

Extreme Challenge: Building in Antarctica

Experiences of a Swiss European Architect



Swiss Polar Day 2022

Hugh Broughton Architects
www.hbarchitects.co.uk

Signy
60°S 45°W

Juan Carlos 1
62°S 60°W

Rothera
67°S 68°W

Halley
75°S 26°W

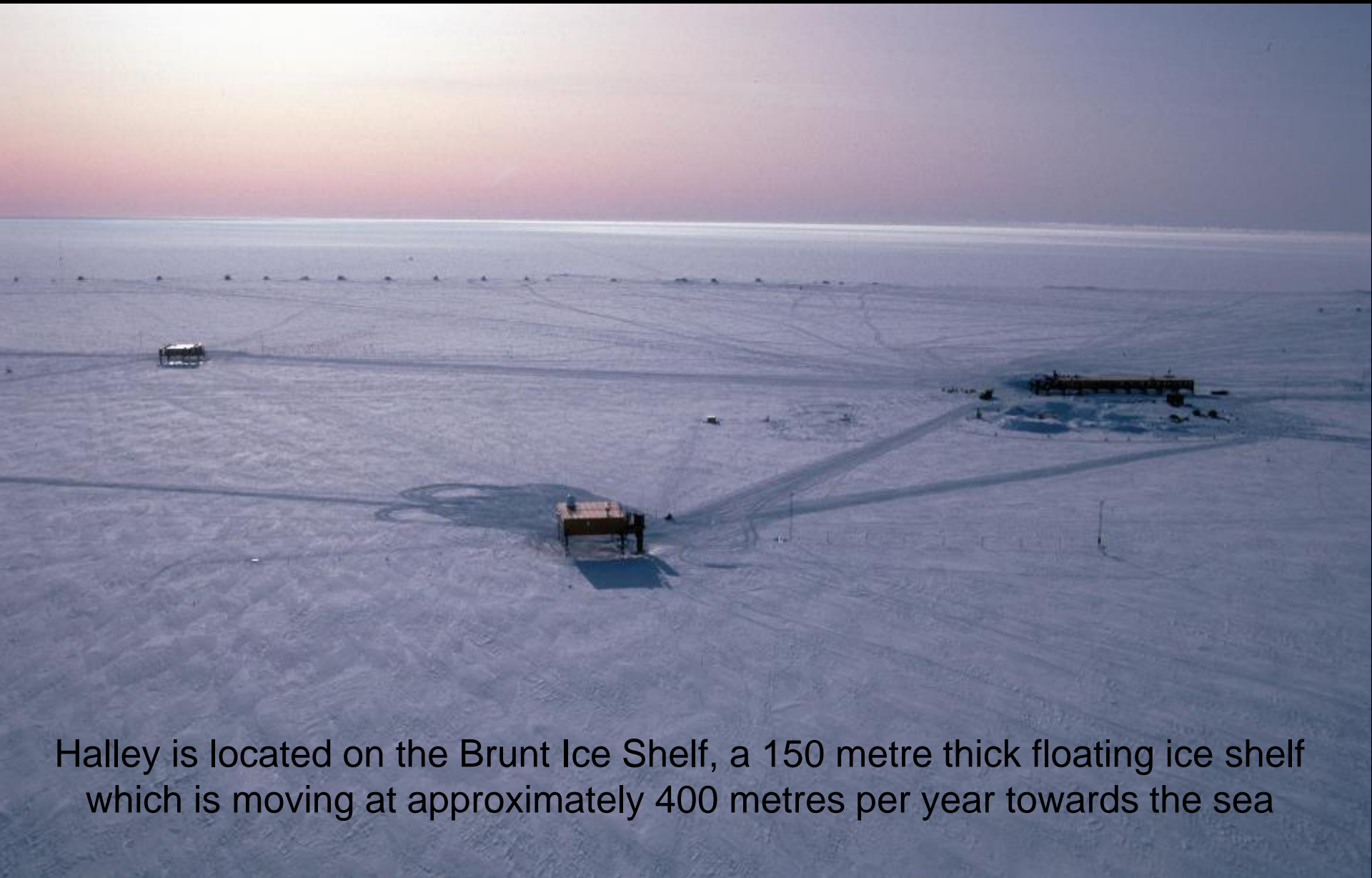
Davis
68°S 77°E

Wilkins
66°S 111°E

McMurdo
77°S 166°E

Scott Base
77°S 166°E

HBA Projects in Antarctica



Halley is located on the Brunt Ice Shelf, a 150 metre thick floating ice shelf which is moving at approximately 400 metres per year towards the sea







Snow accumulation
(c. 1.5m per year)



