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Nuclear-based science benefiting all Australians

Minimising instrument down time when operating the OPAL reactor 300 days per year

Scott Olsen (Former Bragg Institute - now the Australian Centre for Neutron Scattering)

DENIM 2016, Lund, Sweden Sep 19-21 2016.

Talk Outline

1. **Overview of the OPAL Reactor**
2. **Reactor Schedules**
3. **Weekly planning Gantt Chart (MS Project)**
4. **Gantt Charts for Projects**
5. **Asset Management plans**
6. **Web Portal**
7. **SAP**
8. **5S**
9. **Recent examples of instrument upgrades**
10. **Conclusion**

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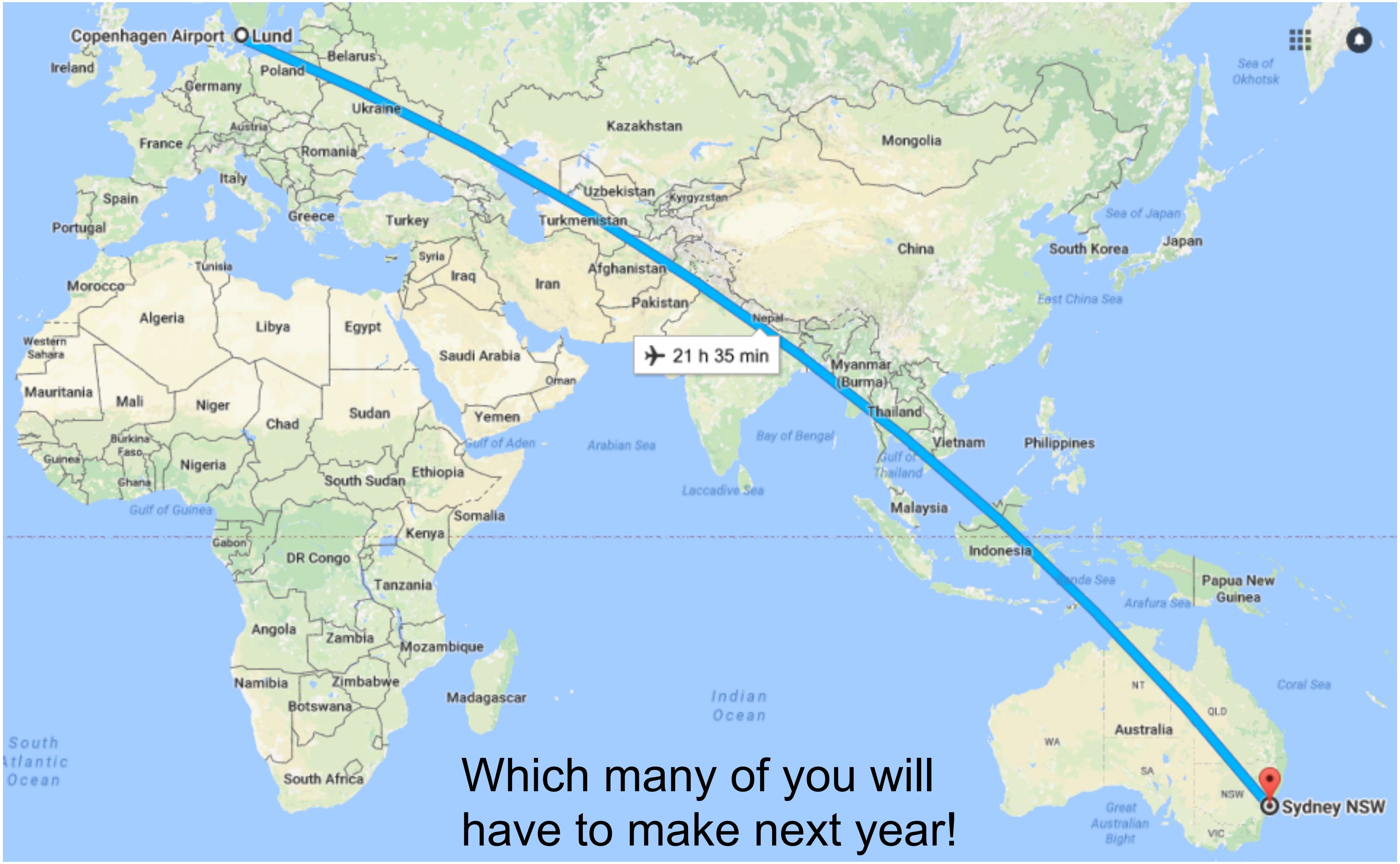
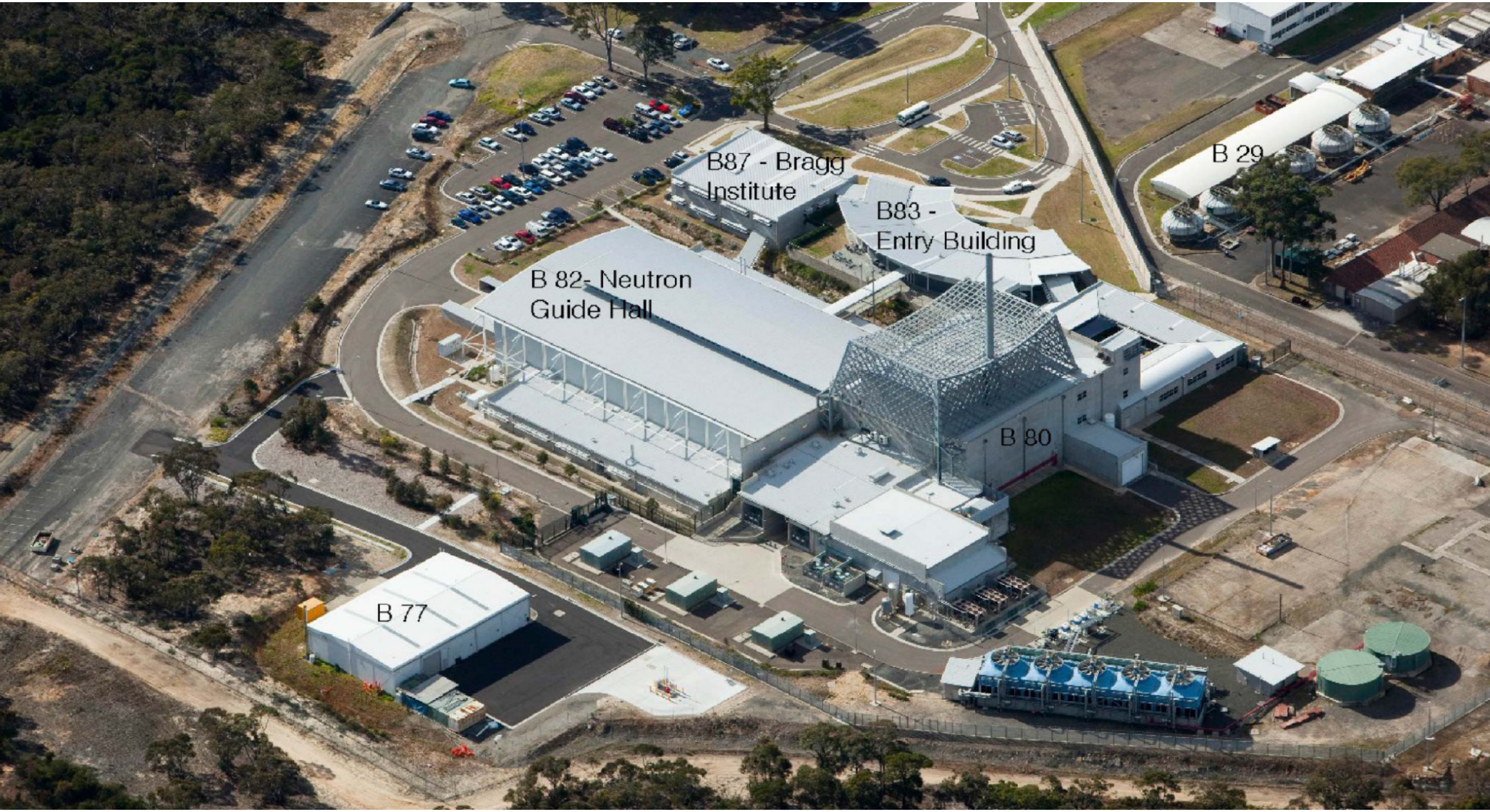
OPAL – 20 MW Reactor, Sydney AUS

A short one day journey from Lund



Which many of you will have to make next year!

