# Honoring Atsuhiko Ochi: A Tribute Session

15/10/2024

The 8th International Conference on Micro Pattern Gaseous Detectors, MPGD 2024

# Session Outline

- Scientific contributions and innovations
- Mentoring and guiding students and the research team
- Contributions to international R&D collaborations (RD51, DRD1) with proper representation of the Japanese community and of its research activities.

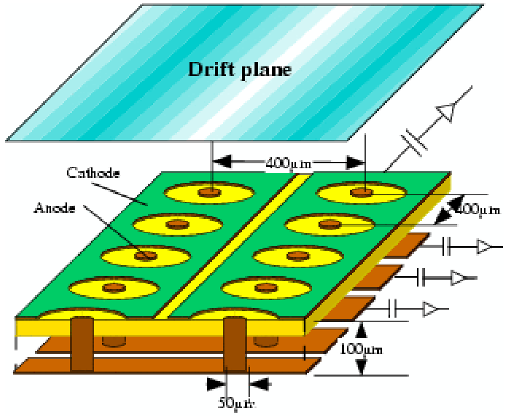

- Kentaro Miuchi, Kobe University
- Masato Takahashi , Kobe University
- Eraldo Oliveri, CERN

# Atsuhiko Ochi great mentor, tireless colleague, and heart-worming friend

Kentaro Miuchi
(Kobe University)
MPGD conference 2024

# Great Mentor

- μ–PIC brought me into NEWAGE, the dark matter business.
- Carbon sputtering (DLC) inspired me to build a TPC with a sheet-resistor field cage.



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Physics Letters B 578 (2004) 241–246

PHYSICS LETTERS B

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Detecting the WIMP-wind via spin-dependent interactions


Toru Tanimori, Hidetoshi Kubo, Kentaro Miuchi, Tsutomu Nagayoshi, Reiko Orito, Atsushi Takada, Atsushi Takeda



PTEP

Prog. Theor. Exp. Phys. **2019**, 063H01 (12 pages)
DOI: 10.1093/ptep/ptz048


**Development of a time projection chamber with a sheet-resistor field cage**


Kentaro Miuchi[1,*], Tomonori Ikeda[1], Hirohisa Ishiura[1], Kiseki D. Nakamura[1], Atsushi Takada[2], Yasuhiro Homma[1], Ko Abe[3,4], Koichi Ichimura[3,4], Hiroshi Ito[1], Kazuyoshi Kobayashi[3,4], Takuma Nakamura[1], Ryuichi Ueno[1], Takuya Shimada[1], Takashi Hashimoto[1], Ryota Yakabe[1], and Atsuhiko Ochi[1]

# Tireless Colleague

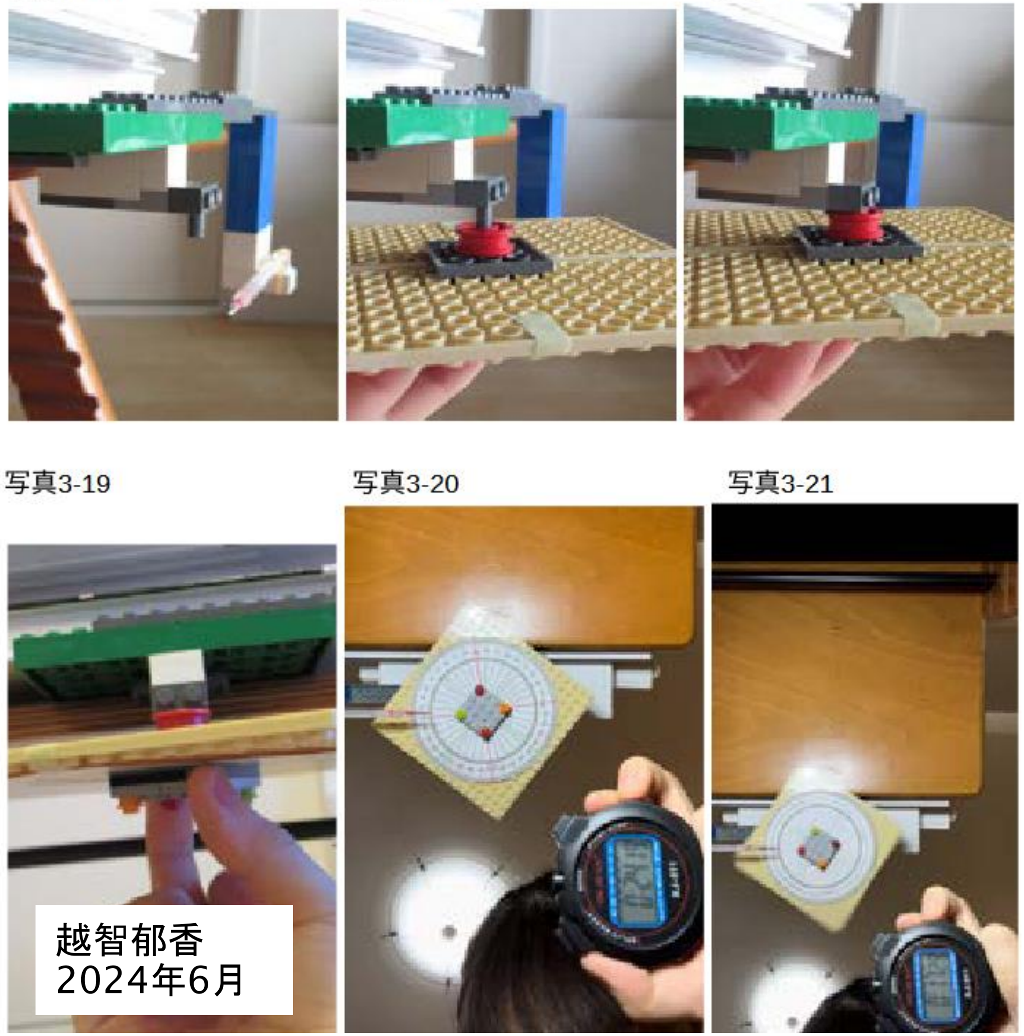
- Initiated Japanese domestic MPGD annual workshop in 2004.
  - International MPGD started in 2009.
- Enjoyed “piping” Japanese community and international groups.
  - His travels need “backups” for teaching…



# Heart-warming Friend

- Playing softball game in animal costume (May 2023).
  - and…
- Atsuhiko's last idea (June 2024)
  - from his daughter's research report.

Softball tournament
@ Kobe




越智郁香
2024年6月

- Many thanks, Ochi-san. Have a good rest.

# Scientific contributions and Detector R&D

We need new "eyes" for catching a glimpse of science frontier.

We welcome students, especially, those who are interested to **make "new" things** and to **love experiments.**

## Atsuhiko Ochi

We need new "eyes" for catching a glimpse of science frontier. The new phenomena and parameters in nuclear and particle physics are realized by measuring the particles (ionized radiation beam) in many cases. I am researching and developing new detectors for measuring that new properties using innovative ideas. Especially, I'm developing Micro Pattern Gaseous Detectors (MPGDs) using modern photolithographic technology on flexible and standard PCB. I'm also joining to the high luminosity LHC experiments for producing new detectors using MPGD technologies. We welcome students, especially, those who are interested to make "new" things and to love experiments.

# Love experiments and make “new” things

# Love experiments

# ATLAS Muons System
# TGCs and NSW Resistive MMs

ATLAS EXPERIMENT

REVIEW OF SCIENTIFIC INSTRUMENTS **77**, 10E709 (2006)

## Thin gap chamber performance tests under several MeV neutron sources

Atsuhiko Ochi and Hironori Kiyamura
*Kobe University, Kobe 657-8501, Japan*

Junichi Kaneko
*Hokkaido University, Sapporo 060-8628, Japan*

Hidetoshi Ohshita and Tohru Takeshita
*Shinshu University, Matsumoto, Nagano 390-8621, Japan*

Shuji Tanaka and Hiroyuki Iwasaki
*High Energy Accelerator Research Organization, Tsukuba, Ibaraki 305-0801, Japan*

Kentaro Ochiai and Makoto Nakao
*Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan*

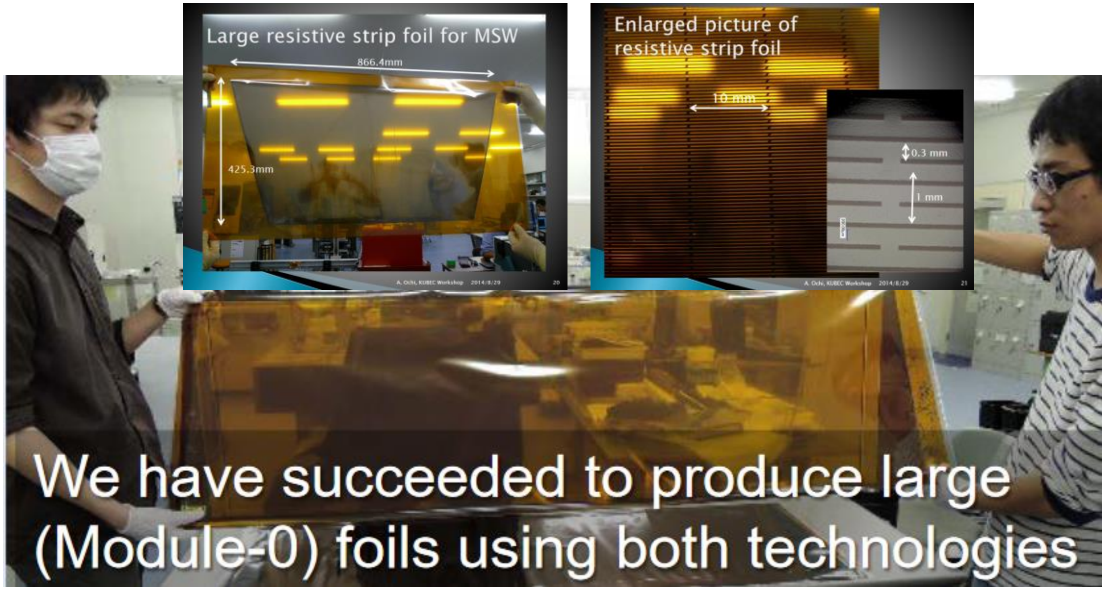
(Received 8 May 2006; presented on 9 May 2006; accepted 27 June 2006; published online 2 October 2006)

EPJ Web of Conferences **174**, 03001 (2018) https://doi.org/10.1051/epjconf/201817403001
*MPGD 2015*

## Development of large area resistive electrodes for ATLAS NSW Micromegas

Atsuhiko Ochi[1,a], on behalf of the ATLAS Muon Collaboration
[1] *Kobe University, Kobe 657-8501, Japan*

