

**Comparison of Results  
from the 1<sup>st</sup> ICCHIBAN Experiment and  
Current Status of the 3<sup>rd</sup> ICCHIBAN Experiment**

一番

Y.Uchihori, H.Kitamura, K.Fujitaka, N.Yasuda (NIRS, Japan)  
and E. Benton (Eril Research Inc.)  
on behalf of ICCHIBAN Working Group and Participants

# Working Group

- Yukio Uchihori (Project Coordinator), NIRS, Japan
- Kazunobu Fujitaka (Chair), NIRS, Japan
- Eric Benton (Deputy Project Coordinator), Eril Research, USA
- Nakahiro Yasuda (Deputy Project Coordinator), NIRS, Japan
- Hisashi Kitamura, NIRS, Japan
- Masashi Takada, NIRS, Japan
- Tadayoshi Doke, Waseda University, Japan
- Cary Zeitlin, LBNL, USA
- Jack Miller, LBNL, USA
- Takeshi Takashima, Nagoya Univ., Japan

# History of ICCHIBAN runs

Feb. 11-13, 2002	1 <sup>st</sup> ICCHIBAN Experiment (For Active Detectors)
May 23-28, 2002	2 <sup>nd</sup> ICCHIBAN Experiment (For Passive Detectors)
Sep. 2-4, 2002	7 <sup>th</sup> WRMISS Workshop on Paris
Feb. 3-6, 2003	3 <sup>rd</sup> ICCHIBAN Experiment (For Active Detectors)
May 19-30, 2003	4 <sup>th</sup> ICCHIBAN Experiment (For Passive Detectors)
Sep. 3-5, 2003	8 <sup>th</sup> WRMISS Workshop on Berkeley

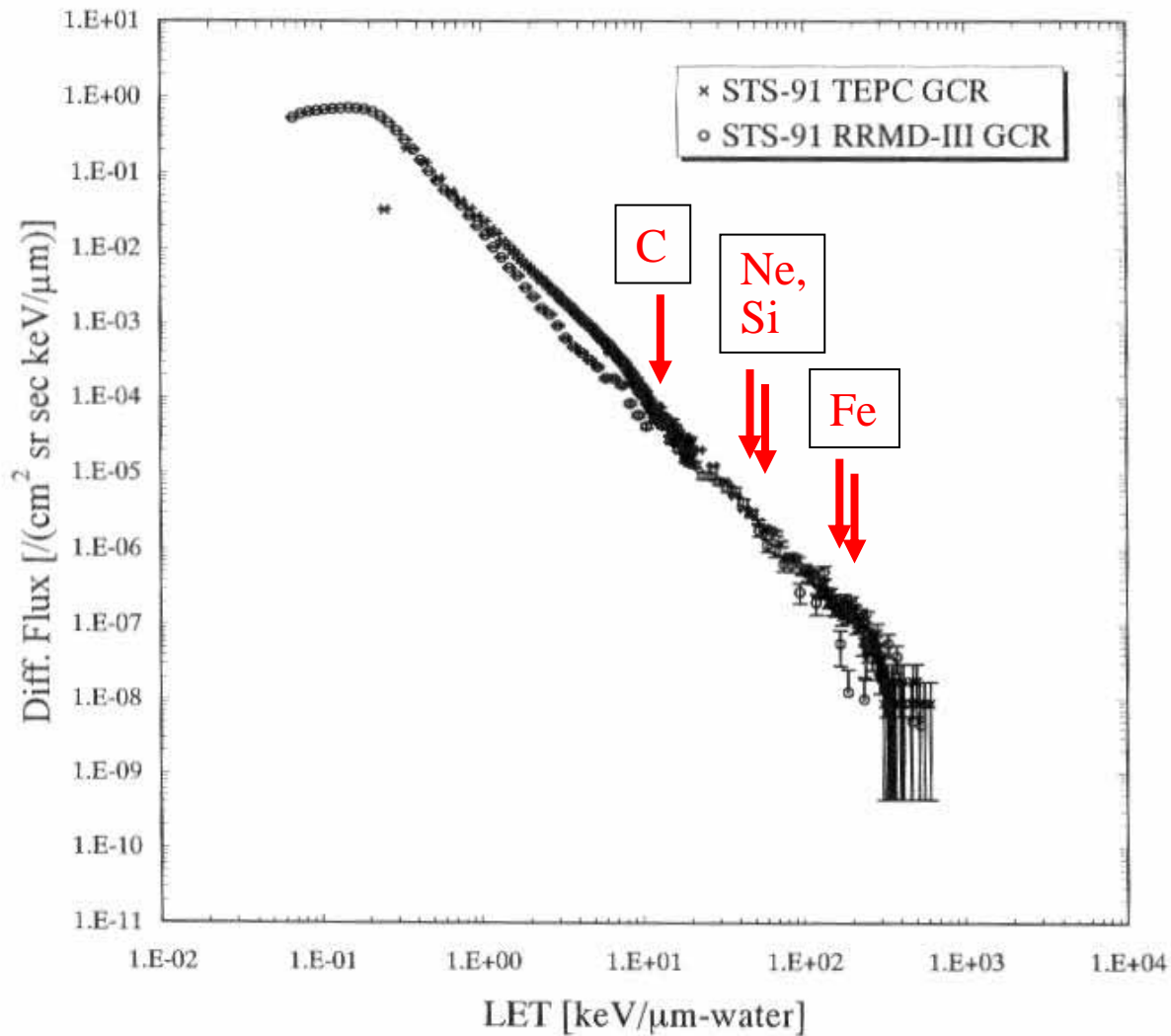
## 1<sup>st</sup> ICCHIBAN Run (2002)

Date	Time		Ion & Energy	LET in H <sub>2</sub> O
Feb. 11	11:00~7:00	20 hrs	C(400MeV/u)	11 keV/um
Feb. 12 & Feb. 13	21:00~7:00 21:00~7:00	20 hrs	Fe(400MeV/u)	204 keV/um