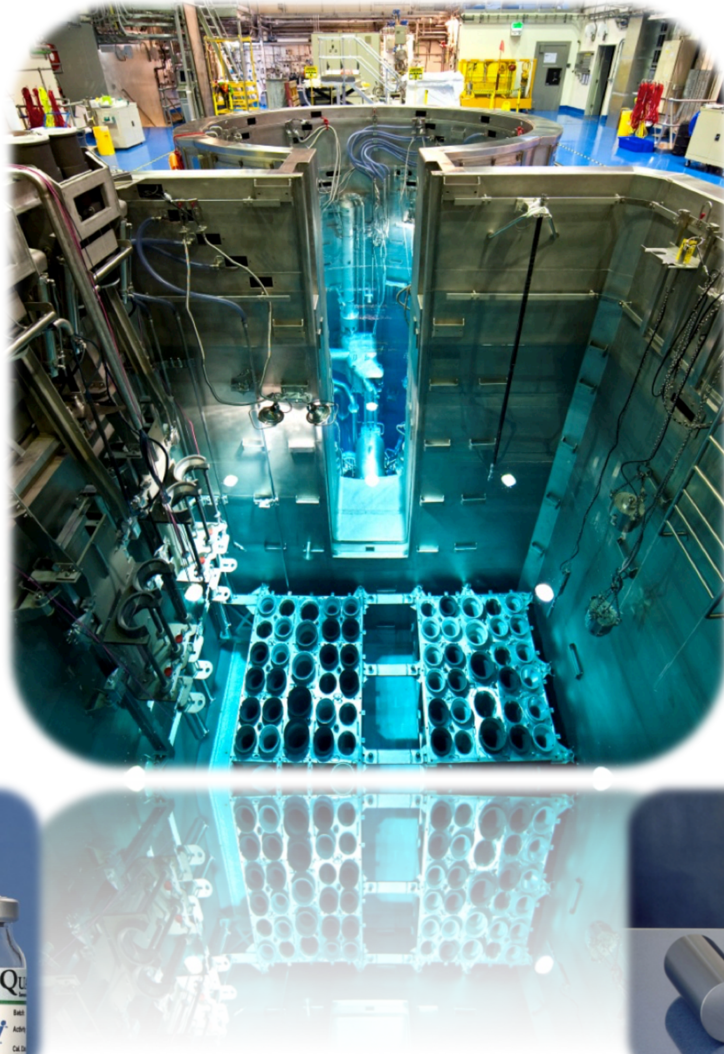
1. OPAL Research Reactor (2008 image).



