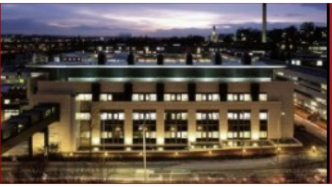
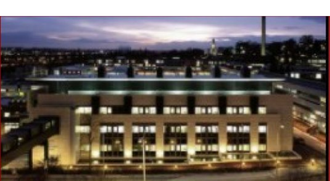
Helium Recycling

Huw Williams
University of Nottingham



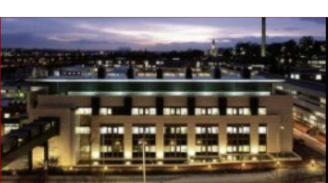
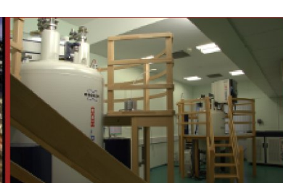
Overview

- Background into UoNs requirements
- Economics of the project
- Technical considerations
- Pitfalls, and issues



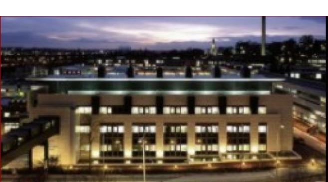
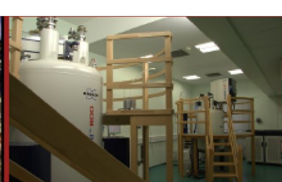

Background: Helium dependence

- The University consumes about 80,000 l of helium per year.
- Most of this is from MRI and physics research
- Our 3 'NMR' Sites. Each consume about 2-3000 l.
- Currently recycle ca 50,000 to a liquifier in physics. Currently only from MRI and Physics labs but back pressures is an issue.

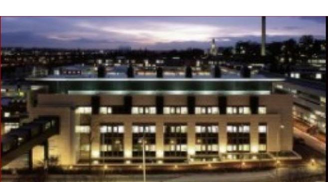
Background: The Problem

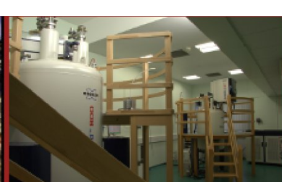
- In 2012 the supply issue became critical. It has since 'got better' (then worse then better again).
- Costs increased.
- The charging landscape has become uncertain
- The supply has been put 'at risk' a number of times.

Background: The risks

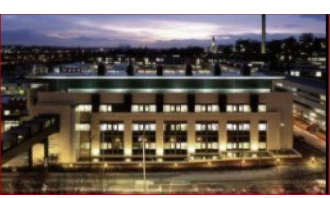
- Some equipment have tight fill windows. Ideal time to fill <--> quench point.
- Volatile prices are difficult to cope with when grants are over 3-5 years.
- Supply issues.





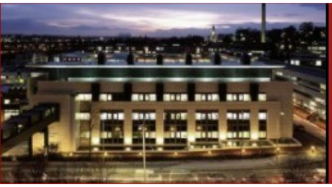
Solutions

- Working with Procurement we flagged up the supply chain risk for the University as a whole. The primary aim was to manage the risk to fluctuations on the open market.
- The aim was to coordinate all our helium recycling across the University building on existing resources.
- Physics at the time were also considering increasing the efficiency of plant



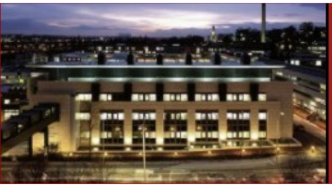

Economics and payback

- Pick a number!
- 11.5% compounded costs: >10 years payback
- 20% compounded costs: ~ 8 Years payback
- Nobody cares on payback outside of 5 years




Proposal

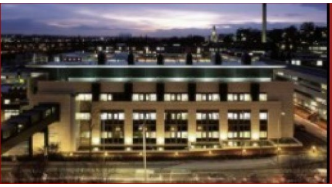
- It cannot be made on ‘payback’ arguments
- You must use risk arguments – potential loss of income and margin.



Grant income at risk

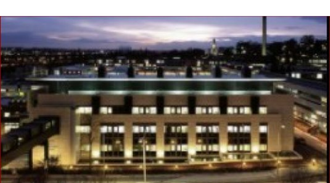
- Research at risk - Calculated as a reduced capacity to do research due to reduced instrumentation.

