Building and Connecting for Discovery

The Role of the ICEHAP and Japanese Group in the IceCube-Gen2 Era

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Mission of the International Center for Hadron Astrophysics (ICEHAP) of Chiba University

- **Hosting high-energy neutrino astronomy and astroparticle physics in Japan**
- **Connecting international multimessenger astrophysics through neutrinos**

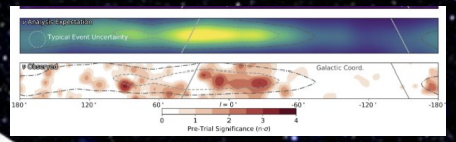
IceCube and IceCube-Gen2 are central to fulfilling both missions

15 years of IceCube science — and toward the next generation

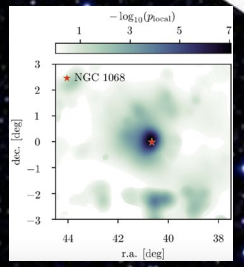
2026

2023

High-energy neutrinos from the Galactic plane



2022

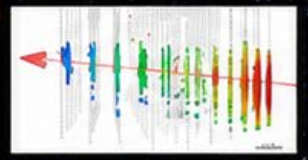


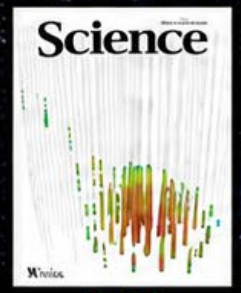
Steady neutrino emission from NGC 1068.

D-Egg selected for the IceCube Upgrade.
About 300 units have been deployed in Antarctic ice.

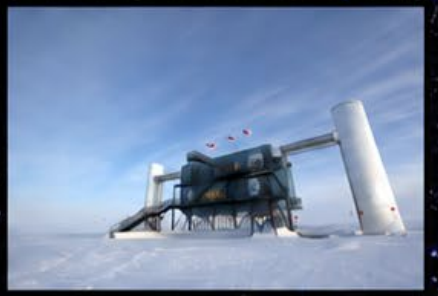
2021

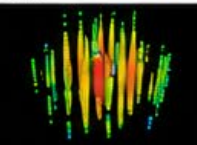
First identification of a cosmic neutrino sourcewith IceCube event IC170922A.

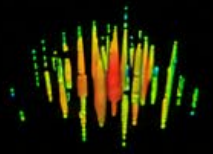




IceCube completed with 5,160 optical sensors.



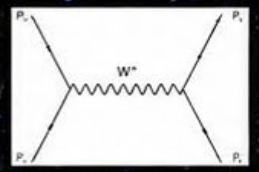


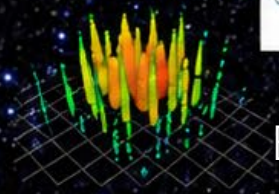


First detection of ultra-high-energy cosmic neutrinos.

The IceCube Laboratory at the South Pole collects data from the in-ice detector.

2017

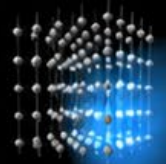




First experimental evidence for the Glashow resonance with the “Hydrangea” neutrino event.

Breakthrough of the year

2013



2011

Our science goal:
Unveil the origins of high-energy cosmic rays with neutrinos in a dynamic universe

The question for the next 15 years - What path should the Japanese group take toward this goal with Gen2?

Our PATH forward

From 15 years of achievement to the next 15 years

Discover — Science and the next direction

Unveil the origin of ultra-high energy cosmic-rays

- neutrinos in a dynamic universe
- multimessenger
- extremely-high energy
- a path beyond the Gen2

Our PATH forward

From 15 years of achievement to the next 15 years

Build Detectors and Technology

Reliable technology and production

- From Japan to international production sites

Discover Science and the next direction

Unveil the origin of ultra-high energy cosmic-rays

- neutrinos in a dynamic universe
- multimessenger
- extremely-high energy
- a path beyond the Gen2

Our PATH forward

From 15 years of achievement to the next 15 years

Build Detectors and Technology

Connect People, Communities, and Data

Discover Science and the next direction

Reliable technology and production

- From Japan to international production sites

Connect researchers, data and communities

- Japan, Asia-Pacific and the global community
- Neutrino and multimessenger: cross disciplinary community

