

# Report on Industry and Sustainability Sessions in Linear Collider Workshops

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Hiroshima University

Oct. 26,2024  
CEPC 2024

# Contents

- A Brief History
- Activities in Industry and Sustainability Sessions
- Summary

## IEEE Industry Exhibition 2016 (Strasbourg, France)



## LCWS2016 (Morioka, Japan): Dec. 2016

<https://agenda.linearcollider.org/event/7371/sessions/4305/#20161206>



## ECFA LC2016 (Santander, Spain): June 2016

<https://agenda.linearcollider.org/event/7014/sessions/3895/#20160601>



## LCWS2017 (Strasbourg, France): Oct. 2017

<https://agenda.linearcollider.org/event/7645/sessions/4537/#20171025>





## ALCW2018 (Fukuoka, Japan): May 2018

<https://agenda.linearcollider.org/event/7826/sessions/4652/#20180529>



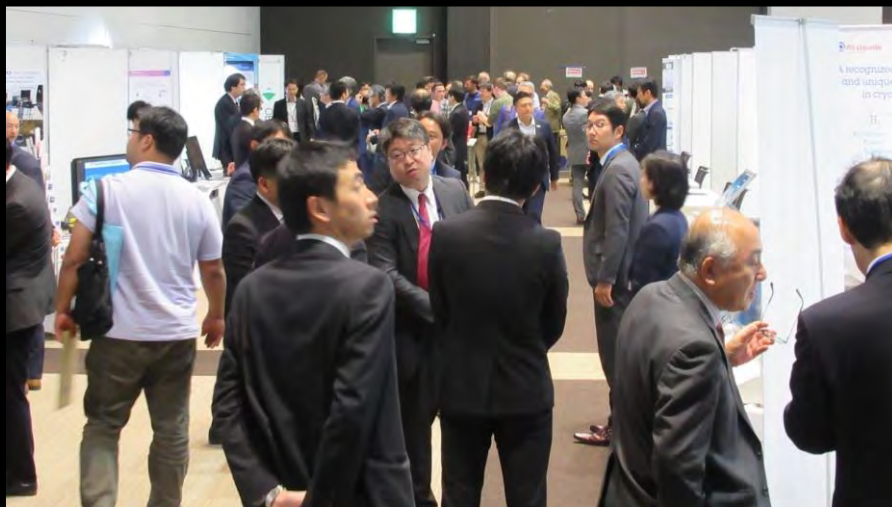
## LCWS2018 (Arlington, USA): Oct. 2018

<https://agenda.linearcollider.org/event/7889>



## LCWS2019 (Sendai, Japan): Oct. 2019

<https://agenda.linearcollider.org/event/8217>  
Session + Exhibition (~ 60 companies)



## LCWS2021 (Europe, Online): Mar. 2021

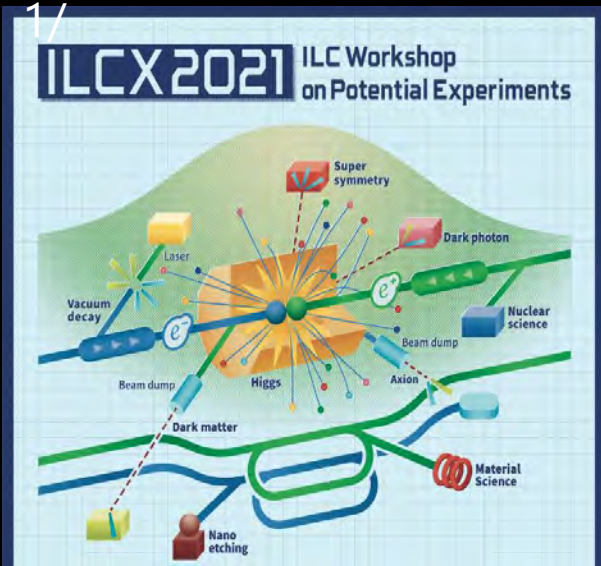
<https://indico.cern.ch/event/995633/sessions/387855/#20210316>





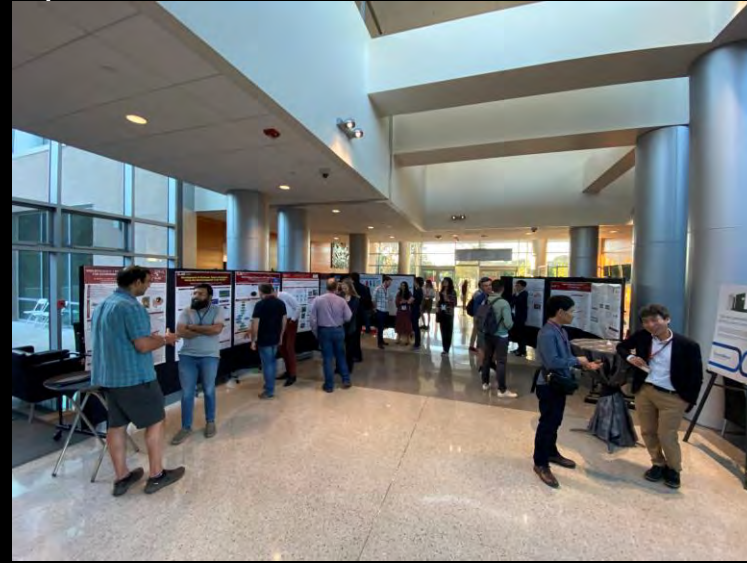
## ILCX2021 (Online/hosted by KEK)

