

# China-Iceland Arctic Science Observatory, CIAO

## Introduction

INTERACT SMF  
Halldór Jóhannsson  
February 2020





# ARCTIC PORTAL



**ENERGY**

**ARCTIC PORTAL** THE ARCTIC GATEWAY

**ApplyGate**  
ApplyGate is a four-year project funded by the EU's Horizon 2020 Research and Innovation programme with a budget of €8 million. The consortium consists of 16 expert organizations from 9 different countries. Working on advanced production in Polar regions and beyond - Understanding Arctic's Connections to Weather and Climate Across the Northern Hemisphere. [More information on APPLYGATE](#)

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Community  
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Science  
Governance  
Library  
Calendar  
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Quebec H3A 4S1  
Canada  
Phone: +1 514 963 1800  
Email: [info@arcticportal.org](mailto:info@arcticportal.org)

**ENERGY**

**COMMUNITY**

**Map**

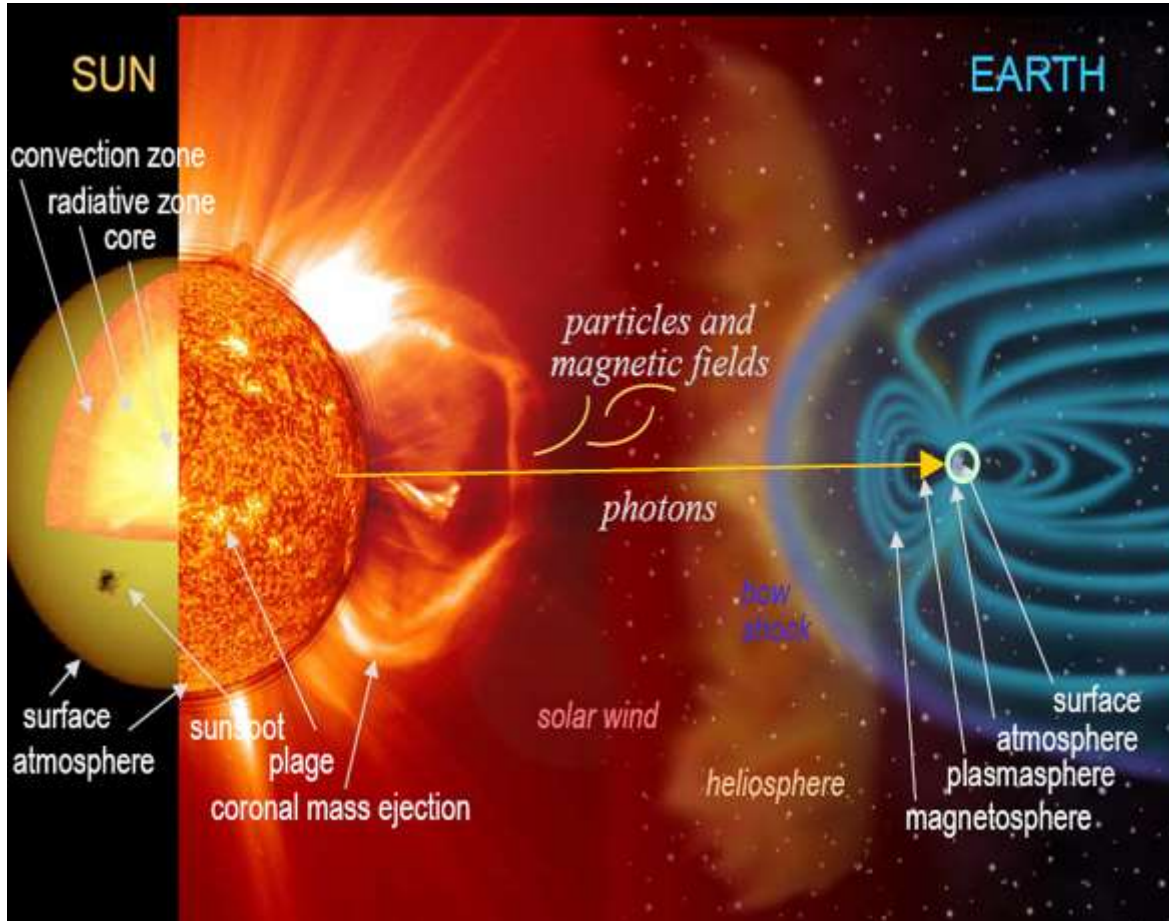
**Global Data Visualization**

Arctic Science Dissemination and Global Public Knowledge

WWW.ARCTICPORTAL.ORG



## Introduction on Polar Atmospheric and Space Physics Division (PASP) in PRIC



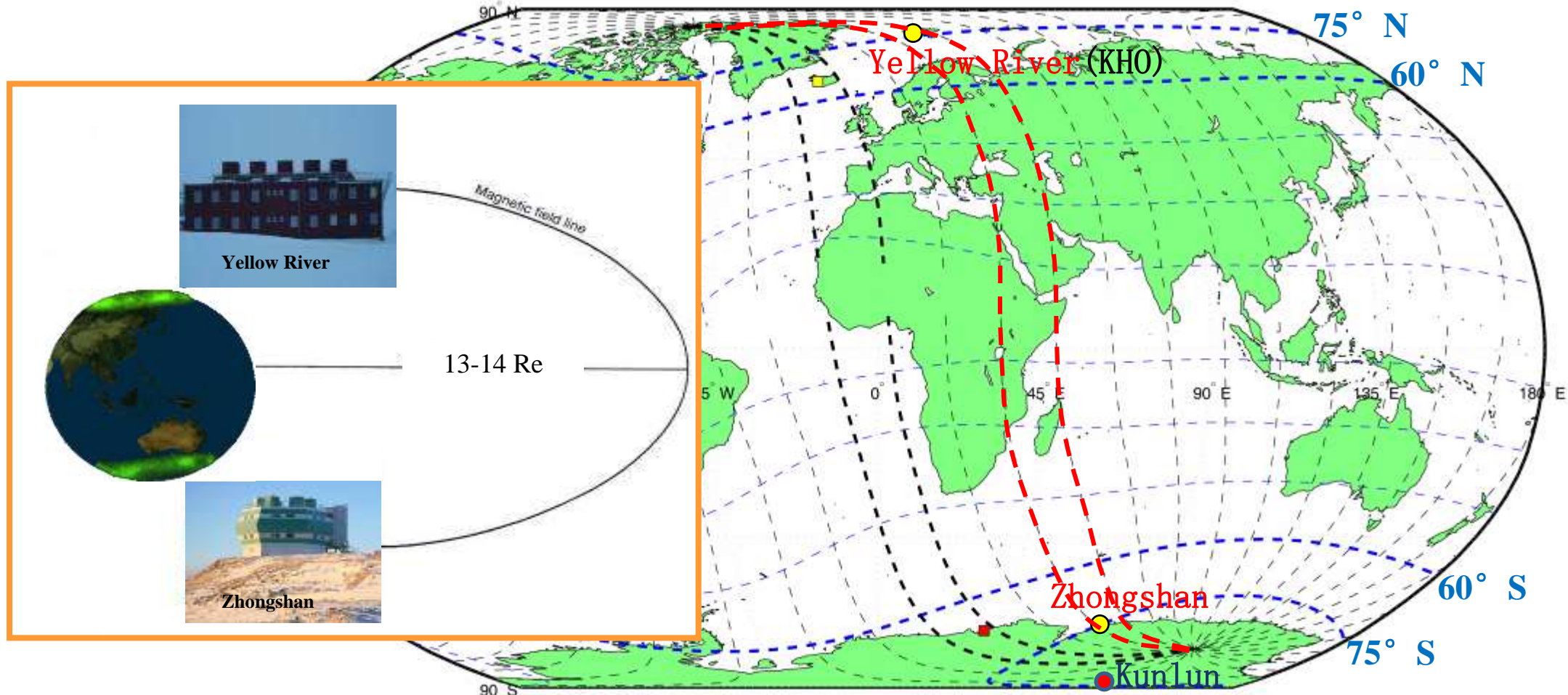
## Main research interests

- Aurora and magnetospheric dynamics
- Polar ionosphere
- Polar upper and middle atmosphere
- Plasma waves in polar regions
- Coupling between solar wind, magnetosphere, ionosphere, and upper /middle atmosphere
- Space weather and climate



**Yellow River Station: (78.9°N, 11.9°E), 76.24°MLAT, MLT≈UT+3h**

**Kjell Henriksen Observatory (KHO):(78.1°N, 16.0°E), 75°MLAT, MLT≈UT+3h**



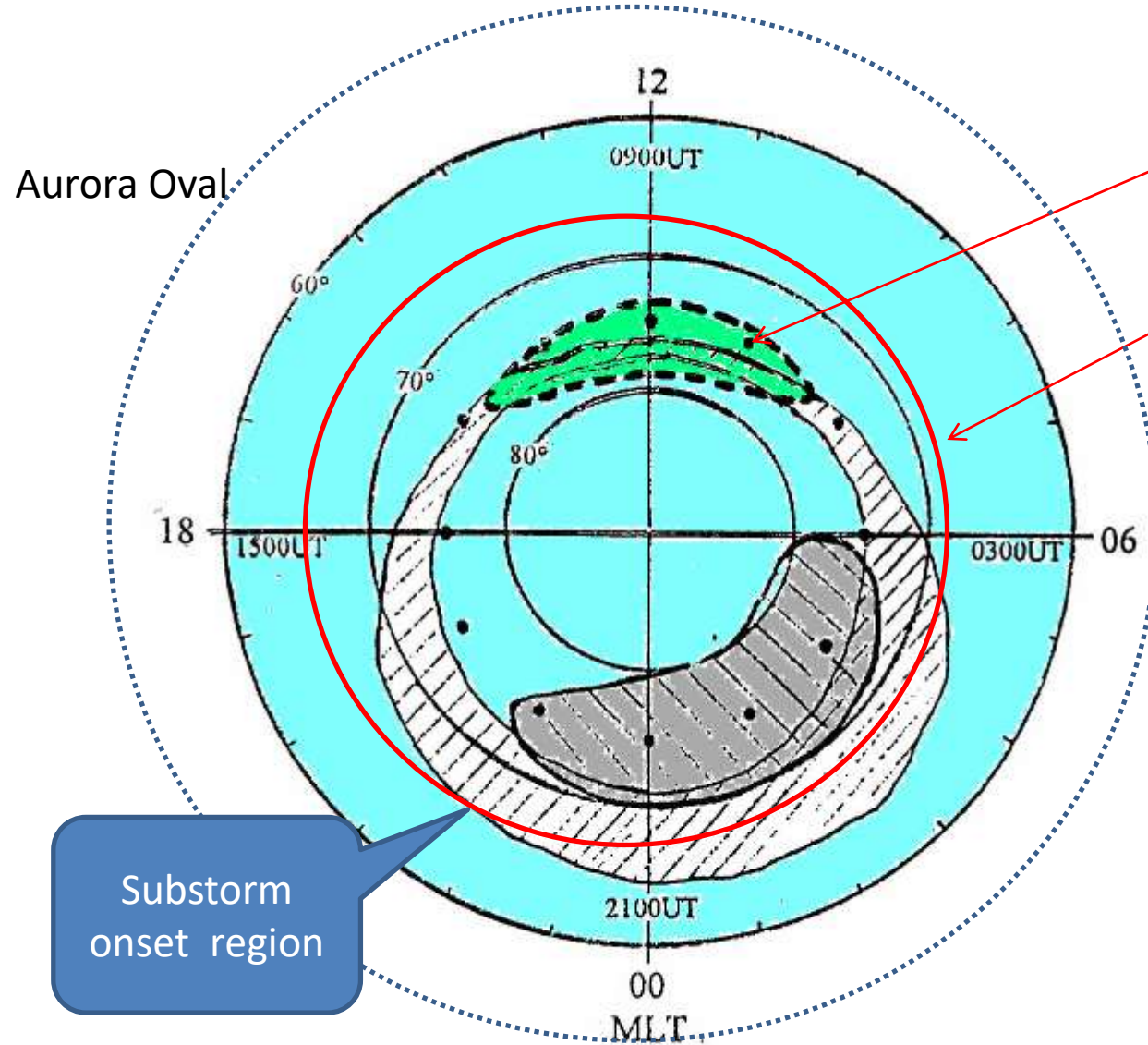
**Zhongshan Station: (69.4°S, 76.4°E), -74.5°MLAT, MLT≈UT+1.75h**

