

KEK's International Initiative on Compact Sources

Susumu IKEDA

High Energy Accelerator Research
Org. (KEK)

KEK is an inter-university research institute corporation.

KEK = Hub-port of Inter-University Research

Strong relationship with University

Academic Communities



J-PARC =

Japan Proton Accelerator Research Complex

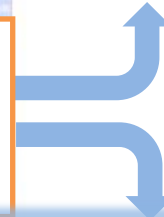
1976

KEK Proton Acc. Facility

Mar. 2006

Medical (Tsukuba Univ.)

12GeV Facility + Booster Synchrotron Utilization
Facility
(Neutrino Hadron Neutron Muon Medical)



J-PARC Project

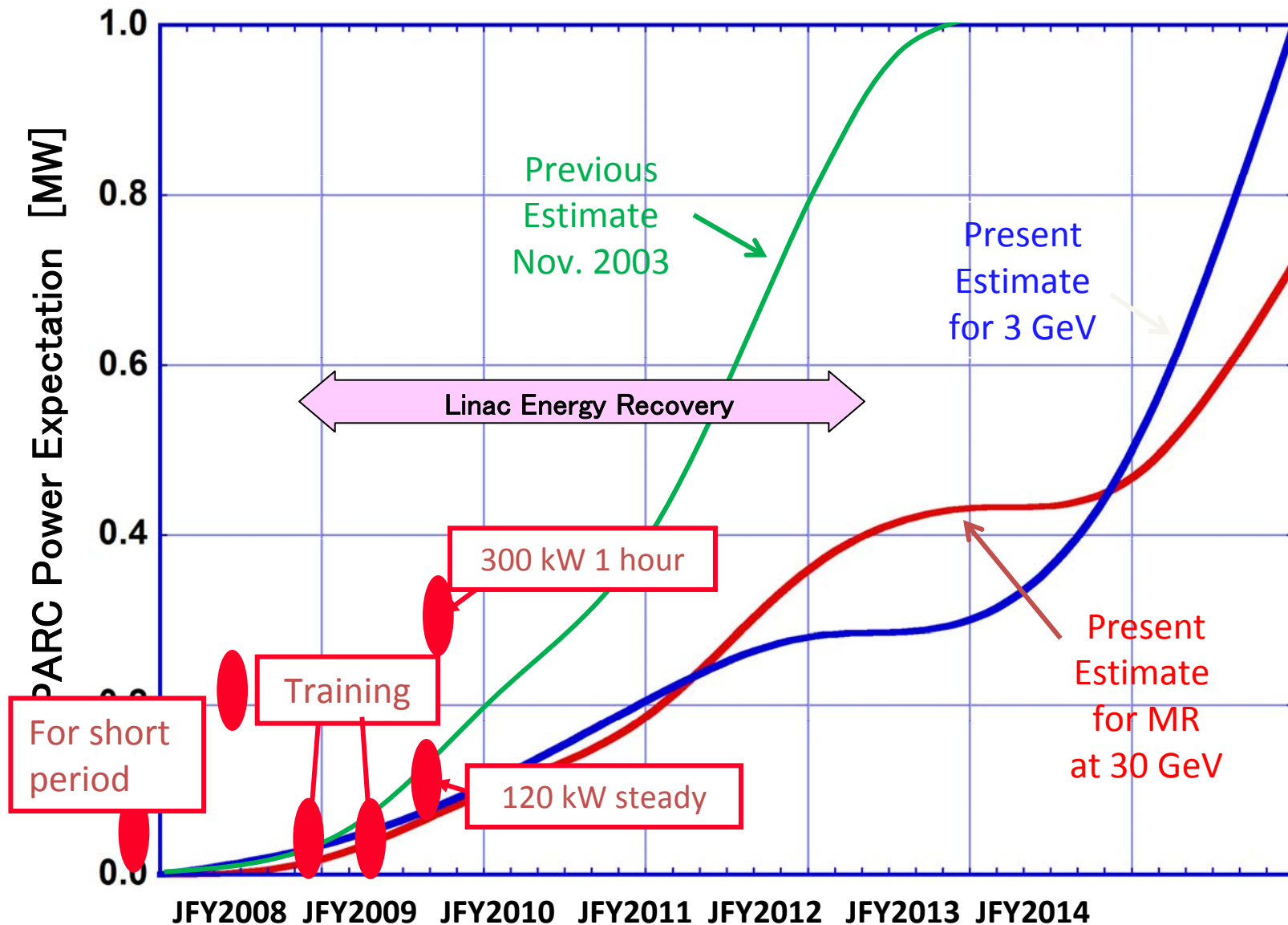
50 GeV Neutrino Hadron
Neutron Muon
Linac 3GeV Neutron Transmutation

Apr. 2001

KEK & JAEA

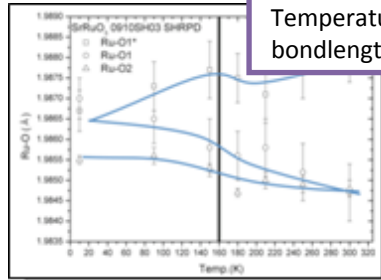


Power-up scenario (revised)



J-PARC/MLF

12 neutron science instruments have already been constructed and additional 3 instruments are under construction. Construction of 3 instruments will start soon:



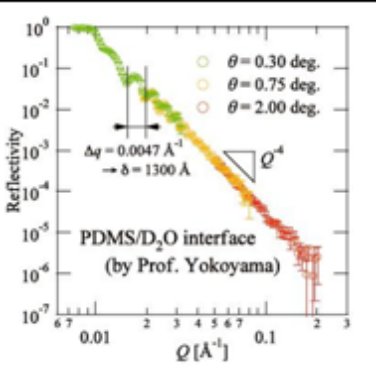
Temperature dependence of the precise bond lengths $l(\text{Ru-O})$ was obtained at BL08.



