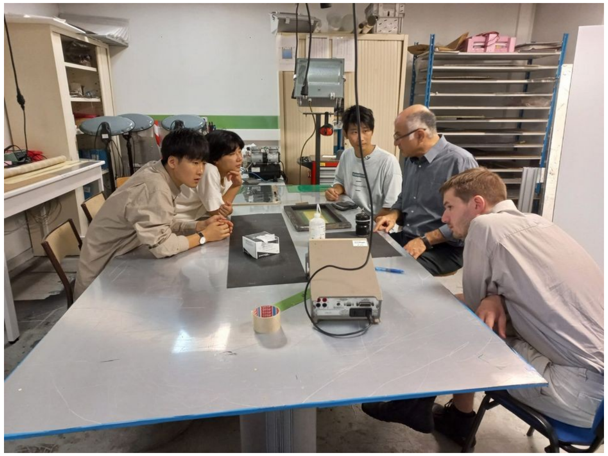
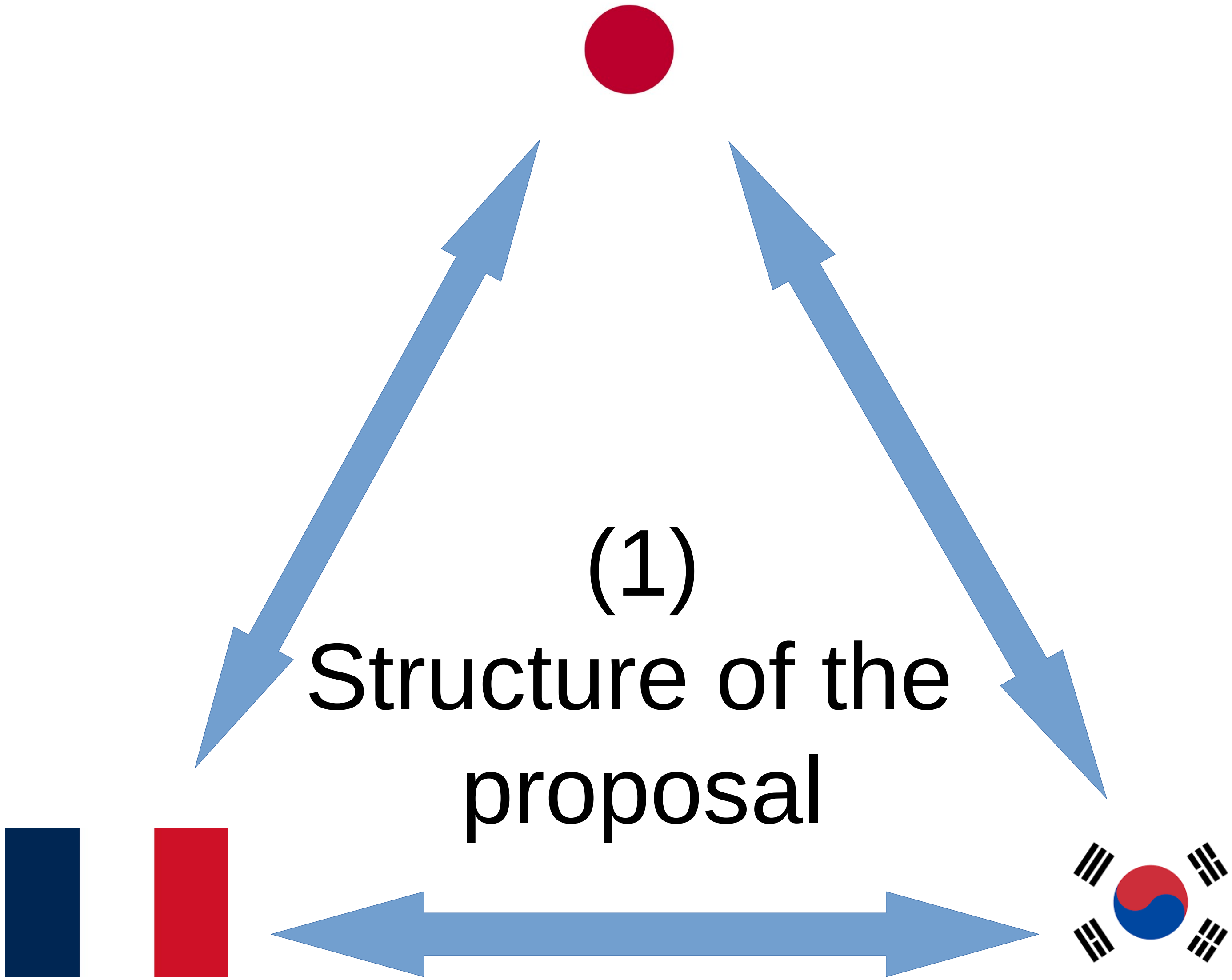
RPC production and assembling facility in Seoul, Korea and J-PARC, Japan

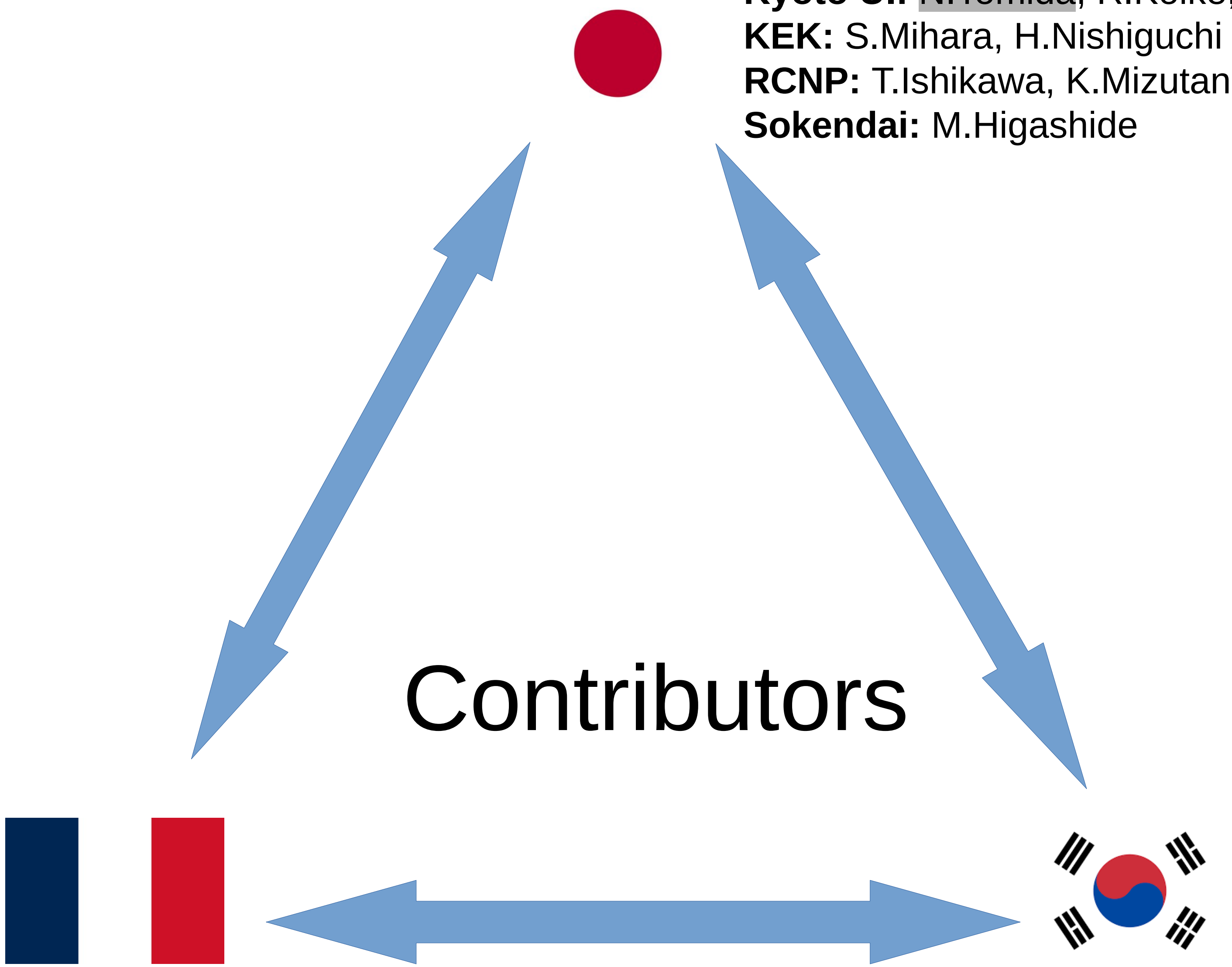


M. Gouzevitch (FR), N. Tomida (JP), M.J.Lee (KR)

Proposal of tripartite extension of FJPPN D-RD-30


(1)
Structure of the proposal

Contributors



Kyoto U.: N.Tomida, R.Koike,
KEK: S.Mihara, H.Nishiguchi
RCNP: T.Ishikawa, K.Mizutani
Sokendai: M.Higashide