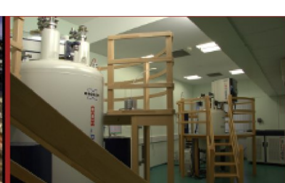
	Research Dependent on Superconducting Magnets/Liquid Helium	
	Annual Grant Income	Annual Margin
Annual losses due to supply disruption	£ 2.8	£ 0.6
Total Losses Over Initial Project Lifetime (5 years)	£ 14.1	£ 3.0



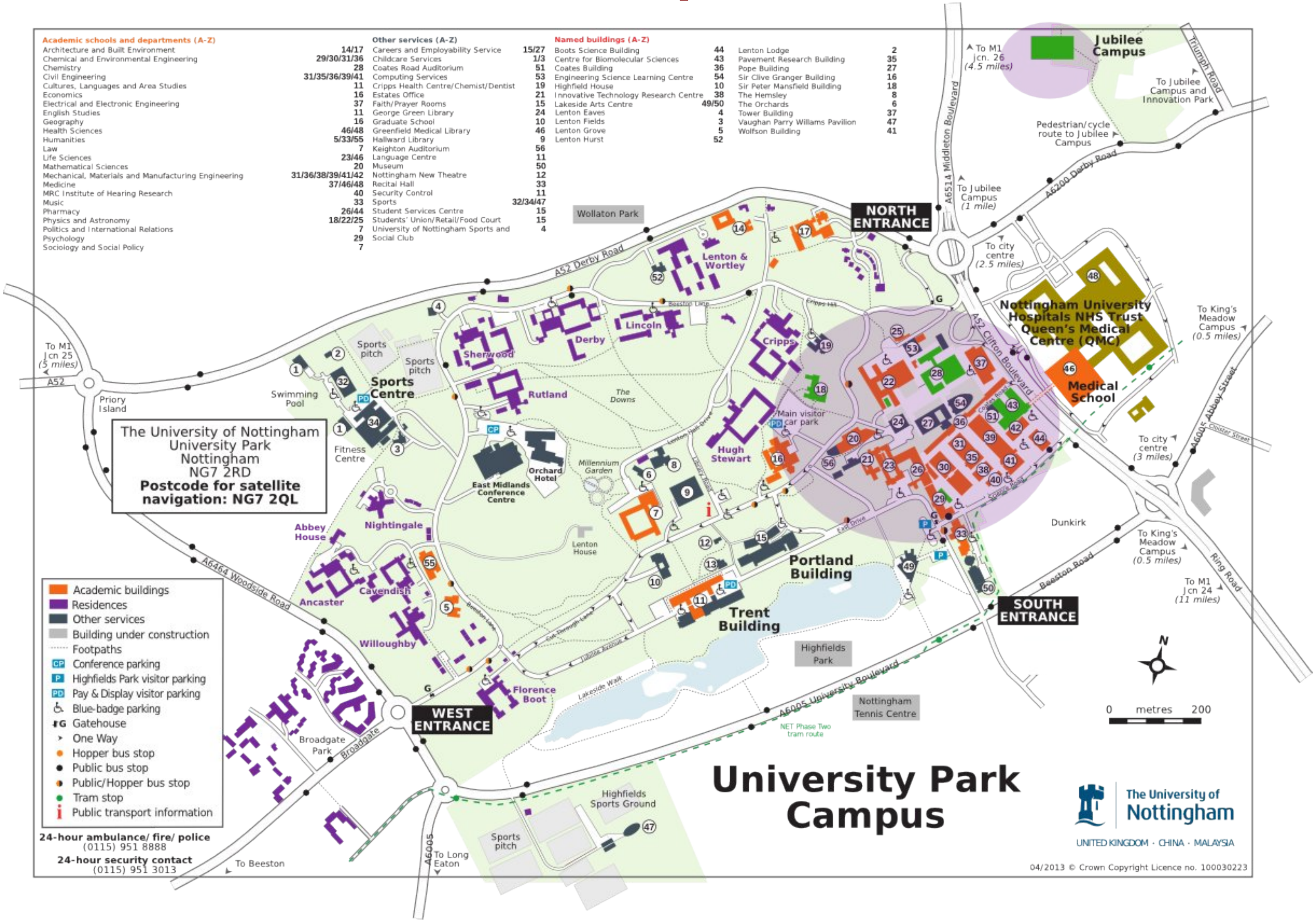
Requirements

- Collect Helium gas from the majority of sites
- Aim to get high levels of recovery - Capture fill and general boil off.
- Ok return is 80%, good return 90%





