2nd BRIKEN WORKSHOP: An Overview of the Project

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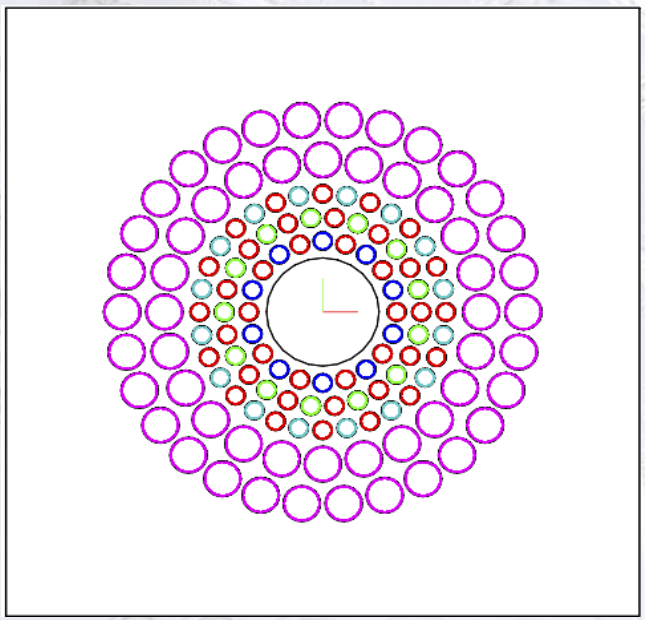
A possible BRIKEN set-up:



Cupola della chiesa Gran Madre di Dio, Torino, Italy

Outline

- Origin of the BRIKEN project
- Summary of the previous BRIKEN Workshop
- Current Status of the Project, what's new?
- Goals for the present workshop
- Summary and Conclusions

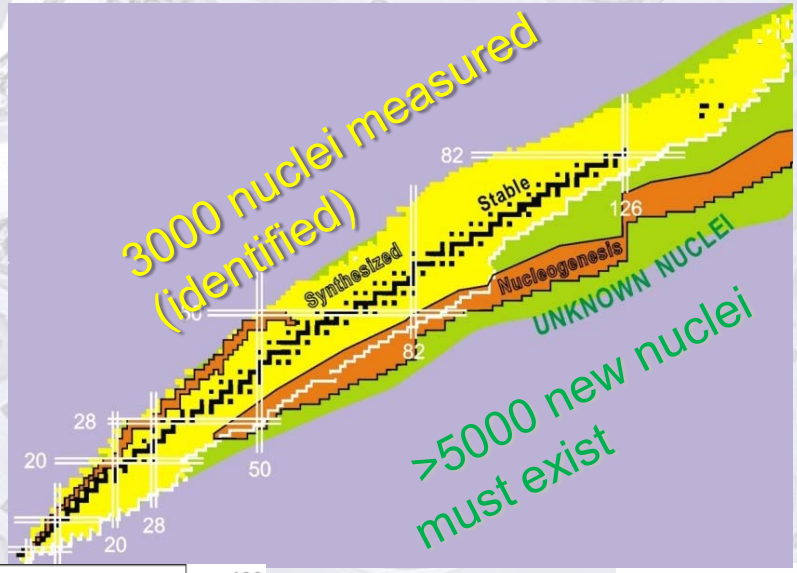
The origin of the BRIKEN Project

- BRIKEN stands for **B**eta delayed neutron emission measurements at **RIKEN**
- BRIKEN was born as a scientific need of nuclear data for:
  - Astrophysics
  - Nuclear structure
  - Reactor technology
- BRIKEN aims at:
  - most exotic nuclei → RIKEN BigRIPS
  - largest detection sensitivity → large neutron detector array (BELEN→ BRIKEN)

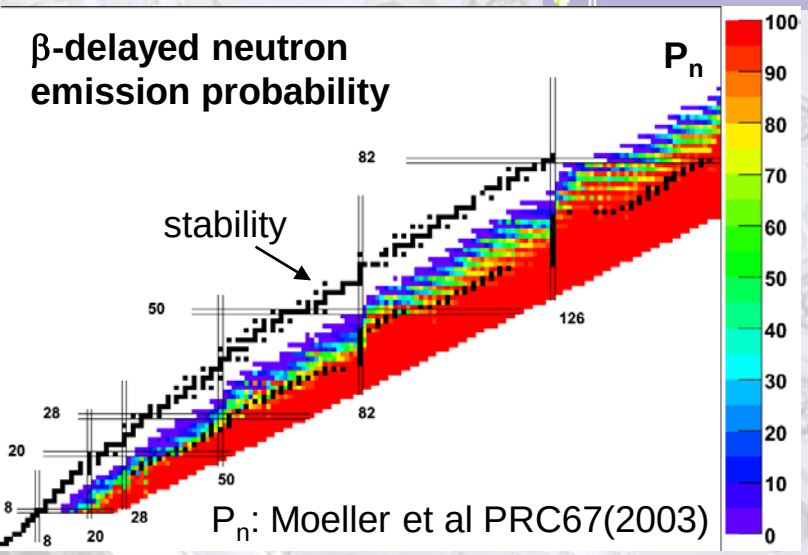
The origin of the BRIKEN Project

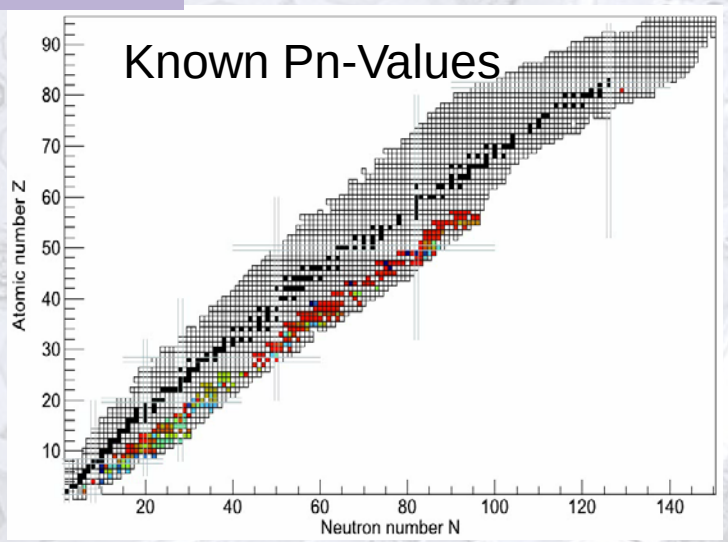
- BRIKEN was born as a scientific need of nuclear data: A REMARK

The knowledge we have on nuclear structure and dynamics is based on about 3000 nuclei, whereas still more than 5000 new nuclei must exist.