IP2I: M.Gouzevitch, I.Laktineh, L.Mirabito
LPCA: C.Carloganu, V.Raspal

Sungkyunkwan U.: M.J.Lee
Hanyang U.: T.J.Kim

FKPPL: 2017-2022

CMS RPC

Development of iRPC chambers for CMS. Heavy Stables Charged Particles trigger development.

2017-2021: IP2I – Hanyang Univ
2022: IP2I – Kyung Hee Univ.

France: IP2I

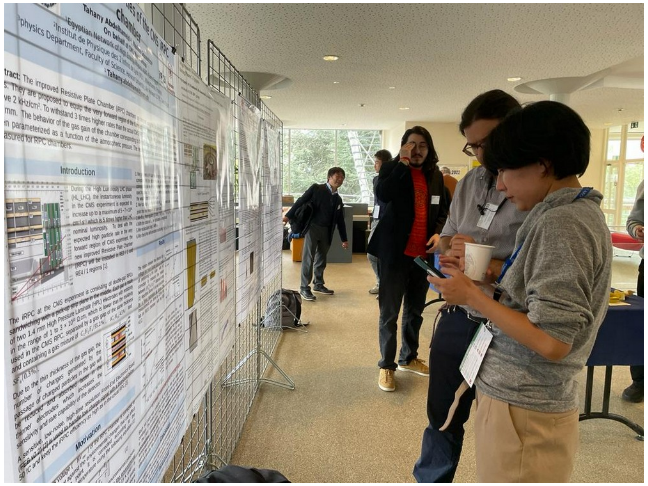
Electronic and readout for iRPC detector on CMS

CERN

Korea: Hanyang Univ., Kyung Hee Univ.

Bakelite gap assembly lab/expertise.
CMS Trigger expertise.

FJPPN: 2023-2024



Exact moment when collaboration started. RPC2022, CERN

Japan: Kyoto Univ.

Multigap Glass RPC for Pi20 beamline.

France: IP2I

Large size strip PCBs
Multi-gap chambers development for TSD-HCAL

D-RD-30: IRPC - TOF and muon tracker RPC construction for the J-PARC π20 beam line

Share of expertise for Multigap RPC chambers for J-PARC MARQ experiement on Pi20 beamline.

Structure of the proposal 2025

Japan: Kyoto Univ., KEK, Sokendai, RCNP

Glass RPC expertise.
J-PARC experimental facility: MARQ, E88, E95

J-PARC,
Had. Exp. Fac.

France: IP2I, LPCA

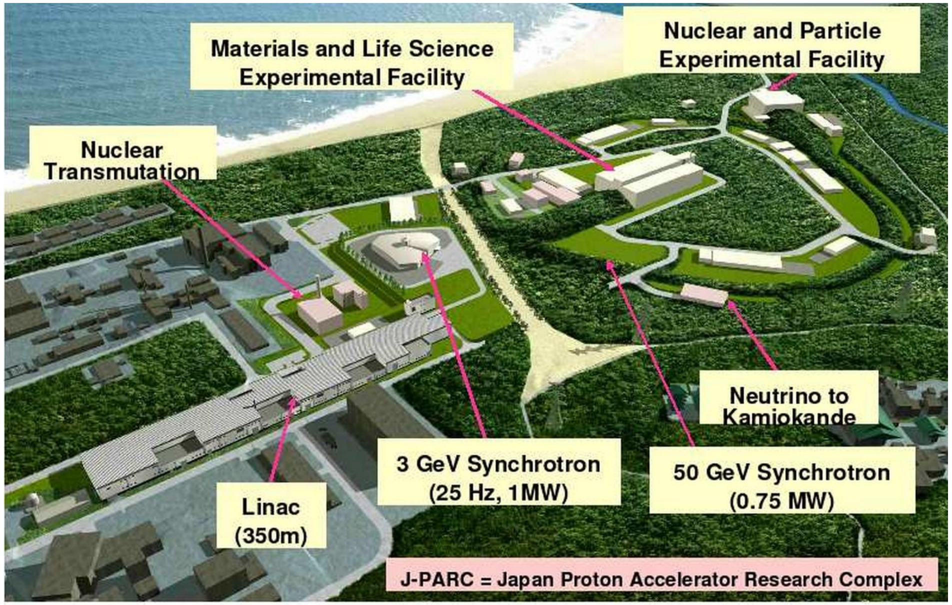
Glass/Bakelite RPC expertise,
iRPC detector for CMS

Korea: Hanyang Univ., Sungkyunkwan Univ.

Glass/Bakelite gap assembly lab/expertise

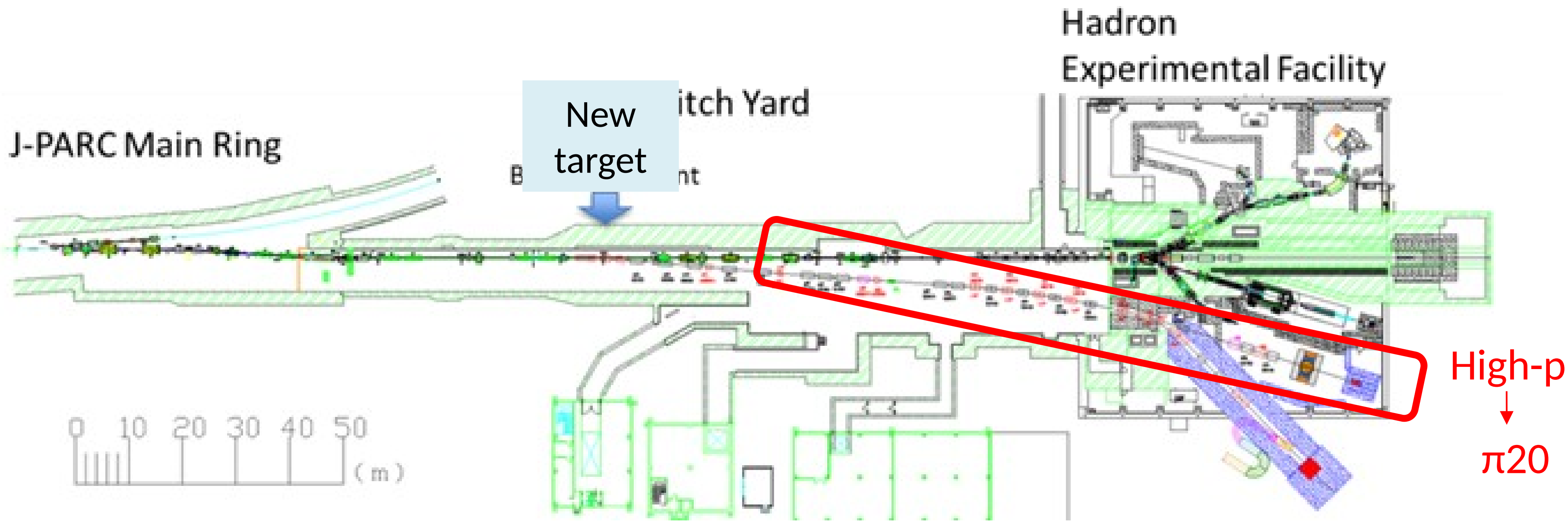
CERN

(2) Multi-gap Glass RPC for J-PARC hadron experiments D-RD-30



J-PARC π20 beamline

New high momentum secondary beamline @ J-PARC



- 2020 : New high-p beamline = 30 GeV primary proton beam

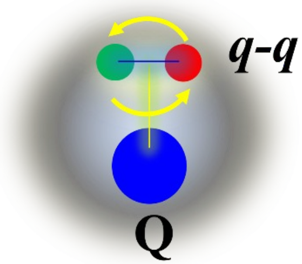
Upgrade ↓
- New target
- Polarity change
- Focusing magnets