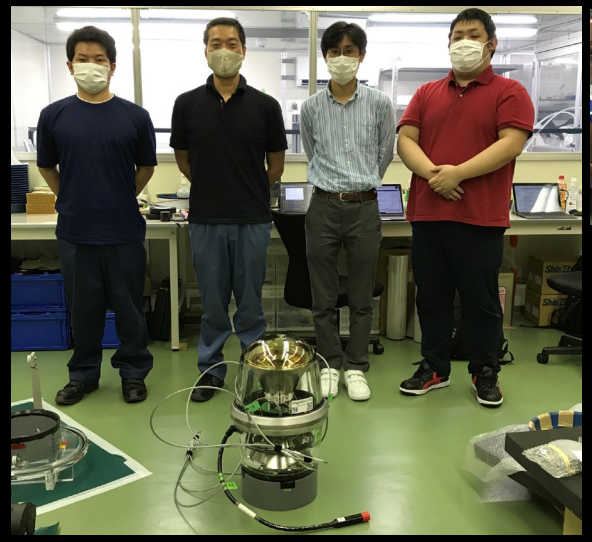
Unveil the origin of ultra-high energy cosmic-rays

- neutrinos in a dynamic universe
- multimessenger
- extremely-high energy
- a path beyond the Gen2

TRUST · CONTINUITY · INTERNATIONAL PARTNERSHIP

IceCube-Upgrade: A Record of Reliable Delivery

- R&D of new optical sensor, D-Egg, began in 2014. Final Design Review approval in Feb 2020
- Production started in April 2020 and was completed by the end of 2021 despite COVID-19
- Full-scale final acceptance testing was conducted from November 2022 to July 2024
- 292 D-Eggs were shipped to Christchurch, NZ from Yokohama in 2024 and installed in the glacial ice in 2025/26



Reliability is Built through Partnership with Industries

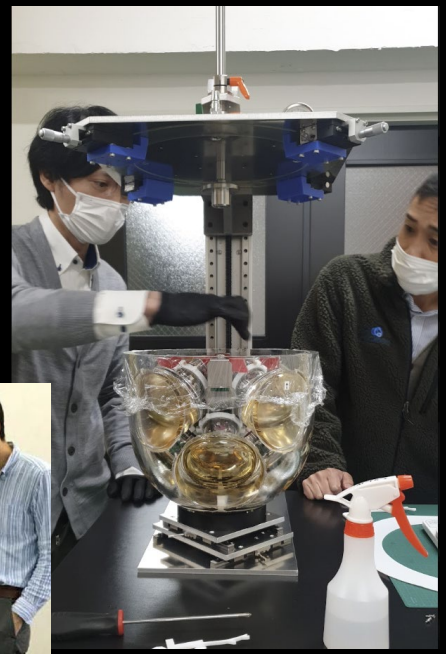
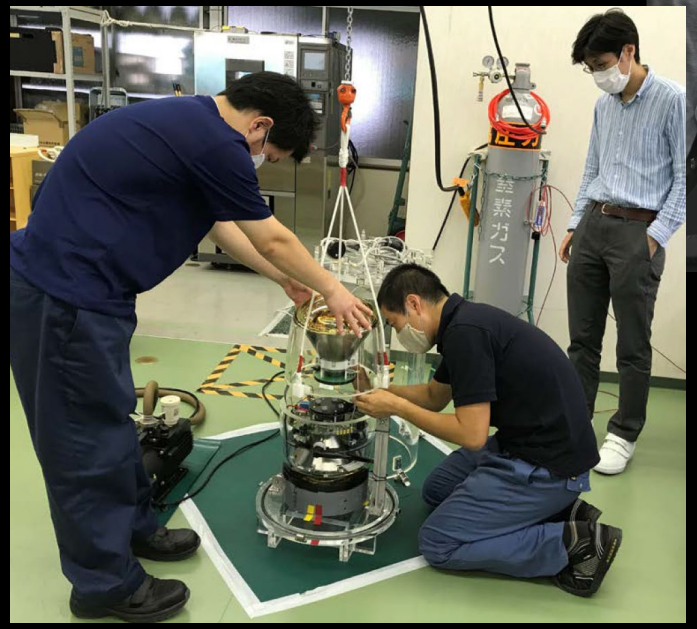
岡本硝子株式会社