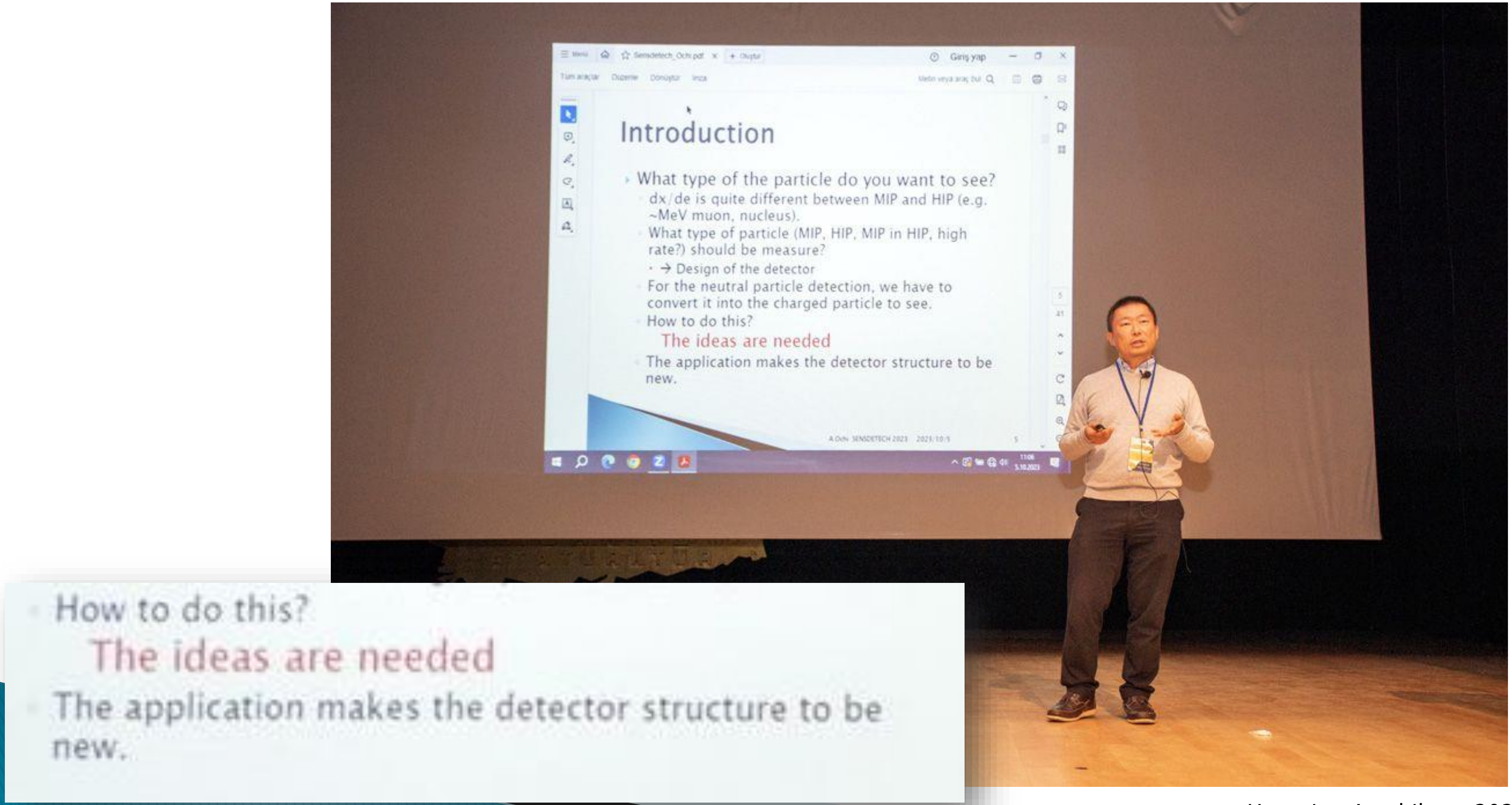
**Abstract.** Micromegas with resistive anodes will be used for the NSW upgrades of the ATLAS experiment at LHC. Resistive electrodes are used in MPGD devices to prevent sparks in high-rate operation. Large-area resistive electrodes for Micromegas have been developed using two different technologies: screen printing and carbon sputtering. The maximum resistive foil size is 45 × 220 cm with a printed pattern of 425-$\mu$m pitch strips. These technologies are also suitable for mass production. Prototypes of a production model series have been successfully produced. In this paper, we report the development, the production status, and the test results of resistive Micromegas.



# Make “new” things ….



## The ideas are needed




SENSDETECH-2023, Invited Speaker: Assoc. Prof. Dr. Atsuhiko Ochi, Department of Physics, Kobe University, “Micro Pixel Chamber and MPGDs, Developments and their applications”

# The Micro Pixel Chamber, μPIC

ELSEVIER
Nuclear Instruments and Methods in Physics Research A 471 (2001) 264–267
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A
www.elsevier.com/locate/nima

## A new design of the gaseous imaging detector: Micro Pixel Chamber

Atsuhiko Ochi[a,*,1], Tsutomu Nagayoshi[a], Satoshi Koishi[a], Toru Tanimori[b], Tomofumi Nagae[c], Mirei Nakamura[c]

[a] *Department of Physics, Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro, Tokyo 152-8551, Japan*
[b] *Kyoto University, Kyoto 606-8502, Japan*
[c] *High Energy Accelerator Research Organization (KEK), Tsukuba 305-0801, Japan*

**Abstract**

The novel gaseous detector "Micro Pixel Chamber (Micro PIC)" has been developed for X-ray, gamma-ray and charged particle imaging. This detector consists of double sided printing circuit board (PCB). The stable operation of Micro PIC is realized by thick substrate and wide anode strips. One of the most outstanding feature is the process of production and the cost. The base technology of producing Micro PIC is same as producing PCB, then detector with large detection area (more than 10 cm × 10 cm) can be made by present technology. Our first tests were performed using a 3 cm × 3 cm detection area with a readout of 0.4 mm pitch. The gas gain and stability were measured in these tests. The gas gain of $10^4$ was obtained using argon ethane (8:2) gas mixture. Also, there was no discharge between anodes and cathodes in the gain of $10^3$ during two days of continuous operation. Although some discharges occurred in the higher gain (approximately $10^4$), no critical damage on the detector was found. 

*Keywords:* Gaseous detector; Imaging; MSGC

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Available online at www.sciencedirect.com
SciVerse ScienceDirect
Physics Procedia 37 (2012) 554 – 560
Physics Procedia
TIPP 2011 - Technology and Instrumentation for Particle Physics 2011

## Development of a Micro Pixel Chamber for the ATLAS upgrade

Atsuhiko Ochi [1], Yasuhiro Homma, Hidetoshi Komai, Yuki Edo, and Takahiro Yamaguchi

*Kobe University,*
*Kobe, 657-8501, Japan*

**Abstract**

The Micro Pixel Chamber (μ-PIC) is being developed as a candidate for the muon system of the ATLAS detector for upgrading in LHC experiments. The μ-PIC is a micro-pattern gaseous detector that doesn't have floating structure such as wires, mesh, or foil. This detector can be made by printed-circuit-board (PCB) technology, which is commercially available and suited for mass production. Operation tests have been performed under high flux neutrons under similar conditions to the ATLAS cavern. Spark rates are measured using several gas mixtures under 7 MeV neutron irradiation, and good properties were observed using neon, ethane, and $CF_4$ mixture of gases. Using resistive materials as electrodes, we are also developing a new μ-PIC, which is not expected to damage the electrodes in the case of discharge sparks.



*Keywords:* MPGD, μ-PIC, HL-LHC, ATLAS, neutron, gaseous detector

Nuclear Inst. and Methods in Physics Research, A 951 (2020) 162938
Contents lists available at ScienceDirect
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journal homepage: www.elsevier.com/locate/nima

## Development of the Micro Pixel Chamber with DLC cathodes

Check for updates

Fumiya Yamane *, Atsuhiko Ochi, Kohei Matayoshi, Keisuke Ogawa, Yusuke Ishitobi

*Kobe University, 1-1 Rokkodai, Nada, Kobe, Hyogo, Japan*

ARTICLE INFO

*MSC:*
00-01
99-00

*Keywords:*
Gaseous detector
Micro Pixel Chamber
MPGD

ABSTRACT

We developed a novel design of a Micro Pixel Chamber (μ-PIC) with resistive electrodes for a charged particle tracking detector in high rate applications. Diamond Like Carbon (DLC) thin film is used for the cathodes. The resistivity can be controlled flexibly ($10^{5-7}$ $\Omega$/sq.) with high uniformity. The fabrication process was greatly improved and the resistive μ-PIC could be operated with an area of 10 × 10 $cm^2$. Resistors for the HV bias and capacitors for the AC coupling were completely removed by applying PCB and carbon sputtering techniques, and the resistive μ-PIC became a very compact detector. The performance of our new resistive μ-PIC was measured in various ways. Consequently, it was possible to attain high gas gains (> $10^4$), high detection efficiency, and position resolution better than 100 μm. The spark probability was reduced, and the new resistive μ-PIC was operated stably under fast neutrons irradiation. These features offer solutions for a charged particle tracking detector in future high rate applications.

**2001**

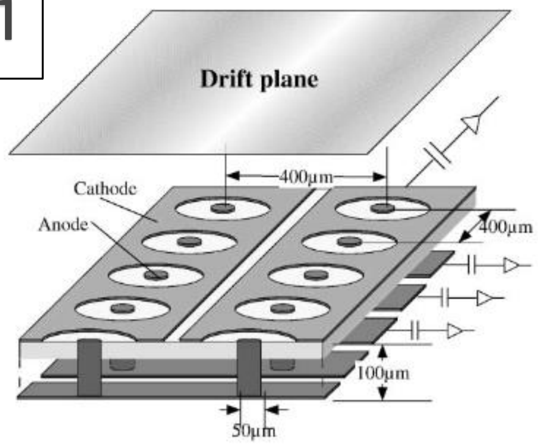


Fig. 1. Schematic structure of Micro PIC.

https://doi.org/10.1016/S0168-9002(01)00996-2

**2012**

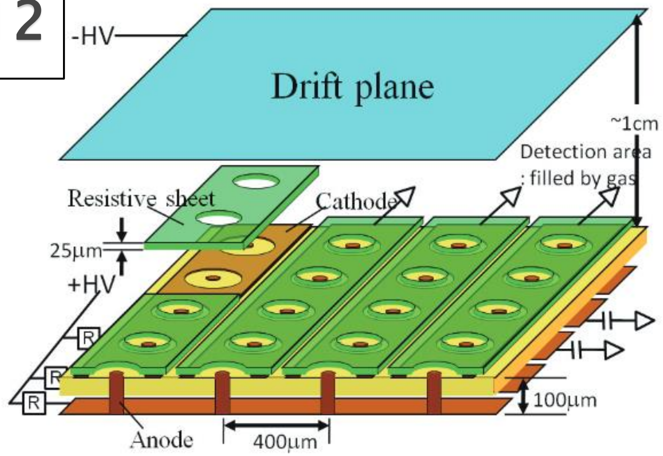


Fig. 9. Schematic structure of μ-PIC with resistive cathodes. It has been developed in order to reduce damage to the readout electrodes caused by sparking, and is currently under tests.