## 3<sup>rd</sup> ICCHIBAN Run (2003)

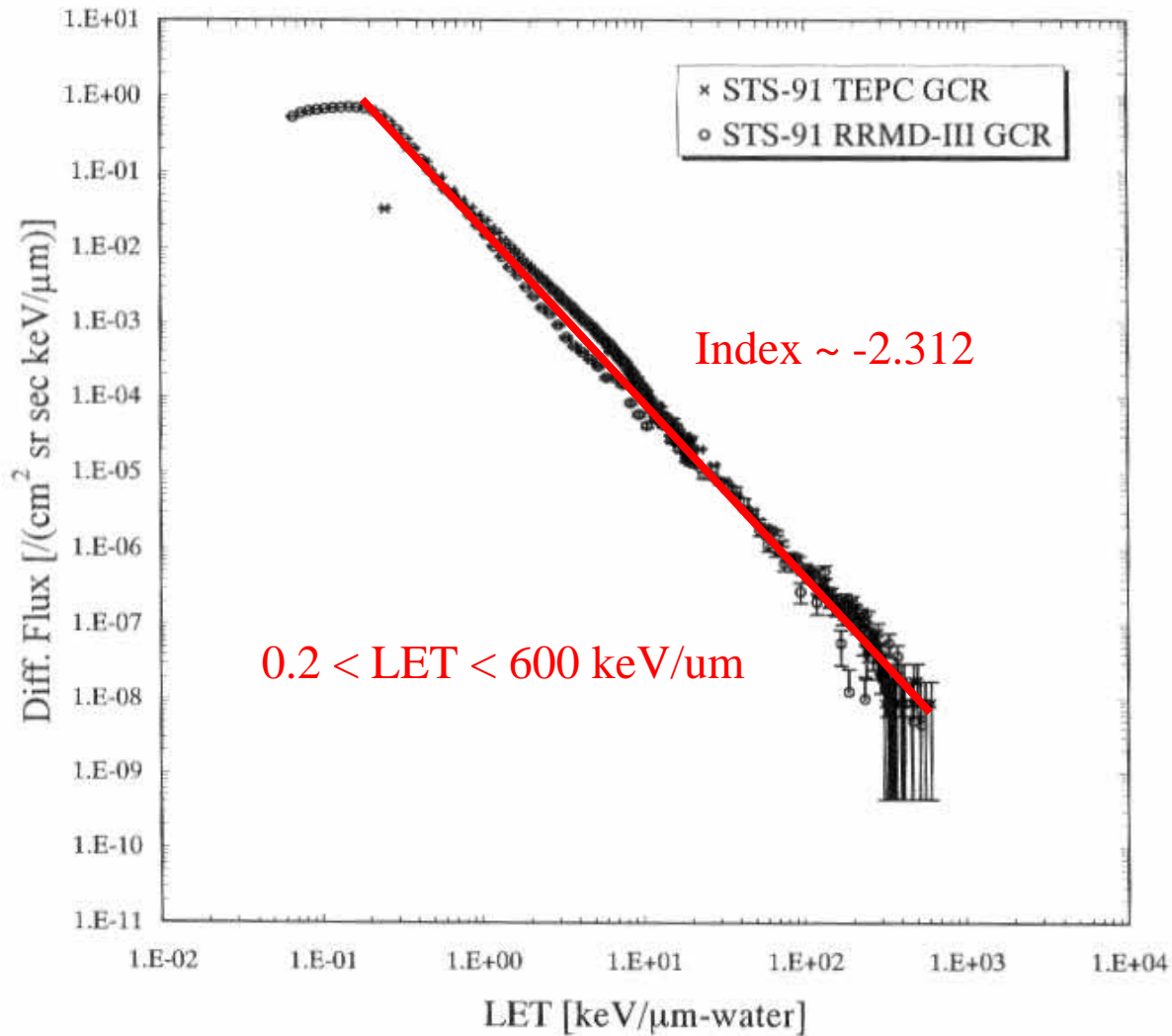
Date	Time		Ion & Energy	LET in H <sub>2</sub> O
Feb. 3 & Feb. 4	21:00~7:00 21:00~7:00	20 hrs	Si(800MeV/u)	46 keV/um
Feb. 5 & Feb. 6	21:00~7:00 21:00~7:00	20 hrs	Fe(500MeV/u)	185 keV/um
Feb. 11	16:00~7:00	15 hrs	Ne(400MeV/u) in BIO	31 keV/um

# Covered LET Region in IC-1 & 3



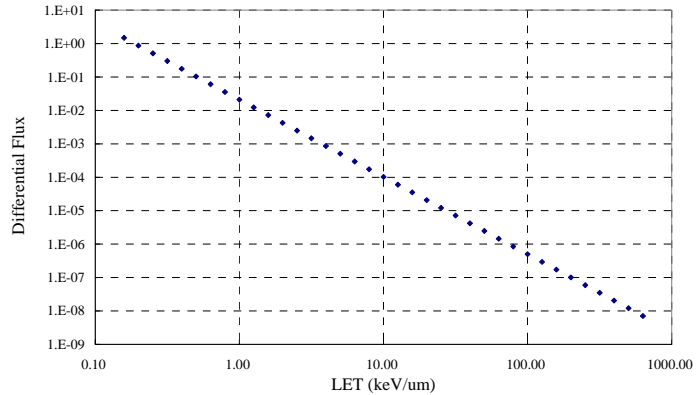
T.Doke et al.,  
Rad. Meas. 33  
(2001) 373

