

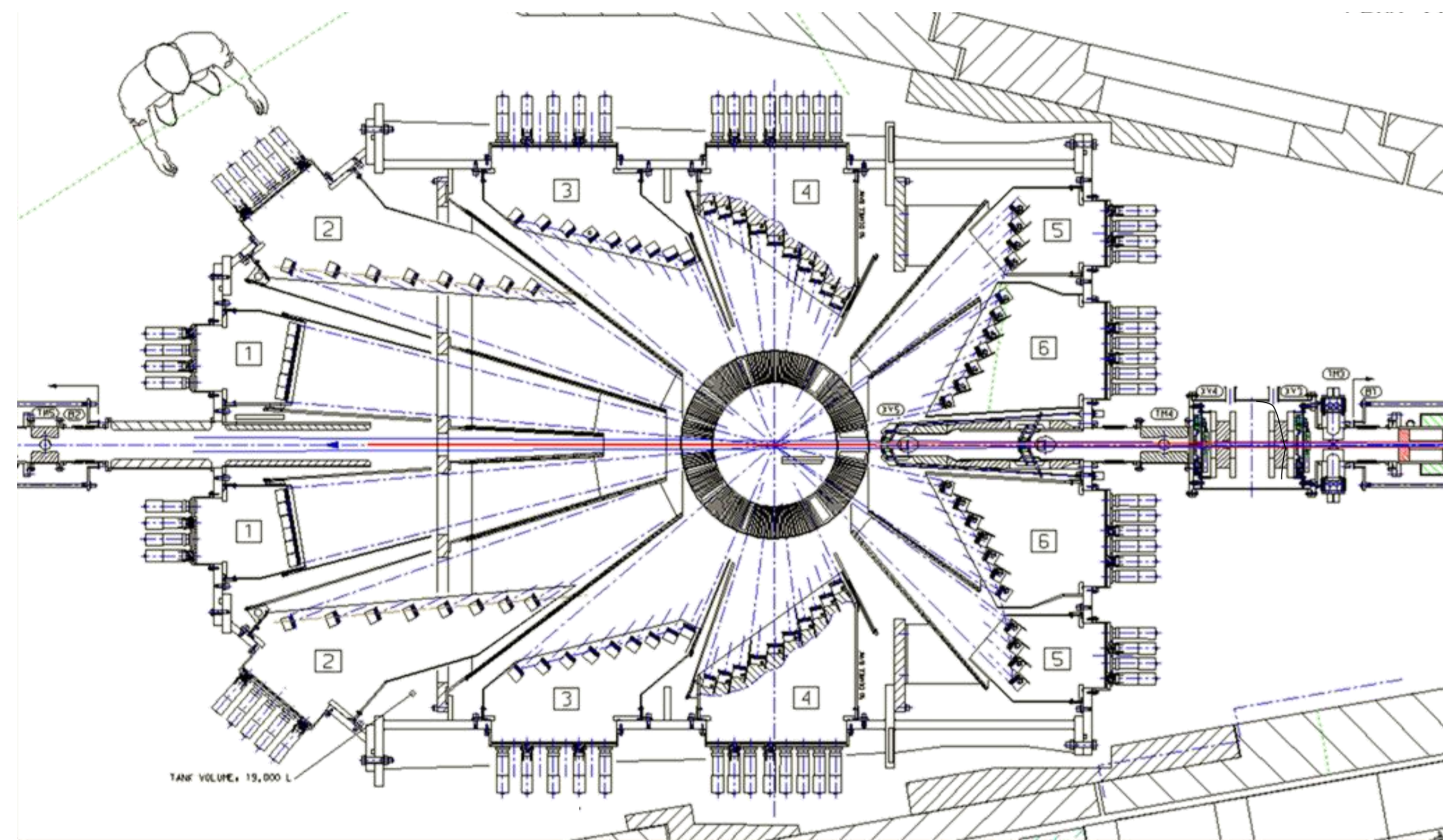
The Polaris Diffractometer at ISIS: Planned Upgrade and New Facilities

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In 2006 the CCLRC Facility Development Advisory Board awarded a grant of £3.3m to ISIS to fund an upgrade to the Polaris medium resolution powder diffractometer. Due for completion in late 2010, the upgraded instrument will have a substantial increase in detector coverage over the current instrument, as well as benefiting from improvements to the incident beam collimation and the provision of a radial collimator around the sample position to reduce the background signals from sample containment equipment. In addition, a further £700k of funding has been provided by the Swedish Research Council Vetenskapsrådet for the provision of advanced sample environment equipment.