<https://agenda.linearcollider.org/event/921>



## LCWS2023 (SLAC)

<https://indico.slac.stanford.edu/event/7467>



## WSFA2023 (Morioka)

<https://wsfa2023.huhep.org/>



## LCWS2024 (Tokyo)

<https://wsfa2023.huhep.org/>

The poster for LCWS2024 features a blue and green background with a stylized particle detector or accelerator structure. The text includes the workshop title, a list of topics, the dates and location, and the organizing institutions. The topics are: Higgs factories, detector technologies, accelerator technologies, data reconstruction, collider systems, physics analysis, sustainability, and particle theory. The dates are 8-11 July 2024 in Tokyo, Japan. The URL is <https://agenda.linearcollider.org/e/lcws2024>. Logos for KEK and ICEPP (The University of Tokyo) are at the bottom.

# Contributions from China

LCWS2018 Texas

Jie Gao (IHEP)

LCWS2019 Sendai

Jie Gao (IHEP)

Chen Wang Wuxi Creative Tech.

LCWS2021

Jiyuan Zhai (IHEP)

ILCX2021

Jie Gao (IHEP)

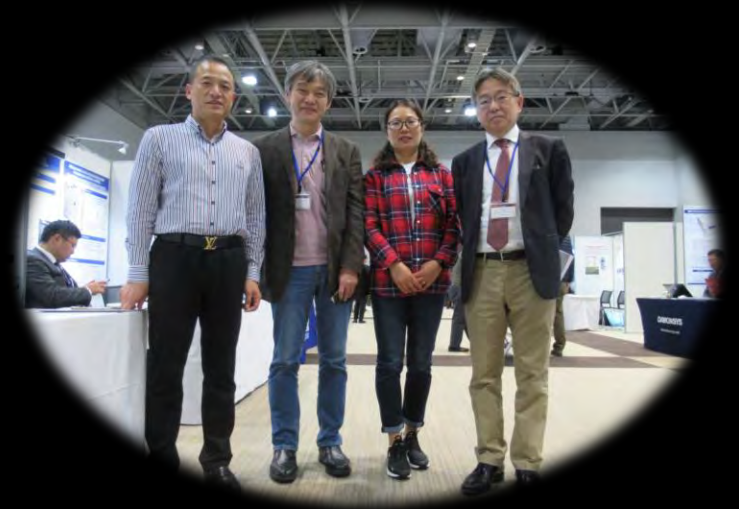
LCWS2023

Zhou Zusheng (IHEP)

LCWS2024

Jinlin Gao/Jie Gao (FullCryo)

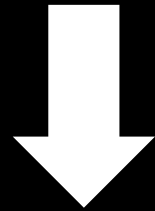
Rui Ge (IHEP)



Wuxi Creative Technologies Co. Ltd  
无锡市创新低温环模设备科技有限公司  
at Industry Exhibition

# HEP has a long history of Industry – Academia Collaboration

- Industry Support in Projects
  - Companies acted as vendors.



- Industry Participation in Projects
- Industry Involvement in Projects

Industry takes part in tasks in a project, providing expertise and resources.

Industry contributes to project-promotion processes

Sustainability !!

Companies now join projects from the very beginning.

This trend is more pronounced for large-scale, long-term projects

# LCWS2024 Industry Session

Introduction and LDG working group on sustainability	Maxim Titov	CEA
AAA activities in Japan	Osamu Jinnouchi	Tokyo Institute of Technology
ILC Vanguard Initiative	Tohru Takahashi	Hiroshima University
ILC Site-Specific Activities by Tohoku ILC Project Development Center	Atsuto Suzuki	Iwate Prefectural University
Introduction of CEPC Industry Promotion Consortium (CIPC)	Jinlin GAO(FullCryo)	Fullcryo
Industrial Efforts for X-Band Accelerator Structure Fabrication (Europe)	Pedro Sanchez Morales	CERN
Innovative Public Procurement	Maite del Corte Sanz	CDTI
Spanish Science Industry update	Erik Fernandez	INEUSTAR
Significance of participating in ILC-related R&D as a regional company located near an ILC candidate site	Shinichi Takizawa	Kondo equipment

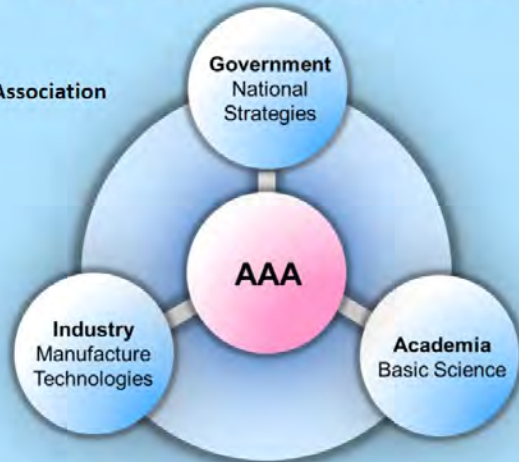


# What is AAA

<https://aaa-sentan.org/>

Advanced Accelerator Association Promoting Science & Technology

General Incorporated Association  
Founded in 2008



Jinnouchi

AAA promotes the ILC in collaboration with Government, Academia, Industry and the local business community