# Index of LET spectrum

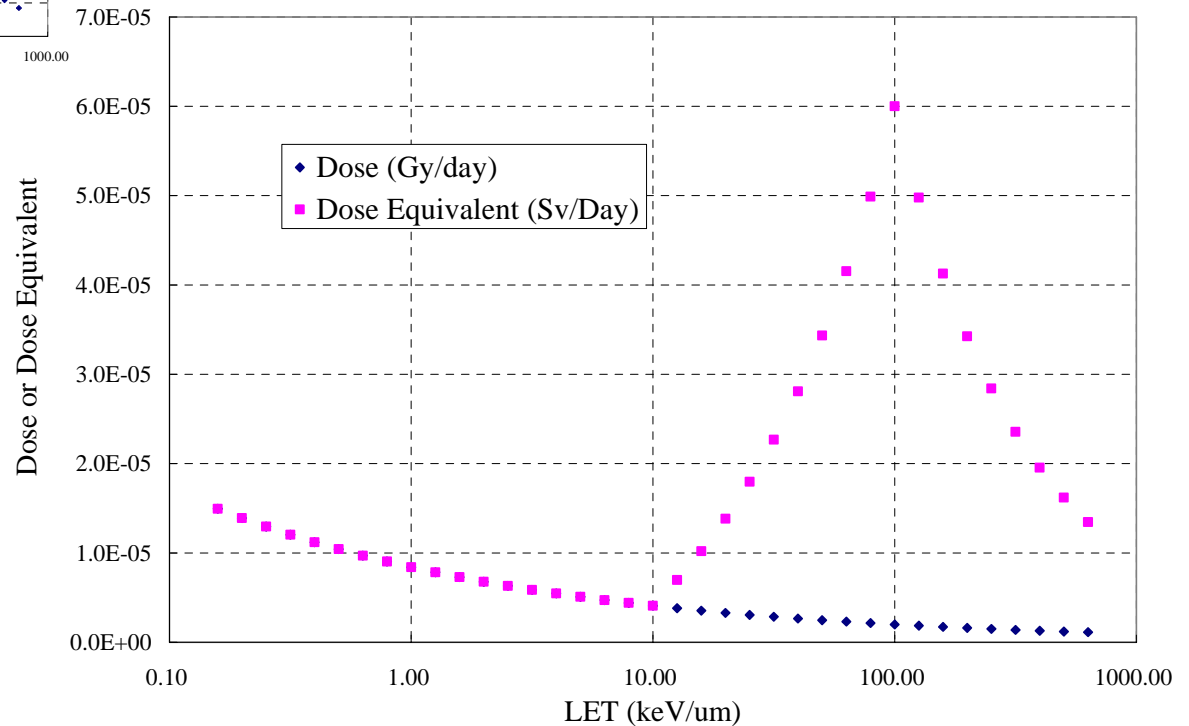


GCR

# Simulation of LET spectrum

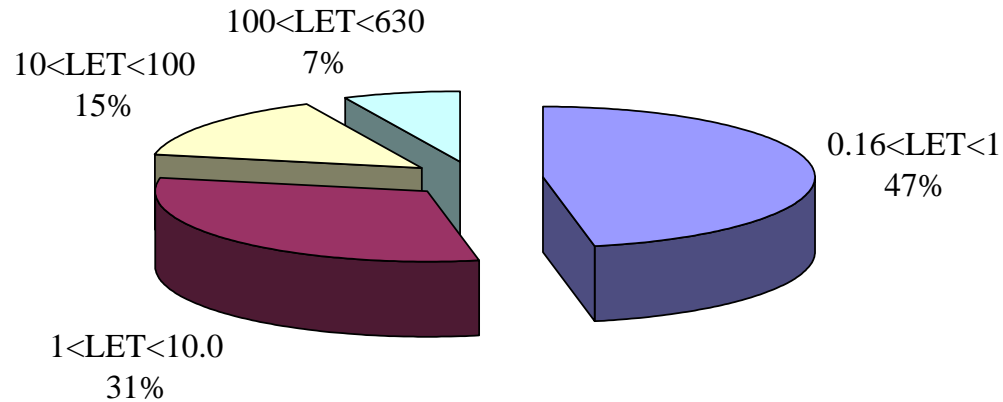


If we mistake calibration  
about 20 % above 10 keV/um,  
Total Dose Equivalent also  
increase about 16 %.

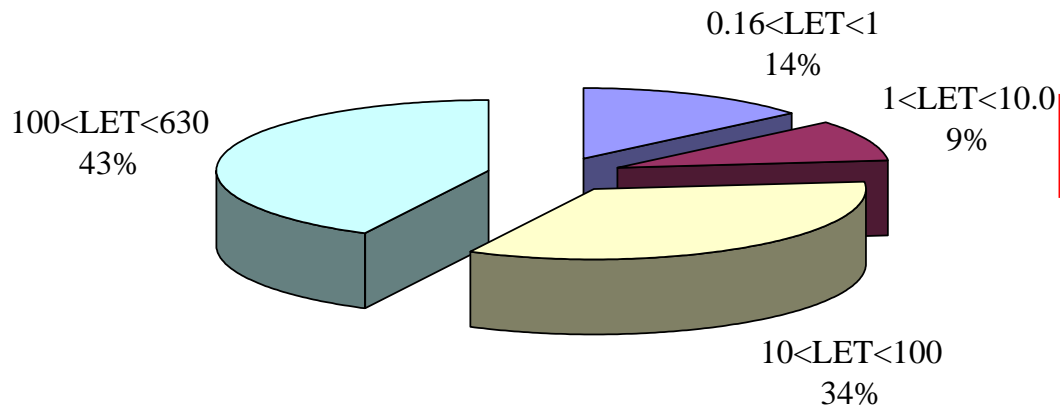


# Heavy Ion Contribution for Dose and DE

GCR



Dose



Dose Eq.