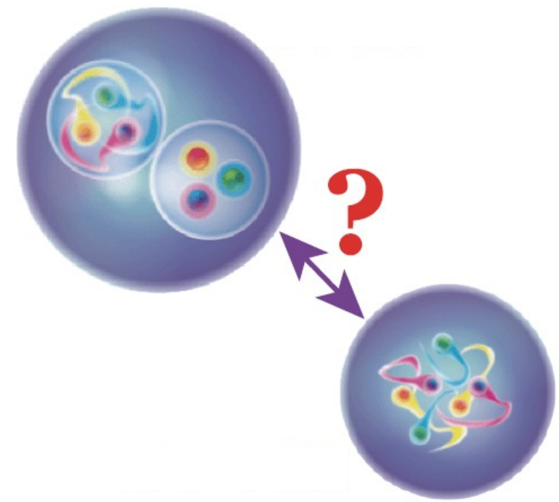
- 2025 **: π20 beam line** **= Positive and negative secondary beam** (π/K/p) in wide momentum range (2-20 GeV/c)

First test beam in 2025/Jan!!

Physics program @ π20 beamline

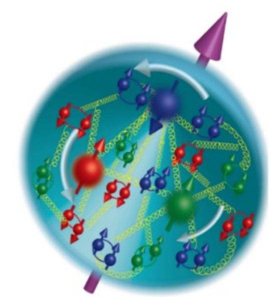
- **Hadron structure**
  - Charmed baryon spectroscopy
  - Ξ (s=-2) baryon spectroscopy





- **Exotic hadrons**
  - High isospin dibaryon search
  - Pentaquark search

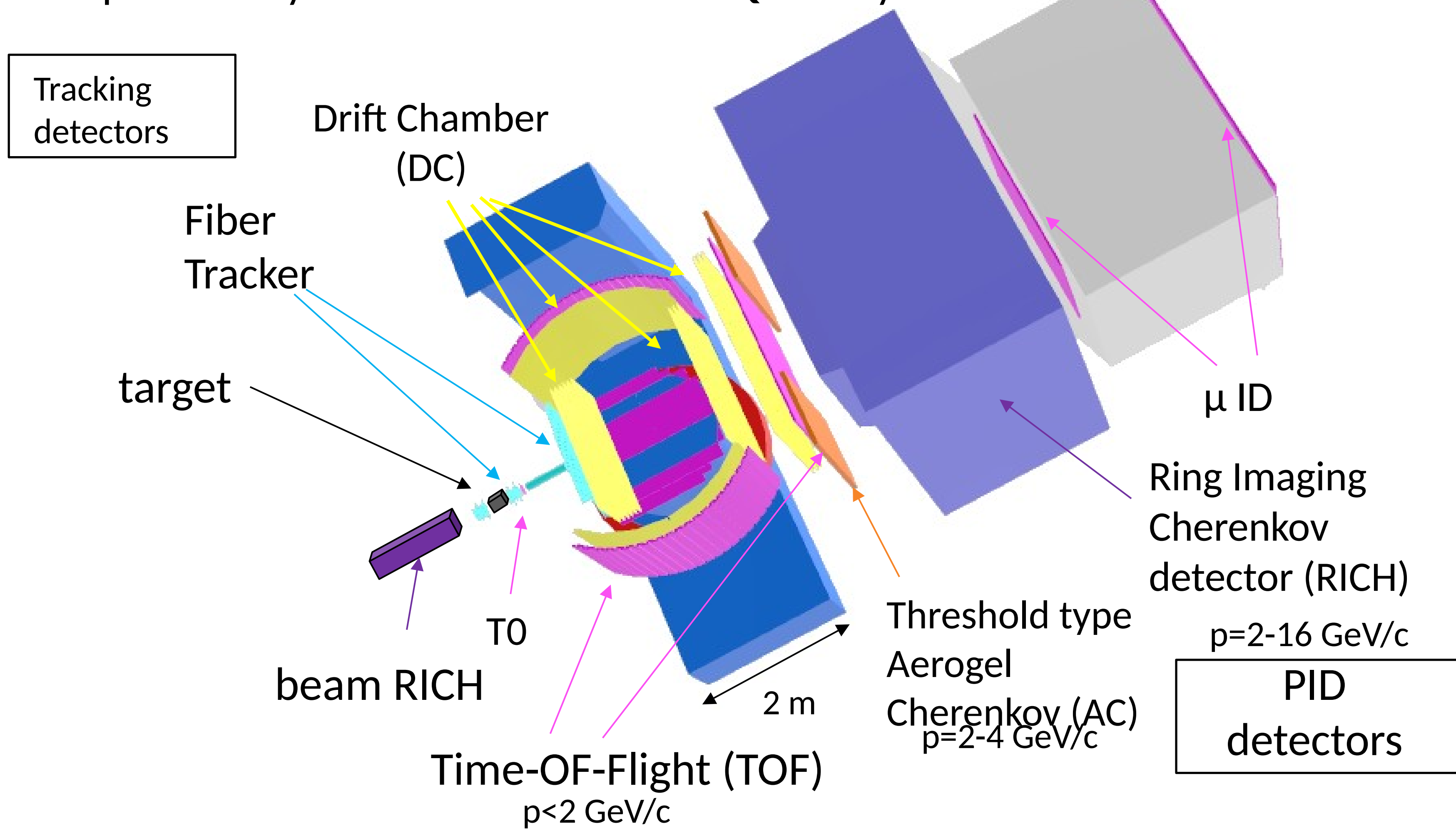
- **Nucleon structure**
  - Measurement of Generalized Parton Distribution Functions (GPDs)
  - Color Transparency



- **Elementary cross sections**
  - Λp scattering cross section
  - Hadronic cross sections for neutrino experiments

MARQ Spectrometer

Multi-Purpose **A**nalyzer for **R**esonance and **Q**uark dynamics



- Streaming DAQ : no hardware trigger, online filtering
- High rate stability : 1MHz/1 mm @ center
- Large acceptance
- High momentum resolution

R. Honda et al., PTEP 123H01 (2021)

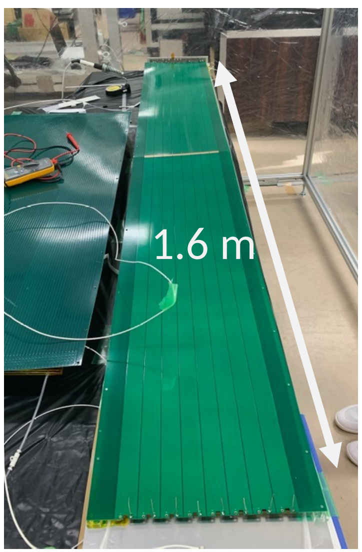
MARQ MRPC

Multigap Resistive Plate Chamber (MRPCs)