Ice shelf

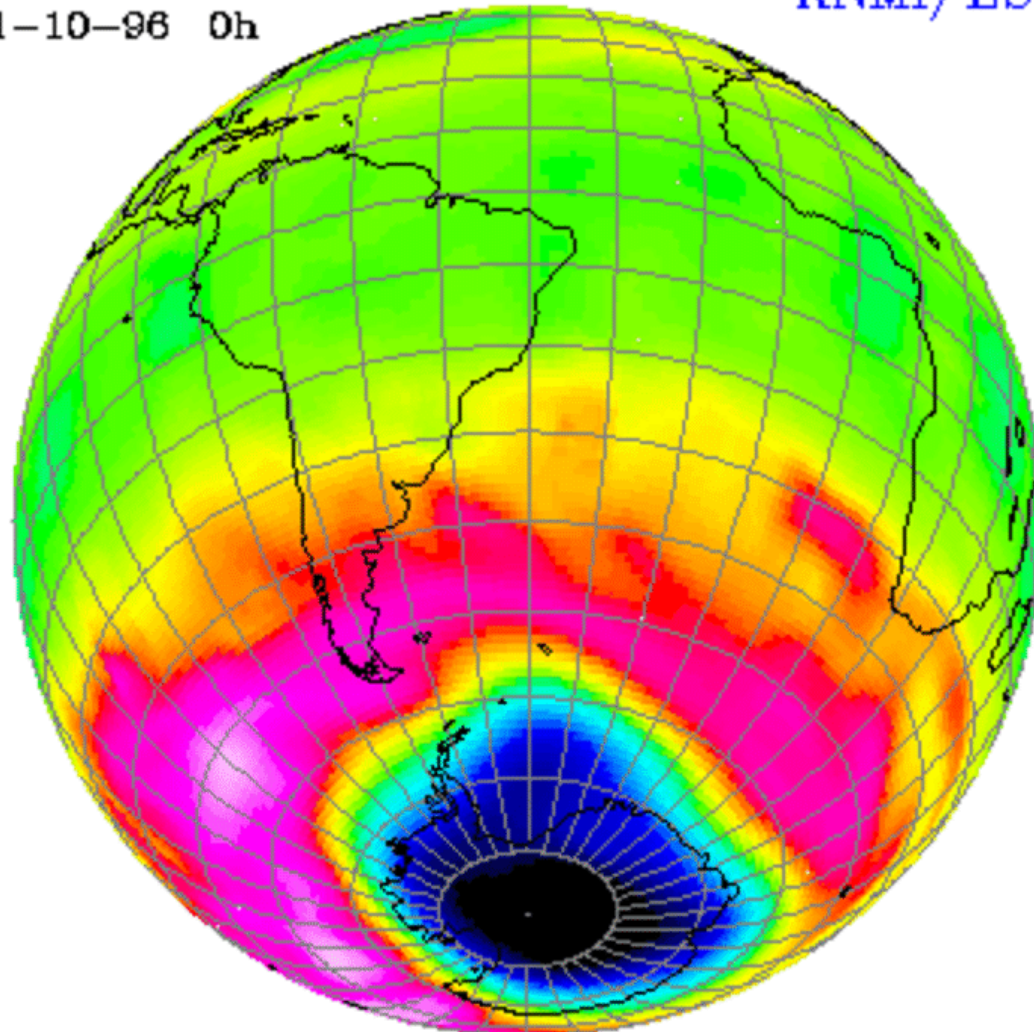
Sea Ice



Halley is where the ozone hole was discovered

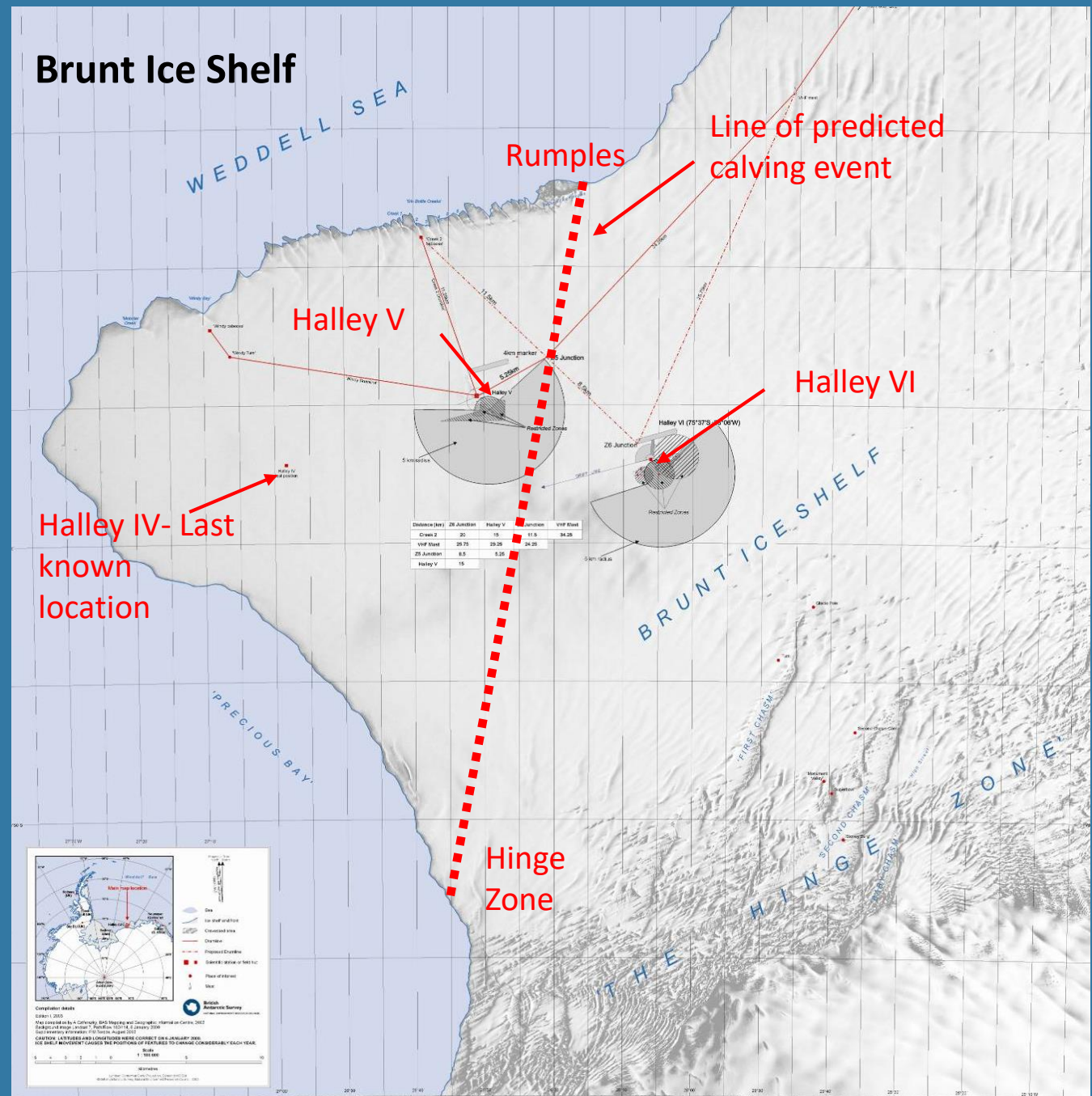
Assimilated GOME total ozone
11-10-96 0h

KNMI/ESA



140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 DU

- Ice Shelf
Moving 400m
per year
towards Sea
- Ice shelf
grounded at The
Rumples and at
the Hinge Zone
- Major calving
event predicted
in 5 to 10 years



Concordia (France-Italy)



Scott Amundsen (USA)



Neumayer III (Germany)



Princess Elisabeth (Belgium)



A hand-drawn sketch of a futuristic train concept, showing a side view of the train and a top-down view of a section. The train is composed of several green and yellow segments. Annotations include:

- STANDARD LENGTH**: A horizontal arrow indicating the length of a segment.
- VARIABLE WIDTH**: A vertical arrow indicating the width of a segment.
- UNDERGROUND TUNNELS**: A dashed line with arrows pointing to the ground below the train.
- CONES = PLUGGING POINTS KNOWLEDGE**: A label pointing to a specific part of the train.
- WHOLE CITY**: A label pointing to the train itself.
- LEG**: A label pointing to a support structure.
- HAILEY VI - BAS**: A label at the bottom right.
- MBR 2.9.03**: A date at the bottom right.
- A HIGHLY INSULATED CONTAINER**: A label at the bottom right.
- SERVICES**: A label pointing to a section of the train.
- MOIST**: A label pointing to a section of the train.
- ACCESS/ESCAPE**: A label pointing to a section of the train.
- SUMMER QUARTERS**: A label pointing to a section of the train.
- VIEW**: A label pointing to a section of the train.
- CHURCH LADDER ACCESS**: A label pointing to a section of the train.
- PLATFOM CAN BE WIDENED FOR WHOLE CITY**: A label pointing to a section of the train.
- CENTRALIZE ACCESS**: A label pointing to a section of the train.
- ROD STAKE**: A label pointing to a section of the train.
- COLLECTOR COILS IN ARMS PLANT AT OFF ENDS**: A label pointing to a section of the train.
- MONITORING RIGIDITY**: A label pointing to a section of the train.
- SCREENED SERVICES & STONES**: A label pointing to a section of the train.
- SERVE FOOD**: A label pointing to a section of the train.
- PUNISH OR COUNSEL**: A label pointing to a section of the train.
- LINK? BUT MOST SERVICES ARE IN STATION**: A label pointing to a section of the train.

HAS THE NEW HALLEY RESEARCH STATION GULD BE LIKE
A STANDARDISED UNIT SUPPORTED AND ADAPTED TO
FUNCTION. EACH MODULE WOULD BE BASED ON A KIT OF
EASY CONSTRUCTION AND LIFE TIME MAINTAINABLE

SUMMIT PLANTHOUSE
SUMMER, POTATOES AND ONIONS
HEATING, DISPOSAL AND WASH-UP
KITCHEN, SLEEPING - 16 PERSON?

