

# **Report of 4th ET symposium (Cryogenic)**

**Kazuhiro Yamamoto**

**Institute for Cosmic Ray Research  
The university of Tokyo**

**KAGRA domestic collaboration meeting  
17 December 2012**

# ***Review talks***

**Afternoon 4th of Dec.**

**Realization and Technologies I**

**Fulvio Ricci**

***“Vision Talk on Cryogenics fo ET”***

**Kazuhiro Yamamoto**

***“Current status of cryogenic system of KAGRA”***

# ***Coating and so on***

**Afternoon 5th of Dec.**

**Realization and Technologies II and III**

**Sheila Rowan,**

***“status of research at Glasgow on coatings”***

**Stuart Reid,**

***“thin film deposition and characterization  
facilities available in the UWS”***

**Massimo Granata, *“loss in the coatings”***

**Stefanie Kroker, *“grating reflectors”***

# *Coating and so on*

Stuart Reid,

*“thin film deposition and characterization  
facilities available in the UWS”*

UWS stands for University of West Scotland  
(near Glasgow airport).

Many apparatus **for thin film**

He **will buy** machine for **IBS**.

His plan : Investigation of **reflective coating**

**DLC** is also possible.

# *Coating and so on*

Massimo Granata, “*loss in the coatings*”

Measurement of mechanical loss  
of  $\text{Ta}_2\text{O}_5/\text{SiO}_2$  coating at cryogenic temperature

**Peak** at cryogenic temperature was **found**.

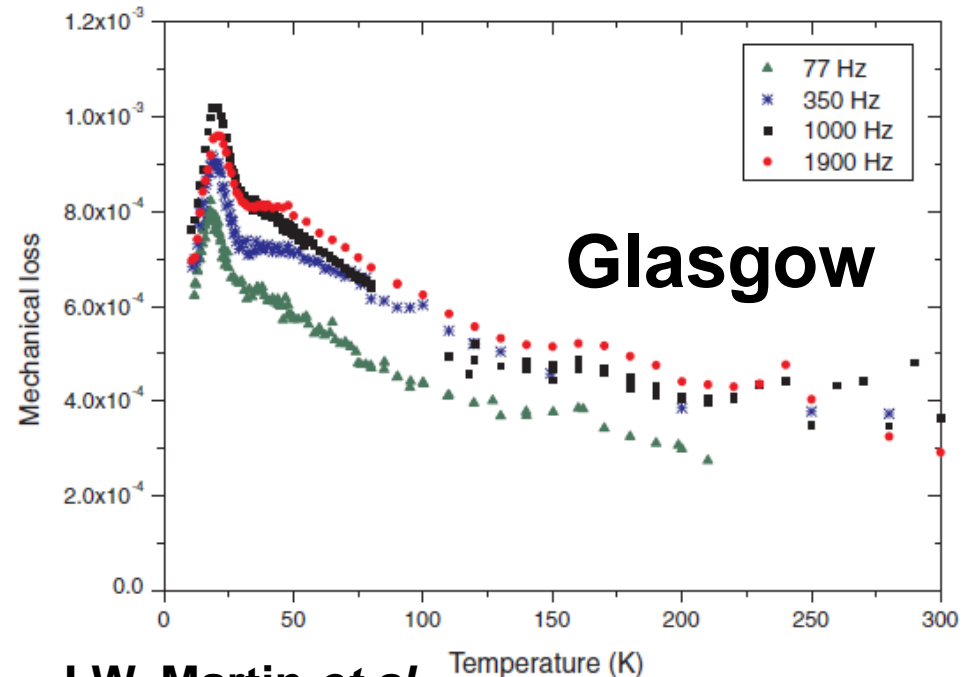
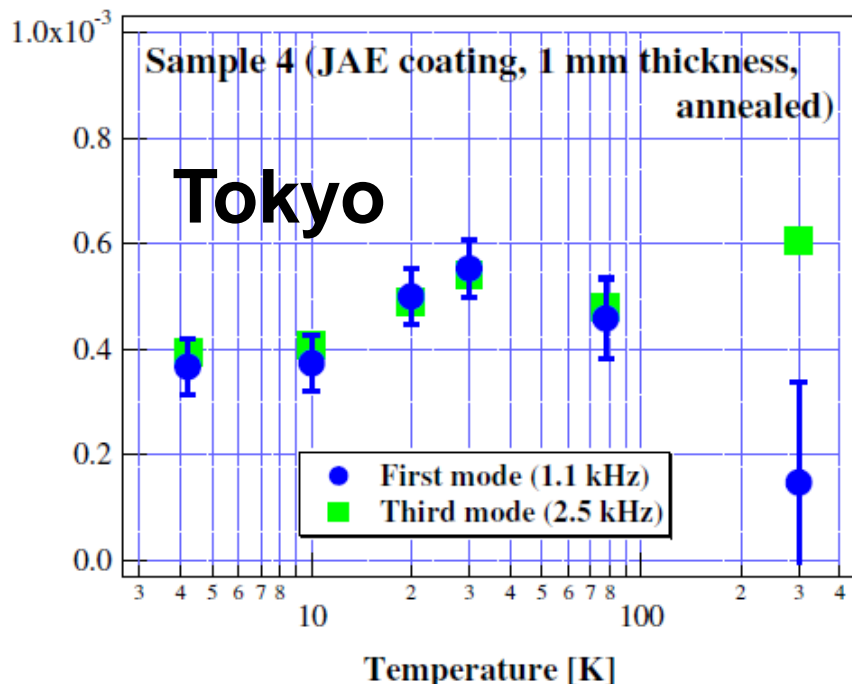
Future plan : **Friction between layers**