OPAL multi-purpose reactor

Neutron Activation

Neutron Beams: scientific research

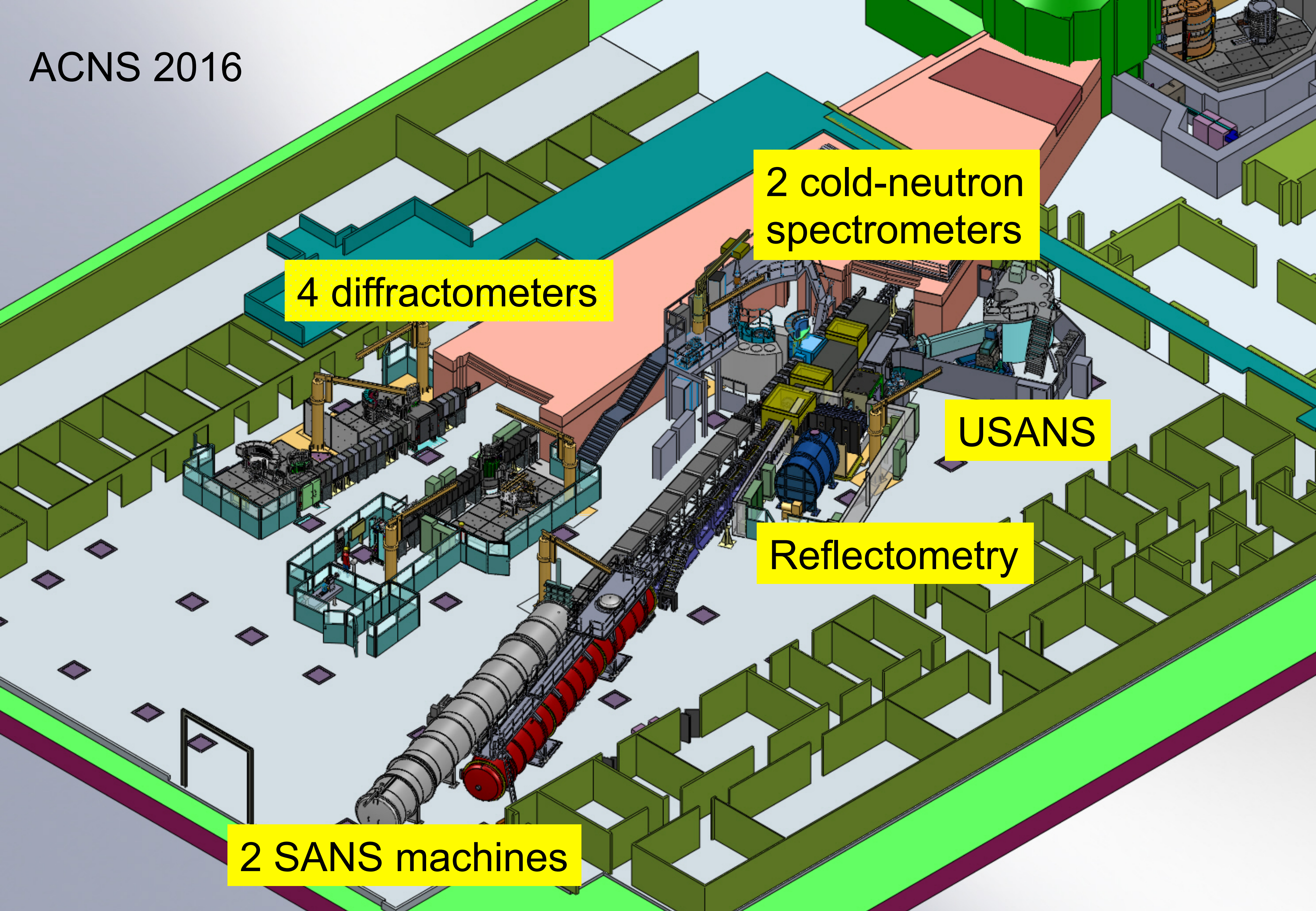


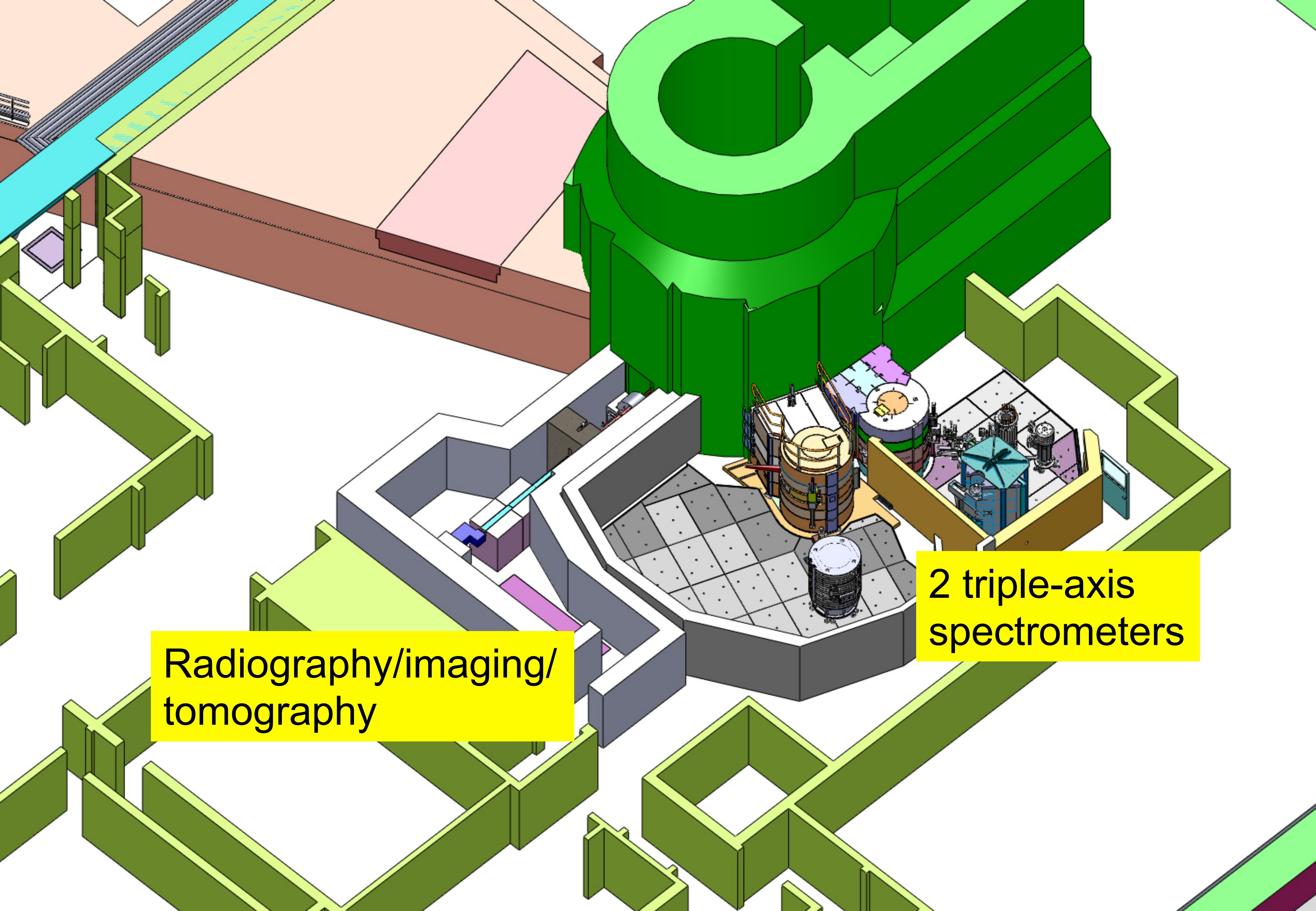
Medical Radioisotopes

Silicon irradiation

Australian Centre for Neutron Scattering.

- The Bragg Institute (2002-2016) undertook neutron research at the old HIFAR reactor until 2006 when the OPAL reactor came on line.
- A major restructure of the 5 research institutes at ANSTO took place in 2015-2016.
- The Institutes have been disbanded and a new structure of 3 major research themes and 9 infrastructure platforms has been developed.
- We are one of those 9 major platforms. Others include the Australian Synchrotron, the Centre for Accelerator Science etc.
- Former Bragg Institute Operations Manager Dr Jamie Schulz is now the Leader of the ACNS. Staff ~80.


ACNS 2016
2 cold-neutron spectrometers
4 diffractometers
USANS
Reflectometry
2 SANS machines


Radiography/imaging/
tomography
2 triple-axis
spectrometers

2. 300 days/yr operation

- Since 2012 the reactor operates at 300 days per year.
- Each year consists of two 12 day shutdowns (24 days) and eight 5 day shutdowns (40 days).
- Maintenance tasks are then scheduled for shutdowns, this generates a high resource load.
- Long shutdown dates announced for the next 5 years.
- All shutdown dates announced 12-18 months in advance.
- Careful forward planning is required.

Task Name	Duration	Start	Finish
2016	**341 days**	**Sun 17/01/16**	**Fri 23/12/16**
JANUARY	5 days	Sun 17/01/16	Fri 22/01/16
FEBRUARY	12 days	Mon 22/02/16	Sat 5/03/16
APRIL	5 days	Mon 4/04/16	Sat 9/04/16
MAY	5 days	Mon 9/05/16	Sat 14/05/16
JUNE	5 days	Mon 13/06/16	Sat 18/06/16
JULY	5 days	Mon 25/07/16	Sat 30/07/16
AUGUST	12 days	Mon 29/08/16	Sat 10/09/16
OCTOBER	5 days	Mon 10/10/16	Sat 15/10/16
NOVEMBER	5 days	Mon 14/11/16	Sat 19/11/16
DECEMBER	5 days	Sun 18/12/16	Fri 23/12/16

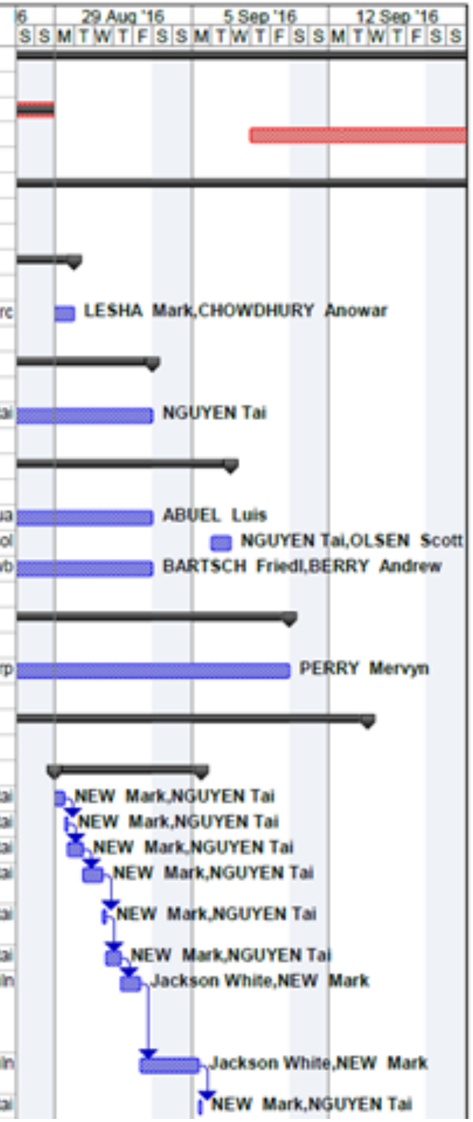
Yearly and 5 year shutdown plans

Task Name	Duration	Start	Finish
2017	**224 days**	**Mon 13/02/17**	**Mon 25/09/17**
STANDARD	5 days	Mon 12/06/17	Sat 17/06/17
FEBRUARY	14 days	Mon 13/02/17	Mon 27/02/17
SEPTEMBER	14 days	Mon 11/09/17	Mon 25/09/17
2018	**224 days**	**Mon 12/02/18**	**Mon 24/09/18**
STANDARD	5 days	Mon 11/06/18	Sat 16/06/18
FEBRUARY	14 days	Mon 12/02/18	Mon 26/02/18
SEPTEMBER	14 days	Mon 10/09/18	Mon 24/09/18
2019	**196 days**	**Mon 4/03/19**	**Mon 16/09/19**
STANDARD	5 days	Mon 19/08/19	Sat 24/08/19
MARCH	120 days	Mon 4/03/19	Tue 2/07/19
SEPTEMBER	14 days	Mon 2/09/19	Mon 16/09/19
2020	**231 days**	**Mon 10/02/20**	**Mon 28/09/20**
STANDARD	5 days	Mon 15/06/20	Sat 20/06/20
FEBRUARY	14 days	Mon 10/02/20	Mon 24/02/20
SEPTEMBER	14 days	Mon 14/09/20	Mon 28/09/20
2021	**224 days**	**Mon 15/02/21**	**Mon 27/09/21**
STANDARD	5 days	Mon 14/06/21	Sat 19/06/21
FEBRUARY	14 days	Mon 15/02/21	Mon 1/03/21
SEPTEMBER	14 days	Mon 13/09/21	Mon 27/09/21

- Where possible shutdown dates do not overlap the Australian Synchrotron. As required staff can move (1000km!) between the two for the shutdowns.
- All requests from scientists (for more than 3-4hrs work) are tracked, logged and prioritised in an MS Project Gantt Chart) - see over. Allows for resource loads to be measured. Instrument scientists do check this closely (just for their instrument).