SUMMIT SLEEPING MODULE
10 BEDROOMS +
KCH. BATHROOMS
BIOSTORE AND STORES

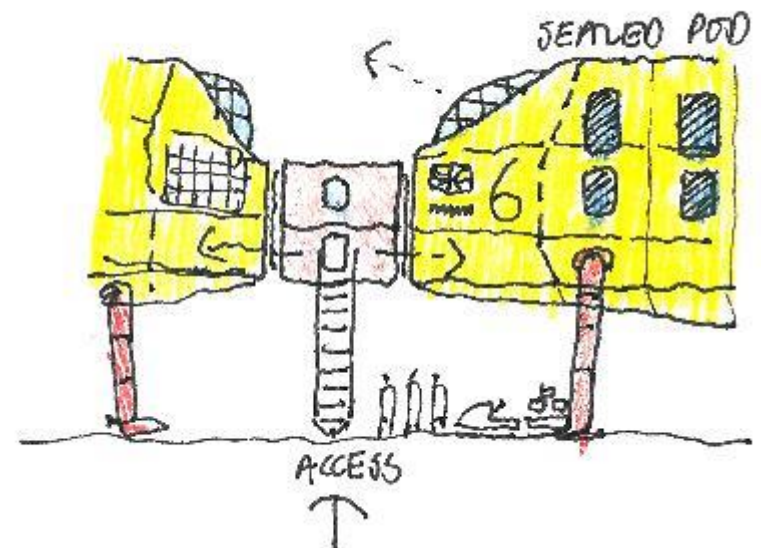
CENTRAL BLOCK - HEART OF HALLS 0
DINING, KITCHEN, FOOD STORES
BAR
GIFT SHOP - TV, LIBRARY
TOILETS, WASHROOMS

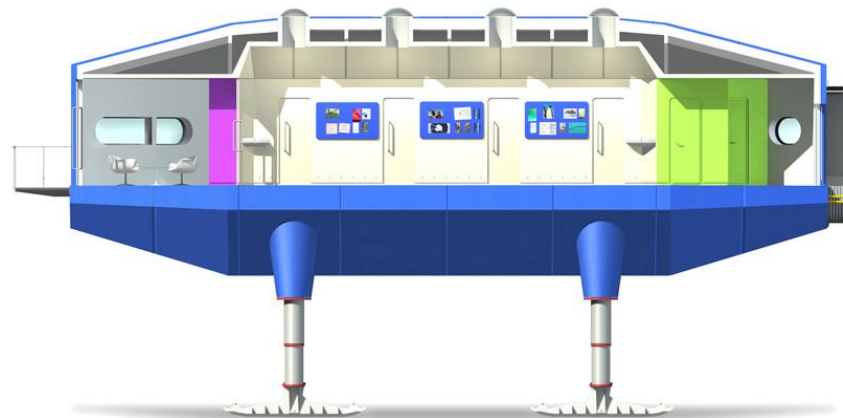
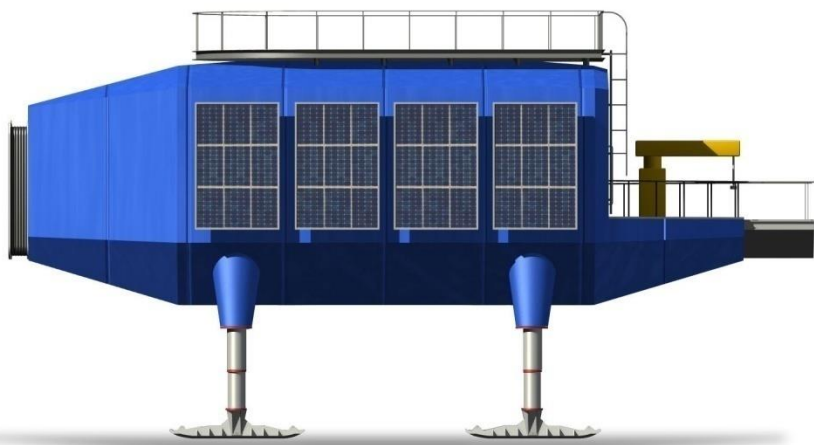
OPERATIONAL REPAIRS
MAINTENANCE AND WORKSHOPS
STATION OVERHAULS, COILED -
GPS AND MULTIMEDIA WALL

BUT DOES IT AGREE TO THE ANTARCTIC STATION PROCESS?
IS IT THE NEW BAR ICON - A SYMBOL OF WORLD SCIENCE?

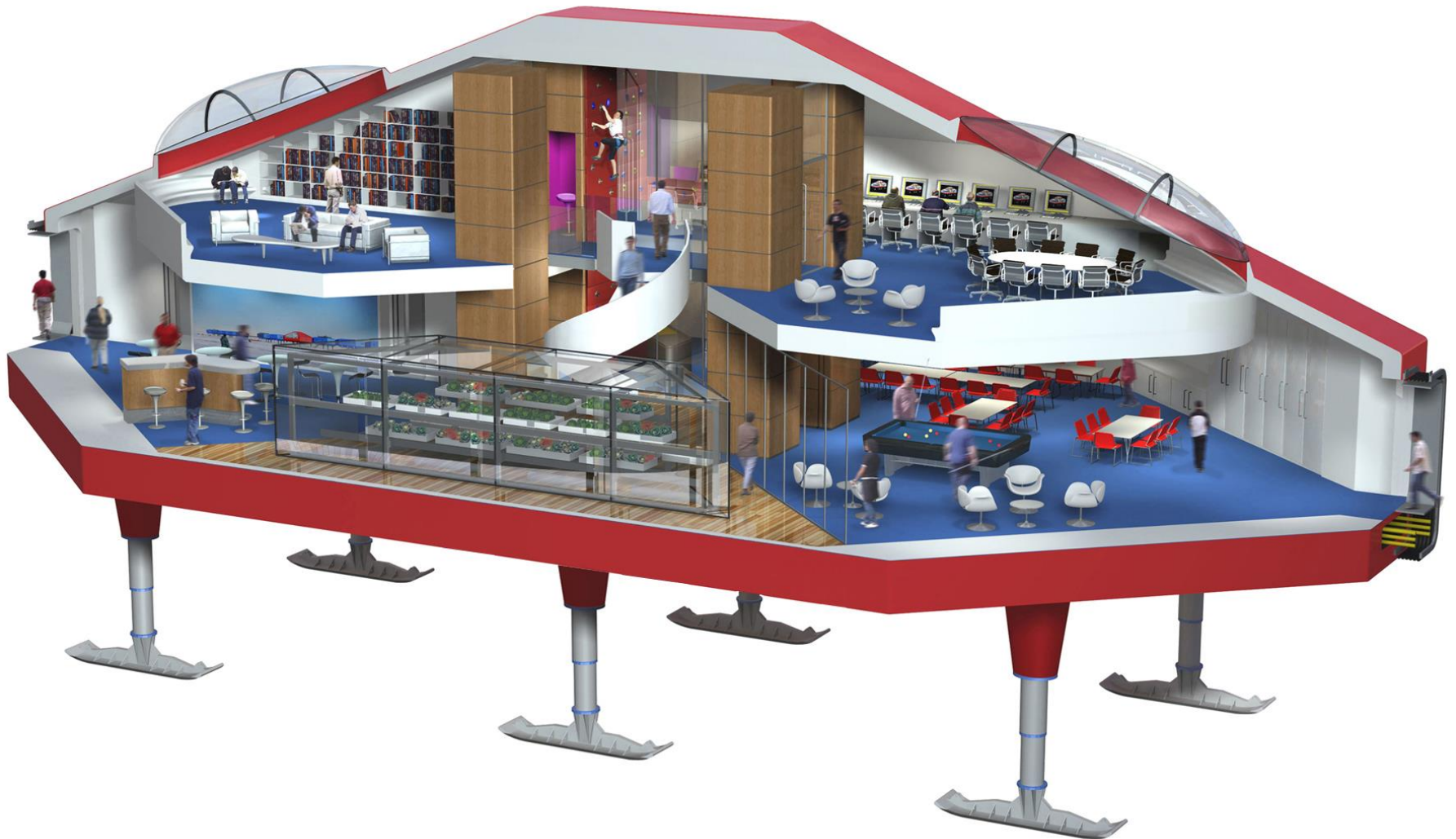
BUT DOES IT RELATE TO THE ANTARCTIC STATION PROCESS?
IS IT THE NEW BAE ICON - A SYMBOL OF WORLD SCIENCE?

