New Capabilities on PELICAN Spectrometer

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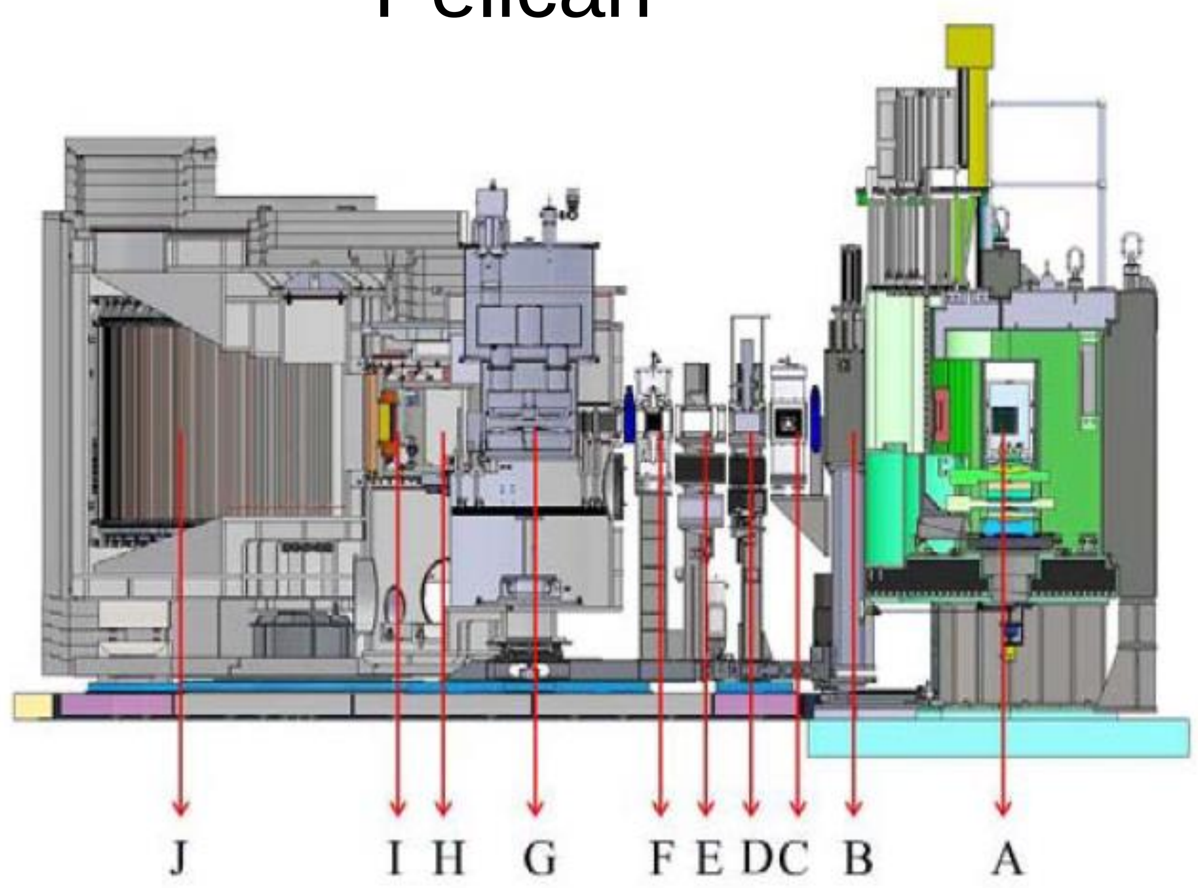
The PELCIAN instrument is a cold-neutron time-of-flight spectrometer located at the Australian Centre for Neutron Scattering [1]. The spectrometer has been in continuous user operation since Oct 2014. Excellent scientific outcomes have been achieved across a wide range of scientific areas including advanced energy materials, novel magnetic materials and multifunctional materials over the last six years. A wide range of sample environments has played a significant role in maintaining and expanding the instrument capabilities from the study of atomic diffusion to the lattice and spin dynamics. In addition to the standard cryofurnace capable of measuring from 1.5 K to 800 K, more complex sample environments such as gas sorption, light irradiation, electric fields and dilution temperatures have been available for the user community. Recently, we have further extended the instrument capabilities to high magnetic fields, fast reaching dilution temperatures and high pressure (up to 2 GPa). These new sample environment capabilities have opened up new scientific opportunities on the instrument.