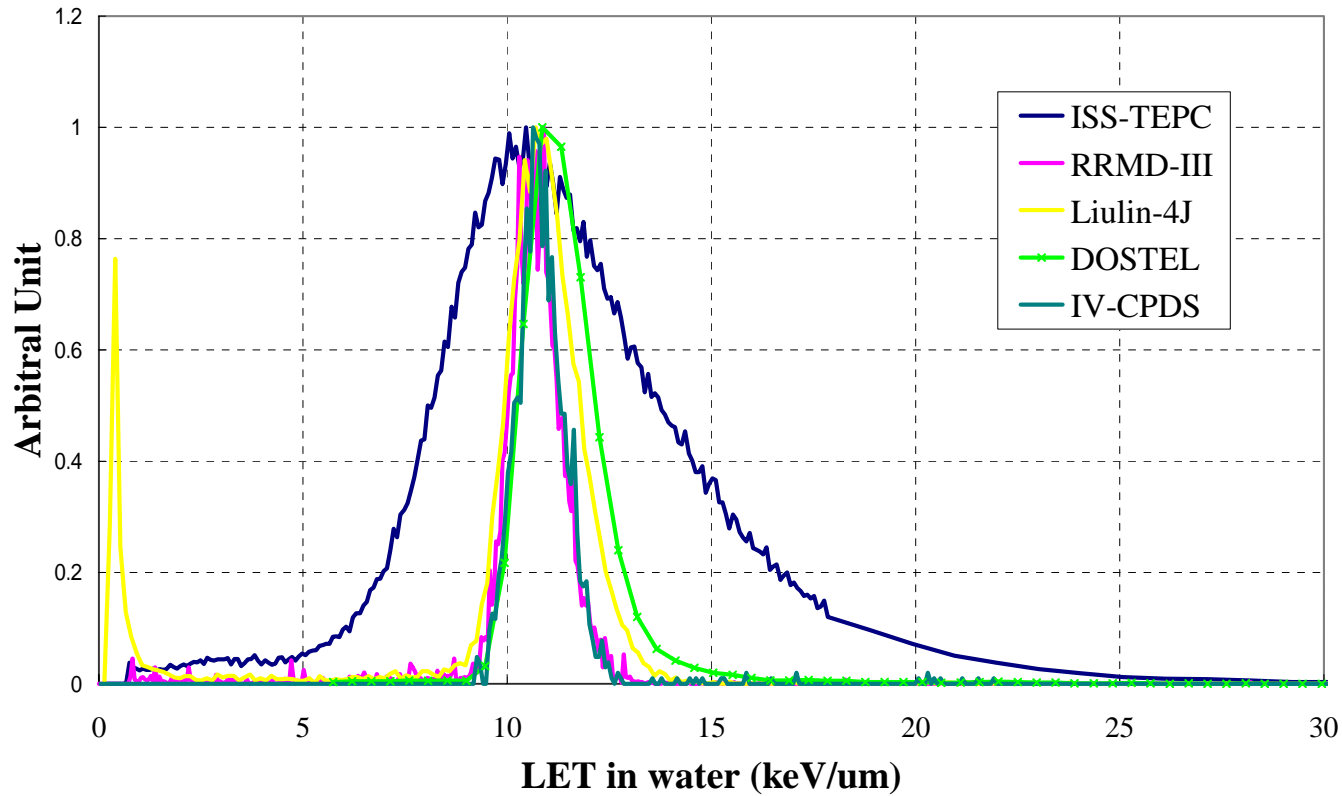
1<sup>st</sup> ICCHIBAN Run

# 1<sup>st</sup> ICCHIBAN Participants

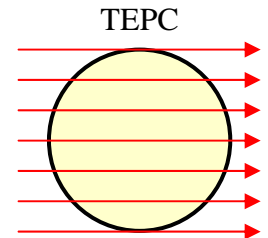
Monitor Name	Institution	Nation	Detection Principle	Type
RRMD-III	Waseda Univ.	Japan	Silicon Telescope	Active
DOSTEL-1	Kiel Univ.	German	Silicon Telescope	Active
DOSTEL-2			Silicon Telescope	Active
DOSTEL-D			Silicon Telescope	Active
Shuttle-TEPC	NASA-JSC	USA	Proportional Counter	Active
ISS-TEPC			Proportional Counter	Active
IV-CPDS			Silicon Telescope + $\checkmark$	Active
Liulin-4J	NIRS	Japan	Silicon	Active
Liulin E087	STIL-BAS	Bulgaria	Silicon	Active
Dosimeter Package	Eril Research	USA	TLD+CR-39	Passive
Dosimeter Package	NASDA	Japan	TLD+CR-39	Passive
Ground Base Detector	LBNL	USA	Silicon Stack + SC	Active

