

HISTORICAL OVERVIEW OF KGWG AND ITS FUTURE

**10th Anniversary of the Discovery of Gravitational Waves and
KGWG Assembly Meeting**

August 27-28, 2025

Hyung Mok Lee (SNU)

My involvement in GW: The third LISA Symposium at Golm (July 2000)

Kip Thorne
Rainer Weiss
Ronald Drever
Bernard Schutz
Bangalore Sathyaprakash
Fred Raab
Karsten Danzmann
Sterl Phinney



Korean Gravitational Wave Group

- Started as a voluntary study group composed of ~ 20 members
- Kick-off meeting of working group was held on: November 21, 2003 (no photo exists)
 - Among participants, Matt Choptuik (UBC), van Putten (MIT)
- Supercomputer Center at KISTI immediately began to support by providing small funds for meetings, and opened a position.
- Numerical Relativity Sub-Group led by Gungwon Kang (KISTI, Currently at ChungAng Univ.)
- Organized a series of summer school on numerical relativity and gravitational waves since 2005
- Sept. 2009 : Presentation in LSC meeting at Budapest. LSC Council approved our proposal
- MOU signed during the LSC Meeting in March 2010
- 2011: KAGRA participation
- 2017: Successful observations of the optical counterpart of GW170817
- 2018: Inauguration of the experimental group at KASI

Early Activities: Numerical Relativity and Gravitation Meetings

- **Preparatory Meetings**

- APCTP topical research program 8th GWWG meetings (중력파 연구모임)
 - December 03-04, 2004, at SNU
- APCTP Topical Program "Astrophysical Sources of Gravitational Waves"
 - December 22-23 at Kunsan (군산 갯벌 연구센터)

- **Numerical Relativity and Gravitational Meetings**

- The first meeting on 2005-06-28 @ KISTI
- Six times in 2005 mostly at KISTI
- 7th - 15th in 2006
- 16th - 23rd in 2007
- 24th - 28th in 2008
- Still continues

(International) Schools on NR and GW

- Schools supported by APCTP
- 2008 Summer School on Computational Methods in Gravitation and Astrophysics
- July 28 - August 1, 2008
- Gaby Gonzalez visited SNU after this school
- 2009 International School on Numerical Relativity and Gravitation
- December 7 - 11, APCTP Seoul Branch Office
- Most recent school: July 28-August 1, 2025 at KASI



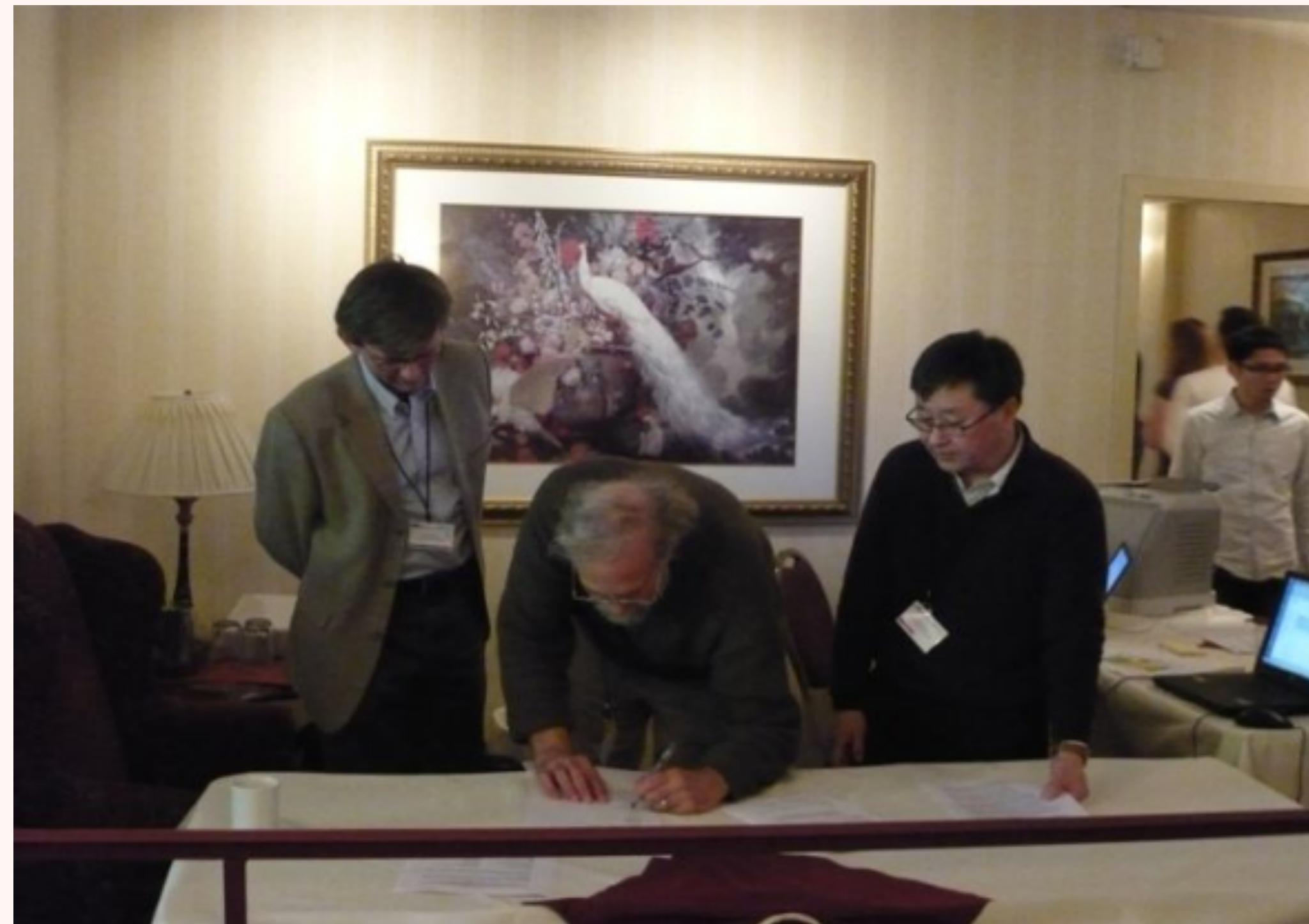
Pre-LSC activities in 2009

- Visits to LSU (Jan. 28-31, 2009), and UWM (Jan. 31-Feb. 3, 2009) Visit to Louisiana State University,
- Gungwon Kang, Changhwan Lee, Hyung Mok Lee
- Hosted by Gaby Gonzalez and Patrick Brady
- Mainly discussed how to join LSC
- Also visited LIGO Livingston
- US-Korean Conference (UKC) 2009
 - Raleigh, North Carolina, July 17-19
 - One session was dedicated to gravitational waves



LSC Meeting in September 2009 at Budapest

- KGWG was invited to give a presentation for joining the LSC at 2009 LSC Meeting in Budapest
- September 21- 24, 2009
- Hyung Mok Lee gave a presentation during the plenary session
- Main point:
 - KGWG will provide computing resources through GSDC facilities
 - Also KGWG members will be participating data analysis efforts
- Major concern: how to overcome time differences to join various telecoms?
- Our proposal was approved by the council.