Almost all these new nuclei are expected to be neutron emitters, and hence, an understanding of this property and the involved technique becomes of pivotal impotance for NS and future studies.





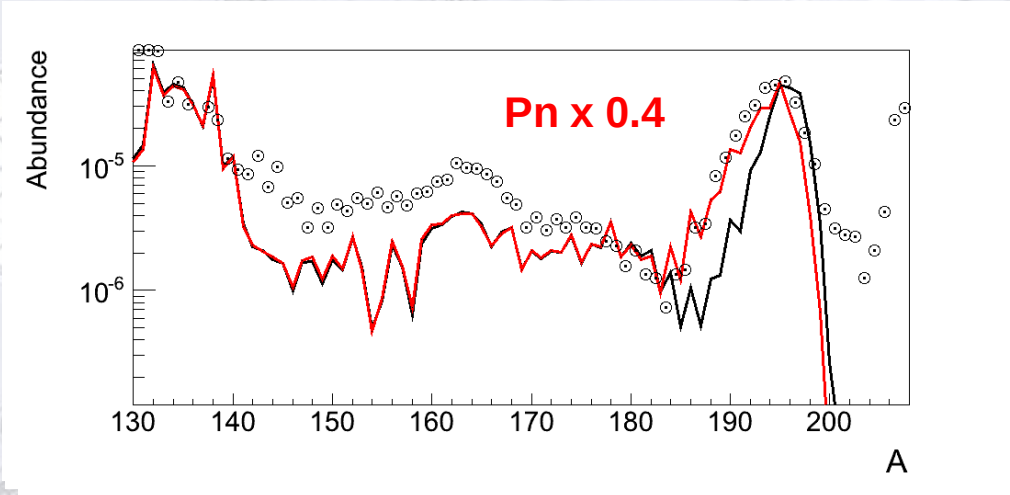
- Practically all NEW nuclei, are expected to be neutron emitters!

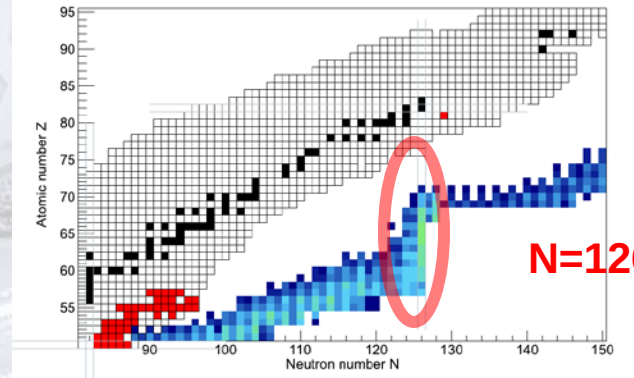
The origin of the BRIKEN Project

- BRIKEN was born as a <u>scientific need</u> of nuclear data for ASTROPHYSICS

During „Freeze-out“:
detour of β-decay chains
⇨ ***r-abundance changes***

During „Freeze-out“:
enhancement of neutron flux
⇨ ***r-abundance changes***





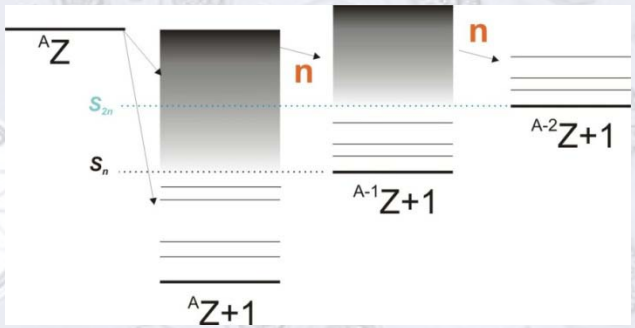
The origin of the BRIKEN Project

- BRIKEN was born as a <u>scientific need</u> of nuclear data for NUCLEAR STRUCTURE

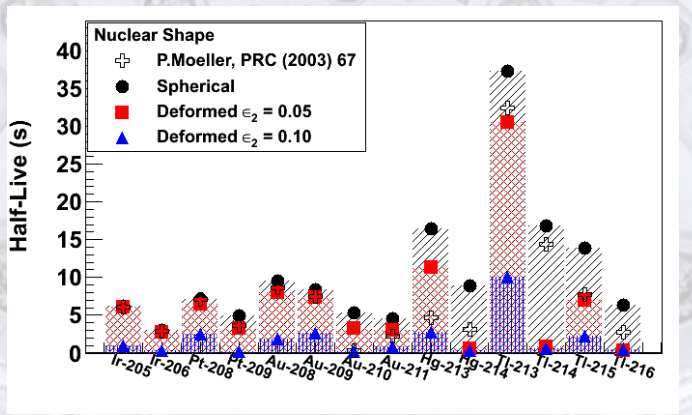
BRIKEN will allow to measure two of the main “gross” properties:

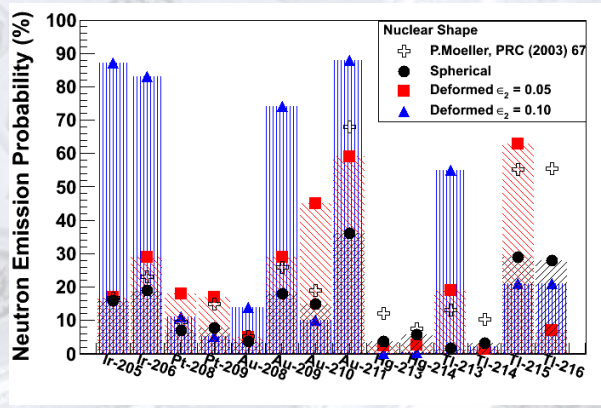
$$P_n = \frac{\sum_{S_n}^{Q_\beta} S_\beta(E_i) f(Z,R,Q_\beta - E_i)}{\sum_{0}^{Q_\beta} S_\beta(E_i) f(Z,R,Q_\beta - E_i)}$$

$$1/T_{1/2} = \sum_{0 \le E_i \le Q_\beta} S_\beta(E_i) \times f(Z,R,Q_\beta - E_i)$$



