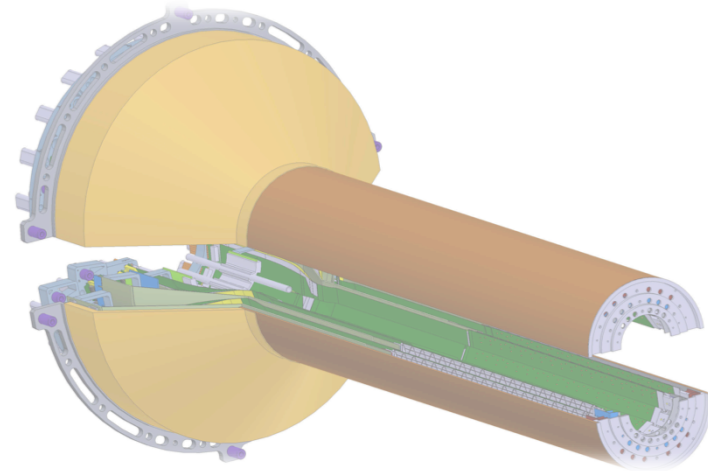


Effort & Plan on MVTX

Yaping Wang

Central China Normal University (CCNU)

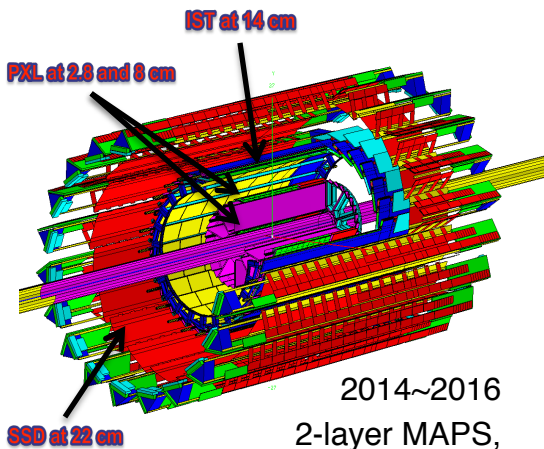
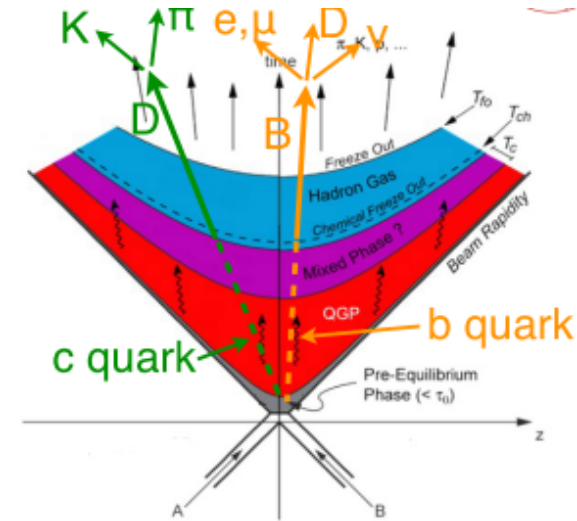


- Introduction
- Open-bottom Physics Measurements with sPHENIX/MVTX
- Effort & Plan on the MVTX
 - Feasibility
 - Interests
 - Organization & Time Schedule
- Summary and Outlook

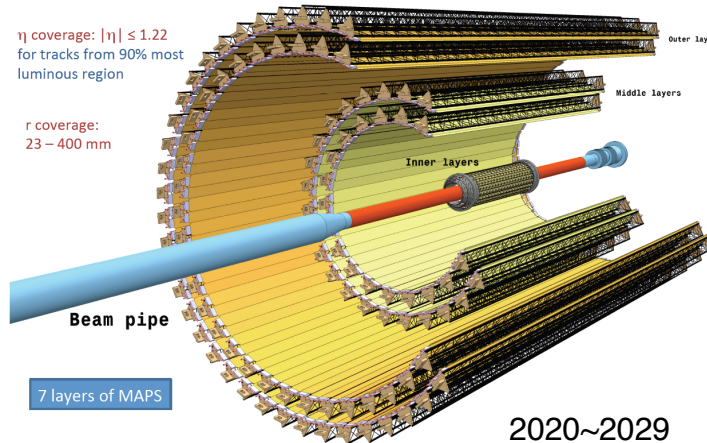
Introduction – Silicon Detector Applications