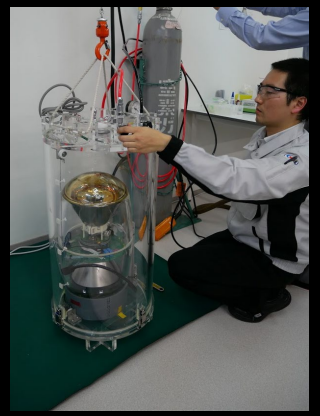
HAMAMATSU
PHOTON IS OUR BUSINESS

SEISGADGET

日本海洋事業
NIPPON MARINE ENTERPRISES

Shin-Etsu

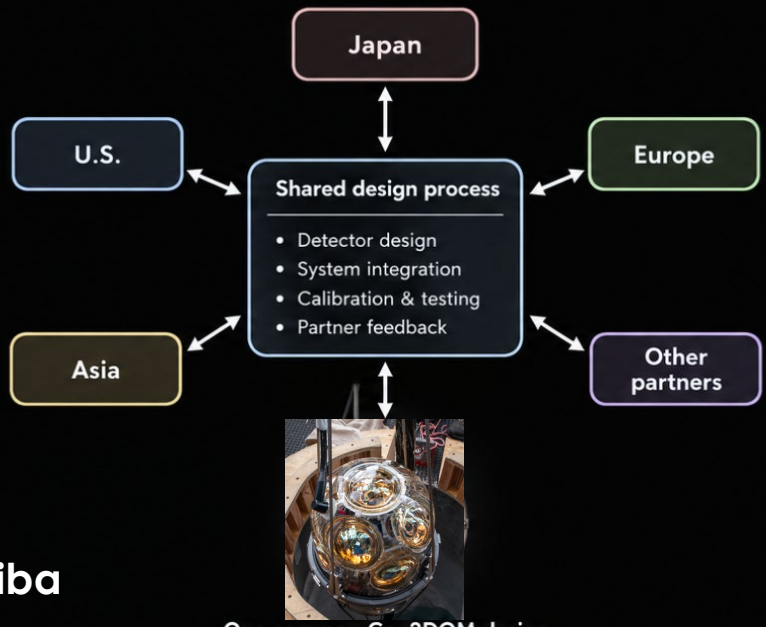





BUILD: Collaborative Gen2 Detector Design

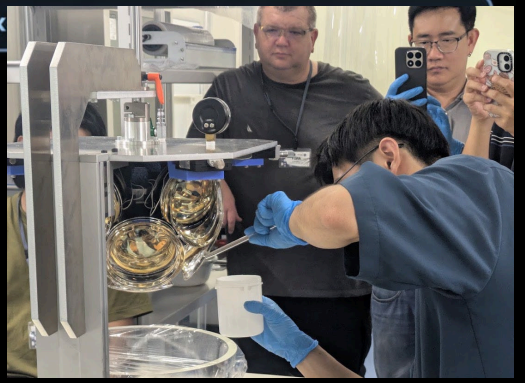
Institutes with different expertise work together to develop one common Gen2-DOM design

- Detector development
- Quality assurance
- Mass production
- Test system
- …



One common Gen2DOM design

Gen2DOM Design Review at Chiba University June 29 – July 3, 2026



BUILD: From Shared Design to Distributed Production

Working together to make the Gen2 DOM manufacturable, testable, and reliable in multiple countries

- Cross-calibrate test facilities to quantify and correct site-dependent systematic differences.
- Ensure equivalent detector performance regardless of manufacturing or testing site.

Gen2-DOM Design

Shared production support

- **Procedure**
- **Training**
- **Tooling**
- **Calibration procedure**
- **Acceptance criteria**

Establish a standard model for international distributed production in IceCube-Gen2

→ A transferable QA methodology for future large-scale international scientific facilities including Asian countries

IceCube-Gen2 Collaboration

- More involvement of Asian countries (Thai, India) in addition to Korea, Taiwan, and Japan

THE ICECUBE-GEN2 COLLABORATION

AUSTRALIA
University of Adelaide

BELGIUM
UCLouvain
Université libre de Bruxelles
Universiteit Gent
Vrije Universiteit Brussel

CANADA
Queen's University
Simon Fraser University
University of Alberta–Edmonton

DENMARK
University of Copenhagen

GERMANY
Deutsches Elektronen-Synchrotron
ECAP, Universität Erlangen-Nürnberg
Humboldt–Universität zu Berlin
Karlsruhe Institute of Technology
Ruhr-Universität Bochum
RWTH Aachen University
Technische Universität Dortmund
Technische Universität München
Universität Mainz
Universität Münster
Universität Wuppertal