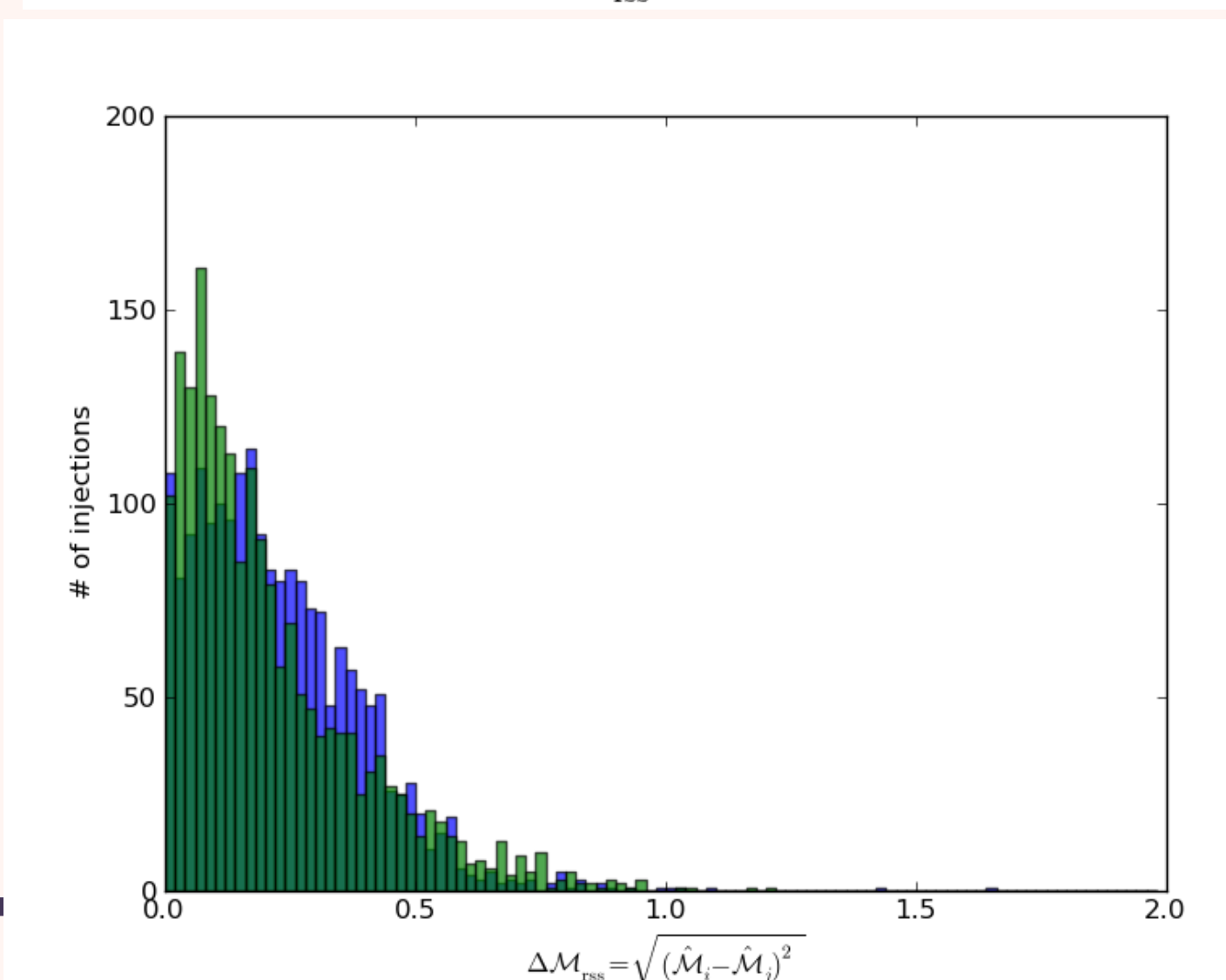
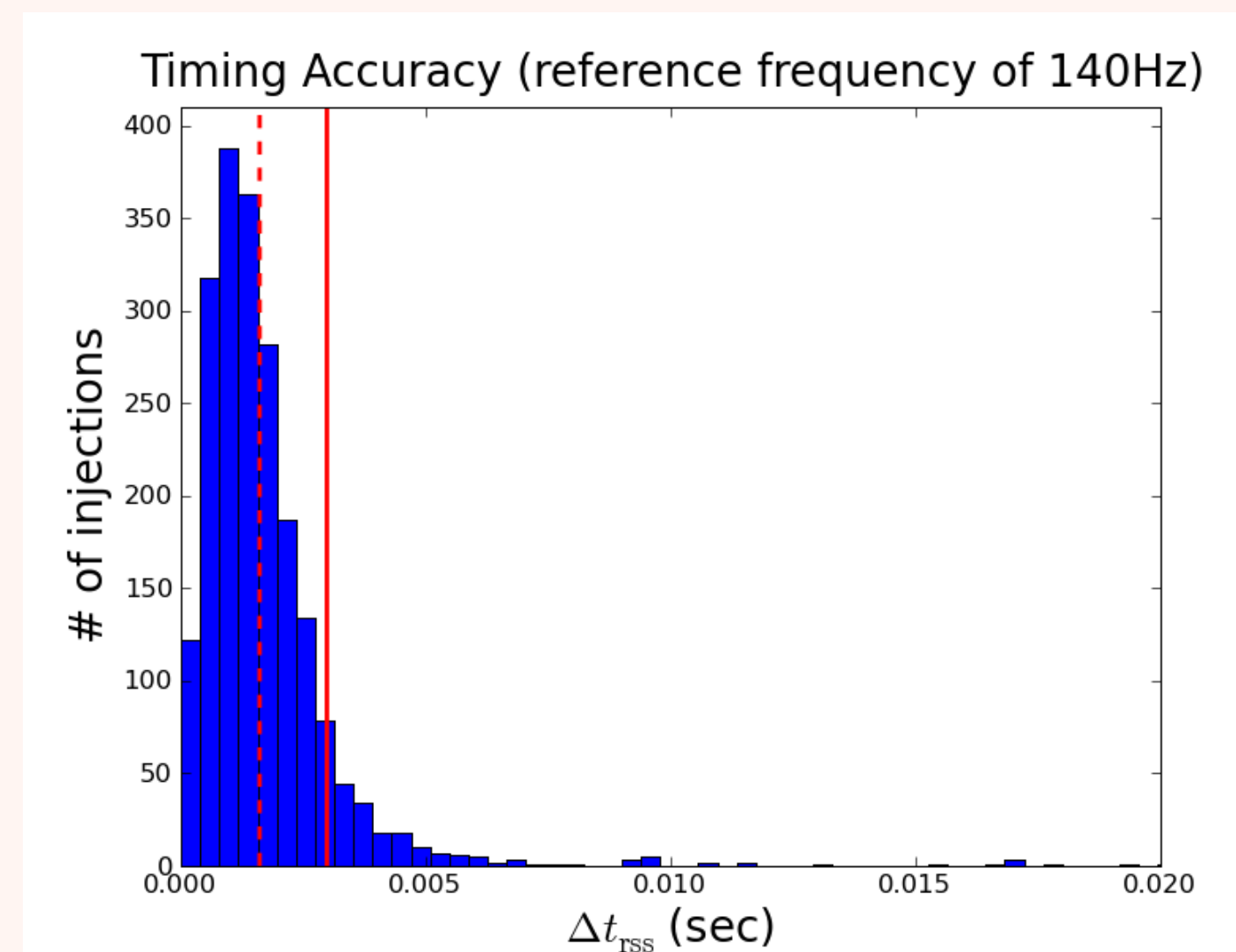
Signing of the first MOU in 2009 (Dave Reitz & Jay Marx), mostly a ceremonial purpose

Sketch of the 2009 Budapest Meeting



Early Works in LSC

- We sent out three students to US
 - Sky localization (오상훈 [NIMS])
 - Parameter Estimation (오상훈 [NIMS])
 - GRB Search (김경민 [한양대])
 - Data Quality Investigation (조희석, 김영민 [부산대])
- These three students became main drivers of GW research activity, especially in the area of data analysis.



Participation in KAGRA

- KGWG joined in LCGT Project (later renamed to KAGRA) at the KGWG-LCGT Joint Workshop held on Jan 21, 2011 at SNU
- 12 members are admitted to LCGT collaboration at the Face-to-Face meeting in August 2011
- Currently, there are more than 20 KAGRA members from Korea
- Eight Korea-Japan joint workshops have been held from 2012 to 2015
- As KAGRA collaboration grows, KJ workshop was transformed to KAGRA International Workshop (KIW) Series.
 - First KIW was held at KISTI on June 23-25, 2016.
 - The latest KIW meeting series continues



The 3rd Korea-Japan Workshop on Dec. 21, 2012@Sogang Univ.