https://doi.org/10.1016/j.phpro.2012.02.397

**2020**

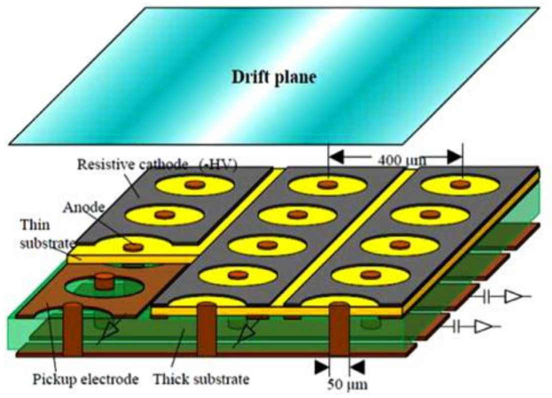


**Fig. 2.** Schematic view of resistive μ-PIC [16]: Insulating layer is sandwiched between resistive cathode and pickup electrode.

https://doi.org/10.1016/j.nima.2019.162938

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## 2001

*Alternative to "Floating Structures"*

Biagi's Micro Dot Chamber (MDC)
- Localized damage
- High field at the anode while smaller at the cathode (cathode field induced discharges reduced)

Drawback: Field distortion from anode lines connecting dots

**μ–PIC → Thick substrate → PCB**
+
**2D readout with equal sharing** (better sharing than with MSGC)
+
Width of strip anode larger than cathode hole side → **reduced Charging up in between anode and cathode**

## 2012

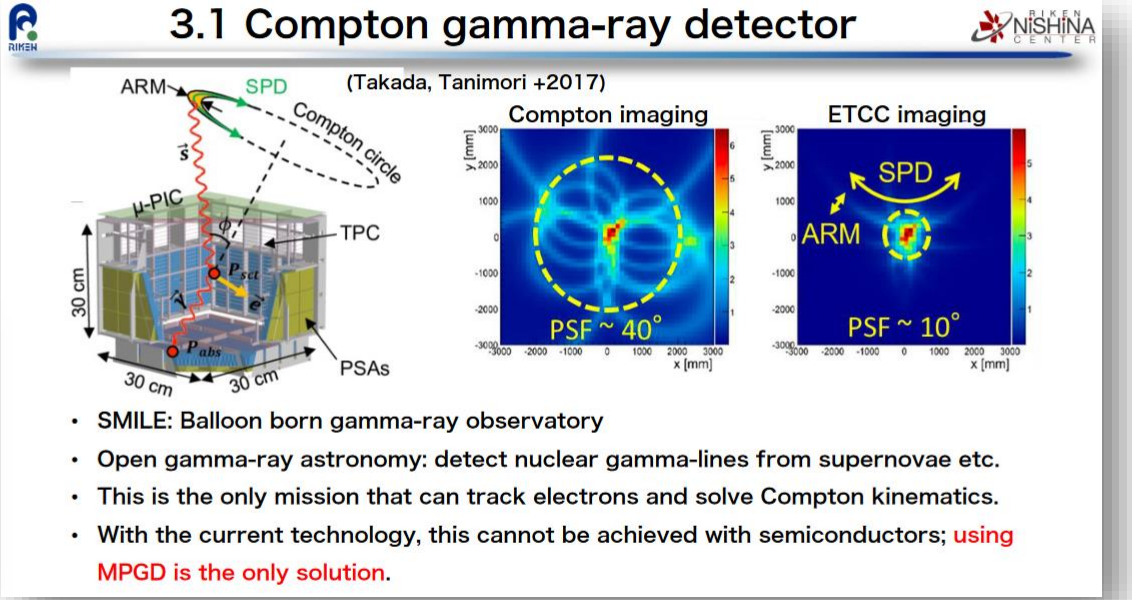
- **Gas studies** (driven by ATLAS requirements)
  - Ar → Ne (**lower spark rate** for fast neutron irradiation)
  - Adding CF4 (**best v drift @ lower field** where collection is better)
- **Introduction of resistive layer on the cathode**

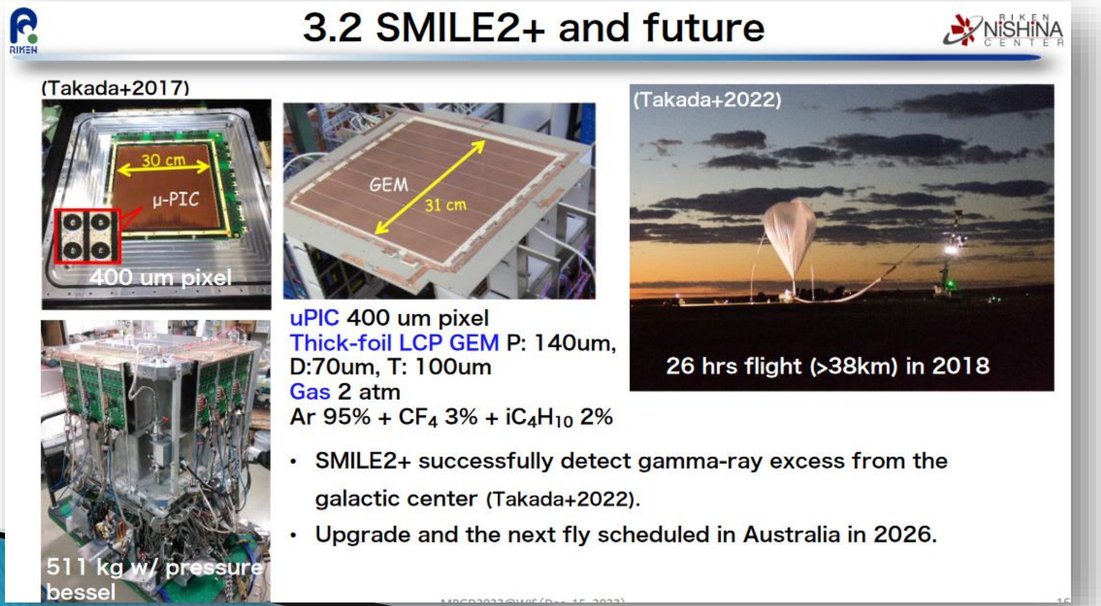
## 2020

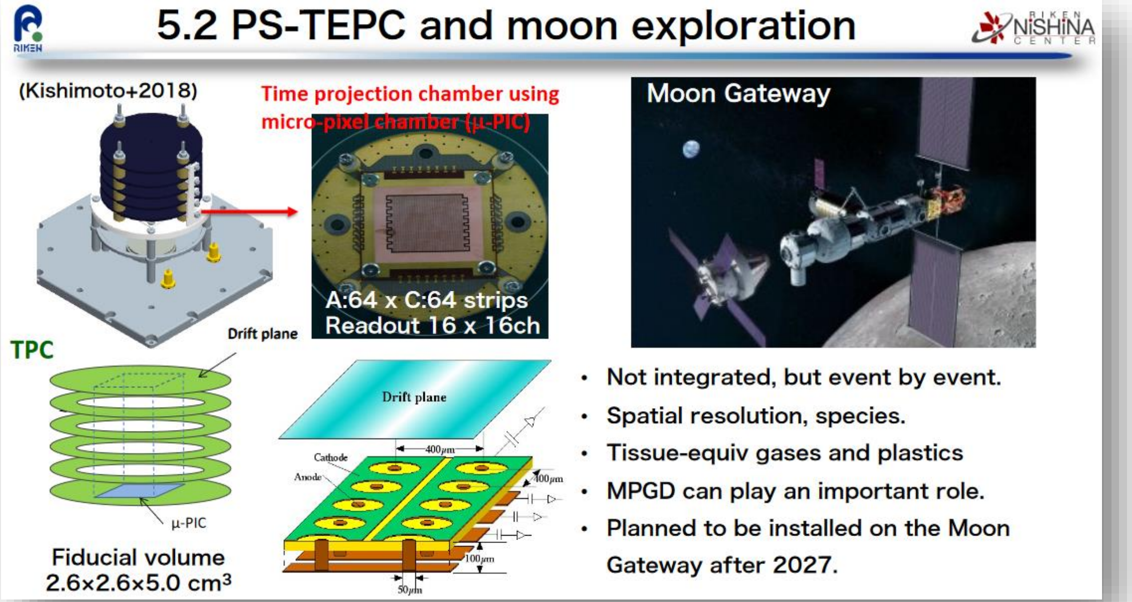
- Use of **DLC as resistive layer** (development @ Kobe in 2012) with good range of resistivities.
- **Replacement of laser drilling** (alignment issue for double layer PCB) for anode production in resistive μ–PIC using transparent dry layer and **photolithography**
- **Compact layout** having protection and biasing resistor and AC coupling capacitor all done via DLC and PCB techniques

# From MPGD 2022…
# μPIC & Space Applications

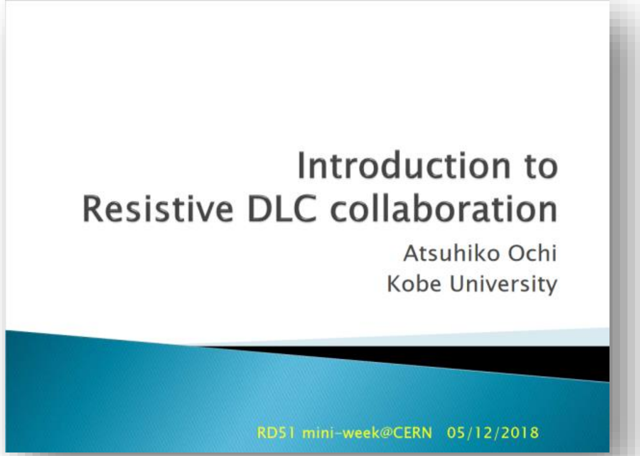




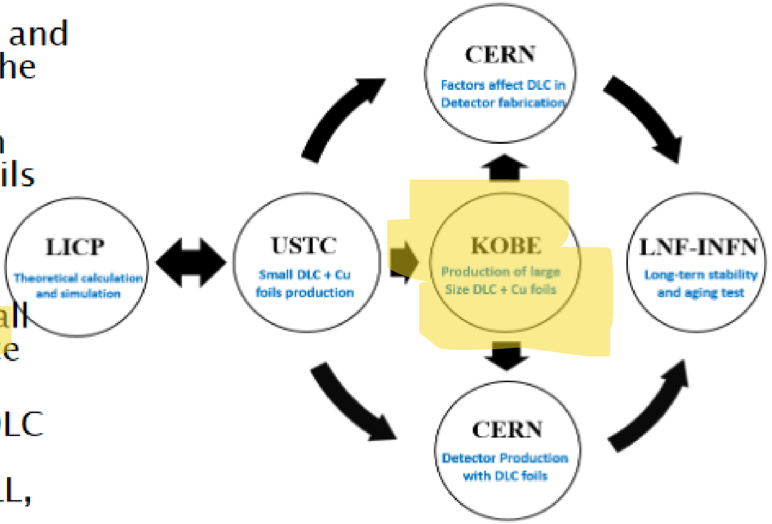
# Resistive DLC Collaboration (RD51 Common Project)





