

Reliability of the accelerator facilities at iThemba LABS

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Lowry Conradie

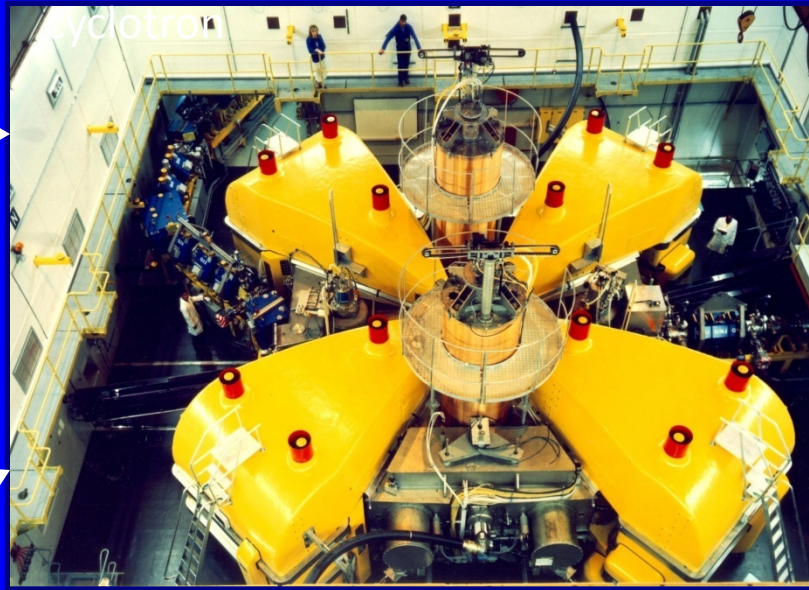


Different accelerators at iThemba LABS

K8 Injector cyclotron 1



K200 Separated sector cyclotron

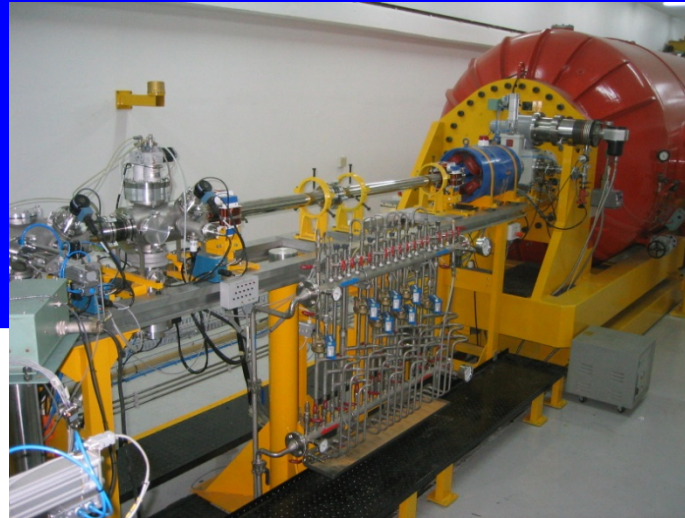