- UNITS MUST APPEAR
THERMODYNAMIC
- FLOAT ABOVE THE ICE



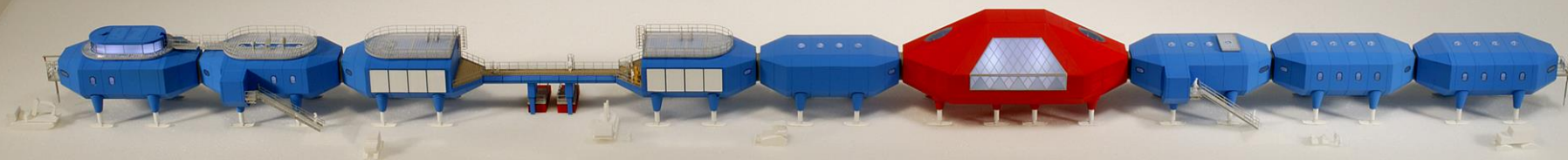


The Central Module = the HEART of Halley VI



- A Science
- B Plant installations
- C Operations
- D Living
- E Sleeping

A A B B C D C E E



South

North

Test modules in South Africa





Moving modules from Halley V to Halley VI (15 kms)















Juan Carlos 1 Spanish Antarctic Base

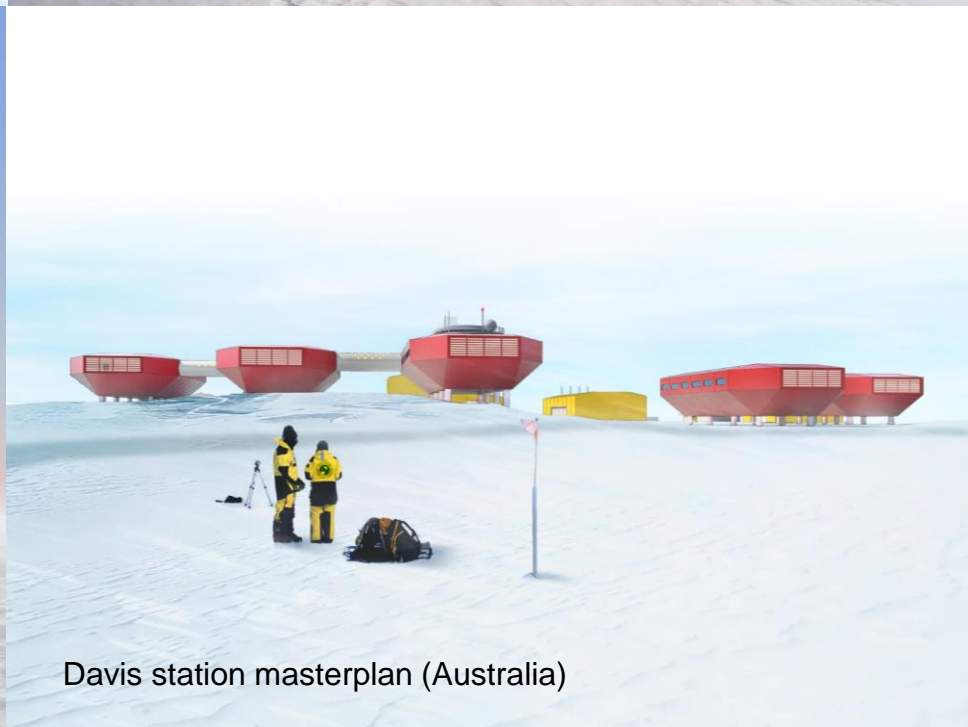


Discovery Building, Rothera Research Station (UK)

as part of the Antarctic Infrastructure Modernisation Programme partnership



Atmospheric Observatory, Summit Station, Greenland (USA)



Davis station masterplan (Australia)

Scott Base, Ross Island, Antarctica



Existing base

Multiple issues need addressing



11 different levels reduce efficiency



Services are difficult to maintain



Key equipment is old



Fire safety is compromised



Snow drifts require management



.. Including roof clearance

Climate

Minimum temperature -57 degC

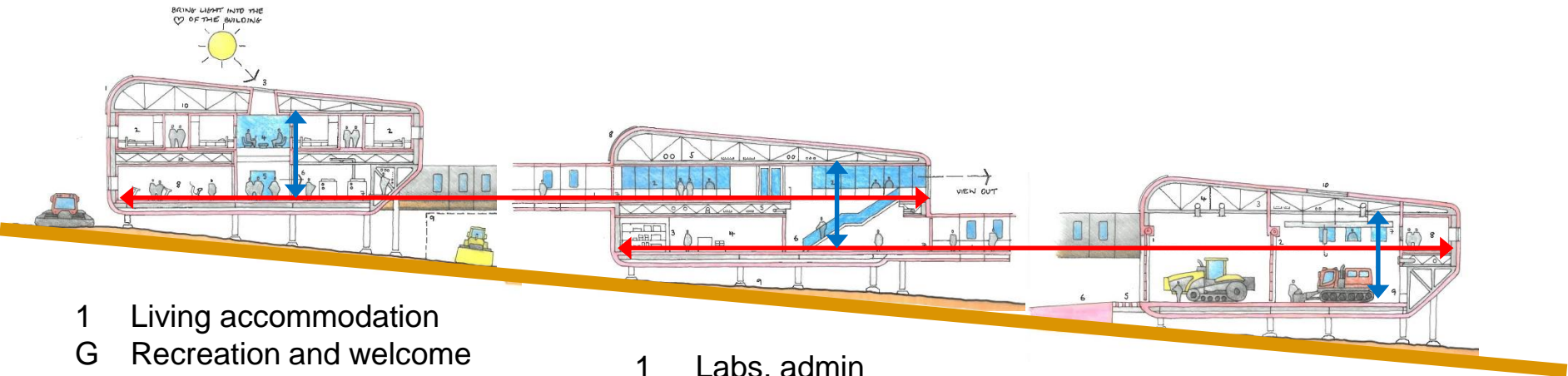
Maximum wind speed 177.8 km/hr



Base concept

Interconnected buildings

Floors in adjacent buildings are at the same level
Each building has two stairs and one lift (hoist)