P_n → β-feeding above S_n → Stringent test on β-strength function
P_n small → $T_{1/2}$ small



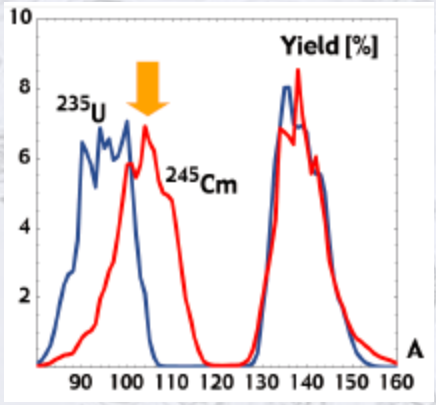


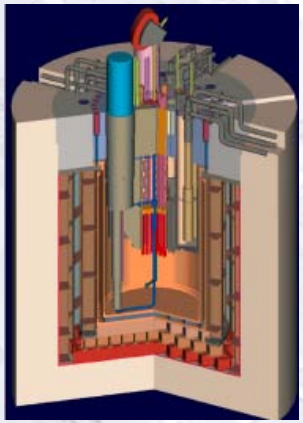
Calculations by K.L.Kratz & B.Pfeiffer

The origin of the BRIKEN Project

BRIKEN was born as a scientific need of nuclear data for REACTOR TECHNOLOGY

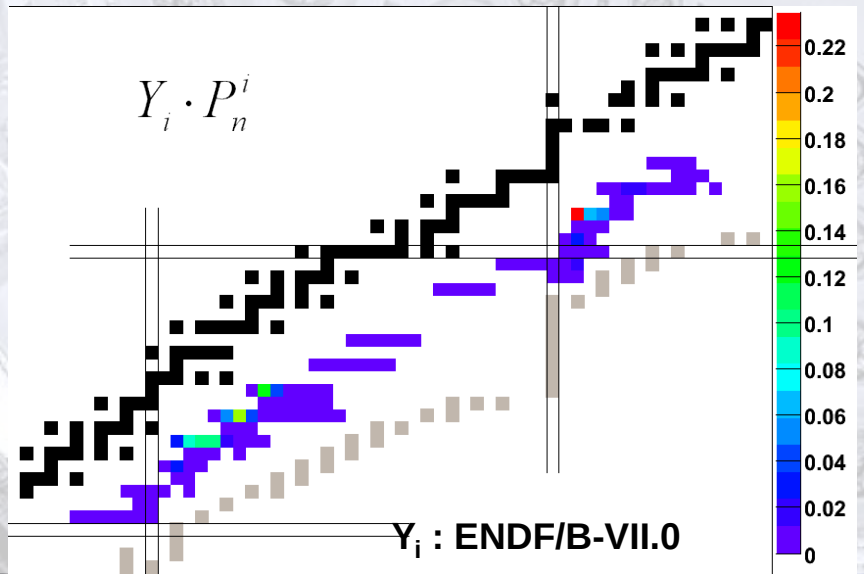
- The delayed neutron fraction β_{eff} is a key parameter in the control of reactor power
- Microscopic **summation calculations** lack still the accuracy of **Keepin six-group formula**
- Reason: **inaccuracies** in fission yields Y and **delayed neutron emission probabilities** P_n

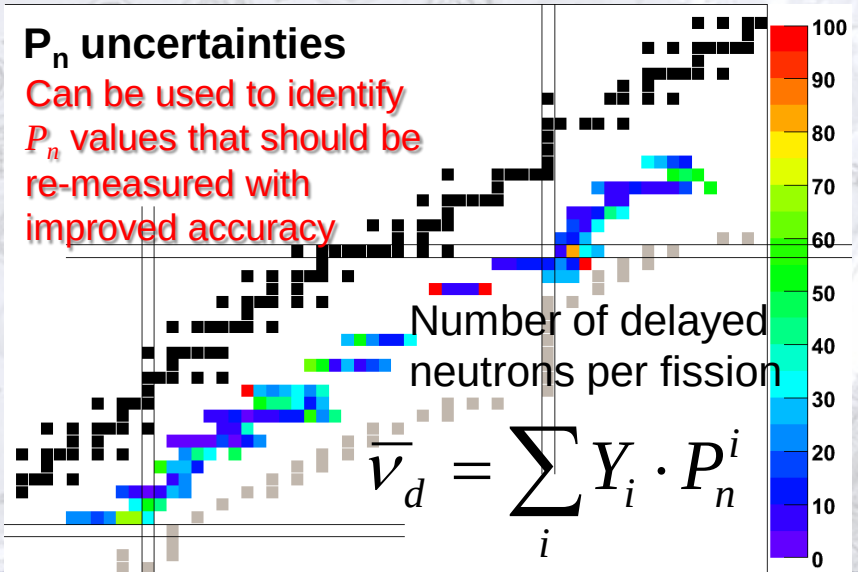




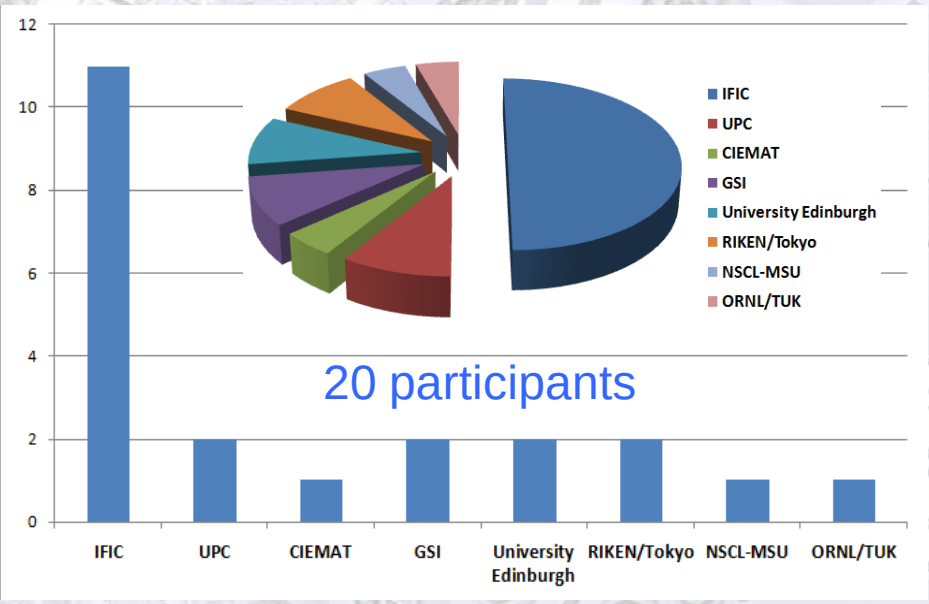
- Fissioning system: ^{235}U, ^{239}Pu, etc
- Neutron Energy

- Design of fast critical reactors (Gen IV), Na, Pb or gas cooled.
- Design of ADS for nuclear waste transmutation.