**KunLun Station: (80.4°S, 77.4°E), -77.6°MLAT**

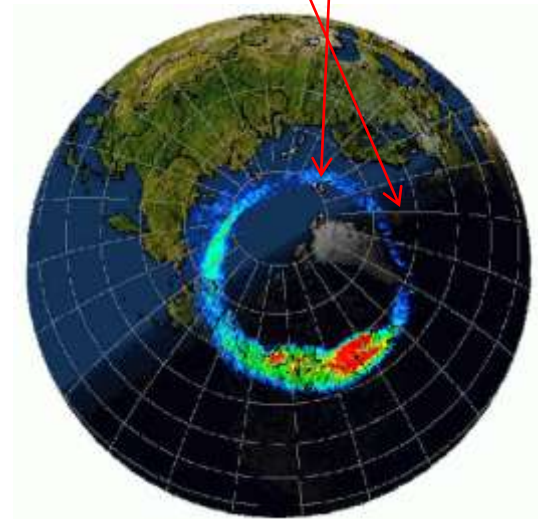


# 中国极地研究中心

## Polar Research Institute of China

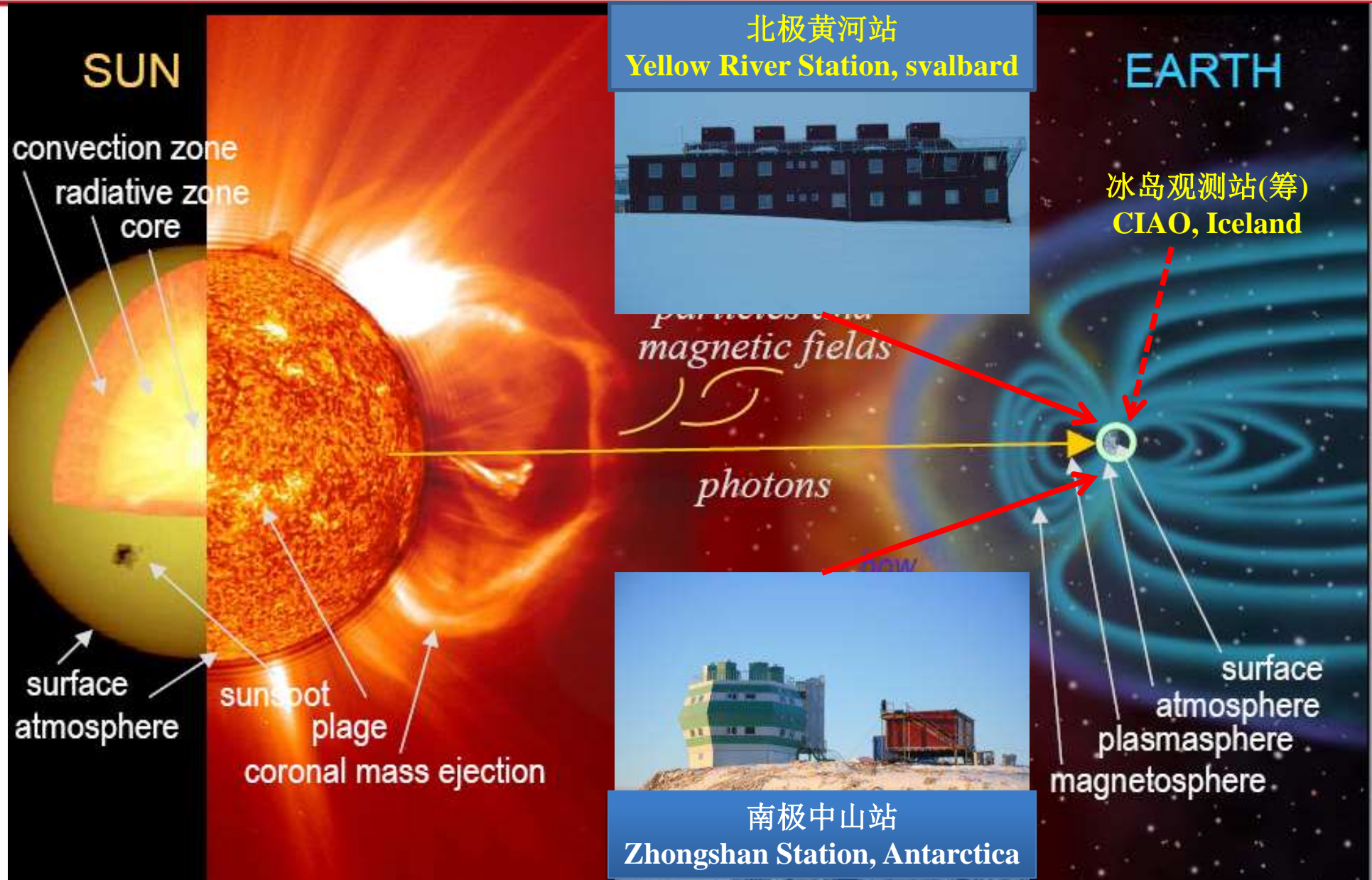


- Zhongshan (Yellow River)
- CIAO, Iceland
- Greatwall





## *Why to establish aurora Observatory in Iceland?*



# Iceland – China - Main agreements

- A Framework Agreement on Arctic Cooperation was signed by Yang Jiechi, former Foreign Minister of China and Össur Skarphéðinsson, former Foreign Minister of Iceland, in April 2012 during an official visit by the former Premier of China, Wen Jiabao, to Iceland.
- A memorandum of understanding in the field of marine and polar science and technology between the Icelandic Ministry for Foreign Affairs and State Oceanic Administration, was signed on the same occasion.
- Agreement on Scientific Cooperation on China-Iceland Joint Aurora Observatory between Science Institute, University of Iceland and PRIC, August 2012
- MoU on Chinese-Icelandic Research Cooperation on Arctic Issues between PRIC and RANNÍS, August 2012
- Framework Agreement on China-Iceland Joint Aurora Observatory, between PRIC and Rannís, 2013 and renewed in 2018.



# Preparation visit to China, June 2012





# The forming of the cooperation

- Xu Long came to Iceland in August 2012. Visited both Reykjavik and Akureyri.
- Site visit by PRIC leaders to Karholl.



# Xu Long leaders at Karholl, August 2012

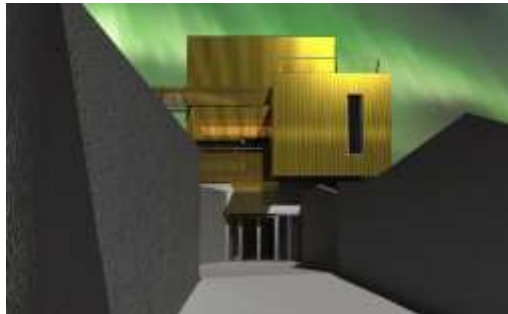


# Xu Long leaders at Karholl, August 2012



# China-Iceland Arctic Observatory - CIAO

- The China Iceland Arctic Science Observatory, CIAO, is based on scientific cooperation agreement between The Icelandic National Research Council - RANNIS and the Chinese Polar Research Inst. – PRIC to facilitate scientific cooperation between the countries.
- The land and facilities at Kárhóll are owned and operated by the a locally established non-for-profit fund AO, in cooperation with RANNIS, under a long-term 99 year use-agreement with Polar Research Institute of China, PRIC.
- First agreement with AO was signed in 2013 and the Observatory was formally opened in October 2018.



# AO and PRIC agreement signed 5 Oct 2013



# Key Partners in the scientific cooperation – Chinese / Icelandic

**China:** Polar Research Institute of China, National Space Science Center, Chinese Academy of Sciences (CAS); Institute of Geology and Geophysics, CAS; China Research Institute of Radio Wave Propagation; National Center for Space Weather; Institute of Space Physics and Applied Technology, Peking University; School of Electronic Information, Wuhan University; School of Earth and Space Science, University of Science and Technology of China; School of Space Science and Physics, Shandong University..

**Iceland:** The Icelandic Centre for Research – RANNIS; Science Institute of the University of Iceland; The Icelandic Meteorological Office; The University of Akureyri; The Icelandic Arctic Cooperation Network; Húsavík Academic Center; The Marine and Freshwater Institute; The Agricultural University; The Arctic Portal.

# The fields of science at CIAO

The partnership with Chinese and international scientists through the Icelandic framework opens for cooperation in multiple fields of Arctic science.

The scientific emphasis will be on, but not limited to:

- solar-terrestrial interaction
- space weather
- upper atmosphere observations
- auroras and geomagnetic field variations
- climatology
- glaciology
- meteorology
- oceanography
- biology
- ecology
- volcanology

All observation data will be made available and open to the international scientific community.



# International scientific cooperation

Among the organizations that are involved in the international cooperation are:







## CNARC


In recent years with rapid changes of climate and environment in the Arctic region and China's economic growth, the interaction between China and the Arctic has been increasingly deepened, which calls for a coherent and sustainable development of the Arctic and China. China-Nordic Arctic research cooperation has been intensified over the past few years and during that period Chinese institutes such as the Polar Research Institute of China (PRIC) and Shanghai Institute of International Studies (SIIS) have strengthened their ties with international counterparts.

