MPGD R&D Activities and Prospects in China

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RD51 Collaboration Meeting
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Outline

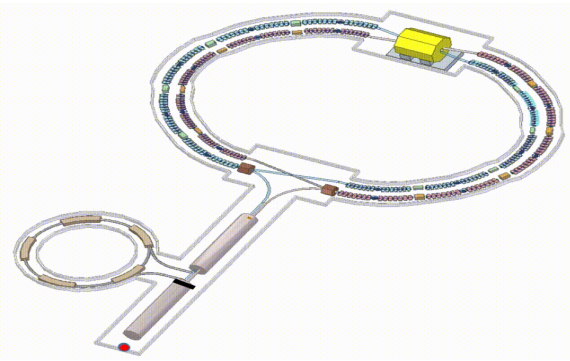
- R&D for fundamental research
- R&D for applications in other fields
- Infrastructure development
- Future prospects

Accelerator-based NP and HEP facilities (proposals) in China

Beijing Electron-Positron Collider (BEPC) : 240 m, 2-4.6 GeV

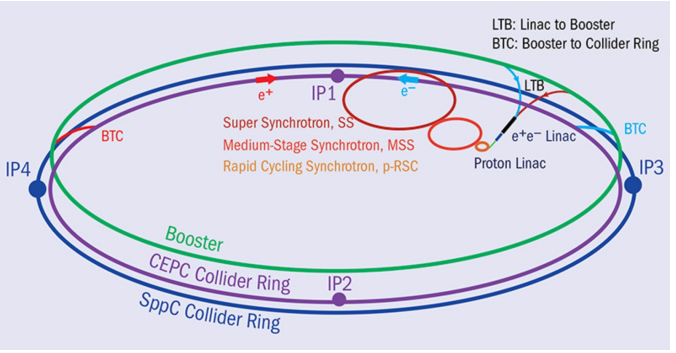
Super Tau-Charm Facility (STCF)

A Tau-Charm factory: ~1 km, 2-7 GeV



Circular Electron-Positron Collider (CEPC)

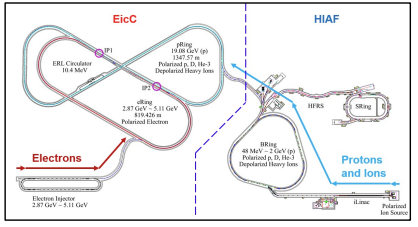
A Higgs factory : ~100 km, 240 GeV



HIRFL : a heavy ion accelerator

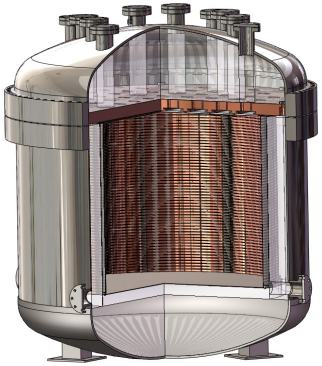
High Intensity heavy-ion Accelerator Facility (HIAF) ~4GeV/u

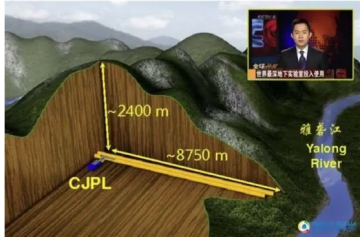
Electron Ion Collider in China (EicC)
20GeV p, 3.5GeV e



Non accelerator Experiments in China (that involve MPGD)

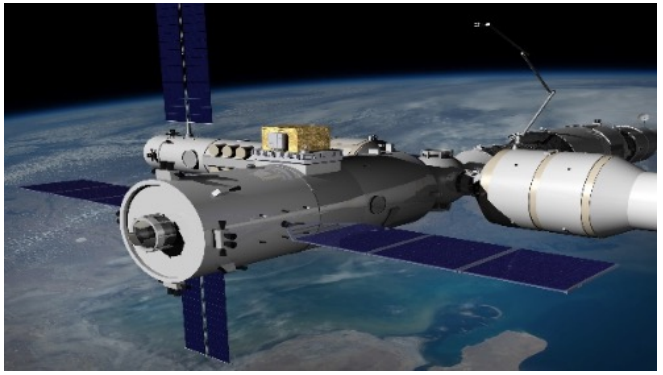
PandaX-III @ CJPL : neutrinoless double-beta decay