Scope



Academic schools and departments (A-Z)
Architecture and Built Environment 14/17
Chemical and Environmental Engineering 29/30/31/36
Chemistry 28
Civil Engineering 31/35/36/39/41
Cultures, Languages and Area Studies 11
Economics 16
Electrical and Electronic Engineering 37
English Studies 11
Geography 16
Health Sciences 46/48
Humanities 5/33/55
Law 7
Life Sciences 23/46
Mathematical Sciences 20
Mechanical, Materials and Manufacturing Engineering 31/36/38/39/41/42
Medicine 37/46/48
MRC Institute of Hearing Research 40
Music 33
Pharmacy 26/44
Physics and Astronomy 18/22/25
Politics and International Relations 7
Psychology 29
Sociology and Social Policy 7
Other services (A-Z)
Careers and Employability Service 15/27
Childcare Services 1/3
Coates Road Auditorium 51
Computing Services 53
Cripps Health Centre/Chemist/Dentist 19
Estates Office 21
Faith/Prayer Rooms 15
George Green Library 24
Graduate School 10
Greenfield Medical Library 46
Hallward Library 9
Keighton Auditorium 56
Language Centre 11
Museum 50
Nottingham New Theatre 12
Recital Hall 33
Security Control 11
Sports 32/34/47
Student Services Centre 15
Students' Union/Retail/Food Court 15
University of Nottingham Sports and Social Club 4
Named buildings (A-Z)
Boots Science Building 44
Centre for Biomolecular Sciences 43
Coates Building 36
Engineering Science Learning Centre 54
Highfield House 10
Innovative Technology Research Centre 38
Lakeside Arts Centre 49/50
Lenton Eaves 4
Lenton Fields 3
Lenton Grove 5
Lenton Hurst 52
Lenton Lodge 2
Pavement Research Building 35
Pope Building 27
Sir Clive Granger Building 16
Sir Peter Mansfield Building 18
The Hemsley 8
The Orchards 6
Tower Building 37
Vaughan Parry Williams Pavilion 47
Wolfson Building 41
Jubilee Campus
To M1 Jcn. 26 (4.5 miles)
To Jubilee Campus and Innovation Park
Pedestrian/cycle route to Jubilee Campus