[Read more](#)

## SYMPOSIA

The third China-Nordic Arctic Cooperation Symposium will take place in May 2015 Shanghai, China and call for abstracts can be found [here](#)

[Read more](#)



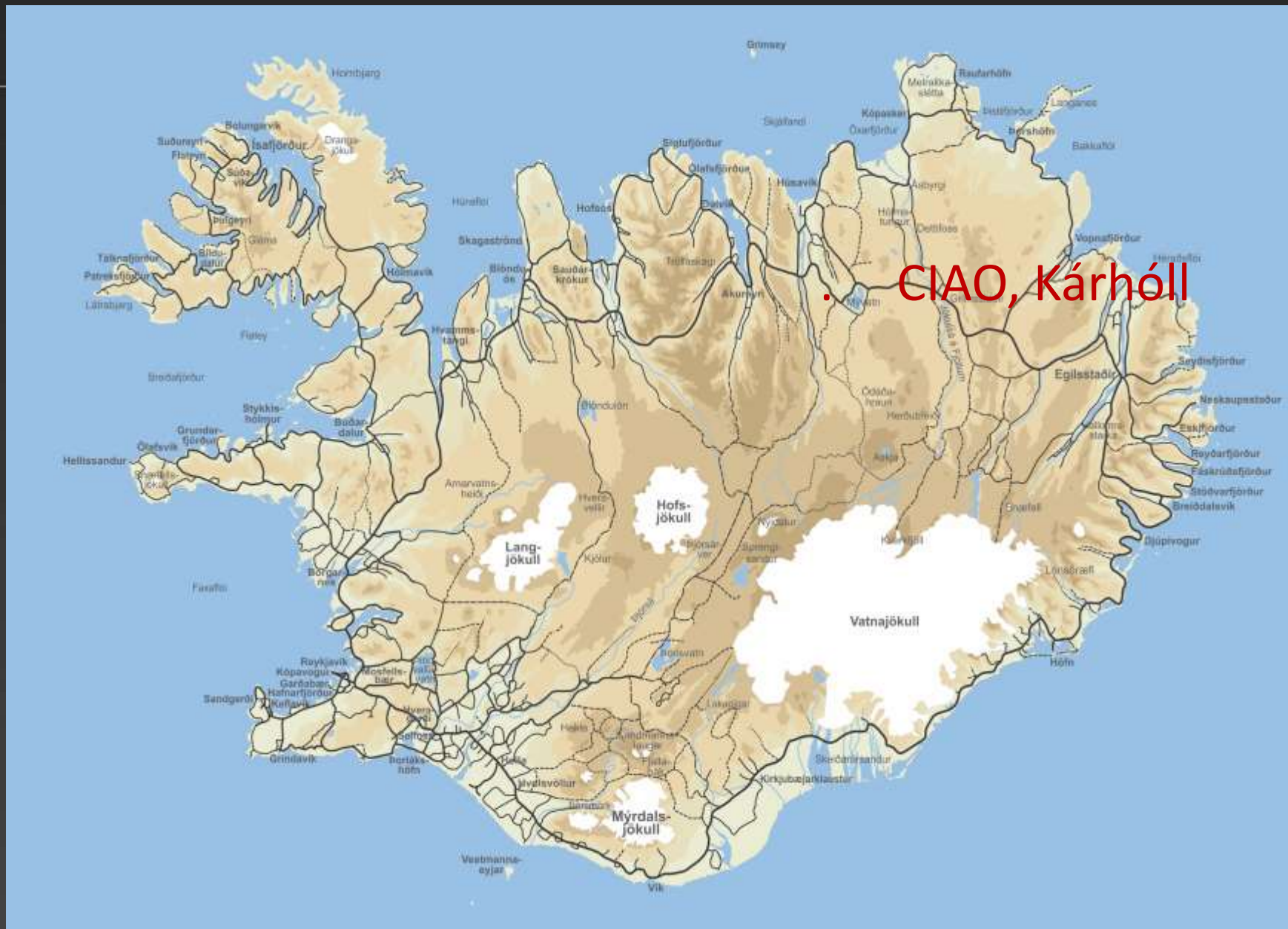
China-Iceland Arctic Science Observatory, CIAO  
 $65^{\circ} 42.431'N, 17^{\circ} 22.017'W$ .