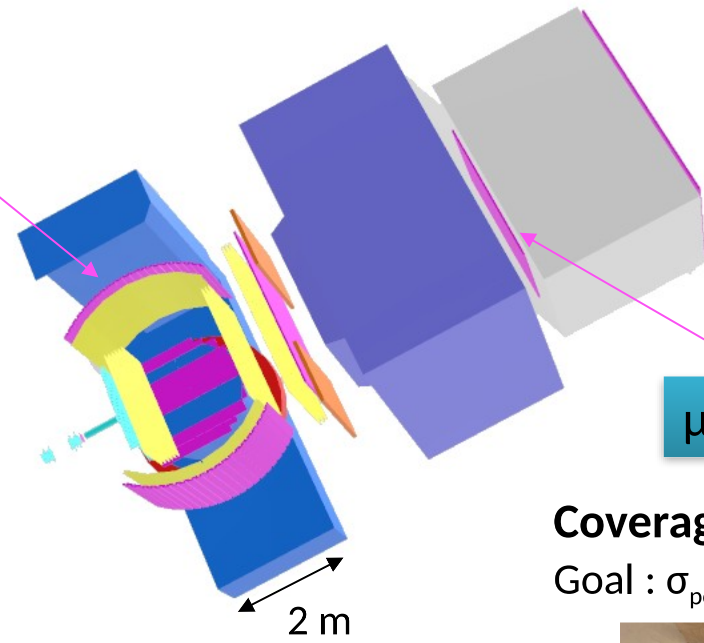
Side TOF

1.6 m long

Goal : σ_{time}= 60 ps in magnetic field



N. Tomida et al., NIM A 1056 (2023) 168581



N. Tomida et al.,
NIM A 1077 (2025) 170517

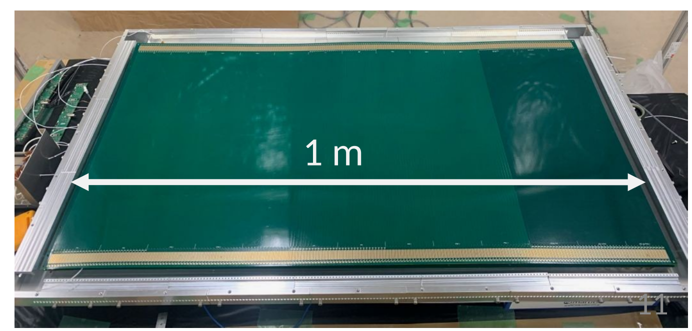
R. Uda et al.,
NIM A 1056 (2023) 168580

μ ID tracker

TOF-tracker

Coverage area : 2.4 m × 1.8 m

Goal : σ_{pos} = 1 mm, σ_{time} = 100 ps

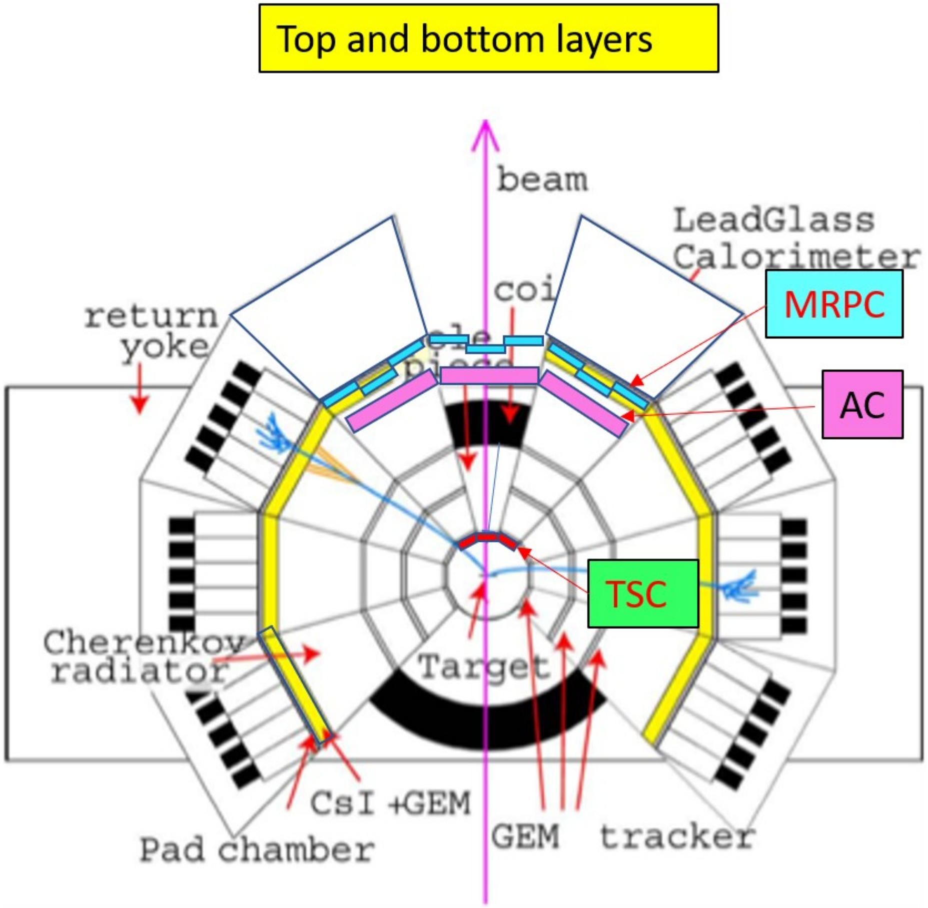


J-PARC : E88/E95

Join RD-30 for 2025 since they use same MRPC detectors

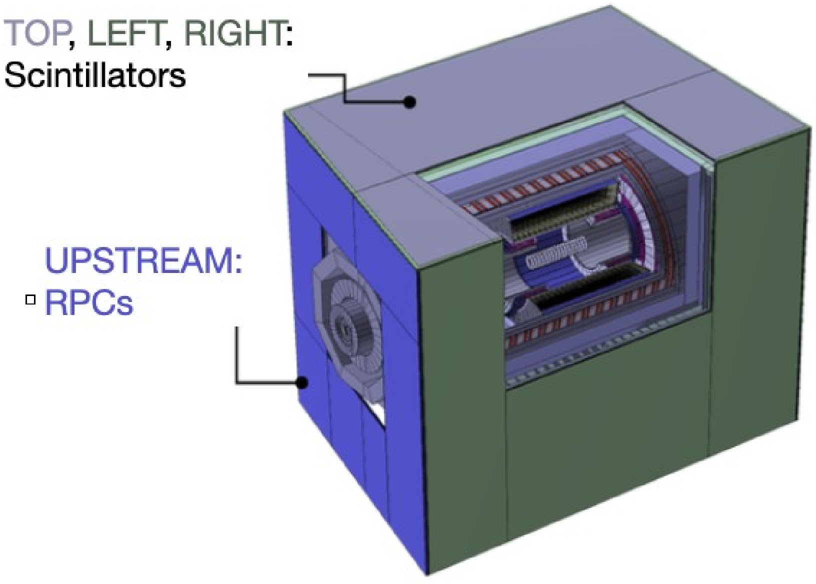
- E88 : φ→KK in nuclei
- E95 : π-p→φn, nucleon resonance

E16 spectrometer + Kaon PID detector (MRPC, AC)