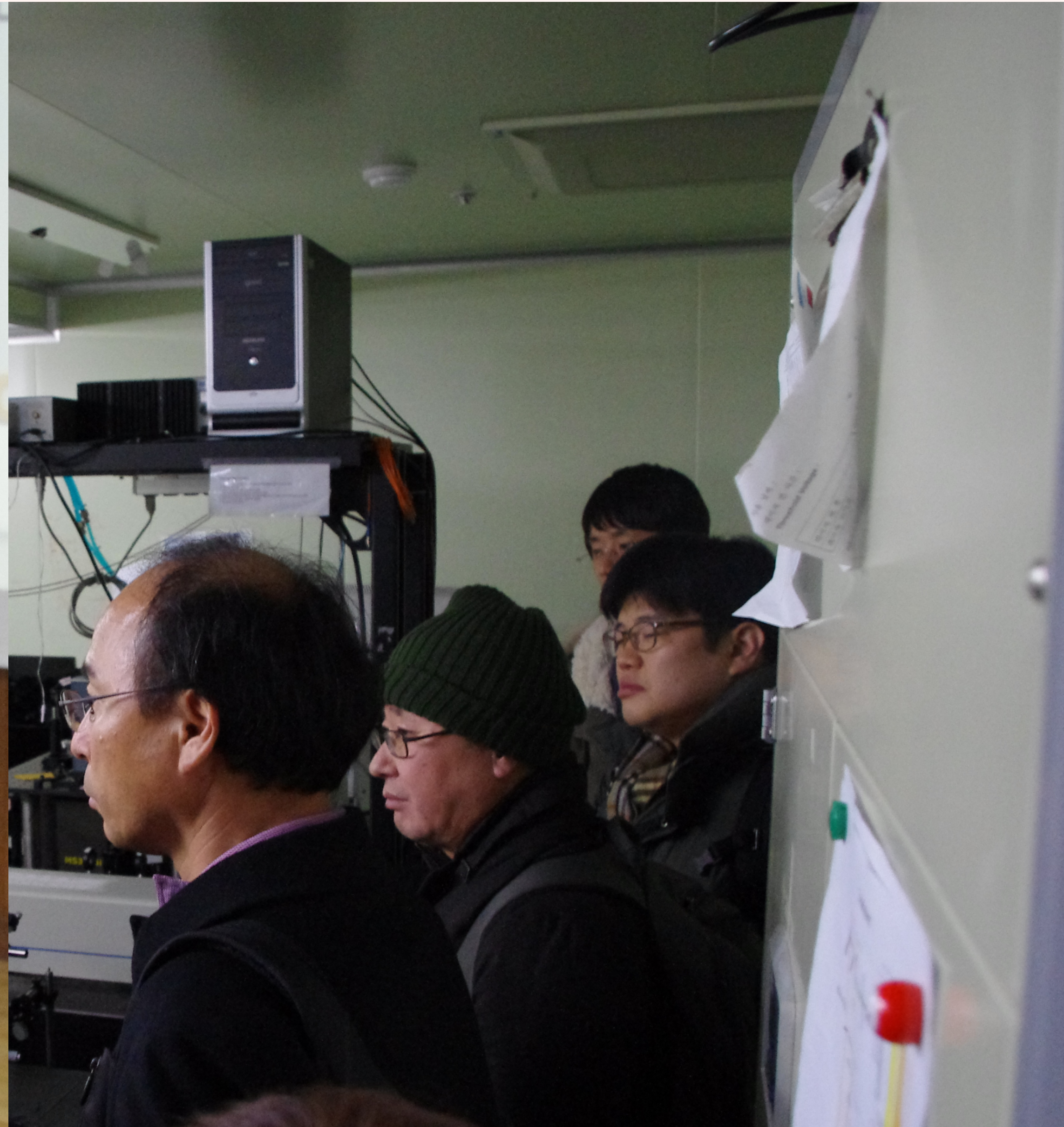


Early KAGRA Meetings: 2012-12-Sogang

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Early KAGRA Meetings: 2013

KAGRA Members

- Tai Hyun Yoon (Korea Univ.), Young Ho Cha (KAERI)
 - Laser
- Kyuman Cho (Sogang Univ.)
 - Interferometer
- Jaewan Kim (Myungji Univ.)
 - Seismometer
- H. M. Lee (SNU), G.W. Kang (KISTI), Changwan Lee (PNU)*, Hyung Won Lee (Inje Univ.)
 - Data Analysis
- John Oh, Sang-Hoon Oh, Edwin Son (NIMS) *
 - Detector Characterization

* Also LSC



The 5th Japan-Korea Joint Workshop on KAGRA

November 29 – 30, 2013 Seoul National University, Seoul, KOREA

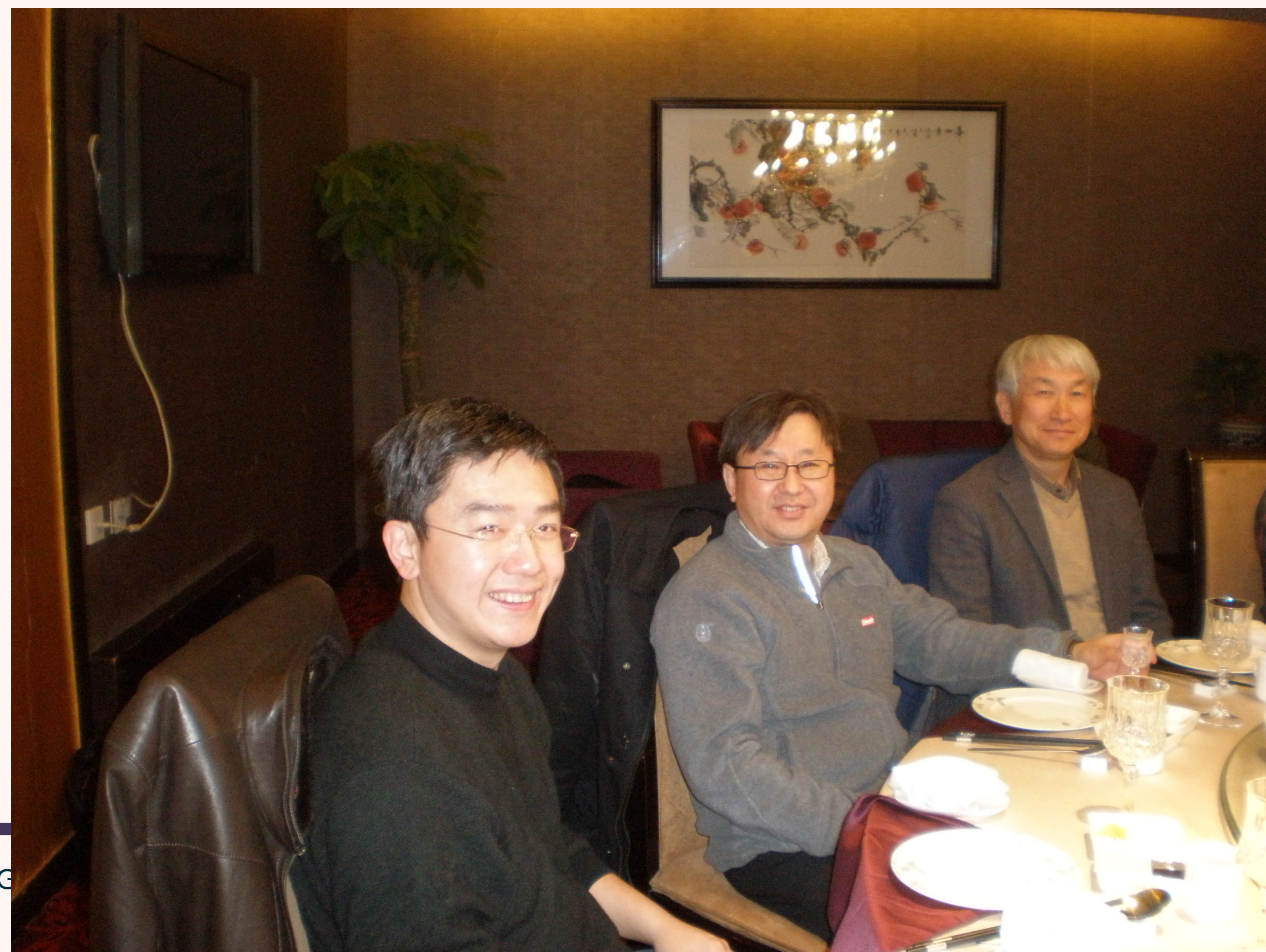
August 27-28, 2023

2015 at Gwangju, just after Amaldi-2015



Efforts to Collaborate with Chinese Colleagues: visit to Beijing in December, 2010

- Rainer Spurzem at NAOC
- Junewei Cao at Tsinghua University



KCK (Korea-China-Kazakhstan) meeting at SNU: 2012-12-17



2015-04 in Beijing, Meeting at KITPC



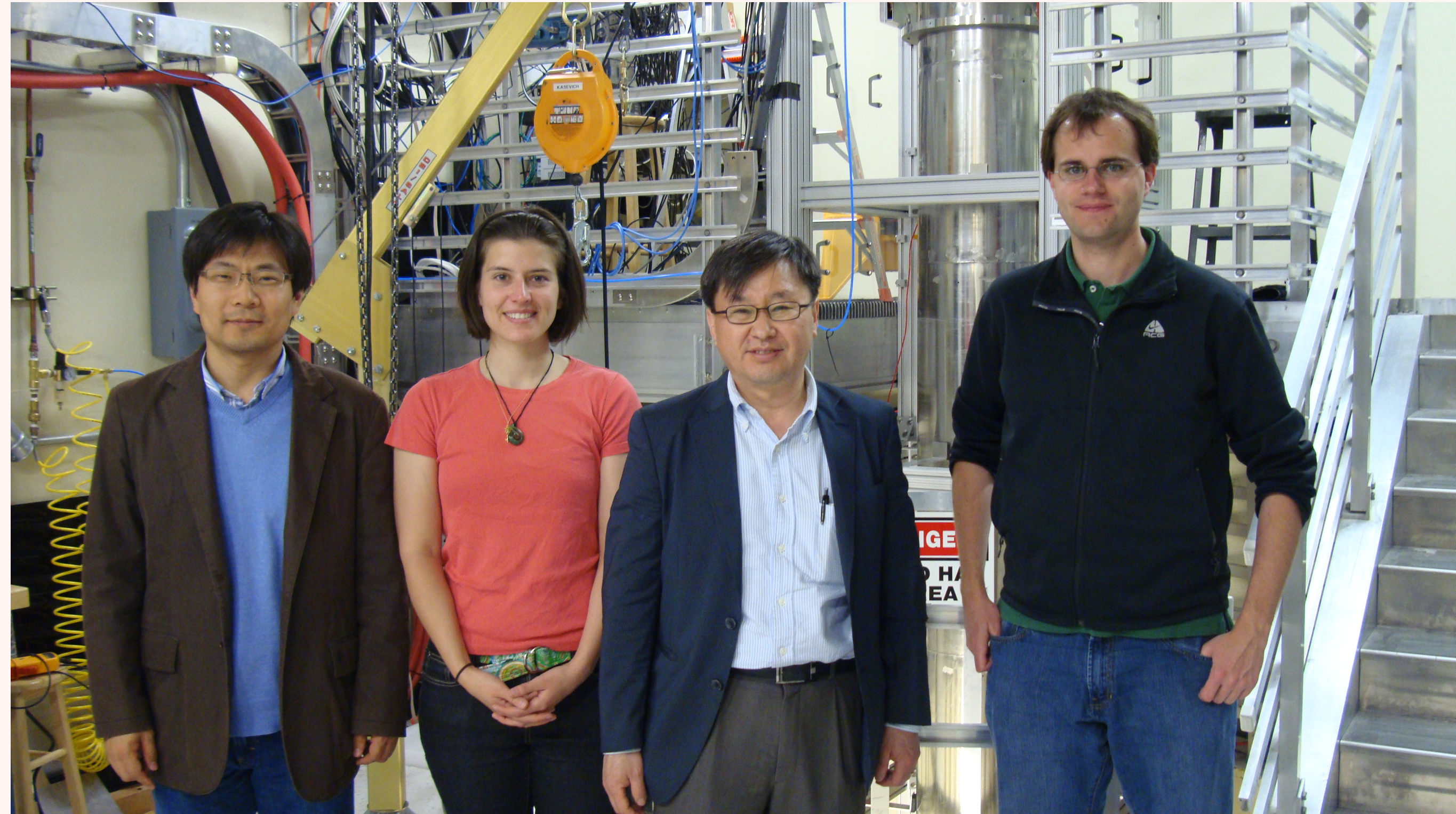
Efforts for IBS proposal: 2011-12 in Alpensia