- 1 Living accommodation
- G Recreation and welcome

- 1 Labs, admin
- G Event staging

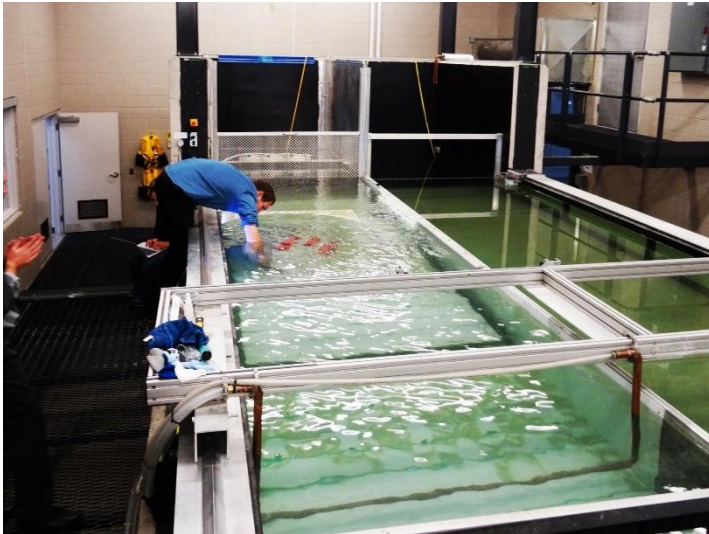
- 1 Field stores
Workshops
- G Stores
Workshops
Cargo

↔ Horizontal link

↕ Vertical link

Snow modelling

RWDI Laboratories, Canada



Water flume at RWDI laboratories



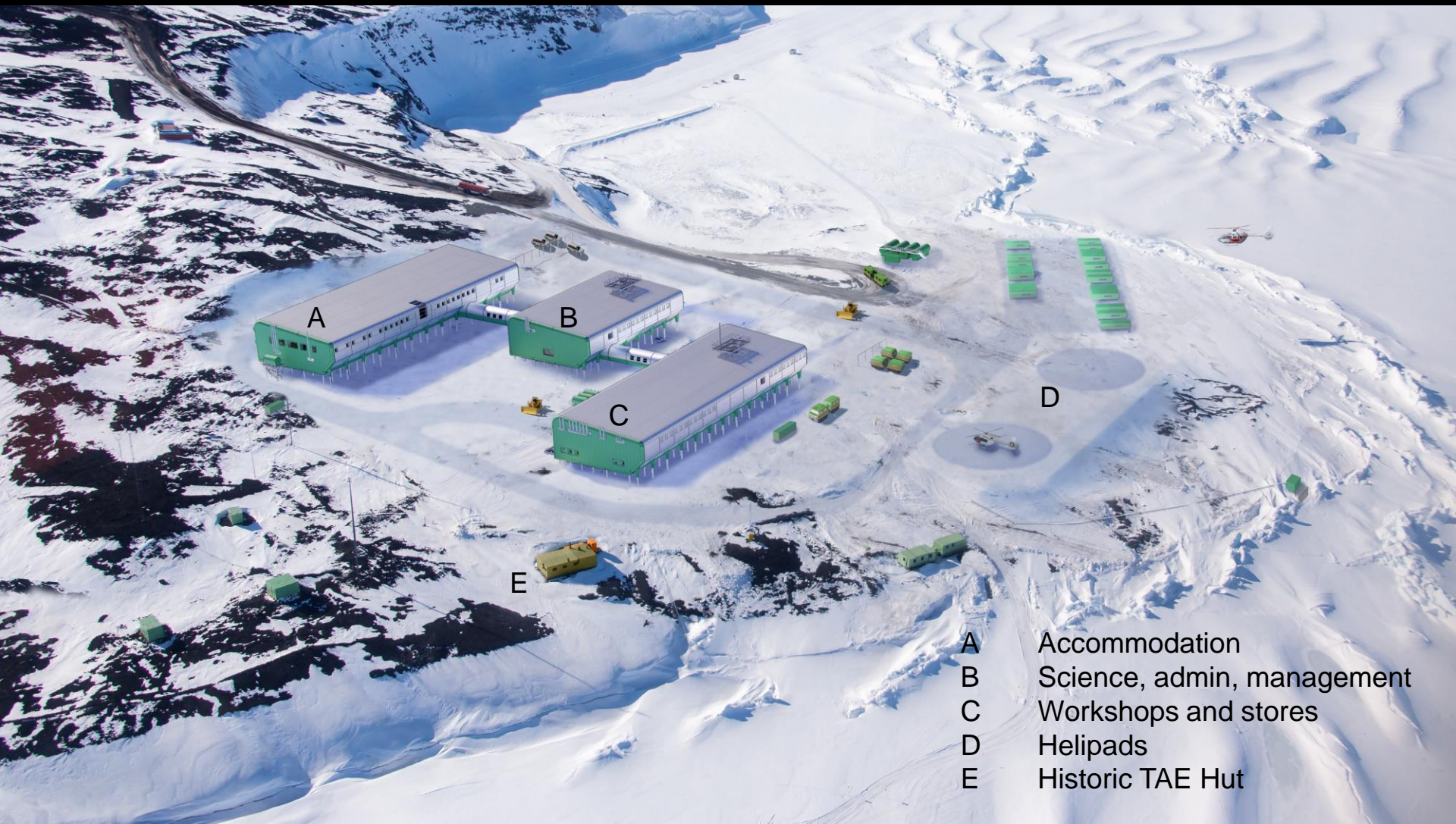
Calibration of flume using existing base model



Option 1 model with constant grade topography



Option 2 model



- A Accommodation
- B Science, admin, management
- C Workshops and stores
- D Helipads
- E Historic TAE Hut

Living spaces to remind the residents of home



Flexible working spaces to support collaboration



Construction and Logistics

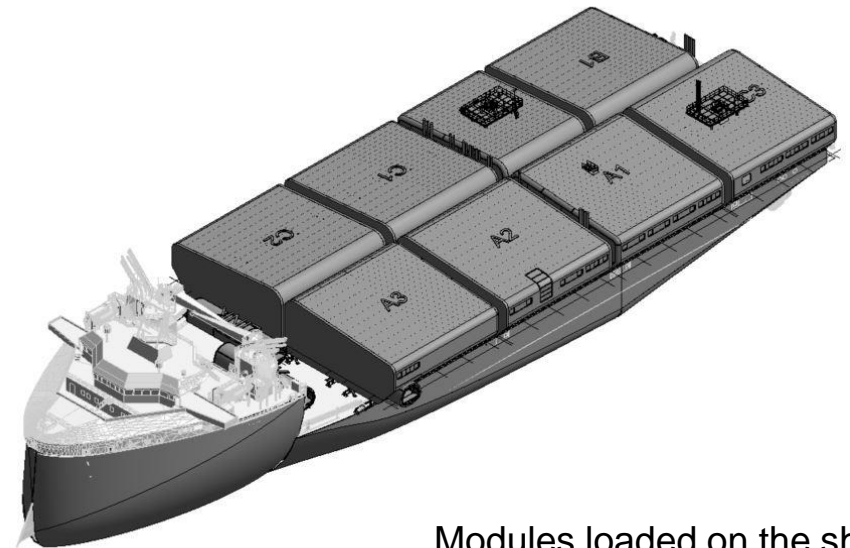


Plan is to build the base in New Zealand & ship in large modular sections on a RORO ice strengthened vessel

2023 Commence site preparation
2028 Complete construction in Antarctica



Self propelled motorised transporters



Modules loaded on the ship



Renewable energy

Ross Island Wind Energy Network



- Currently 1 MW with three turbines
- Equivalent to 500,000 litres of fuel pa
- 11% of fuel consumption of McMurdo and Scott Base
- Increasing to 2MW with Scott Base Redevelopment
- Will provide 70% of the energy demand for Scott Base

Innovation – what next?