China Jinping Underground Laboratory

HERD and POLAR-2 @ China's Tiangong space station

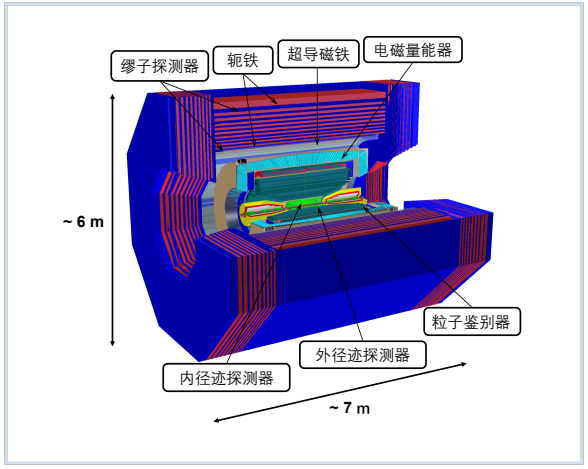


HERD : The High Energy cosmic-Radiation Detection (HERD) facility
POLAR-2: Polarization of gamma-ray bursts

eXTP: Enhanced X-ray Timing and Polarization mission

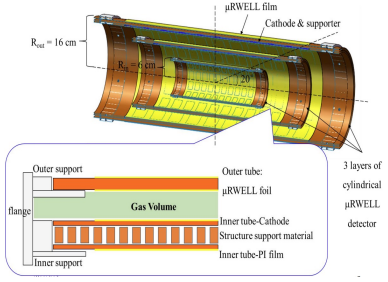
MPGD R&D for STCF

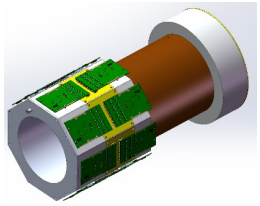
STCF detector conceptual design

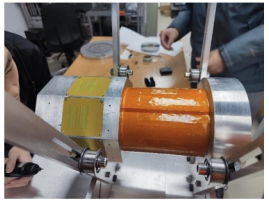


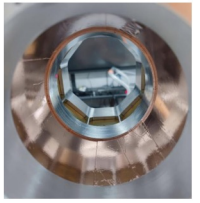
Inner Tracker: MPGD option

Cylindrical uRWELL



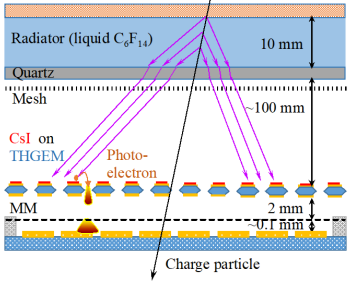


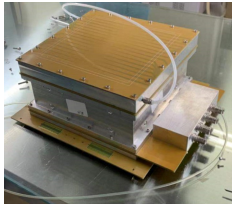


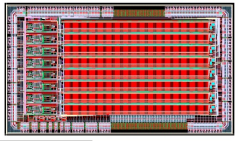


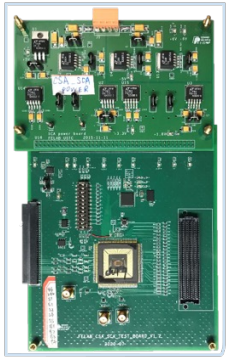
Barrel PID: RICH

THGEM + Micromegas





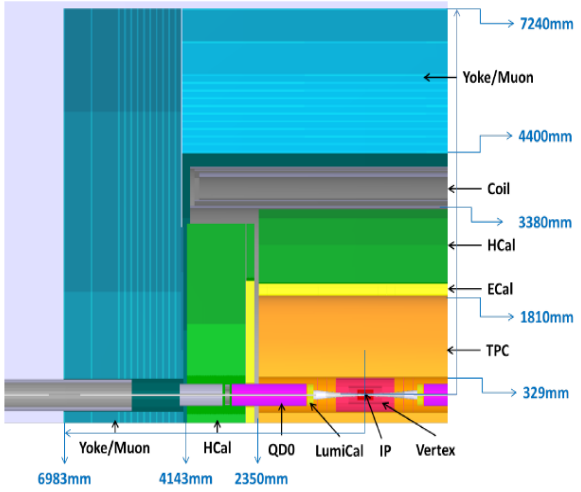




Funded by USTC and Chinese Academy of Sciences