- IBS (Institute for Basic Sciences) is a government-funded research institute that conducts basic science research and relevant pure **basic research**.
- It was established in 2011
- KGWG wanted to have an establishment at IBS.
 - Experiment should be a key ingredient
 - KGWG started a series of brain-storming meetings for new concepts for the GW experiments
- Very first meeting on Atom Interferometry: Dec, 2011 at Alpensia Resort
 - Experimentalist
 - Theory and detector concept: Suejeet Rajendran at Stanford University



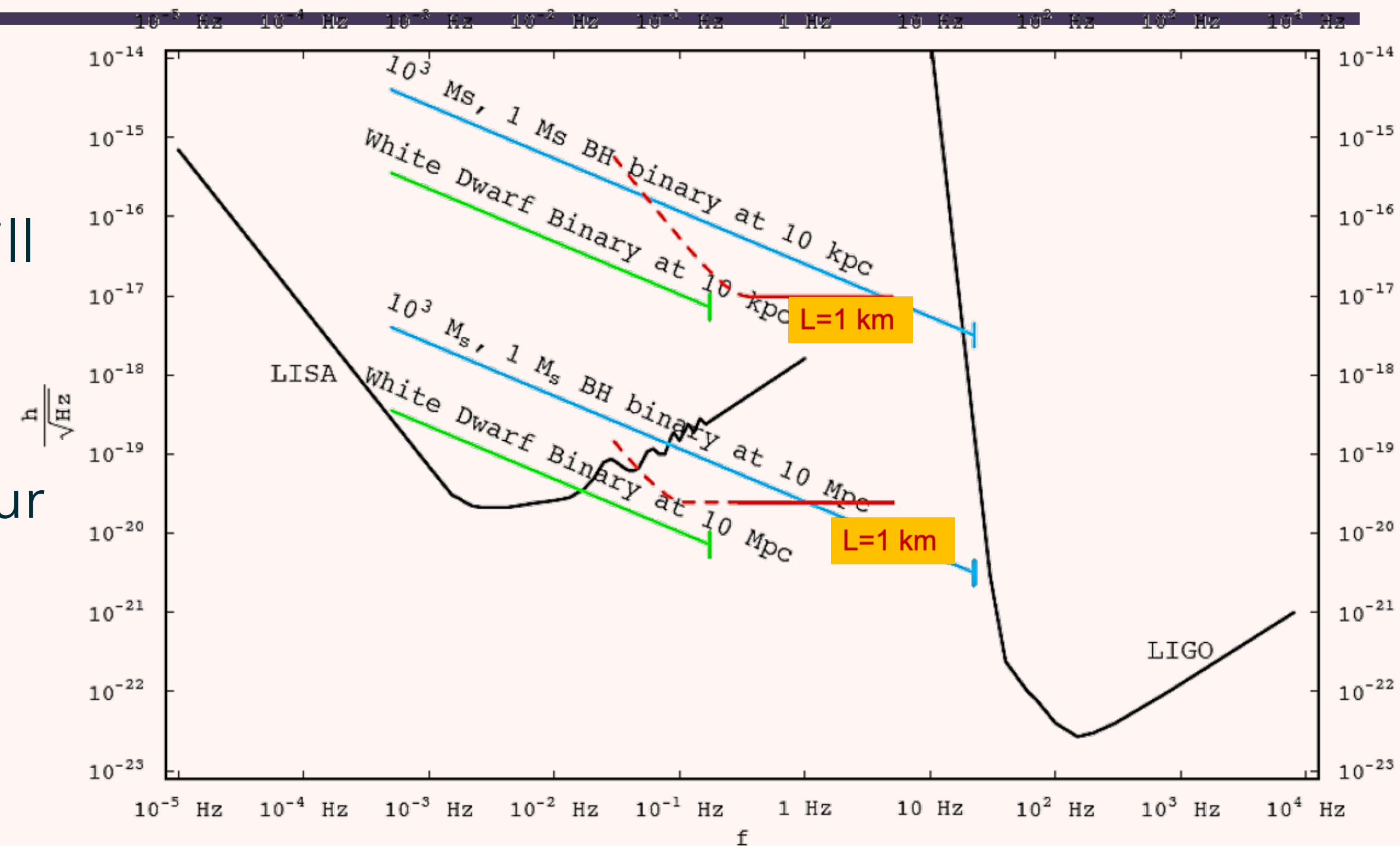
Visit to Stanford Atom Interferometer Lab in 2012-04-

- We desperately need experimental project for IBS proposal and atom interferometer was regarded as a good candidate because there was an expert in Korea: Jaewan Kim at Myungji University
- He was on sabbatical at Stanford University's Mark Kasevich Group
- Gungwon and Hyung Mok Lee visited Kasevich Lab at Stanford in April 2012



IBS Proposal: first version in 2012

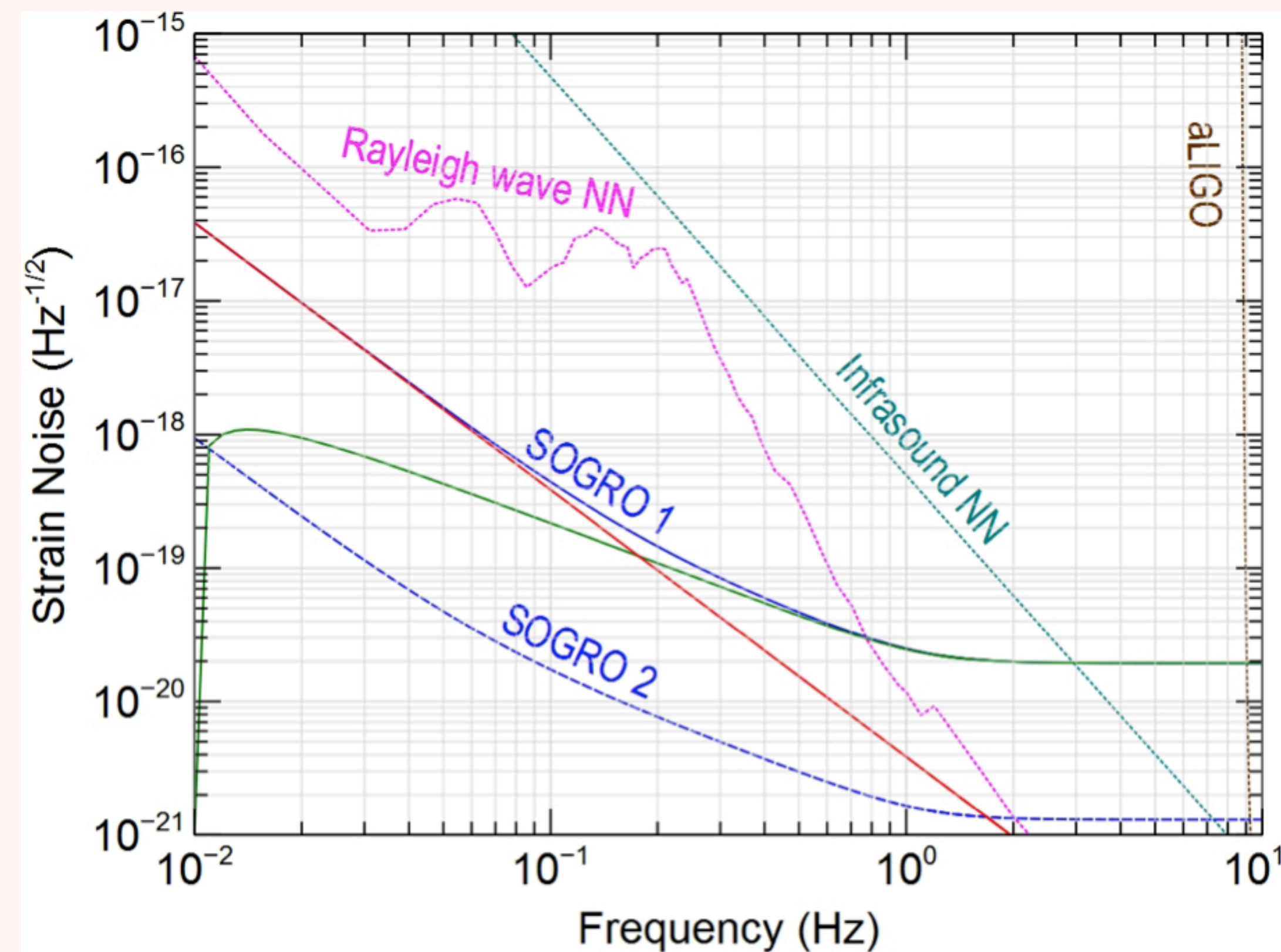
- There was no deadline, but IBS announced that they will have the second evaluation process during June - August, 2012
- In order to meet this schedule, we needed to submit our proposal by the end of May
- There was a meeting among 'astrophysicists' on May 8, 2012 at Daejeon.
- No consensus was reached: maybe there could be several proposals on astrophysics.
- GW community wanted to prepare atom interferometry based detector construction
- First proposal was submitted on May 31 with broad range of research topics covering experiments, theory, data analysis and astrophysics.