To Jubilee Campus (1 mile)
A6200 Derby Road
A6514 Middleton Boulevard
NORTH ENTRANCE
To city centre (2.5 miles)
Wollaton Park
A52 Derby Road
Lenton & Wortley
Nottingham University Hospitals NHS Trust Queen's Medical Centre (QMC)
Medical School
To King's Meadow Campus (0.5 miles)
To city centre (3 miles)
To M1 Jcn 25 (5 miles)
A52
Priory Island
Sports pitch
Sports Centre
Swimming Pool
Fitness Centre
Sherwood
Derby
Lincoln
Cripps
Rutland
The Downs
Hugh Stewart
Main visitor car park
Orchard Hotel
East Midlands Conference Centre
Millennium Garden
Lenton House
Dunkirk
The University of Nottingham
University Park
Nottingham
NG7 2RD
Postcode for satellite navigation: NG7 2QL
Abbey House
Nightingale
Ancaster
Cavendish
Willoughby
Portland Building
Trent Building
Highfields Park
SOUTH ENTRANCE
To King's Meadow Campus (0.5 miles)
To M1 Jcn 24 (11 miles)
Beeston Road
Ring Road
A6464 Woodside Road
Florence Boot
WEST ENTRANCE
Broadgate Park
A6005 University Boulevard
Nottingham Tennis Centre
NET Phase Two tram route
Highfields Sports Ground
Sports pitch
To Beeston
To Long Eaton
A6005
0 metres 200
N
Academic buildings
Residences
Other services
Building under construction
Footpaths
Conference parking
Highfields Park visitor parking
Pay & Display visitor parking
Blue-badge parking
Gatehouse
One Way
Hopper bus stop
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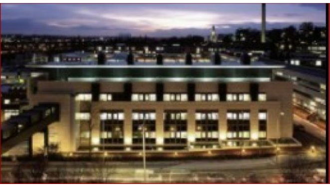
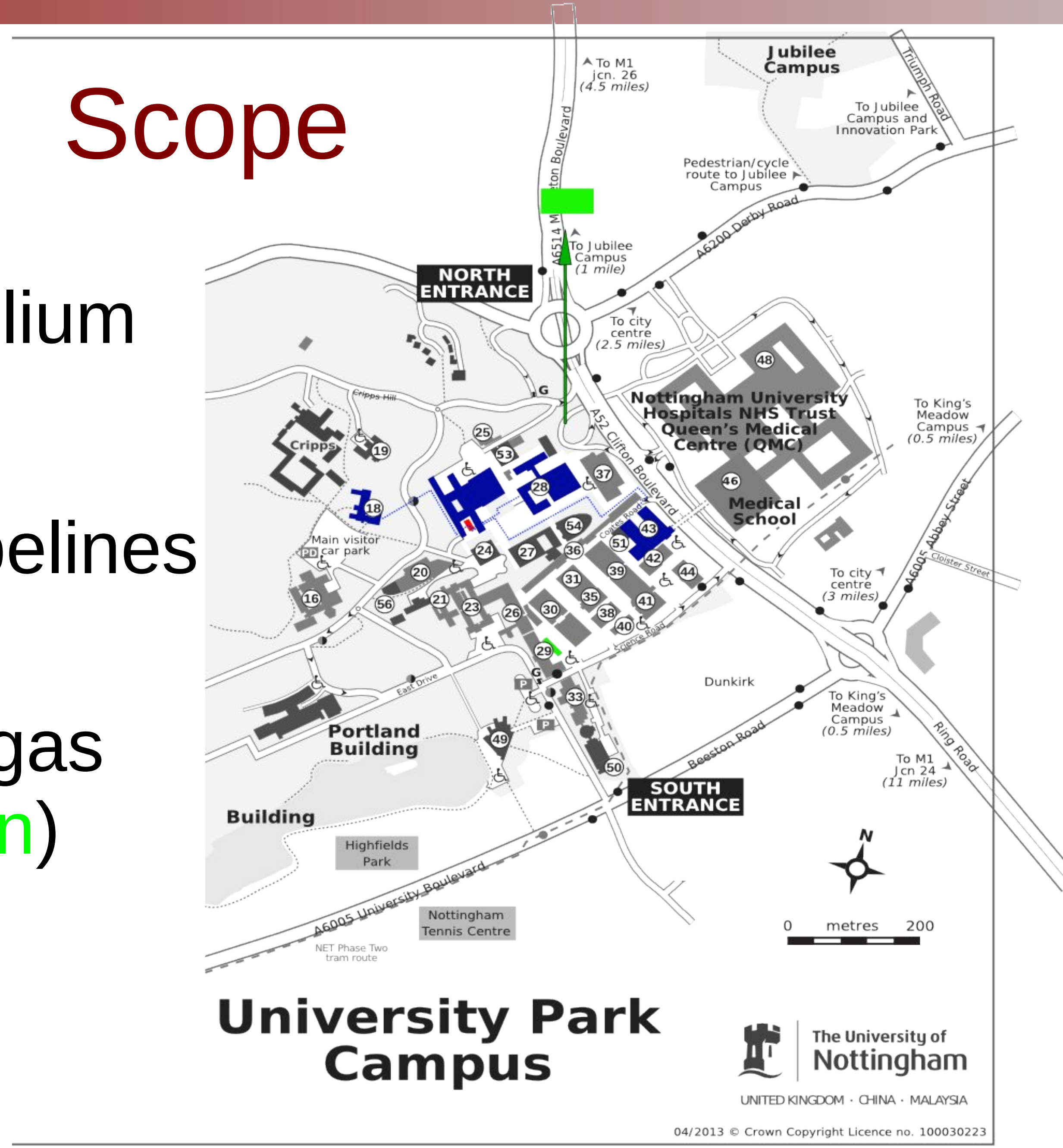
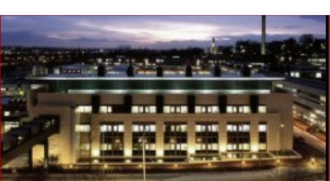


Scope

- 6 Sites using helium
- 1 liquifier (Red)
- 4 sites using pipelines (Blue)
- 2 using remote gas collection (Green)





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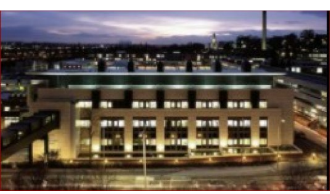
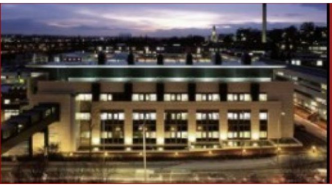
Budget

- About £40k (2012) per site.
- Includes about £1000 per magnet to couple up.
- Then you need a liquifier.