AAA activities in Japan



# SPANISH SCIENCE INDUSTRY

Ineustar

Medium-long term vision and COLLABORATION



Our goal is to help to:

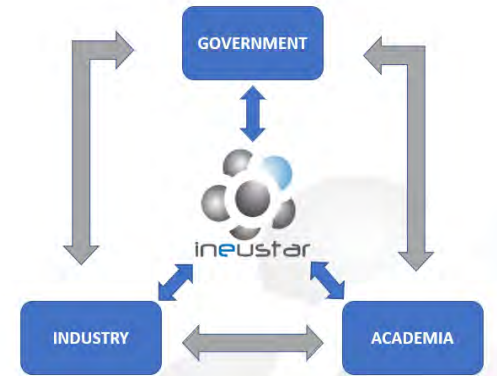
Increase economic impact

Boost technology transfer

Dissemination

Boost of R&D promotion

New activities attraction



Fernandez

© INEUSTAR, 2024

LCWS 2024

9



## Industrial Efforts for X-Band Accelerator Structure Fabrication

LCWS2024

Pedro Morales Sánchez

9/7/2024

Morales Sánchez



# Introduction of CEPC Industry Promotion Consortium (CIPC)

Jinlin Gao  
2024.7.9 Tokyo

CEPC Industrial Promotion Consortium (CIPC)

Klystron

Vacuum

SC



## Superconducting Cavities

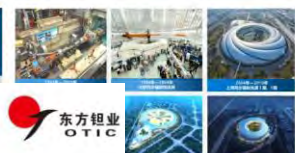


High performance 1.3GHz 9 Cell cavity



参加加速器领域  
国家重大科学工程  
(共计12项, 已建成6项)

## Superconducting magnets



List of magnet class items

序号	名称	型号	数量	备注
1	超导二极磁铁	SR-1000	1000	
2	超导四极磁铁	SR-1000	1000	
3	超导六极磁铁	SR-1000	1000	
4	超导校正磁铁	SR-1000	1000	
5	超导偏转磁铁	SR-1000	1000	
6	超导注入磁铁	SR-1000	1000	



## CEPC main ring (650MHz) and Booster (1.3GHz) SC high frequency

- 2011 DESY - XFEL  
RRR300 Nb: 8 tons, 30% of the project
- 2012 Michigan State University - FRIB  
RRR250 Nb: 8.5 tons, 70% of the project
- 2014 Fermilab - LCLS II  
RRR300 Nb: 5 tons, 50% of the project
- 2017 INFN and STFC - ESS  
RRR300 Nb: 12.5 tons, 100% of the project
- 2019 IBS - RISP, CERN - HL-LHC, Fermilab - PIP-II, Sh RRR300 niobium material procurement in progress

宁夏东方超导科技股份有限公司  
Ningxia Oriental Superconducting Technology Co., LTD.

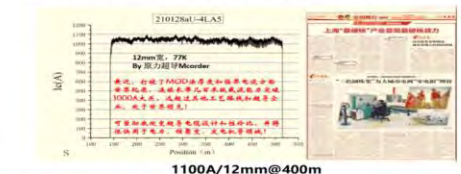


## The second generation high-temperature SC tapes

The superconducting layer produced by Shangchuan Superconductor has a production capacity of wider tapes of 20-40mm; double-lane design; Multiple production Yields up to 400 km/year

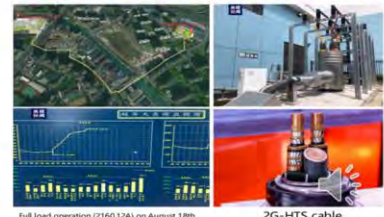


Coating and Low-temperature pyrolysis High-temperature crystallization



上海上创超导科技有限公司 (SCSC)

1.2-km 35 kilovolt superconducting power cable transmission line  
Length: 1.2 km  
Loading Current: 2.2 kA  
Loading Voltage: 35 kV  
HTS Materials: 2G tapes from SCSC & SST  
Cable Structure: Three-phase integrated  
Total area: Save 70% of underground pipegallery space



Full load operation (2160.12A) on August 18th

上创超导  
Shanghai Creative Superconductor



## high efficiency klystron direction



324MHz Mechanical design of klystron tubes



Kunshan National Research Institute's research and development of 324MHz klystron has completed mechanical design, component processing, cavity welding, tuning and focusing coil integration

324MHz Focusing coil system for klystrons

昆山国力电子科技有限公司  
Kunshan GuoLi Electronic Technology Co., Ltd

CEPC Industrial Promotion Consortium (CIPC)



## Vacuum technologies



Anhui East China Optoelectronic Technology Research Institute Co., Ltd. specializes in special microwave and microelectronics, special light sources, special displays and other electronic components, and has established a R&D, design and simulation platform covering microwave, millimeter wave, terahertz and other professional directions, R&D and process test equipment and software.

安徽华东光电技术研究所有限公司  
Anhui East China Optoelectronic Technology Research Institute Co., Ltd

CEPC Industrial Promotion Consortium (CIPC)

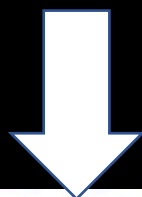




Advanced fabrication



to Reality



## CLIC Developments: Pushing Boundaries with Industry Collaboration

Real-world Example:

- Collaboration on X-band structures has led to the development of



## CLIC Developments: Pushing Boundaries with Industry Collaboration



### From Academia to Reality: Collaborative Projects - Muhig

MANUFACTURING IN THE UK FOR HIGH GRADIENT CAVITIES

- High-precision machining techniques for complex copper shapes.
- Innovative brazing methods to ensure robust and reliable structure joining.
- Advanced quality control procedures to guarantee tight tolerances.