K11 Cyclotron

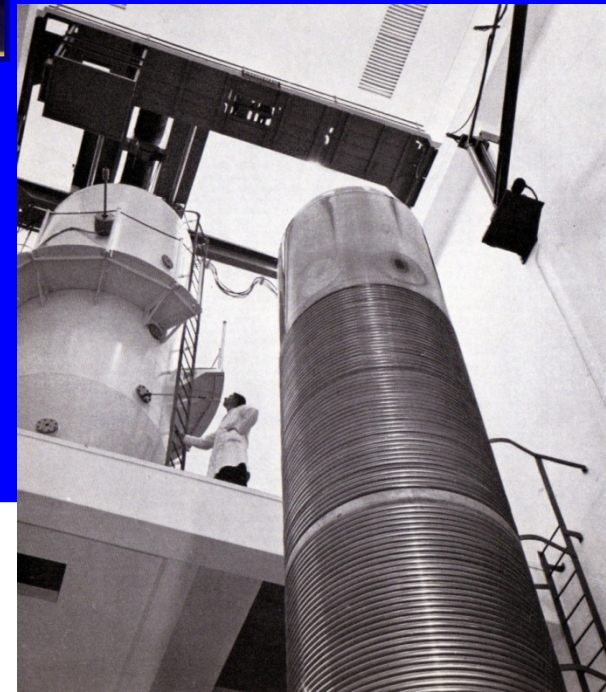


K8 Injector cyclotron 2

6MV EN Tandem



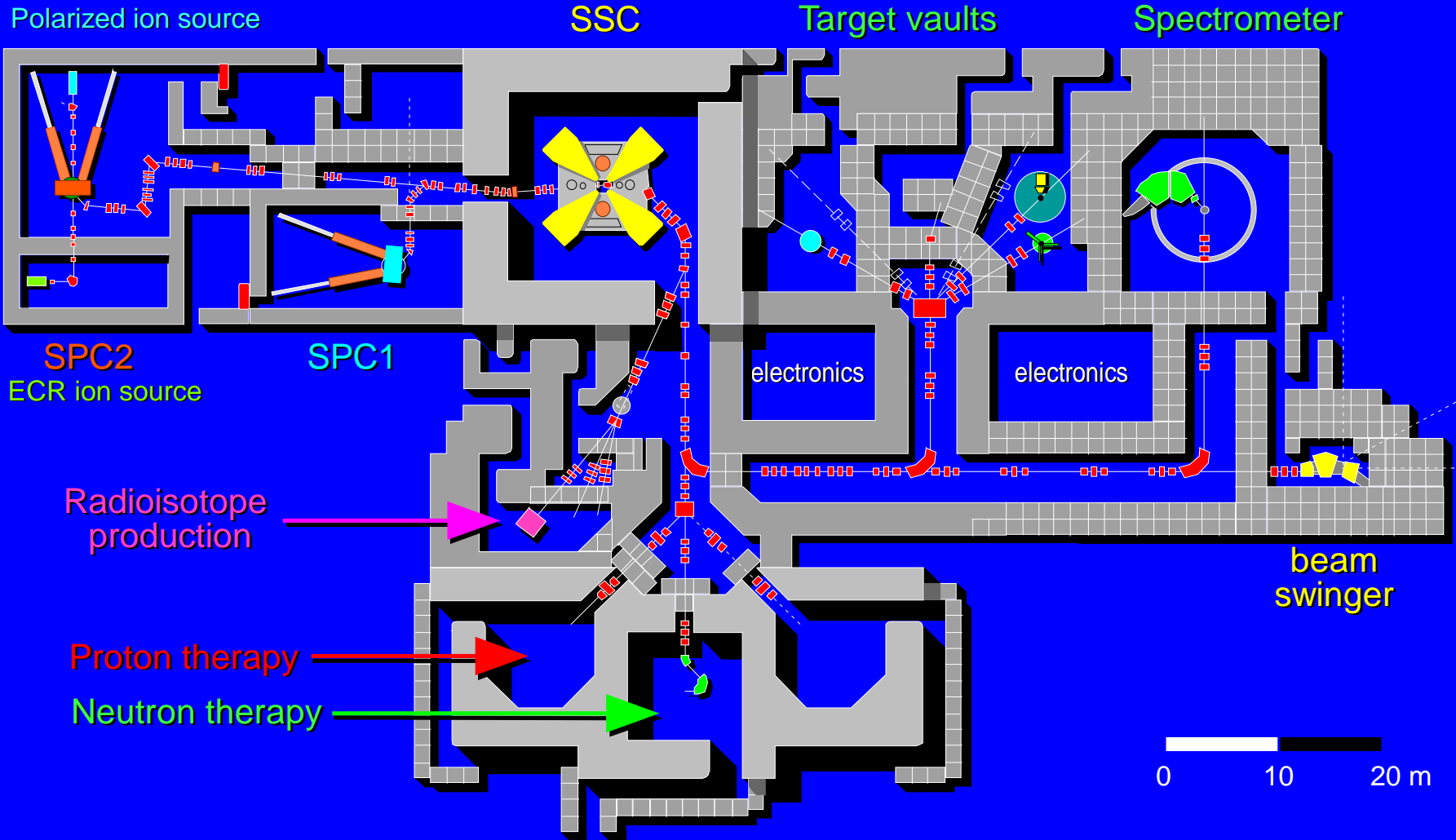
6MV Van de Graaff



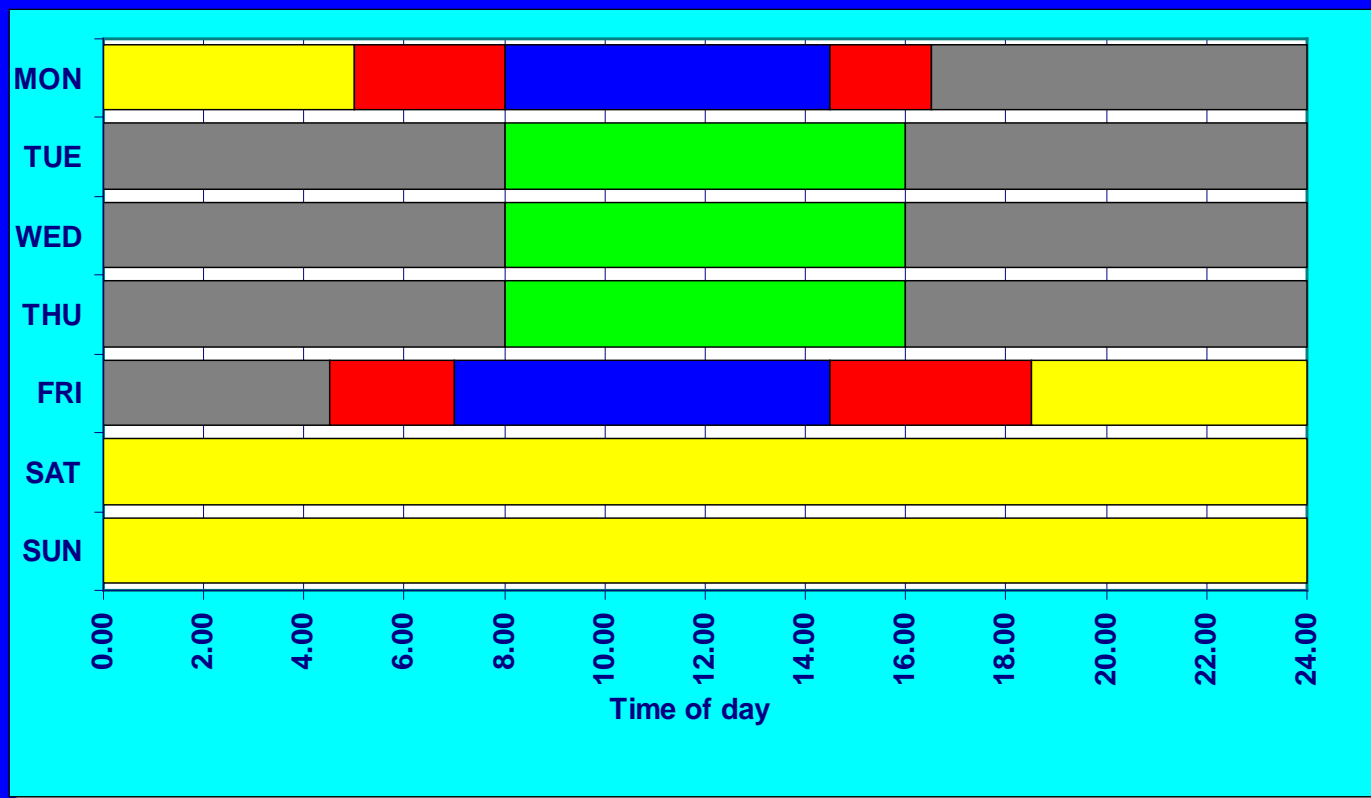
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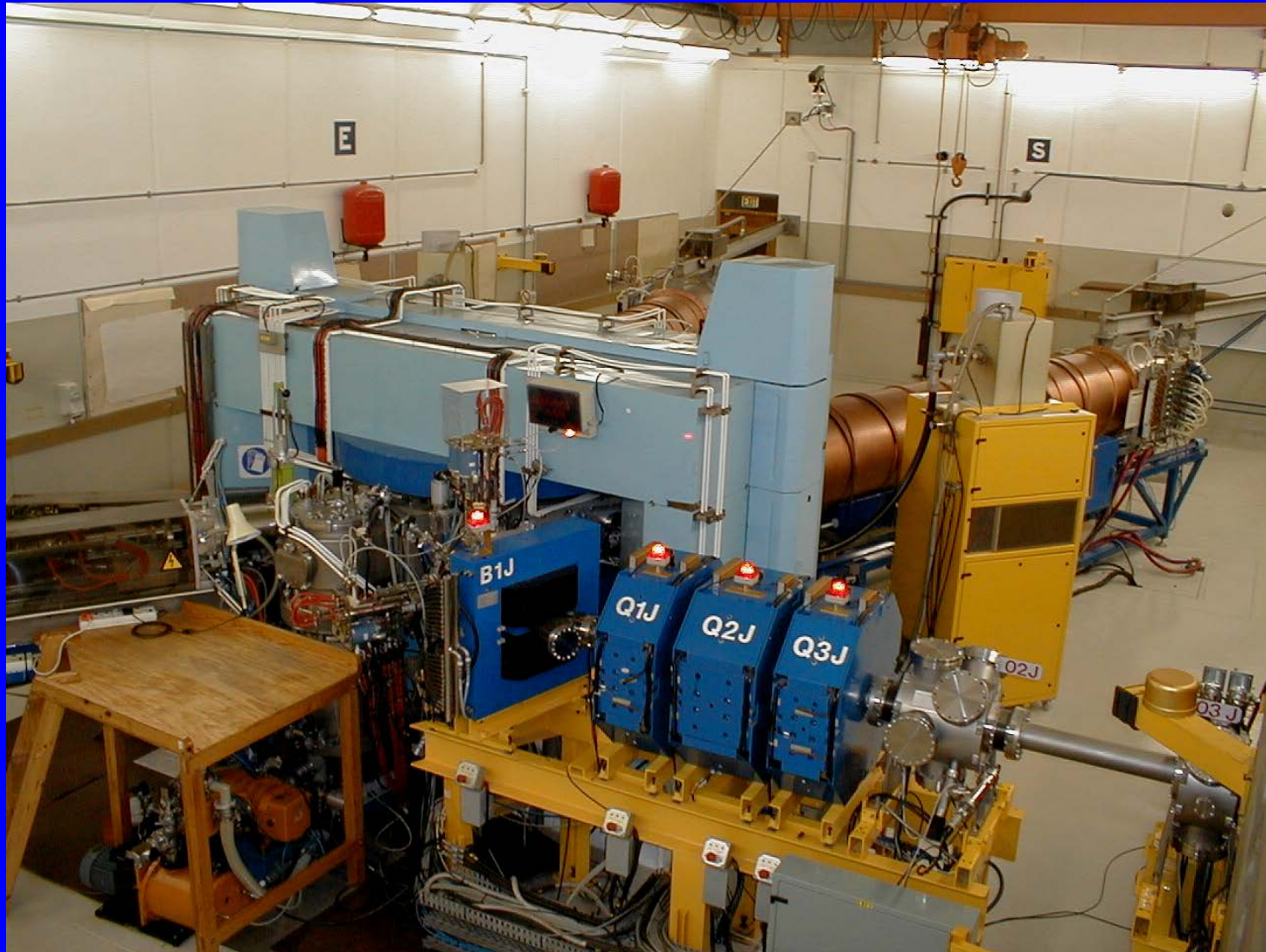