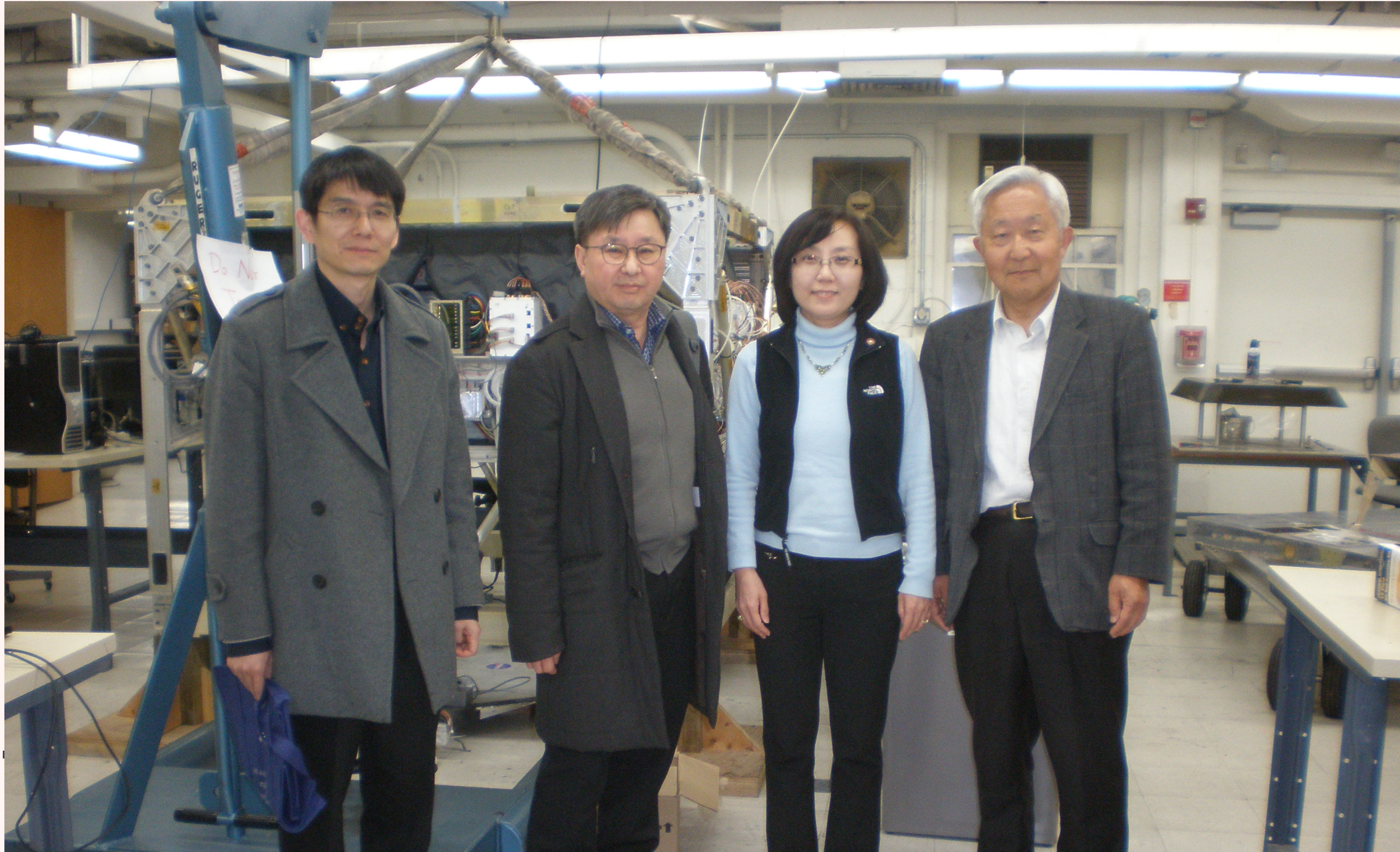
- (1) Next Generation Detector Subgroup:
 - a) Develop atom interferometer GW detectors
 - b) Develop frequency measuring Fabry-Perot GW detector (FMGWD)
 - c) Carry out basic research on other types of the next generation detectors.
- (2) Laser Subgroup
 - a) Develop high precision phase-locked laser system for atom interferometer
 - b) Supply other laser sources for atom interferometer
 - c) Develop clean high power laser for KAGRA
- (3) Data Analysis Subgroup
 - a) Develop data analysis strategy and pipelines for atom interferometer
 - b) Analyze the noises for the atom interferometer
 - c) Carry out analysis of LIGO/VIRGO data
- (4) Electro-Magnetic Subgroup
 - a) Carry out reverberation mapping of galaxies in redshift between 1 and 2.
 - b) Measure the mass of the black holes for galaxies at redshift up to 7.
 - c) Develop models for the growth of the black holes in cosmic time
 - d) Carry out GRB/Supernovae research based on transient surveys
- (5) Theory subgroup
 - a) Numerical relativity
 - b) Cosmological aspect of GW
 - c) Physics of Compact objects

The Second IBS Proposal: 2014, revision in 2015

- The first proposal was declined soon after the submission.
- We came to know Prof. Hojung Paik at Univ. of Maryland
- He worked for the development of gravity gradiometer based on superconductor technology.
- If the gravity gradiometer becomes very sensitive, it can detect the gravitational waves.
- The GW detector concept was called SOGRO (Superconducting Omni-directional Gravitational Radiation Observatory)
- We submitted another proposal, to construct SOGRO in 2015.
- It was also turned down again, but KGWG Community continues to work on this concept.



2013-03, meeting with Prof. Hojung Paik at Maryland



International Meetings Organized by the KGWG

- **Gravitational Waves: New Frontier**

- Jan. 16-18, 2013 at Seoul National University
- Supported by the Korean Academy of Science and Technology (KAST)
- ~100 participants

- **The 11th Edoardo Amaldi Conference**

- June 21-26, 2015 at Gwangju
- Last Amaldi Conference before the first detection of the GW
- ~140 participants
- Public lecture by Bernard Schutz



Amaldi 2015

- During ‘Gravitational Waves: New Frontier’ meeting held at SNU in Jan. 2013, Stan Whitcomb (Caltech) mentioned the possibility of inviting Korea to GWIC.
- On June 4, 2013, Stan Whitcomb sent out ‘call for proposal’ for the 2015 Amaldi Meeting.
- Hyung Mok Lee notified our intent to host Amald-2025 to Stan on June 11.
- Hyung Mok Lee gave a presentation at GWIV meeting on June 14, 2013, during the Amaldi-2013/GR-2013 at Warsaw.
 - The presenters include Korea, Hungary and US.
- Later on that day, I was told the Korea was selected.