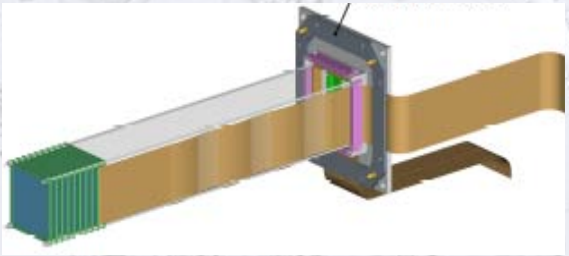




Summary of the 1st BRIKEN Workshop



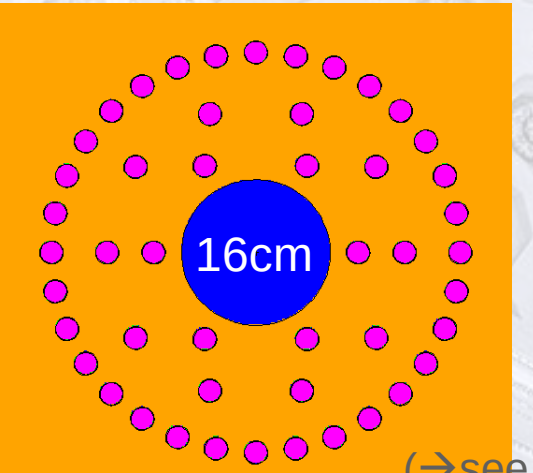
- Implantation/Decay device discussed (WAS3ABI vs. AIDA) and decided: **AIDA**

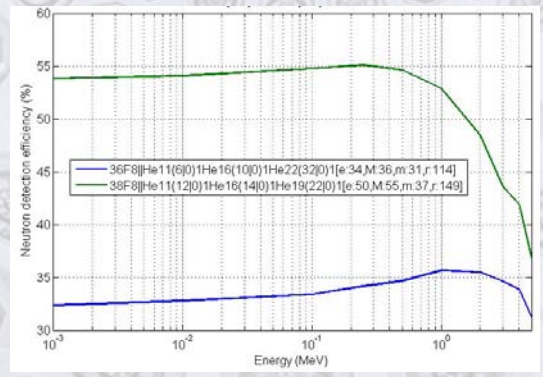


(→see talk by T.Davinson)

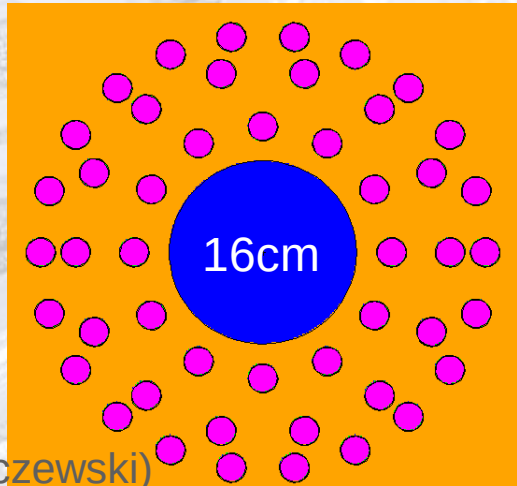
- Preliminary configuration for BRIKEN detector (at that time just BELEN):

48 tubes → ε_n=54%





48 tubes → ε_n=33%



MCNPX Simulations by UPC-Barcelona Group

(→see talks by K.Matsui, G.Cortes, J.L.Tain, K.Rykaczewski)

Summary of the 1st BRIKEN Workshop

- General talks:
  - Experiments with BELEN detector at JYFL and at GSI, R.Caballero (UPC)
  - (early) Plans for VANDLE at RIKEN, M.Madurga (Univ. of Tennessee)

    (→see talks by F.Montes, K.Rykaczewski, R.Caballero)
  - One talk dedicated to Digital Data Acquisition System (J.Agramunt)

    (→see talks by Baba-san, J. Agramunt)
- A flavour of the BRIKEN physics:

Presenter	Institute	Physics
A. Estrade	University of Edinburgh, UK	Synergy for masses and neutron branching measurements
I. Dillmann & M. Marta	GSI Darmstadt, Germany	Multiple neutron emitters, several candidates around ^{78}Ni and ^{132}Sn
D. Cano-Ott	CIEMAT Madrid, Spain	High-accuracy data on FF neutron branching ratios for GenIV reactors and ADS systems
C. Domingo-Pardo	IFIC Valencia, Spain	b-delayed n-emission for the Rare Earth Peak (A =160 region)
F. Montes	NSCL-MSU, USA	b-decay studies relevant for the A=130 r-process peak (^{139}Sb)