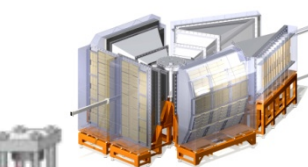
HRC



TAIKAN



Structure of the polymer/water interface could be observed within 2 hours



S-HRPD

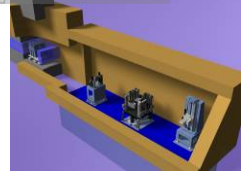


NOBORU

PLANET

AMATERAS

ARISA-II



TAKUMI



iMATERI



NNRI

iBIX



NOP



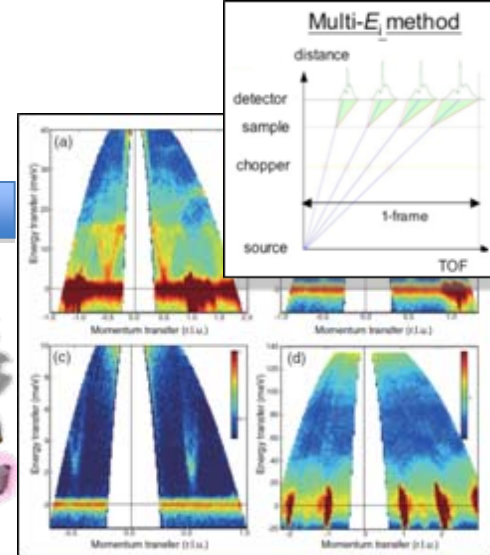
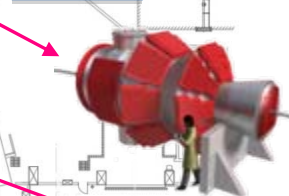
DNA



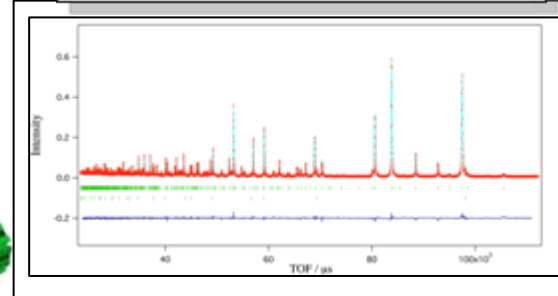
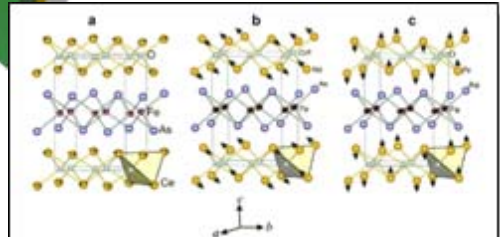
4SEASONS



NOVA



Multi-Ei measurement have been demonstrated for the first time (Nakamura et al., JPSJ 2009)



Small amount of high-pressure-synthesized sample can now be used for structure solution. FeAs superconductor was studied with only 0.05 cc at BL08.

Three major projects in KEK

- J-PARC project
 - Operating with JAEA
 - About 200 Oku yeon = about 200 M\$
 - Construction fee; 1500 Oku yen= about 1500M\$
- B-Project
 - Super B project ; Upgrading of B-project
 - Construction of Super B starts soon
 - several 100 Oku yeon = several 100 M\$
- PF-Project
 - ERL project ; Future plan of the PF
 - Not yet approved
 - several 100 Oku yeon = several 100 M\$
 - designing

We

- Directly face to the construction, operation and developing of the major projects toward the Top science
 - Very busy
- Additionally, interested with the compact neutron source
 - KEK is an inter-university research institute corporation
 - The Origin of KEK power comes from the universities
 - The compact one can provide university activities (including education) in the fields of accelerator science, Material sciences and so on
 - Compact one has supported developments of large facility

Example

- Hokkaido's compact source has contributed to develop new devices and innovative instruments for J-PARC
 - Detector and data taking system;
 - Haba, Muto, Satoh (KEK) will talk
 - Uno (KEK) will talk
 - Instruments; MF-SANS FURUSKA has talked
 - Imaging Kiyanagi talks next
 -