Ultralow Temperature -10 mK

- **Triton successfully tested on Pelican.**
- **Achieved 10 mK base temperature, in about three hours.**
- **Comprehensive testing of background completed.**
- **Open up new scientific opportunities at ultralow temperatures approaching zero K, for example, searching for spin liquid state in novel magnetic materials.**

Installation of Triton

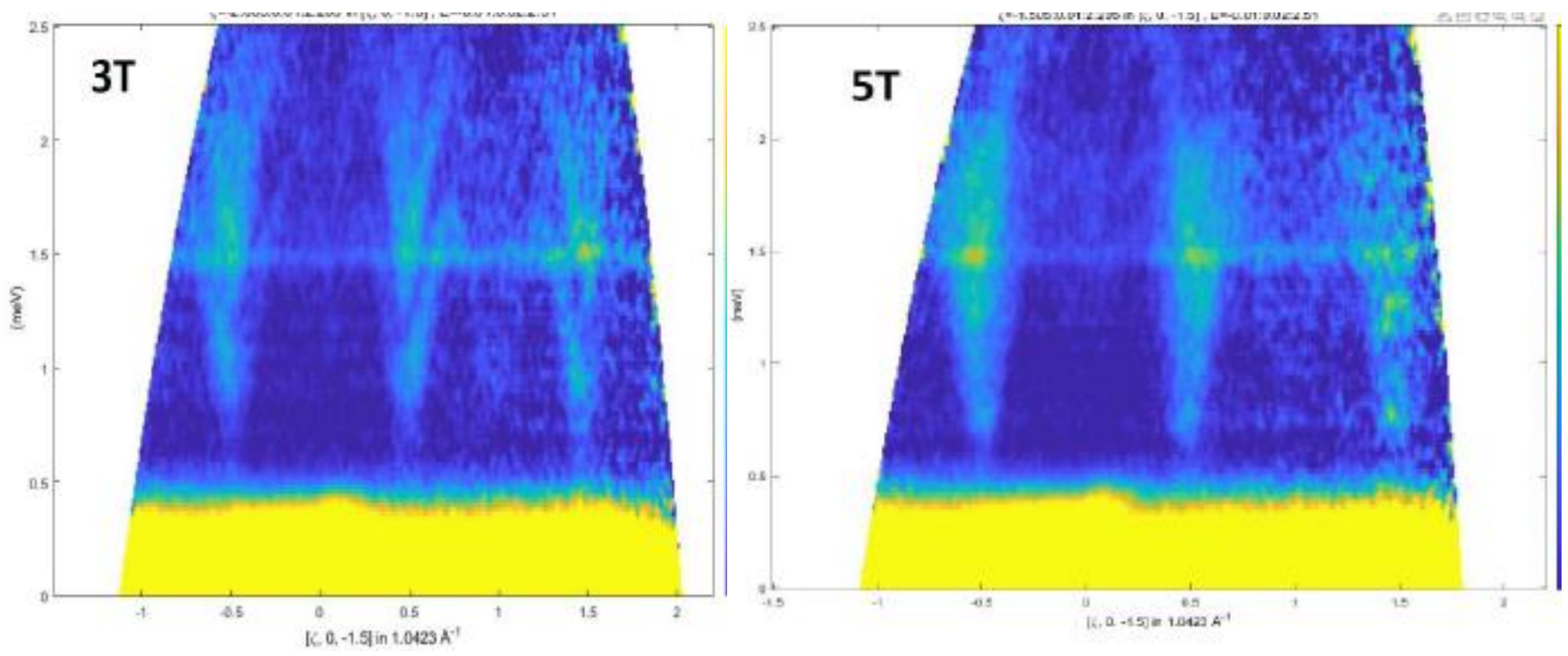
Pelican



High Magnetic Field -7 T

- **7 T superconducting magnet successfully tested on Pelican.**
- **Achieved up to 7 T magnetic field with variable sample temperature from 300 K down to 1.5 K.**
- **Several user experiments performed successfully.**
- **Open up new scientific opportunities for spin dynamics under high magnetic field.**

A strong dispersion along H- direction indicates the significant exchange interaction along this direction for this magnetic material. The change of the dispersion from 3 T to 5 T magnetic field is clearly observable as a result of phase transition around 4 T. (Courtesy of Kirrily Rule, ACNS)