# Coating and so on

**Discrepancy** between Tokyo and Glasgow

$\text{Ta}_2\text{O}_5/\text{SiO}_2$

$\text{Ta}_2\text{O}_5$  or  $\text{SiO}_2$



K. Yamamoto *et al.*,  
Physical Review D 74 (2006) 022002.

I.W. Martin *et al.*,  
Classical and Quantum Gravity  
27 (2010) 225020.

# ***Fibers and so on***

**Afternoon 5th of Dec.**

**Realization and Technologies II and III**

**Karen Haughian, “*Silicate bonding of Silicon*”**

**Giles Hammond, “*Cryogenic Silicon Suspensions*”**

**Yusuke Sakakibara, “*Sapphire fibers*”**

# ***Fibers and so on***

Yusuke Sakakibara, “***Sapphire fibers***”

Quality check

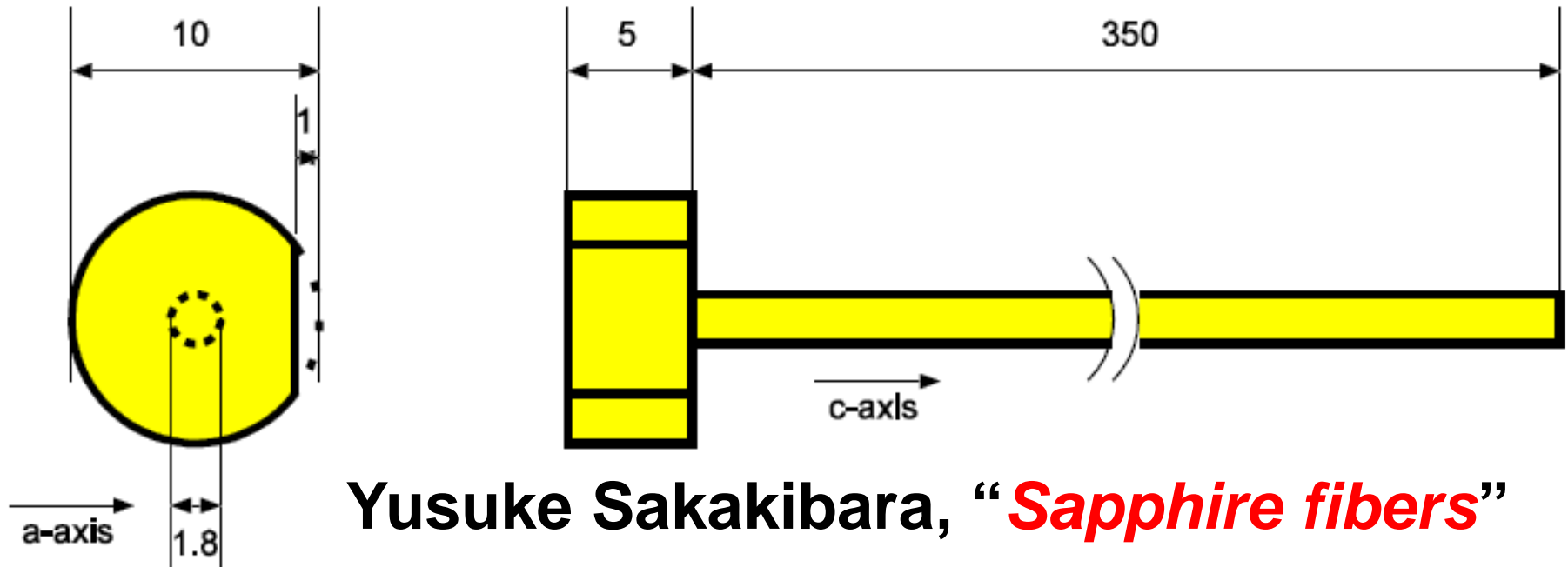
**Q-value** and **profile** of **Moltech** fibers:

Y. Sakakibara at **Glasgow** and **Jena**.

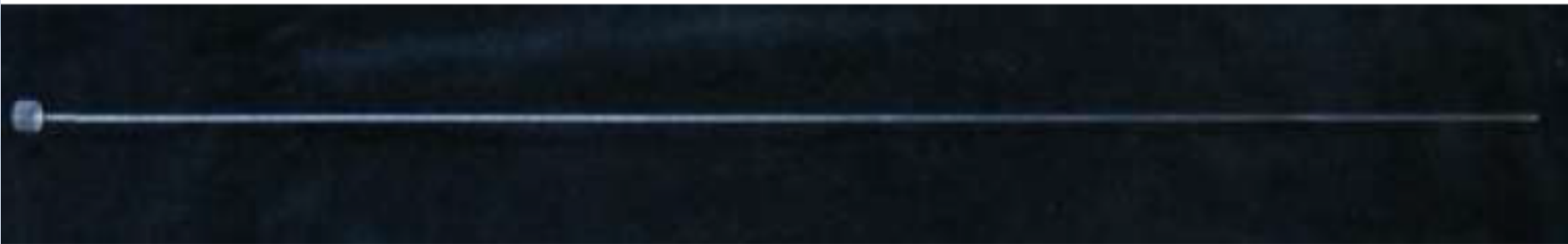


# Sample

- Sapphire fiber from Moltech
- Grown along c-axis

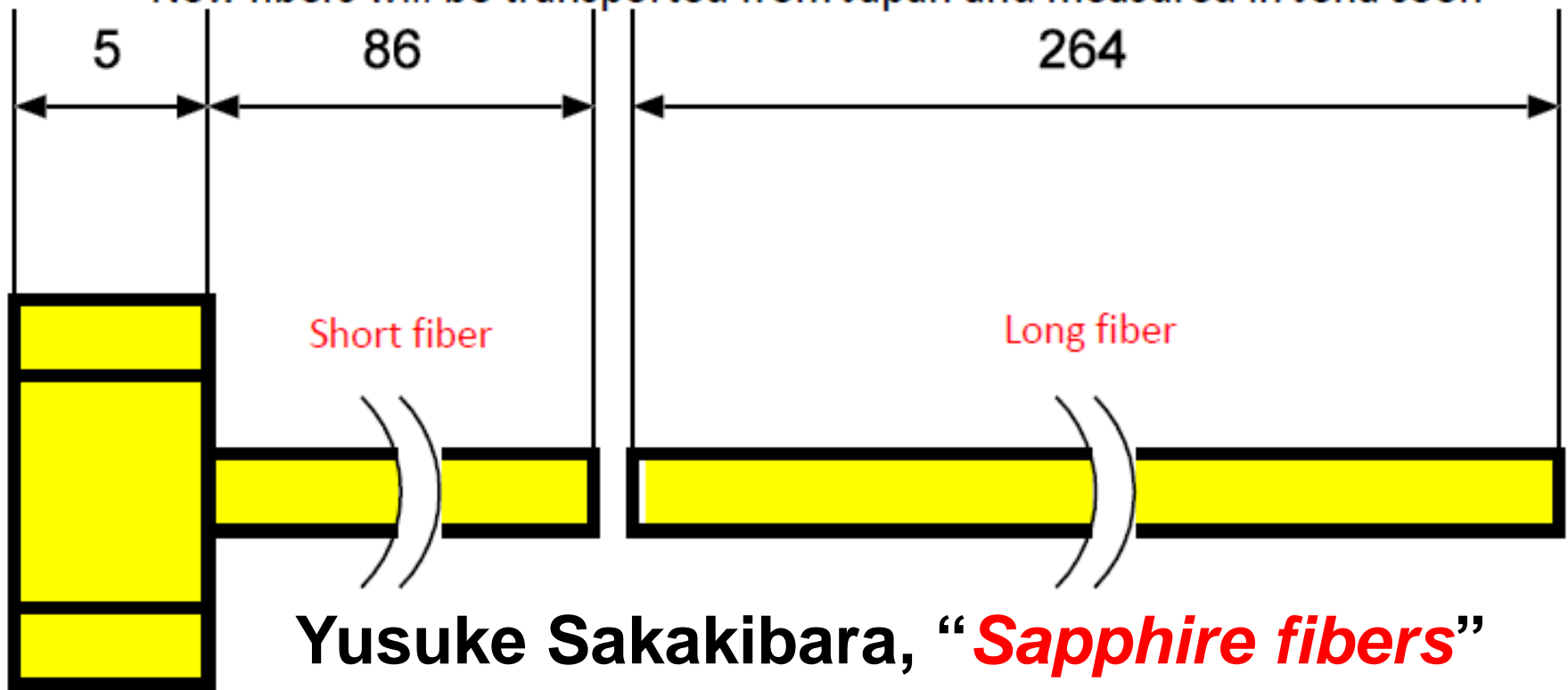