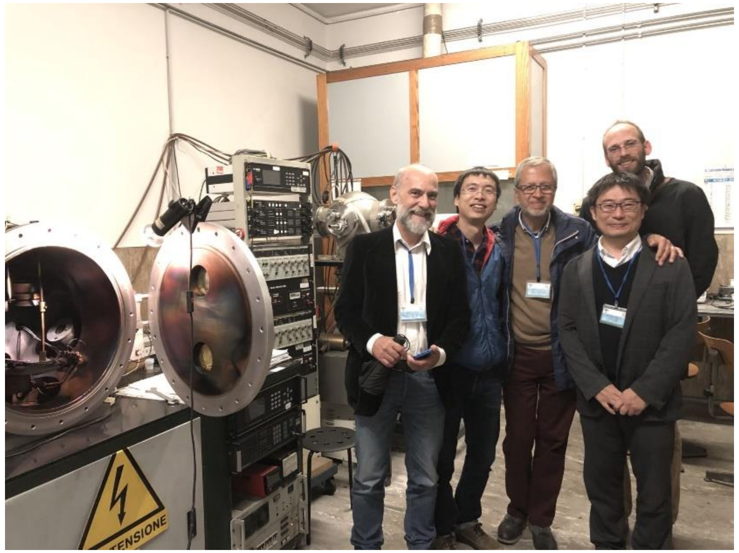
## DLC Common project (2018-)

- LICP: on the basis of theoretical calculation and simulation, give USTC team a guidance of the work
- USTC: produce different bare DLC foils with different surface resistivity and also DLC foils with Copper coating (DLC+Cu)
- Kobe University: produce large size DLC & DLC+Cu foils in order to study the reproducibility of the process tuned on small prototypes and the uniformity of the surface resistivity of the DLC
- CERN: study the behavior and changes of DLC properties under manufacturing processes foreseen for MPGD construction (i.e. μRWELL, resistive GEM and THGEM)
- LNF-INFN: study stability of bare DLC properties under current drawing on bench (w/irradiation)
- CERN: produce detectors with DLC foils
- LNF-INFN: perform aging and spark test of DLC based detectors (with different radiation)




https://indico.cern.ch/event/761831/contributions/3236762/attachments/1765980/2867435/DLC_CP_Intro_ochi_181205_v2.pdf

# International Workshop on Resistive Coatings for Gaseous Detectors, 2019, Bari



**Past Experience with DLC and Workshop Goals** — *Prof. Atsuhiko Ochi*

*Aula Multimediale, INFN Bari* — 09:30 - 10:15

https://agenda.infn.it/event/18156/contributions/89402/attachments/62886/75562/DLC_ochi_190513_1.pptx

**Micro-patterning techniques for DLC layers in MicroMegas and uPic detectors** — *Prof. Atsuhiko Ochi*

*Aula Multimediale, INFN Bari* — 15:45 - 16:00

https://agenda.infn.it/event/18156/contributions/89408/attachments/62910/75608/DLC_ochi_190513_2_v2.pptx

**Industrialization of the DLC deposition process** — *Prof. Atsuhiko Ochi*

*Aula Multimediale, INFN Bari* — 09:30 - 09:50

https://agenda.infn.it/event/18156/contributions/89427/attachments/62955/75663/DLC_ochi_190513_3_v2.pptx

PoS PROCEEDINGS OF SCIENCE

## Carbon Sputtering Technology for MPGD detectors

**Atsuhiko Ochi*, Yasuhiro Homma, Yuji Yamazaki, Fumiya Yamane, Tsuyoshi Takemoto**
*Kobe University*
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**Tatsuo Kawamoto, Yousuke Kataoka, Tatsuya Masubuchi, Yuki Kawanishi, Shingo Terao**
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*E-mail:* Tatsuo.Kawamoto@cern.ch, Yousuke.Kataoka@cern.ch, tatsuya.masubuchi@cern.ch, yuki.kawanishi@cern.ch, shingo.terao@cern.ch

**2014**

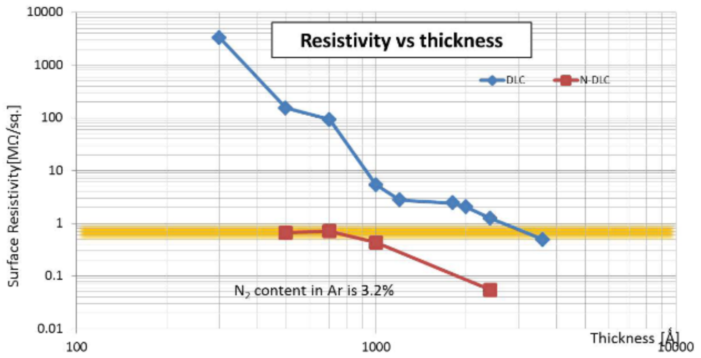



**Figure 4:** Surface resistivity as a function of the sputtered carbon thickness. The blue line shows the resistivity of pure carbon sputtering, and the red line shows that of Nitrogen doped foils. The orange band represents the required resistivity for the ATLAS MicroMEGAS.

ICEPP The University of Tokyo | KOBE UNIVERSITY | JSPS Core-to-Core Program | 科研費 KAKENHI

# Studies on DLC characterisation

Kensuke Yamamoto[A]

S. Ban[A], W. Li[A], A. Ochi[B], W. Ootani[A], A. Oya[A], H. Suzuki[B], M. Takahashi[B]
([A]The University of Tokyo, [B]Kobe University)

RD51 Collaboration Meeting
4-8 December 2023



## What we **want to know** about DLC

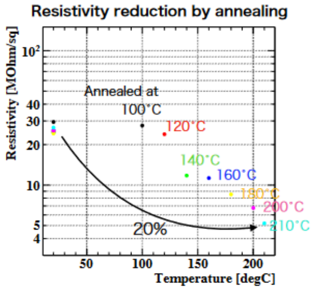
- **Used in various industries**, e.g. coating
  - Characteristics should be known in the field of material science
  - Few documentation on DLC deposited by physical sputtering method
  - ➡ Somehow import knowledge into gaseous detectors in HEP
- Amorphous carbon
  - Properties of both $sp^2$ and $sp^3$
  - ➡ What is the fraction between $sp^2$ and $sp^3$?
- Attached well on **polyimide**
  - ➡ Can DLC be deposited on other substrates?
- **Resistivity can be controlled** by
  - Nitrogen doping for resistivity reduction
  - Thickness with an accuracy of 100%
  - Thermal annealing with an accuracy of 10%
  - ➡ What is the mechanism of thermal annealing?

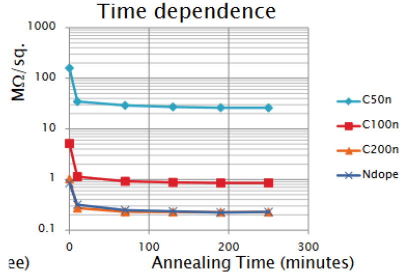


## Thermal annealing observation

**2023**

- Thermal annealing reduces resistivity
  - **Depends on temperature**
  - **NOT depends on time**
- Resistivity can be controlled with an accuracy of 10%
- **We did NOT know the mechanism**



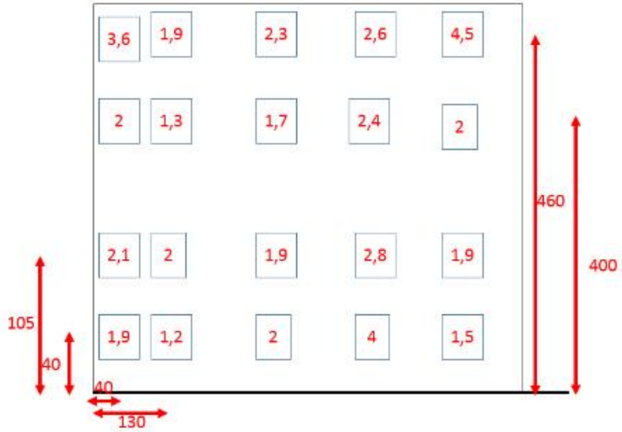




A.Ochi, Resistive DLC meeting 2020/3/26

# The Ochi Probe

## RESISTIVITY MEASUREMENTS

Resistivity measurement protocole defined and reproducible, using circular probe and square 'Ochi' probe for plain coating

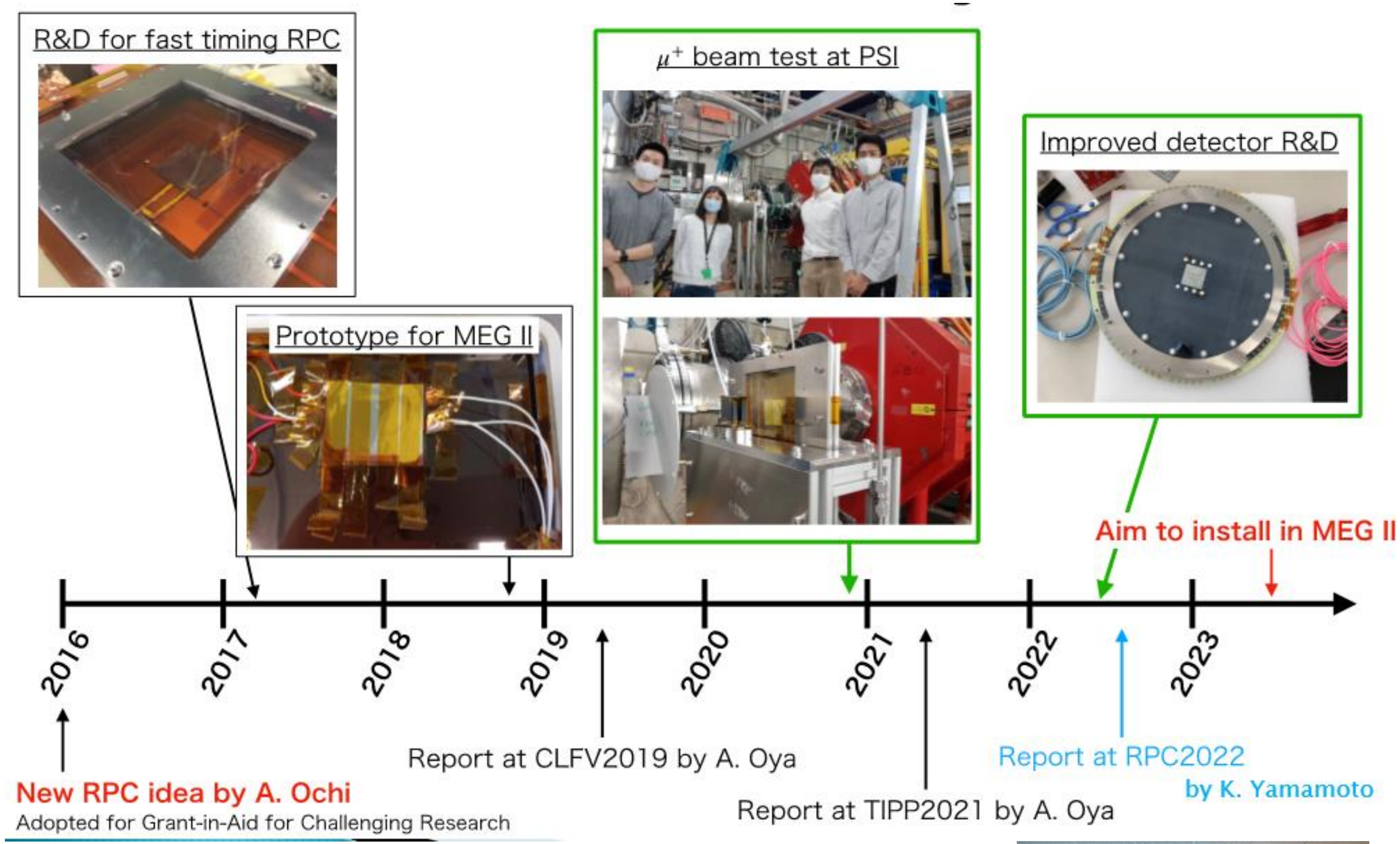



And 'square counting' for resistive strips

under Microscope

AIDA 2020, 4th annual - P. Colas April 03, 2019

# Resistive Plate Chambers with DLC Electrodes





Nuclear Instruments and Methods in Physics Research A 1064 (2024) 169375

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Full Length Article

Prototype study of $0.1\%X_0$ and MHz/cm$^2$ tolerant Resistive Plate Chamber with Diamond-Like Carbon electrodes