3. Operational tasks Gantt Chart

ID	Task Name	Start	Finish	Charge Code	Resource
1	**Reactor Cycles**	**Sat 2/05/09**	**Sun 13/11/16**		
2	**Past Cycles**	**Sat 2/05/09**	**Sun 24/07/16**		
70	Cycle 80	Sat 30/07/16	Sun 28/08/16		
71	Cycle 81	Thu 8/09/16	Sun 9/10/16		
72	Cycle 82	Sat 15/10/16	Sun 13/11/16		
73	**Work List**	**Mon 1/06/09**	**Tue 29/11/16**		
74	**Echidna**	**Mon 13/07/09**	**Fri 8/04/16**		
162	SAP Work Orders	Tue 2/02/16	Tue 2/02/16		
163	**Wombat**	**Tue 4/08/09**	**Mon 29/08/16**		
164	**Completed Work**	**Tue 4/08/09**	**Fri 29/07/16**		
248	Changeover to new HM servers	Mon 29/08/16	Mon 29/08/16	BRAG000008	mle,anowarc
249	SAP Work Orders	Tue 2/02/16	Tue 2/02/16		
250	**Kowari**	**Mon 13/07/09**	**Fri 2/09/16**		
251	**Completed Work**	**Mon 13/07/09**	**Tue 26/07/16**		
349	Cutting Lpg plates	Fri 12/08/16	Fri 2/09/16	BRAG000005	tai
350	SAP Work Orders	Tue 2/02/16	Tue 2/02/16		
351	**Koala**	**Thu 10/09/09**	**Tue 6/09/16**		
352	**Completed Work**	**Thu 10/09/09**	**Fri 29/07/16**		
417	Install new photodiode	Mon 8/08/16	Fri 2/09/16	BRAG000003	lua
418	Install new laser mounting rig after approval	Tue 6/09/16	Tue 6/09/16	BRAG000003	tai,sol
419	Installation of prototype box for read/write electronics	Mon 18/07/16	Fri 2/09/16	BRAG000003	fkb,andrewb
420	SAP Work Orders	Tue 2/02/16	Tue 2/02/16		
421	**Joey**	**Mon 5/10/09**	**Fri 9/09/16**		
422	**Completed Work**	**Mon 5/10/09**	**Fri 27/05/16**		
463	Sample mounting jig, C shapped, Chi rotation	Mon 22/08/16	Fri 9/09/16	BRAG000010	mrp
464	SAP Work Orders	Tue 2/02/16	Tue 2/02/16		
465	**Pelican**	**Mon 1/06/09**	**Tue 13/09/16**		
466	**Completed Work**	**Mon 1/06/09**	**Wed 10/08/16**		
941	**Polariser Installation - Shutdown**	**Mon 29/08/16**	**Mon 5/09/16**		
942	Remove Shielding	Mon 29/08/16	Mon 29/08/16	BRAG000007	mln,tai
943	Install Polariser	Mon 29/08/16	Mon 29/08/16	BRAG000007	mln,tai
944	Modify exsiting cap screw heads to clear polariser	Mon 29/08/16	Tue 30/08/16	BRAG000007	mln,tai
945	Modify Boroflex sheet shielding between tower 1 & polarizer	Tue 30/08/16	Wed 31/08/16	BRAG000007	mln,tai
946	Test travel of all stages and confirm all axis have clearance	Wed 31/08/16	Wed 31/08/16	BRAG000007	mln,tai
947	Modify cable chain mounting point on tower 1	Wed 31/08/16	Thu 1/09/16	BRAG000007	mln,tai
948	Clip cables along arm from under the mono shielding, up the support frame. Provide loop so that z stage can go up and down reliably (previous cable chain was removed)	Thu 1/09/16	Fri 2/09/16	BRAG000007	jacksonw,mln
949	Cut cables to length, terminate, test, commission and communicate the values to Ferdi.	Fri 2/09/16	Mon 5/09/16	BRAG000007	jacksonw,mln
950	Install all shielding	Mon 5/09/16	Mon 5/09/16	BRAG000007	mln,tai



4. Project Gantt Charts

- Instrument builds or major upgrades all run MS Project. Several can be rolled into a program gantt chart.
- Also can be integrated with the operations Gantt Chart to ensure resources are available.

- Project Lessons:
- Hot commissioning tasks always take longer than planned for and on many instruments can take 1-3 years to get the SNR to optimum levels.
- There is a need for change control on all the little twicks performed in hot commissioning, otherwise the as built drawings are incorrect – and future upgrades are compromised.
- Time also has to be allocated for the preparation of maintenance plans and spare parts inventories for all parts of the instrument.

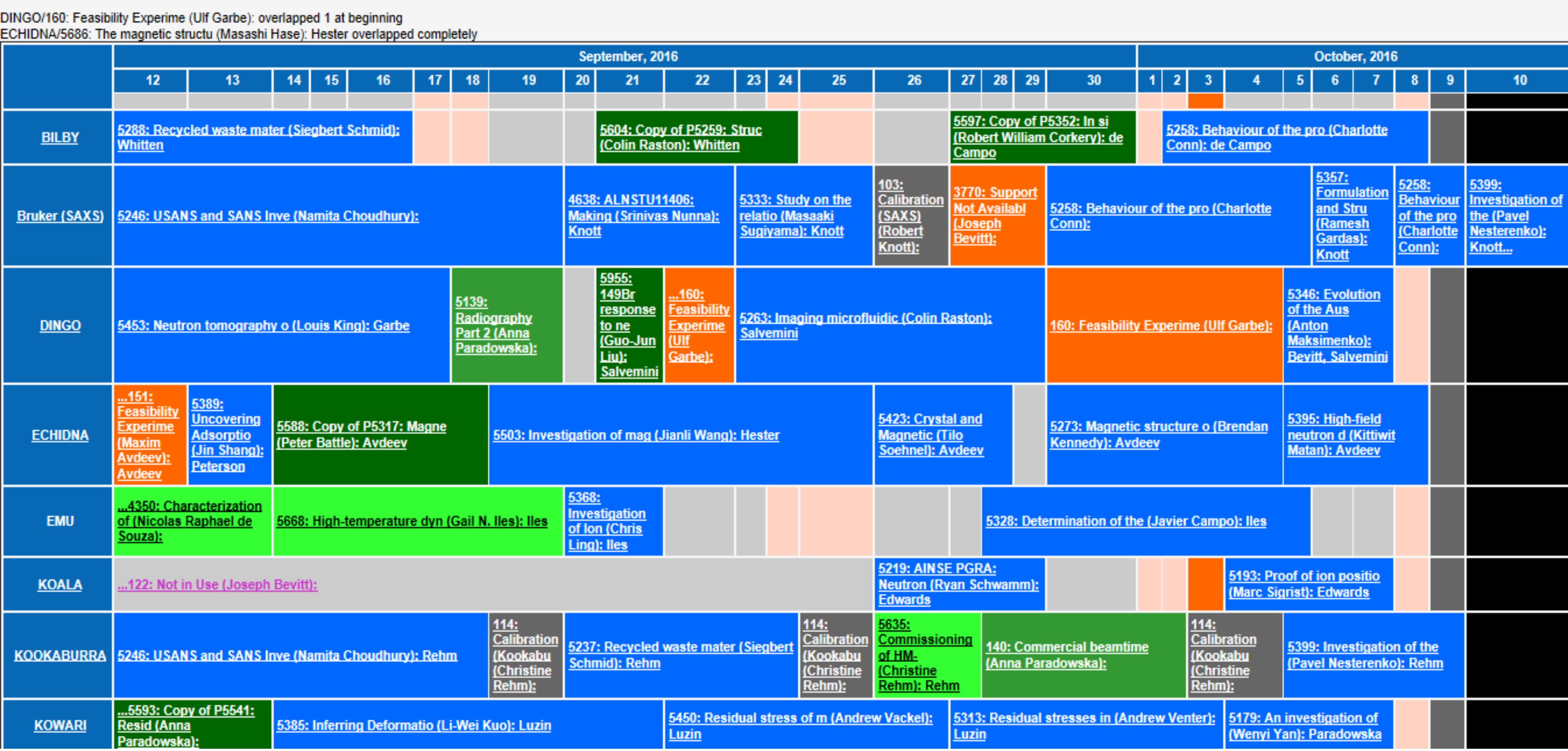
5. Asset Management Plan Spreadsheet

AMP now includes future items (wish lists).

