJOR RADIUS/MINOR RADIUS	3	1.5
HEIGHT/WIDTH	1.6	2
REQUIRED SHAPING	MUCH	LITTLE
MAGNET I/PLASMA I	10	2

A SPHERICAL TORUS CONCEPT, THE STX WILL BE PROPOSED TO DOE



LARGE COIL PROGRAM

- ALL SIX COILS NOW IN TANK
- STARTUP EXPECTED IN LATE OCTOBER



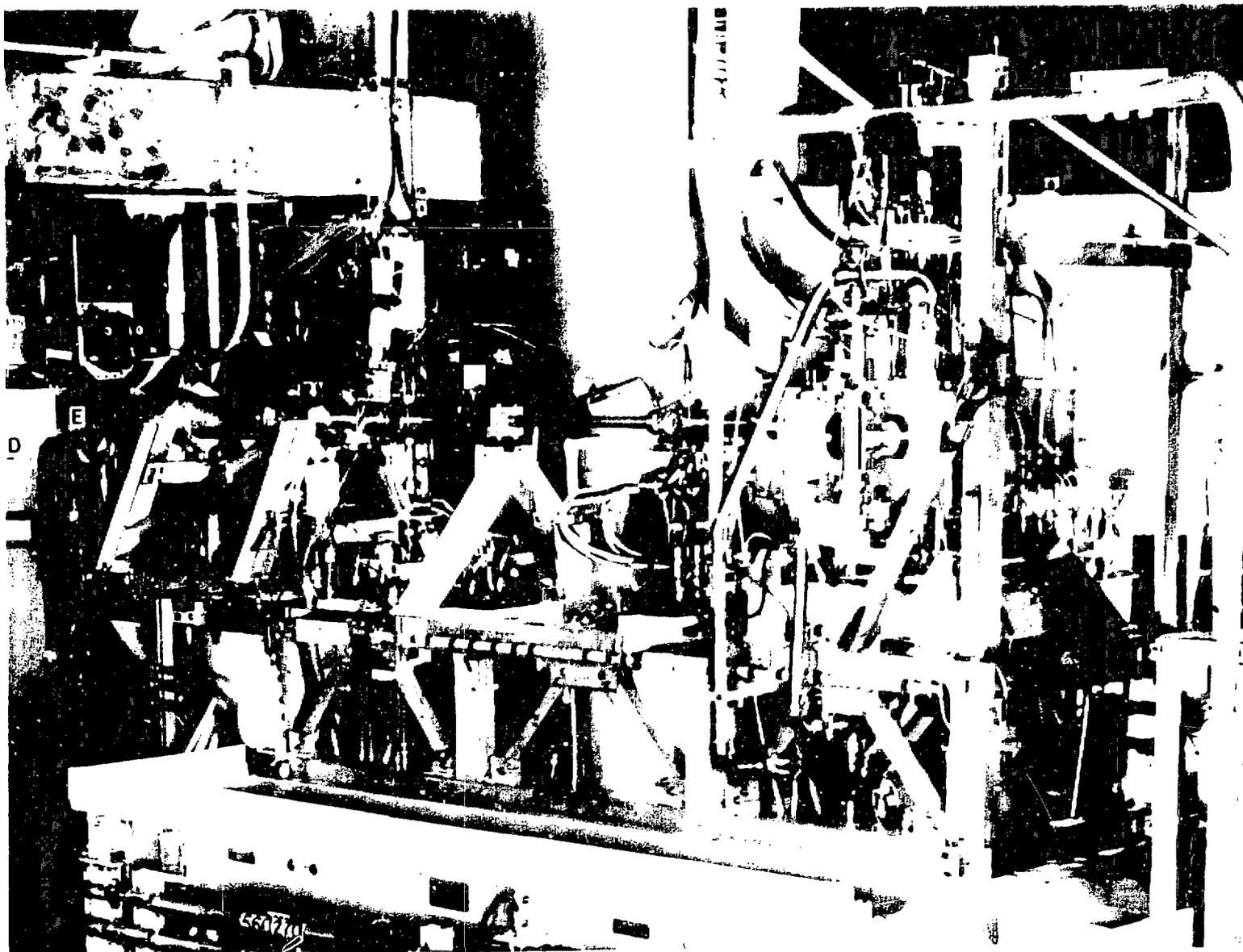
PELLET INJECTOR PROGRAM

- REPEATING PNEUMATIC INJECTOR USED ON TFTR
 - 2.7 and 4.0 mm DIAMETER PELLETS
 - 1500 m/sec
 - 5 PELLETS PER DISCHARGE

- CENTRIFUGAL INJECTION BEING IMPROVED
 - GOAL OF >1000 m/sec, 30 PELLETS/sec
 - VARIABLE PELLET SIZE

- 8-SHOT DEUTERIUM INJECTOR BEING DEVELOPED FOR TFTR