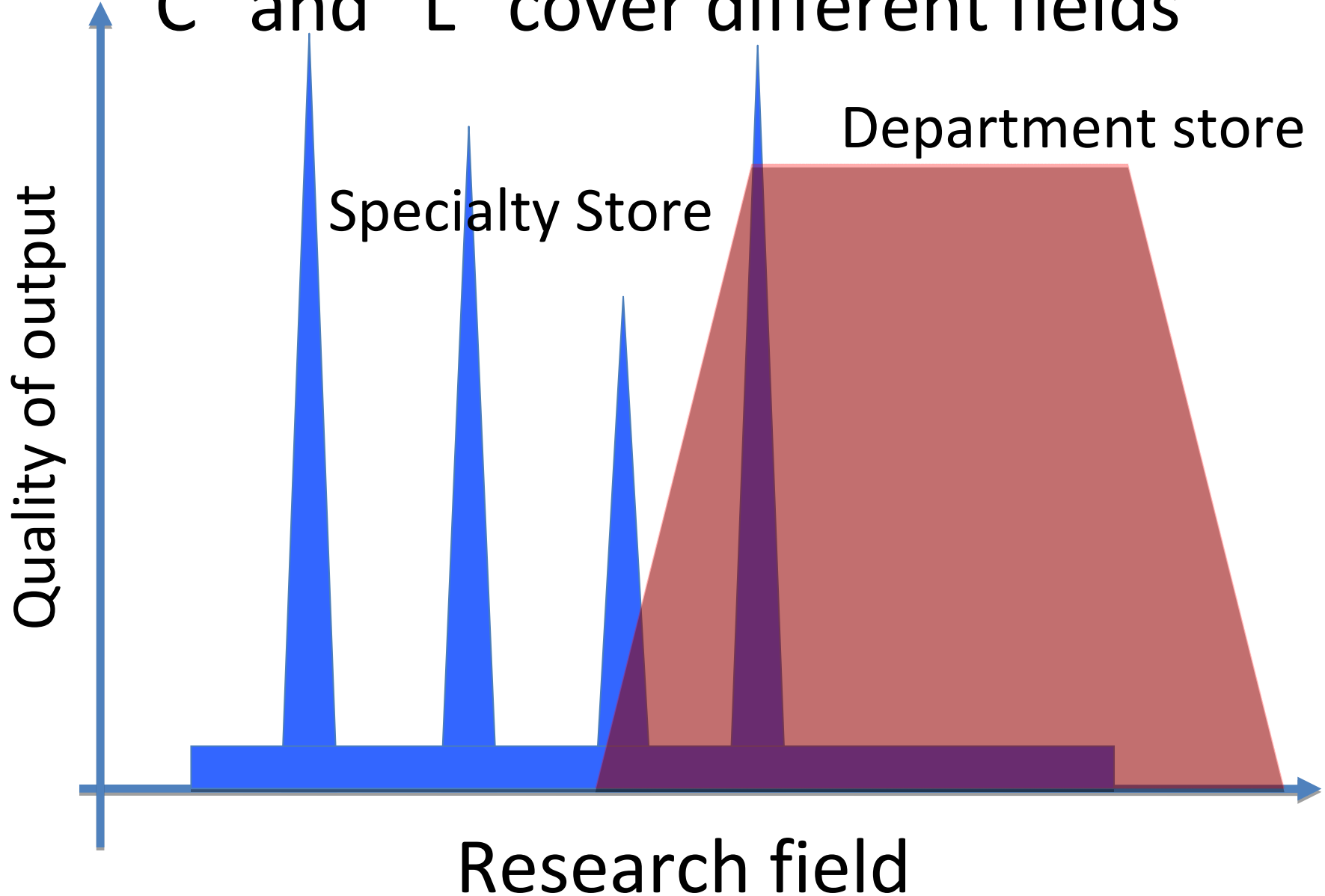
Strong points and Weak points of “L”

- Strong point of “large-sized neutron source”
 - Perform top sciences in WIDE scientific fields
 - Provide new opportunities in the WIDE areas
 - Averaged parameter values are selected
 - Repetition rate
 - Proton Pulsed Width
 - temperature, size, shape of the moderator
- Weak point
 - High construction fee and high operation fee
 - Only one
 - Large space
 - Hard access
 - Averaged parameter values MUST be selected
 - It is not the best for “the specific use” although it is widely better for “the standard use”

Strong points of “C”

- It is to turn over WEAK POINT of “L”
 - low construction fee and low operation fee
 - Several or many
 - Allows long period experiments
 - Specific instruments can occupy in a long period
 - small space
 - easy access
 - Specific parameter values CAN be selected
 - “C” has the freedom of parameter selection
 - All trials are permitted
 - It can be the best for “the specific use”

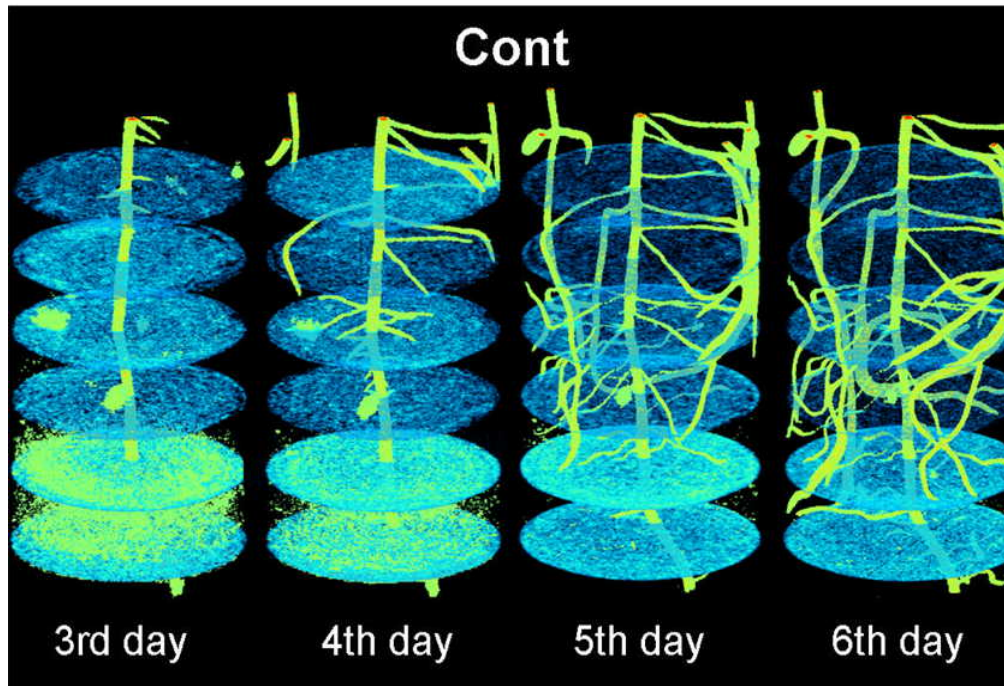
“C” should not be a compact one of “L”
“C” and “L” cover different fields