Vertex Detector for HF physics measurements in HIC experiments

- **MAPS**, hard radiation, low material budget, low power consumption, fast readout, high spatial resolution
- Produced mostly from initial hard partonic scatterings at RHIC energies; exposed to the whole evolution of the Quark-Gluon Plasma (QGP)
- Yield or mass not (significantly) altered within the QGP, sensitive to parton-medium interactions and medium properties

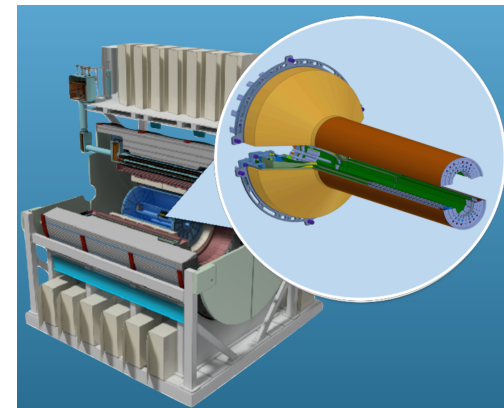


2014~2016
2-layer MAPS,
360M pixels, $20\mu\text{m} \times 20\mu\text{m}$,
inner layer $0.4\% X_0$



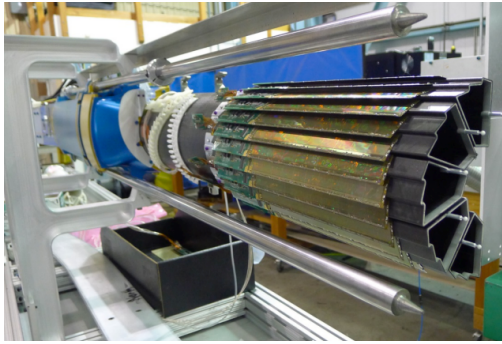
7 layers of MAPS

2020~2029
7-layer MAPS, 12.5G pixels,
inner layer $0.3\% X_0$



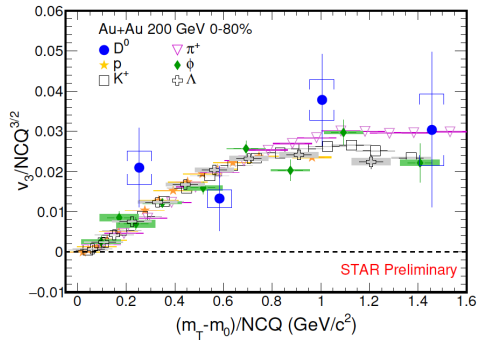
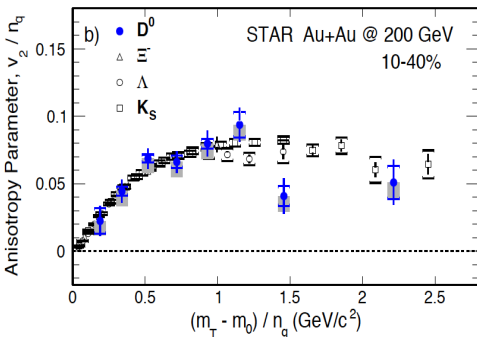
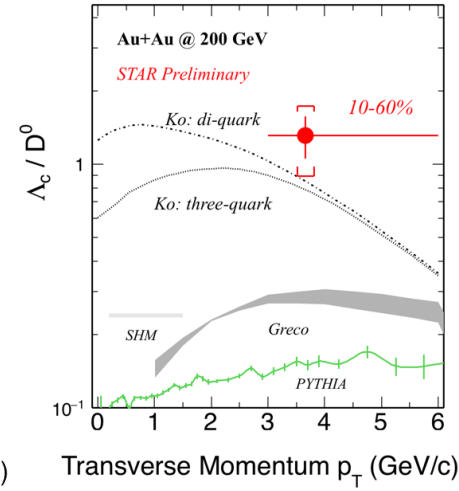
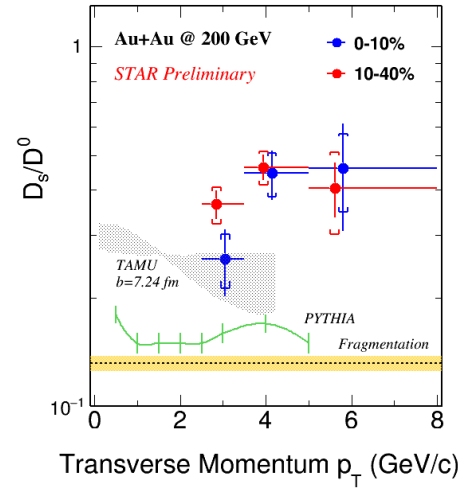
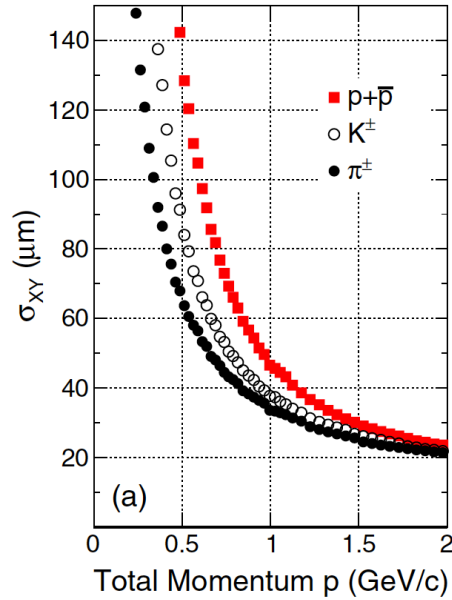
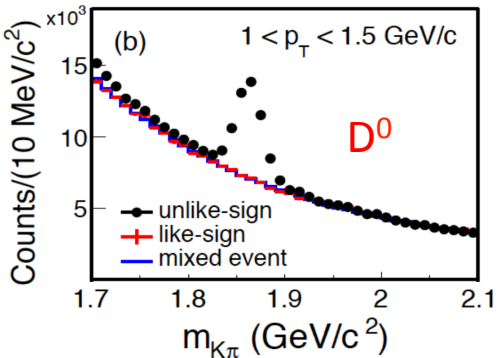
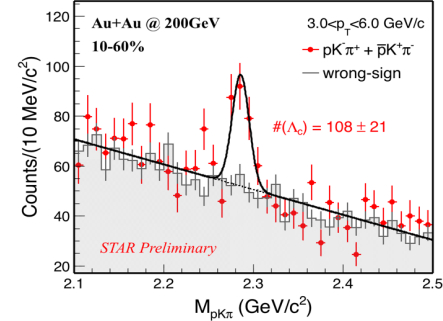
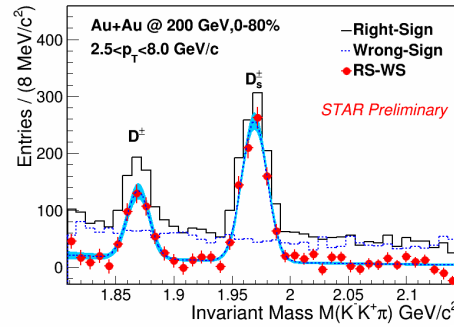
Proposed 2019~2023@sPHENIX
Replica of ALICE ITS Inner Barrel