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11Th Edoardo Amaldi Conference on Gravitational Waves

June 21-26
Gwangju, KOREA

Report by Hyung Mok Lee (LOC Chair)
at GWIC
June 28, 2014



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11th Edorado Amaldi Conference on GRAVITATIONAL WAVES

June 21-26, 2015 GWANGJU, KOREA

www.amaldi11.org amaldi11@astro.snu.ac.kr

INVITED SPEAKERS

Eugenio Coccia (University of Rome "Tor Vergata", Italy)

Peter Fritschel (MIT, USA)

Jonathan Gair (University of Cambridge, UK)

Bala Iyer (ICTS, Bangalore, India)

Frederique Marion (LAPP, France)

Paul McNamara (ESA, Netherlands)

Samaya Nissanke (Radboud U, The Netherlands)

Ryan Shannon (CSIRO Astronomy and Space Science, Australia)

Masaru Shibata (YITP, Kyoto University, Japan)

Deirdre Shoemaker (Georgia Tech, USA)

LOC

Hyung Mok LEE (Seoul Nat'l U., Chair) | **Gungwon KANG** (KISTI) | **Sang Hoon OH** (NIMS) | **John J. OH** (NIMS)

Chang-Hwan LEE (Pusan Nat'l U.) | **Myeong-Gu PARK** (Kyungpook Nat'l U.) | **Sang Pyo KIM** (Kunsan Nat'l U.)

Seung Hee KO (Gwangju Convention Bureau) | **Hyunju NOH** (Seoul Nat'l U.) | **Eunjung OH** (Seoul Nat'l U.)

Keun-Young KIM (Gwangju Institute of Science and Technology) | **Naewoong Park** (Chonnam Nat'l U.)



First Detection: GW150914

- Soon after the Amaldi-2025, we learned the possible detection of GW on September 14, 2015
- KGWG prepared its own press conference on Feb. 12, 2006, in coordination with the LSC.
- The news was extensively covered by all kinds of media.

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Post detection LVC Meeting: 2016-03-Stanford



Awards/Prizes

- 2016-12 2016 Special Breakthrough Prize
 - 3,000,000 Dollars in total, \$1916.28 per person
- 2017.1. Gruber Prize in Cosmology
 - LIGO Team
- 2017-12. Korean Science Journalist Association, Award of the year



- 2016-12 2016 Special Breakthrough Prize
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- LIGO Team
- 2017-12. Korean Science Journalist Assoc

보낸 사람: **Hreha, Sarah** sarah.hreha@gruber.yale.edu
제목: 2016 Gruber Cosmology Prize - LIGO Team Members
날짜: 2017년 1월 5일 오전 1:36
받는 사람: hmlee@snu.ac.kr

SH

Dear Hyung-Mok Lee:

We are writing you in your role as a member of the LIGO team, to offer congratulations on being listed as part of the 2016 Gruber Cosmology Prize. As you may already know, the Prize was awarded last July at the 21st International Conference on General Relativity and Gravitation, to Ronald Drever, Kip Thorne, Rainer Weiss, and the LIGO Discovery Team, for pursuing a vision to observe the universe in gravitational waves, leading to a first detection that emanated from the collision of two black holes. The \$500,000 cash award was split evenly between Drs. Drever, Thorne, and Weiss. While we were unable to include individual team members in the prize award itself, we have added the list of 1000+ names provided to us by Drs. Thorne and Weiss to our website so that your inclusion is officially recognized. We understand this work to have been an incredible, collaborative effort and applaud the recognition it continues to receive.

The Gruber Cosmology Prize is awarded annually to honor a leading cosmologist, astronomer, astrophysicist or scientific philosopher for theoretical, analytical, conceptual or observational discoveries leading to fundamental advances in our understanding of the universe. The Prize recipients are chosen by the Cosmology Selection Advisory Board. Its 2016 members were: Andrew Fabian, University of Cambridge; Robert Kennicutt, University of Cambridge (Chair); Helge Kragh, Niels Bohr Institute; Sadanori Okamura, Hosei University; Frans Pretorius, Princeton University; Subir Sarkar, University of Oxford; and Rashid Sunyaev, Max Planck Institute for Astrophysics. Owen Gingerich of the Harvard-Smithsonian Center for Astrophysics and Martin Rees of the University of Cambridge also serve as special Cosmology advisors to the Foundation.

The citation to the 2016 Prize reads:

The Gruber Foundation proudly presents the 2016 Cosmology Prize to Rainer Weiss, Kip Thorne, Ronald Drever, and the entire LIGO team for pursuing a vision to observe the universe in gravitational waves, leading to a first detection that emanated from the collision of two black holes.

This remarkable event provided the first glimpse into the strong-gravity regime of Einstein's theory of general relativity that governs the dynamics of black holes, giving direct evidence for their existence, and demonstrating that their nature is consistent with the predictions of general relativity.

The team list, the official press release, and other information is available on our website, at: <http://gruber.yale.edu/prize/2016-gruber-cosmology-prize>

Again, congratulations on your wonderful science!

With warmest regards,

Sarah Hreha

- 2016-12 2016 Special Breakthrough Prize
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보낸 사람: **Hreha, Sarah** sarah.hreha@gruber.yale.edu
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2016-12-2016 Special Breakthrough Prize

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Efforts within Asia-Pacific Region

- October 2016
 - Rainer Weiss, Kip Thorn and Ronald Drever were named as Shaw Prize recipients.
 - Chinese university of Hong Kong (Jonnie Li) hosted a small workshop to commemorate this occasion and invited several people from Korea, Taiwan, India and Australia.
 - Korean participants: Hyung Won Lee, Sang Hoon Oh, Youngmin Kim, Kyungmin Kim, Hyung Mok Lee
- Discussion on Multi-band, Multi-Messenger GW astronomy effort discussion was held during the APCTP GW Workshop held at Institute of Physics, Academy Sinica in Taipei during April 20-25, 2025.