Focus on sustainability

ALTERNATIVE FUELS

Move away from reliance on MGO fuel

IMPROVE ENERGY STORAGE

Phase Change Materials

EFFICIENT / REDUCED ENERGY USE

Smart Grid Control, Improved Building Performance, Remote Science

Polar vs High Altitude Research Stations

Any similar challenges?

Sphinx Observatory, Junfrauojch





Harsh environment



Health & Safety



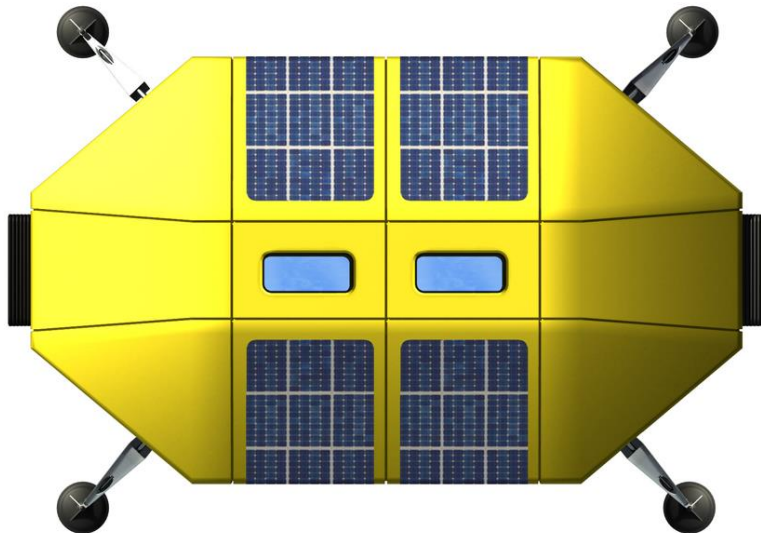
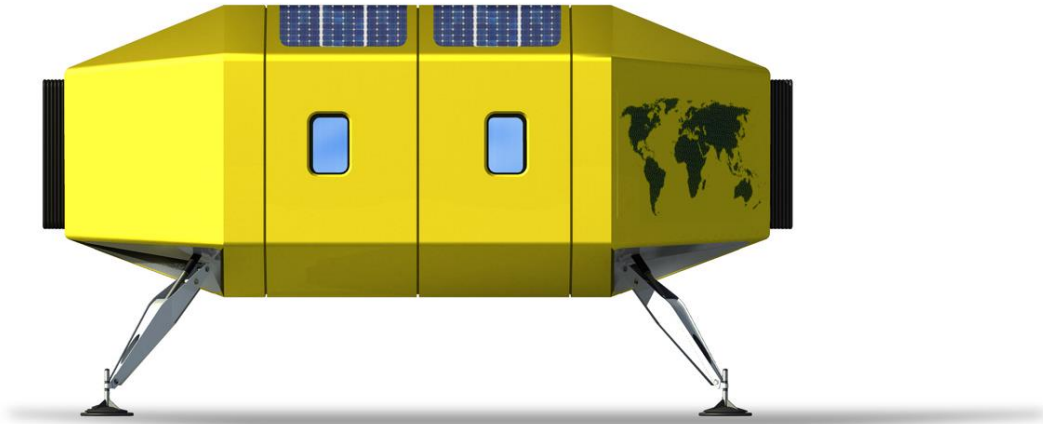
**Complex logistics &
use of prefabrication**



A small community

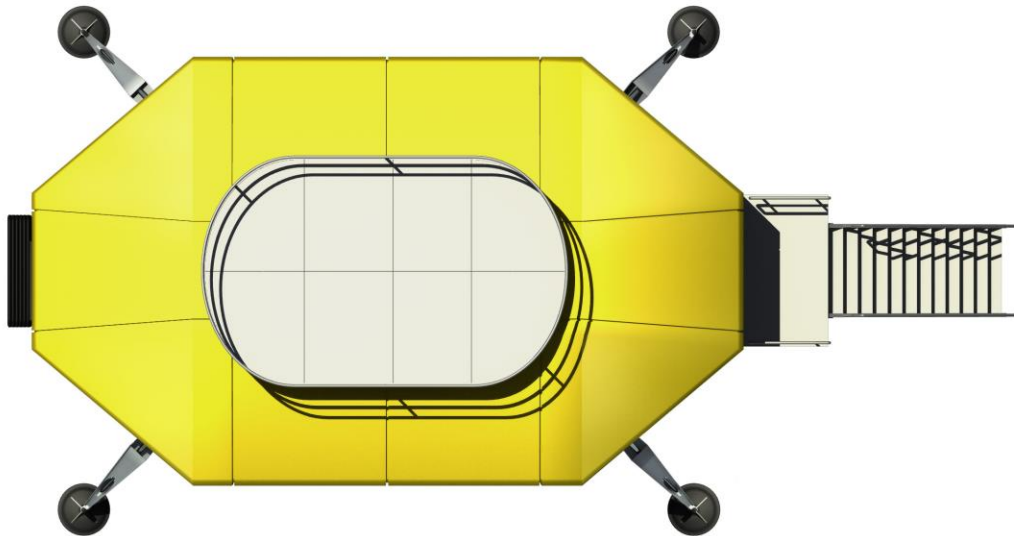
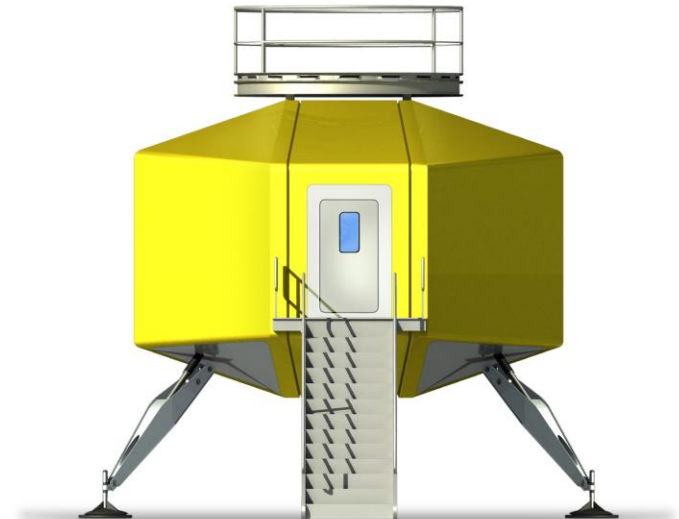
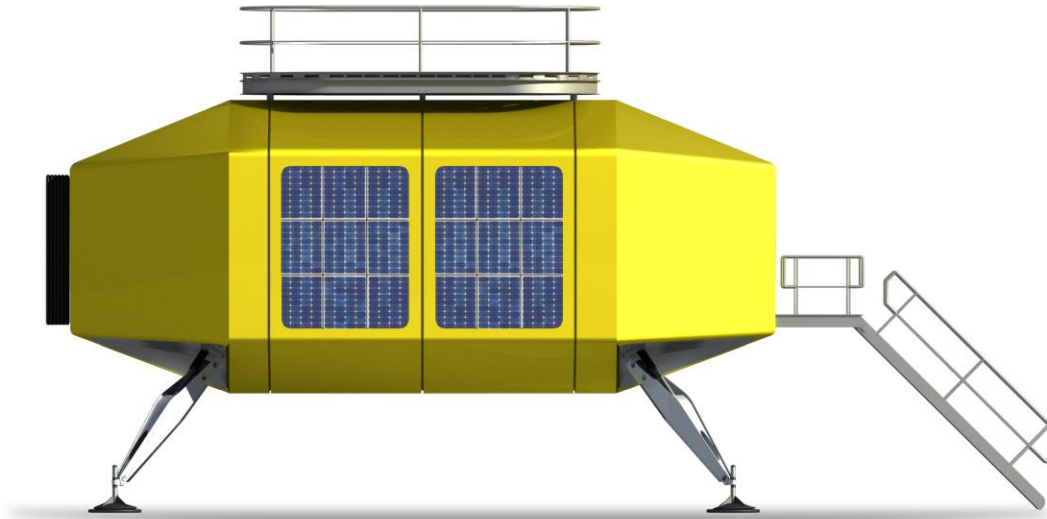
Concept for a more mobile future