Yusuke Sakakibara, “*Sapphire fibers*”



# Sample broken during transportation

- Broken fiber
  - It had double enclosures during transportation
  - Packing more securely was necessary
  - Some force during transportation?
  - New fibers will be transported from Japan and measured in Jena soon

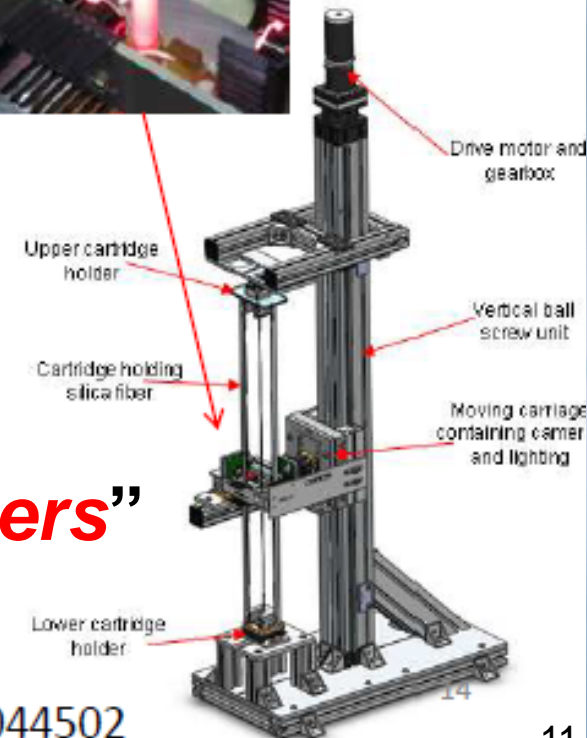
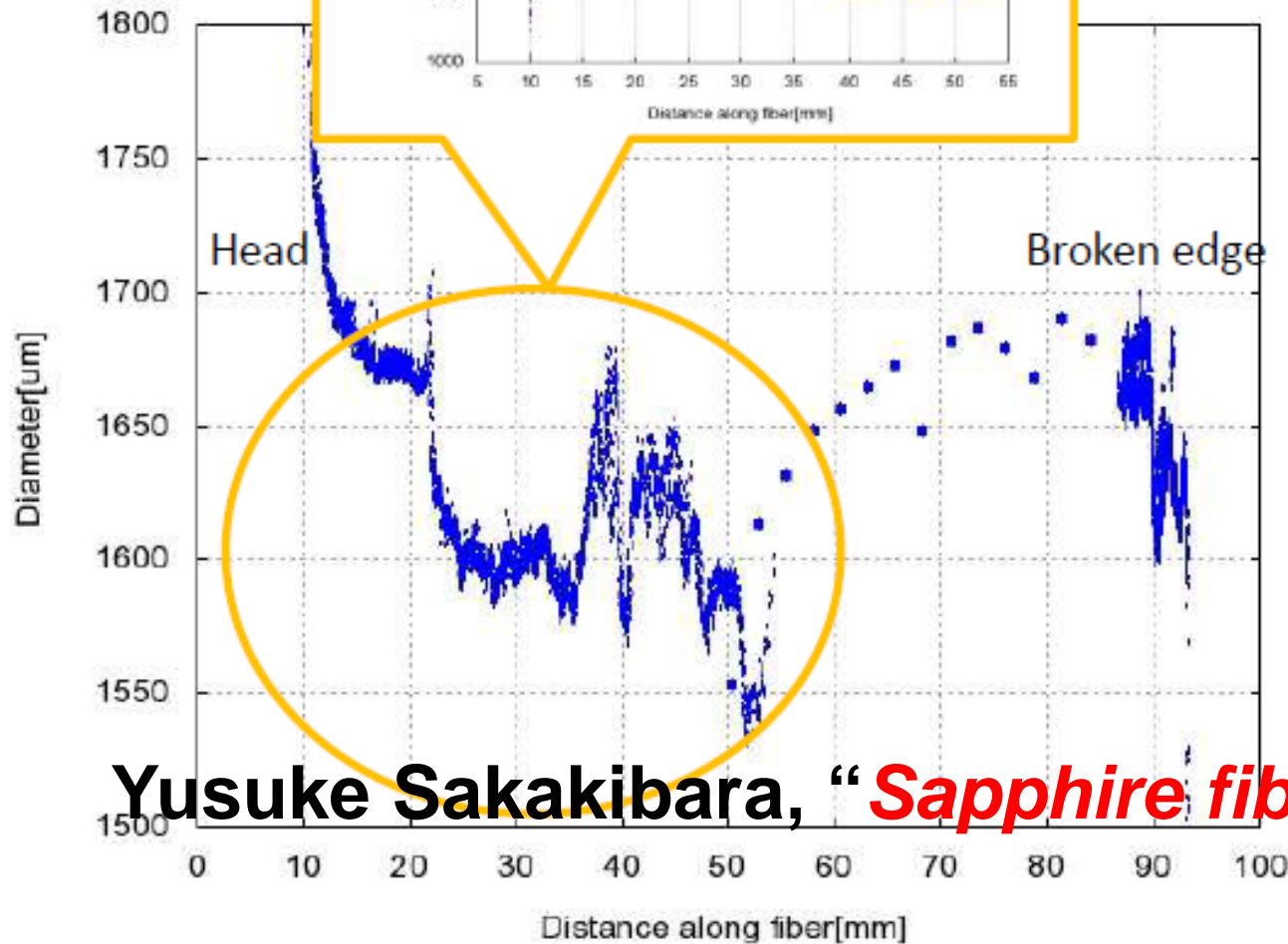