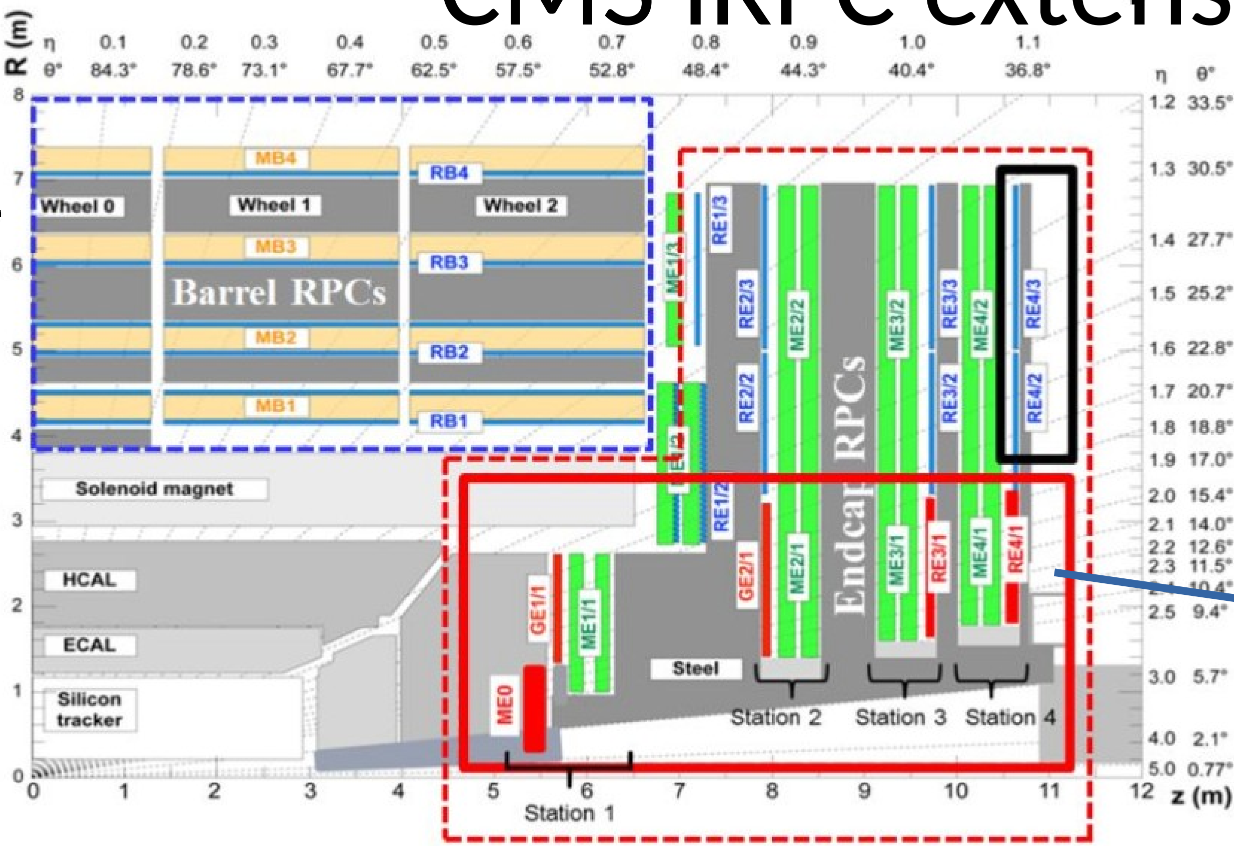
(3) Twin-gap Bakelite iRPC from CMS for COMET experiment CRV

Join FJPPN RD-30 for 2025 and new FKPPN proposal (RPCGAP)

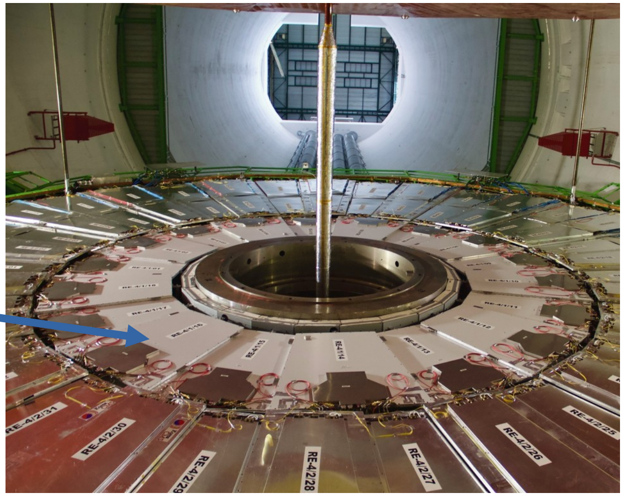


CMS iRPC extension

More details

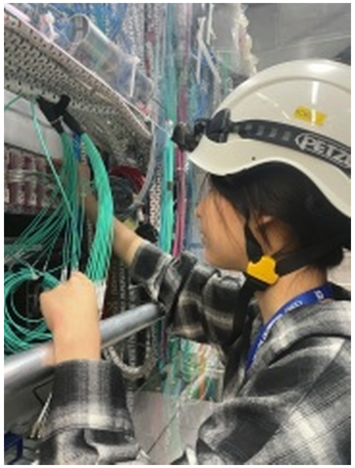


IRPC station



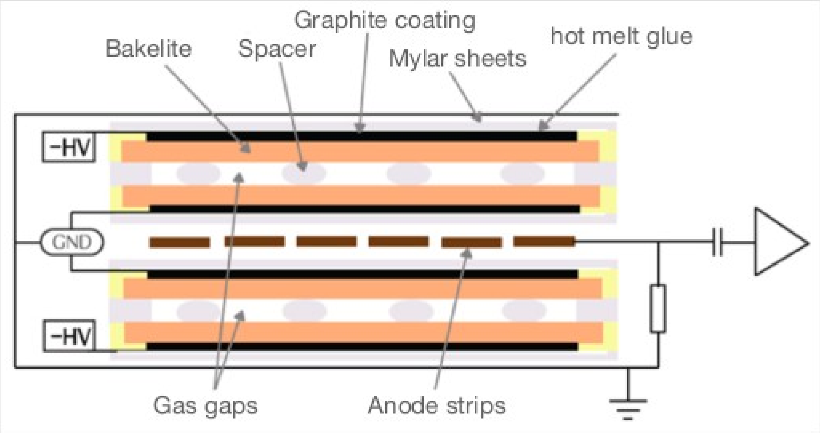
Installation

M2 student from Hanyang University: iRPC certification



The CMS iRPC

- Double-gap iRPC detectors
- Each gap made of two 1.4 mm low-resistivity (order of 10^{10} Ωcm)
- High Pressure Laminate electrodes Separated by a gas gap of the same thickness.
- Two readout panels: made of a thin (0.6 mm) Printed Circuit Board (PCB)
- Each PCB has 48 strips and equipped with a FEB.
- To identify the position along the strip, the read out of the iRPC detectors is from both sides of a strip end, low radius (LR) and high radius (HR).



- The new layout reduces the amount of the avalanche charge produced by the passage of a charged particle through the detector.
- This improves the RPC rate capability by reducing the needed time to collect this charge.

This and Following 6 slides taken from a communication by Ece Asilar in RPC2024 workshop (Santiago de Compostella)

https://indico.global/event/6191/sessions/9265/#20240910

The CMS iRPC

Italy,
Korea

- Bakalite :
  Long lasting, not fragile, can be very large in size, easy to handle.
  Allow use of flex piping, without a necessity of very well control of humidity.

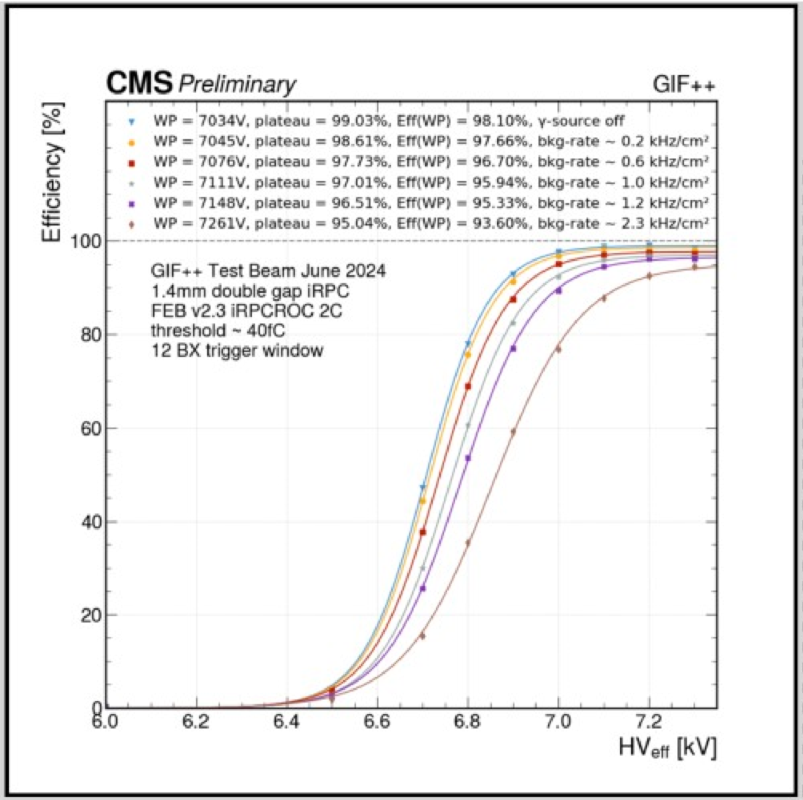
- PCB :
  A quite large solution (60 x 170 cm^2) and resistant.
  2D readout without multi layer strip. No XY ambiguities.
  Perfect impedance matching (better than 5%).