### From Academia to Reality: Collaborative Projects - DEFT

EUROPEAN PLASMA RESEARCH ACCELERATOR

DEEP ELECTRON FLASH THERAPY

### From Academia to Reality: CERN



Innovation Fostering in Accelerator Science and Technology

EuPRAXIA is large-scale European project aiming next-generation research facility dedicated to plas Inside this project X-band accelerators are potent drive particle beams.



Develop a next-generation medical linear accelerator for FLASH (FLash therapy with Advanced Synchrotron Head) therapy using a CLIC-based accelerator structure.

More info

WP7: High Brightness Accelerators for Light Sources:

A specific work package dedicated to X-band technology for light source applications.



# Promoting a Project with Industry/Local Community

## ILC Vanguard Initiative (IVI)

to facilitate and accelerate preparatory tasks for the ILC in Japan

No official decision for the ILC in Japan yet, however .....

A lot of works to do in



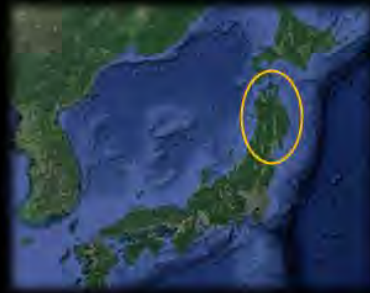
Management planning



City development design



Environmental assessment

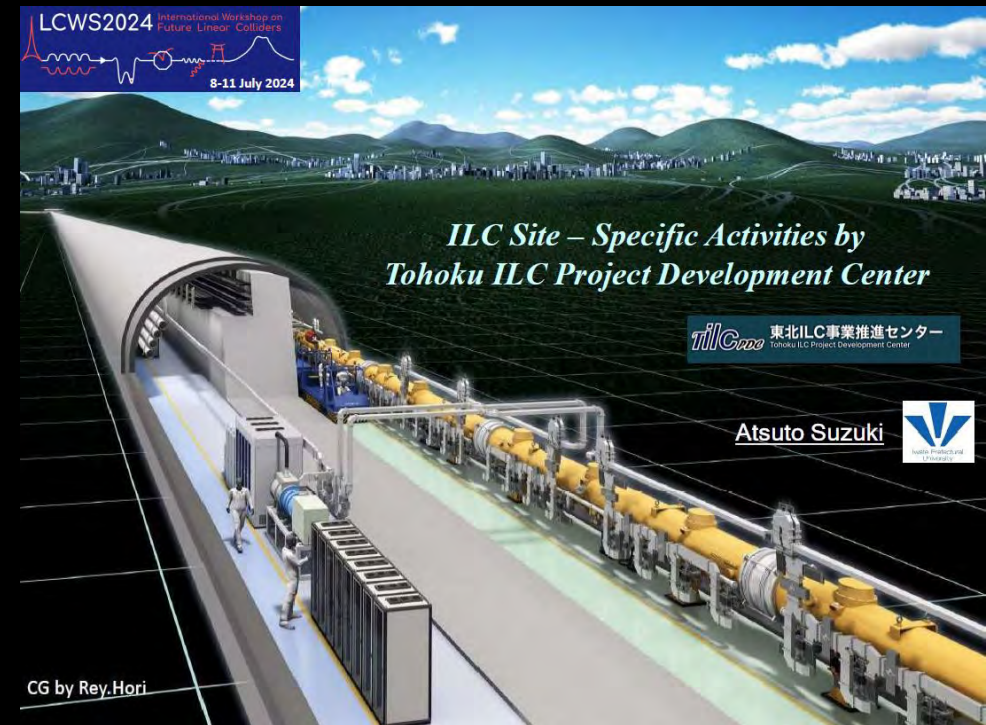


with local communities



time consuming

Takahashi



Suzuki



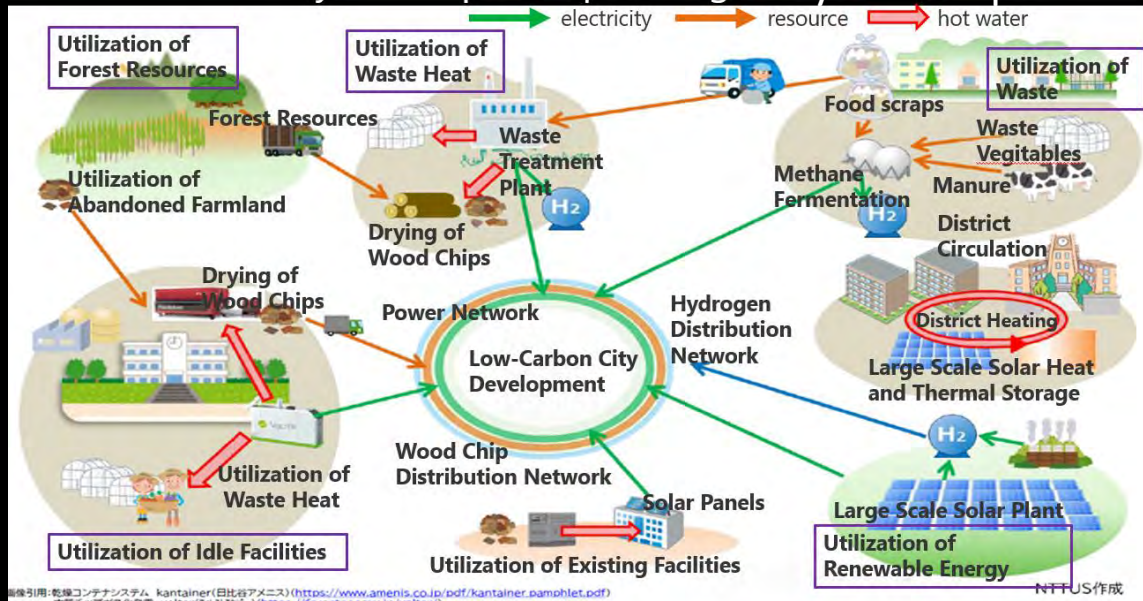
# Industry Involvement in Projects: an example

