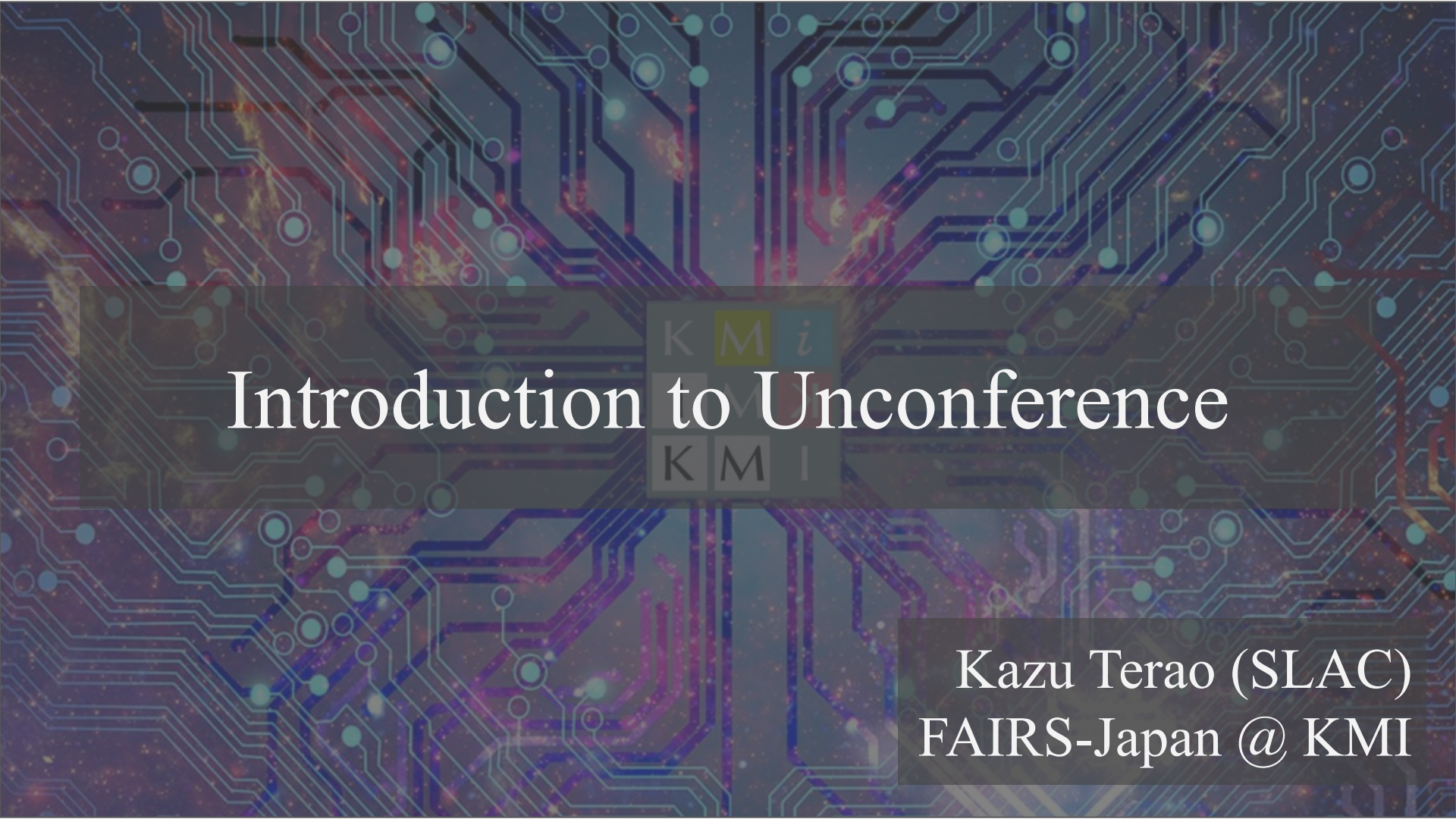




Introduction to Unconference

K M I

K M I

Kazu Terao (SLAC)
FAIRS-Japan @ KMI

Goal of the workshop

- A white paper that summarizes the outcome of the workshop
 - Impactful scientific challenges
 - AI/ML research directions to address them
 - Potential areas of collaboration across domains
 - Build research plan for identified cross-domain AI topics
 - Analyze how that plan fits in the current projects vs. new proposal

Step 0: Split!

- **Cosmology and Astrophysics**

- Haley Bowden, Nhat Minh Nguyen, Sung Hak

- **Neutrino Physics**

- Takuya Tashiro

- **Collider Physics**

- Sourav Dey, Tianji Cai, Petar Rados

- **Accelerator Physics**

- Fumihiko Tamura, Takahiro Nishi

Unconference Step-by-Step Guide

Goal of the unconference sessions

- The goal: capture everyone's input to build the core of the white paper

How?

1. Form small groups: 3-5 people per group
2. Group discussion: everyone say/share something in the group
3. Group presentation: connect your ideas with other groups = everyone
4. Session report: consolidate a summary from all groups

Four sessions

- Session 1: identify and understand challenges in your area of physics
- Session 2: brainstorm potential AI/ML applications to address challenges
- Session 3: brainstorm steps to realize solutions and find synergies
- Session 4: group by identified common AI topics and develop R&D plan

Step 1: Form groups (5 minutes)

Session leads lead this process. 5 minutes. Go!