Agriculture, Forestry

Root Growth in the soil

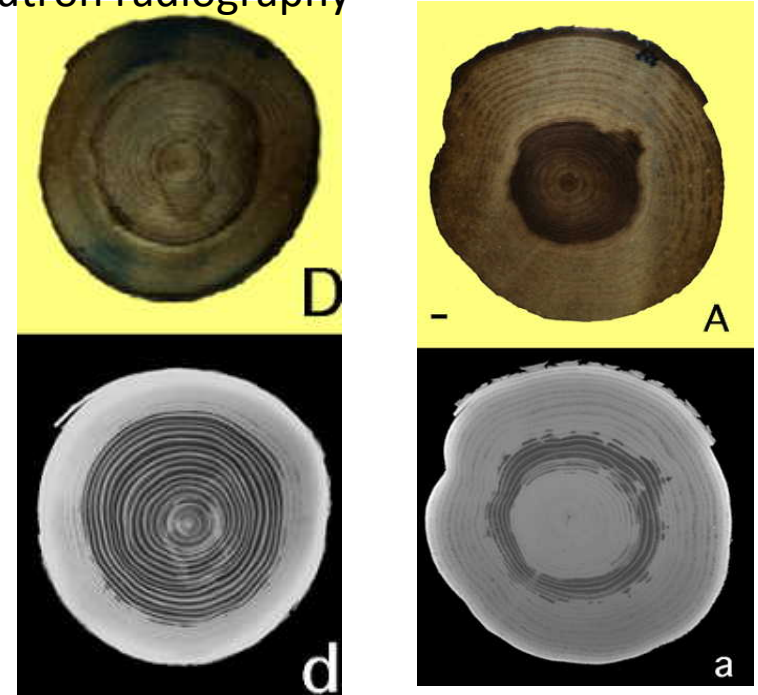
Neutron radiography



Low CT Value High

Dehydration of Wood

Neutron radiography



樹種の違いによる水分量の差(スギ)

(水分量の多いところほど白く表示される)

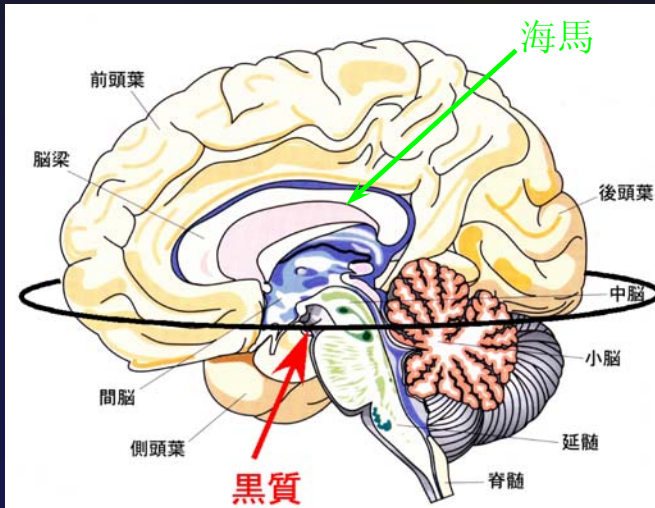
赤心→心材部に水分が少ない

黒心→心材部に水分が多い

(加工後、経年で歪みが出る)

Medical use

1. Parkinson's disease and Alzheimer's disease



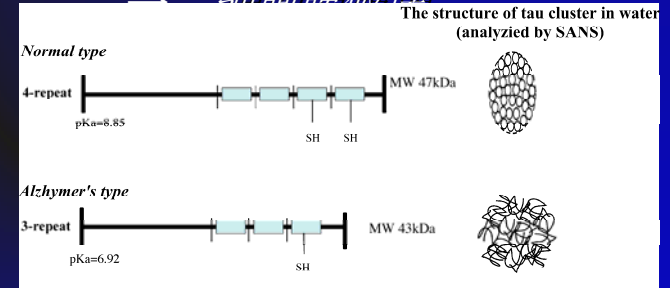
◎Parkinson's disease (黒質)

- ・プロテアゾームシステム異常
→ 不用なタンパク質の除去
- ・シヌクレイン等のタンパク質の構造異常
→ 細胞内凝集体形成

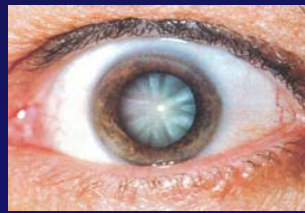
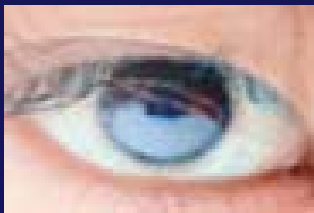
◎Alzheimer's disease (海馬)