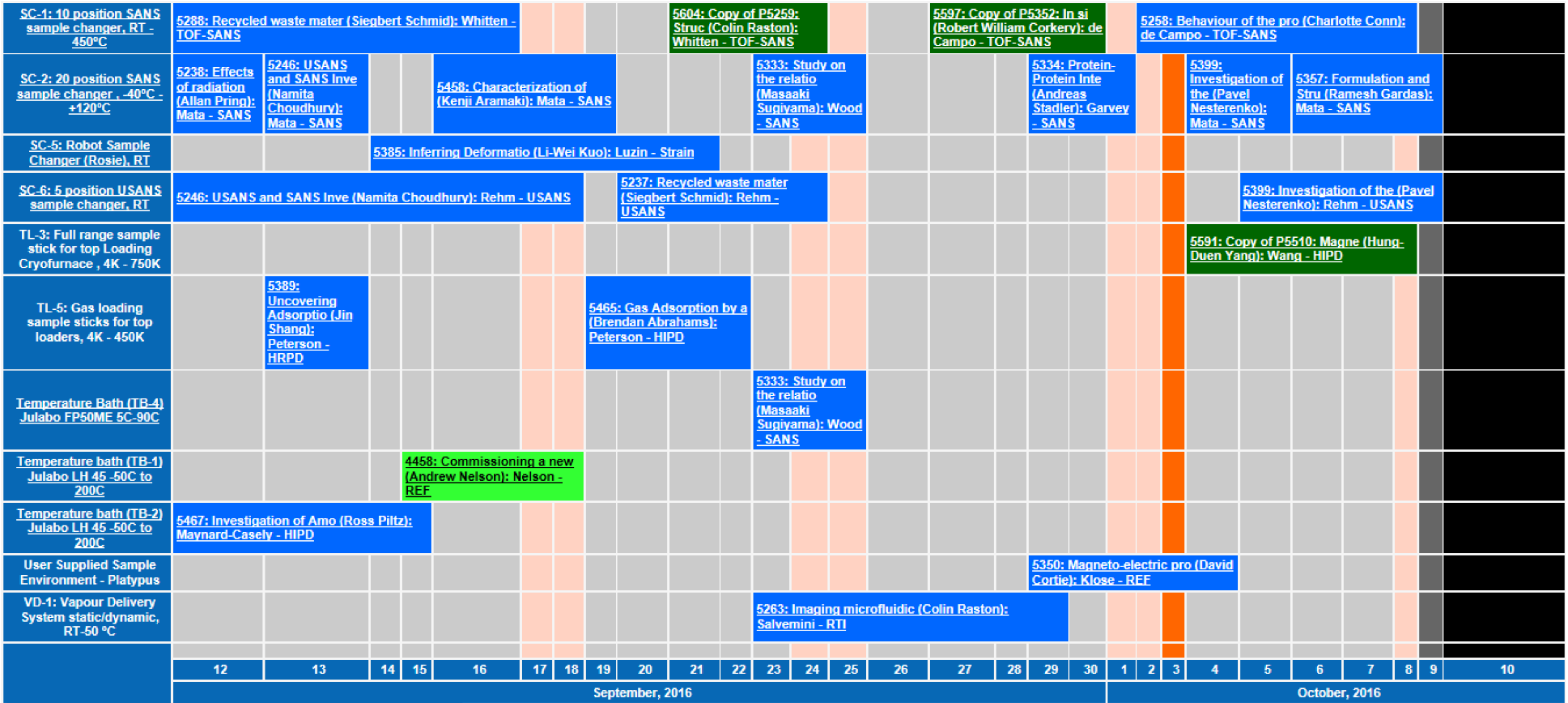
Items have to be on the AMP in order to win capital money.

116	Water Chillers											$0.0		
117				Quokka	Chiller for Velocity Selectors FL601		2007	10	Poor	2017	$8,000	$11,466.6	Low	
118				Platypus	Chiller for Choppers FL601		2007	10	Poor	2017	$8,000	$11,466.6	Low	
119				Bilby	Chiller for Velocity Selectors FL1203		2013	10	Good	2017	$12,000	$13,530.0	Low	
120				NGH	Spare Fl1203 Water chiller		2016	10	Good	2017	$12,000	$12,000.0	Low	Spare purchased 2016
121				SAXS	Chiller for SAXS		2006	10	Poor	2017	$12,000	$17,901.9	Low	
122				XREF	Heat Exchange XREF		2006	10	Poor	2017	$12,000			
123												$0.0		
124	Collimation & Slits (Manual)											$0.0		
125			Collimation	NGH	Neutron Guides & Tank Includes everything in the Bunker	207833-6	2007	20	Medium	2027	$1,567,610	$2,246,901.5	High	
126			Collimation	PELICAN	Polariser Power supply		2011	5	Poor	2016	$10,000	$12,214.0	Low	
127			Collimation	BILBY	Neutron Guides, apertures Motors, encoders	209477	2014	10	Good	2024	$1,745,800	$1,891,202.6	Medium	
128			Detector stage	KOWARI	5mm diameter collimator		2014	20	Good	2034	$25,000	$27,082.2	Low	
129			Detector stage	KOWARI	3mm diameter collimator		2014	20	Good	2034	$25,000	$27,082.2	Low	
130			Detector stage	KOWARI	2mm diameter collimator		2014	20	Good	2034	$25,000	$27,082.2	Low	
131			Detector stage	KOWARI	10mm diameter collimator		2014	20	Good	2034	$25,000	$27,082.2	Low	
132			Collimation	KOWARI	Neutron Guides, aperturesMotors, encoders	207831-7	2006	12	Poor	2018	$416,050	$620,673.7	Medium	
133			Collimation	WOMBAT	50mm collimator.	207837-4	2006	20	Medium	2021	$131,950	$196,846.3	Medium	
134			Collimation	ECHIDNA	Removable collimator	207830-7	2006	15	Medium	2021	$149,500	$223,027.8	Low	
135			Collimation	TAIPAN	15,20,30,45 minute collimators	207835-5	2006	15	Medium	2021	$244,200	$364,303.6	Low	
136														
137	BE Filters													
138		PELICAN	Be Filter	PELICAN	Vacuum system and Filter		2012	15	Good	2027	$60,000	$70,410.7	Low	
139		PELICAN	Be Filter	PELICAN	Compressor		2012	15	Good	2027	$40,000	$46,940.4	Low	
140		BE Filter	Be Block	KOOKABURRA	Brush Wellman		2013	15	Good	2028	$12,000	$13,530.0	Low	
141		BE Filter	Vacuum Shroud	KOOKABURRA	Janis		2013	15	Good	2028	$10,000	$11,275.0	Low	
142		BE Filter	Closed Cycle Fridge	KOOKABURRA	Janis		2013	15	Good	2028	$20,000	$22,549.9	Low	
143		BE Filter	Vacuum Pump	KOOKABURRA	Pfeiffer		2013	15	Good	2028	$8,000	$9,020.0	Low	
144		BE Filter	Compressor Supply Transformer	KOOKABURRA			2013	15	Good	2028	$20,000	$22,549.9	Low	
145		BE Filter	Linear Stage	KOOKABURRA	Scitek		2013	15	Good	2028	$10,000	$11,275.0	Low	
146		BE Filter	Temperature Monitor	KOOKABURRA	Lakeshore		2013	15	Good	2028	$5,000	$5,637.5	Low	
147		TAIPAN BE Filter		TAIPAN	Includes entire system, tank, shielding, pumps, detectors etc	6001084	2015	10	Good	2025	$2,633,500	$2,740,975.2	Medium	
148														
149	Beam Stop													
150		KOOKABURRA	Beam Stop	KOOKABURRA	Superior Welding		2013	20	Good	2028	$10,000	$11,275.0	Low	
151		KOOKABURRA	Beam Attenuator	KOOKABURRA	Hiwin Linear Stage		2013	15	Good	2028	$10,000	$11,275.0	Low	