- FEB :
  FEB and PCB shape can be flexible. Easy to plug.
  Design is open to changes at component level

The iRPC is an elegant solution with low number of channels for a large chamber with 2D readout.

The CMS iRPC

	iRPC
High Pressure Laminate thickness	1.4 mm
Num. of Gas Gap	2
Gas Gap thickness	1.4 mm
Resistivity (Ωcm)	0.9 - 3 x 10^{10}
Charge threshold	< 50 fC
space resolution (eta)	1.5 cm
space resolution (phi) strip pitch driven	0.3-0.6 cm
Intrinsic time resolution	0.5 ns

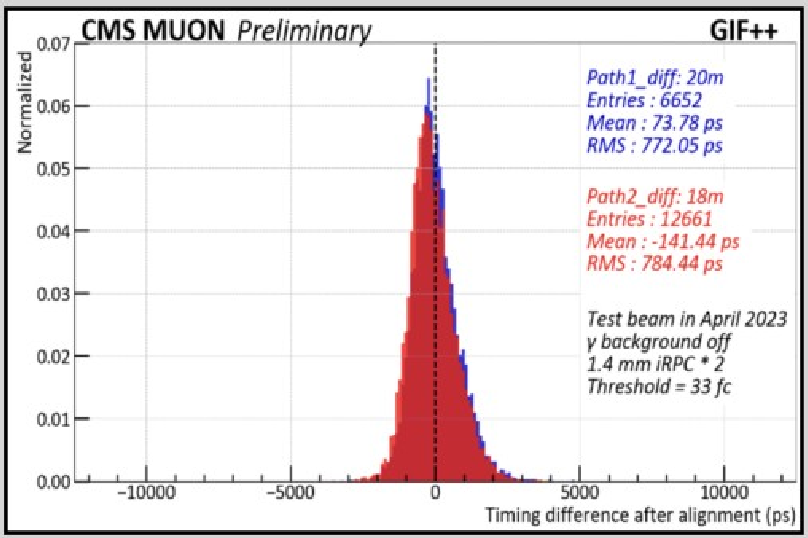


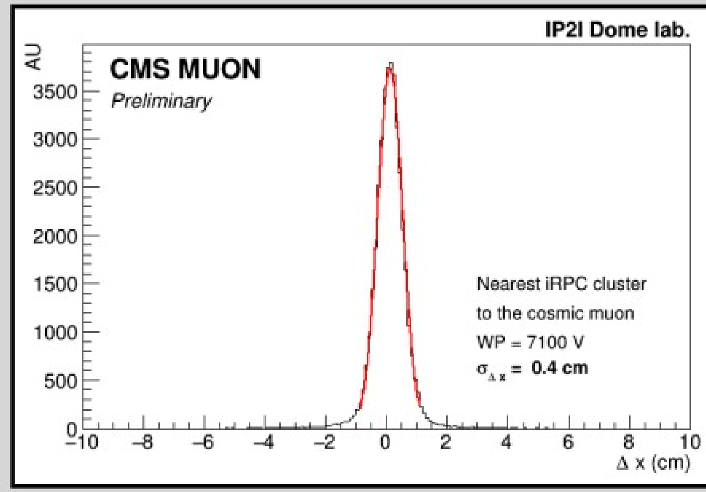
See presentation from Jules Vandenbroeck

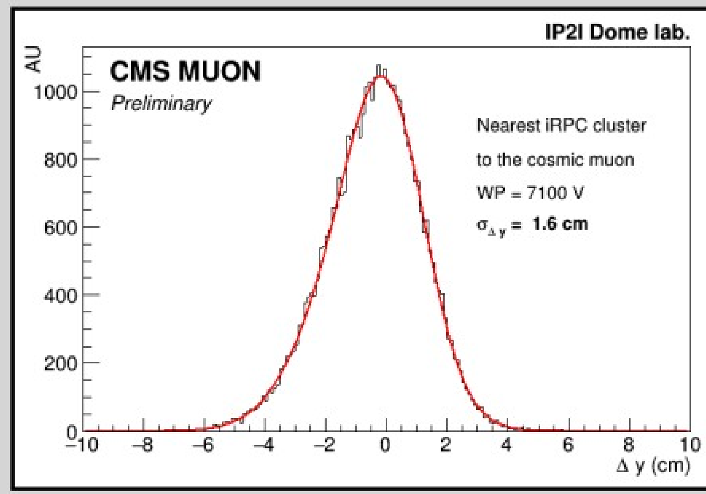
The iRPC ensures high efficiency for high background rates

The CMS iRPC

The iRPC ensures 550 ps time resolution;
x, y resolution 0.4 cm, 1.6 cm



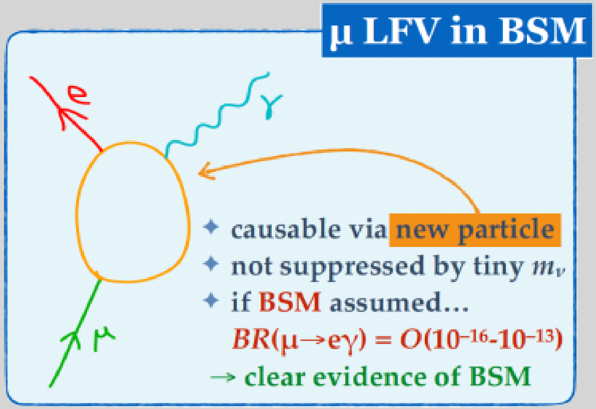




See presentation from Jules Vandenbroeck

An alternative experiment for the use of RPC chambers : The COMET Experiment

A search for muon to electron conversion at J-Parc



- Observation of neutrino oscillations confirms the existence of neutrino mass and neutral lepton flavour violation.
- The neutrino mass terms predict charged lepton flavour violation (CLFV) at loop level
  - These processes are highly suppressed due to the tiny values of neutrino masses.
- Many beyond the SM physics models predict sizeable CLFV that may well be accessible experimentally.

One of the most interesting CLFV processes which can occur is the transition of a muon to an electron in the presence of a nucleus $\mu N \to eN$.

The image is from Hajime NISHIGUCHI Talk in ICHEP 2024

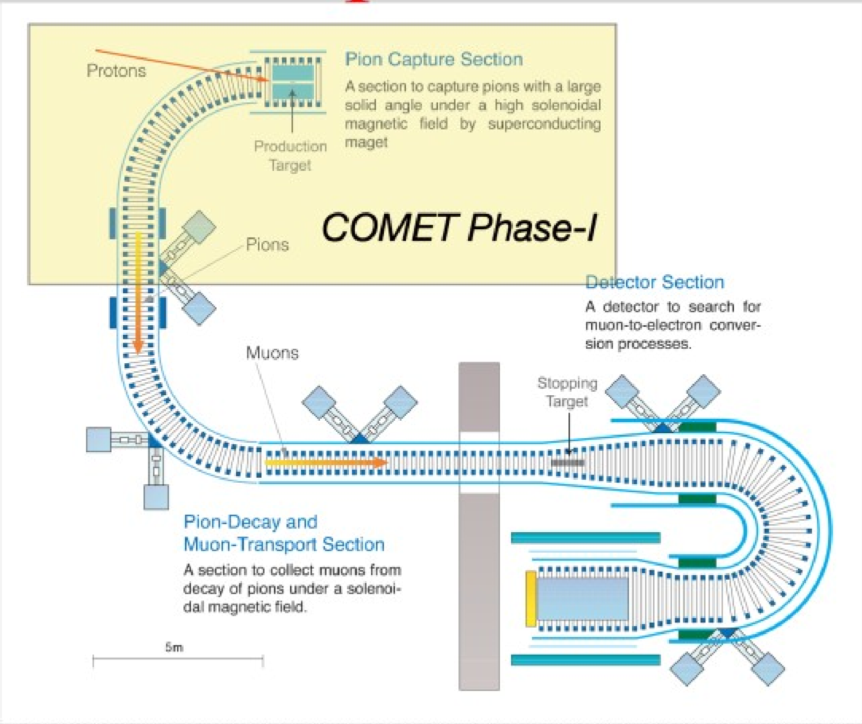
An alternative experiment for the use of RPC chambers : The COMET Experiment