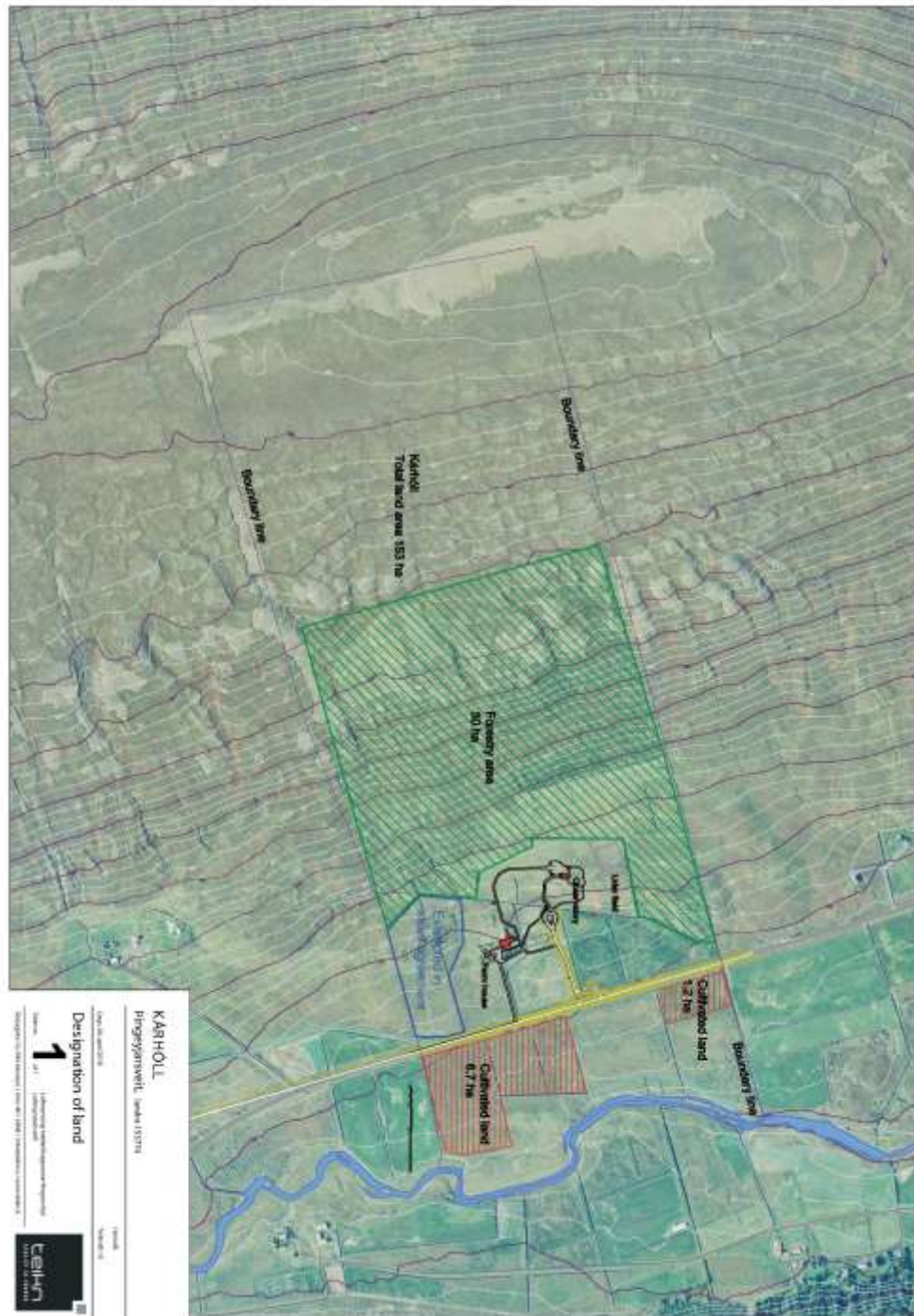
156 hectares of land

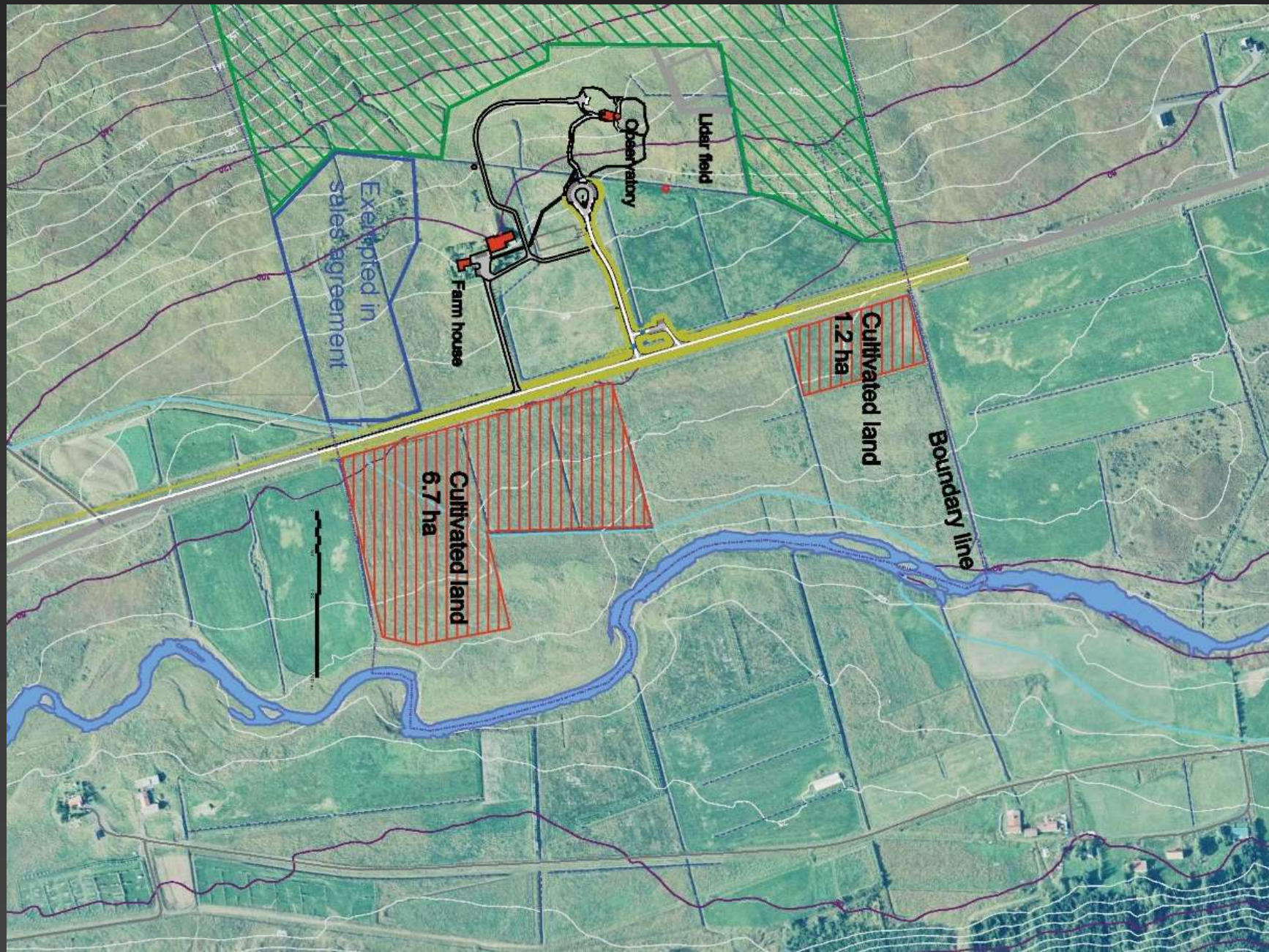
760 m<sup>2</sup> Research building

Accommodation for 10 people +

Storage facilities

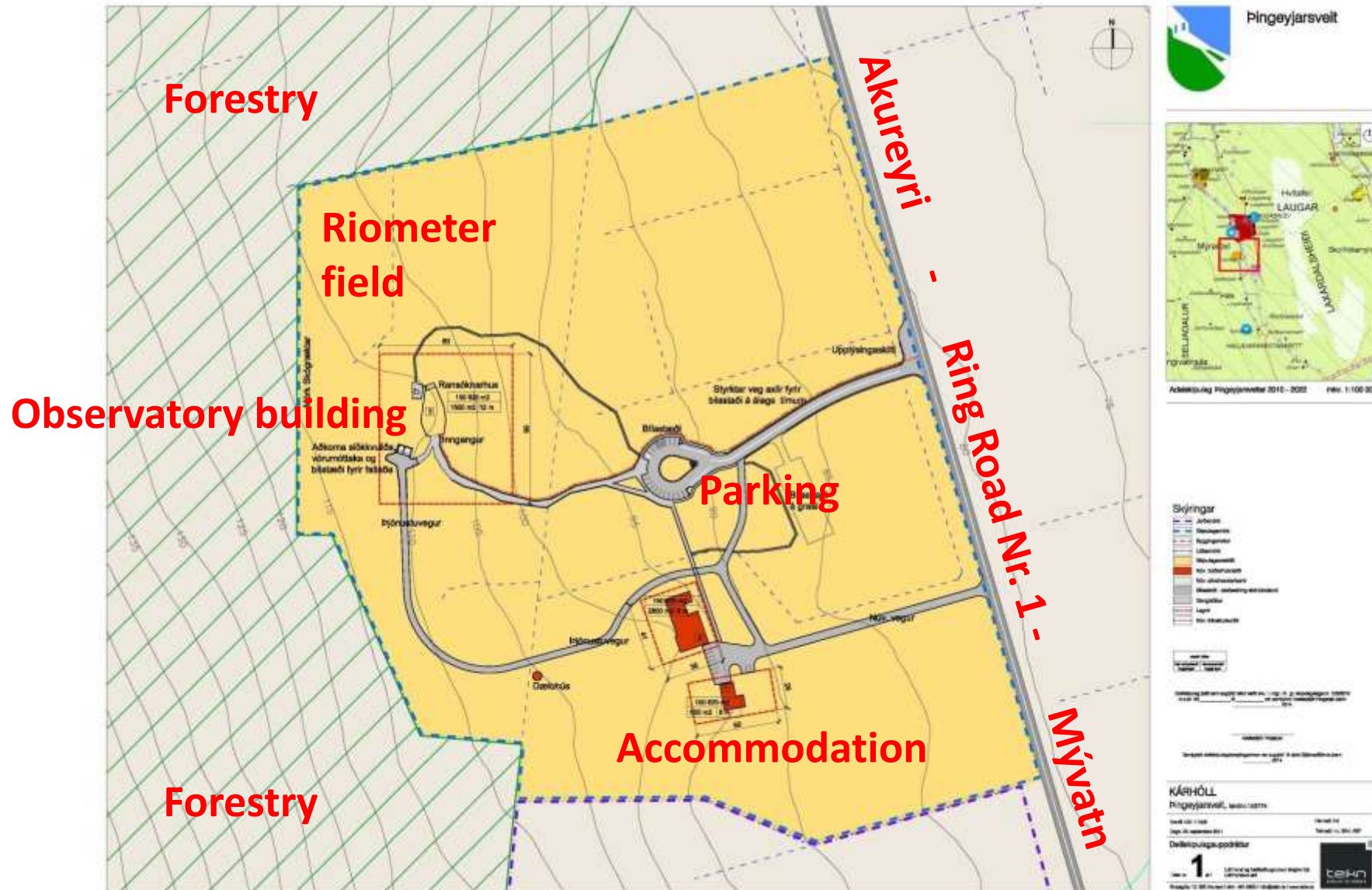








# Site plan for Kárhóll, Reykjadalur



# The building – 760 m<sup>2</sup> on three floors





# The building – 760 m<sup>2</sup> on three floors



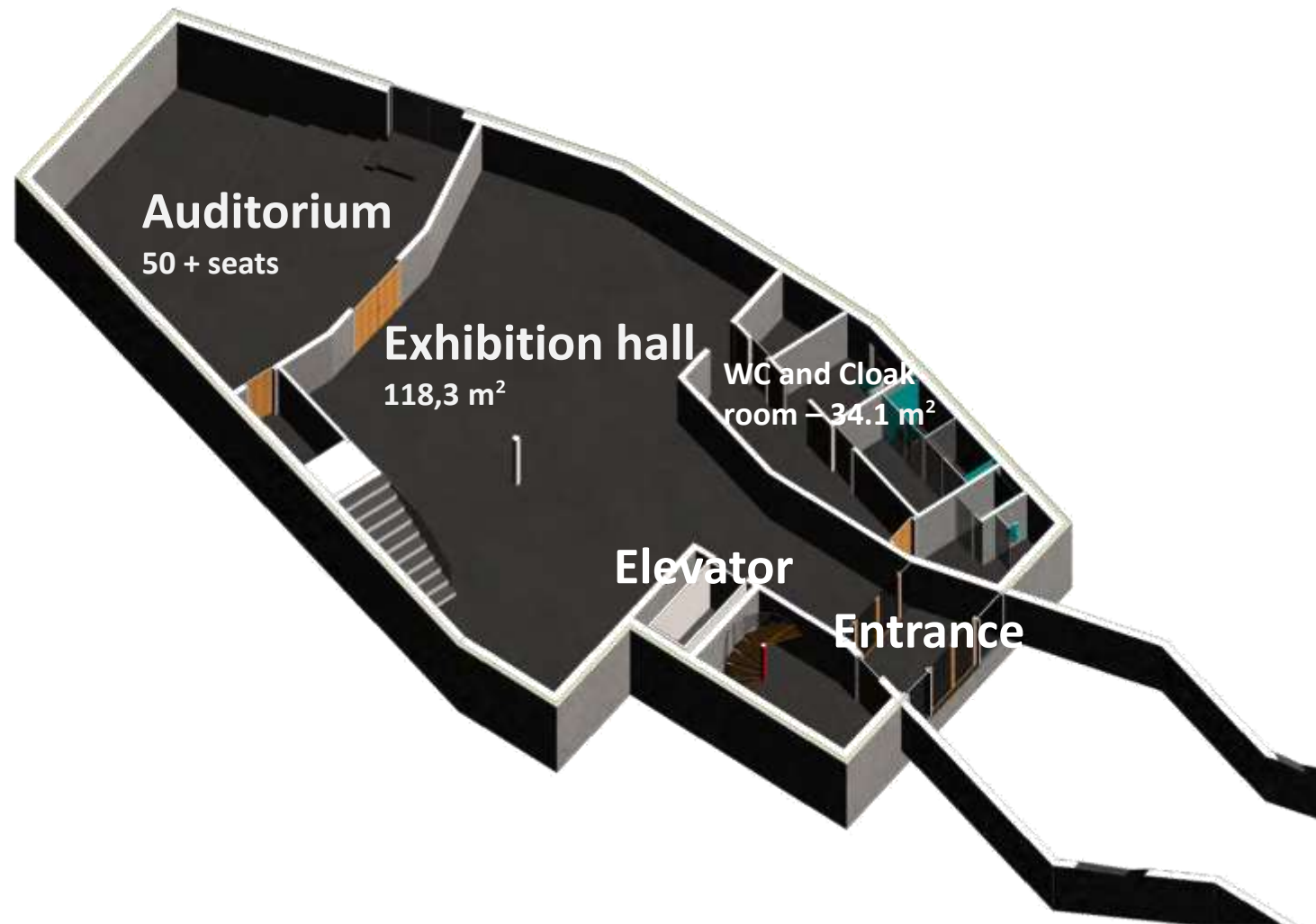
# The building – 760 m<sup>2</sup> on three floors