Separated-Sector Cyclotron Facility



Beam Schedule



Solid-pole injector cyclotron 1



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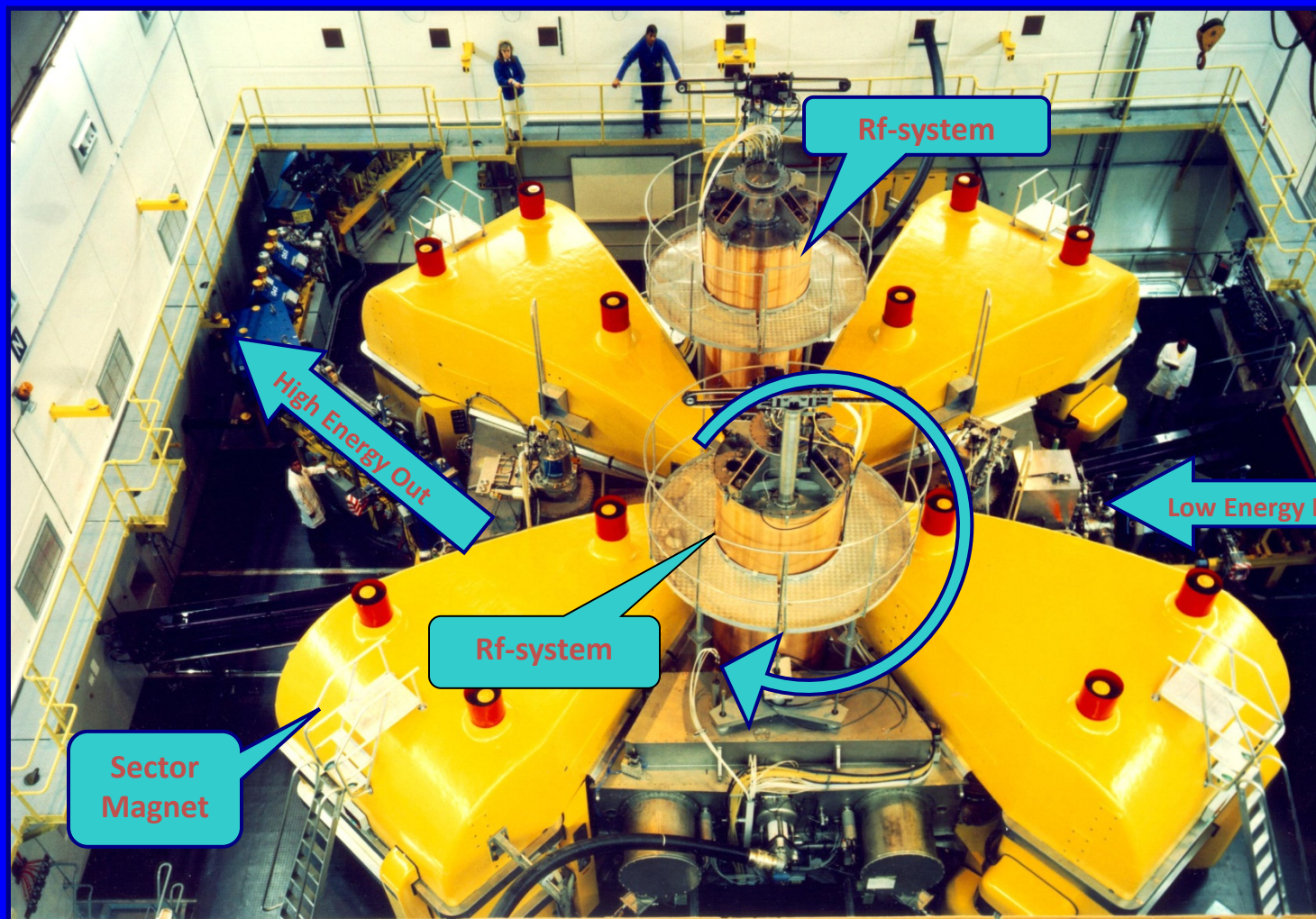
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The Separated-sector cyclotron