MPGD R&D for CEPC

CEPC baseline detector conceptual design

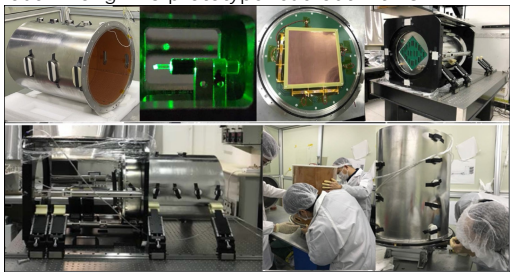


Funded by the Ministry of Science and Technology of China

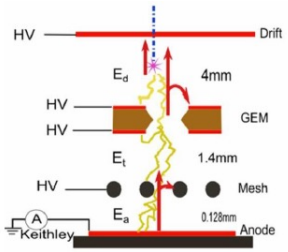
A lot of synergy between CEPC and ILC

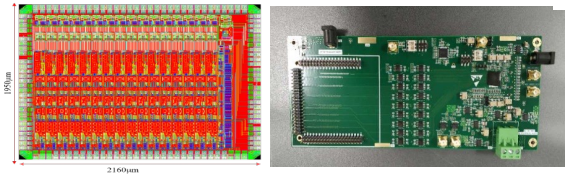
Central tracker: TPC with MPGD

A 50cm-long TPC prototype read out with GEM+MM



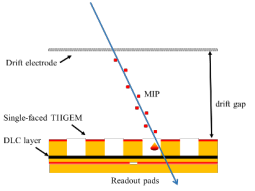
GEM+MM

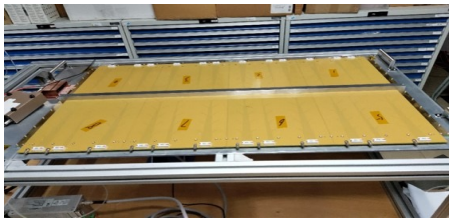




Low power readout ASIC chip developed with 65 nm CMOS process. 16 chs/chip, 2mW/ch

Digital HCAL: large-area RWELL

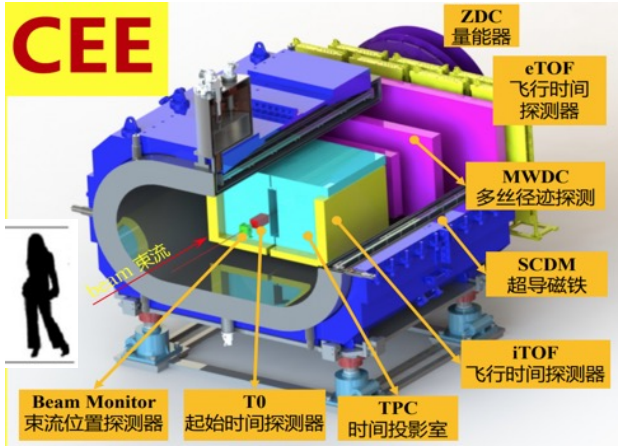




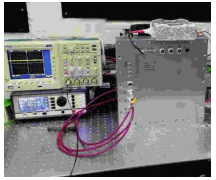
MPGD R&D for CEE, HIAF and EicC

External-target Experiment (under construction)
@ Cooling storage ring of HIRFL

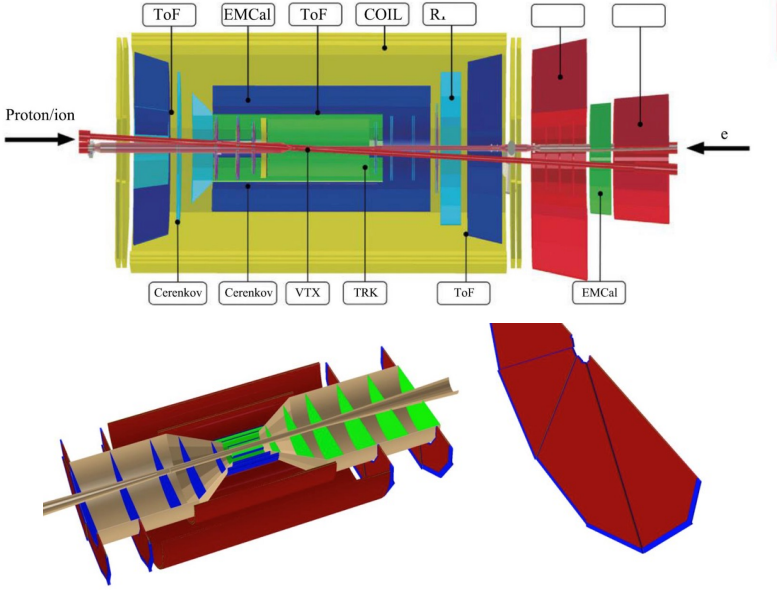
Funded by National Natural Science Foundation