# Comparison for Carbon Run

ICCHIBAN-1, Carbon 400MeV/u

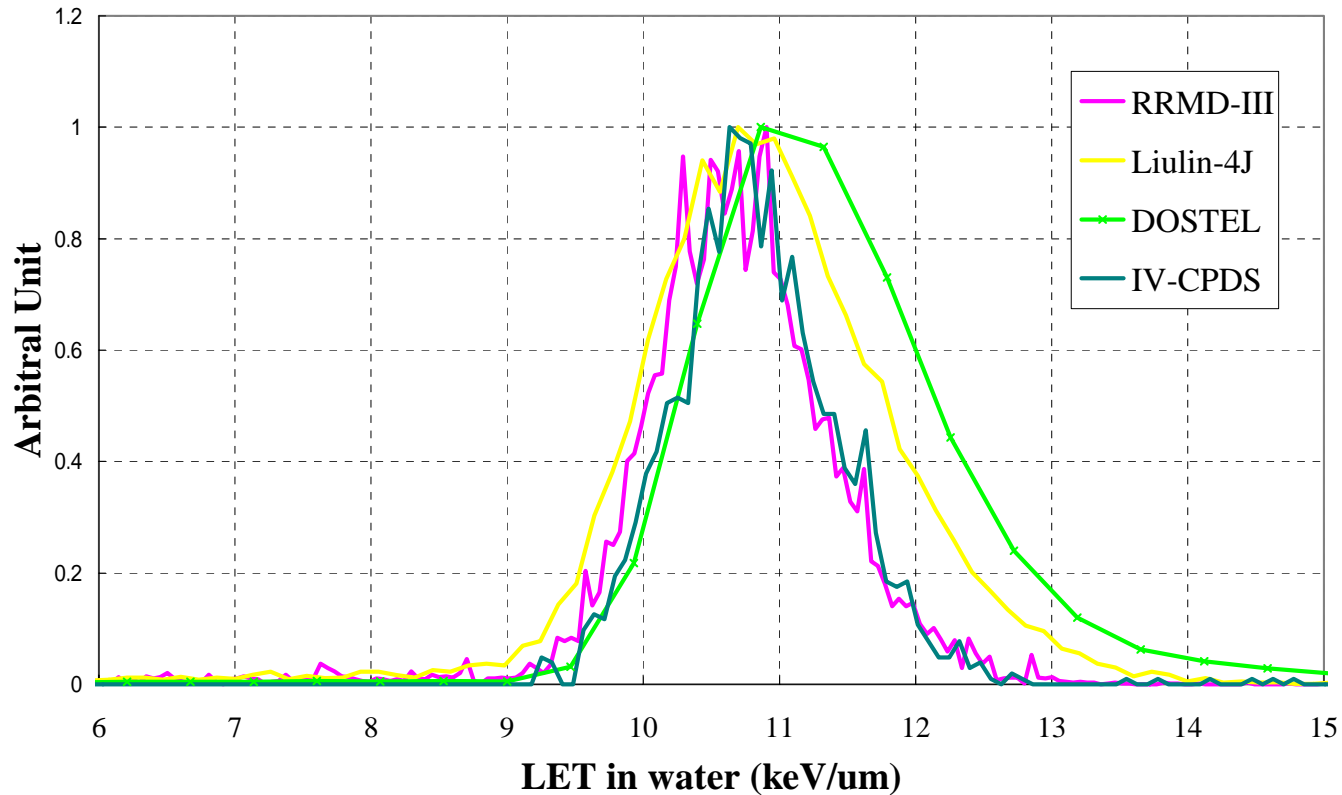


0 degree  
Center  
No Absorber



# Comparison for Carbon Run (Only Si Detectors)

ICCHIBAN-1, Carbon 400MeV/u



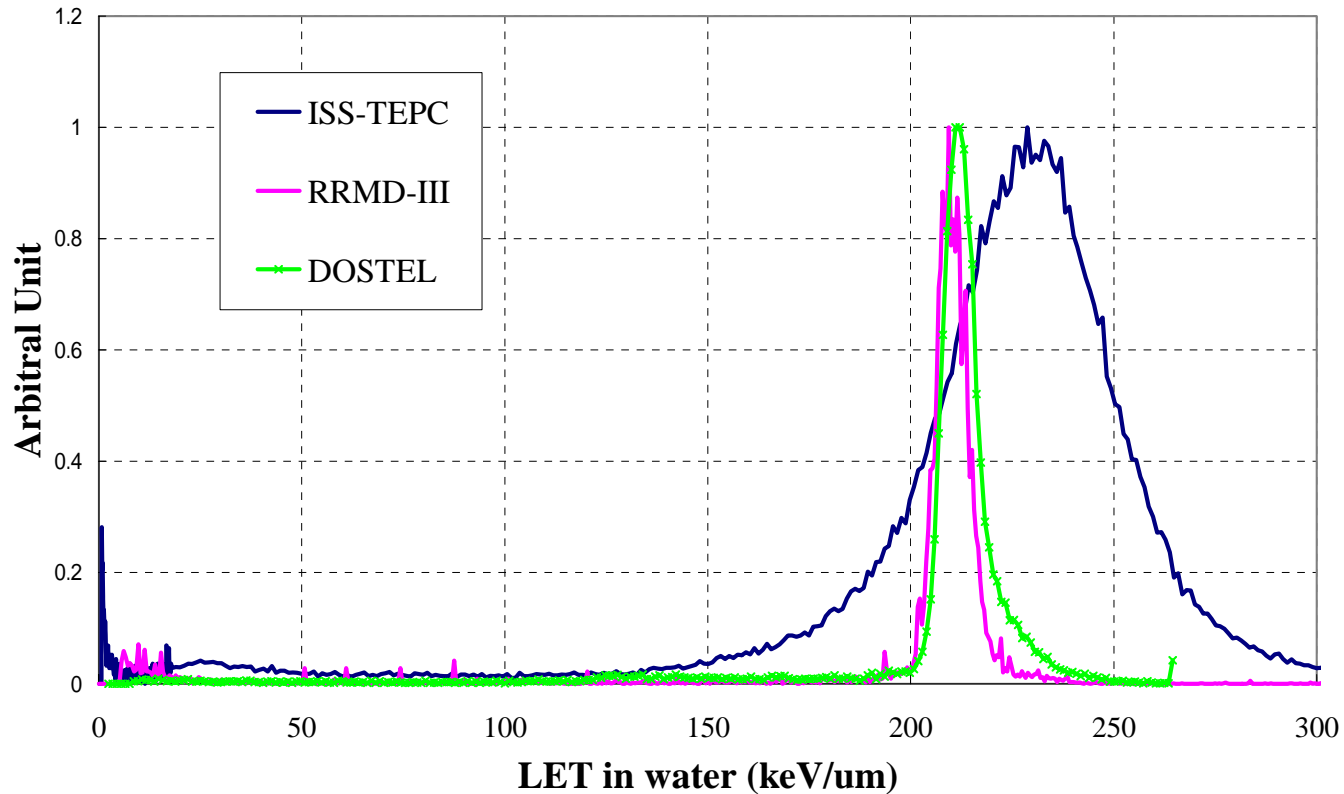
0 degree  
Center  
No Absorber

# Comparison Table (C400, 0deg., Center)

	Avg. LET (keV/um- H <sub>2</sub> O)	Avg. y <sub>f</sub> (keV/um- H <sub>2</sub> O)	Avg. y <sub>d</sub> (keV/um- H <sub>2</sub> O)	Quality Factor (ICRP-60)
RRMD-III	10.6	-----	-----	1.26
DOSTEL-2	10.7	-----	-----	1.6
DOSTEL-D	(10.7)	-----	-----	1.7
IV-CPDS	N.R.	-----	-----	N.R.
ISS-TEPC	-----	11.76	13.49	2.39
Liulin-4J	(9.8) 10.8	-----	-----	(1.29) 1.32
Calculation	10.9	-----	-----	(1.29)

# Comparison for Iron Run

ICCHIBAN-1, Iron 400MeV/u



0 degree  
Center  
No Absorber

CPDS and  
Liulin-4J  
have no data.

# Comparison Table (Fe400, 0deg., Center)

	Avg. LET (keV/um- H <sub>2</sub> O)	Avg. y <sub>f</sub> (keV/um- H <sub>2</sub> O)	Avg. y <sub>d</sub> (keV/um- H <sub>2</sub> O)	Quality Factor (ICRP-60)
RRMD-III	198.24	-----	-----	21.23
DOSTEL-1	227.6	-----	-----	20.0
DOSTEL-2	(227.6)	-----	-----	20.3
ISS-TEPC	-----	222.53	235.63	15.54
Calculation	207.2	-----	-----	(20.8)

# 3<sup>rd</sup> ICCHIBAN Run



# 3<sup>rd</sup> ICCHIBAN Participants

Monitor Name	Institution	Nation	Detection Principle	Type
RRMD-III	Waseda Univ.	Japan	Silicon Telescope	Active
DOSTEL-1	Kiel Univ.	German	Silicon Telescope	Active
DOSTEL-2			Silicon Telescope	Active
DOSTEL-D			Silicon Telescope	Active
Shuttle-TEPC	NASA-JSC	USA	Proportional Counter	Active
ISS-TEPC			Proportional Counter	Active
IV-CPDS			Silicon Telescope + Č	Active
Liulin-4J	NIRS	Japan	Silicon	Active
Dosimeter Package	Eril Research	USA	TLD+CR-39	Passive
Ground Base Detector	LBNL	USA	Silicon Stack + SC	Active

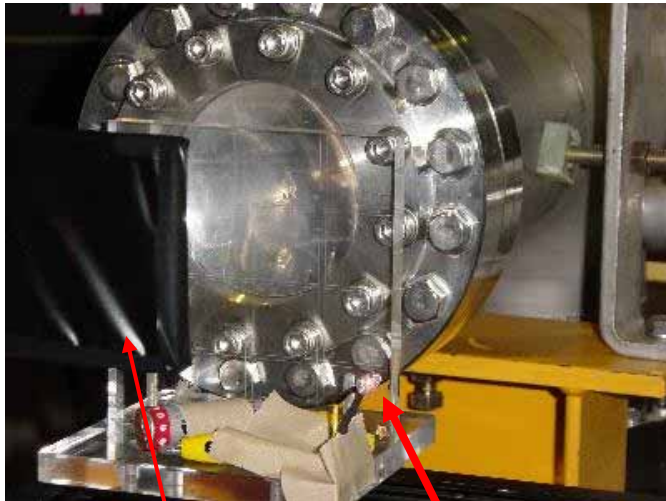
# 3<sup>rd</sup> ICCHIBAN Run (2003)

Date	Time		Ion & Energy	LET in H <sub>2</sub> O
Feb. 3 & Feb. 4	21:00~7:00 21:00~7:00	20 hrs	Si(800MeV/u)	46 keV/um
Feb. 5 & Feb. 6	21:00~7:00 21:00~7:00	20 hrs	Fe(500MeV/u)	185 keV/um
Feb. 11	16:00~7:00	15 hrs	Ne(400MeV/u) in BIO	31 keV/um