Introduction – Open Charm Measurements at STAR



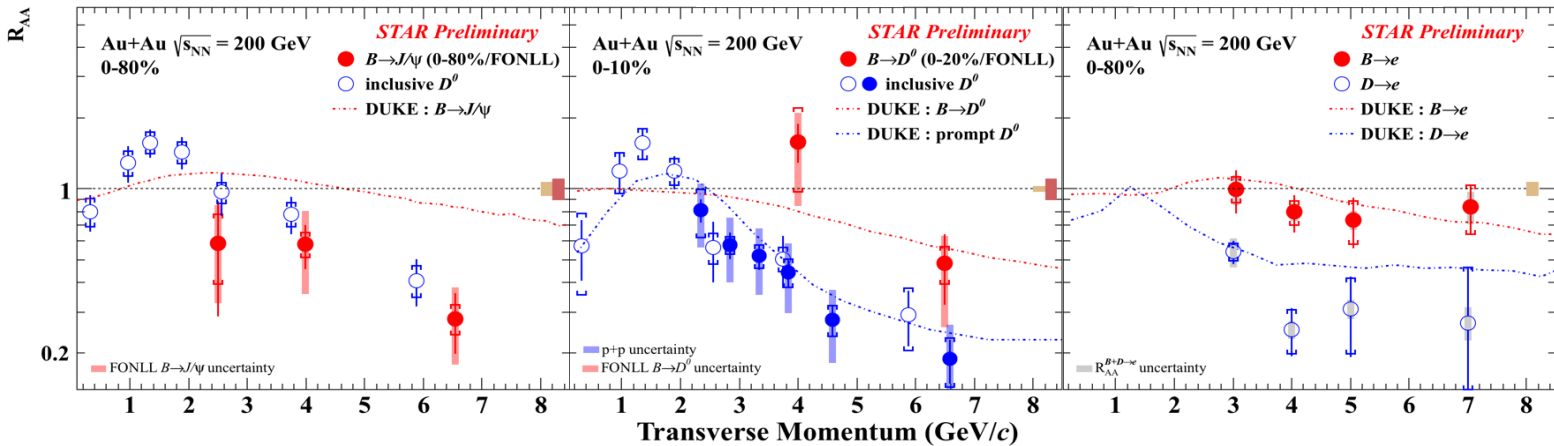
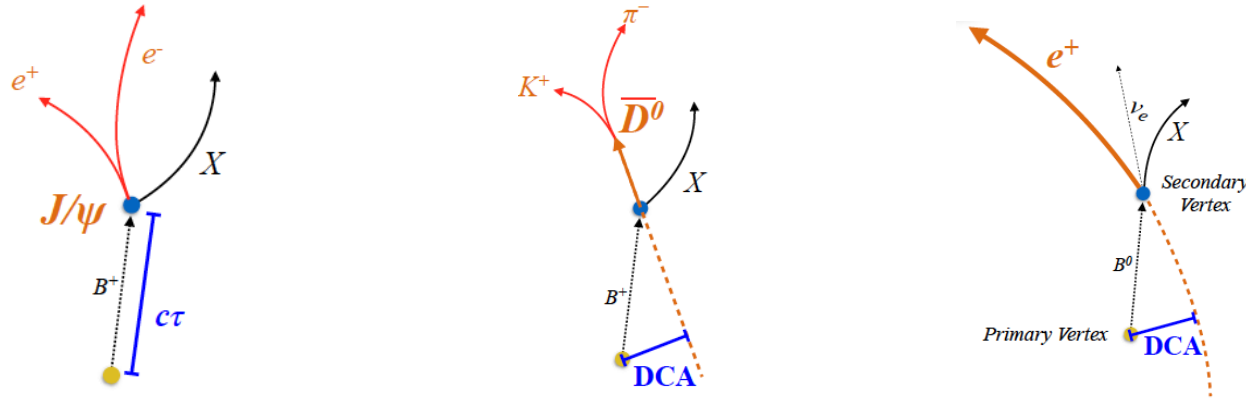
PXL@STAR-HFT
2-layer MAPS, 360M pixels, 20 $\mu\text{m}\times 20\mu\text{m}$, inner layer 0.4%X

3B minimum-bias Au+Au events at $\sqrt{s_{NN}} = 200$ GeV with HFT recorded in 2014 and 2016



- D^0 v_2 for 10-40% follows mass ordering and NCQ scaling of other hadrons
- First D^0 v_3 measurement, which follows NCQ scales with other hadrons
→ non-zero at RHIC
- Strong enhancement observed over PYTHIA
- **First Λ_c reconstruction in A+A collisions**