- ・微小管結合タウの構造異常

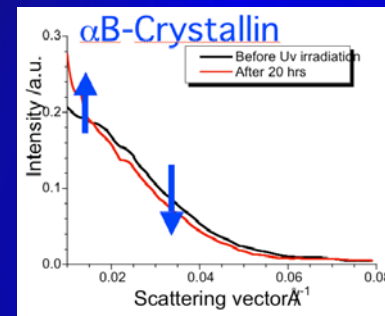
細胞膜破壊



2. Cataract



◎水晶体内クリスタリンの構造異常



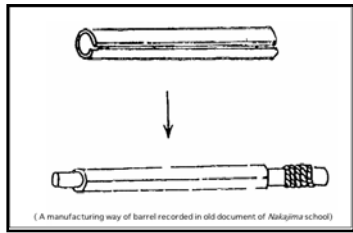
紫外線照射による
大きな凝集体の
増加

Matchlock gun

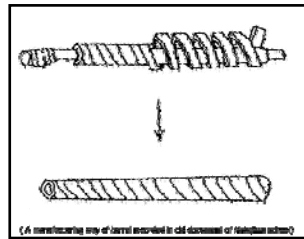
銃身の
製作技法の識別



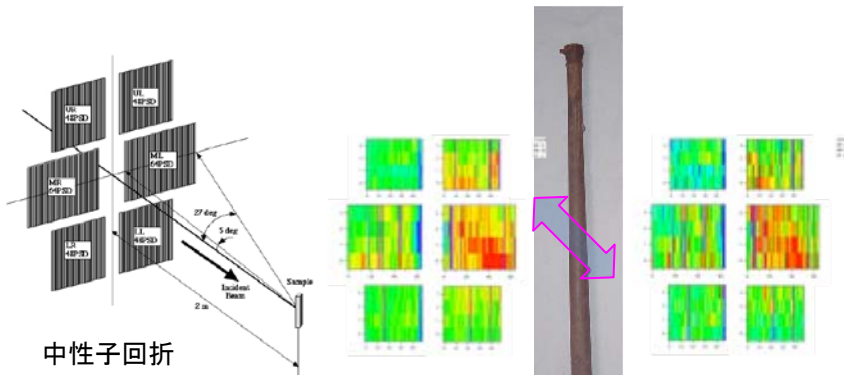
どちらの製作法？



餛飩張



巻張



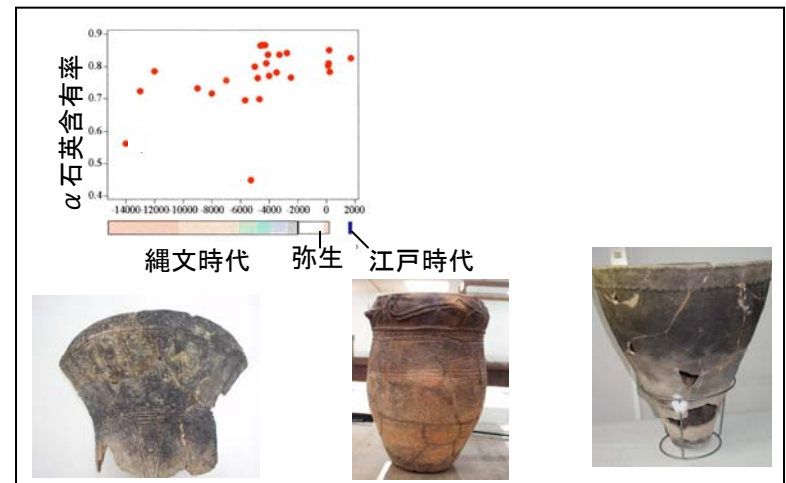
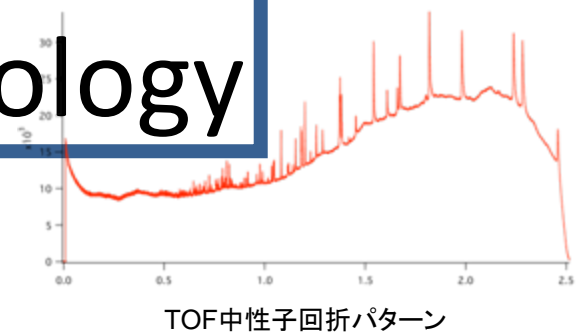
斜め方向の残留応力 → 巻張