Yusuke Sakakibara, “*Sapphire fibers*”



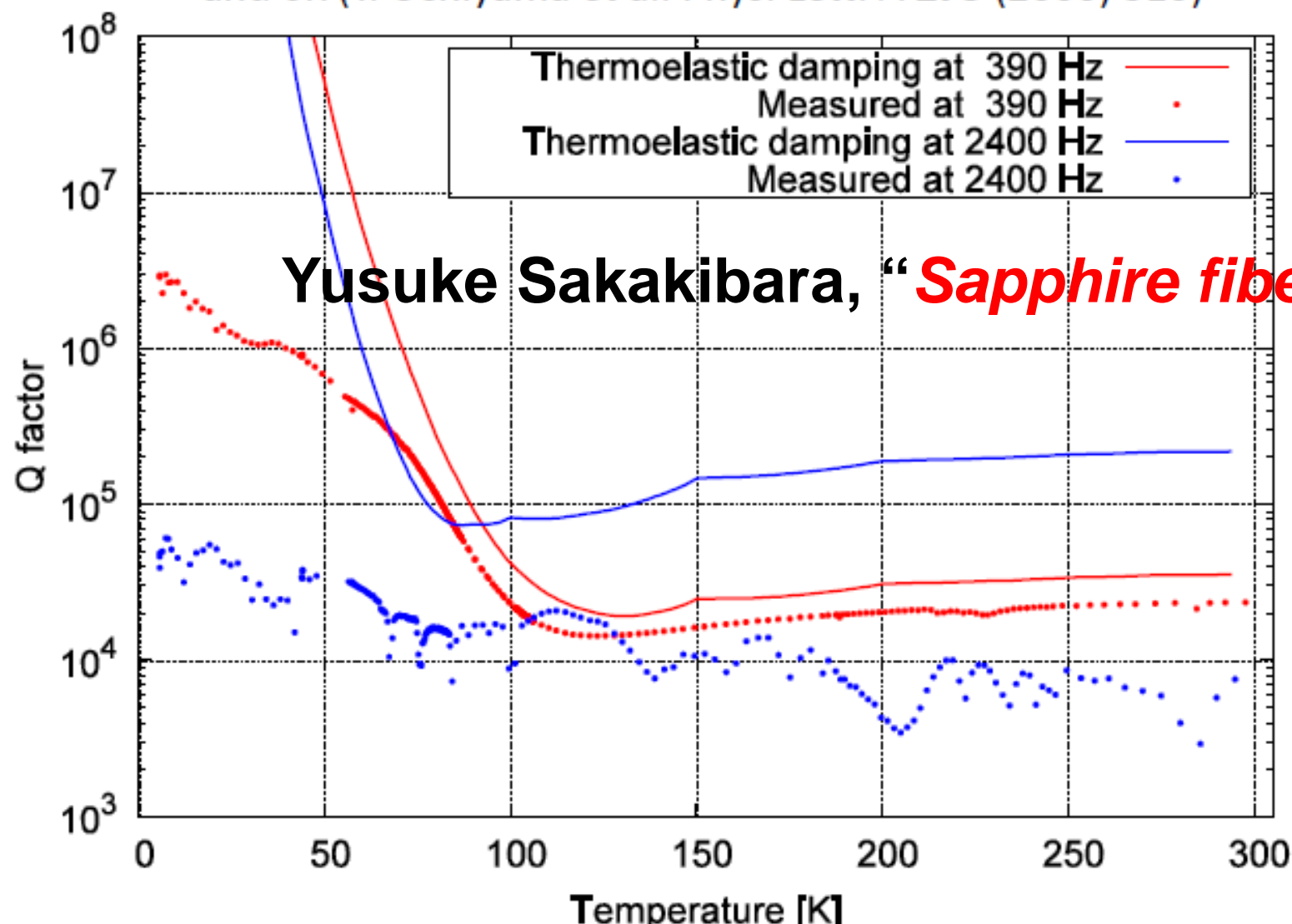
# Fiber profiles

- Profiles taken by fiber profiler
- High magnification cameras measure diameter of fiber
- Surface roughness 0.1 mm



# Result

- Result of first mode (390 Hz) above 100 K is consistent with thermoelastic damping
- Second mode (2400 Hz) has higher loss than thermoelastic damping
- Comparable with result of another sapphire fiber  $1.1 \times 10^7$  at 199 Hz and 6K (T. Uchiyama et al. Phys. Lett. A **273** (2000) 310)



# *Fibers and so on*

Yusuke Sakakibara, “*Sapphire fibers*”

Quality check

**Q-value** and **profile** of **Moltech** fibers:

Y. Sakakibara at **Glasgow** and **Jena**.

Although they are **broken**,

the measurement result is **promising**.

Two **Moltech** fibers and two **IMPEX** fibers

were **sent** to **Jena** (29<sup>th</sup> of Nov.).