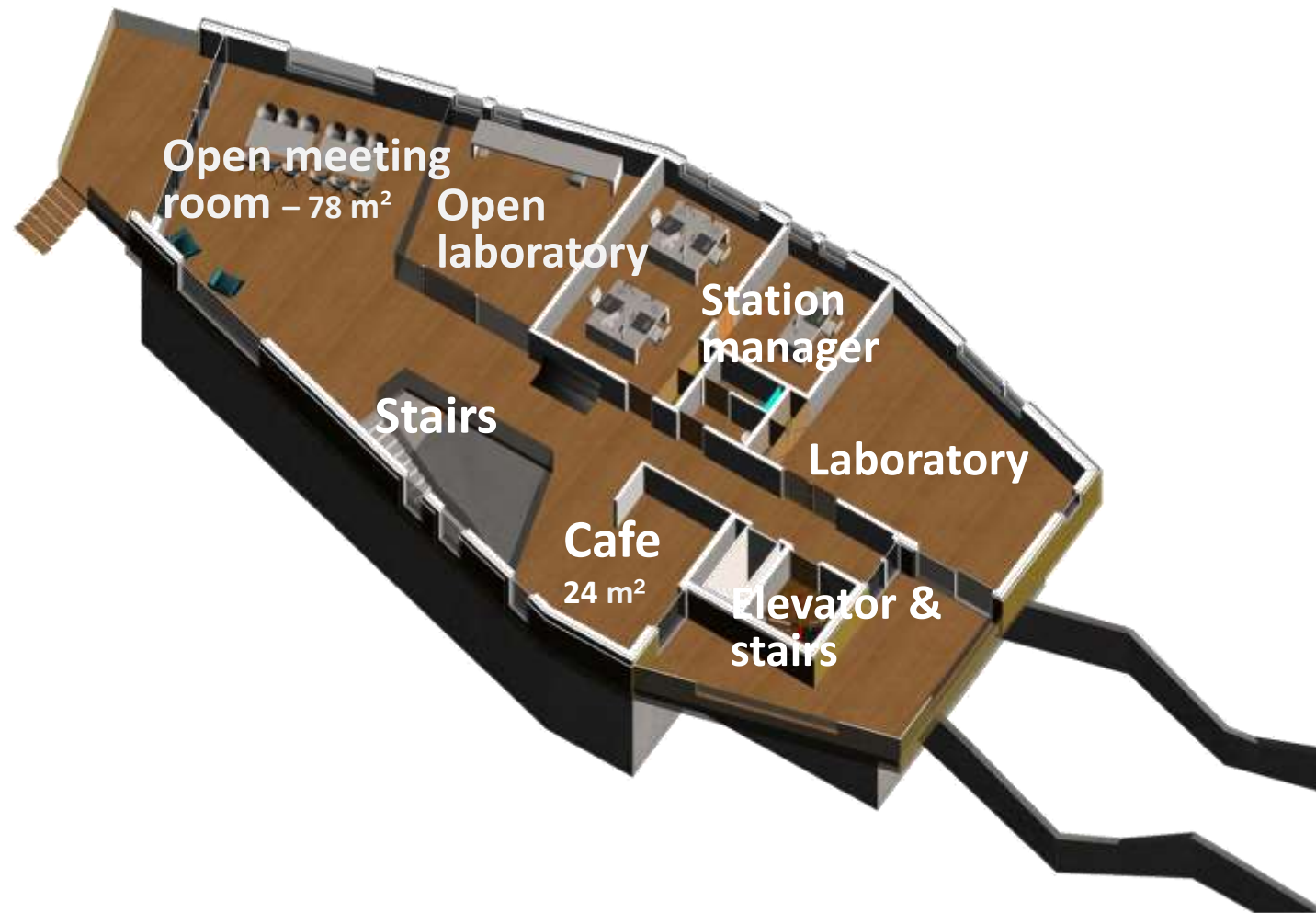
# The building – 760 m<sup>2</sup> on three floors



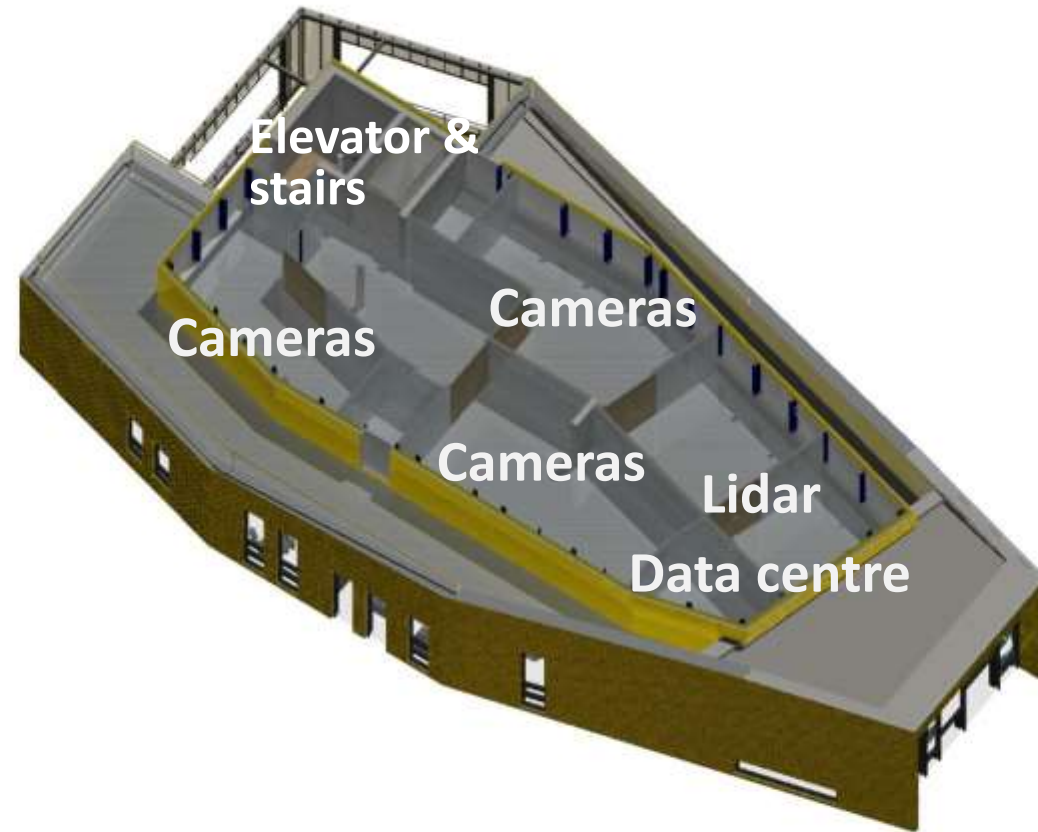
# The building – ground floor – exhibition centre



# First floor – administration and research



# Second floor – research



# Inauguration of the site on June 2. 2014



Construction started in June 2015!





# Laying of the cornerstone, Oct. 10th 2016



# The Opening – October 2018



At the Opening of the China-Iceland Arctic Observatory - CIAO in October 2018.



## The cooperation

The aim of this cooperation is to further scientific cooperation between Icelandic and Chinese scientists and to advance knowledge in multiple fields of Arctic science. Participation by scientists from other nations is encouraged.

The Arctic Observatory is governed by a joint organizational and management committee, the CIAO board, with the support of an international Science and Outreach committee. The scientific emphasis will be on, but not limited to: the understanding on solar-terrestrial interaction and space weather by conducting polar upper atmosphere observations such as auroras and geomagnetic field variations; climatology; glaciology; oceanography; biology; ecology; and other related fields of science.

Special emphasis will be on outreach to the public. Within the he CIAO will be a Guest centre dedicated to Science Communication based on

# The Opening – October 2018

## Research partners

**Iceland:** The Icelandic Centre for Research, Science Institute of the University of Iceland, the Icelandic Meteorological Office, The University of Akureyri, the Icelandic Arctic Cooperation Network, Húsavík Academic Center, Arctic Portal.

**China:** Polar Research Institute of China, National Space Science Center, Chinese Academy of Sciences (CAS); Institute of Geology and Geophysics, CAS; China Research Institute of Radio Wave Propagation; National Center for Space Weather; Institute of Space Physics and Applied Technology, Peking University; School of Electronic Information, Wuhan University; School of Earth and Space Science, University of Science and Technology of China; School of Space Science and Physics, Shandong University.