Jomon ware

年代による
焼成温度の違い



Archeology



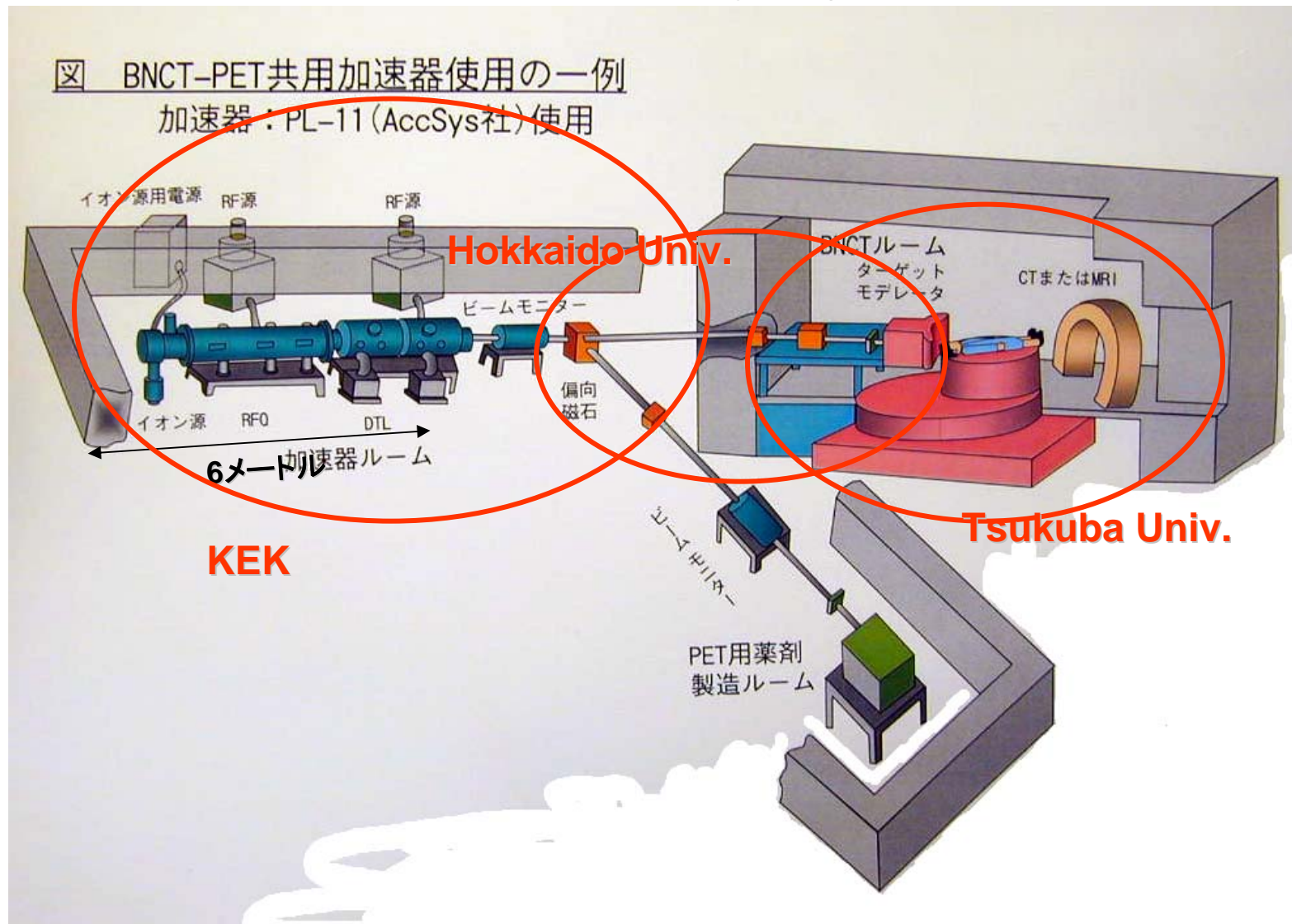
縄文前期

縄文中期

縄文後期

Conceptual drawing of BNCT-PET accelerator system

BNCT project

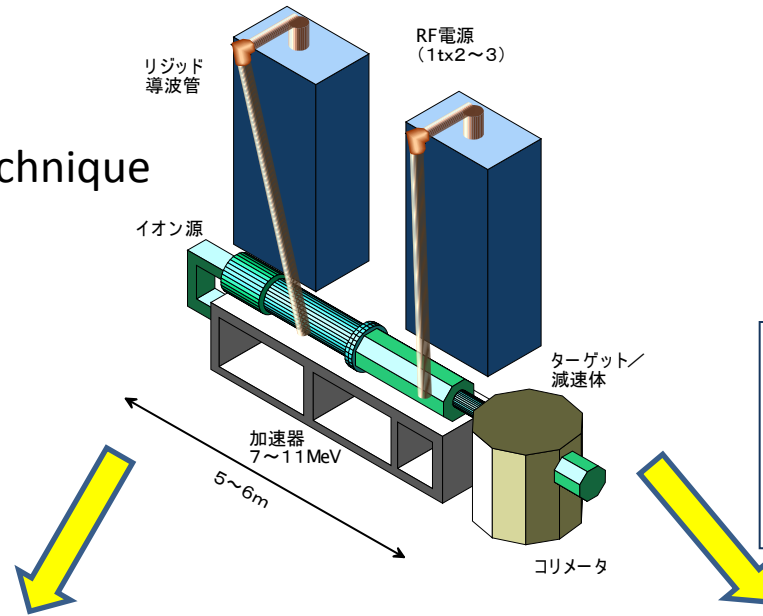


RIKEN Project



Aug 15-18, 2010, Beijing

Neutron imaging technique



Mobile neutron source

Applying to manufacturing technique

Quality control by small neutron sources at each factory

stationary

Applying to large scale structure materials

Measurement the bridge outdoors

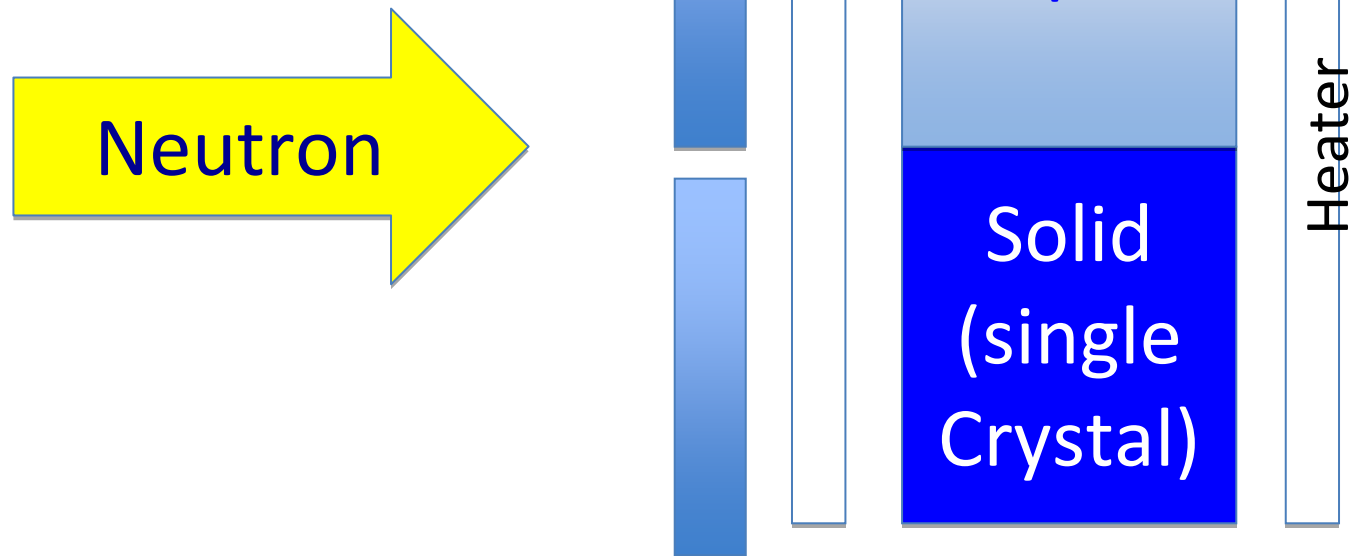
transportable

cheap price and easy to access, easy to handle

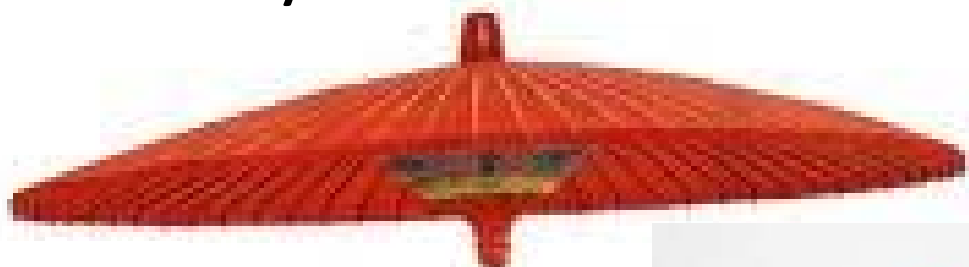


On-beam Synthesis & Composition of new materials ($A_xB_yC_z$)