# ***Sapphire fibers***

**Sapphire fibers with nail heads**

**Ettore Majorana asked IMPEX HighTech GmbH**  
(German company).

**They can make similar fibers**  
(nail heads on the **both** ends).

**Finally ...**



# ***Sapphire fibers***

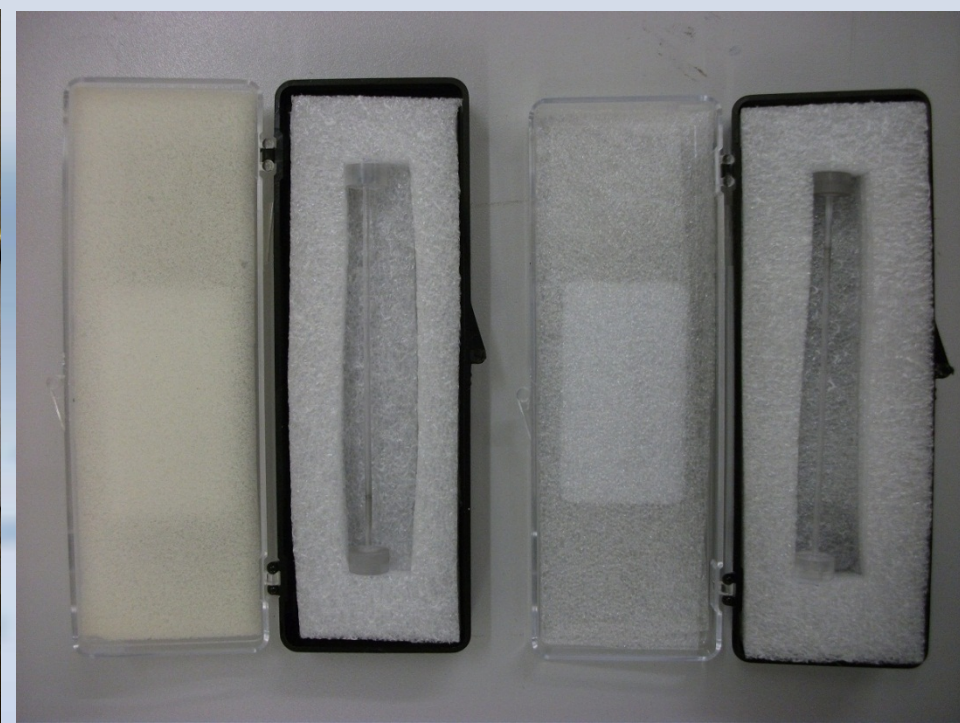
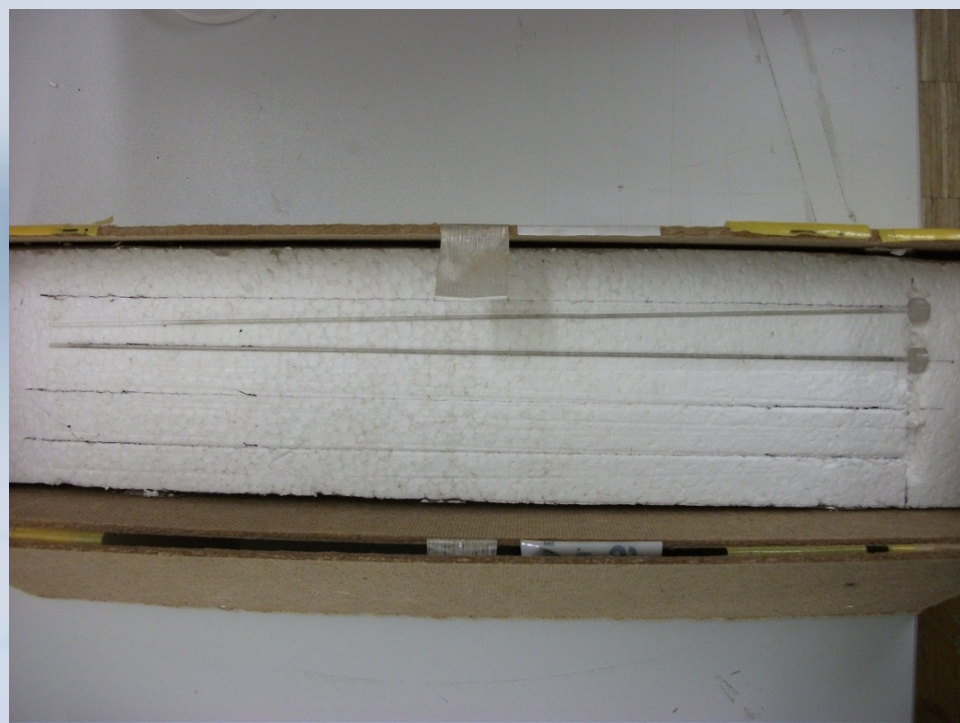
**Sapphire fibers with nail heads**



**IMPEX fibers arrived ! (15<sup>th</sup> of Nov.)**

# *Sapphire fibers*

Two **Moltech** fibers and two **IMPEX** fibers  
were **sent** to **Jena** (29<sup>th</sup> of Nov.).



**They survived !** (Photos from Jena)



# ***Jena***

**6<sup>th</sup>-7<sup>th</sup> Dec. 2012**

**Kazuhiro visited Friedrich-Schiller-Universitaet Jena.  
Yusuke measured Q-values of sapphire fibers.**

**<http://gwdoc.icrr.u-tokyo.ac.jp/cgi-bin/private/DocDB/ShowDocument?docid=1420>**

# ***Jena***

**6<sup>th</sup>-7<sup>th</sup> Dec. 2012**

**Ronny, Christian, Ettore (skype from Rome), Yusuke, and Kazuhiro discussed the strategy.**

**In Jena**

**Q-value with other type clamps,  
Thermal conductivity,  
Unbroken Moltech fibers, IMPEX fibers,  
X-ray (crystal structure), impurity measurement**