A mini-module for remote science



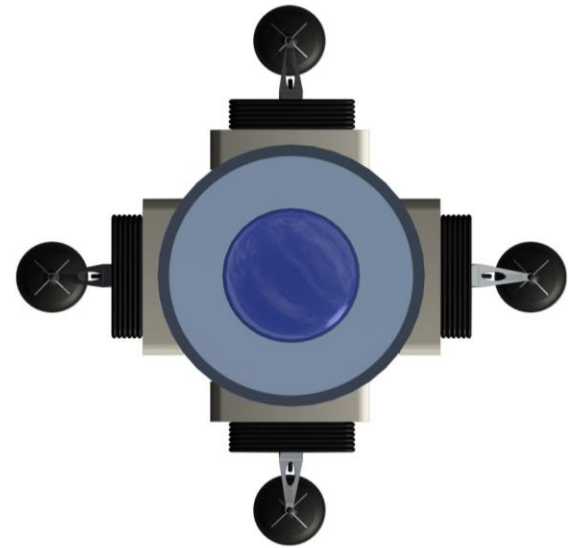
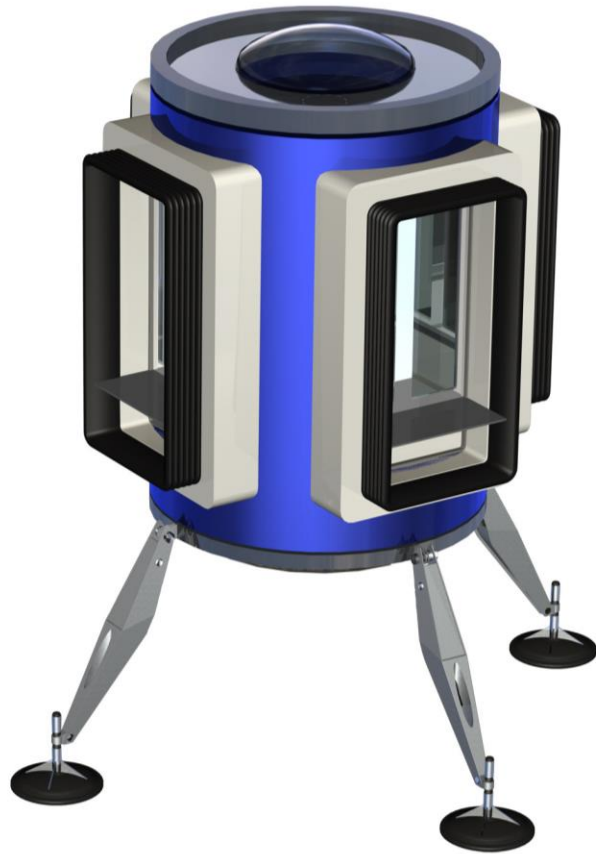
Mobile mini-modular camp