Technical Considerations

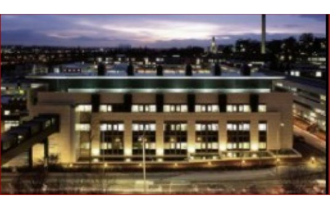
- Back pressures and gas volumes
- Pipeline or Gas collection



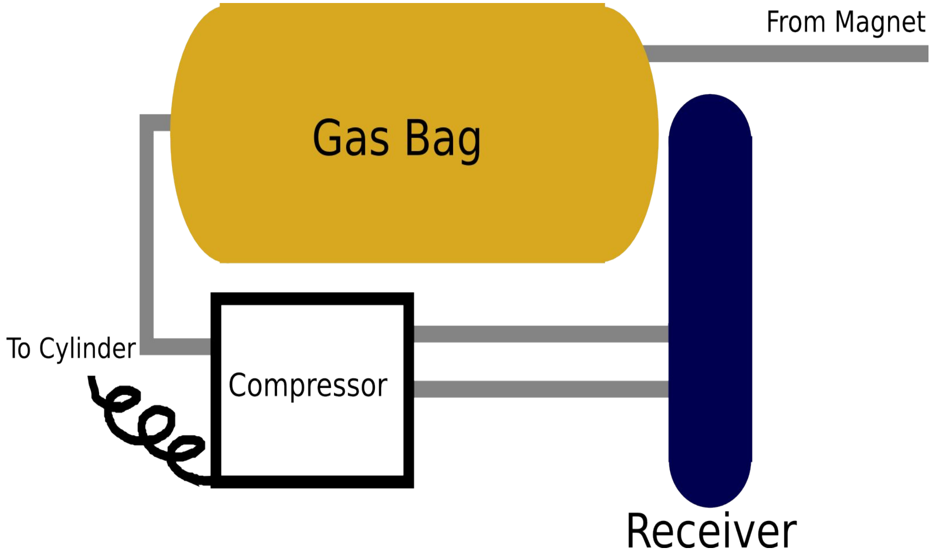
Gas Volumes - Back of envelope numbers

- **<u>400 MHz</u>**
- Fill: 40 l He 100 days
- 0.3 m^3 per day (0.01 m^3/h)
- Fill time: ca 20min
- Fill Loss: 20% = 6 m^3 (18 m^3/h)
- BP: 20-30 mbar

- **<u>800 MHz</u>**
- Fill: 180 l He 50 days
- 2.1 m^3 per day (0.04 m^3/h)
- Fill time: ca 40 min
- Fill Loss: 20% = 27 m^3 (40 m^3/h)
- BP: 100 mbar