GEM readout for TPC



EicC Detector Conceptual Design

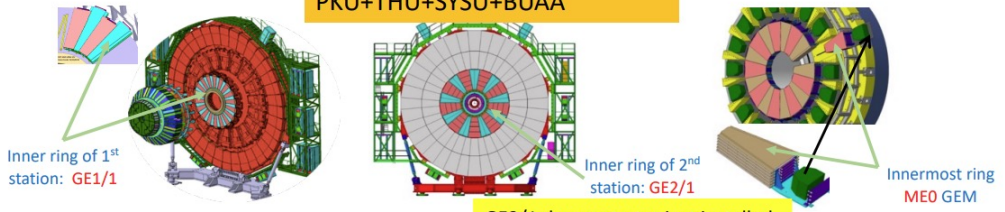


MPGD options for trackers: uREWLL , Micromegas in the design and optimization phase

CMS GEM upgrade project

Tasks by CMS-China in GEM Upgrade

PKU+THU+SYSU+BUAA



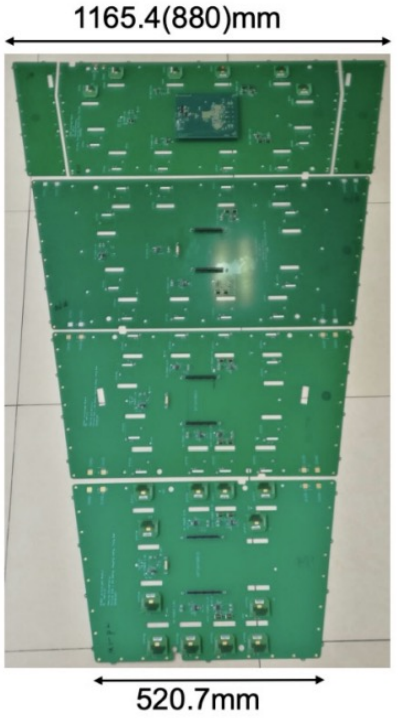
GE2/1 demonstrator just installed

Upgrade GEM		GE1/1	GE2/1	ME0
Number of GEMs*		288（=2×36×4）	288（=2×18×8）	216（=2×18×6）
Plan	R&D	2013-2017	2014-2020	2014-2022
	Mass-Production	2017-2019	2020-2022	2022-2024
	Install. & Commi.	2018-2021	2022-2024	2024-2026
Tasks of Chinese Group		Prod. & Test of all GEB in China，GEM Assembly & Test, Install. & Commission at CERN	Design & Prototyping of GEB，Assembly. & Test of ~1/8 GEM in China，Install. & Commission at CERN	Design & Prototyping of GEB，Assembly. & Test of ~1/5 GEM in China，Install. & Commission at CERN

GE1/1 see beams! Monika Mittal's talk

*（Total Num.=Num. of stations × Num. Of module /station × Num. of GEMs /module）

Annual progress



Funded by Ministry of Science and Technology and National Natural Science Foundation

MPGD R&D for non-accelerator Experiments

Micromegas for PandaX-III

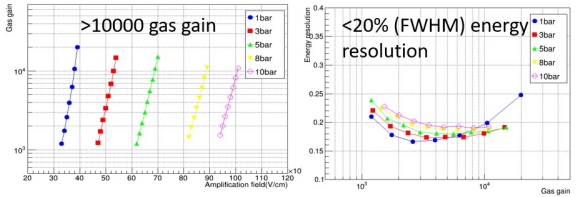
Funded by Ministry of Science and Technology of China

Design for High radiopurity

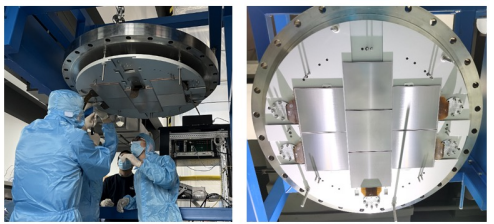
- Stainless steel mesh
- Thermal bonding film
- Flexible PCB
  - Ge anode
  - Copper strip
- Pure copper substrate