Kei Ieki [a], Weiyuan Li [b], Atsuhiko Ochi [c], Rina Onda [b], Wataru Ootani [a], Atsushi Oya [b,*], Masato Takahashi [c], Kensuke Yamamoto [b]

[a] International Center for Elementary Particle Physics, The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan
[b] Department of Physics, The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan
[c] Department of Physics, Kobe University, Kobe 657-8501, Japan



ARTICLE INFO

Keywords:
RPC



ABSTRACT

A novel Resistive Plate Chamber (RPC) was designed with Diamond-Like Carbon (DLC) electrodes and performance studies were carried out for 384μm gap configuration with a 2 cm × 2 cm prototype. The use of thin films coated with DLC enables an ultra-low mass design of less than $0.1\% X_0$ with up to a four-layer configuration. At the same time, 42% MIP efficiency, and 180 ps timing resolution per layer were achieved in a measurement performed under a 1 MHz/cm$^2$ non-MIP charged particle beam. In addition, we propose a further improved design for a 20 cm-scale detector that can achieve 90% four-layer efficiency in an even higher 4 MHz/cm$^2$ beam. In this paper, we describe the detector design, present the results of performance measurements, and characterize the rate capability of the DLC-based RPCs with a performance projection for an improved design.



https://doi.org/10.1016/j.nima.2024.169375

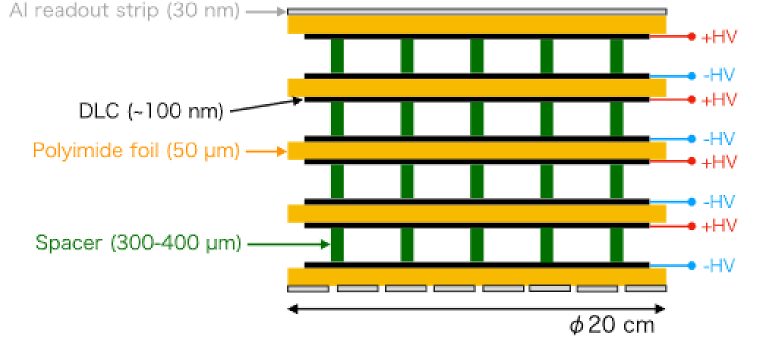
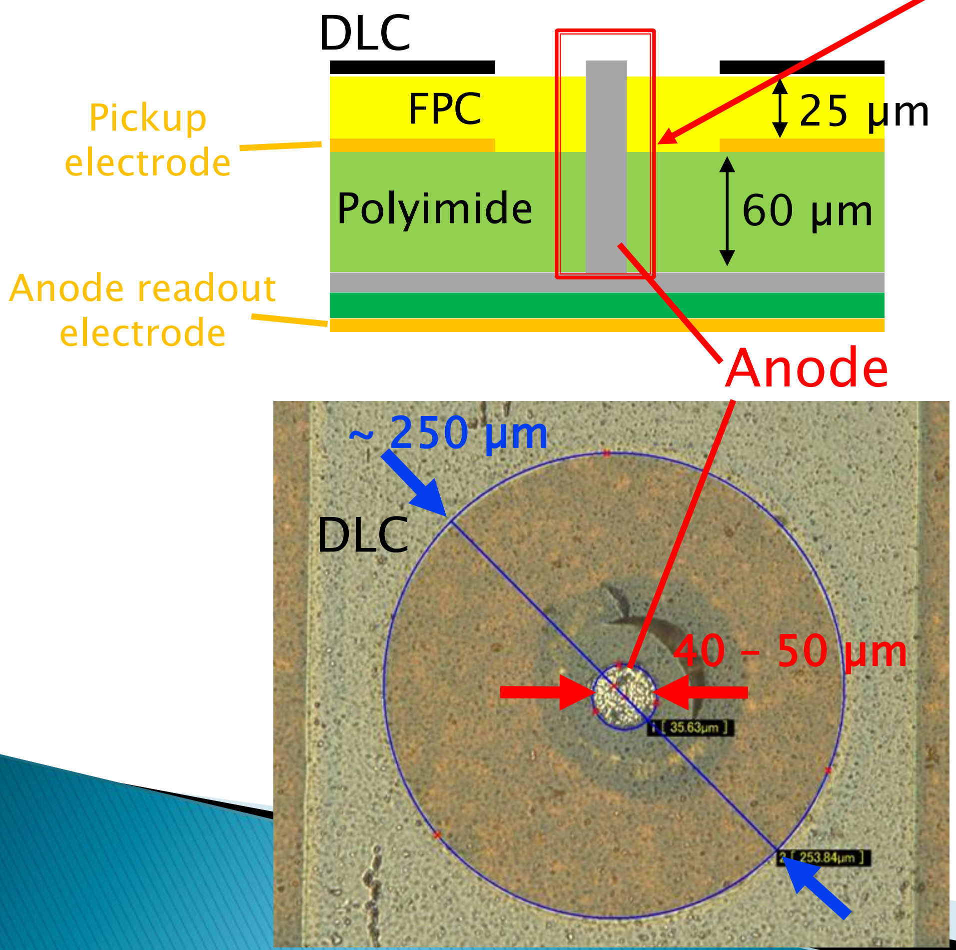



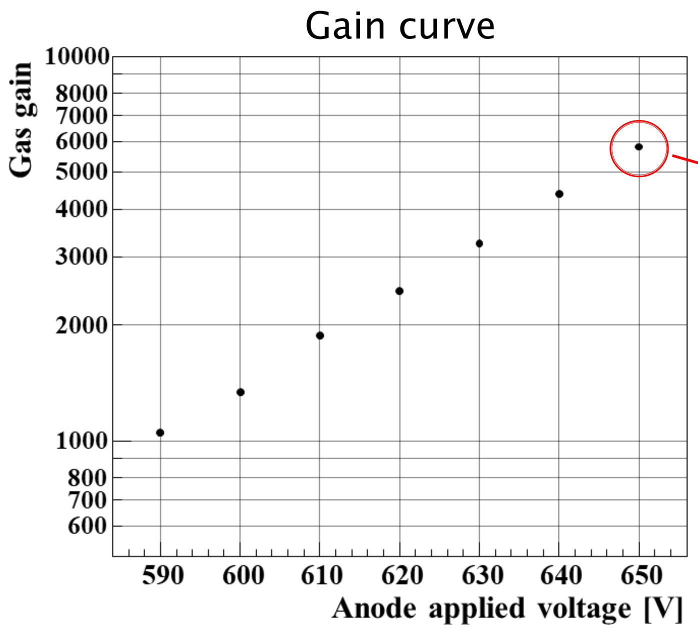

**Fig. 1.** Concept of Resistive Plate Chamber with DLC-based electrodes for the MEG II experiment. The high voltages are applied independently to each layer. The number of layers is limited because of the requirement of less than $0.1\% X_0$.

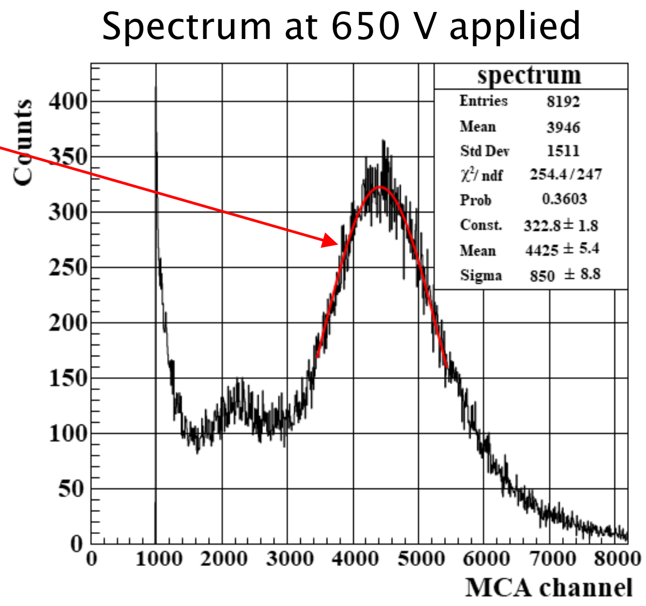
# Atsuhiko's latest works on DLC μ-PIC

- Anode via formation by laser drilling.




- Performance for $^{55}$Fe X-ray was measured using MCA.
  - We obtained around **$6 \times 10^3$** of gas gain.



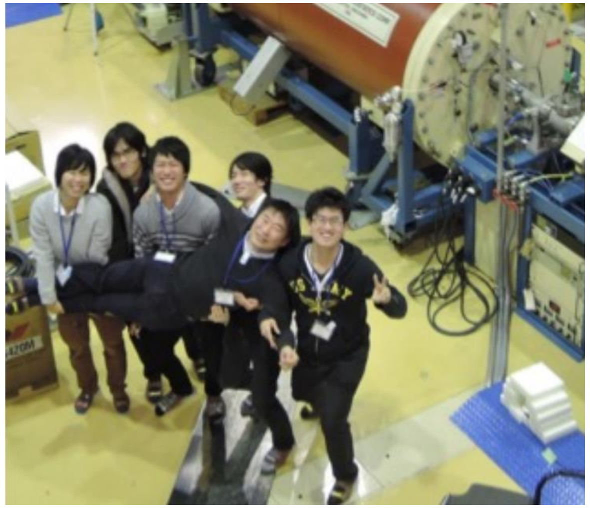

- Unfortunately, DLC μ-PIC developments are suspended in Kobe
  - Manpower, budget, etc...