## International cooperation, including:



# The Opening Interior



# The Opening Interior



# The Opening Interior



# The Opening Interior



# The Opening Interior





# The Opening Interior



# The Opening Interior



# The Opening Interior



# The Opening Interior



# The Opening Interior



# Top of the line infrastructure



# Cultural cooperation



# The Opening Interior

Open  
room

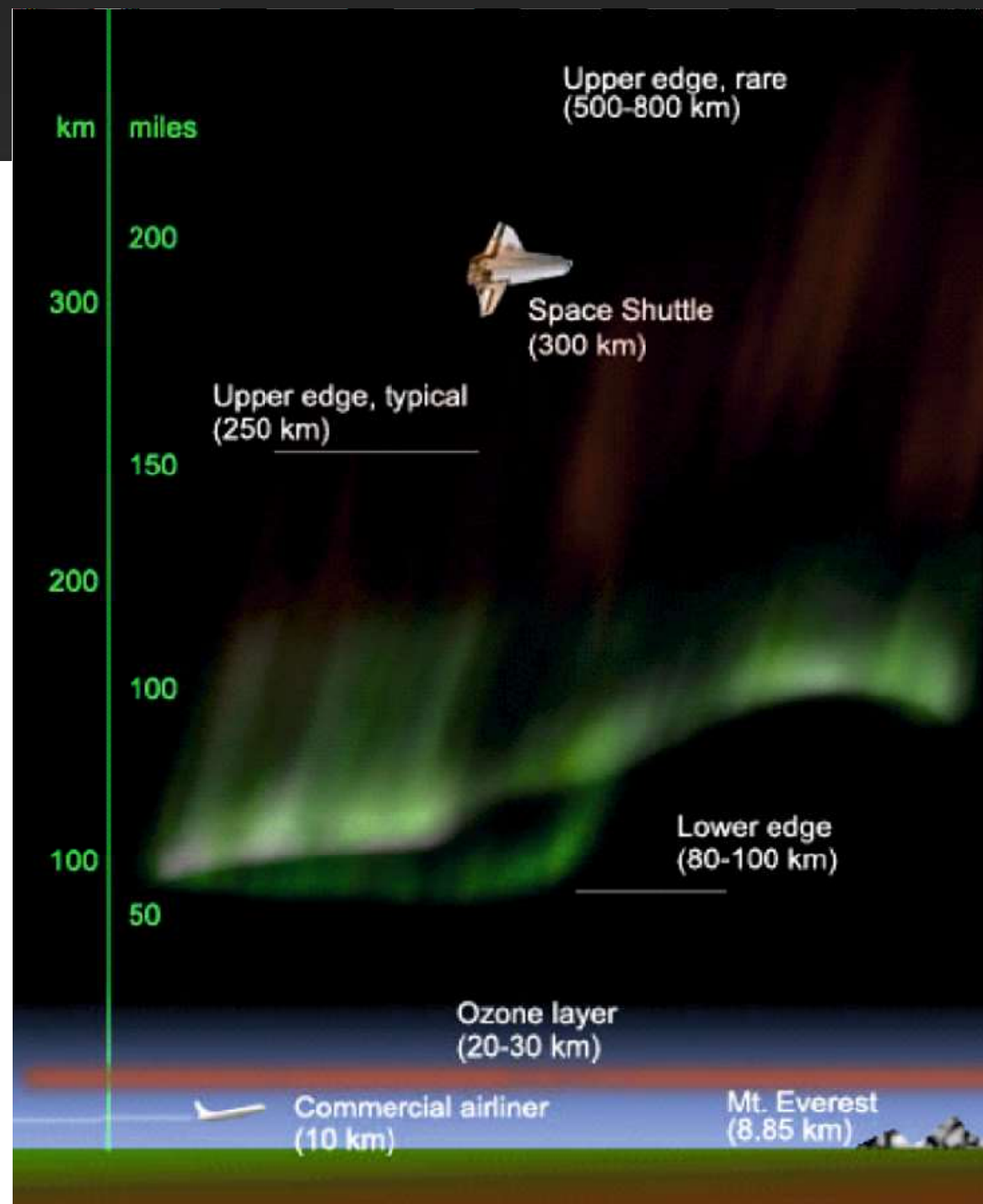




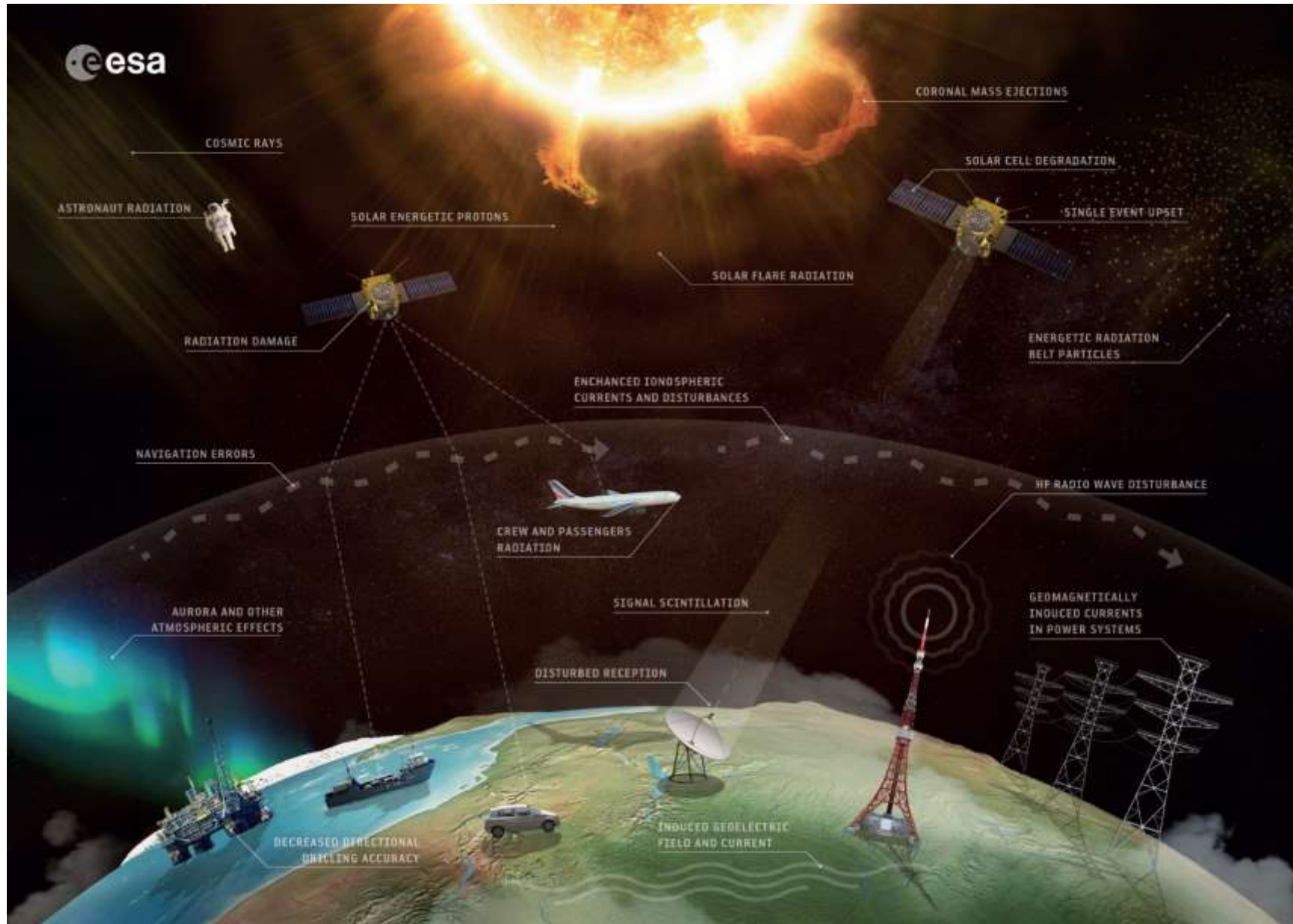
## The current equipment at CIAO to monitor the Aurora:

- **Cameras** – real-time all-sky cameras, monitoring the aurora
- **Lidar** – measuring the distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor.
- **Riometer field** – listening to the Aurora, The riometer (relative ionospheric opacity meter) determines the radio-wave absorption in the ionosphere by measuring the received cosmic-noise power. Riometer responds to the diurnal variations in solar radiation, and measures the occurrence, intensity and time variations of ionospheric absorption caused by particle precipitation and X-ray illumination of the atmosphere.
- **Magnetic meters** – monitor the earth's magnetic field variations

# Aurora



# Space weather – effects on our daily lives



# Imaging Riometer Array

The Global Riometer Array (Gloria) is an attempt to unite the different riometry groups around the world (and their [riometers](#)) to provide a global overview of solar-terrestrial physics (STP) events, which is an international collaborative program for scientific investigation of the role of particle precipitation in the sun-earth connection.

In particular it aims at an improved understanding of the coupling mechanism between the solar wind, magnetosphere and the ionosphere.

There are currently over 20 imaging riometer arrays worldwide, both hemispheres. By providing a global overview of STP processes we will be in a better position to understand them.