Introduction – Open Bottom Measurements at STAR

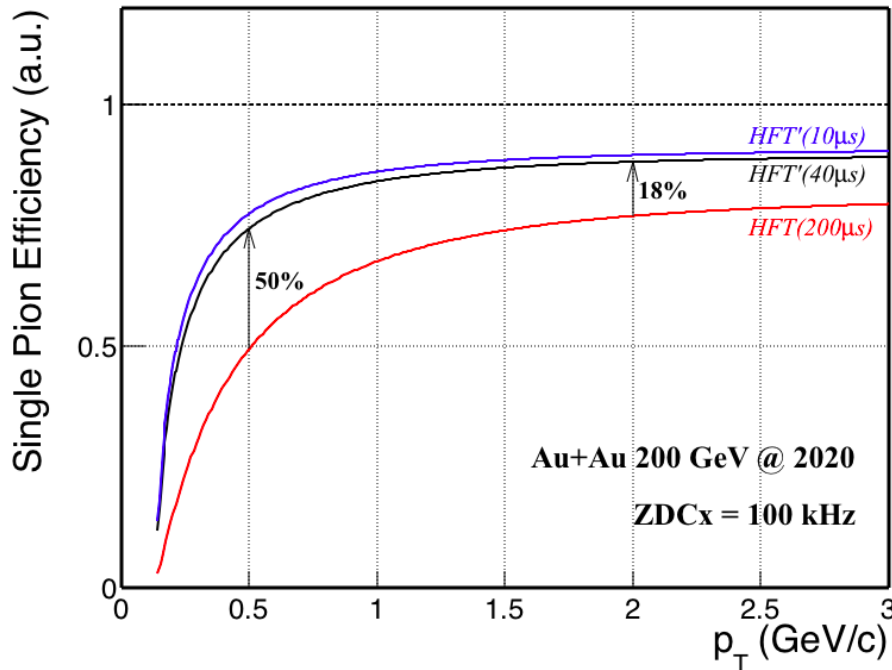


- First measurements on open bottom physics via DCA method with help of HFT
- Suppression observed for all three channels at high p_T
- $B \rightarrow e$ is less suppressed than $D \rightarrow e$ (2σ effect)

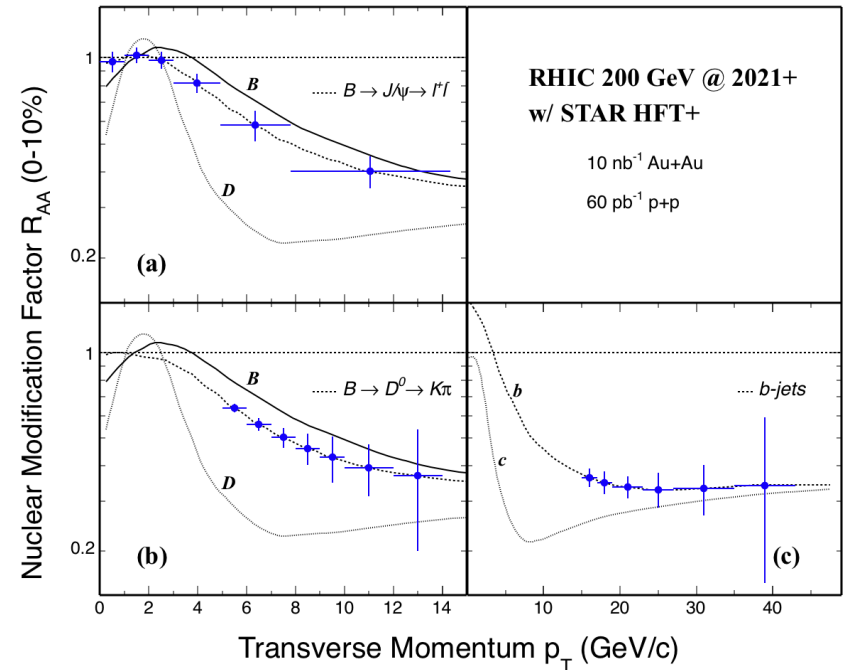
At LHC energies, the ALICE ITS upgrade will enable high precision measurements on rare probes from high to very low transverse momentum.

Open-bottom Physics Measurements with sPHENIX/MVTX

There was a proposal in STAR to construct a faster pixel detector, **HFT+**, to replace the HFT for precision measurements of open-bottom physics.