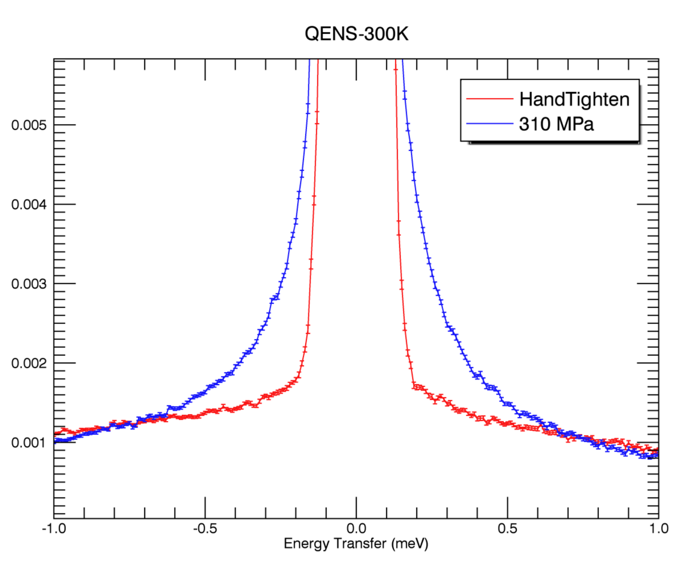


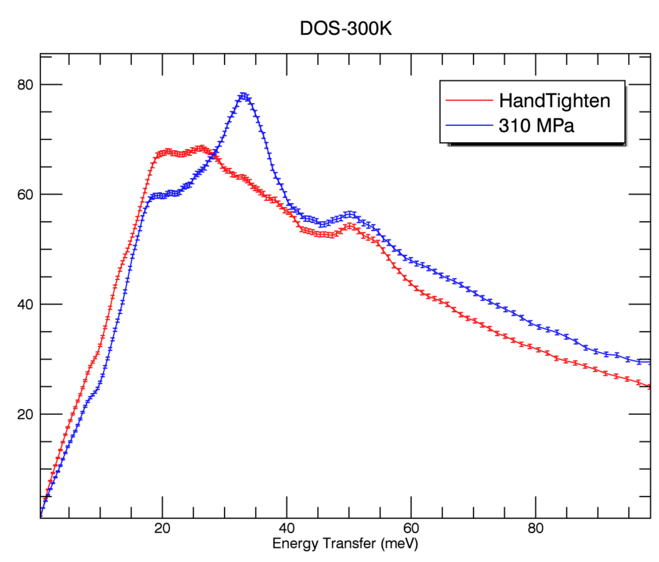
High Pressure – up to 2 GPa

- **High Pressure Cell successfully tested on Pelican in collaboration with CSNS.**
- **Achieved up to 2 GPa pressure with sample temperature from 300 K down to 100 K.**
- **Several user experiments performed successfully.**
- **Open up new scientific opportunities for material dynamics under high pressure, for example, pressure induced order to disorder phase transition, responsible for caloric effect in plastic crystals [2]; Protein dynamics for deep sea life under hundred MPa pressure.**

CuBe-NiCrAl: Max: 2 GPa
High Strength Al-alloy: Max: 0.5 GPa
(Courtesy of Bao Yuan and Xin Tong, CSNS)

A phase transition from a disordered state to an ordered state is induced by high pressure as shown with a less broadening of quasielastic neutron scattering (blue) at 310 MPa pressure as compared to the pressure corresponding to hand tightening (red). This pressure induced phase transition is also reflected in the phonon density of states with well defined vibration modes (blue-310 MPa) as compared with much broaden peaks (red-hand tighten). This order-disorder phase transition can potentially be used in solid state cooling technology. (Courtesy of Bing Li, CAS)





ACNS sample environment team is gratefully acknowledged for the support in commissioning of these new equipment.

References:

[1] D. H. Yu, *et a*l. Pelican – a time of flight cold neutron polarization analysis spectrometer at OPAL. J. Phys. Soc. Jpn 82, SA027 (2013) .

[2] B. Li *et al.* Colossal barocaloric effects in plastic crystals, Nature, 567, 506, (2019). **https://doi.org/10.1038/s41586-019-1042-5**

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