PANDA X

12/2019 V1 | 02/2020 V2 | 04/2020 V3 | 08/2020 V4 | 11/2020 V5 | 06/2021 V6

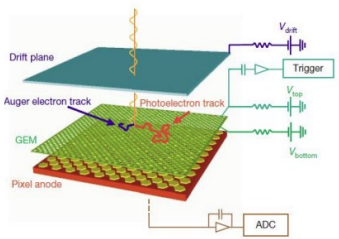


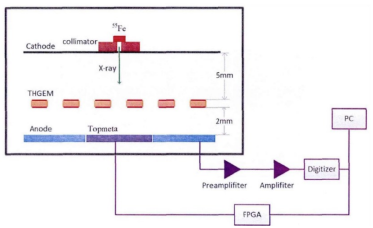
Test at 10bar Ar(3.5% Iso) with a 5.9 keV X-ray source

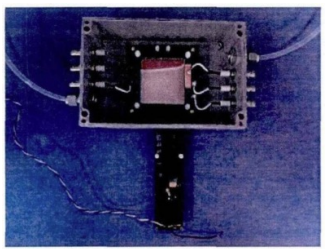


Completed the 7-detectors TPC prototype

X ray polarization measurement in space

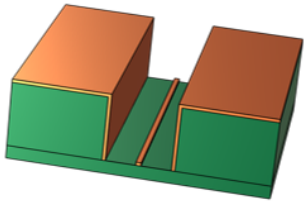




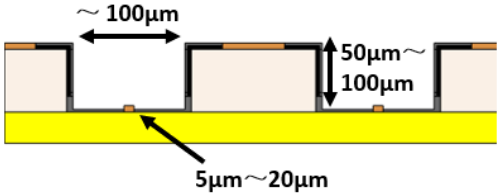


Generic / Non-project Oriented R&D

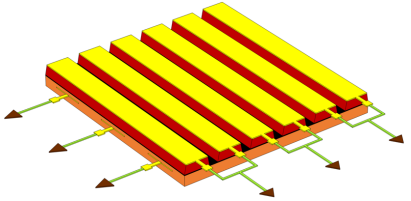
PCa & µRPCa



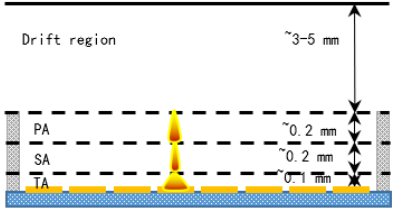
Pitch=4mm
Thickness=1mm
Width=1mm
Anode = 80µm



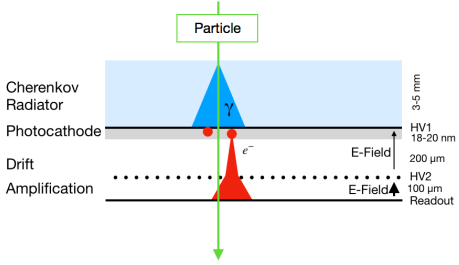
µRGroove



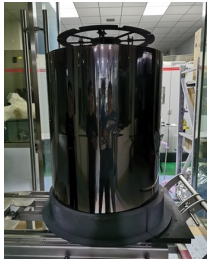
Double/Triple Micromegas



PIC-SEC



resistive DLC coating



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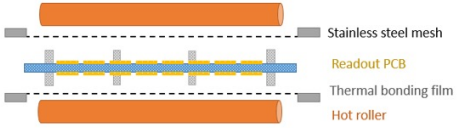
Thermal bonding method for manufacturing Micromegas

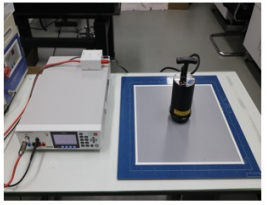
Thermal bonding processing



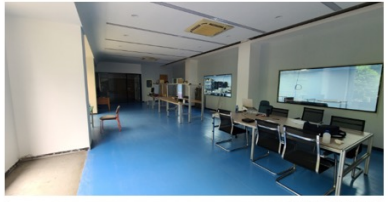
- No etching, no pollution
- Easy to handle at lab
- Easy to make new structures
- Cheap
- Φ0.5mm- Φ1mm spacers, ~1cm pitch

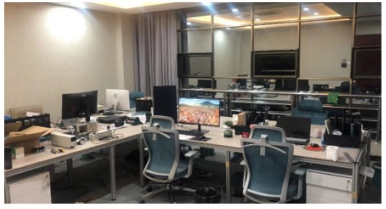
➔easy to clean, especially for large area