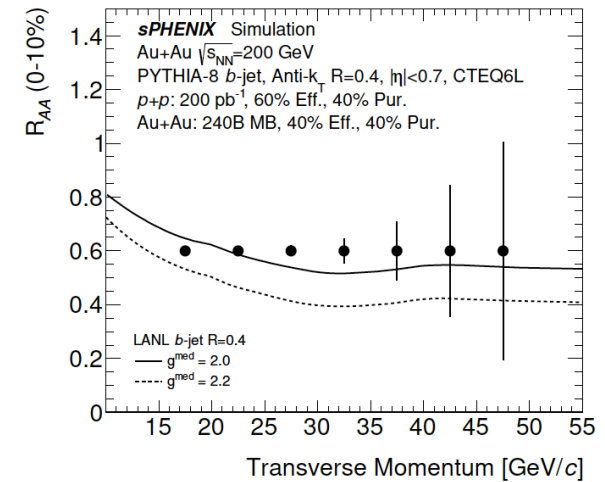
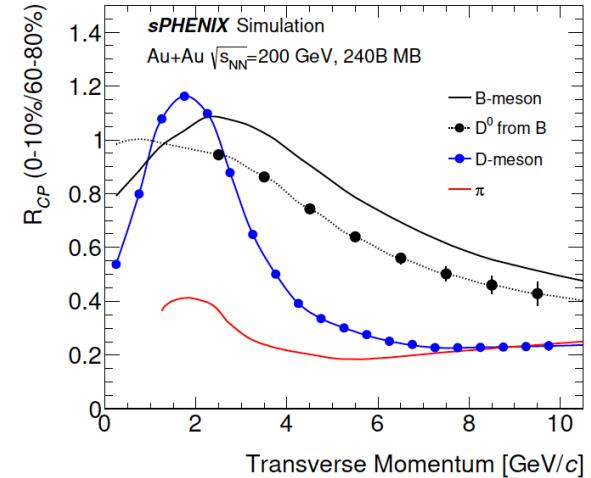
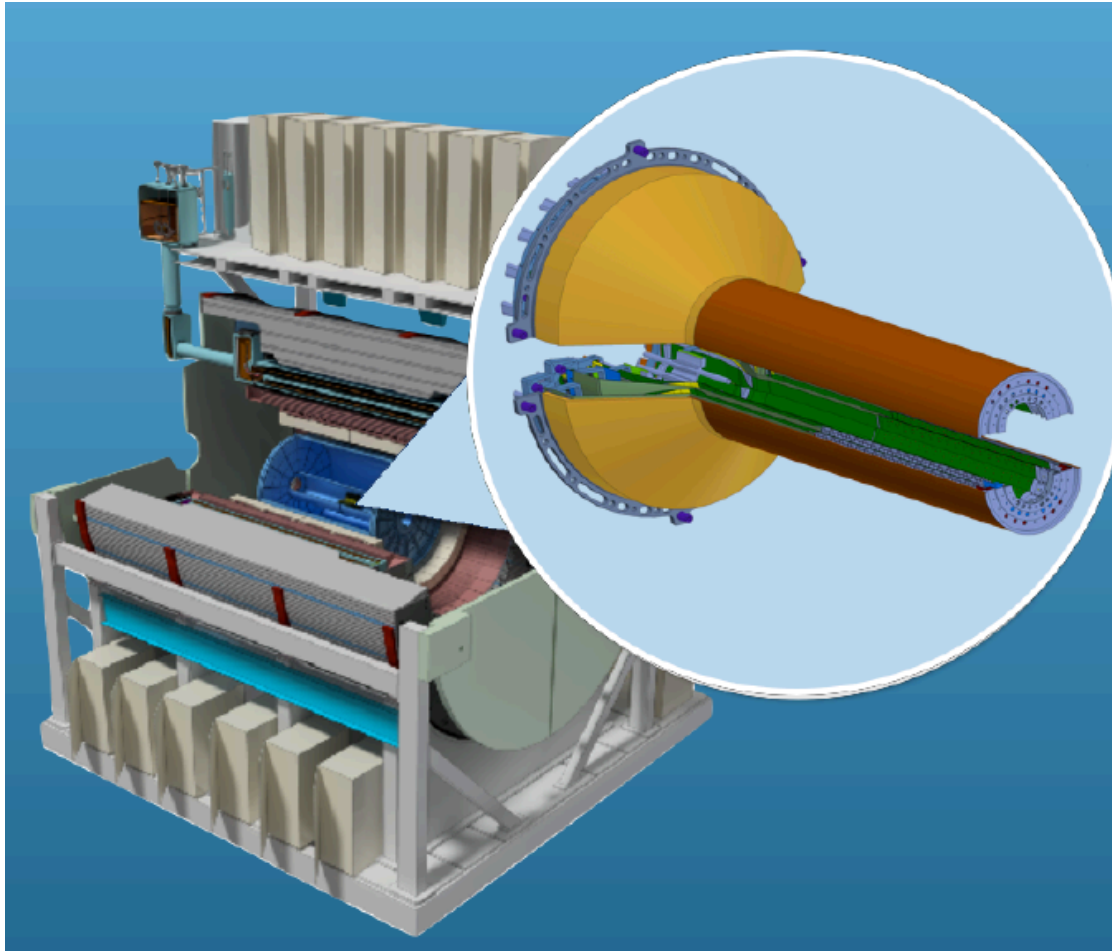
HFT (~200 μ s) \rightarrow HFT+ (< 20 μ s)