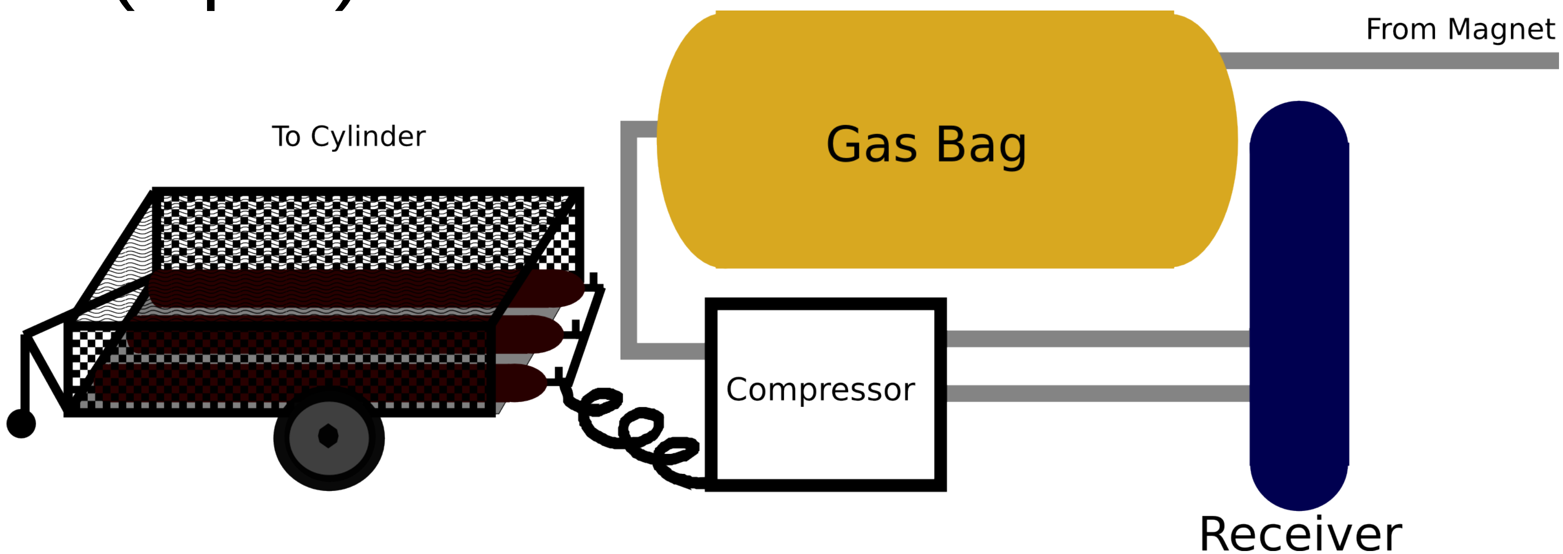
Technical Options: Collection



- ***Gas Bag Holds ca 6 m^3***
- ***Compresses cylinders to ca 200 Bar***
- ***Solenoid valves on inlet close on over inflation***

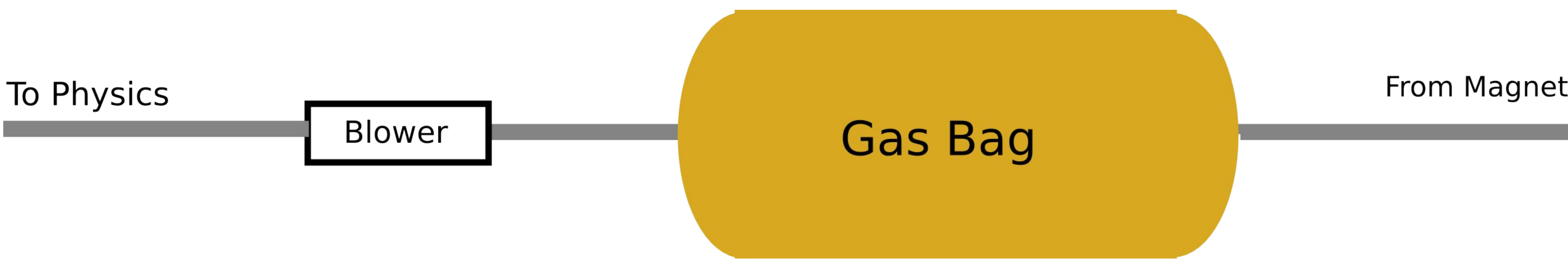
Trailer

- Capacity of 5 x 10m3
- 65 l (liquid)
- Could use 6 cylinders at 300 Bar = 120 l (liquid)
- Pressure vessel regulations
- ADR regulations
- Breakaway Hose