members from universities, companies

Individual Participation from Universities and Companies



## Low Carbon city Development



## Governance model

	Preparation	Construction	Operation
Site (Surface)	Environment and Land Study	City planning, construction Environment assessment Land acquisition negotiation Land development planning	Land development
Facility (Underground)	Tohoku facility design	Facility construction preparation office geo. survey	Facility const. org. International Laboratory Detector construction Accelerator Equipment
Technology (International)	ITN	ILC Pre-Lab (Acc. Technology)	International Laboratory

## Environmental Assessment



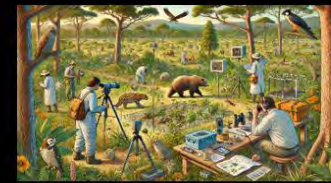
Atmospheric  
air quality  
noise  
vibration  
stench



Water  
water quality  
sediment  
ground water



Soils  
topography and Geology  
ground level  
soil contamination



Animals  
Plants  
Ecosystem



Scenery  
people and nature



Waste  
Greenhouse gases



# Collaboration with a local Company

## KONSETSU×ILC



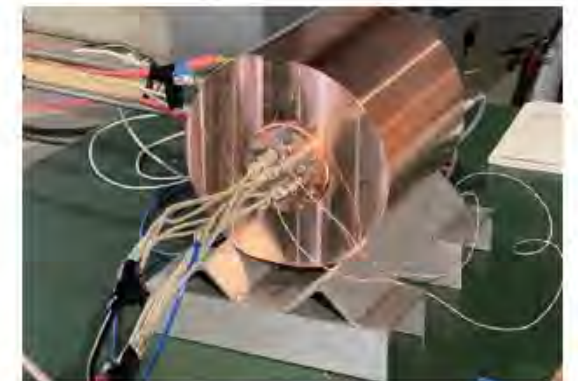
- A water cooling system was designed and fabricated to cool a part of the positron source, collimator.
- Simulation of the water cooling effect was performed by the Iwate Industrial Research Center using ANSYS.
- The simulation results were verified using the evaluation device produced by Metal Technology Company, MTC.



Positron source experimental setup CG model



Positron source experimental equipment



Evaluation machine  
(manufactured by Metal Giken)

# LCWS2024 Sustainability Session

Efforts toward a Green ILC in Japan	Masakazu Yoshioka	Iwate University
CEPC Green Accelerator Technology Development	Rui GE	IHEP, CAS
A Sustainability Strategy for the Cool Copper Collider	Brendon Bullard	SLAC
Sustainability Efforts for Present and Future Accelerator Facilities	Emilio Nanni	SLAC
Whole Life Cycle Assessment approach for linear colliders	Suzanne Evans	ARUP
Lifecycle Inventory input to an LCA for ILC and CLIC	Steffen Doebert	CERN
Need of the hour: Carbon Utilized Concrete (CUCO)	Kumar Avadh	Kajima Co.
Challenges and breakthroughs in recent RF Solid State PA design by Radial Combiner design with Initiatives for SDGs	Riichiro Kobana	R&K Company LTD
Commercialization and fundamental research of waste heat recovery technology using adsorption heat storage materials	Yuichi Kouno	Higashi Nihon Kiden Kaihatsu



# Co<sub>2</sub> matters

## Sustainability Considerations for Accelerator and Collider Facilities

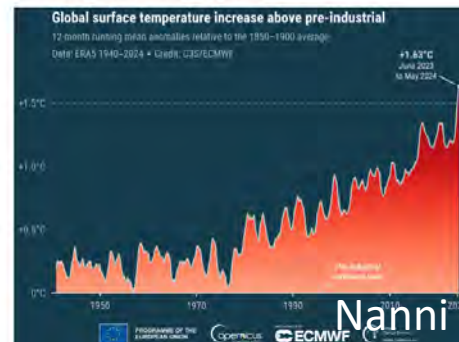
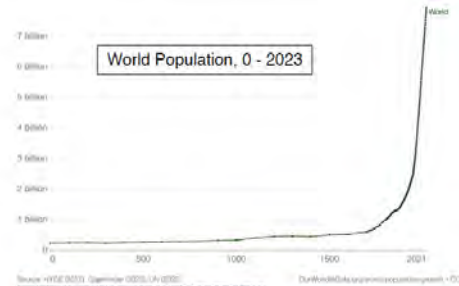
Emilio Nanni on behalf of the ICFA Sustainability Panel