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Neutron Therapy



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Proton therapy vault



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Operating Statistics for the past 7 years

Year	Beam Supplied as:		% of Scheduled beam time for:	
	% of Total time	% of *Scheduled time	Energy Changes	Interruptions
2008	62.0	82.45	4.9	17.5
2009	70.5	82.45	6.6	7.7
2010	67.6	82.18	6.3	8.3
2011	68.9	85.91	6.8	6.0
2012	69.9	82.04	7.1	9.3
2013	63.0	81.17	6.2	10.7
2014	67.3	80.81	6.5	9.7

- Scheduled time is total calendar time minus scheduled maintenance time and the days that the laboratory is officially closed during December.

Replacement of the 4 MW Uninterruptable Power Supply (UPS) battery bank R15M



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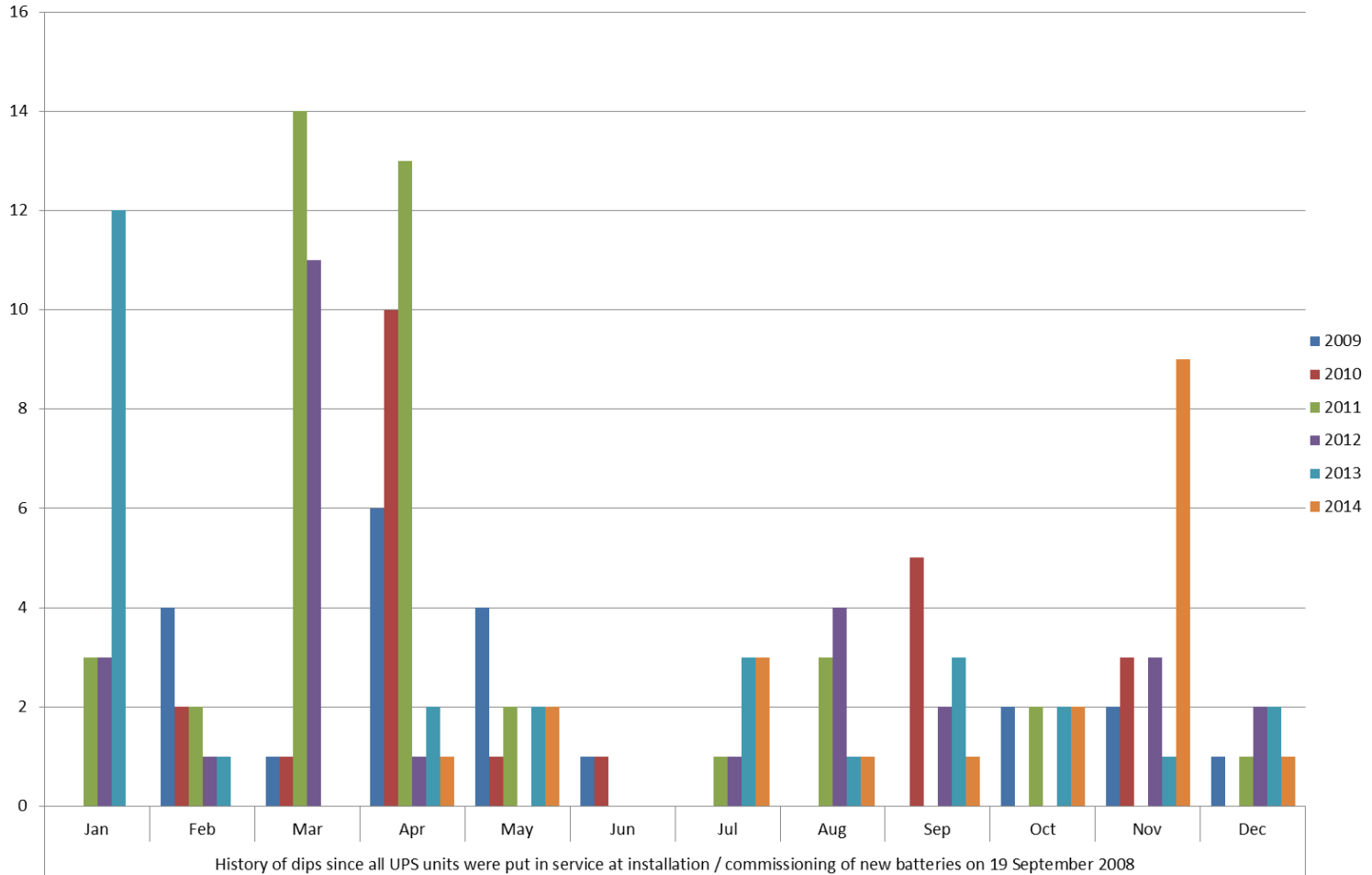
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Power Dips 2009 - 2014