Instrument design



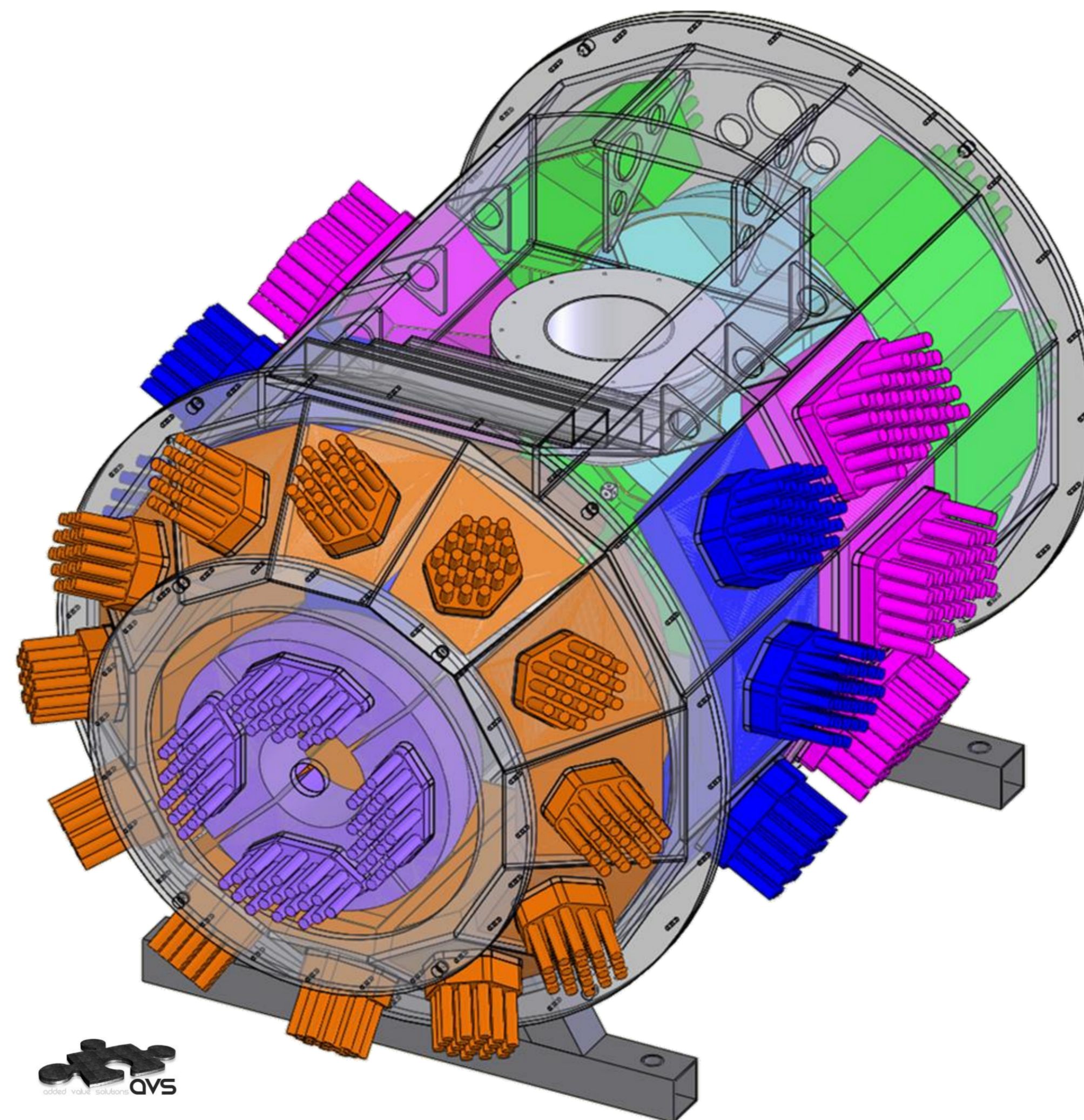
The upgraded Polaris will have a primary flight path of 14m. 40 detector modules will give a total coverage of ~44% of the maximum possible 4π steradians.

Opportunities for new science

- **Materials for energy production and storage.**
H storage media, fuel cell oxides, Li⁺ battery materials, radiation resistant ceramics.....
- **Disordered and nanostructured materials.**
piezoelectric perovskites, negative thermal expansion, catalysts, nanostructured materials, glasses.....
- **In-situ diffraction.**
electrochemical processes, reaction kinetics, hydrothermal synthesis.....
- **High pressures and earth science.**
equation-of state measurements, pressure-induced amorphisation, explosives and propellants.....
- **Texture studies and archaeometry.**
solar cells, corrosion resistant coatings, strain history of rocks, non-destructive testing and authenticity of artefacts.....