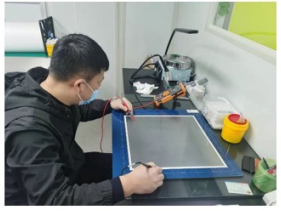
➔less than 1% spacer area

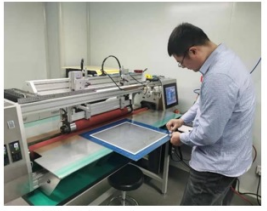


Dedicated site for mass production (**540 m² ,** outside the campus)

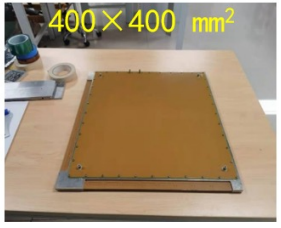


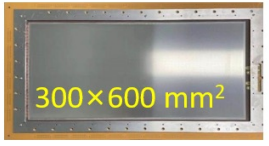






- Full-developed equipment and fabricating process
- Full-time manpower
- M^2 scale capability



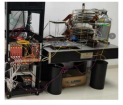


MPGD activities for other applications

Muography with thermal bonding Micromegas

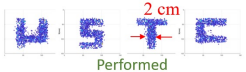
Design:


First version:
6 layers of
15cm×15cm
~100 μm resolution

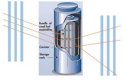



Second version:
8 layers of
40cm×40cm
~100 μm resolution


μSTC: μ(muon) Scattering tomography & Transmission imaging faCility

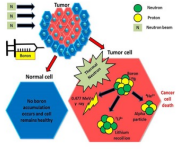



Plan

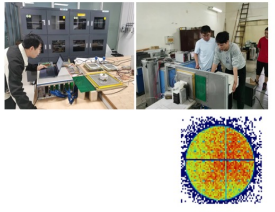



Medical applications

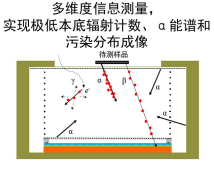
boron neutron capture therapy

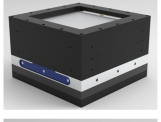


Proton therapy



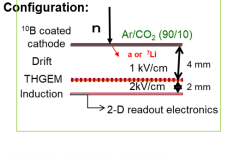
Low-background radiation monitoring

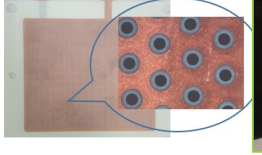





Samples	Lead content	Remaining events (48h)
Nothing	0	1
5052 aluminum-magnesium alloy sheet	0	1
H62 brass sheet	0	1
Lead-free solder	0	1
Tin-lead solder	70%	7
Lead sheet	100%	10

China Spallation Neutron Source



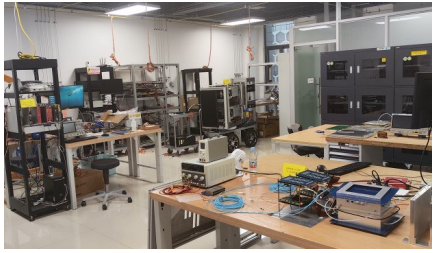


Infrastructure developments

At USTC

MPGD Lab1 (~180m^2)

MPGD Lab2 (~90m^2)



Clean Room (~90m^2)

Cleaning Room (~50m^2)

More developments in other institutes: IMP，CIAE, Beijing University, Guangxi University，Nanhua University ….

MPGD community in China

- A MPGD consortium was established in China in 2017 with 21 institutes and >100 members (students included)
- Annual workshops, webpages, mailing lists …. for exchange and communication
- The community continues to grow

40 participants

150 participants

Future prospects

- Scientific research and education facility/platform project (covering both building space and devices/equipment) in the national 14th 5-year plan has been pre-approved. The large R&D platform will be located at one of the USTC campuses.

No.	Area (m^2)	Purpose	Type (Floor)
1	330	Coating、Sand blasting and Cleaning	Normal (G)
2	200	Chemical Etching	Normal (G)
3	220	Photoetching	Clean Room (G)
4	400+360	Detector Assembling and Test	200m^2 Normal (G)，200m^2 Clean Room (G) 360m^2 Normal (F1)
5	300	Gas PMT	Clean Room (G)
6	150	Equipment and Gas supply	Normal (G)
Total	1960 m^2		

MPGD is one of the main technology R&D lines for this platform.

Space allocated to gaseous detectors (mainly MPGD) R&D

- A pre-R&D program has been approved by the Ministry of Science and Technology for Super tau-charm facility project.
- A full-scale STCF R&D program funded by the local government has been pre-approved
- Applying for a major R&D project for EicC from National Natural Science Foundation