COMET Phase-I

- Construct up to first 90° bend and place detector.
- Perform direct beam measurement
  - No backward σ_{π} data so far
  - No real background data so far
- Perform μ-e search with an intermediate sensitivity ($O(10^{-15})$)

COMET Phase-II

- Complete all transport
- Perform μ-e search with a full sensitivity ($O(10^{-17})$)

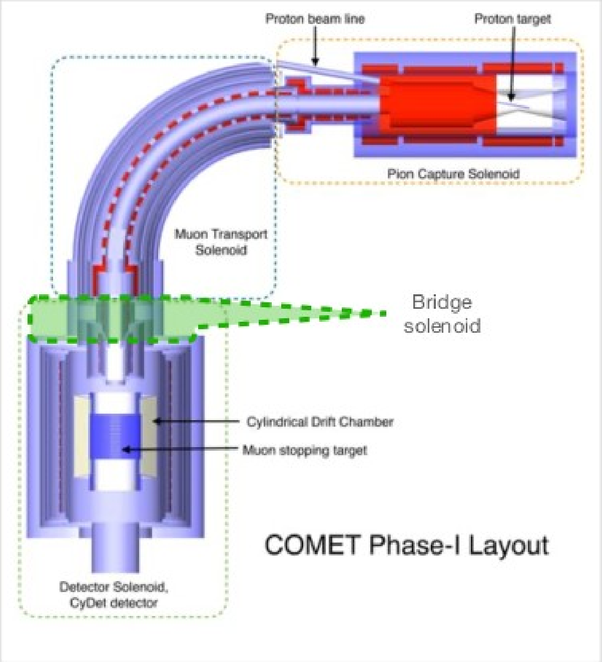


The content is from The COMET Experiment TDR

An alternative experiment for the use of RPC chambers : The COMET Experiment

Cosmic Ray Veto

- Cosmic Ray muons can decay in flight or interact with the materials around the area of the muon-stopping target and produce signal-like electrons in the detector region.
- The region around the BS that requires active shielding has a surface of 4.5 x 4.5 m².
- Simulations show a large neutron contamination hit rate of the order of kHz.
- Thin detectors,
  nanosecond time resolution,
  operated at efficiencies better than 95% is proposed.



In the TDR originally a glass RPC was envisaged,
iRPC proposes a "turn key" solution.

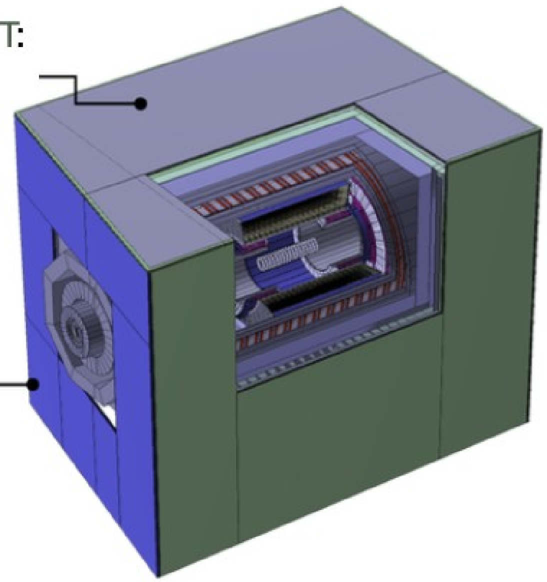
The content is from the COMET Experiment TDR

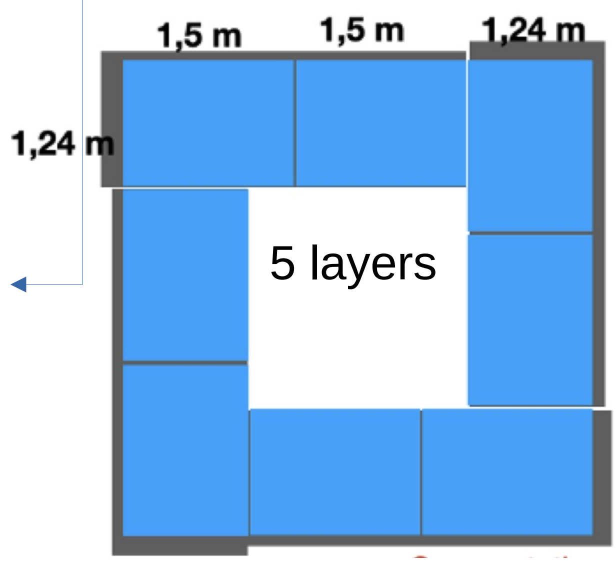
COMET

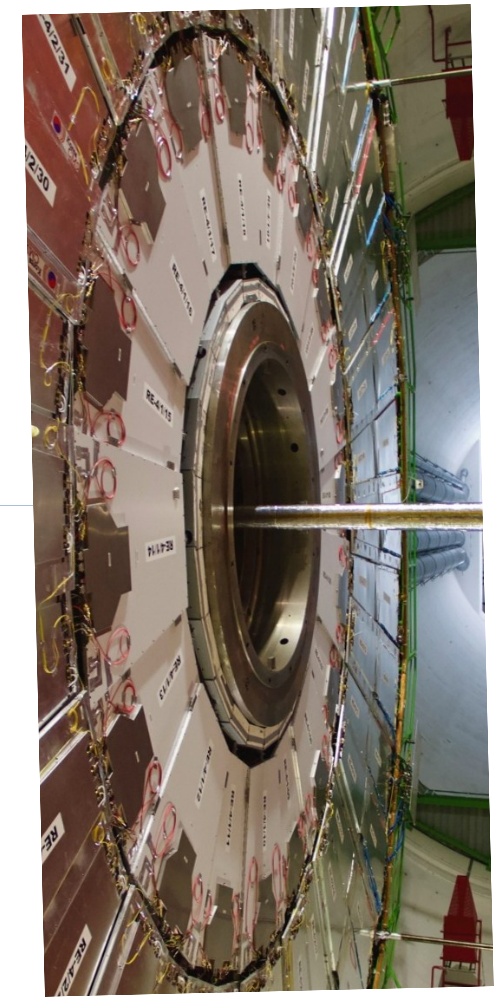
CMS

TOP, LEFT, RIGHT:
Scintillators

UPSTREAM:
▫ RPCs







(4) Activities 2024
and
Proposal for 2025

Summary 2024:
FJPPN D-RD-30

Target 1: Produce prototype MRPCs with new gas spacers and gas tight method based on techniques developed in IP2I/Lyon.

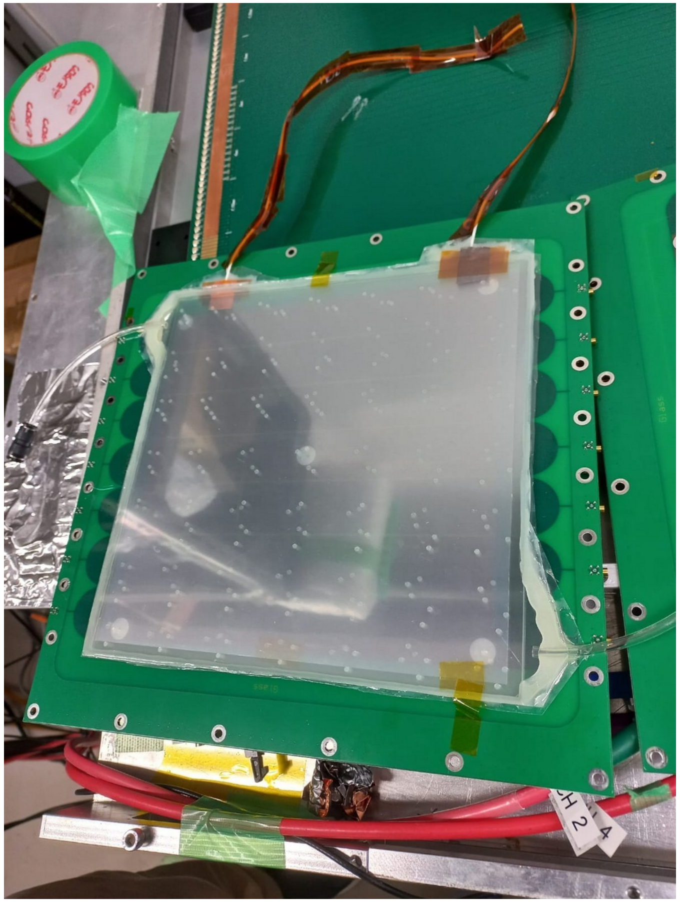
→ IP2I spacers hand made. Kyoto U. found Taiwanese company doing them. Test successful. Sent back to France.