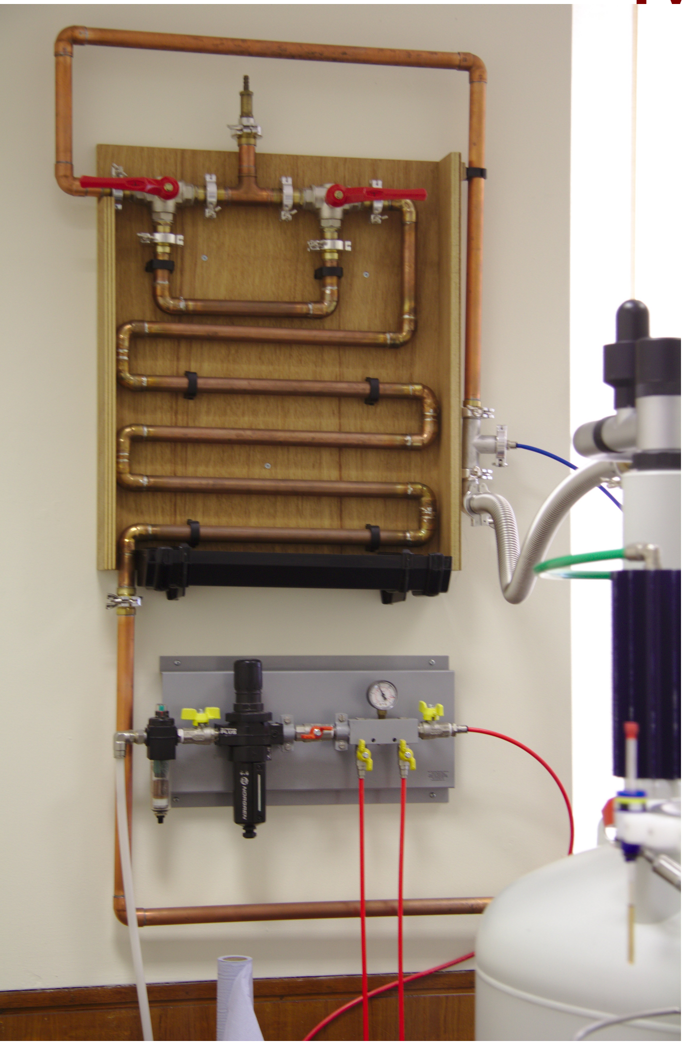


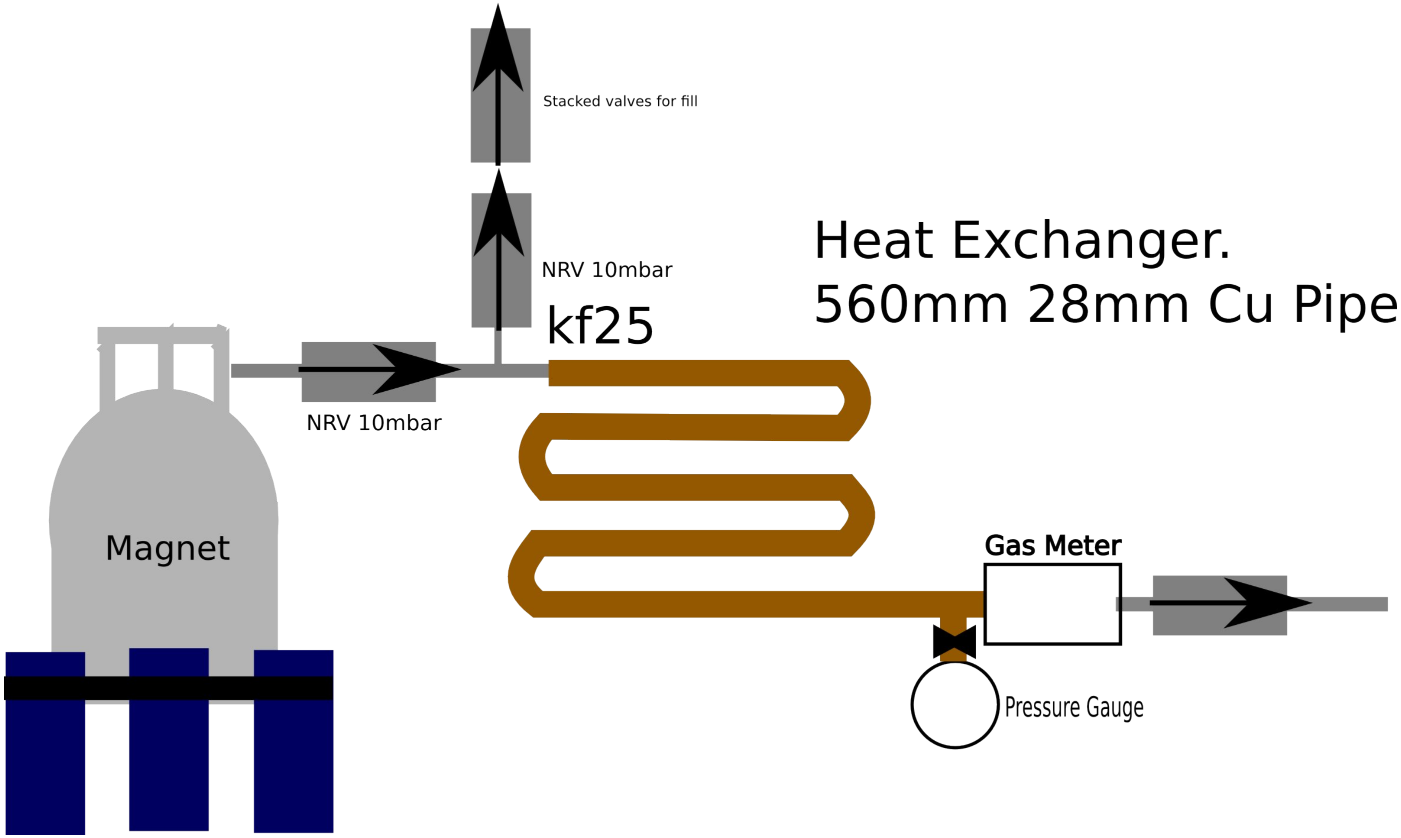
Pipeline

- 63mm PE pipe
- Solenoid valves on input.
- Blower 3-phase
- Need annual static pressure test



Magnet coupling





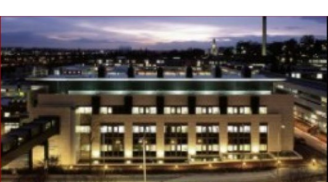
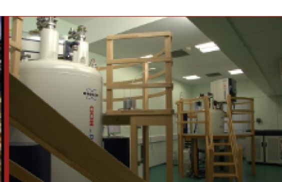
Technical Options: Pipeline or Collection

Pipeline

- ✗ Installation and routing.
- ✓ Ongoing maintenance.
- ✗ Tracing future faults - leaks!
- ✓ no cost increase at high flow.

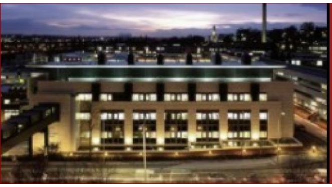
Collection

- ✗ Site planning, space noise.
- ✗ Ongoing maintenance.
- ✗ Attended operation.
- ✓ Routing issues and distance to recovery.
- ✗ For high flow cost increases.

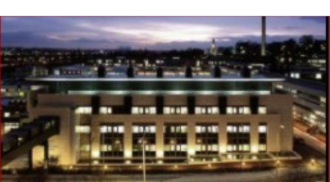
State so far

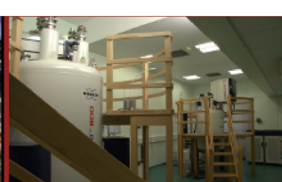
- Run some tests with fills on 400 system upto gas bag.
- All pipe lines have been installed. Gas bag and blowers being installed over the next month...