- **Panel members:**
  - **Europe:** Mike Seidel (PSI, Switzerland), Jerome Schwindling (CEA/IRFU, France), Ruggero Ricci (LNF, Italy), Peter McIntosh (STFC, UK), Roberto Losito (CERN, Switzerland), Maxim Titov (CEA), Denise Völcker (DESY)
  - **Asia:** Takayuki Saeki (KEK, Japan), Yuhui Li (IHEP, China), Hiroki Okuno (Riken, Japan), Jui-Che Huang (NSRRC, Taiwan), Eugene Levichev (BINP, Russia)
  - **America:** John Byrd (ANL, USA), Soren Prestemon (BNL, USA), Thomas Roser (BNL, USA), Andrew Hutton (JLAB, USA), Robert Laxdal (TRIUMF, Canada), Mary Convery (FNAL, USA), Emilio Nanni (SLAC, USA)
- **Mandate:**
  - Assess and promote developments on energy efficient and sustainable accelerator concepts, technologies, and strategies for operation
  - Assess and promote the use of accelerators for the development of Carbon-neutral energy sources.
  - Formulate recommendations on R&D and support ICFA with networking across the laboratories and with communications.
- Many laboratories are expanding their use of Carbon-highly welcome development it does not replace or ob and reduced energy consumption, which is the focus t

ICFA Sustainability Panel

### Thoughts on sustainability – importance of reduced energy consumption

- Human life on earth as we know it is endangered by the unsustainable exploitation of many natural resources.
- Maybe most importantly, over the last 250 years the availability of essentially unlimited amounts of fossil energy has resulted in rapid population growth and unsustainable use of many natural resources.
- The most urgent issue but certainly not the only one: CO<sub>2</sub> from burning fossil fuels accumulates in the atmosphere. CO<sub>2</sub> in the atmosphere is the primary determinant of the earth's average surface temperature.
- The future accelerator projects will overlap in time with increasingly more extreme weather events around the world and urgent demands to cut CO<sub>2</sub> emissions.



Nanni

## Efforts toward a Green ILC in Japan

Masakazu Yoshioka, Iwate/Iwate prefectural University  
July 9 2024

### Argument from the start : why global warming is accelerating? My naive view point, or rather than a very personal philosophy

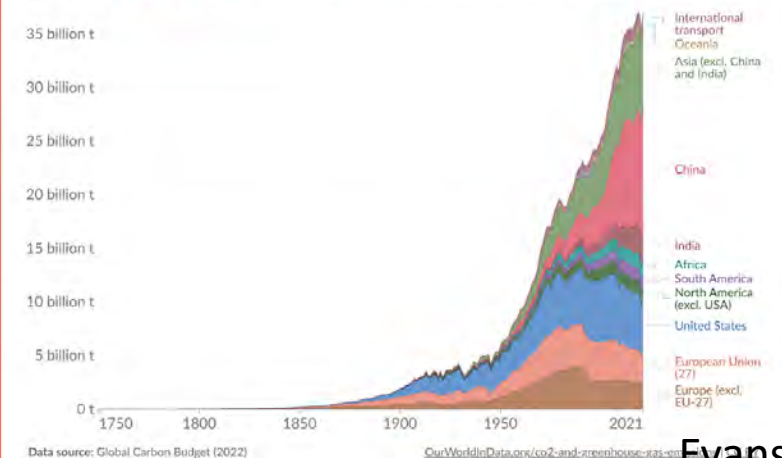
- Before the Industrial Revolution, CO<sub>2</sub> emitted by human activities and CO<sub>2</sub> absorbed and accumulated by the natural world were **in balance and the global cold/warm cycle was a natural phenomenon.**
- To begin with, CO<sub>2</sub> is stored in **forests, soil, oceans, and atmosphere.**
- After the Industrial Revolution, carbon liberation due to the rapid increase in fossil fuels has caused **a loss of that balance**, and atmospheric CO<sub>2</sub> concentrations are increasing.
- In addition, human activities, especially **agricultural land expansion and concentration of specific crops**, also impair nature's ability to absorb and store CO<sub>2</sub>.
- In other words, what we need to do today is clear: (1) make efforts to **reduce the excessive emissions of greenhouse gases** and (2) work to **restore nature's ability to absorb CO<sub>2</sub>.**

Yoshioka

LCWS2024\_Sustainability\_Yoshioka\_July9

## Annual CO<sub>2</sub> emissions by world region

To limit global warming to 1.5°C (relative to 1900), the estimated remaining carbon budget from the beginning of 2020 is **< 300 billion t** [https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC\\_AR6\\_WG1\\_SPM\\_final.pdf](https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WG1_SPM_final.pdf)



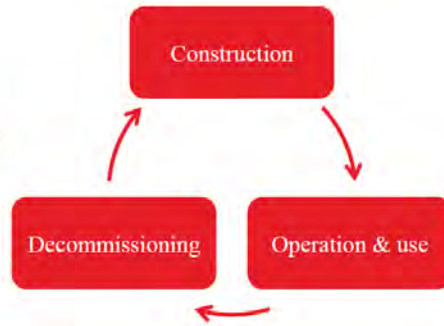
Evans

LCWS 2024



Life cycle assessment

A life cycle assessment systematically assesses the environmental impact of a product or asset throughout its life cycle



Lifecycle Inventory Input to an LCA for ILC and CLIC

Steffen Doebert on behalf of the CLIC/ILC Sustainability Team  
 LCWS 2024, Tokyo, Japan, 8-11 of July

