13th INTERNATIONAL STELLARATOR WORKSHOP

<u>Historical Background to Stellarators at ANU</u>

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Toroidal plasma studies started (under Bruce Liley) in 1964 with a capacitor-bank-powered thick -copper -shell stabilised toroidal "θ –z pinch" apparatus, LT- 3 which could operate over a wide range of toroidal to poloidal magnetic field ratios, ie 1>>q>>1. It soon showed best results when q>1, ie as a tokamak., and produced the earliest results linking mhd mode structure and disruptions to q values. Later work extended to runaway phenomena, the Ware pinch, etc. During the period 1964-69, while most toroidal interest was in strong pinches and stellarators, it was the only tokamak outside USSR.
This was replaced in the late 1970's by a somewhat larger (R/a=0.5/0.1m) thin-shelled torus with toroidal coils (4T max) powered by the very large Homopolar Generator (HPG), with greatly improved diagnostic access and an extremely fast and accurate position control. It was used mainly for detailed studies of mhd activity including pre-disruption phenomena, and as a test-bed for novel diagnostics (eg far forward scattering from fluctuations at 10 μm).

To escape the global plethora of tokamaks existing by then, design studies began in 1977 for a large stellarator that would use the availability of the HPG and its potential to supply megampere currents to solve the then main problems facing stellarators, viz.the modularity essential for a reactor and accommodating the large forces on the helical windings at high fields and reasonable aspect ratios (as evidenced inW7-b). A design based on the concept of combining toroidal and helical elements into self-supporting cage-like modules using large cross-section copper alloy conductors emerged, and winding laws optimised to provide greatest plasma volume, largest transform etc. by iterative computation using codes developed from Culham. The final design had parameters like B<4T, R=3.1m,<a>=0.34m, t (a)≥ 0.6, t (0) =0.2, but was never built! (The above engineering problems were solved later much more elegantly in Garching.)

The planned closure of the HPG in early 80's and enforced reliance on capacitor banks and <10MVA available mains power meant reappraisal just at the time when the heliac concept (which avoided strong helical windings!) emerged from PPPL. To test the still unproven configuration a table-top model, SHEILA,(R/<a>=19/3cm) was built in 1984. This, particularly after the ORNL inspired helical control winding was added, proved so productive and versatile as a research tool that the design for a much larger device, H-1, was commenced. Detailed measurements on SHEILA not only confirmed all the calculated vacuum field properties, but gave considerable confidence in understanding the effects of eg mechanical errors , wave propagation and surface structure etc. and indeed supported the whole heliac concept as a flexible and practical research tool despite the unfamiliar geometry. H-1 itself was designed around available resources (eg power supplies, space, machine tools and a large stock of copper conductor) and originally built and operated on a very small budget. In 1995 it became a National Facility with Federal Government funding which has resulted in considerable upgrading of facilities, especially of plasma heating and magnet.power supplies.