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Number of Power Dips Recorded

Year	Number of dips
2009	21
2010	23
2011	41
2012	28
2013	29
2014	26
Average/year	28

Replacement batteries for the UPS

- Batteries were initially replaced by maintenance free gel batteries. These batteries only lasted 4 years.
- Busy with a tender process to replace the batteries.
- In-depth analysis of the battery technologies was performed.
- Technologies to avoid are gelled electrolyte and Lead-Calcium .
- The technology we are going with is a low antimony selenium alloy battery. Which dominates the European market.
- Battery banks are dimensioned for a constant power discharge for 15 minutes. A depth of discharge below 80% must be avoided. With minor maintenance every 6 months one can achieve 1200 cycles over a life span of 20 years.
- Delivery upon approval will take 16 weeks.



Alternative to the UPS Diesel generator and flywheel system R56M



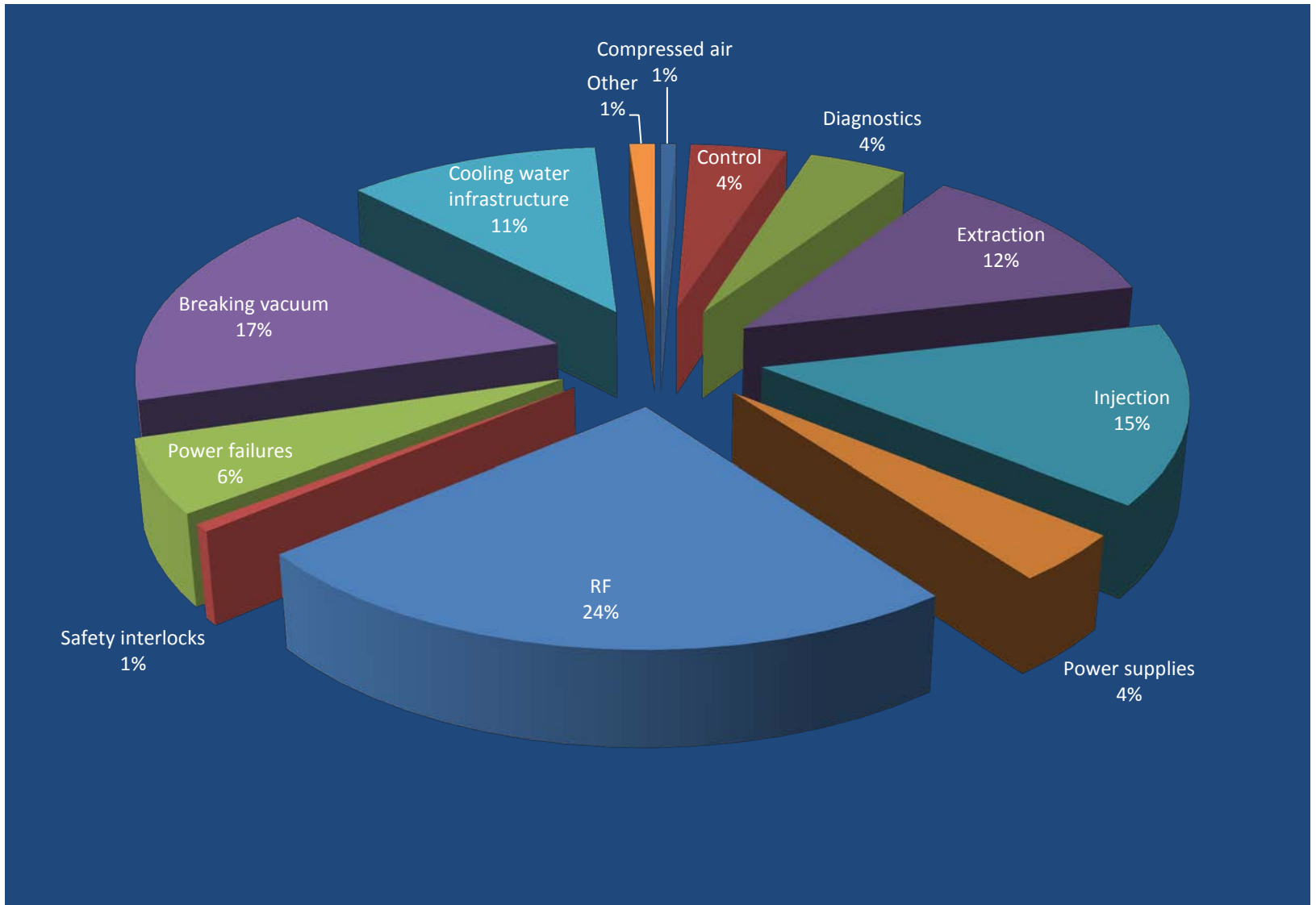
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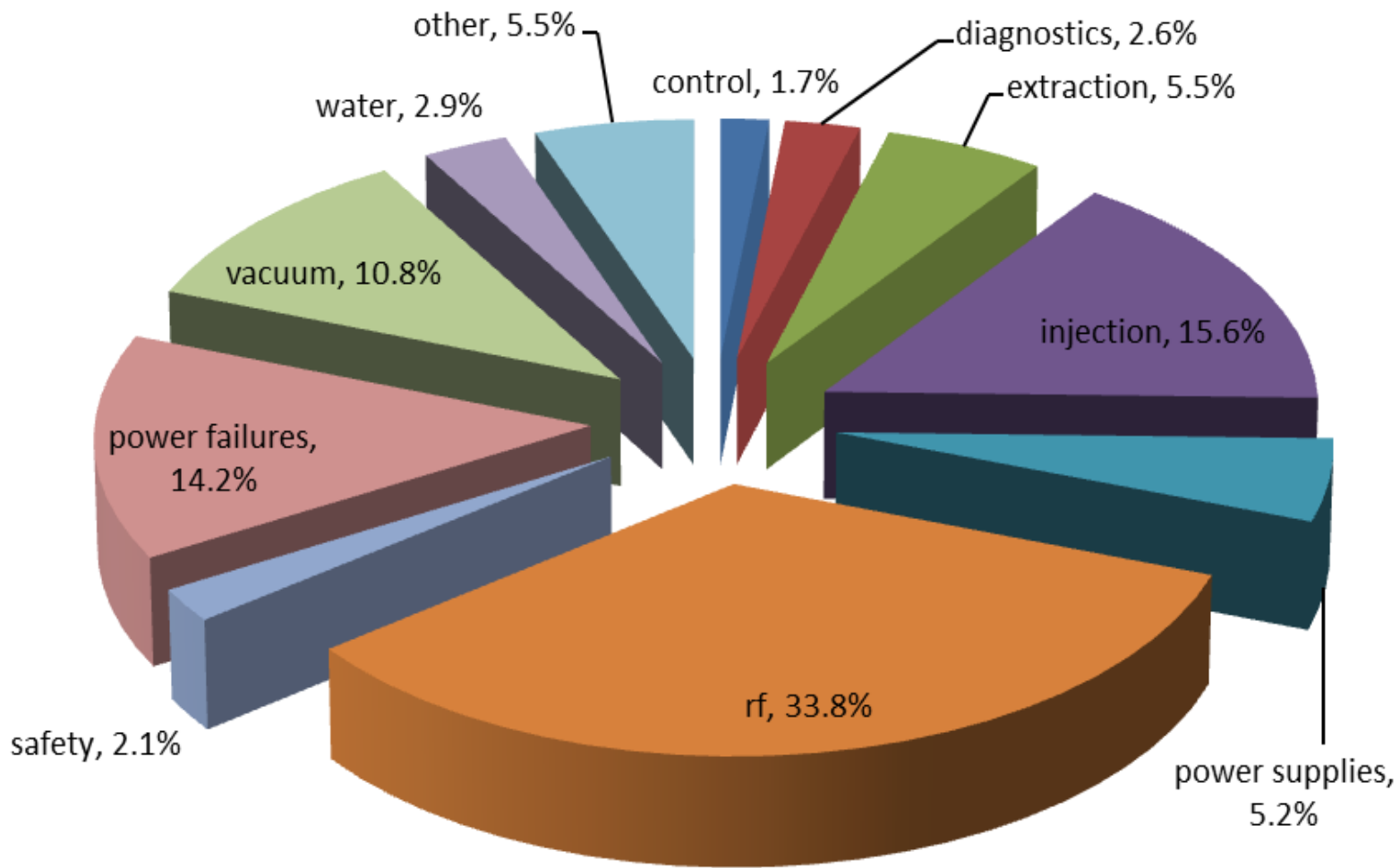