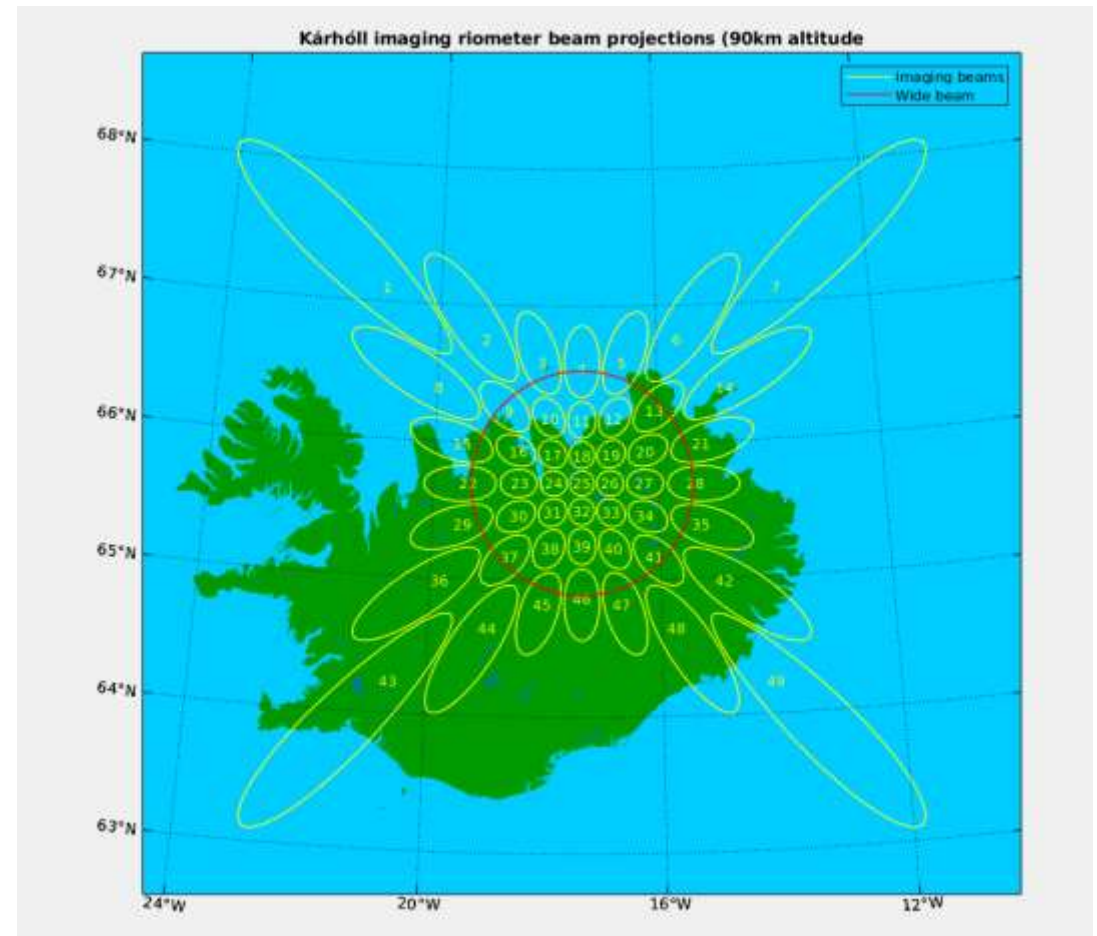
# Riometer field

Riometer field at CIAO – in cooperation with Lancaster University, UK

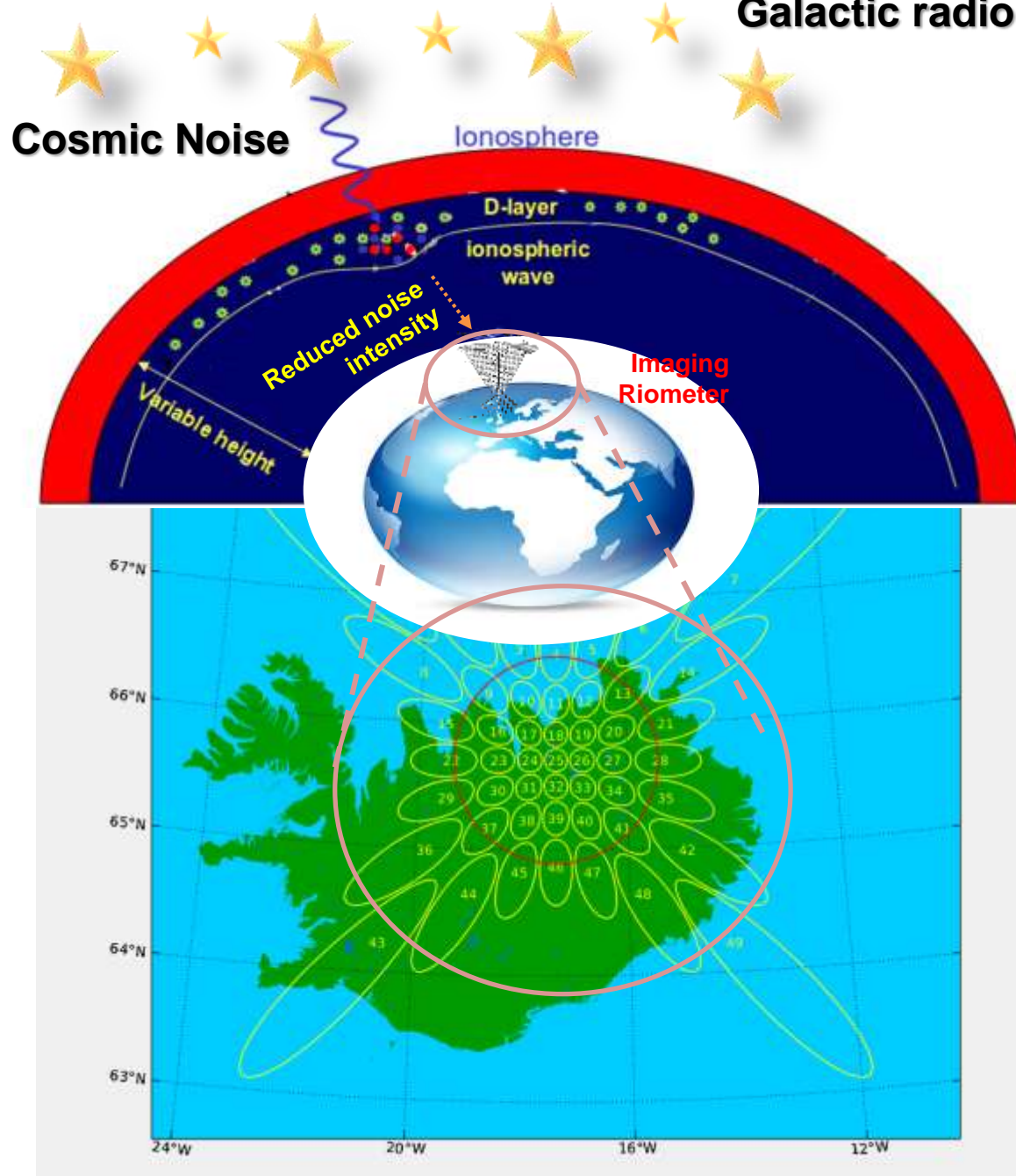


# Riometer field - Imaging Riometer

Riometer field at CIAO – technical equipment and the science



## Galactic radio sources



The Aurora makes the atmosphere opaque to radio noise from our galaxy at altitudes of 60-100 km, reducing the intensity of the noise received at the ground.

The imaging riometer works like a camera, taking a picture of the radio noise once a second

The 8 x 8 array receives 1 image/second at 38.235 MHz and forms 49 imaging beams.

# Arctic Science Observatory, CIAO

## Outreach!





# Science Communication - CIAO

## METEOROLOGY

Meteorology is a branch of the atmospheric sciences which includes atmospheric chemistry and atmospheric physics, with a major focus on weather forecasting.


Meteorology consists of the following areas:

Microscale (10 to 1000 m)	Mesoscale (1000 m to 1000 km)	Synoptic scale (1000 km to 2000 km)	Global scale
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Meteorology has application in:

- Weather forecasting
- Aviation meteorology
- Agricultural meteorology
- Hydro-meteorology
- Nuclear meteorology
- Maritime meteorology
- Military meteorology
- Environmental meteorology
- Renewable energy

General circulation of the Earth's atmosphere:



Main meteorological parameters are:

Wind speed	Temperature	Humidity
Precipitation	Cloud cover	Air pressure

Meteorology plays an important role in climatic research as a part of a coupled ocean-atmosphere system.

China Iceland Arctic Observatory - www.CIAO.is

## SPACE WEATHER

Space weather is a branch of space physics and aeronomy concerned with the time-varying conditions within the Solar System, including the solar wind, encompassing the space surrounding the Earth, including conditions in the magnetosphere, ionosphere, thermosphere, and mesosphere. It refers to the time-variable conditions in the space environment that may affect space-borne or ground-based technological systems.

Space weather real-time monitoring at the Arctic Observatory.

Riometer field and the control room at the Arctic Observatory.

Magnetometer - Data from 21 October 2018 at the Arctic Observatory.

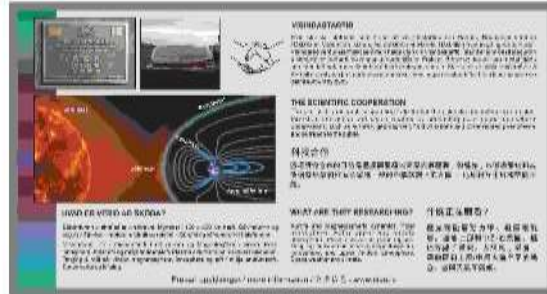
WISer Camera at the Arctic Observatory.

China Iceland Arctic Observatory - www.CIAO.is

- Emphasis is on science communication and outreach to the public, including through an on-sight Exhibition Centre as well as through virtual cooperation with remote science centres, for education and supporting tourism companies.
- Under the framework agreement between PRIC and RANNIS Iceland is to lead the outreach, including the operation of the Science and Outreach centre, management of its activities and its planned exhibition.

# Information Signs

2.



3.



Skilti 2 og 3. Um vísindastarfið, hvað verið sé að skoða og svo hönnun og upplýsingar um rannsóknarstöðina.



1.



CIAO  
再見

Skilti í stálramma með fæti - skiltafliður 130cm á breidd x 80cm á hæð. CIAO skorið út í fótinn - einnig með kínverskum táknum.  
3 skilti í röð - Norðurljósarannsóknarstöð, vísindasamstarfið og rannsóknarhúsið.



CIAO — ARCTIC SCIENCE OBSERVATORY



Járnsúla hægra megin við innkeyrsluna á mótis við áningarstað. Litur gylltur sambærilegur klæðningu á húsinu.

Hæð á súlunni 400cm x 50cm á breidd.

Stafir skornir í járnið.



KÁRHÖLL / ARCTIC SCIENCE OBSERVATORY

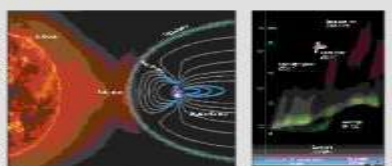


**WORLDWIDE SCIENCE OBSERVATORY**  
This facility, the Arctic Science Observatory (ASO), is a joint project of the Icelandic and Canadian governments, with the Icelandic government providing the land and the Canadian government providing the funding. The ASO is a unique facility that will allow scientists to study the Arctic region in a way that has never been possible before.

**ARCTIC SCIENCE OBSERVATORY**  
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**AURORA**  
Aurora is a unique facility that will allow scientists to study the Arctic region in a way that has never been possible before.

**VIÐNASTARFIR**  
The facility is a unique facility that will allow scientists to study the Arctic region in a way that has never been possible before.



**THE SCIENTIFIC COOPERATION**  
The aim of the Aurora is to provide a unique facility for scientists to study the Arctic region in a way that has never been possible before.

**VIÐNASTARFIR**  
The facility is a unique facility that will allow scientists to study the Arctic region in a way that has never been possible before.

Mögulegt skilti við innganginn.  
Stærð á skiltifleti 150cm á hæð og 145cm á breidd.



# Aurora – Guest Centre – Outreach Exhibition

- The main observatory building is 760 m<sup>2</sup> on three floors.
- The 215 m<sup>2</sup> ground floor, including the auditorium seating over 50 people, is dedicated to the Outreach Exhibition Centre with another 100 m<sup>2</sup> + on the first floor for displays, meetings and catering.

## **Science Tourism: services and products for Dancing with the Lights - Aurora exhibition**

- **Further the public's scientific understanding** including on solar-terrestrial interaction and space weather
- to design new science exhibition related services and products for international science communication
- support science education
- to increase the understanding of the environmental, cultural and social dynamics
- to promote entrepreneurship to realize the potential of 'place-based' development opportunities for tourism and experience industries
- to provide new business opportunities for local companies

# AURORA – Kárhóll initial exhibition concept

## METEOROLOGY

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Meteorology consists of the following areas:

Microscale (1-2 km, within a day)	Mesoscale (10-100 km, 1 day - 1 week)	Synoptic scale (1-3000 km, 2-6 days)	Global scale
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Meteorology has application in:

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- Nuclear meteorology
- Maritime meteorology
- Military meteorology
- Environmental meteorology
- Renewable energy

General circulation of the Earth's atmosphere:

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China Iceland Arctic Observatory - www.CAO.is

## SPACE WEATHER

Space weather is a branch of space physics and aeronomy concerned with the time varying conditions within the Solar System, including the solar wind, emphasizing the space surrounding the Earth, including conditions in the magnetosphere, ionosphere, thermosphere, and exosphere. It refers to the time-variable conditions in the space environment that may affect space-borne or ground based technological systems.

Space weather real-time monitoring at the Arctic Observatory.

Riometer field and the control room at the Arctic Observatory.

Magnetometer - Data from 1. October 2018 at the Arctic Observatory.

All Sky Camera at the Arctic Observatory.

China Iceland Arctic Observatory - www.CAO.is

## AURORA

Aurora is an extraordinarily dynamic light display seen in the high latitudes sky, and it is a visual manifestation of the solar wind-magnetosphere-ionosphere interaction chain. It is caused by precipitating energetic particle beams colliding with atoms and molecules in the upper atmosphere.

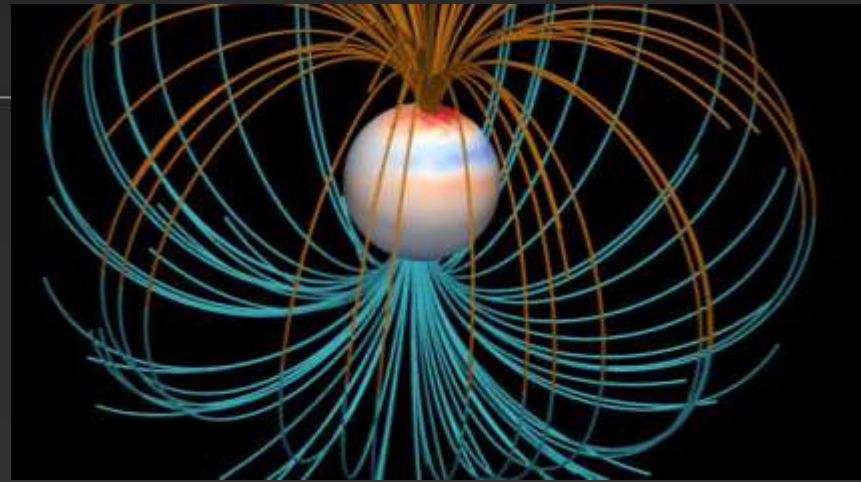
Aurora at Kárhóll, October 2018.