6.Web portal – instrument booking system

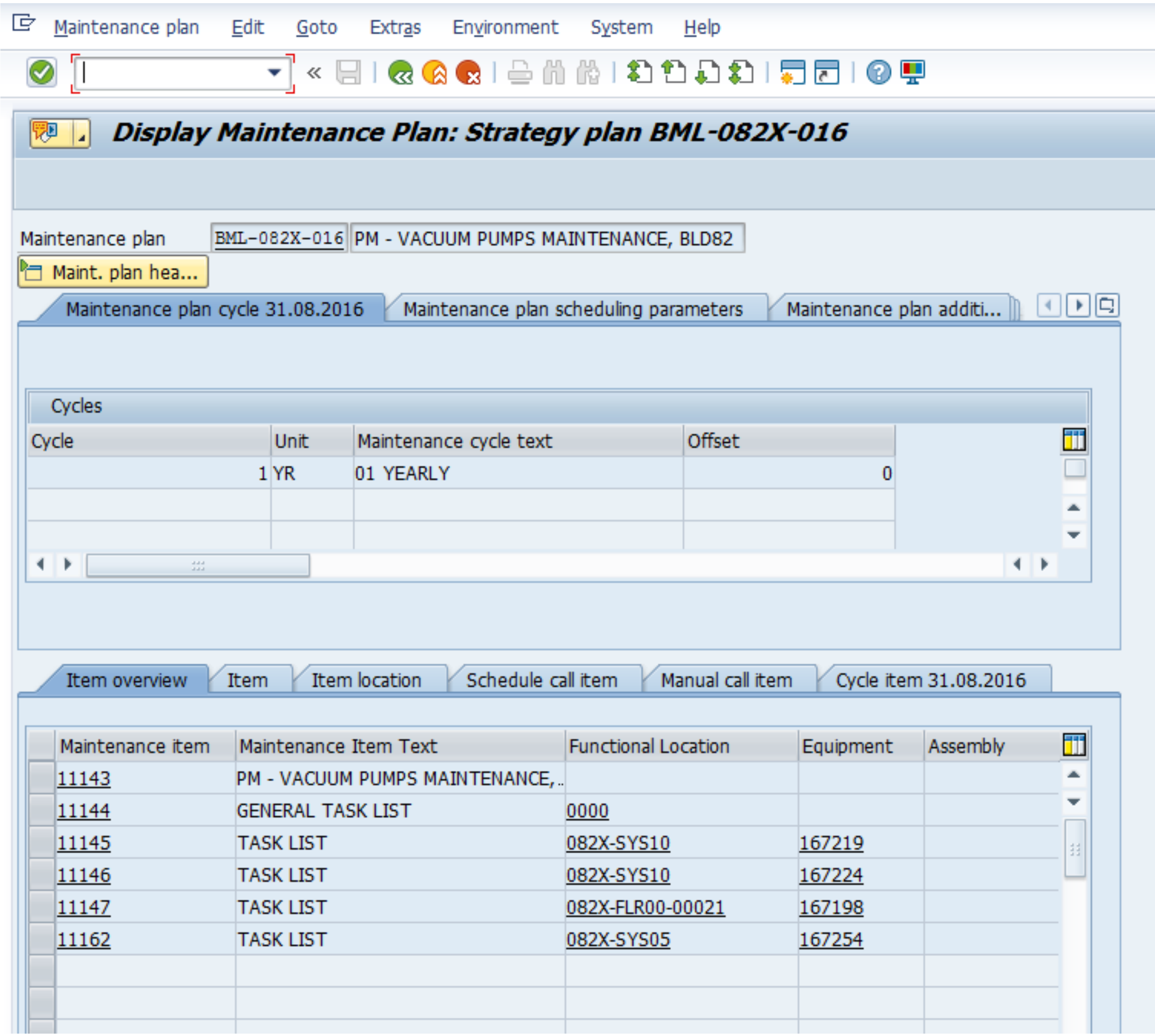


- The web portal system (being upgraded now) lists the experiment, contact scientist and other requirements (eg sample environment, lab gear) required for an experiment.
- This ensures nothing is double booked and indicates any gaps where maintenance or upgrades can take place during a cycle.



7. SAP™

- All maintainable equipment is registered in SAP.
- Work orders are automatically created.
- Some smaller sections run on spreadsheets.
- Quite a resource load to set up, relatively easy to keep going.
- Train staff to speak SAP.