INDIA
Tata Institute of Fundamental Research

ITALY
University of Padova

JAPAN
Chiba University
Osaka Metropolitan University

NEW ZEALAND
University of Canterbury

REPUBLIC OF KOREA
Chung-Ang University
Sungkyunkwan University

SWEDEN
Stockholms universitet
Uppsala universitet

SWITZERLAND
Université de Genève

TAIWAN
Academia Sinica

THAILAND
Chiang Mai University

UNITED KINGDOM
University of Oxford

UNITED STATES
Columbia University
Drexel University
Georgia Institute of Technology
Harvard University
Lawrence Berkeley National Lab
Loyola University Chicago
Marquette University
Massachusetts Institute of Technology
Mercer University
Michigan State University
Ohio State University
Pennsylvania State University
South Dakota School of Mines and Technology
Southern University and A&M College
Stony Brook University
University of Alabama
University of Alaska Anchorage
University of California, Berkeley
University of California, Irvine
University of Chicago
University of Delaware
University of Kansas
University of Maryland
University of Nevada, Las Vegas
University of Notre Dame
University of Rochester
University of Utah
University of Wisconsin–Madison
University of Wisconsin–River Falls
Whittier College
Yale University

ICECUBE GEN2

CONNECT : multimessenger facilities

Connect for Science

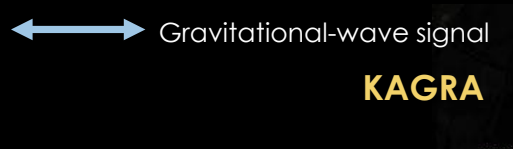
Network development in the IceCube-Gen2 era

The time evolution of the neutrino signal (inner-region information) and electromagnetic signals (outer-layer information) reveals the energy-release process.