**Around March, these fibers will be sent to Rome and Ettore continue the investigation.**

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# ***Summary (Jena)***

**Yusuke's stay in Glasgow and Jena is quite **fruitful**.**

**First step** of ELiTES is **excellent**  
and we should **proceed**.

**ELiTES WP1-WP2 meeting :**  
**19:00, 19<sup>th</sup> Dec. 2012 (Wed)(JST).**



# *Jena*

## **Weihnachtsmarkt in Jena**

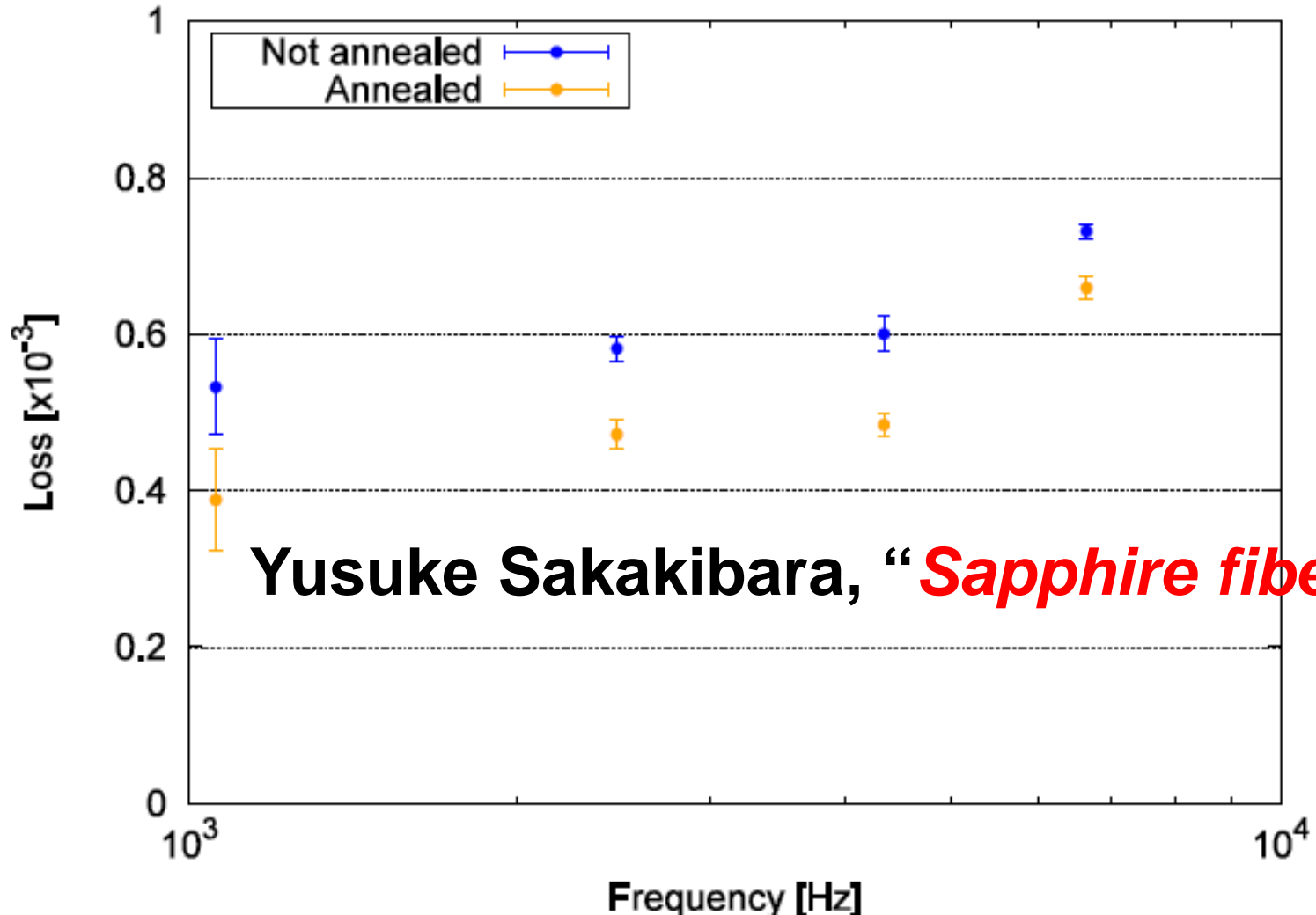


**Frohe Weihnachten !**

# Result •

## Coating loss

- Comparable to result of K. Yamamoto
- Annealing decreases loss of coating
- Measurement in cryogenic temperature will be conducted in future



Yusuke Sakakibara, “*Sapphire fibers*”