Pitfalls, barriers and 'issues'

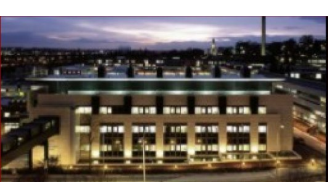
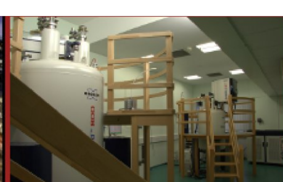
- Cost.
- Time - who leads the project.
- Single point of failure - cooperation with other Universities.
- Co-ordination across multiple schools departments, and external consultants.
- Responsibility with-out authority - (Most risk so most motivated)





Other Advantages

- Recycling a non-renewable resource.
- Closer co-operation between all helium users.
  - Reduced costs on deliveries.
- Improved helium planning - local source of helium.
- Ability to use gas or liquid.
- Small reserve of helium.

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Acknowledgements

Physics

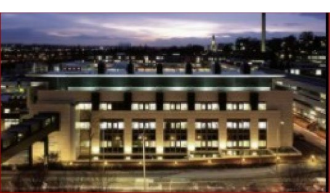
- John Middleton
- Chris Pallender
- Peter Smith

Procurement

- Denise Lord

Chemistry

- Adrienne Davis
- Kevin Butler



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