There are three main emission lines of the aurora within the visible part of the spectrum:

- The Oxygen 6300 Å emission (1 Å=0.1 nm), the 'red line', is excited by the transition from  $O(^1D)$  to  $O(^3P)$ , has a peak altitude of 230 km. The low atmospheric density at high altitudes and the low sensitivity of eyes at this wavelength make it often hard to be seen.
- The Oxygen 5577 Å emission, the 'green line', has a peak altitude of 110 km, is the brightest emission, results from the transition from  $O(^1S)$  to  $O(^1D)$ .
- The molecular Nitrogen 4216 Å emission, the 'blue line', has a peak altitude of about 80 km, is emitted by the transition from  $N(^2P^o_2)$  to  $N(^2D^o_2)$ .

China Iceland Arctic Observatory - www.CAO.is





# Aurora – photo taken at the observatory





# Mockup of a Satellite



Mockup of satellite, lidars or magnetic measurement equipment for people to view up close



# Interactive equipments



Interactive touch screen

ITSYH



3D virtual glasses

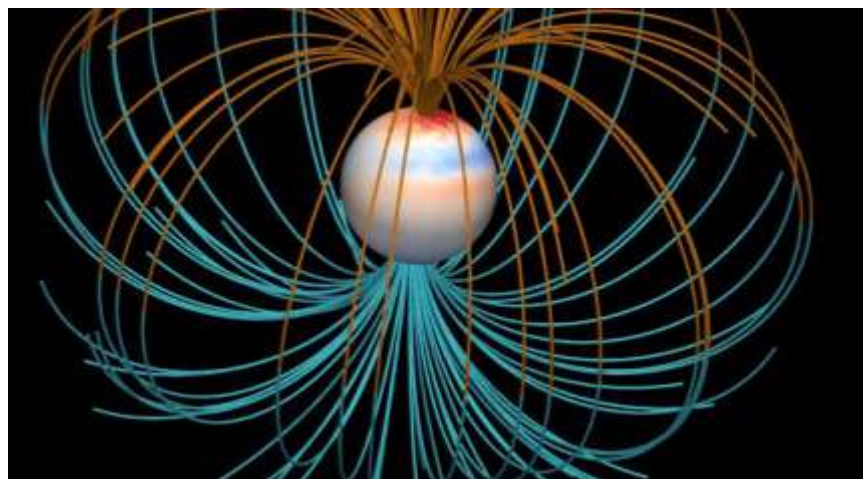


Interactive wall screen - touchable

# Play with magnetic and sand



To simulate the poles



# AURORA

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Aurora at Kárhölli, October 2018.

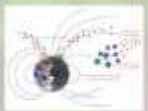
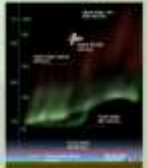


There are three main emission lines of the aurora within the visible part of the spectrum.

**Red** The Oxygen 6300 Å emission (1 Å=0.1 nm), the 'red line', is emitted by the transition from  $O(^1D)$  to  $O(^3P)$ , has a peak altitude of 230 km. The low atmospheric density at high altitudes and the low sensitivity of eyes at this wavelength make it often hard to be seen.

**Green** The Oxygen 5577 Å emission, the 'green line', has a peak altitude of 110 km, is the brightest emission results from the transition from  $O(^1S)$  to  $O(^1D)$ .

**Blue** The molecular Nitrogen 4278 Å emission, the 'blue line', has a peak altitude of about 90 km, is emitted by the transition from  $N_2(^1K'_{g,2})$  to  $N_2(^1B'_{g,2})$ .



THE COLOR OF THE NORTHERN LIGHTS DEPENDS ON THE TYPE OF ATOM INVOLVED IN THE COLLISION. OUR ATMOSPHERE CONSISTS MAINLY OF OXYGEN AND NITROGEN ATOMS. BECAUSE THE COMPOSITION OF OUR ATMOSPHERE VARIES, DIFFERENT COLOURED AURORAS OCCUR AT DIFFERENT HEIGHTS.

RED LIGHTS

240 KM & ABOVE

GREEN LIGHTS

UP TO 160 KM

PURPLE LIGHTS

95 KM & ABOVE

BLUE LIGHTS UP TO

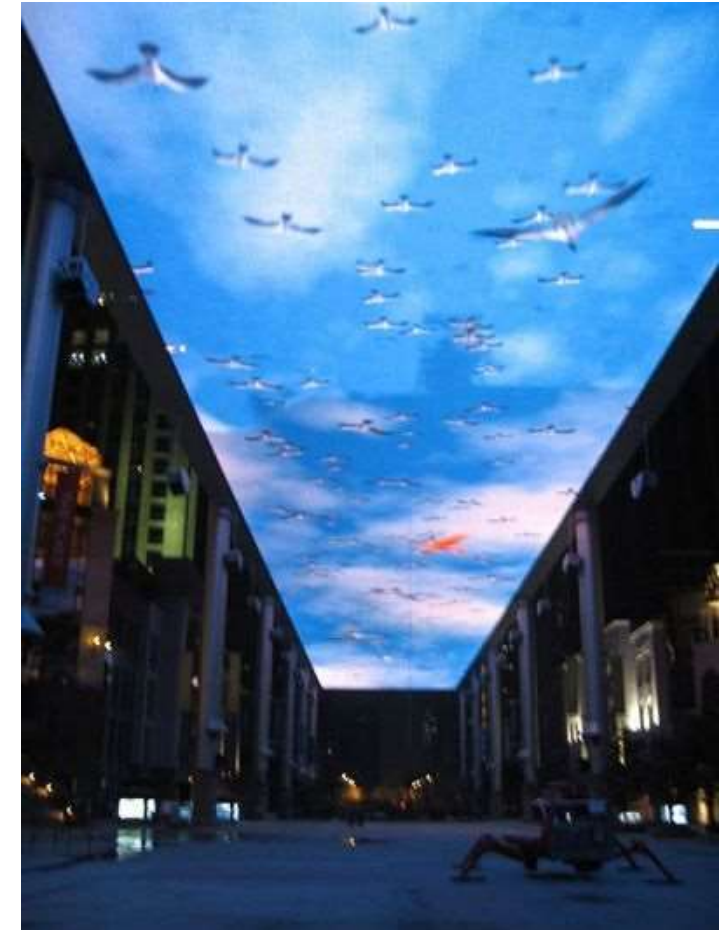
95 KM

Explain the different types of colours of the Northern lights graphically

Play with colours!



# Play with colours and forms!



# Play with colours and themes

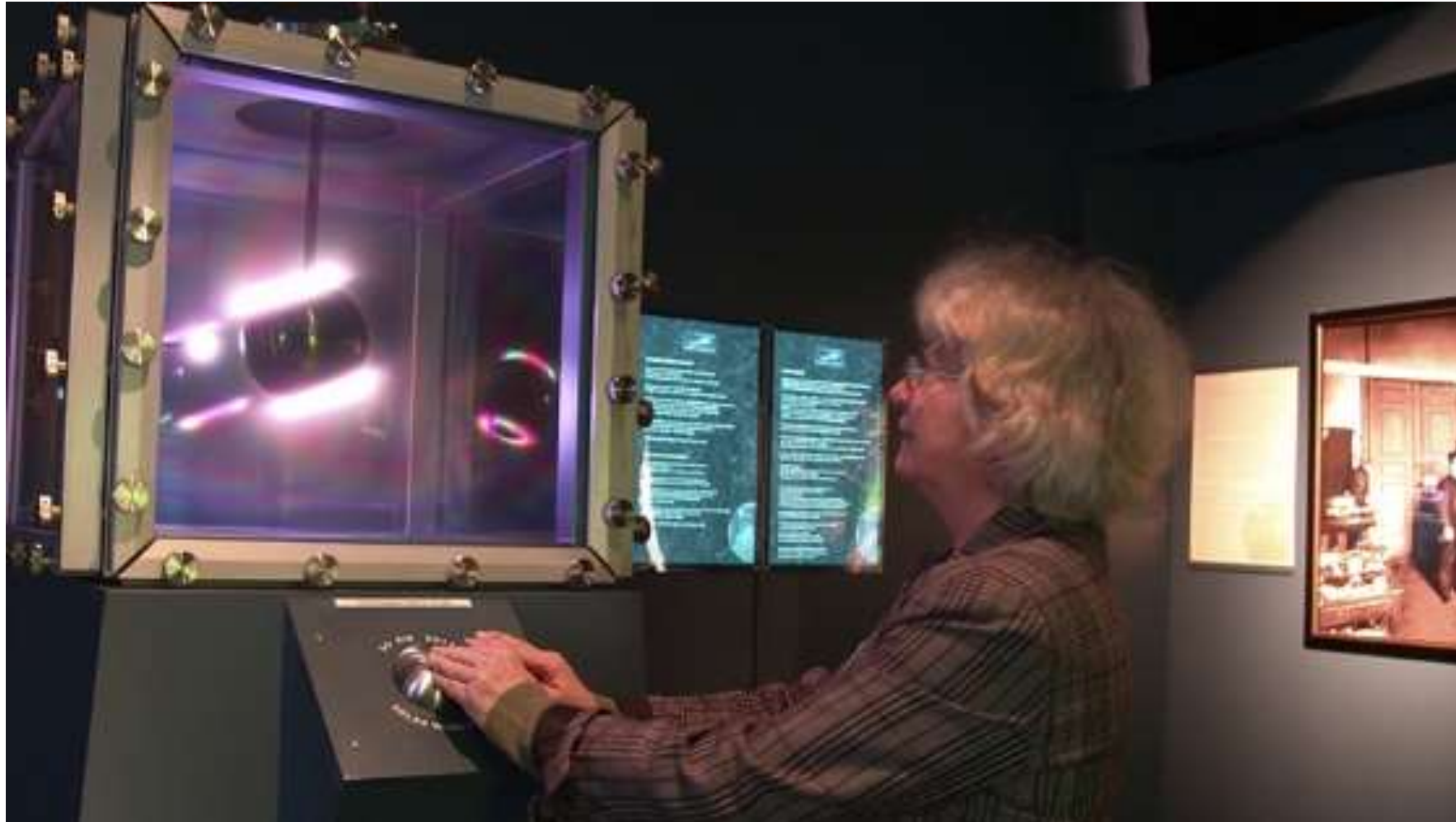


# Play with colours and themes





# Interactive equipments



[https://en.uit.no/tmu/aktuelt?p\\_document\\_id=451575](https://en.uit.no/tmu/aktuelt?p_document_id=451575)

Safn í Tromsø

- Interactive equipments such as playing with the magnetic field
- monitoring equipments such as weather station – mock-ups!

Thank you

[www.ciao.is](http://www.ciao.is)