Energy module



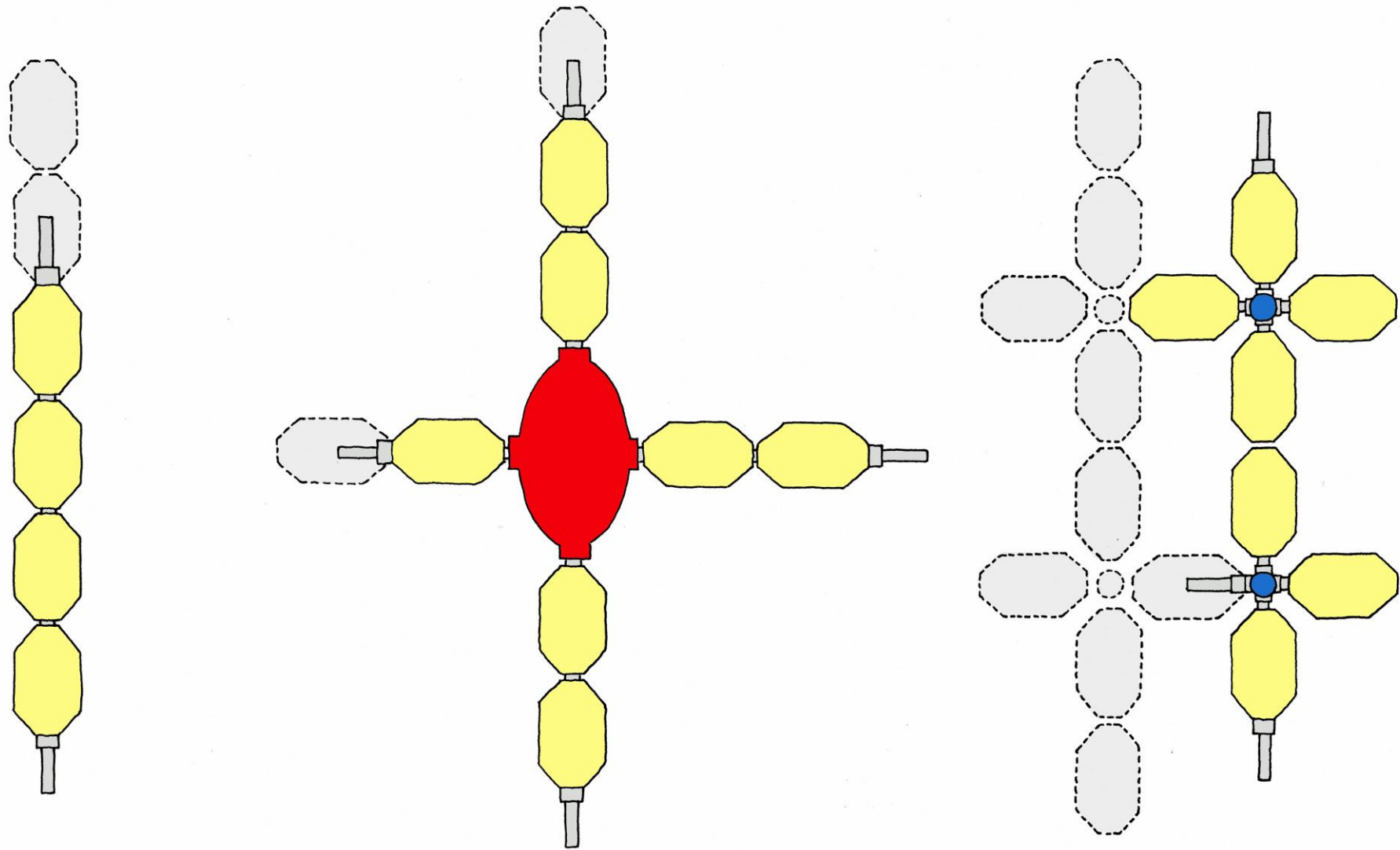
Mobile mini-modular camp

Connecting module



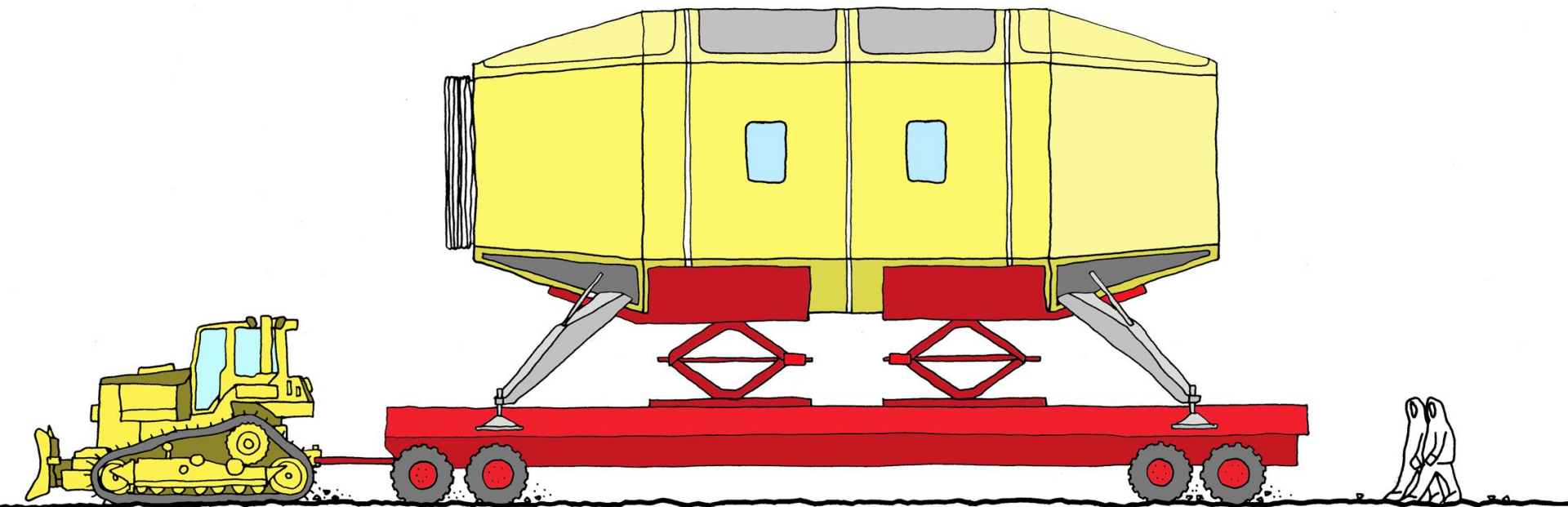
Mobile mini-modular camp

Layout options



Mobile mini-modular camp

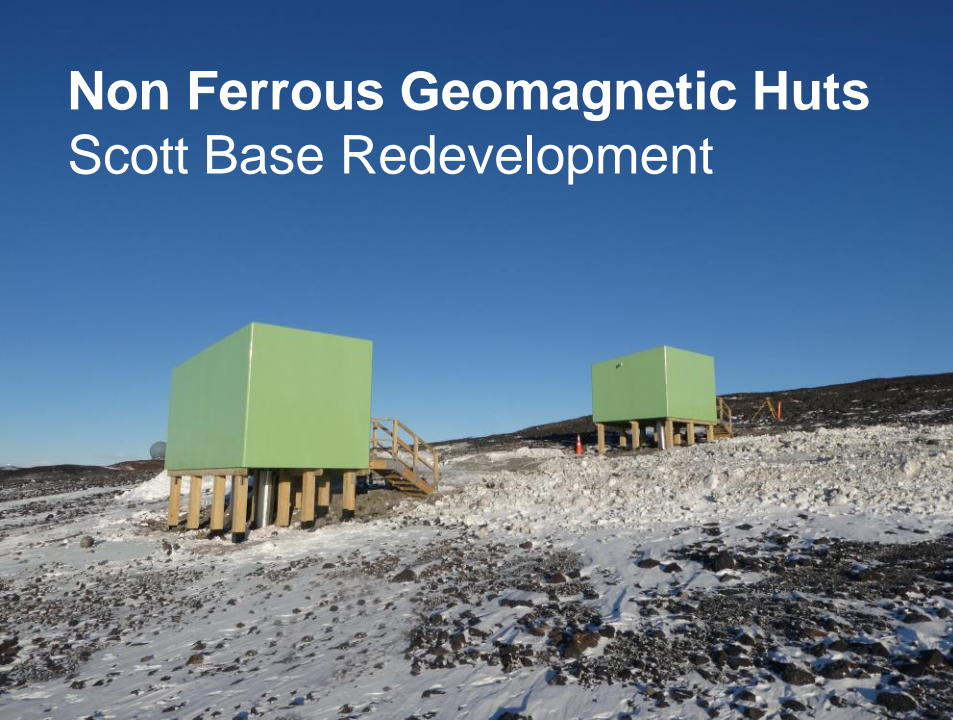
Delivery by hydraulic trailer

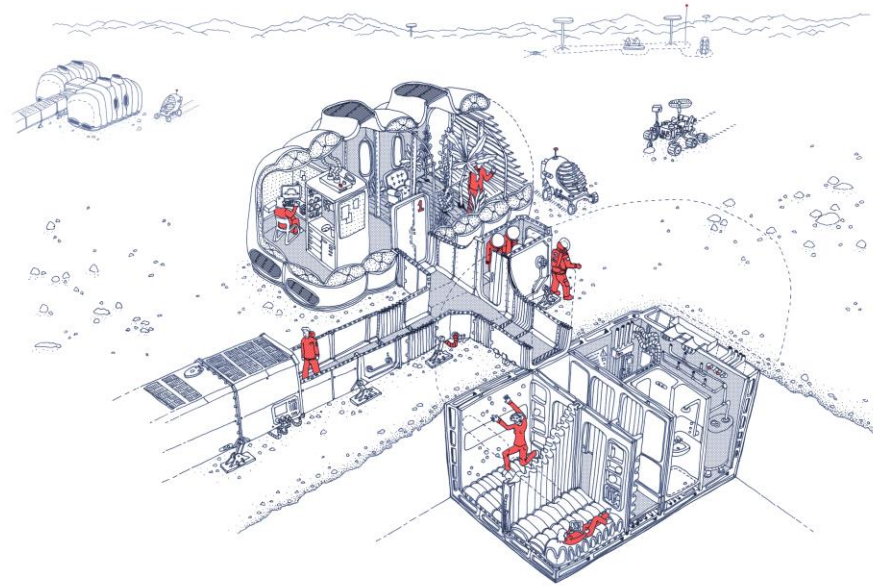




Non Ferrous Geomagnetic Huts

Scott Base Redevelopment





Building a Martian House

With Ella and Nicki and Pearce Plus

Building a Martian House, Bristol, England