Vacuum vessel

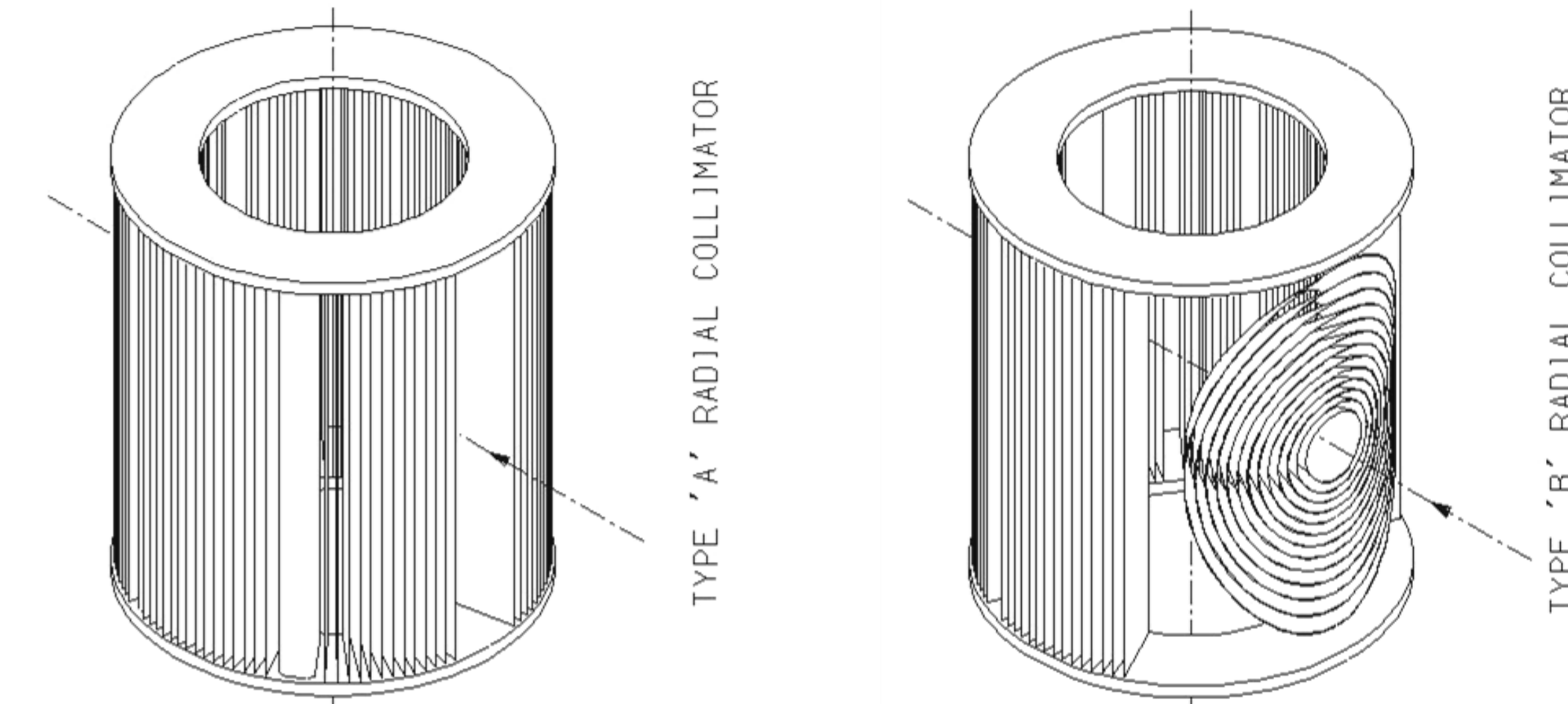
The upgraded instrument will feature a large vacuum vessel (below) inside which all the detectors will be mounted. Constructed out of stainless steel and having a volume of ~20,000 litres, this tank has been designed in Spain by AVS, and will be built in Spain by Cadinox as part of an "in kind" contribution to ISIS.



Comparison of the current Polaris instrument performance (in brackets) with predicted performance of the upgraded instrument.

Detector Bank		2θ Range (°)	Secondary Flight path (m)	Solid Angle (ster)	Count rate increase	Δd/d (%)	d _{max} (Å)
very low angle	1	6 - 14 (13 - 15)	2.3 (2.2)	0.26 (0.01)	~21	>2.7 (3.0)	19.6 (21.0)
low angles	2 3	19 - 34 (28 - 42) 40 - 67	2.4 - 1.3 (2.7 - 1.7) 1.6 - 1.0	1.04 (0.05) 0.92	~29	1.2 - 1.9 (1.2) 0.85	8.7 (8.2) 7.0
90 degrees	4	75 - 113 (85 - 95)	1.1 - 0.7 (0.8)	1.33 (0.48)	~3.0	0.51 (0.66)	3.2 (4.1)
back-scattering	5 6	135 - 143 (130 - 160) 146 - 168	1.5 - 1.4 (1.3 - 0.6) 1.2 - 0.8	0.59 (0.29) 1.53	~3.6	0.30 (0.53) 0.30	2.7 (3.2) 2.7