Neutrino transient signal

IceCube-Gen2

One possible example



Gravitational-wave signal

KAGRA

X-ray burst signal detection

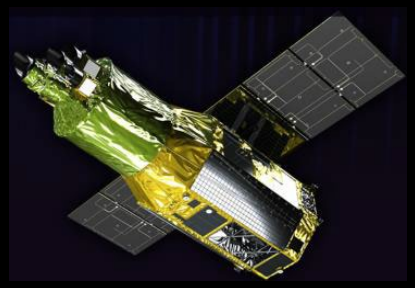
hiZ-GUNDAM

Subaru PFS

Optical spectroscopic follow-up begins; source distance is determined

Subaru PFS

XRISM



Sensitive deep X-ray follow-up

XRISM/NICER

CTA

Gamma-ray follow-up

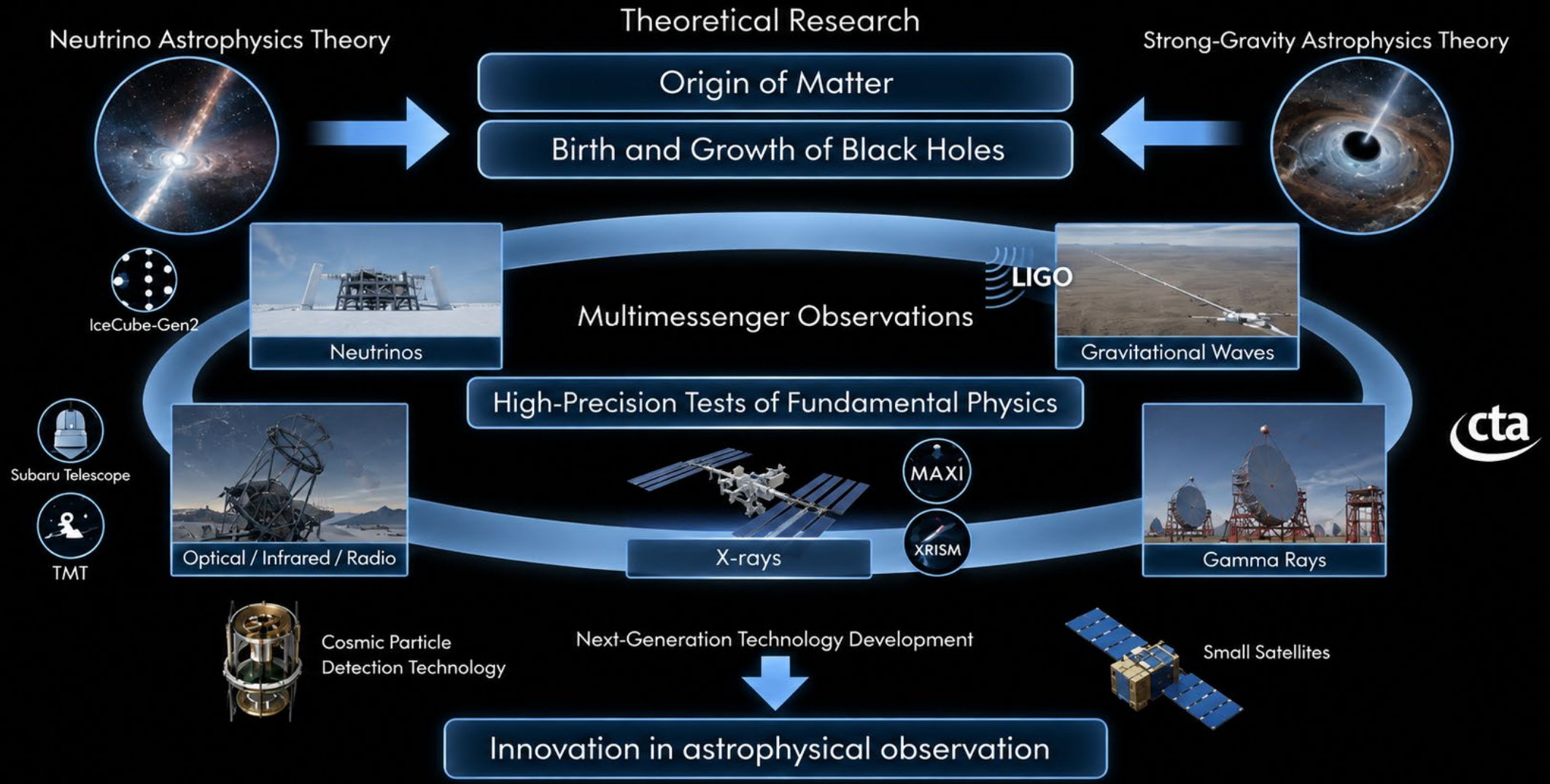
CTA

Connect: multimessenger community in Japan

Grant-in-Aid for Transformative Research Areas (A)

The creation of multi-messenger astrophysics

https://multimessenger.jp/

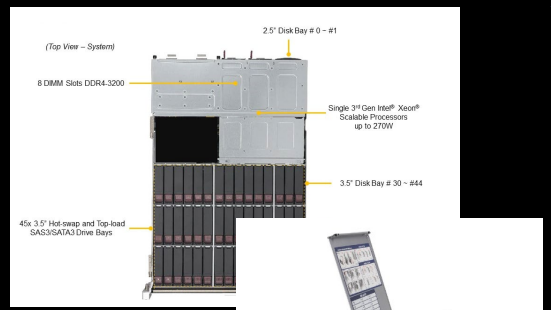


CONNECT: Dual-Purpose Data Sharing

Exploration Data Warehouse

data warehouse
~500 TB unfiltered data (Pass3)

Storage for analysis-driven filters and innovative selections



Test new ideas without early bias

Shared compute service
~100 cores

Consulting for multimessenger analyses

Community Data Service

Japanese + Asia/Pacific access for IceCube data resources ~300TB

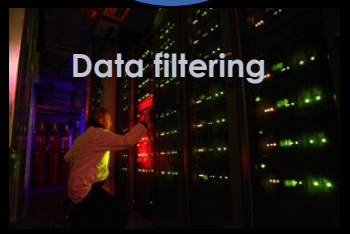
Public data with tutorials

From private infrastructure to shared scientific capability

CONNECT: Data Flow from IceCube to the Community

IceCube
South Pole Neutrino Observatory

IceCube → WIPAC → ICEHAP Data & Computing Server → Users



Data Sharing for Follow-up Observations

Japan / Asia-Pacific hub
Japanese and Asian multimessenger community

- Tutorial Development & Updates
- Technical Consulting
- Real-Time Alert Analysis