List Edit Goto Structure Environment Settings System Help

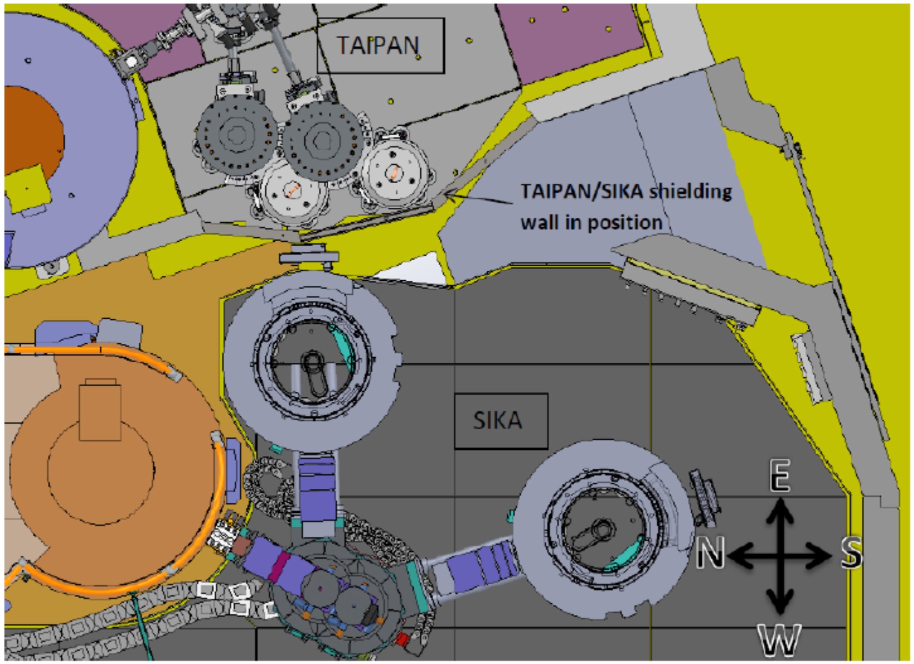
Display Equipment: Equipment List

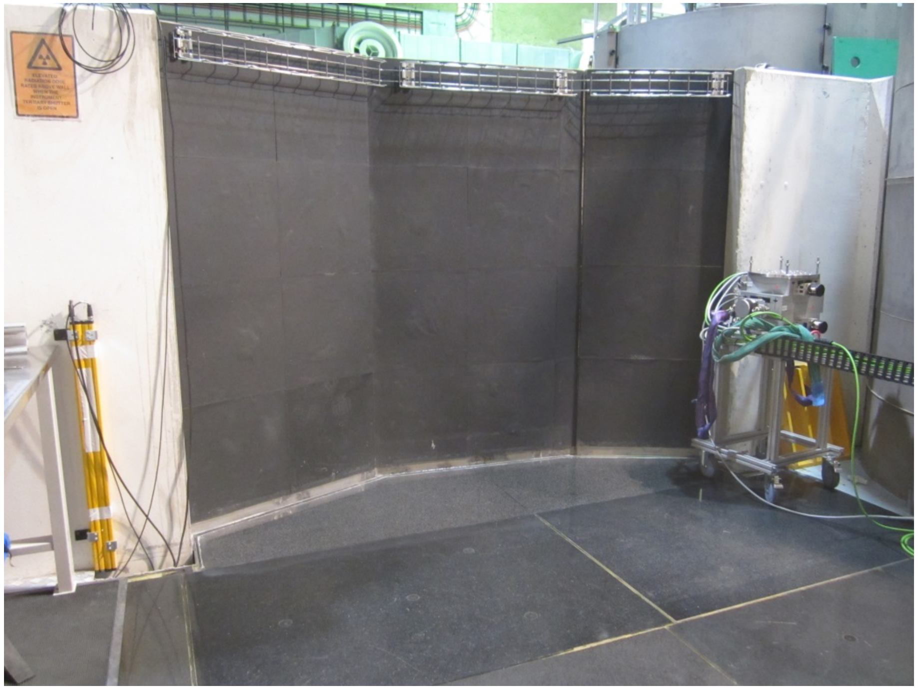
S	Equipment	Object type	Description of technical object	Location	Room	Manufacturer of asset	Model number	Manufacturer part number	ManufS
	165435	HSS	HARNESS-FALL ARREST	B082	0024	B-SAFE	BH05200		447400
	203181	HSS		B082		MILLER		M1020065	H08791
	203182	HSS		B082		MILLER		M1020065	H08791
	166204	LFR	HOIST - ABBEY	B082	H.00.024	ARMSTRONG	ARMFC5A		
	166960	LFR		B082	0041	ARMSTRONG			ARMFC1
	180103	HST	HOIST - CHAIN - ELECTRIC	B082		GIS	GCH 500/-N. M3.2		GCH/50
	180104	HST	HOIST - CHAIN - ELECTRIC - 282/82	B082		GIS	GCH 500/-N. M3.2		GCH/50
	180314	HST	HOIST - CHAIN - LEVER	B082		HES	OMLB075		905031
	180315	LDV	HOIST-CHAIN-LEVER	B082		HES	OMLB075		950501
	165297	WSH	HOT WATER SYSTEM	B082	0050	RHEEM			156191
	165870	WSH		B082	0001	RHEEM	111050R7		171960
	165871	WSH		B082	0110	RHEEM	61631507		
	165877	HUM	HUMIDIFIER - 5420-HM-001	B082	H.00.030				
	165885	HUM	HUMIDIFIER - 5420-HM-002	B082	H.00.050				
	165788	HUM	HUMIDIFIER - 5420-HM-003	B082	H.00.001				
	165893	HUM	HUMIDIFIER - 5420-HM-004	B082	H.04.021				
	165798	HUM	HUMIDIFIER - 5420-HM-005	B082	H.00.018				
	165894	HUM	HUMIDIFIER - 5420-HM-006	B082	H.00.021				
	165984	HUM	HUMIDIFIER - 5420-HM-007	B082	H.00.018				
	165964	HUM	HUMIDIFIER - 5420-HM-008	B082	H.00.010				
	165878	HUM	HUMIDIFIER - 5420-HM-009	B082	H.00.110				
	165975	HUM	HUMIDIFIER - 5420-HM-010	B082	H.00.110				
	167182	ICE	ICE MAKER	B082	0011	SCOTSMAN	AF80		
	167267	ICE		B082	0024	SCOTSMAN	AF80		
	168989	INC	INCUBATOR	B082	0034	THERMOLINE SCIENTIFIC	TEI-13G		25783
	167273	IND	INDICATOR - TEST	B082	0027		7 jewel		
	167274	IND		B082	0027		7 jewel		
	167382	IND		B082	0027		0.01 - 0.8mm		
	167383	IND		B082	0027		0.01 - 0.8mm		

8. 5S organisational methodology

- From the Japanese words for Sort, Shine Standardise, Straighten, Sustain
- Slowly being implemented in the Neutron Guide Hall.
- Saves time in hunting around for parts – especially for emergency breakdown repairs.
- Everything has a home! If its not needed it gets red tagged and after a month thrown away.
- Challenges include ongoing maintenance of the areas, and the fact that scientists from certain cultural backgrounds DON'T like to throw ANYTHING out EVER.

9. Minimising downtime on neighbouring instruments during major upgrades – Case Study 1 – Dance floor extension for the thermal triple axis spectrometer

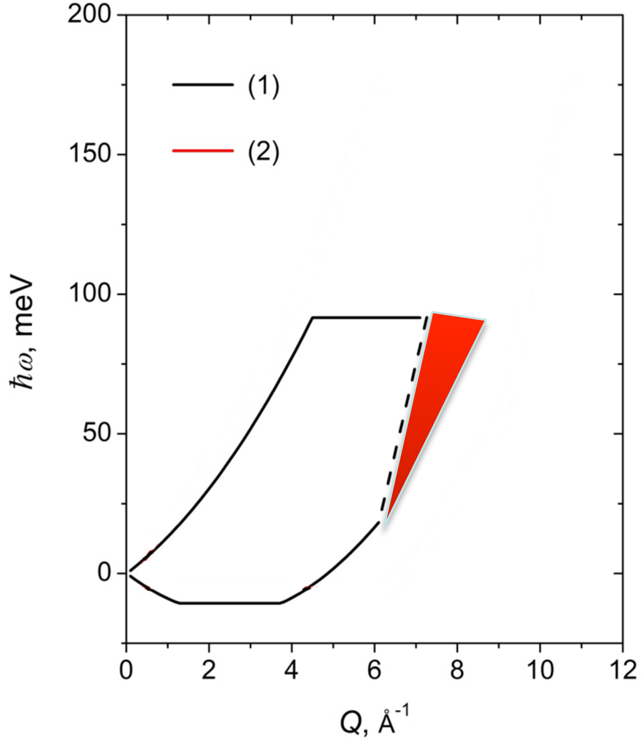




- Issue – Enclosure Wall – aim to replace and allow for greater momentum transfer at higher incident Energies – key was to only take the cold triple axis down for one 28 day cycle.
- Step 1 – Remove concrete wall – modify and reuse parts.
- Step 2 – Design more compact Steel/Pb/Steel wall
- Step 3 – Additional dance floor. Keeping slope < 50um/m and steps below 50um.

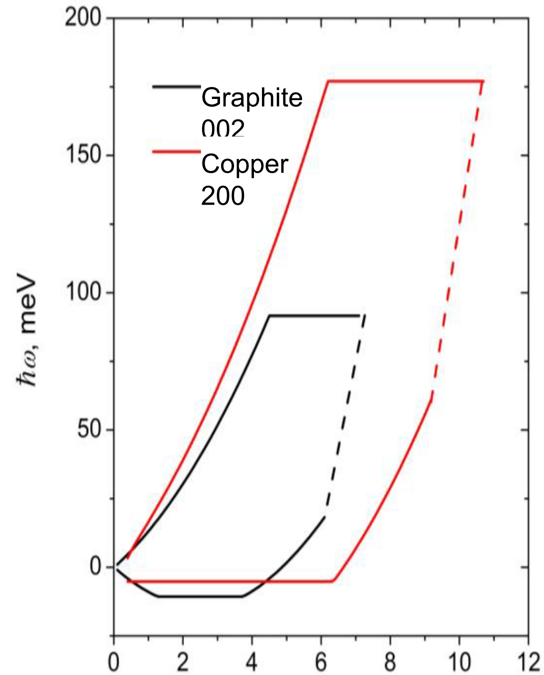
Study 1 con't: Increase in Incident Energy & Momentum Transfer for the thermal triple axis

- Lessons learnt – Breakdown all the steps , allocate time and people and have a widespread review, and wherever possible, <u>rehearse the steps first</u>.
- Outcome – reasonable performance increase (see below) – downtime kept to a minimum
- Second stage – Installation of a double mono took place last month – lesson learnt – detailed FATs, wide team of people to review SAT and installation plans. Allow for the unexpected – confirm drawings are <u>as-installed.</u>