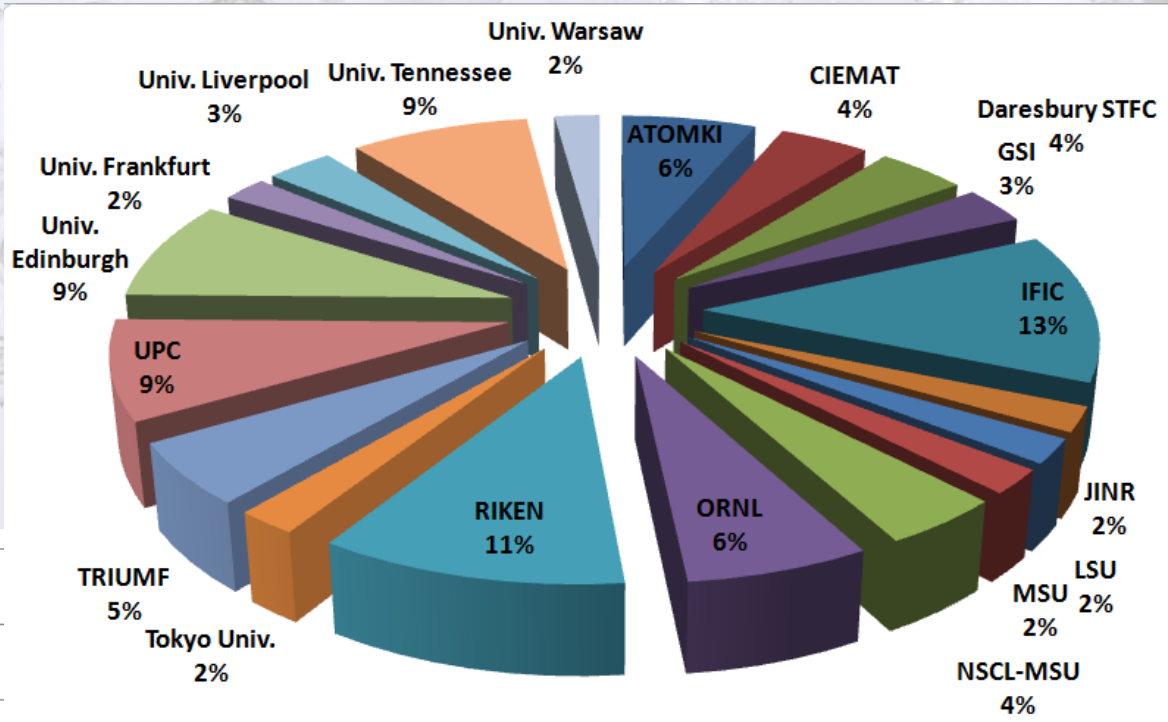
- We will enjoy more detailed and new proposal ideas in this workshop!

RIKEN feelings about this

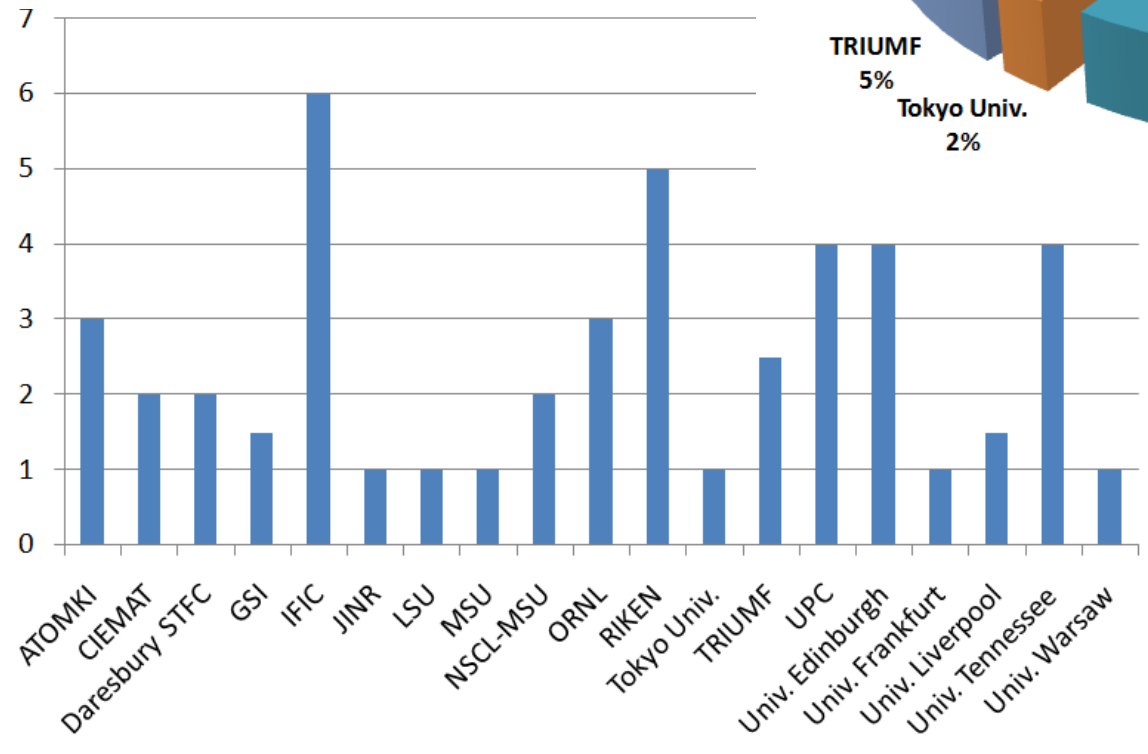
The serious stuff: Workshop @ RIKEN in 2013

- beta-n is important → Real chance of beam time allocation
- Identify Collaboration / Collaboration philosophy & aims
- Physics cases
- Regions of interest overlapping with beta-gamma
- Import regulations (specially 3He)
- Technical
  - Selection of detector type (3He? liquid scintillator? Better 3He?)
  - Location/background test
- OTHER
- GOAL IS TO GET RIKEN COMMITMENT TO RUN BETA-N EXPERIMENTS

Current status of BRIKEN, what's new?



50 scientists from 19 institutions!



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Current status of BRIKEN, what's new?

- As stated in the previous workshop: one needs to define the Collaboration terms, a policy for data-analysis and publication, etc.
- Declared interest of several additional institutions: ATOMKI Hungary, ORNL, TUK USA TRIUMF Canada, etc.

Scientific Collaboration Agreement

Beta delayed neutron measurements at RIKEN Collaboration (BRIKEN)

Participating Institutions (iao):

ATOMKI Institut for Nuclear Research, Hungary.

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas CIEMAT, Spain.

Daresbury Laboratory STFC, UK.

GSI Helmholtzzentrum für Schwerionenforschung GmbH, Germany.

Instituto de Física Corpuscular IFIC (CSIC-University of Valencia), Spain.

Joint Institute for Nuclear Research JINR, Russia.

National Superconducting Cyclotron Laboratory- Michigan State University NSCL-MSU, USA.

Oak Ridge National Laboratory ORNL, USA.

RIKEN Nishina Center, Japan.

Tokyo University, Japan.

TRIUMF Canada's National Laboratory for Particle and Nuclear Physics, Canada.

Universitat Politècnica de Catalunya UPC, Spain.

University of Edinburgh, UK.

University of Frankfurt, Germany.

University of Liverpool, UK.