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2012

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2014

New cooling towers for the infrastructure



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New cooling towers for the chillers



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Chiller replacement



- 30 year old industrial chiller units to be replaced
- R8m funding allotted
- Sustainable cost saving on electrical power
- Improved reliability of operation



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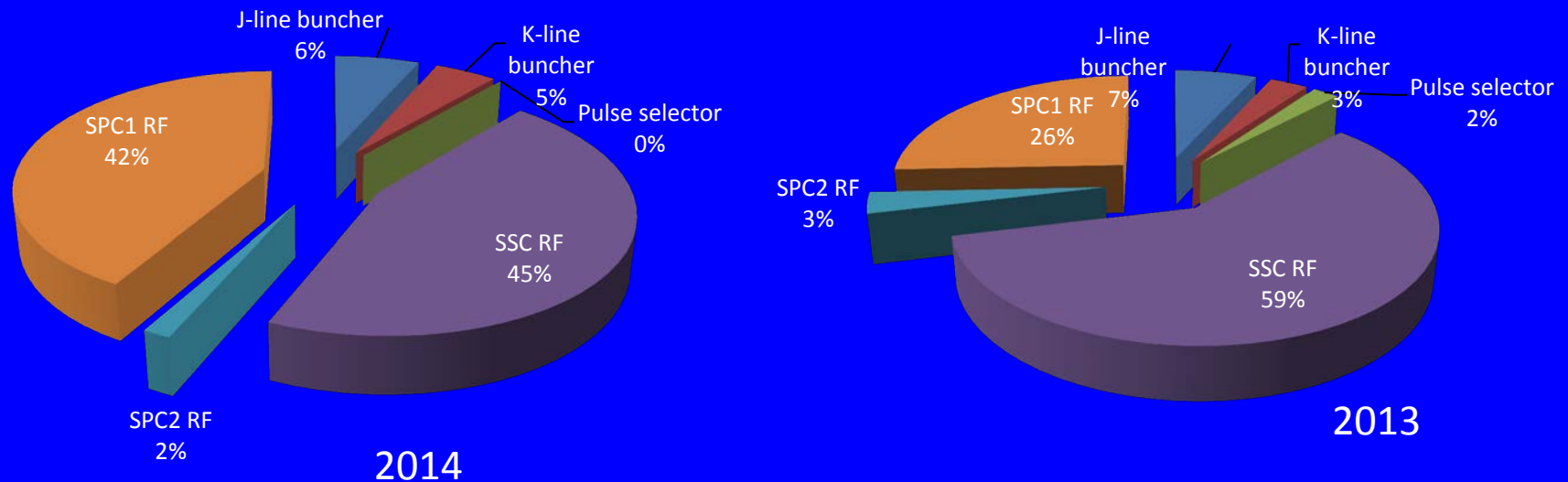
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RF interruptions

- An area of concern remains RF related interruptions.
- The bulk of the RF interruptions occur in the SSC with 59% in 2013 and 45% in 2014.
- To address this finding, the interruptions related to the RF systems, which largely stems from problems with the two SSC RF amplifiers, a capital investment has been made to build a new spare amplifiers for the SSC and SPC1.
- Developed new low level rf control system