- Neutron monitor in a part of synthesis & composition
 - Concentration of X, Y and Z (n-resonance)
 - Temperature (n-resonance)
 - perfection of sample



KEK-University Collaboration on Compact Source



KEK - RIKEN

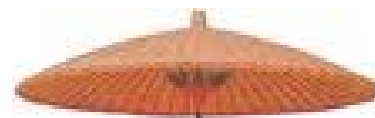


KEK - Kyoto Univ.
(will open soon)

KEK - Hokkaidoh Univ.



KEK - Tsukuba Univ.

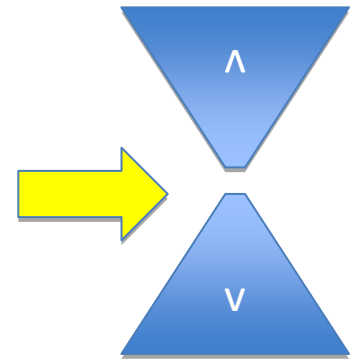


毛ゼン付

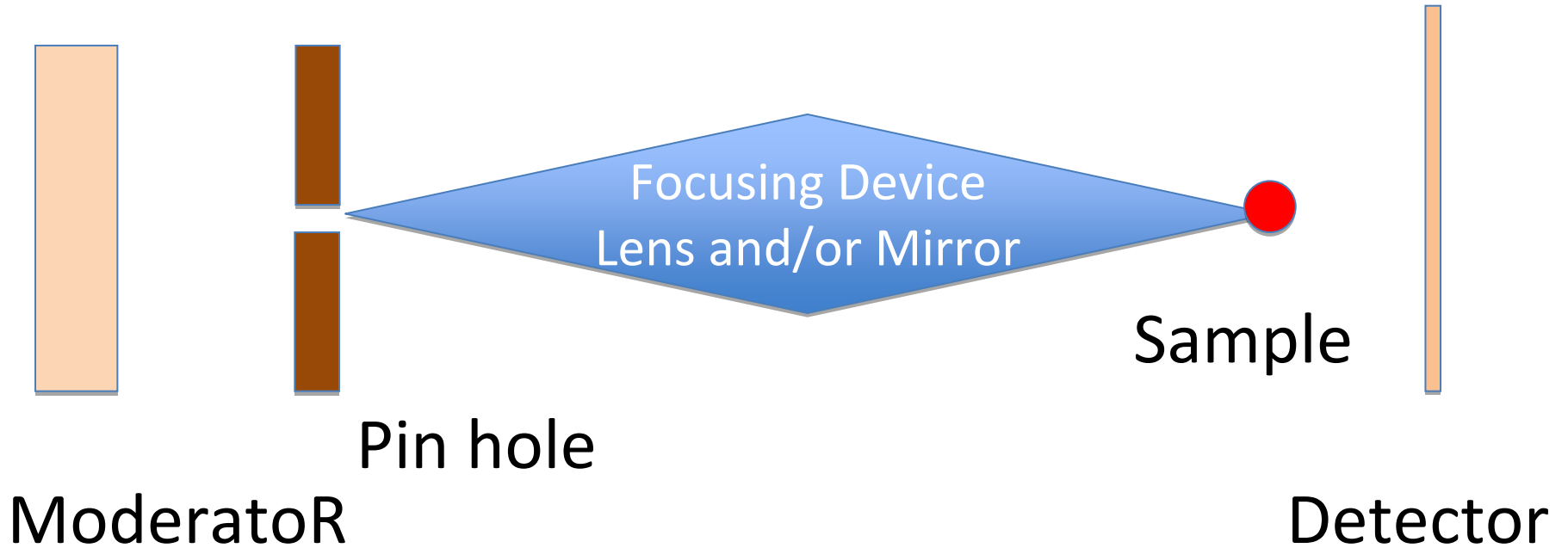


Trends of material science

- L3S = Light, Slim, Short and small
 - 輕薄短小
 - Small sample, small area of sample
- Extreme condition
 - Small sample, small area of sample
 - Low repetition
 - High pulsed magnetic field (-100T)
 - It realizes in a long interval of several seconds