- Session 1: randomly form 3-5 people per group within your frontier
- Session 2: same group as the session 1
- Session 3: form groups across the frontier

Step 2: Group discussion (about 50 minutes)

Each group answer 4 charge questions + summarize the answers in a “quad chart”

1. Meet the members and introduce :)
2. Open your session's google drive
3. Copy the “template” quad chart
4. Group discuss and answer questions
5. Summarize answers in the chart

09:00	Scientific Challenges: Unconference Introduction				Kazuhiro Terao
	ES635, Nagoya University				09:00 - 09:20
	Group II: Astro and Cosmology	Group III: Accelerator Physics	Group IV: Collider Physics	Group I: Neutrinos	
10:00	ES621 09:20 - 10:20	ES735 09:20 - 10:20	ES606 09:20 - 10:20	ES635, Nagoya University 09:20 - 10:20	
	Group III: Discussions	Group I: Discussions	Group II: Discussions	Group IV: Discussions	
	ES735 10:20 - 10:50		ES621 10:20 - 10:50	ES606 10:20 - 10:50	
11:00	Coffee Break				10:50 - 11:10
	ES635, Nagoya University				
	Summary for Accelerator Physics				Fumihiko Tamura et al.
	ES635, Nagoya University				11:10 - 11:40
	Summary for Collider Physics				Peter Rados et al.
12:00	ES635, Nagoya University				11:40 - 12:10

Navigate Through

Google Drive

Quad Chart Example For Session 1

Links to templates in [session 1](#), [session 2](#), and [session 3](#)

Session 1: Identify critical research challenges in science domains

1. What are the critical research challenges and their scientific impacts?
2. What are the nature of the challenges (why is it difficult)?
3. What are the current and/or past approaches? What are the issues with them?
4. Were they identified at FAIRS-Japan 24'? What has changed/made progress?

To-do's:

- In your group, copy this template, fill the quad chart (next slide) with answers.
- Have your group present the quad chart to other groups in the same session
- Work with all participants in your session to consolidate ideas from all groups

- **FAIRS2024 White paper:** <https://arxiv.org/pdf/2608.27807>

Accelerator physics

- **Design optimization:** high-fidelity accelerator simulations can take thousands of compute-hours, making systematic exploration of new accelerator configurations difficult. A particularly open problem is moving beyond optimizing fixed designs toward discovering genuinely new lattices, components, and beam-manipulation strategies.
- **Autonomous operation and control:** modern accelerators contain thousands of subsystems and millions of monitored variables. The challenge is not just finding an optimal configuration, but maintaining it as machine conditions drift because of aging, environment, and other effects.
- **Fault prediction and recovery:** detecting anomalies early enough to avoid interruptions or hardware damage, while distinguishing genuine failures from benign fluctuations.
- **Virtual diagnostics and information reduction:** reconstructing quantities that cannot be measured directly, including the full six-dimensional beam phase space, and reducing enormous streams of machine information into something operators can use.

Cosmology and astrophysics

- **Intractable inference:** Bayesian forward modeling is conceptually appropriate, but likelihoods can be intractable and sampling becomes prohibitively expensive as the number of parameters and data complexity increase.
- **Systematic uncertainties:** effects such as baryonic feedback, galaxy formation, photometric-redshift uncertainty, selection effects, dust, intrinsic alignments and lens modeling increasingly dominate as statistical uncertainties shrink.
- **Using information-rich nonlinear scales:** large cosmological scales are theoretically cleaner but contain less information, while small scales contain much more information but are entangled with poorly modeled nonlinear and astrophysical effects.
- **Simulation limitations:** observations are incomplete and simulations are approximate, so validating models exclusively against simulation can itself become a source of bias.
- **Discovery of unexpected phenomena:** rare transients, unusual lenses, novel source populations or new physics must be found among huge backgrounds of ordinary astrophysical phenomena and instrumental artifacts

Neutrino physics

- **High-dimensional event reconstruction:** infer neutrino energy, direction, flavor and interaction topology across very different detector technologies and energy regimes.
- **Fast, accurate and unified simulation:** neutrino interactions, hadronic propagation and detector response all need to be modeled together, but the simulations are computationally expensive and imperfect.
- **Systematic uncertainties and simulation-to-data differences:** imperfect models of neutrino-nucleus interactions, detector response and hadronic interactions directly limit physics measurements.
- **Limited calibration information:** some relevant detector conditions, energies and event topologies cannot be adequately covered by calibration or test-beam data.
- **Rare-event detection:** examples include supernova neutrinos and other low-rate processes hidden within large backgrounds and detector noise.
- **Experimental optimization:** detector geometry, beam configurations, calibration strategies and analyses form very large parameter spaces that currently depend substantially on expert-driven optimization.

Scientific Challenges & Impacts

Nature of Challenges: Why Difficult?

Current/Past Approaches and Issues

Identified in 24'? Why not / Progress made

Step 3: Group Presentation (5 min x number of groups)

In each session, every group presents the quad chart(s)

- Questions/Discussion after every group presentation
- Session leads will have to consolidate ALL quad charts.
 - Take notes and ask questions to understand fully!
- Aim for 5 minutes per group!

Step 3.5: Coffee Break! (25 minutes)

Everyone comes back to the main room

Session leads consolidate all group reports to build the session summary

Everyone else enjoy a coffee break

Step 4: Session Report (20+10 minutes x 3 sessions)

Facilitators present the summary from all groups to the whole workshop.

Everyone in the workshop: comment/question

- Make sure your input is included
- Engage and learn about what other sessions have discussed

Questions?

Ready to Unconference?