# Mentoring and guidance of student

Masato Takahashi
(Kobe University)

# Mentoring and Guidance

- Atsuhiko valued student's initiative.
  - He gave us the knowledge and ideas to carry out researches.
- Atsuhiko was very accommodating to students.
  - Students could easily ask him for help with anything they didn't understand.
  - His interest and delight in the reported results motivated the students to study.
  - He stood with students on the problems.
- Atsuhiko's connections were also used in the students' study



# Seminar on gaseous detectors

- Atsuhiko organized a seminar on gaseous detectors every year from 2015
  - For master's students at Kobe Univ. (internal)
  - Journal club
- Atsuhiko supplemented the details and historical talks

Textbook

Innovative Applications and Developments of Micro-Pattern Gaseous Detectors

Tom Francke
*Myon, Sweden*

Vladimir Peskov
*CERN, Switzerland*

# Theses of Atsuhiko's students (link in Japanese)

## Micro Pixel Chamber (μ-PIC)

(2006)
Micro Pixel Chamber(μ-pic) の
安定性向上と高増幅率化に向けた研究
KEIKA Tomohiro

(2008)
修士学位論文
メッシュ付き μ-PIC の安定動作に向けた研究
KOBAYASHI Seiji

(2009) 修士学位論文
メッシュ付 μ-PIC の Ion Back-Flow 減少と
電子収集率向上に向けた研究
TANABE Akira

Micro Mesh μ-PIC

(2010)
修士学位論文
ATLAS upgrade に向けた μ-PIC の開発研究
MIYAZAKI Kazuki

→ Inclusive studies for ATLAS upgrade

(2012)
ハドロン衝突実験に向けた
μ-PIC の読み出し回路の開発
YAMAGUCHI Takahiro

→ Electronics developments for ATLAS

## LTCC μ-PIC

(2019)
セラミック素材を用いた
Micro Pixel Chamber(μ-PIC) の開発研究
SETSUDA Hikaru

→ Using the Low-Temperature Co-fired Ceramics (LTCC) as insulation layer

## Resistive MicroMEGAS

(2012)
ATLASアップグレードに向けた
MicroMEGASの開発とその性能評価
EDO Yuki

Start using Diamond-like carbon

(2014)
ATLAS アップグレードに向けた
MicroMEGAS抵抗電極の開発
TAKEMOTO Tsuyoshi

(2016)
宇宙線を用いた MicroMEGAS の
飛跡測定性能の評価
SAITO Daiki

(2014)
ATLAS Phase-I Upgrade に向けた
MicroMEGAS の性能評価
YAMANE Fumiya

(2016)
ATLAS 実験アップグレードにおける
MicroMEGAS 検出器の
放射線耐性の研究
NAGASAKA Noriko

(2017)
ATLAS アップグレードに向けた
高放射線環境における
Micromegas の動作試験
MATAYOSHI Kohei

→ Studies for ATLAS upgrade

## Resistive μ-PIC

(2012)
μ-PIC の放電抑制に関する研究
KOMAI Hidetoshi
平成 25 年 3 月 23 日

→ Using carbon-loaded polyimide as a resistive cathode

(2017)
Development of the Micro Pixel Chamber with resistive electrodes
Fumiya Yamane
Kobe University Department of Physics

→ Start using Diamond-like carbon
F. Yamane, NIM A 941 (2019) 162938

(2018)
150GeV/c ミューオンビームを用いた
DLC μ-PIC の性能評価
ISHITOBI Yusuke

(2021)
DLC を用いた resistive μ-PIC の
ガス増幅率向上のための研究
TANIGUCHI Daigo

(2021)
高速多チャンネル読み出しシステム APV25/VMM3a を
用いた DLC μ-PIC の性能評価
NAGASAKI Daichi

→ Multi-channel readout

(2022)
DLC を用いた resistive μ-PIC の
X線イメージングについての研究
YAMAGUCHI Tsubasa

→ Optical readout

→ Performance measurements of DLC μ-PIC

## RPC with DLC

(2017)
炭素スパッタを用いた積層型
Fast Timing RPC の開発
OGAWA Keisuke

→ For fast timing RPC

(2022)
MEG II 実験背景事象抑制に向けた
DLC-RPC 検出器の開発
TAKAHASHI Masato

→ Application to MEG II

## Other resistive MPGDs

修 士 学 位 論 文
(2015)
炭素スパッタを用いた Resistive GEM の開発
YAMAUCHI Satoru

→ Carbon sputtered GEM

(2016)
抵抗電極を有した MPGD における
電荷伝播の研究
HASEGAWA Hiroaki

→ Charge induced on resistive electrode

# Look to other fields

NEPCON JAPAN 2023


↑ Atsuhiko

- Atsuhiko took me to a corporate exhibition
  - We need to know what technology is out there in the world.
    → Important inputs to detector development.
- Atsuhiko met a company at an exhibition.
  - Since then, he and this company have had a long relationship in μ-PIC development.

- We were taught many things from Atsuhiko.
  - Not only about research
- With his teachings in mind, I hope to nurture Atsuhiko's detector ideas (DLC μ-PIC, DLC-RPC).

*Atsuhiko said me*
*"I have done everything, no regrets."*

# International Detector R&D Collaborations RD51 and DRD1

# RD51 / DRD1

Atsuhiko played a significant role **in the formation of the RD51 Collaboration.**

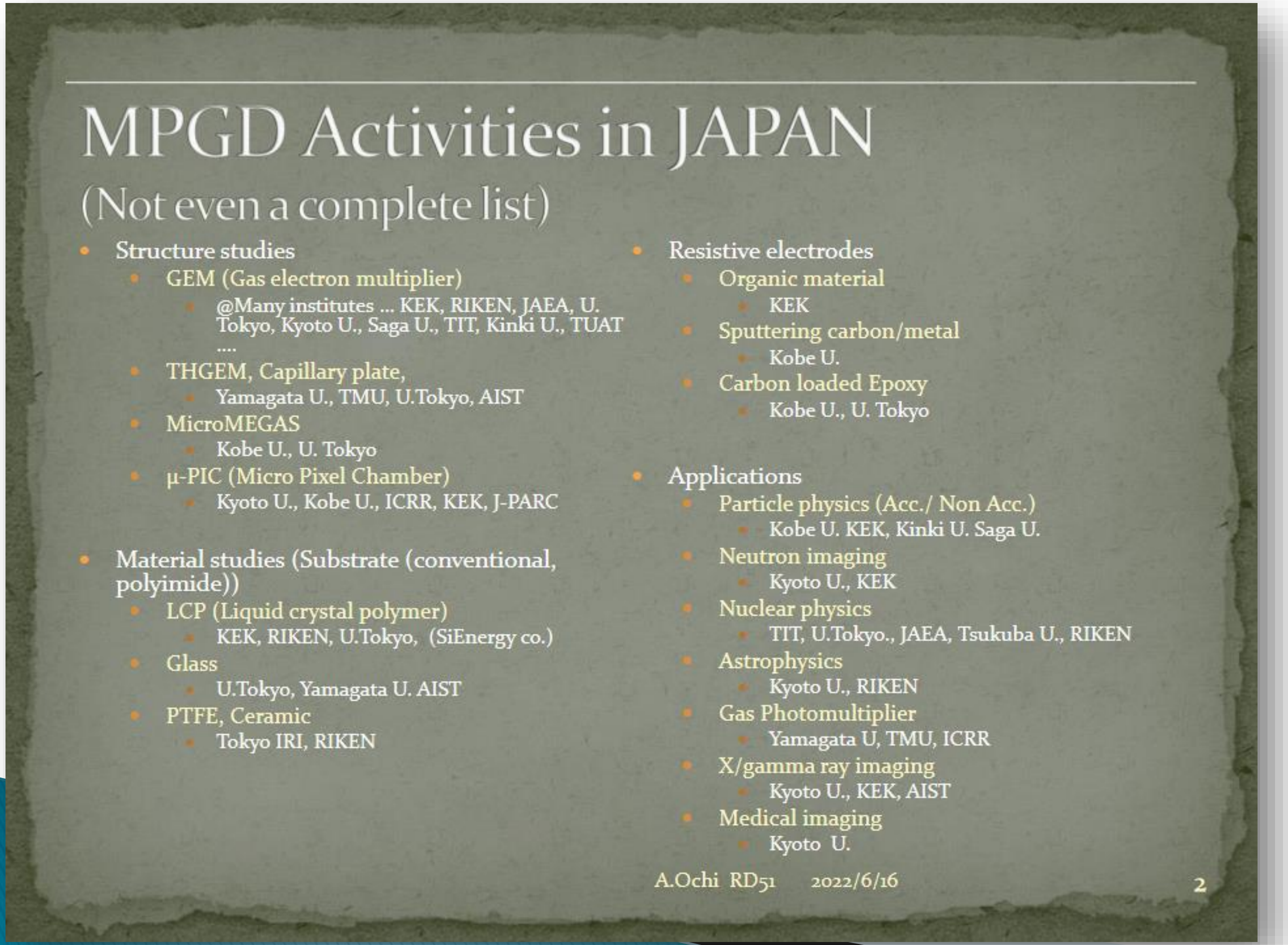
He served the community as:

- **Management Board Member**
- **Collaboration Board Chair**
- **Scientific Secretary**
- **Responsible for the Common Projects**

Atsuhiko participated to the organization of **MPGD2011 in Kobe**, which was the first conference held in Asia as part of the international series.

During the **transition to DRD1** Atsuhiko has been very **active** and made a crucial contribution by **maintaining strong ties with the Asian community and in particular with Japan.**

# Sharing with RD51/DRD1 Colleagues the ongoing R&D in Japan

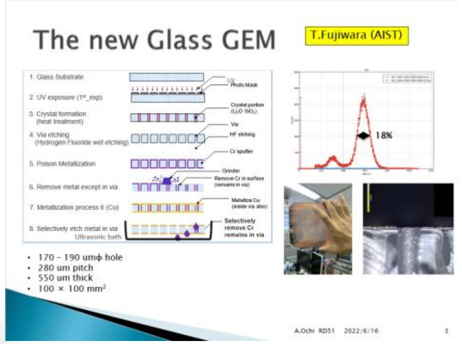


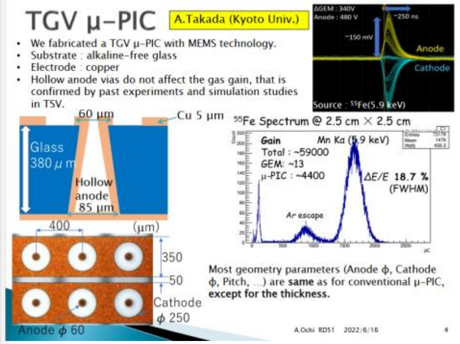
## MPGD Activities in JAPAN

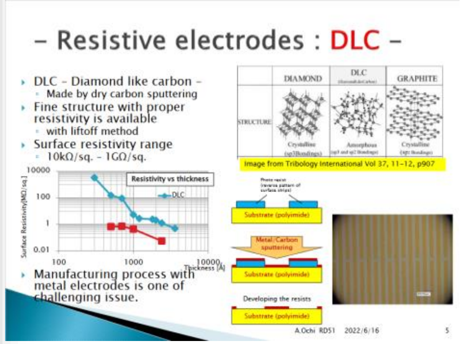
(Not even a complete list)

- Structure studies
  - GEM (Gas electron multiplier)
    - @Many institutes ... KEK, RIKEN, JAEA, U. Tokyo, Kyoto U., Saga U., TIT, Kinki U., TUAT ....
  - THGEM, Capillary plate,
    - Yamagata U., TMU, U.Tokyo, AIST
  - MicroMEGAS
    - Kobe U., U. Tokyo
  - μ-PIC (Micro Pixel Chamber)
    - Kyoto U., Kobe U., ICRR, KEK, J-PARC
- Material studies (Substrate (conventional, polyimide))
  - LCP (Liquid crystal polymer)
    - KEK, RIKEN, U.Tokyo, (SiEnergy co.)
  - Glass
    - U.Tokyo, Yamagata U. AIST
  - PTFE, Ceramic
    - Tokyo IRI, RIKEN
- Resistive electrodes
  - Organic material
    - KEK
  - Sputtering carbon/metal
    - Kobe U.
  - Carbon loaded Epoxy
    - Kobe U., U. Tokyo
- Applications
  - Particle physics (Acc./ Non Acc.)
    - Kobe U. KEK, Kinki U. Saga U.
  - Neutron imaging
    - Kyoto U., KEK
  - Nuclear physics
    - TIT, U.Tokyo., JAEA, Tsukuba U., RIKEN
  - Astrophysics
    - Kyoto U., RIKEN
  - Gas Photomultiplier
    - Yamagata U, TMU, ICRR
  - X/gamma ray imaging
    - Kyoto U., KEK, AIST
  - Medical imaging
    - Kyoto U.