 - VARIABLE PELLET SIZES, VELOCITIES, AND INTERVALS

**AN ORNL-BUILT REPEATING PELLET INJECTOR WAS SUCCESSFULLY
OPERATED ON THE TFTR AT PRINCETON**

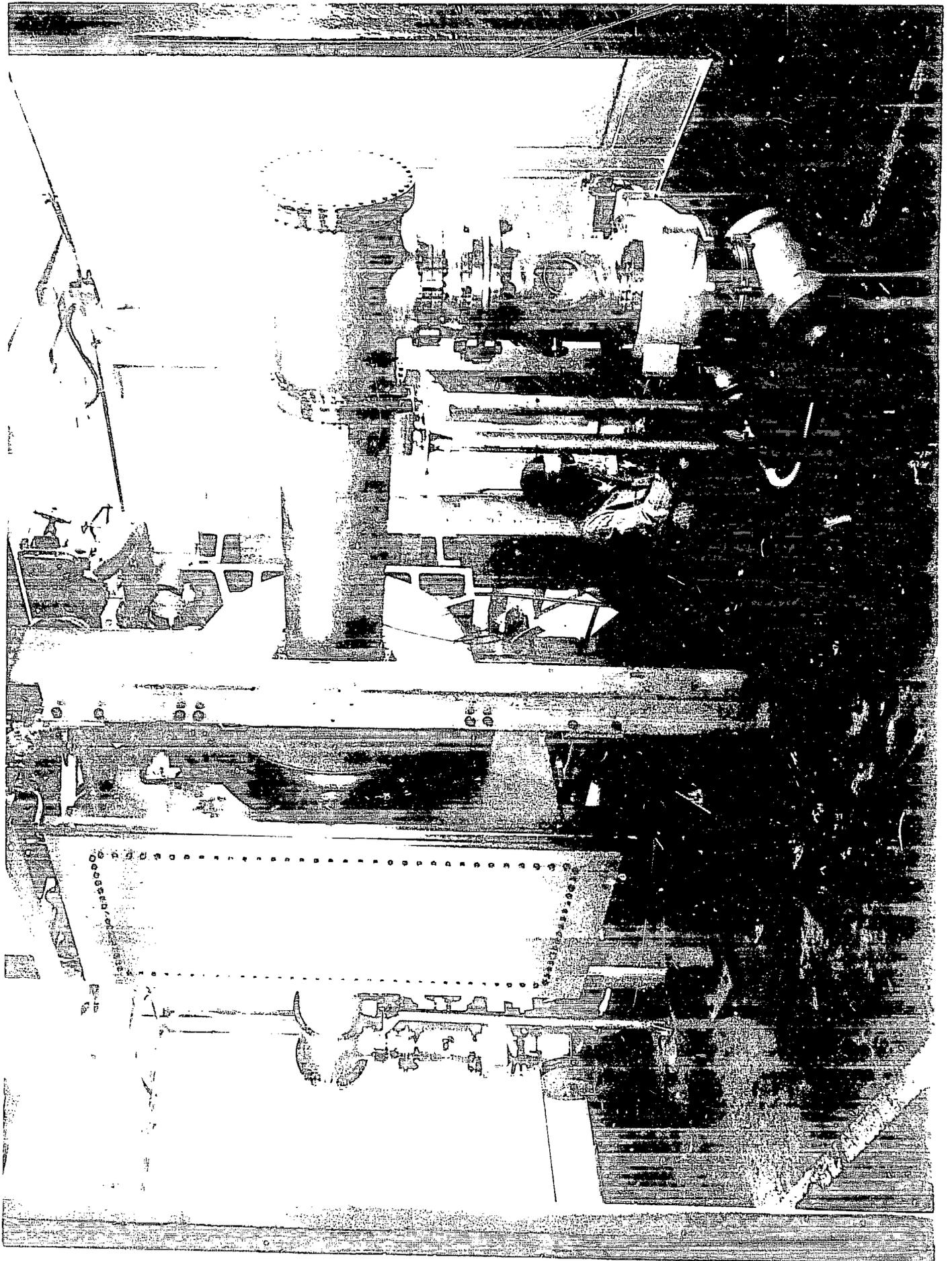


RF HEATING PROGRAM

- RF TEST FACILITY COMPLETED
 - SUPERCONDUCTING MAGNETS
 - STEADY-STATE ECH-GENERATED PLASMA
 - FLANGED OPENING EQUIVALENT TO LARGEST TFTR PORT

- MULTIMEGAWATT VACUUM FEED-THROUGH DEVELOPED
 - 90 kv, 1.0 kA
 - TESTED 55 kv STEADY-STATE

- IMPROVED ANTENNAS AND FARADAY SHIELDS BEING DEVELOPED



RF FEED-THROUGHS HAVE BEEN VERY SUCCESSFUL