## Differences with IC-1

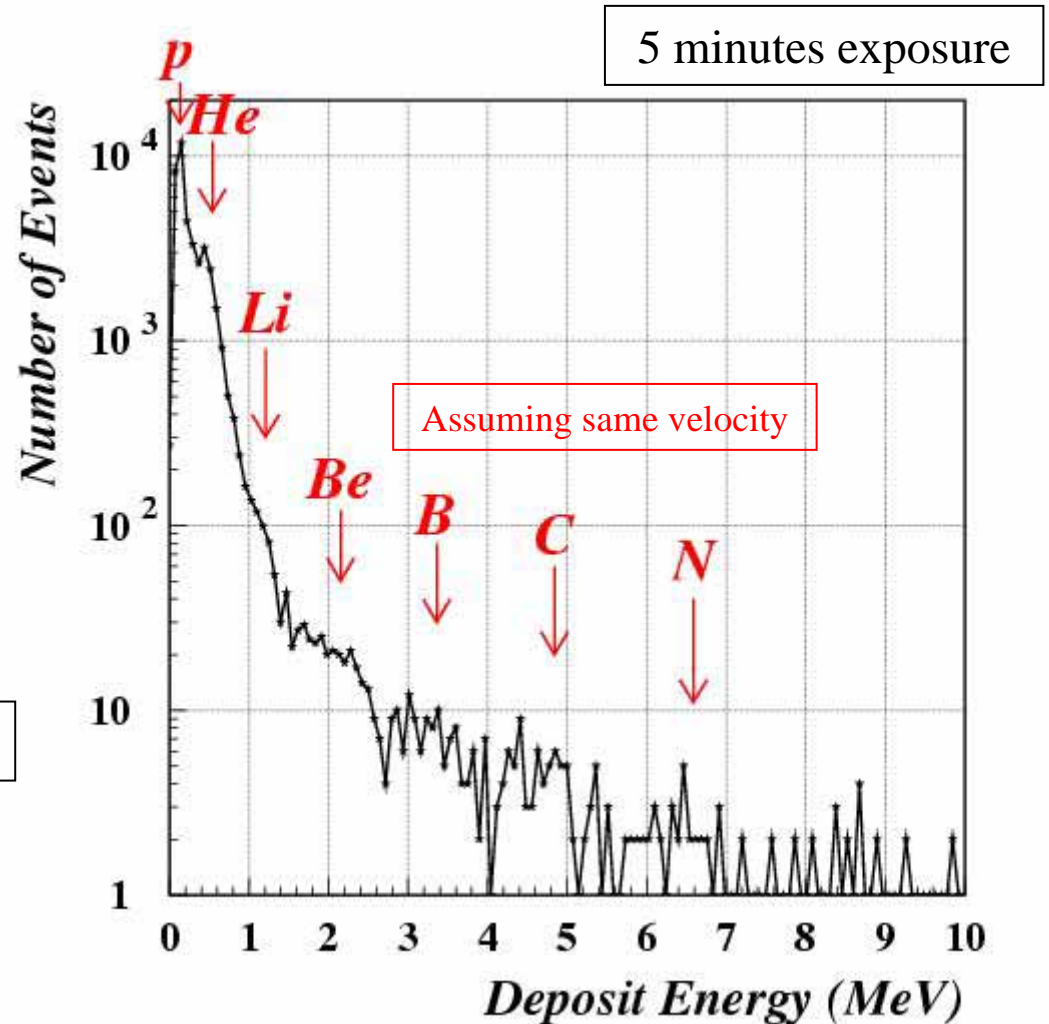
- Different Ions and Energy (Highest in HIMAC)
- Fragment Beam
- Wide, Uniform Beam at Biology Room in HIMAC

# Fragments from Si(800) Beam (Liulin-4J data)

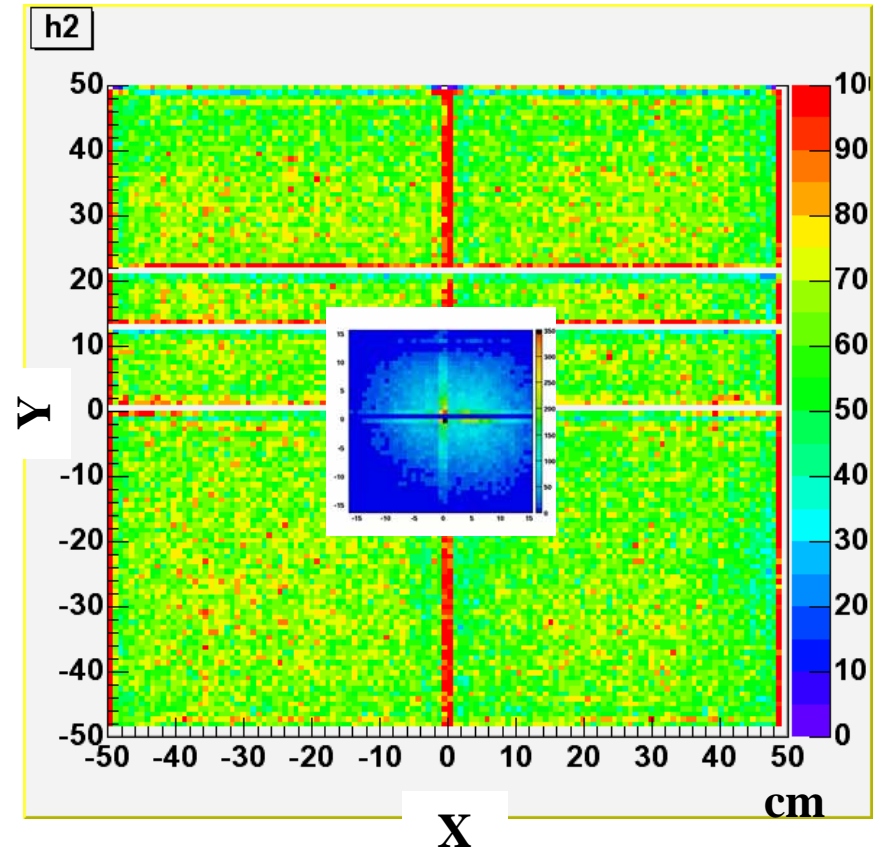
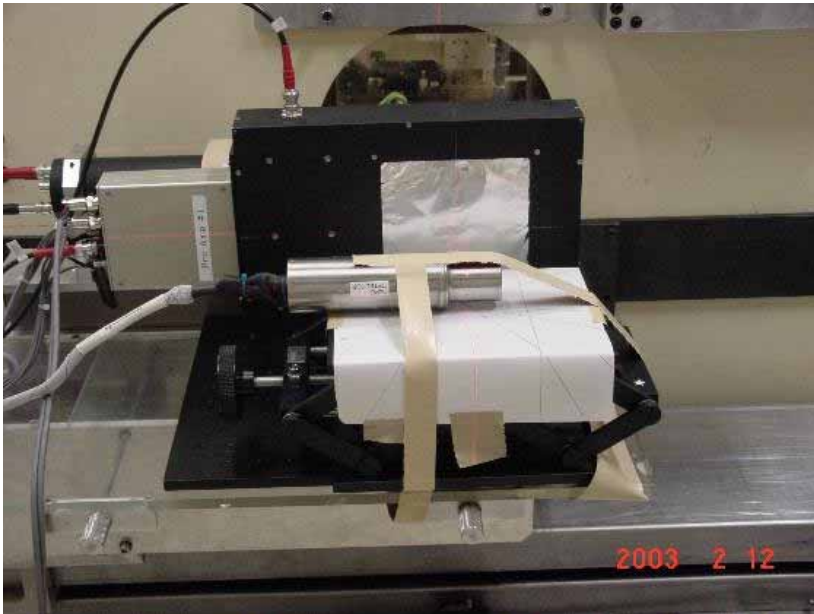