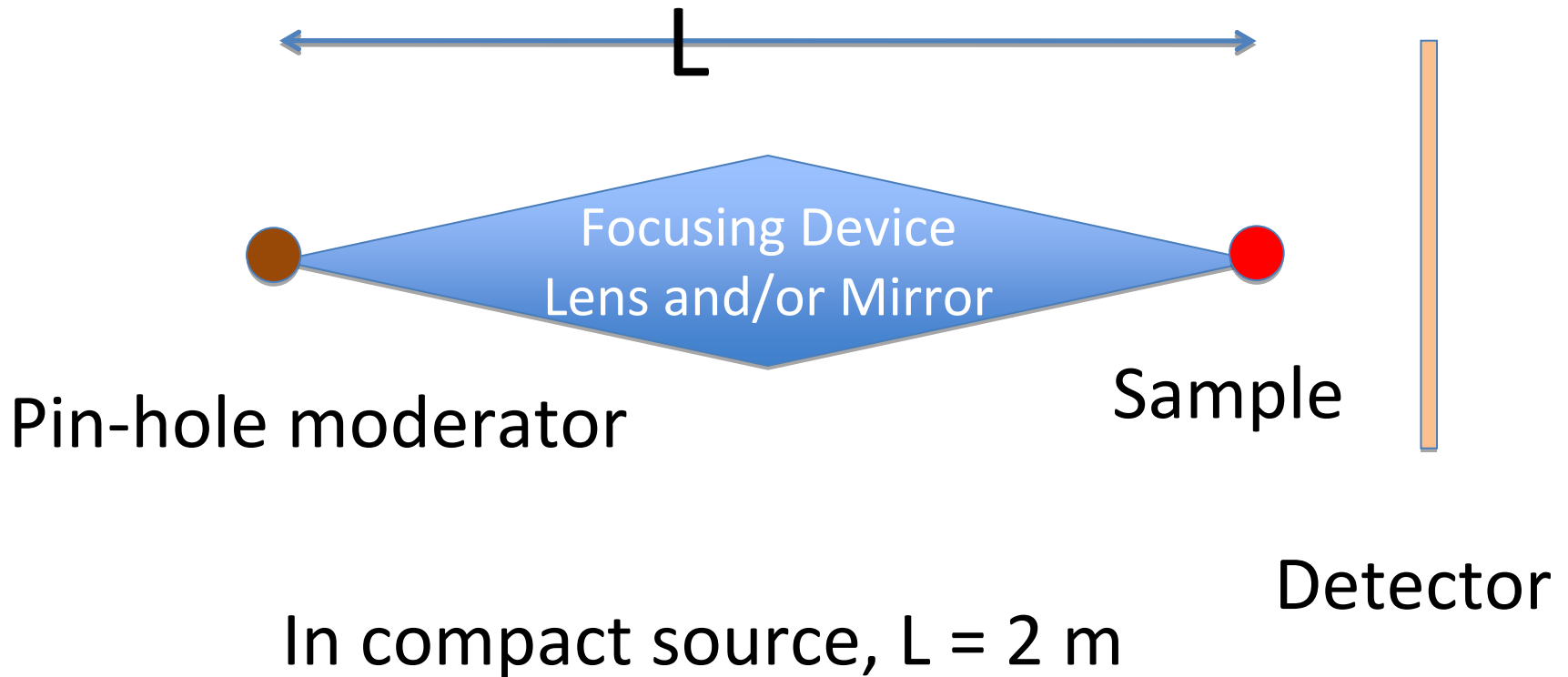


Focusing devices fit in with the trends



It needs a pin hole source !

If a pin-hole moderator is realized



Very simple structure, very Low background !
(because of less total neutron number)

Possibility of the pin-hole moderator

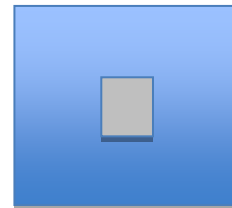
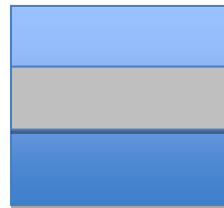
- Grooved moderator (Hokkaido, KENS, ISIS)

Flat

1D-Grooved

2D-Grooved

A front view



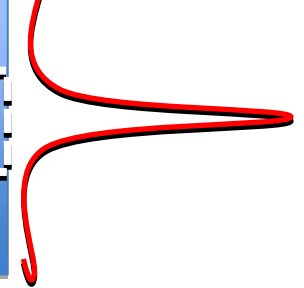
Neutron density 1

1.5 – 3

10 (expected)



A side view



All trials are permitted in “C”

- Grooved $\times 10$
- High density H-materials; $\text{CH}_4 \times a$
- Single crystal reflector $\times b$ (David talked)
 - Bend single crystal reflector; focus $\times b1$
- Very low temperature moderator $\times c$

Dream

Max. neutron density

$10 \times a \times b \times b1 \times c = 100$ times of flat one

(this is not total neutron number) in specific range

Compact Source

- Construct fee; several Oku-Yen= several M\$
- Size; 10x10 (m²) ?
- Acc. Power ; 10MeV x (1mA) = 10kW
- **Total neutron number = 1/100** of large-sized
 - Ref.; Large-sized facility = 1MW

If 100 times density (pin-hole moderator) is realized,

Experiments with focusing devices

Generally, “L” = “C”

Since “C” allows very large solid angle measurements (because of short L),

in a special case, “L” < “C”

Note;

“C” realizes lower background
because of less total neutron number

Possibility of KEK contribution

- KEK itself is a part of University (KOKEN-DAI). It can provide education for the young students in the doctor course
 - we have done
- KEK accelerator scientists studied large-sized acc. in a long period. The experience are huge.
 - They may give important hints for reliability of acc. , less take-care to Acc. and so on which are necessary for compact neutron developments

Japan = A country where many people live to an advanced age
KEK staff also lives to a great age (expect). It expands the chance of their hints

A blue gradient graphic that looks like a scroll or a piece of paper. It has a light blue top section and a darker blue bottom section. The top edge is rounded, and there are two circular cutouts: one at the top left and one at the bottom left, suggesting the scroll is unrolled. The text is centered on the scroll.

Thank you for your
attention

Susumu Ikeda
KEK