University of Tennessee Knoxville UTK, USA

Louisiana State University LSU, Baton Rouge, USA

Mississippi State University, Mississippi State, USA

University of Warsaw, Warsaw, Poland

- Nature of the project:
  - Campaign of β-delayed neutron measurements at RIKEN
- Terms of the Collaboration:
  - Open Collaboration Project
  - Commitment with instrumentation
- Milestones:
  - Present Workshop
  - NP-PAC, December 2013
  - Commissioning: 2014 (?)
  - Campaign: 2014/2015 (?)
- List of collaborators
- Signing institutions
- Annex:
  - Hardware Contributions
  - Software Contributions

To be discussed/agreed in this Workhsop!

RIKEN feelings about this

The serious stuff: Workshop @ RIKEN in 2013

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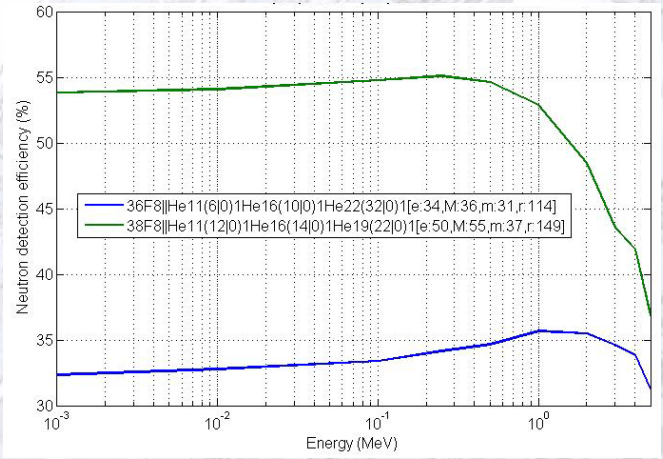
Current status of BRIKEN, what's new?

Institute	Instrumentation	Amount
Univ.Edinburgh	AIDA (+ DACQ)	
IFIC-Valencia	Self-triggered digital DACQ	
UPC-Barcelona	^{3}He-Counters 8 atm 68 cm x 2.5 cm	42
GSI-Darmstadt	^{3}He-Counters 10 atm 68 cm x 2.5 cm	10
RIKEN Nishina	^{3}He-Counters 5 atm 40 cm x 2.5 cm	26
ORNL	^{3}He-Counters 10 atm 70 cm x 5.1 cm	58
	^{3}He-Counters 10 atm 70 cm x 2.5 cm	16
JINR	^{3}He-Counters 4 atm 50 cm x 3 cm	20 (or more)
ORNL/TUK/IFIC/UPC	Readout electronics	

Current status of BRIKEN, what's new?

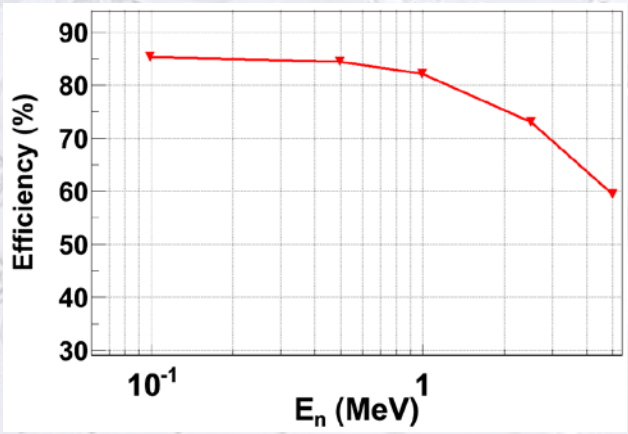
48 tubes → $\varepsilon_n^{0.5MeV}$ = 54%

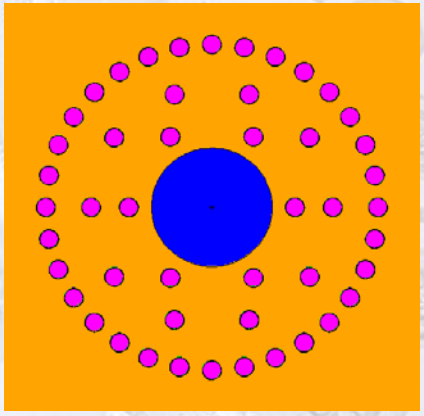
153 tubes → $\varepsilon_n^{0.5MeV}$ = 85%

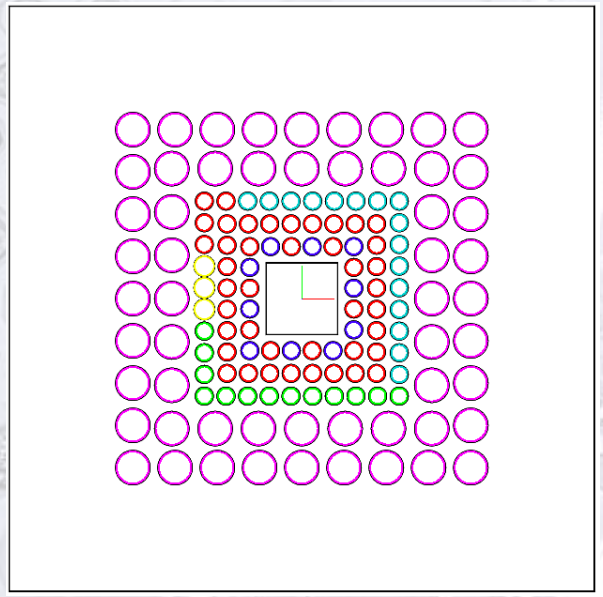


of ^{3}He tubes **x3**

Efficiency **up by 60%**
(a factor 1.6)