Plastic Scintillator  
(50umt)

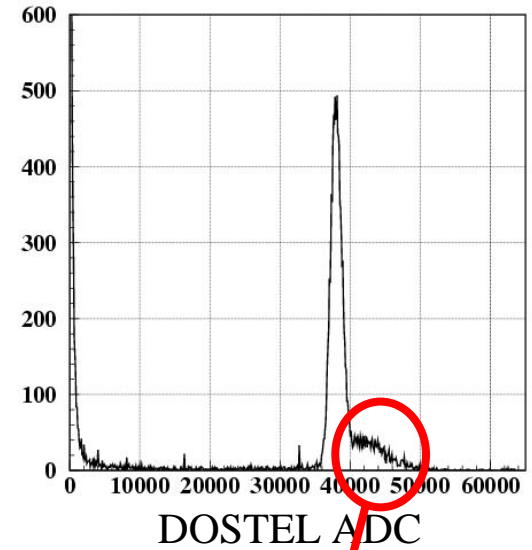
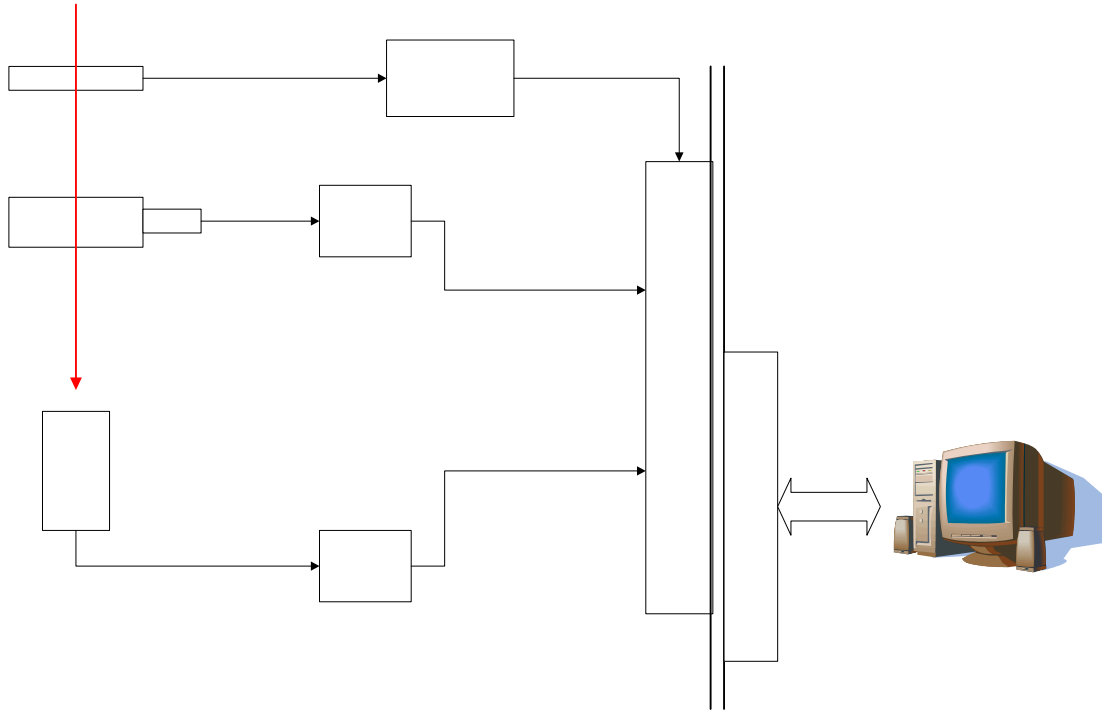
Acryl Target (1cmt)



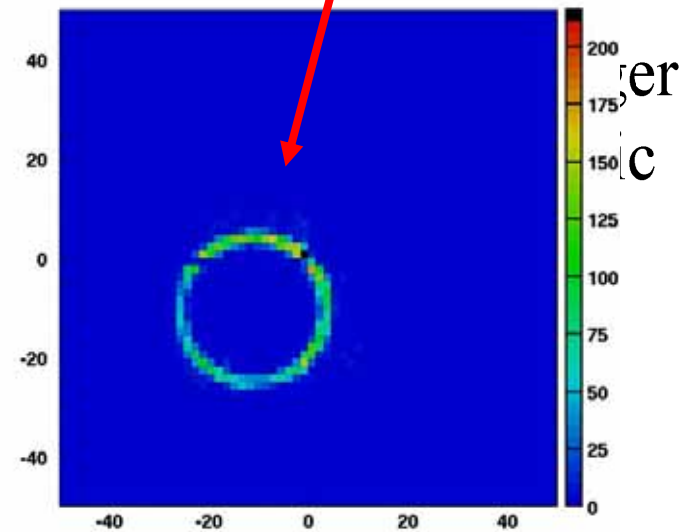
# Wide and Uniform Beam in BIO



# Position Sensitive Detector + Monitor



Trig. SC



## *What have we gotten from ICCHIBAN-1 & 3?*

- Very Good Calibration for high LET region.
- Comparison of LET distribution and calculation method between detectors.
- Understanding of other detectors.
- Confirmation of hardware problems.
- Confirmation of software problems.