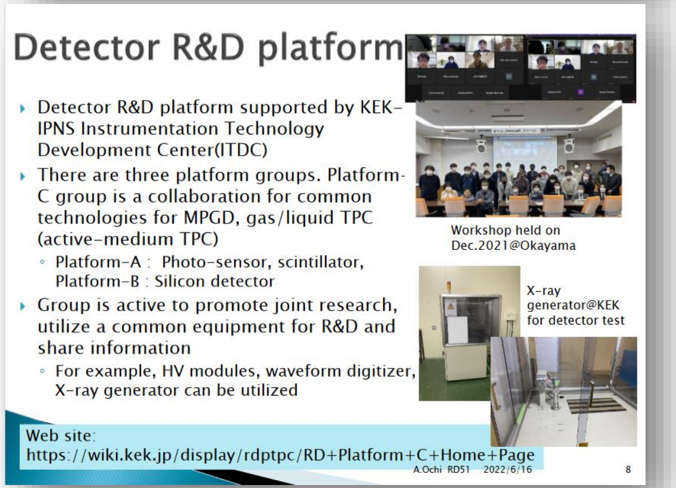
A.Ochi RD51 2022/6/16 2

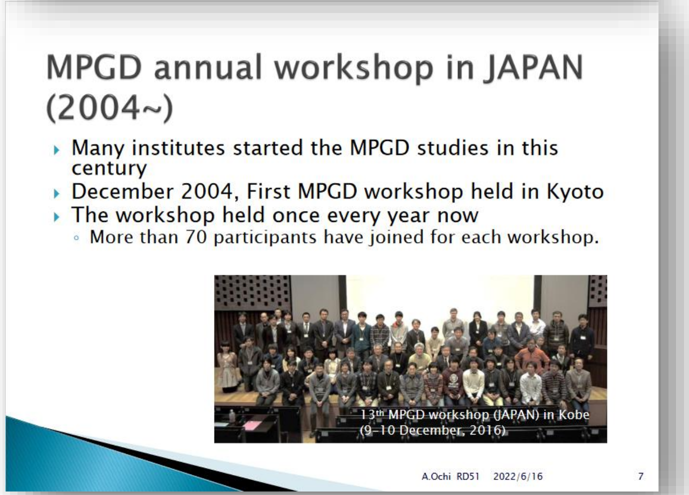






# Sharing with the Japanese Community the ongoing R&D in RD51/DRD1

**Overseas Developments in MPGD Technology - Towards the Launch of DRD1**

Since 2009, RD51 has functioned as an international collaboration for MPGD (Micro-Pattern Gaseous Detectors) development for the past 15 years. However, RD51 will come to a productive conclusion at the end of 2023. Starting in 2024, DRD1 will be launched, bringing together the MPGD, RPC, wire chamber, straw chamber, and other gaseous detector communities. This talk will focus on summarizing the achievements of RD51 and introducing DRD1, while also covering the latest overseas developments in MPGD technology.

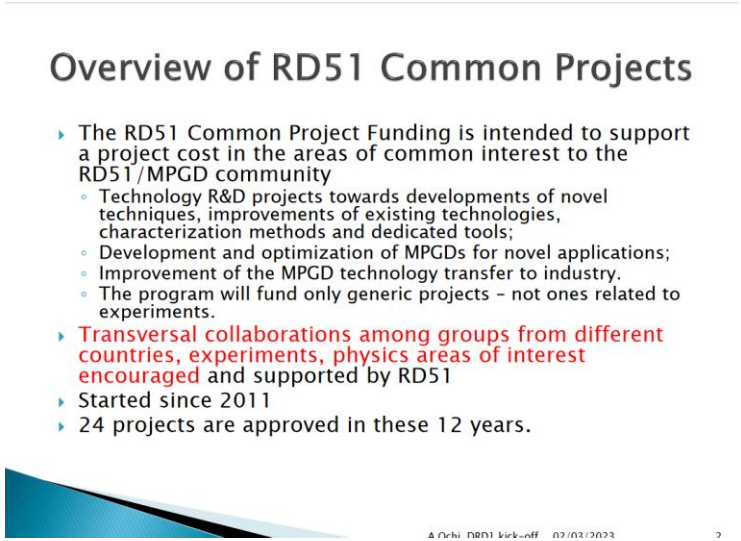


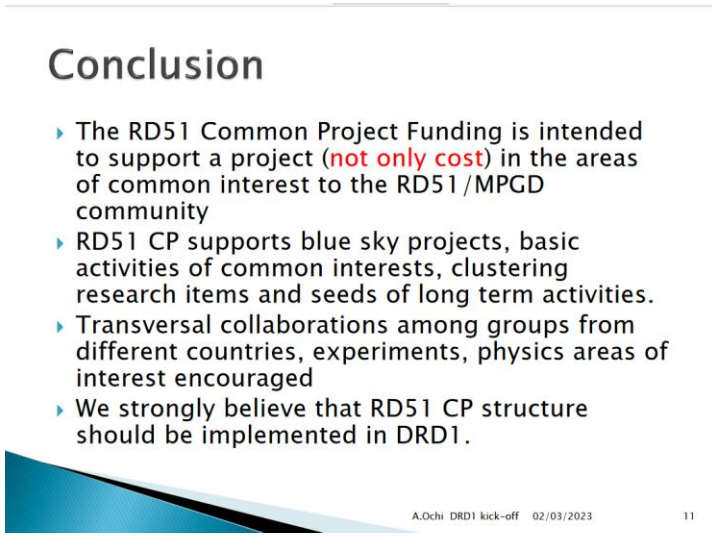


From **MPGD & Active媒質TPC2023研究会**
https://conference-indico.kek.jp/event/240/contributions/4513/attachments/3215/4361/%5B18-11%5D%20MPGD%E9%96%8B%E7%99%BA%E3%81%AB%E3%81%A4%E3%81%84%E3%81%A6%E3%81%AE%E6%B5%B7%E5%A4%96%E3%81%AE%E7%8A%B6%E6%B3%81.pdf

# RD51Common Projects

| Year | Title | Contact person |
|---|---|---|
| 2011 | A low mass microbulk with real XY strips structure | Theo Geralis |
| | MPGDs technology laboratory for training, development, fabrication, applications and innovation | Rafael Gutierrez |
| | Thin and high-pitch laser-etched mesh manufacturing and bulking | Paul Colas |
| | Development of innovative resistive GEM alpha detectors for earthquakes | Guy Paic |
| | Large-area THGEM detector evaluation with SRS electronics | Amos Breskin |
| 2012 | R&D on large area GEMs for the ALICE TPC upgrade | Chilo Garabatos Cuadrado |
| | High resolution UV scanner for MPGD applications | Dezso Varga |
| 2014 | Measurement and calculation of ion mobility of some gas mixtures of interest | Chilo Garabatos |
| | Fast Timing for High-Rate Environments: A Micromegas Solution | Sebastian White |
| | Development of a novel Micro Pattern Gaseous Detector for Cosmic Ray Muon Tomography | Paolo Iengo |
| 2016 | Sampling Calorimetry with Resistive Anode MPGDs (SCREAM) | Maximilien Chedeville |
| | New Scintillating gases and structures for next-generation scintillation-based gaseous detector | Diego Gonzalez Diaz |
| 2017 | Development of modular multilayer GEM units | Alexander Milov |
| 2018 | Modular & General purpose Ultra Low Mass GEM Based Beam Monitors | Gabriele Croci |
| | DLC based electrodes for future resistive MPGDs | Yi Zhou |
| | Study of negative ion mobility and ion diffusion for Negative Ion TPCs | André Cortez |
| 2019 | Discharge Consortium in quest for Spark-Less-Avalanche-Microstructures | Piotr Gasik |
| | Pixelated resistive bulk Micromegas with integrated electronics | Fabrizio Petrucci |
| | Resistive materials and resistive-MPGD concepts & technologies | Shikma Bressler |
| 2020 | Optical readout studies for negative ion TPCs | Florian M. Brunbauer |
| | Large area high-granularity segmented mesh microbulk forfuture rare event searches | Javier Galan |
| 2021 | Comprehensive studies of the glass, ceramic- and kapton-THGEMs in high- and low-pressure TPCs | Pawel Majewski |
| | Development for Resistive MPGD Calorimeter with timing measurement | Piet Verwillligen |
| 2022 | Study of MPGD performance in liquefied noble gases | Vitaly Chepel |




We will support DRD1 in launching the first call of DRD1 common projects in honour of Atsuhiko.


https://indico.cern.ch/event/1245751/contributions/5286570/attachments/2603392/4495797/RD51_CP_230301_v2.pdf

# The International MPGD Conferences

Atsuhiko contributed to all the International Conferences on Micro-Pattern Gaseous Detectors from the first edition in Kolymbari








# MPGD2011 @ Kobe


# Contributions @ MPGD Conferences


- MPGD2009, Development of Micro-Mesh Micro-Pixel Chamber
- Speaker: Dr Atsuhiko Ochi (Kobe University (JP))
- https://indico.cern.ch/event/50396/contributions/2023479/attachments/963736/1368375/m3pic_mpgd09_ochi.ppt


- MPGD2011, Development of Micro Pixel Chamber with higher resistive electrodes
- Speaker: Dr Atsuhiko Ochi (Kobe University (JP))
- https://iopscience.iop.org/article/10.1088/1748-0221/7/05/C05005/pdf


- MPGD2013, Micro Pixel Chamber with resistive electrodes for spark reduction
- Speaker: Dr Atsuhiko Ochi (Kobe University (JP))
- https://indico.cern.ch/event/258852/contributions/1589892/attachments/456077/632106/Ochi_resistive_upic_v2.pdf


- MPGD2015, Development of large area resistive electrodes for ATLAS NSW MicroMegas
- Presenter: Dr Atsuhiko Ochi (Kobe University (JP))
- https://agenda.infn.it/event/8839/contributions/75862/attachments/55222/65135/ochi_mpgd2015_v7.zip


- MPGD2017, Japan MPGD community
- Speaker: Dr Atsuhiko Ochi (Kobe University (JP))
- https://indico.cern.ch/event/581417/contributions/2558345/attachments/1465339/2265067/MPGD_JAPAN_Ochi_vf.pdf