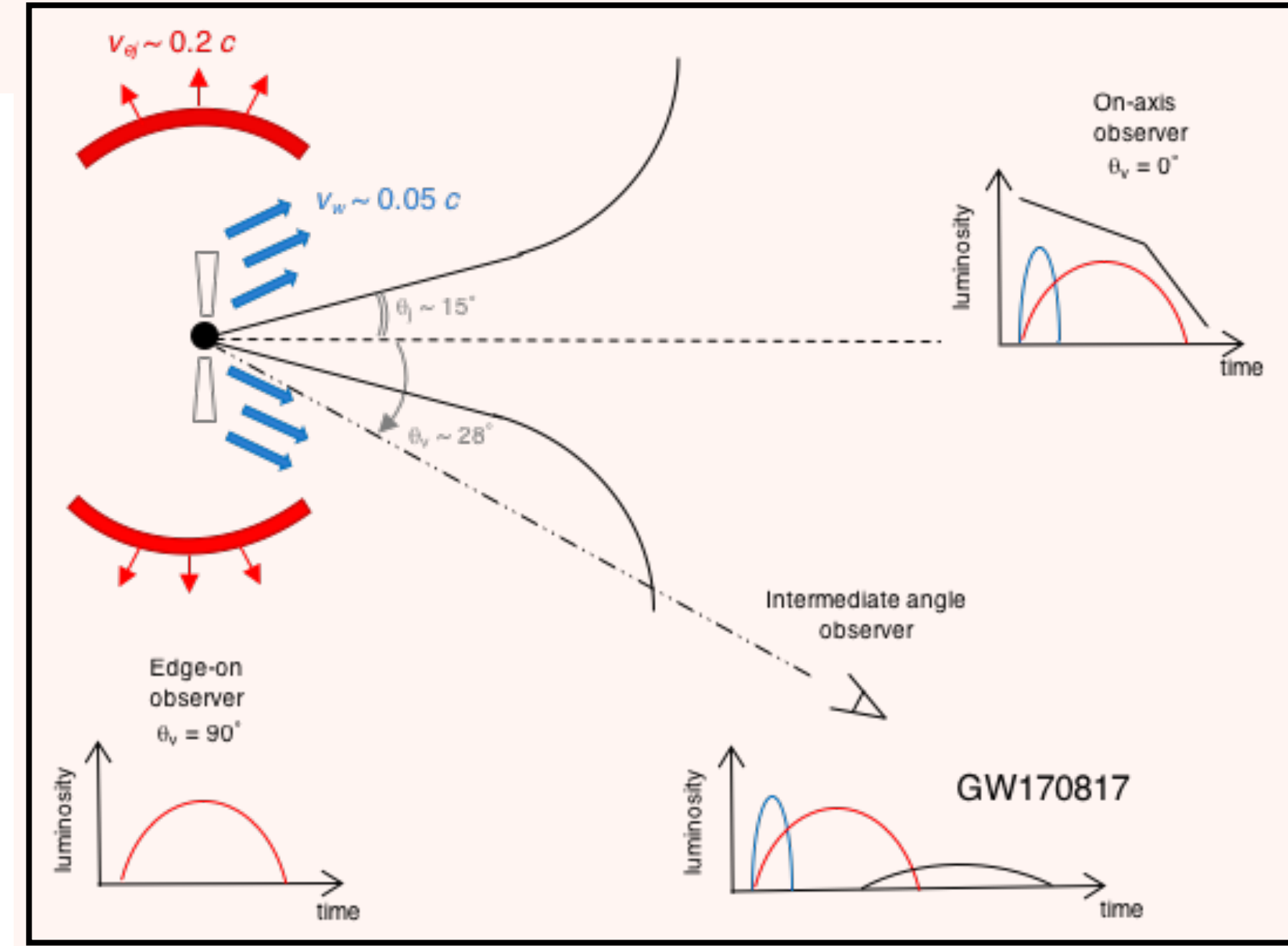
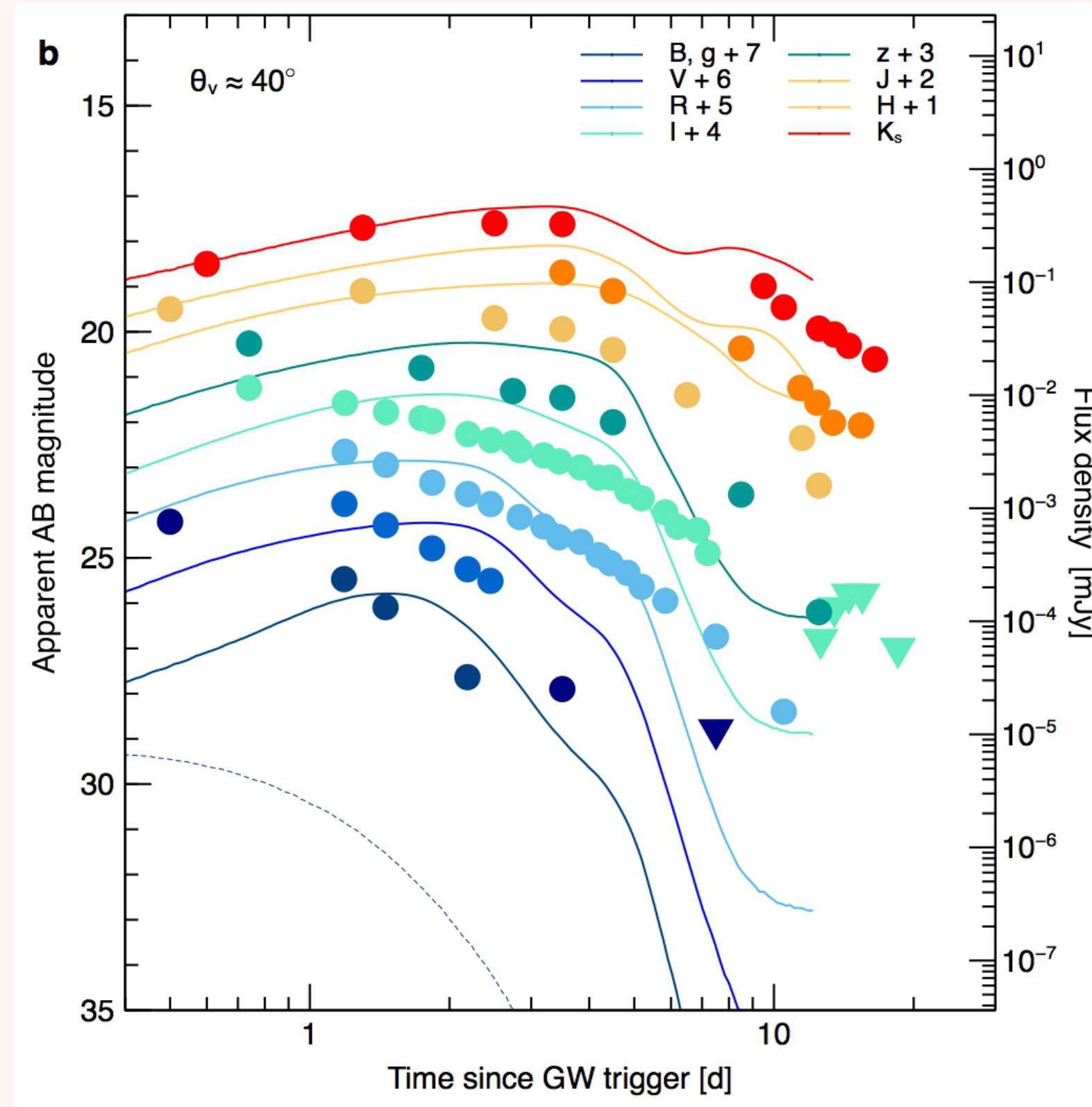
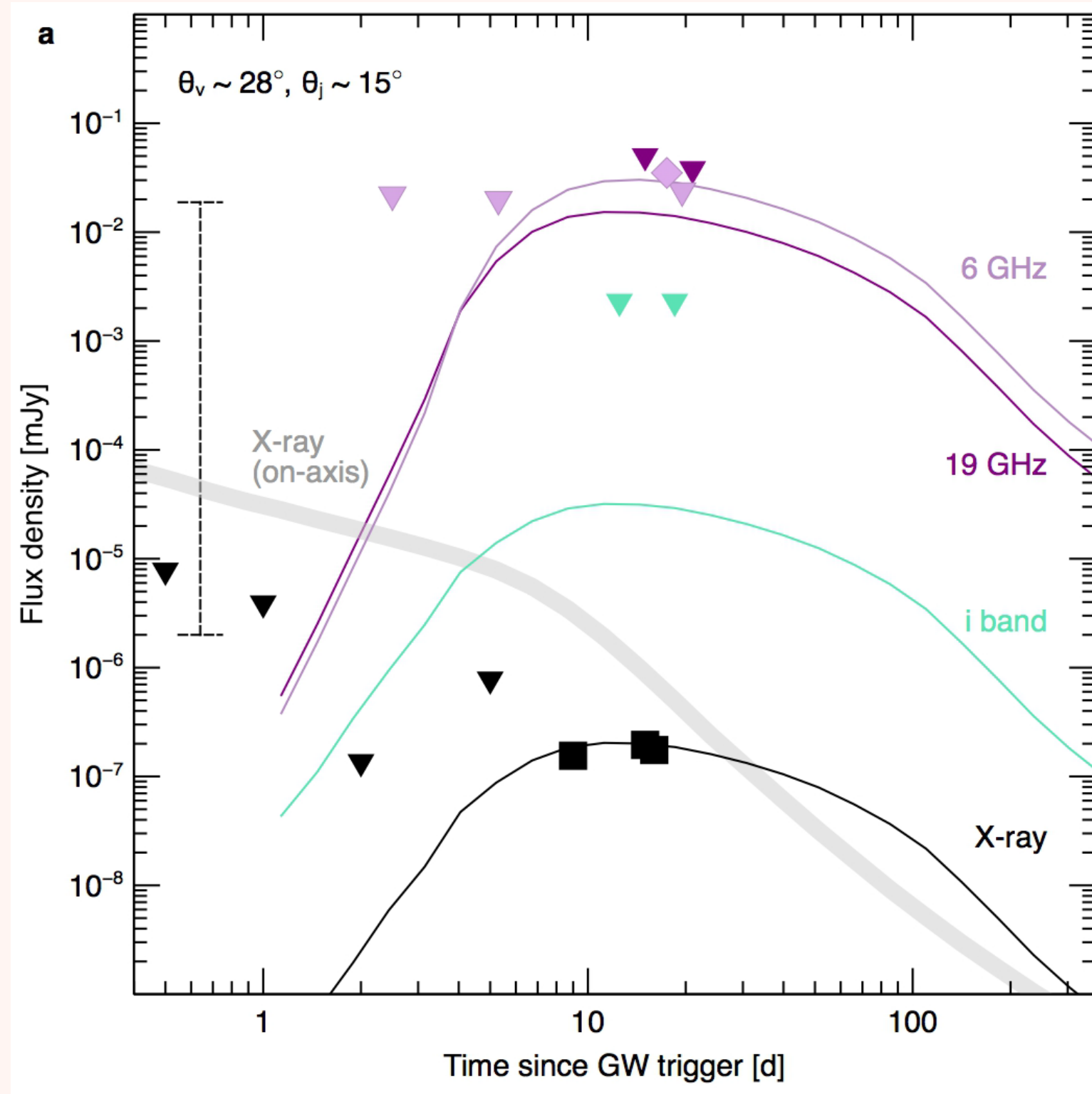
Left: Rainer Weiss (1932- August 25, 2025)

Multi-messenger Astronomy: GW170817

- Korean facilities were well located to do the followup observations for GW170817, and thus obtained accurate light-curves at various wavelengths



Multi-wavelength Light Curves



- **Red:** fast-moving neutron-rich ejecta (isotropic kilonova at IR)
- **Blue:** Neutron-free wind along the polar axis. Kilonova emission optical wavelengths. Not visible to edge-on observers as
- **Black:** Synchrotron radiation visible at radio, X-ray, and optical wavelengths.