New Digital Low Level RF Control System



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Rear View of The New Low Level RF Control System



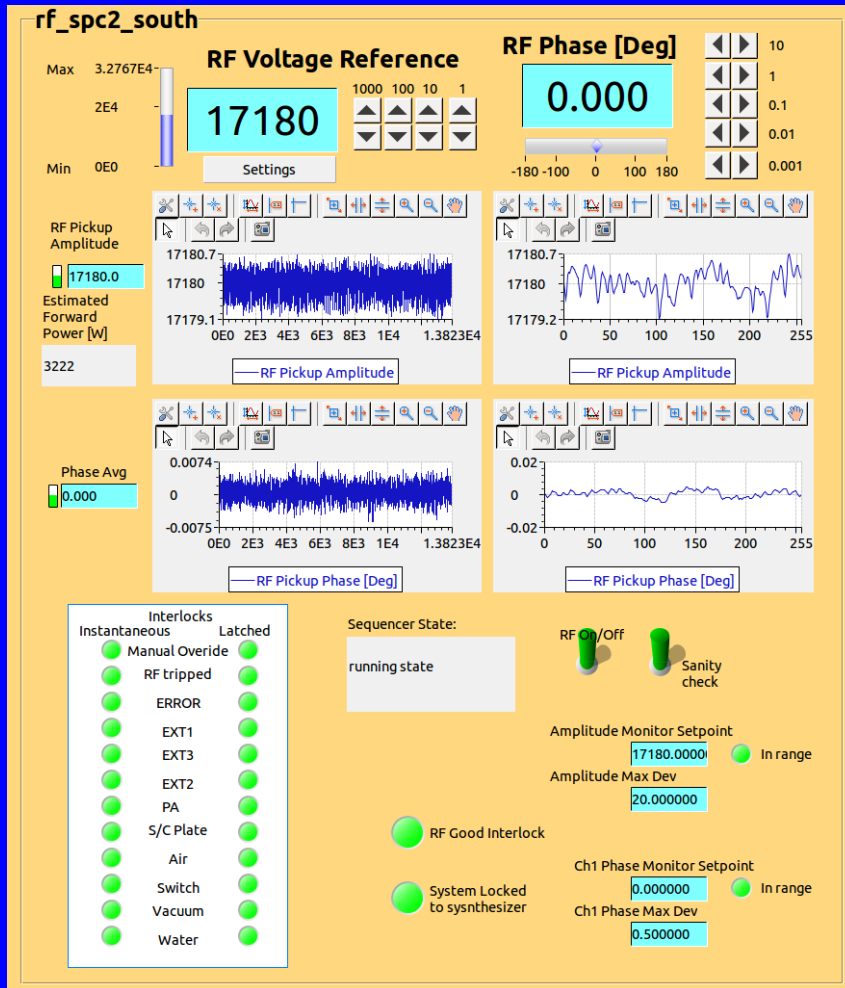
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Operator Interface



- EPICS Based
- Written in Control System Studio
- Digitally programmable
- Real time diagnostics of Amplitude and Phase signals



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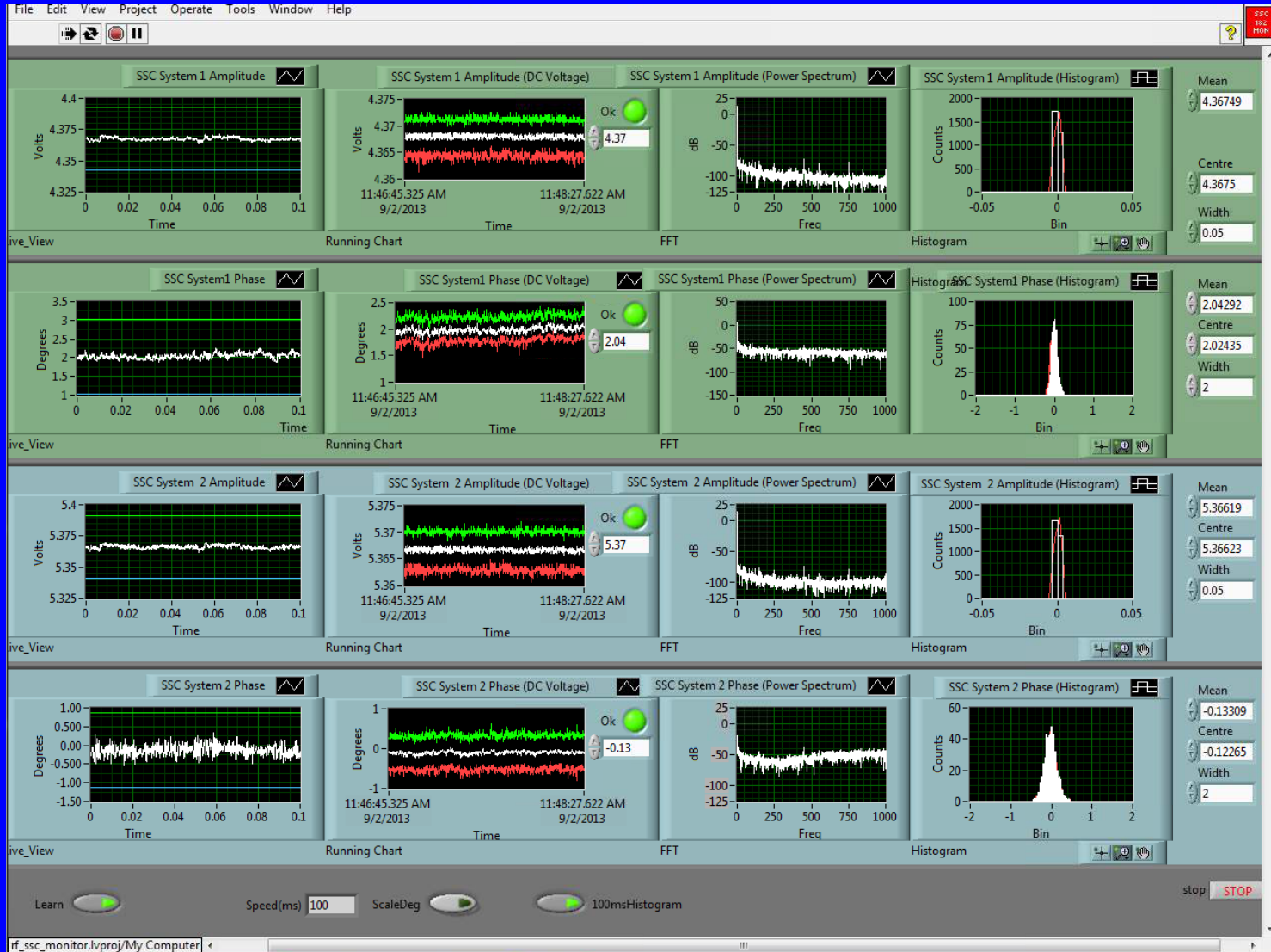
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Operational Reliability and Stability