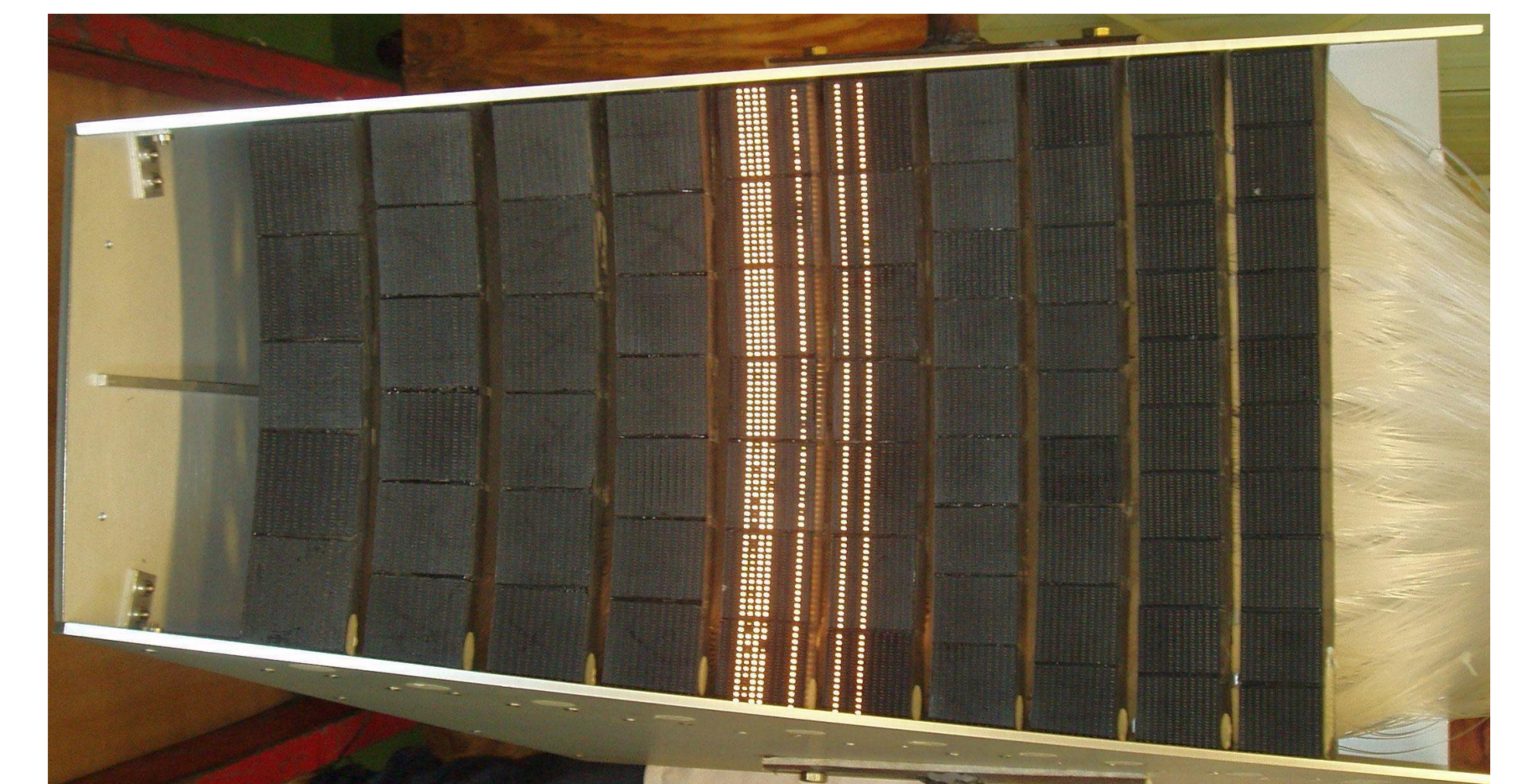
Radial collimator



Two options are being considered for the design of the radial collimator.

- Type A (left), comprises straight vertical vanes, and is similar to the design currently used successfully at ISIS on GEM. This design will oscillate.
- Type B (right), employs a mix of straight vanes close to $2\theta=90^\circ$ scattering angles and curved cones at forward- and back-scattering angles. This design will not oscillate.

Detectors



Each detector module is built from a series of modular blocks arranged to follow the Debye-Scherrer cones. The photograph shows a test of the optical fibre coding prior to attachment of ZnS scintillator