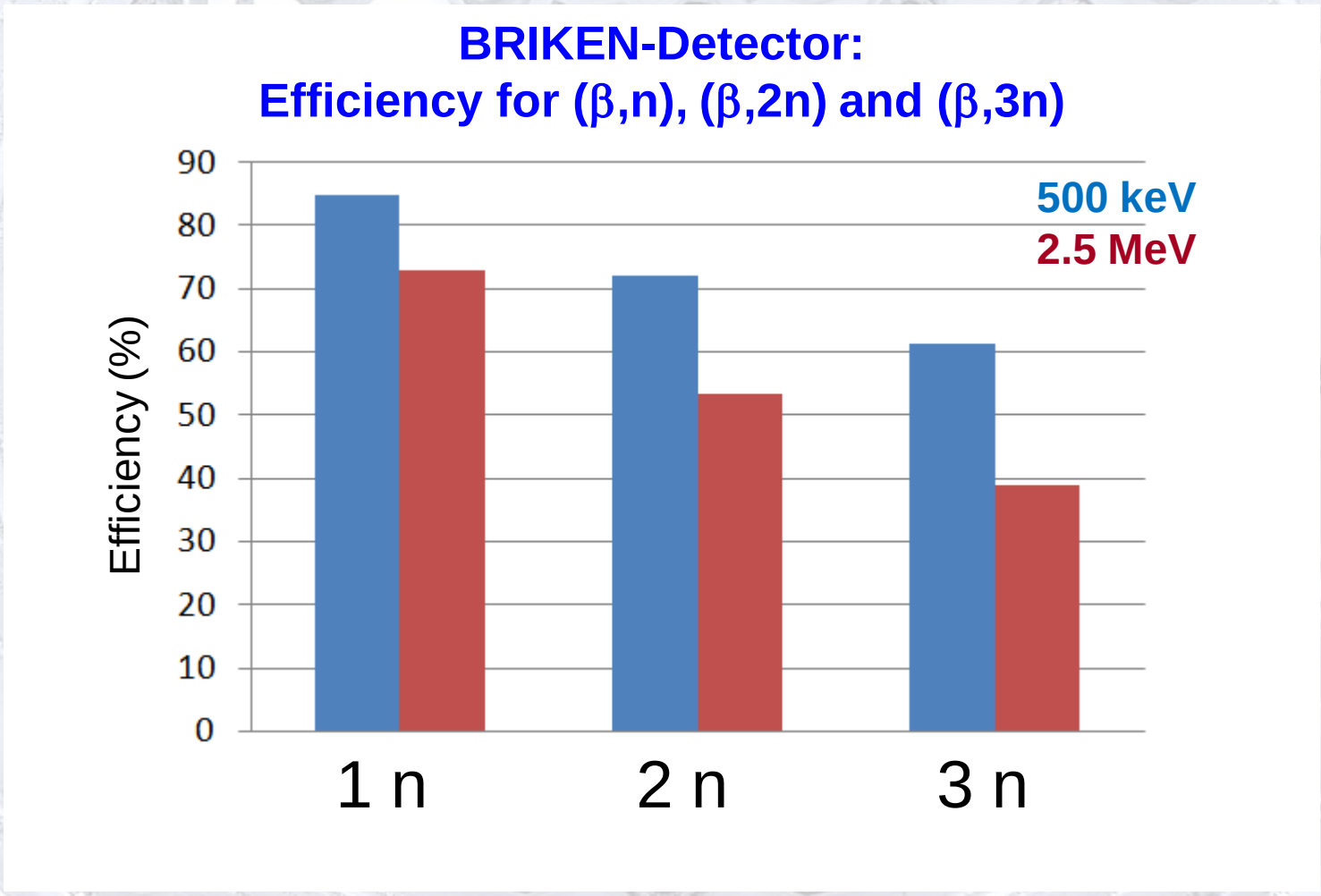




- The only limit will be the neutron branching itself → if there are neutrons, we will see them!

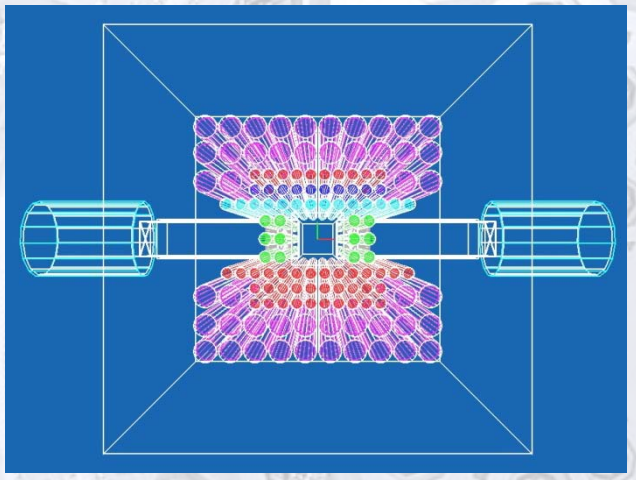
Current status of BRIKEN, what's new?

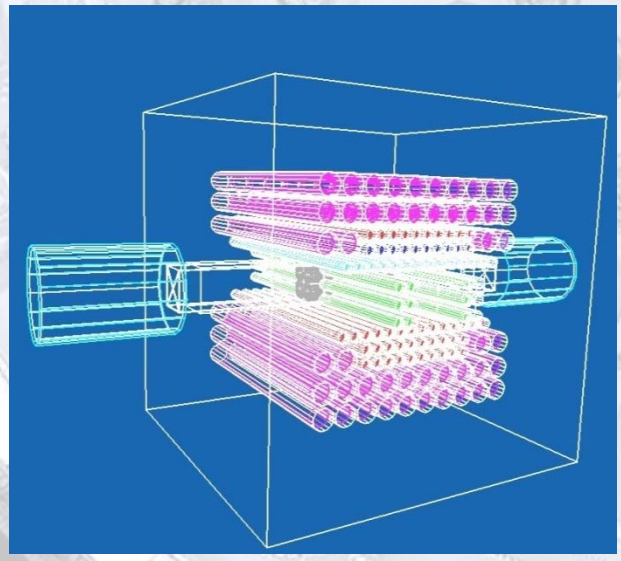
BRIKEN: a unique possibility to measure multiple neutron emitters!