A sustainable strategy for the Cool Copper Collider

Martin Breidenbach<sup>1</sup>, Brendon Bullard<sup>1</sup>, Emilio Nanni<sup>1</sup>, Dimitris Ntounis<sup>1,2</sup>, Caterina Vernieri<sup>1,2</sup>  
 1) SLAC National Accelerator Laboratory, 2) Stanford University

International Workshop on Future Linear Colliders  
 Industry and Sustainability Session (LCWS2024)  
 July 9, 2024



NATIONAL ACCELERATOR LABORATORY



Stanford University



U.S. DEPARTMENT OF ENERGY



CEPC Green Accelerator Technology Development

Rui Ge  
 Institute of High Energy Physics, CAS

On behalf of CEPC accelerator team

# Collaboration with Companies

LCWS 2024  
Industry / Sustainability Session

Commercialization and fundamental research of waste heat recovery technology using adsorption heat storage materials

Higashi-nihon [KidenKaihatsu Co.,Ltd.\(HKK\)](#)

Yuichi Kouno

Higashi-Nihon Kiden Kaihatsu (Sustainability)

EAJADE Workshop on Sustainability in Future Accelerators (WSFA2023)

## The Future of Construction: Carbon-Negative Concrete for a Greener Tomorrow

Kajima Corporation  
Dr. Kumar Avadh (PhD. University of Tokyo)  
Research Engineer

Kajima Corporation (Sustainability)

 KAJIMA CORPORATION

2023/9/26

LCWS2024, July 9, 2024

Challenges and breakthroughs  
in recent RF Solid State PA design  
by Radial Combiner design with Initiatives for SDGs

Presented by Riichiro Kobana  
R&K Company Limited

R&K (Sustainability)

**R&K Company Limited**  
721-1 Maeda, Fuji-City, Shizuoka-Pref. 416-8577, Japan  
Tel: +81-545-31-2600 E-mail: info@rkc.co.jp  
Fax: +81-545-31-1600 URL: http://www.rkc.co.jp

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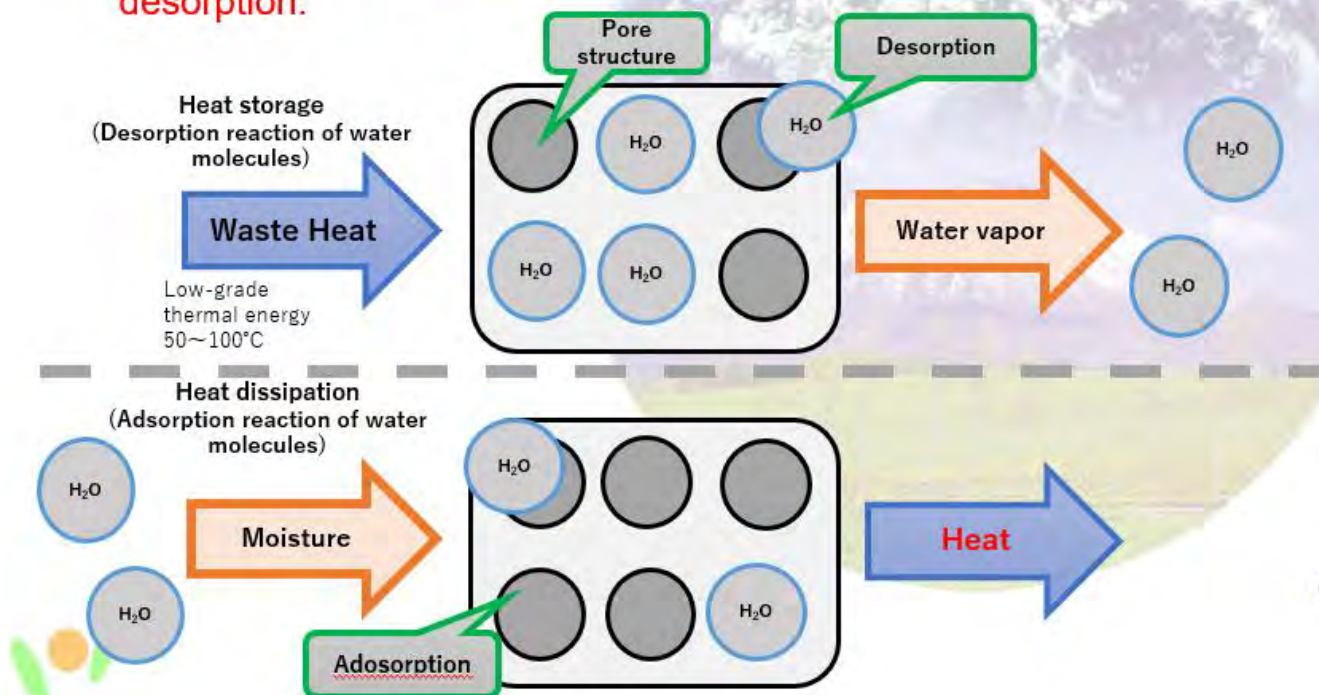


## Commercialization and fundamental research of waste heat recovery technology using adsorption heat storage materials

Higas

HASClay® is an inorganic adsorbent material composed of a composite of amorphous hydroxyl aluminum silicate (HAS) and low-crystallinity clay.

HASClay® has the ability to store thermal energy with the principle of energy transfer by water vapor desorption.