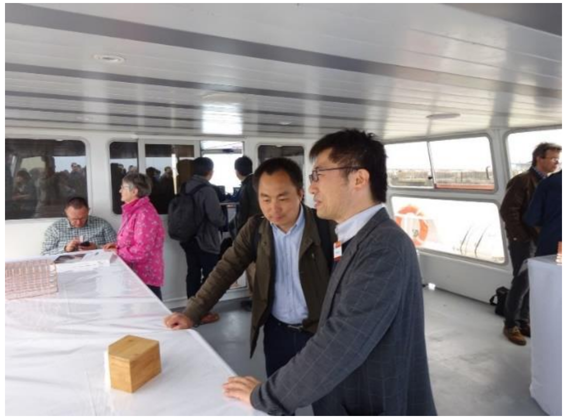

- MPGD2019, Development and performance tests of mu-PIC with DLC electrodes
- Presenter: Dr Atsuhiko Ochi (Kobe University (JP))
- https://iopscience.iop.org/article/10.1088/1742-6596/1498/1/012001/pdf


- MPGD2022, Development of DLC-RPC for Radiative Decay Counter of MEG II Experiment
- Speaker: Dr Atsuhiko Ochi (Kobe University (JP))
- https://indico.cern.ch/event/1219224/contributions/5130743/attachments/2566728/4425225/ochi_mpgd2022_v2.pptx

## MPGD Conferences … and more



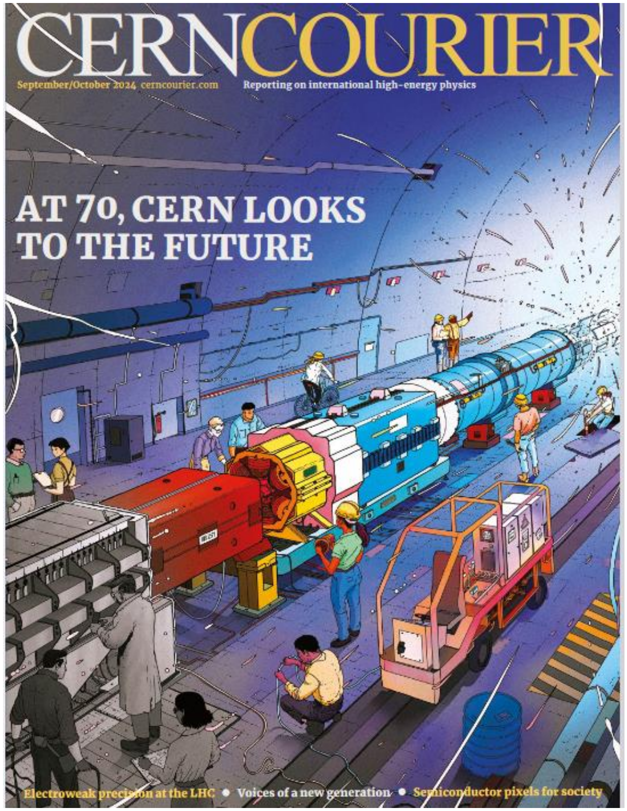








Scientific Discussion… and More



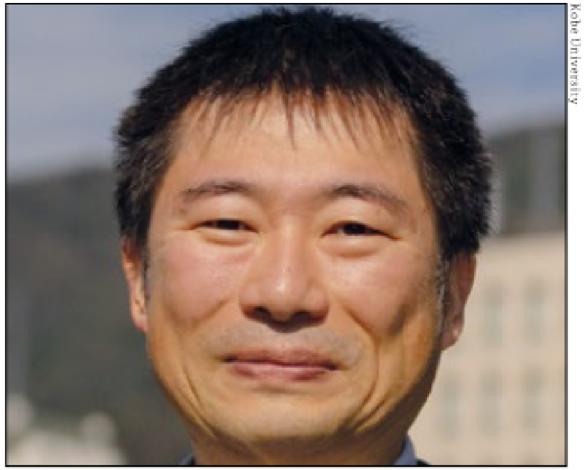

https://cerncourier.com/wp-content/uploads/2024/09/CERNCourier2pOct-digitaledition.pdf

ATSUHIKO OCHI 1969–2024

# Brilliance in detectors

Atsuhiko Ochi, a brilliant, passionate detector and experimental physicist, passed away on 29 April 2024 at the untimely age of 54. A source of innovative ideas at the forefront of radiation detectors, he made outstanding contributions to the development of micropattern gaseous detectors (MPGDs) that are recognised worldwide. He was also a distinguished lecturer whose inexhaustible passion, dedication and remarkable character captivated the many students he mentored.

Atsuhiko began his research at the Tokyo Institute of Technology, initially focusing on large-area avalanche photodiodes as fast photon and soft X-ray detectors. In 1998 he defended his PhD thesis "Study of Micro Strip Gas Chamber as a Time-Resolved X-ray Area Detector", earning the second High Energy Physics Young Researcher's Award from the Japan Association of High Energy Physicists. In 2000, alongside Toru Tanimori, he introduced the micro pixel chamber (micro-PIC), a new gaseous detector for X-ray, gamma-ray and charged-particle imaging. It was fully developed using printed circuit board technology and free of floating structures like wires, mesh or foils, featuring a pin-shaped anode surrounded by a ring-shaped cathode.



Kobe University

*Atsuhiko Ochi made significant contributions to MPGD and other gaseous detectors.*

In 2001 Atsuhiko moved to Kobe University, where he joined the ATLAS experiment and devoted his efforts to commissioning the ATLAS thin gap chambers (TGCs). He was also in charge of integrating the front-end electronics on the KEK TGC detectors and of detector quality assurance and control. Later, at CERN, he led the acceptance quality control of the ATLAS TGCs.

Atsuhiko could always merge his love for experiments with a passion for new ideas. "We need new 'eyes' to catch a glimpse of science's frontier", he once said. Along with his group in Kobe, while making significant contributions in ATLAS to the design and construction of the new large resistive micromegas for the Muon New Small Wheel, he conducted R&D on the use of sputtered layers of diamond-like carbon (DLC) as resistive elements to quench discharges and played a crucial role in connecting with Japanese industry. He was among the first to test the technology with micromegas, apply it to the micro-PIC detector, and pioneer its use as electrodes for the novel resistive plate chambers he proposed for the MEG II experiment. He supported the use of DLC in the final TPC micromegas of the near detectors of the T2K experiment while serving as a liaison person with BE-Sput in Kyoto. DLC is now the predominant approach in most new resistive MPGD detectors.

In his research, Atsuhiko always placed great emphasis on mentoring students and giving them access to a worldwide community of experts, facilities and experiments. He meticulously shared all relevant research conducted by Japanese colleagues, ensuring proper visibility and recognition for his community. This has been crucial in the international RD51 collaboration on MPGD technologies, within which he played a significant role in its formation and management. During the transition from the MPGD-based RD51 collaboration to the upcoming DRD1, which encompasses a broader scope of technologies and applications, Atsuhiko made a crucial contribution by maintaining strong ties with the Asian community.

Atsuhiko's vibrant enthusiasm and infectious smile leave an irreplaceable void. His departure is a profound loss, leaving behind a loving wife and two children.

**His colleagues and friends.**

# Messages and photos

- Photos: https://cernbox.cern.ch/s/CqhZtE9smEeyadZ
- Messages: https://cernbox.cern.ch/s/sZ83h8lyjn2cGnP

Dear Colleagues and Friends,

Today we gather to pay tribute to an exceptional researcher and dear friend, Atsuhiko Ochi. Since the mid-2000s, Atsuhiko and I have worked together, often in friendly competition. While he was developing the micro-Pic detectors, we were in the middle of developing the GEM and Micromegas detectors.

Atsuhiko' s achievements were impressive in their technicality and precision. He used many cutting-edge techniques in the industry and was one of the first to introduce vacuum deposited layers to fabricate MPGDs. Our paths crossed significantly when the introduction of resistive layers became obvious. True to form, Atsuhiko proposed a cutting-edge technique: DLC (Diamond-Like Carbon). This idea, after much back and forth, now seems to be the ideal solution to meet future challenges. Atsuhiko was a visionary in this field.

Atsuhiko was a diamond in the rough, and he left us a piece of himself through this material that is Diamond-Like Carbon. His legacy will continue to shine in our work and in the technological advances he inspired.

Rest in peace, Atsuhiko. You will remain forever in our hearts and memories.

Rui

Very sorry to hear about Atsuhiko Ochi, I remember him very well in our interactions at CERN, his important contributions to the field, and the MPGD conference committee meetings over nearly the last 15 years.

Deepest condolences to his colleagues, friends and family.

Our community owes a lot to his bright ideas, and I agree with Amos in dedicating a session to him at one of the next conferences.

Best regards,
Archana

Dear Colleagues,

my feelings are very near to those expressed by Leszek, Maxim and Eraldo:
Atsuhiko 's personality as a scientist and as a friend has been greatly appreciated and has brought wide richness to our community.

Condolences to all those who now are deeply missing him,
Silvia

Dear friends.

I'm deeply saddened by the terrible news regarding passing away of our beloved Atsuhiko.
What a wonderful person, from all points of view.
We will certainly miss him and his smile.
I suggest dedicating a session to his memory in the forthcoming MPGD meeting, inviting one of his close collaborators to present him as a person and scientist.
So sad...

My sincere condolences to his family, friends and colleagues – in Japan and in RD51-DRD1.
Amos

Dear Friends, Dear Colleagues,

Atsuhiko recently visited our country with a humble attitude and spoke at our congress. We were discussing the projects we would work on together. Today, I was saddened to learn about his passing. I extend my condolences to the entire his family and students.

Yalcin

Dear friends,
It is hard to believe that Atsuhiko is no longer with us. He made significant contributions to the RD51 project and was a truly wonderful person. Please convey my heartfelt condolences to his family.
Sincerely
Vladimir

Dear Colleagues,

I join everyone to express my deep sadness and sorrow on the passing of Atsuhiko. My thoughts are with his loved ones, family, friends. May his soul rest in peace.

Kondo

Dear Eraldo, Colleagues,
Very sad news indeed. Atsuhiko was a great colleague, and I enjoyed working
with him on RD51 very much. It is very hard to understand that he is no longer
with us. My thoughts are with his family, friends and many colleagues who are
bearing this great loss.
Andy

Dear Leszek, Eraldo, Maxim, friends,

I am deeply saddened to hear about Atsuhiko' s passing.
Atsuhiko' s contributions to our community and his positive attitude will be deeply missed.
I fully support the idea to have a dedicated session/event to his memory and to his contribution in the forthcoming DRD1 meeting,
My thoughts are with his family, students, and colleagues during this difficult time.
Sincere condolences,

Anna

If you want to submit photos (link)
If you want to submit a message (link)


MPGD 2009 – Kolympari, Crete
MPGD2011 and 8th RD51 Collaboration Meeting
29 August - 3 September 2011
Kobe, Japan
MEG II
Development of resistive electrodes for ultra-low mass and high-rate capable DLC-RPC in MEG II experiment
Kensuke Yamamoto