Target 2: Produce prototype MRPCs with different HV electrodes such as conductive polymer, fluorocarbon resin and graphite ink used in IP2I.

→ Several prototypes made using different HV coatings on polyamide sheets as proposed in IP2I. It was found that IP2I ink is hard to import in Japan an other ink is used now.

Target 3: Test wire-readout TOF-tracker MRPCs

→ Tests performed. Analysis of results ongoing

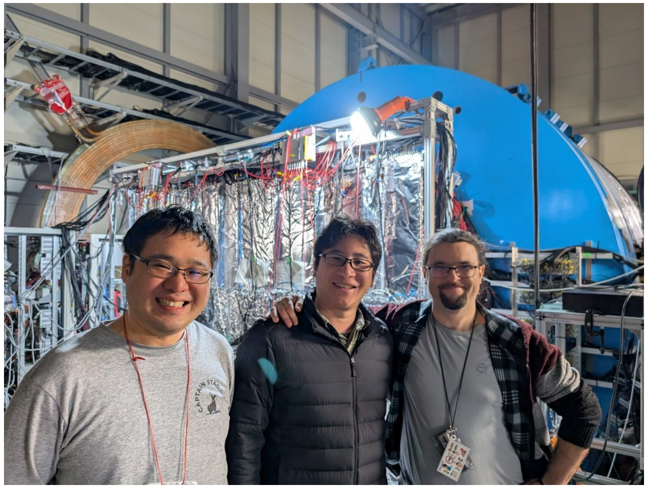


R. Koike, student from Kyoto U. got prize for best talk by RPC2024 workshop

"A TOF-tracker MRPC for simultaneous measurements of timing and position at the π20 beamline of J-PARC"

Summary 2024:
FJPPN RD-30

- First visit of French PI to Japan: COMET week in J-PARC, Kyoto U., Spring-8



MRPC array in SPring-8 also used as test facility

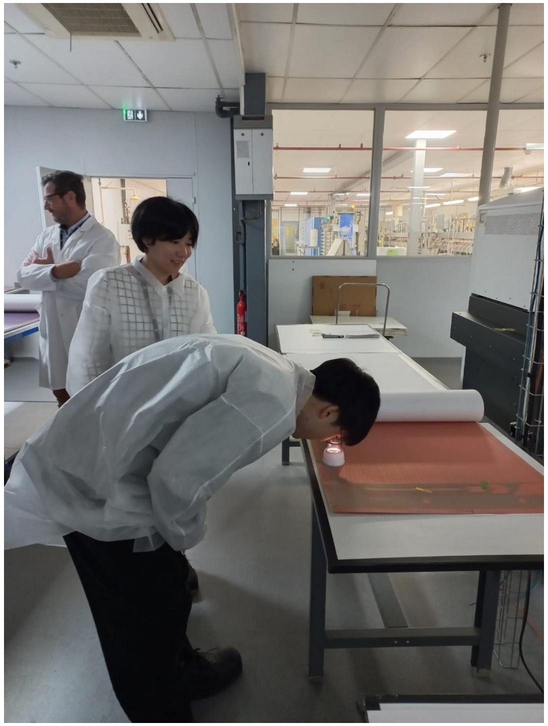
Memories from Bamboo forest
(AI based on real painting by R.Johnson)

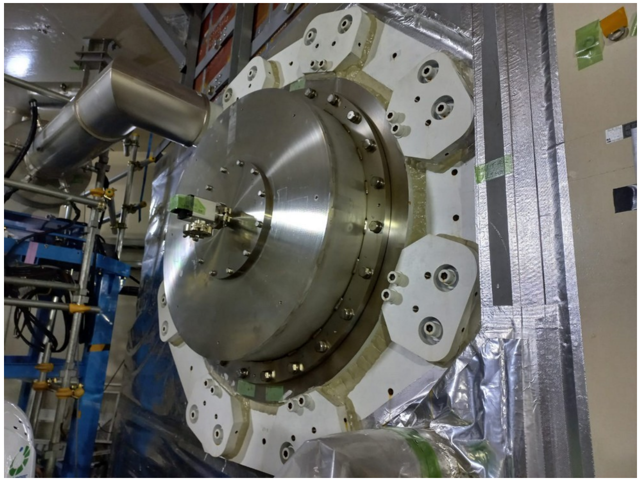
Seminar in Kyoto University

Prop. 2025: RPC (FJPPN)

1) Finalise MARQ-MRPC design. Test large size PCBs used in iRPC. Made by French company ELVIA (Normandy) and certified in IP2I. Perform test beams.

2) Design and test basic elements for iRPC adaptation to COMET CRV.





Visits:
JP → FR
FR → KR, JP foreseen
KR → FR, JP under discussion

Prop. 2025: J-PARC Facilities (FJPPN)

Establish the RPC assembly facility at J-PARC:

1) **2026 - E88/E95:** TOF detector which later is recycled for MARQ MRPC (10 gaps) 100 cm x 20 cm, 20 chambers
2) **2026 - COMET:** CRV, 150 x 130 cm, 20 RPC modules.
3) **2028 - MARQ:** Tracker, 100 cm x 50 cm (5 gaps), 10 chambers. TOF, extra 20 chambers.

CERN 904 assembly facility in 2023

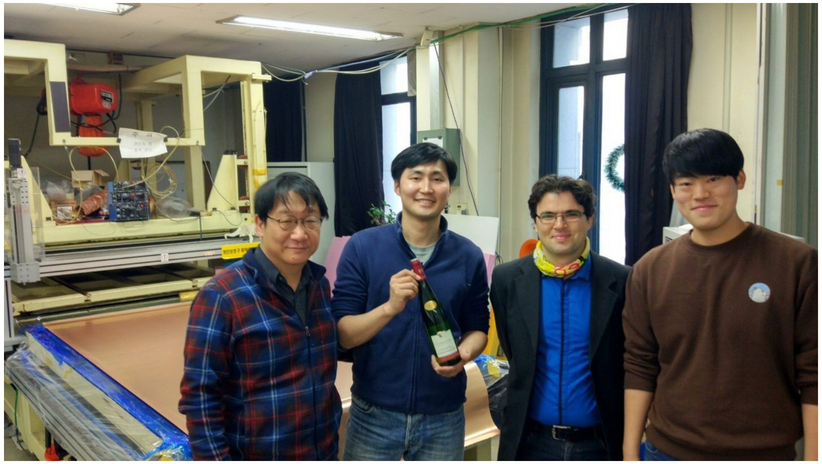
[More photos]

Prop. 2025: Seoul Facilities (FKPPN)

Reorganise the KODEL gap assembly facility in transition between 2 universities after the end or iRPC gap production:
KODEL (Korea University) → KBSI (Korea University) + Hanyang University
Be ready for gap production in 2026:

1) **2026 - E88/E95:** TOF detector which later is recycled for MARQ MRPC (multi-gap: 10 gaps) 100 cm x 20 cm, 20 chambers
2) **2026 - COMET:** CRV, 150 x 130 cm, 40 RPC gaps, 20 ROC modules.
3) **2027 – CMS RPC :** around 200 gaps.
4) **2028 - MARQ:** Tracker, 100 cm x 50 cm (multigap - 5 gaps), 10 chambers. TOF, extra 20 chambers.

KODEL lab in 2017



SUMMARY

We propose to build on of the few tripartite proposals FJKPPN around an RPC assembly and test facility in J-PARC useful for 4 experiments (COMET, MARQ, E88, E95) and reactivate/perpetuate the ROC gap production lab in Korea for J-PARC assembly facility but also CMS gap reparation during LHC LS3 break.