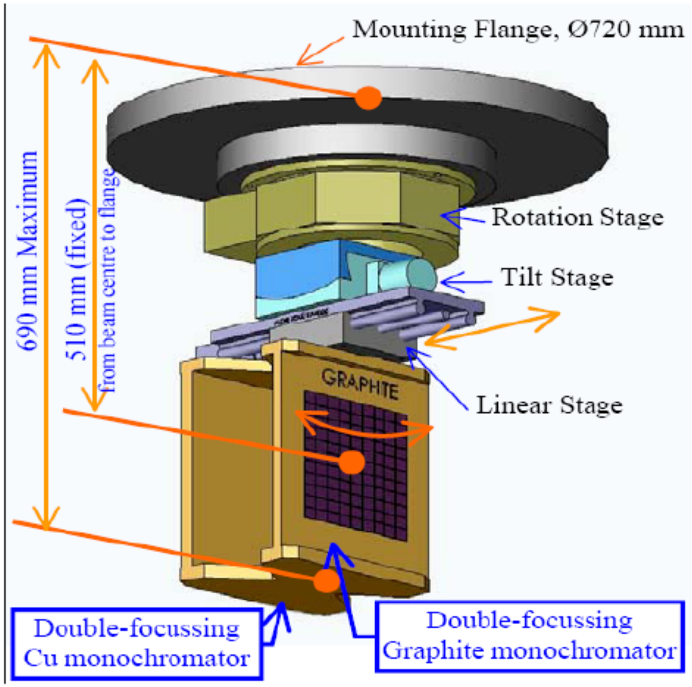


Additional transfer range

Energy transfer



Momentum transfer

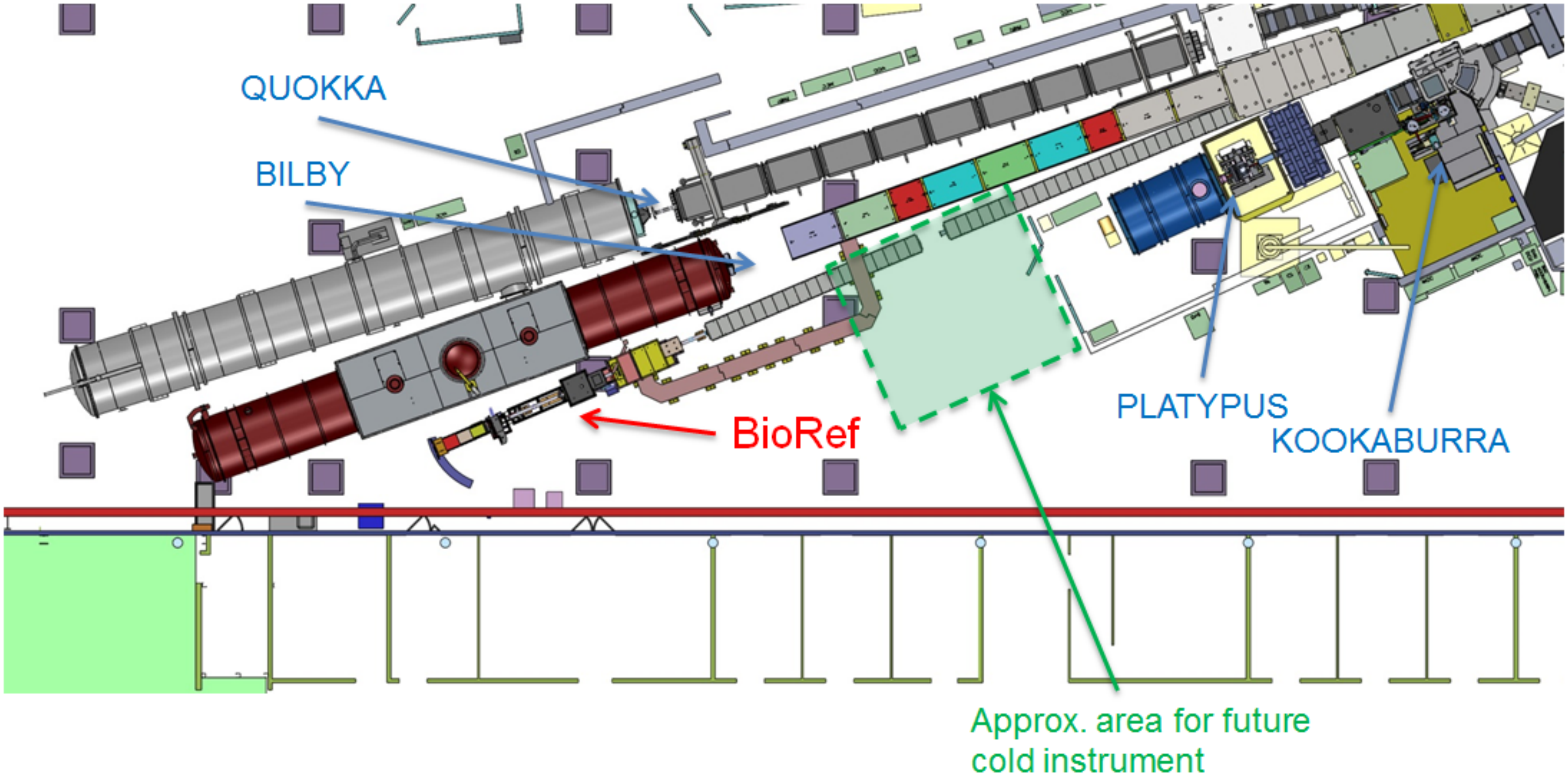


Case Study 2 – Installation of a second SANS inside the shielding of the first SANS

- Issue – All shielding for the 1st SANS had to be replaced due to second SANS instrument.

- Step 1 – Remove concrete wall – modify and reuse parts.
- Step 2 – Designed 4m high, 6m long 0.1m wide SS dividing wall – seismic rated. (refer to P.Constantine talk DENIM 2015)
- Step 3 – Keep loss of beam time to a single 28 day cycle.
- Lesson learnt – measure more than once, check way more than twice.
- Feedback actual dose measurement to the nuclear simulation team.

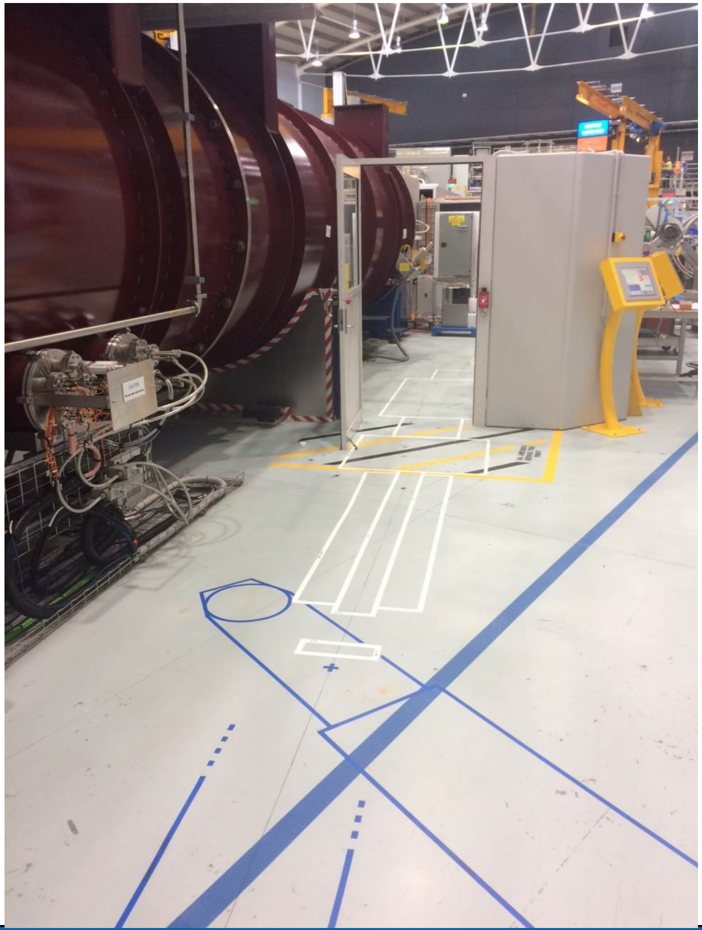
Case Study 3 – Installation of the HZB instrument BioRef right against the new SANS Bilby



- Bio Ref due down under in about 6 months

Implications for the new SANS

- Issue – Enclosure Wall – will need to come down and an entire new access designed.
- Step 1 – This instrument will be built from the back (downstream) and go upstream.
- Step 2 – Bilby shielding walls (which were 2nd hand from Quokka) – may then be reused again for Bio Ref.
- Refer to Stewart Pullen's DENIM 2016 – in 3 hours time! for more details.



Conclusion

- With very high availability of neutrons comes the requirement to plan very carefully. The tools described in this talk allow us to sell to management a realistic plan for both maintenance and upgrades.

- Planning also allows us to minimise last second ad hoc requests from scientists and users.

- Major upgrades and new instruments need wide spread reviews with multi-disciplinary teams.

- ‘Bathtub’ curve on maintenance and upgrade costs, low initially at a new facility, spikes around the 8-10 year mark due to the need for many replacements and major services at once.

Impressions of Lund

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Nuclear-based science benefiting all Australians