HASClay

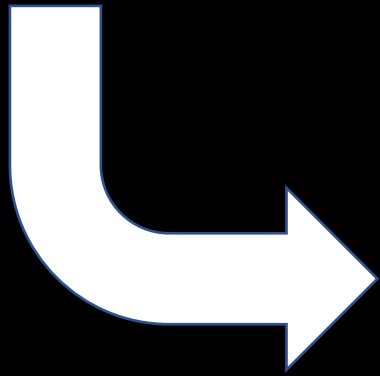


The appearance of HASClay®  
(Developed by Masaya Suzuki of AIST)

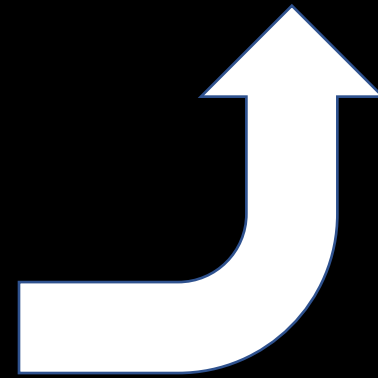
Stores low grade (50~100°C)  
thermal energy



Waste/low  
grade heat  
50°C



HASClay

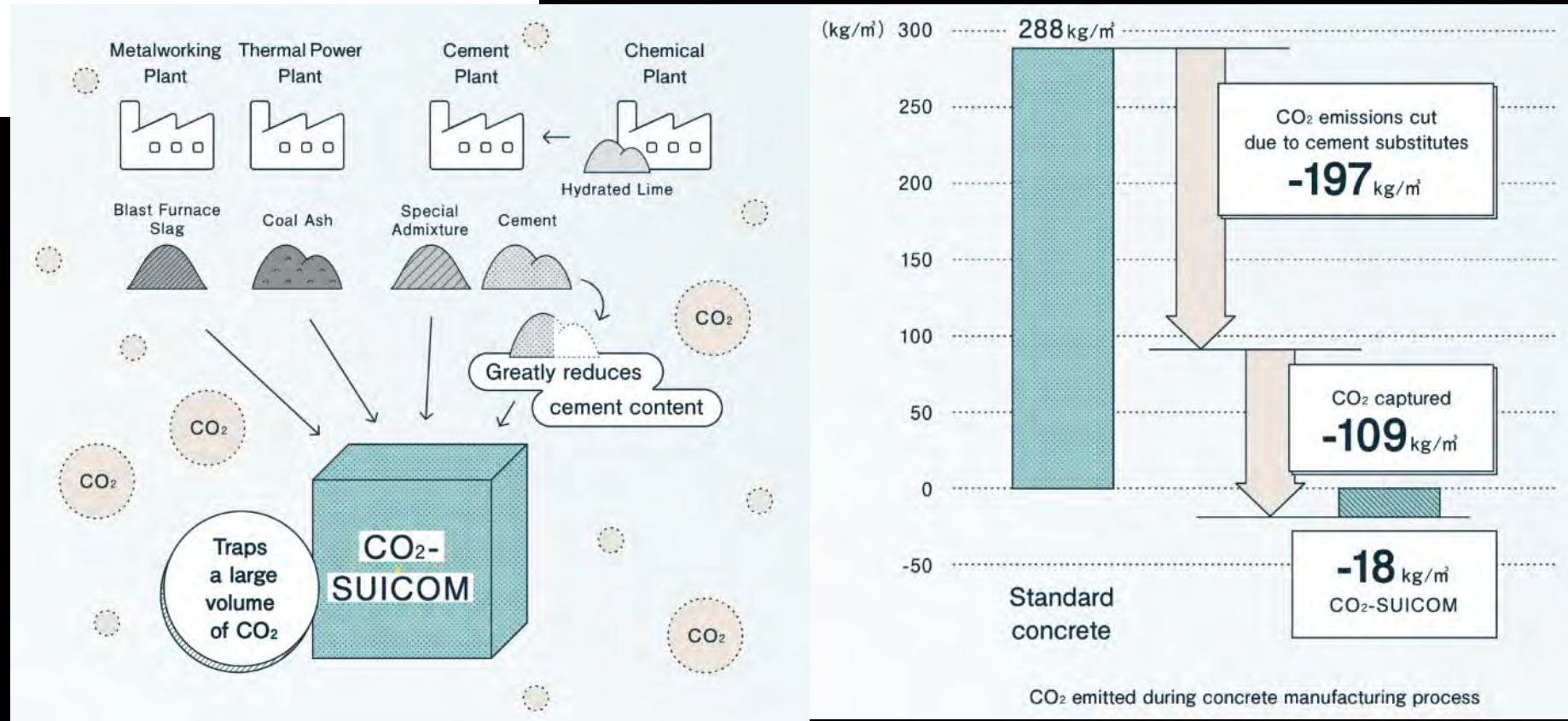


~40km



# The Future of Construction: Carbon-Negative Concrete for a Greener Tomorrow

Kajima Corporation  
Dr. Kumar Avadh (PhD. University of Tokyo)  
Research Engineer



# Summary

- Long history of industry – academia collaboration
  - Industry Help/Support -> Participation/Involvement
  - Industry/Sustainability sessions have been indispensable in LC workshops over the last decade.
- Sustainability has been a recent key word
- Collaboration with companies in ILC candidate site in Japan is very active