Nature article by NASA/Korean group: constraints on jet angle

Experimental Groups

- KGWG had very limited experimental experts
- New group at **Korea Astronomy and Space science Institute (KASI)**, led by Sungho Lee from 2019
- Development of squeezing technologies for long wavelength lasers (1056, 1550, 2000 nm), together with KAIST
- Participating the EPR squeezing experiment led by Virgo
 - Development of mode cleaners and mode matching telescopes, together with Kyunghee University
- Collaboration with the KAGRA filter cavity project
- ET squeezed light working Group
- **SungKyunKwan University** led by Kyungha Lee
- Atomic structure characterization via TEM
 - Annealing the samples in the lab, and measuring the systematic atomic structure changes in the coating.
- Software developments for ePDFs.
- Other Groups
 - **SOGRO Study team**
 - **ENIGMA** (East-Asia Superconducting Gravity Measurement Network) at NIMS

Center for the Gravitational-Wave Universe

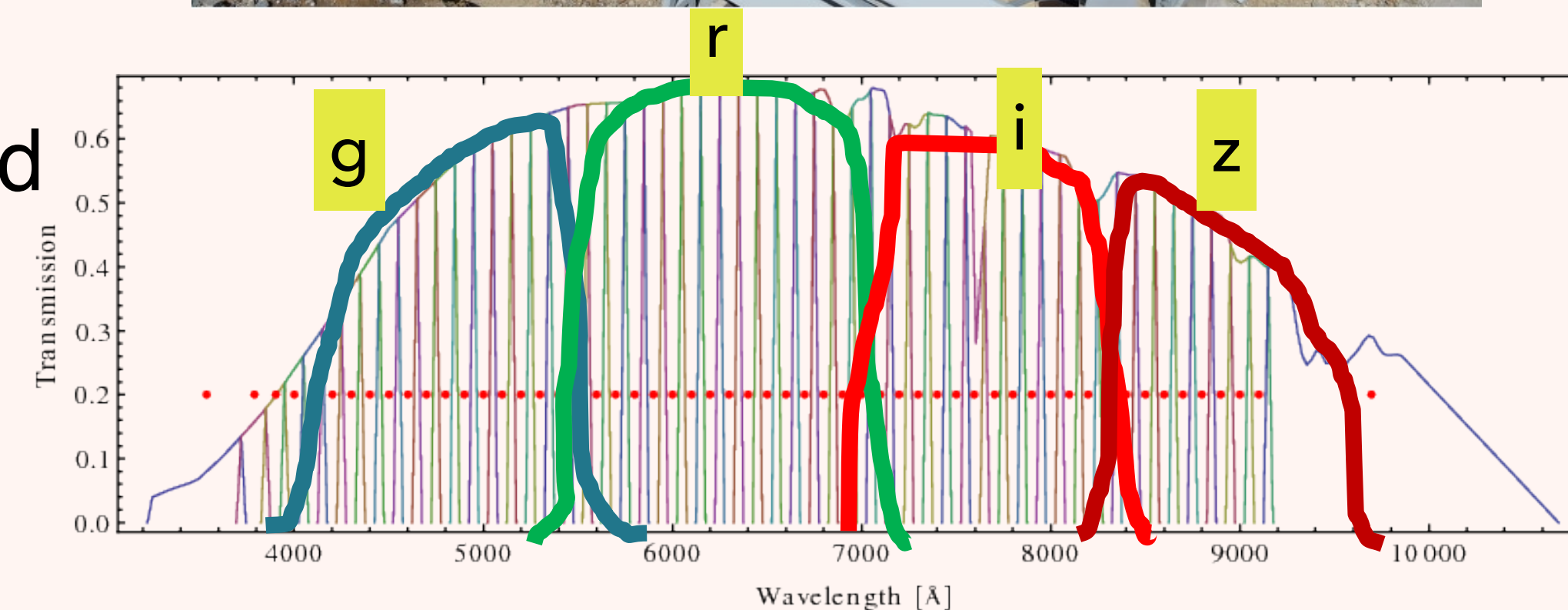
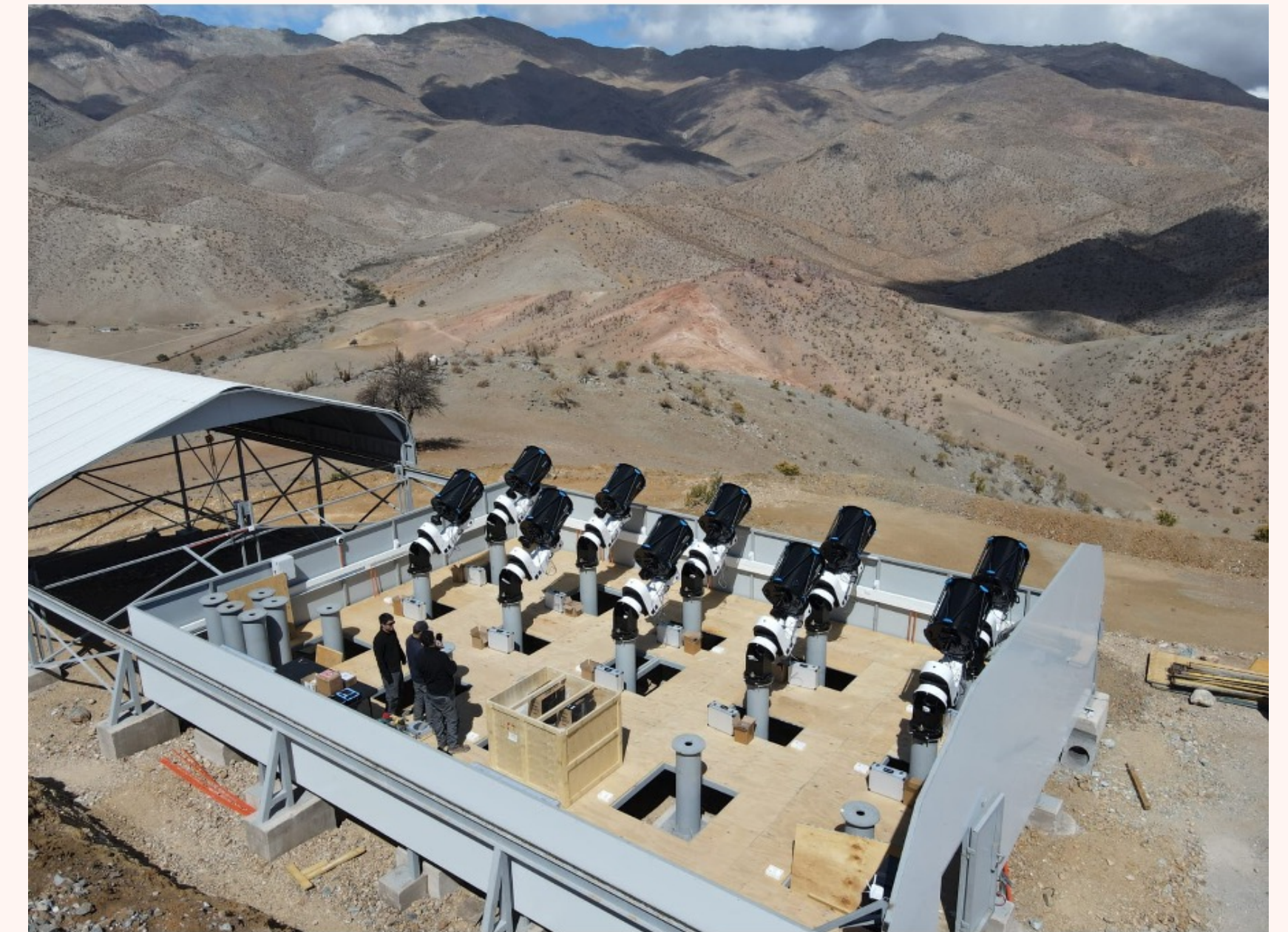
(<https://gwuniverse.snu.ac.kr>)

- A Research Center supported by the National Research Foundation, under the National Science Challenge Initiative program
 - Duration: July 1, 2021 - December 31, 2025
 - Annual Budget: 200 Million KRW/year (x 4.5 years)
- Aims:
 - Rapid identification of the afterglows from the merger of neutron star binaries for the identification of host galaxy and thus obtaining accurate and independent determination of Hubble constant.
 - Carry out theoretical studies for better understanding of GW sources, and EM counterparts.
- Human resources:
 - 6 Permanent members
 - 7 postdocs
 - Several Associate members

A new facility: 7Dimensional Telescope

- We are building a system of telescope composed of 20 telescopes of 50 cm aperture (\sim Effective $D \sim 2.2$ m if all telescopes are combined)
- Imaging wide field with 40 medium band filters (each telescope has 2) \rightarrow **low resolution spectroscopy** for every pixel in the field of view
- It can cover **large area** of sky repeatedly:
 - Wide-field, time domain, spectroscopic telescope
 - Suitable for the survey of transients such as GRB and Kilonovae and other surveys require large FOV and spectroscopic information
- 16 telescopes are installed

Photo courtesy of Myungshin Im



Future of KGWG

- Member:
 - KGWG started with a very small number of people.
 - It now has close to 100 members, but still relatively small
 - The growth depends on the level of funding and diversity of research areas
 - Experimental groups started recently.
 - Active participation in current and future detectors is necessary to increase experimental groups
- Involvements in future detectors: ET, CE, LISA, LGWA, DECIGO...
- Numerical relativity
- Machine learning
- Close collaboration within Asia-Pacific region