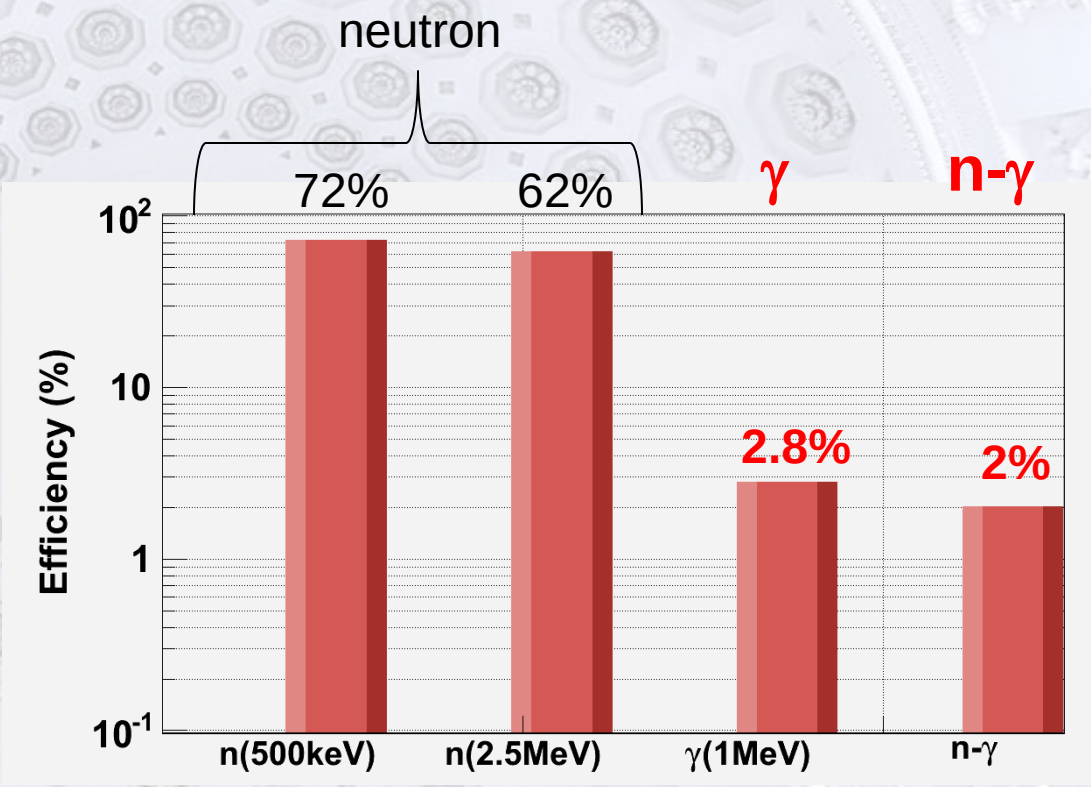


Current status of BRIKEN, what's new?

BRIKEN: a high performance also for gamma-neutron correlations!

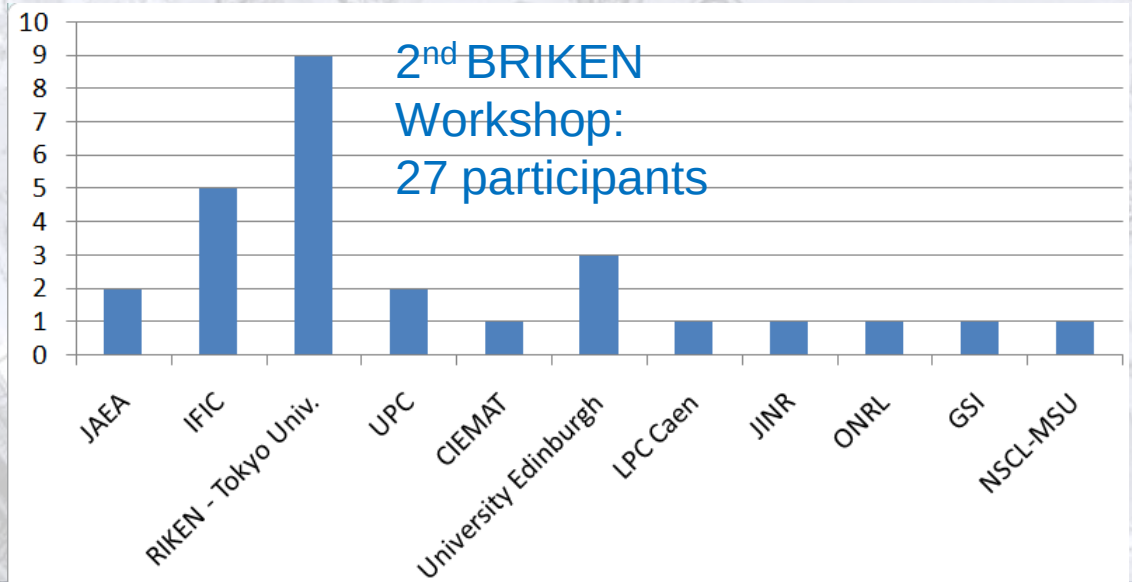


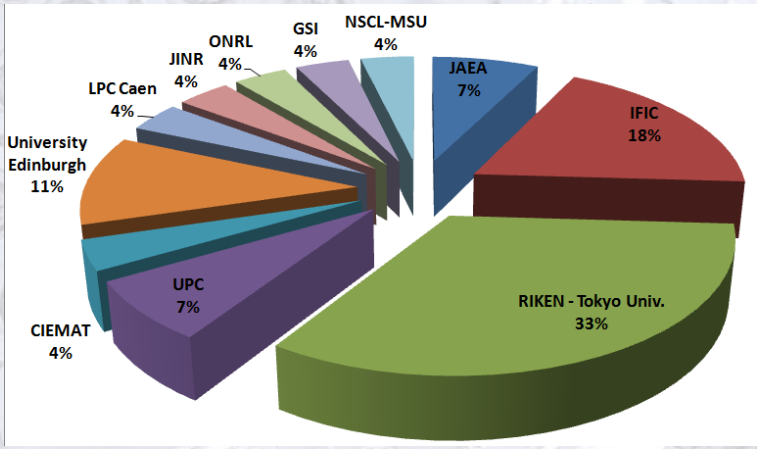




Goals for the present workshop

- Discuss the set-up for BRIKEN: converge towards the best geometry (or set of geometries) for high efficiency, for flat efficiency, for high energy, hybrid geometry, etc
- Acquistion system issues: two triggerless systems (BRIKEN N-detector + AIDA) to be combined with a trigger-asisted system (BigRIPS Tracking Detectors).
- Discuss physics cases, identify overlaps, merge wherever possible.
- Discuss / Agree on Collaboration Philosophy, Terms, Data Analysis Policy, etc.
- BRIKEN needs to run in “campaign mode”, allocate beam-time for all experiments in a raw.





Summary and Conclusions

• Beta Delayed Neutrons play a role of pivotal importance in many scientific areas (astrophysics, nuclear structure, nuclear technologies).

•BRIKEN is already a large scale –open- project, with 50 scientists and 19 institutions (and growing).

• The Collaboration has defined (preliminarily) its milestones, commitments, data analysis and publication policy (Scientific Collaboration Agreement), to be agreed and discussed in this workshop. Overlap between proposals will be checked before the PAC and an efficient use of the beam time will be priorized.

•The unique combination of very exotic beams attainable (only) at RIKEN BigRIPS with the largest attainable neutron-detection efficiency represents an excellent opportunity to gain such information: let’s go for it!

Thank you,
and
enjoy this workshop!