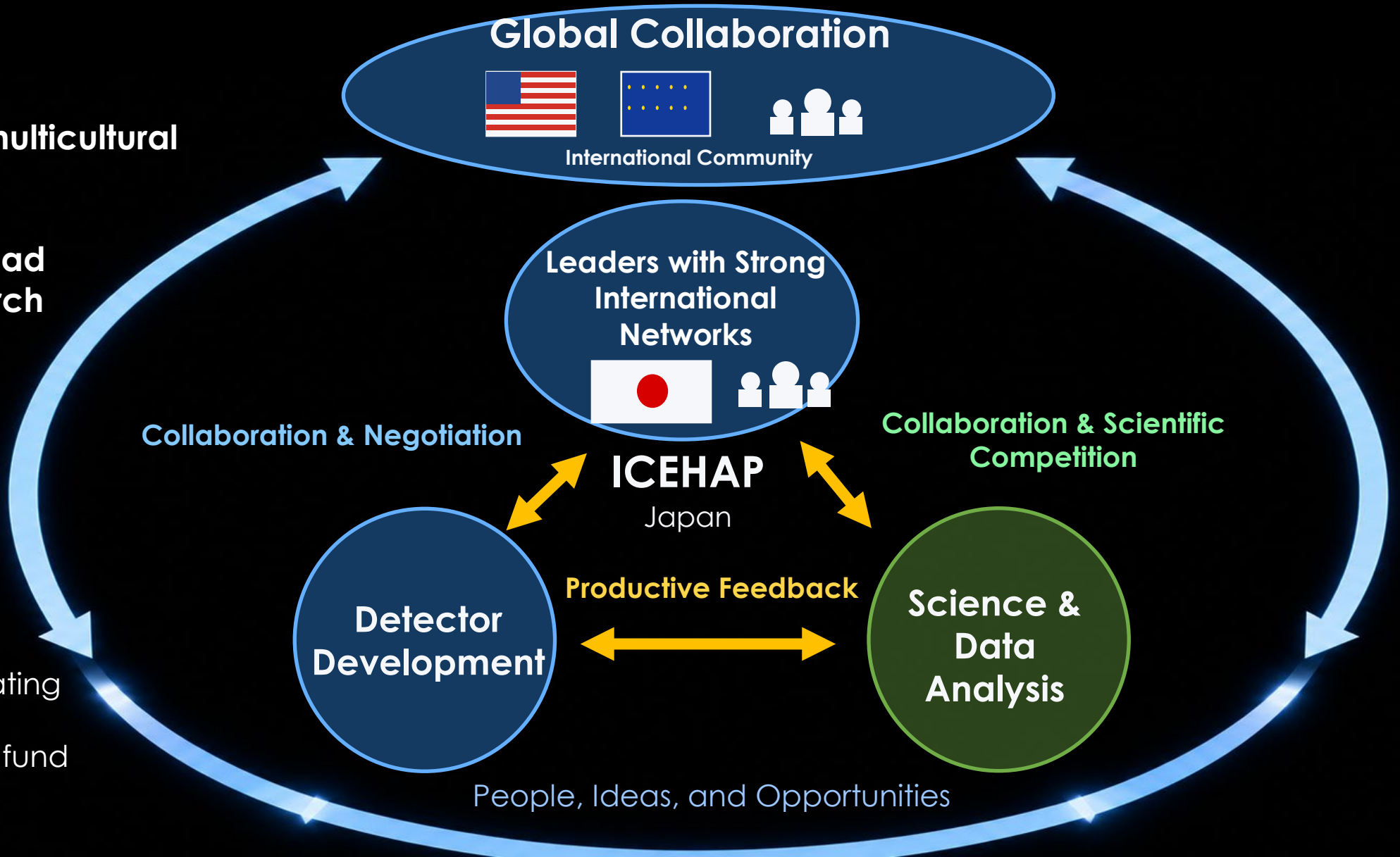
What the hub provides

Data access | **Tutorials** | **Alert analysis** | **Consulting** | **Simulation** | **Shared compute**

Lowering the barrier for new analyses and faster multimessenger follow-up

Developing the Next Generation of Scientists through International Collaboration

- **Multinational and multicultural environment**
- **Researchers who lead Science and research community**



Also supported by "Elucidating the Univers's Creation with Neutrinos" Grant-in-aid for fund for the promotion of joint international research

From 15 Years of Trust to the Next 15 Years

- **Reliable technology and international production**
  From detector development to trusted global partnerships
- **Shared infrastructure and connected communities**
  Data, computing, and multimessenger networks
- **People who can carry the collaboration forward**
  Experience, mobility, and trusted international relationships

Continuity of people, infrastructure, and partnerships allows what we have built to grow into lasting scientific capability