## More...

- Most of silicon detector show good agreement of LET spectrum.
- TEPC shows wide distribution but it comes from its structure (chord length).
- Several monitors could not measure high LET ions like Fe because they were concentrated to measure protons and light ions.
- A Peak and average values of Fe LET distribution of ISS-TEPC were not consistent with Fe LET.
- LET distribution of DOSTEL was good agreement for calculation. But, because the monitor could not measure path length in silicon, it must assume average path length for isotropic exposure.
- RRMD-III has good LET distribution. But we can see small portion of digitalization problem.

# Limitations of Intercomparison

- We understand that the ICCHIBAN comparison with heavy ion beams is not characterize all ability of monitors.
- Space radiation includes not only heavy ion but also protons and neutrons.
- In addition, we should consider the cost benefit, power consumption, available space, easy maintenance and so on when we evaluate all monitors.
- Because of these limitations, we cannot summarize the results from ICCHIBAN runs yet.
- We have to perform intercomparison experiments not only at HIMAC but also at proton and neutron facilities.



## *What is the target of future ICCHIBAN runs?*

- Wide, uniform beam in BIO to compare total dose in all monitors.
- Isotropic exposures to confirm angle dependency.
- Proton runs in Loma Linda Univ. Medical Center Synchrotron Facility.
- Neutron runs...
- If possible, intercomparison in space environment.

# Future of ICCHIBAN runs

Sep. 3-5, 2003	8 <sup>th</sup> WRMISS Workshop on Berkeley
Sep. 6-8, 2003	1 <sup>st</sup> Proton-ICCHIBAN Experiment (For Active and Passive Detectors)
Feb. 14-18, 2004	5 <sup>th</sup> ICCHIBAN Experiment (For Active Detectors)

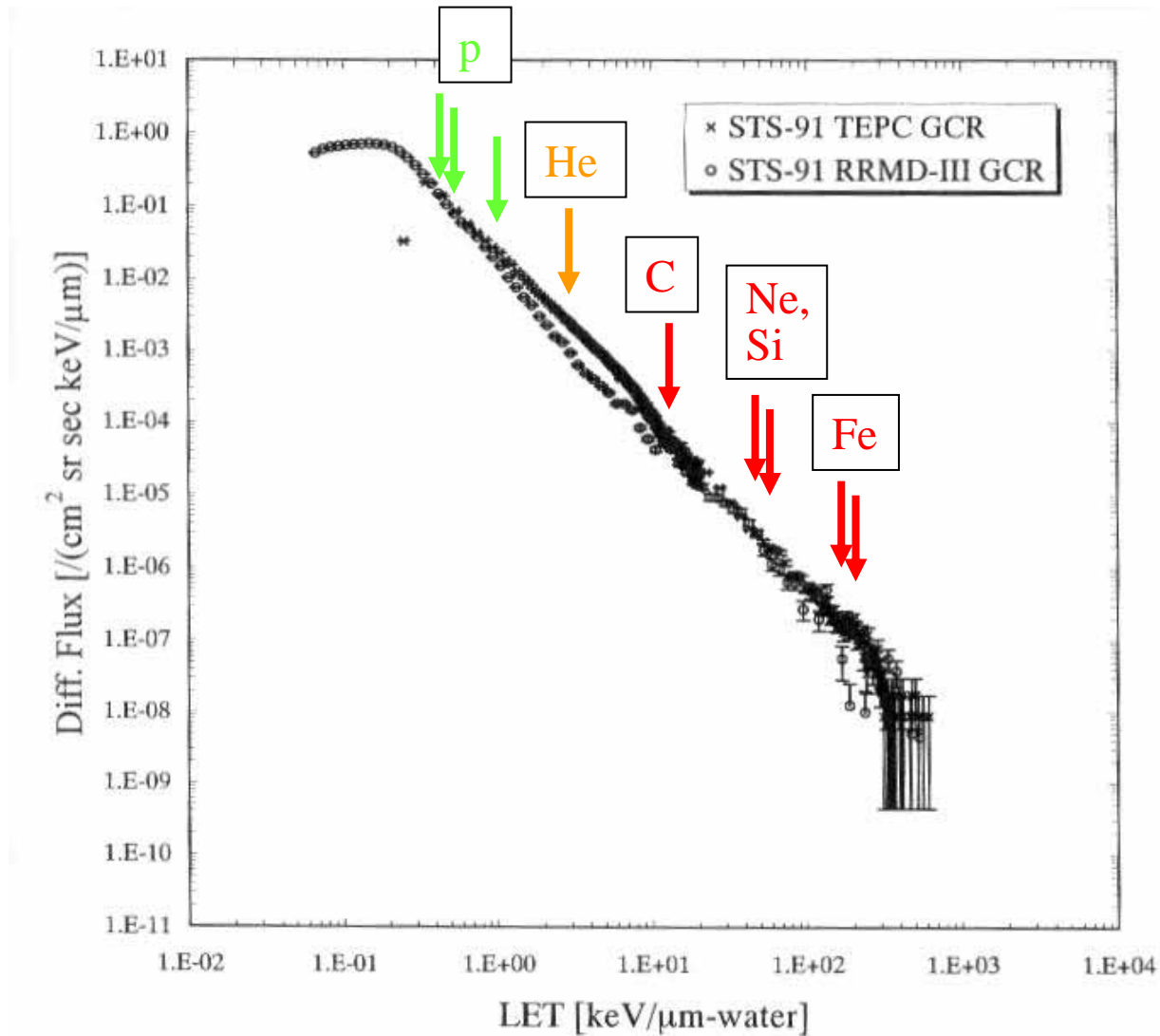
Winter, 2003	BRADOS Intercomparison (Space-ICCHIBAN #0) (For Passive Detectors)
--------------	--

IMBP, NIRS, ERI&OSU, ATI

# 5<sup>th</sup> ICCHIBAN Run (2004)

Date	Time		Ion & Energy	LET in H <sub>2</sub> O
Feb. 14	10:00~20:00	10 hrs	C(290MeV/u) in BIO	15 keV/um
Feb. 16	20:00~7:00	11 hrs	He(150MeV/u) in BIO	2.2 keV/um
Feb. 17	22:00~7:00	9 hrs	He(150MeV/u) in BIO	2.2 keV/um

# Covered LET Region in P-IC-1 & IC-5



T.Doke et al.,  
Rad. Meas. 33  
(2001) 373

# Conclusion

- 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> ICCHIBAN runs were carried out successfully at HIMAC in 2002 and 2003.
- We have compared the results and it will be published as HIMAC report in NIRS soon.
- 1<sup>st</sup> Proton-ICCHIBAN run will be performed on Sep. 6-8 at Loma Linda Synchrotron Facility and 5<sup>th</sup> ICCHIBAN run for active detectors will be performed on Feb. 14-18 2004. We welcome your participation to these runs.

*Thank you very much for your  
participation and your support  
for ICCHIBAN project!*