- Commissioned in October 2014
- No call outs or beam interruptions
- The system is fully automated to resume of any external conditions
- Greater than 1/10000 Amplitude Stability
- Greater than 0.01 Phase stability

RF Diagnostic system



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Advantages of migrating to EPICS control system

- 1. All of our motion controlled components have been moved over to the EPICS platform and have proven to be very reliable, with remote, off site monitoring and diagnosis proving to be very useful for maintaining our 24 hour, 7 days a week service.

2. By setting alarms on these components one is able to diagnose problems before they become critical and take action to reduce down time.

This granularity also allows one to present user friendly display pages helping operators control devices effectively.

Control Room upgraded to monitor many more variables



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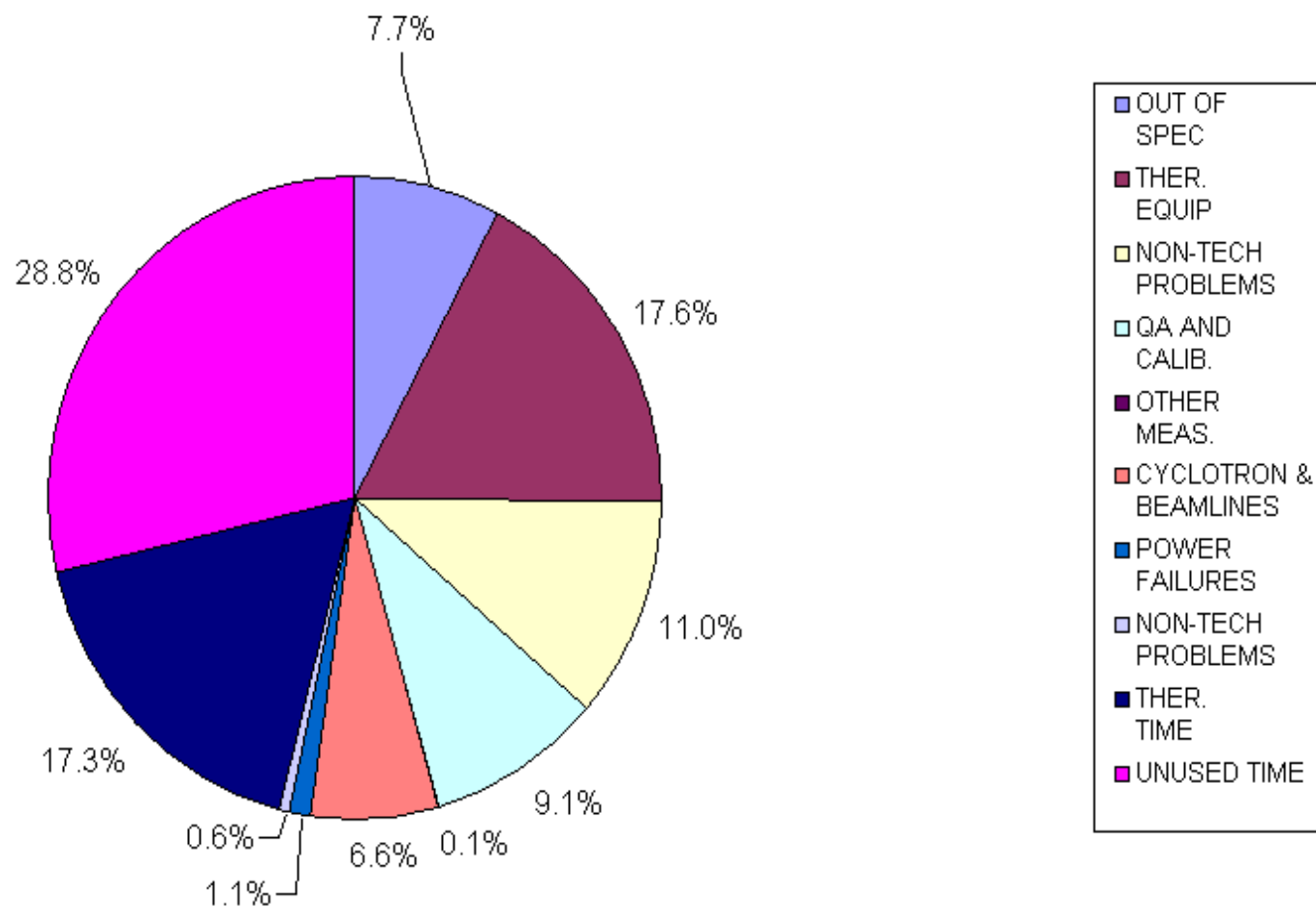
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Summary of neutron therapy treatment statistics

Year	Scheduled Treatments	Days	Completed	%	Fields	Re-scheduled	%	Patients Started
2010-11	292	109	277	94,9	902	15	5,1%	22
2011-10	399	111	370	92,7	1295	29	7,3%	29
2012-13	222	102	209	94,1	788	15	5,9%	20
2013-14	236	101	208	88,1	671	28	11,9%	15
2014-15	290	78	165	92.2	808	24	8.3%	13

Neutron Therapy Time Analysis for 2014



Thank you



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