Projected statistical errors for R_{AA} (0-10%) based on RHIC pp and AuAu running in 2022+

- The proposed HFT+ was complementary to the ALICE ITS at the LHC

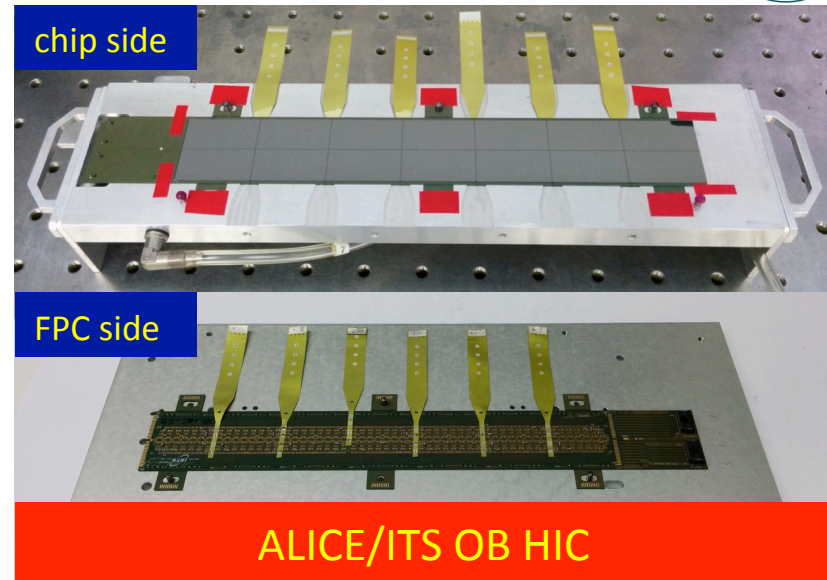
Open-bottom Physics Measurements with sPHENIX/MVTX



- ~~The proposed HFT+ was complementary to the ALICE ITS at the LHC~~ → now sPHENIX/MVTX at RHIC.
- The bottom quark measurements will complete the heavy flavor and jet programs at RHIC.

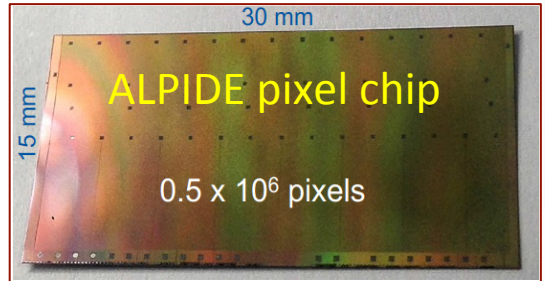
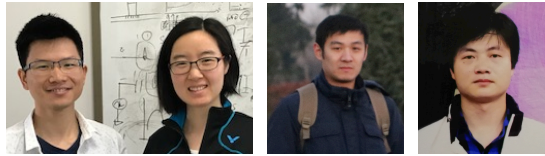
Effort & Plan on MVTX – Feasibility

- Efforts on ALPIDE chip design since 2012
- Machine workshop (~150 m²)
- **Clean room** was constructed and run in good status since November, 2016
 - ✓ Ground floor (vibration velocity RMS ~ 3 μm/s)
 - ✓ Temperature/humidity controllable
 - ✓ ISO6 clean level ~ 70 m² (2.6 m head room) + ISO7 clean level ~ 20 m² (2.9 m head room)
 - ✓ Grounding terminals provided (ESD protection)
 - ✓ Gas supply system
- Pixel chip assembly & inspection machine (IBS **ALICIA-6**), wire-bonding machine (F&K Delvotec G5 64000), pull tester (DAGE 4000) and HIC testing system are in working status
- **20% ALICE/ITS OB HIC module assembly & test (~7500 ALPIDE chips) for one year**
- **Pre-series production started in Dec. 2017**
- **Series production started in April, 2018**
- Long-term plan: (1) ALICE ITS calibration and alignment; (2) open-bottom production at LHC.



Dr. Yaping Wang

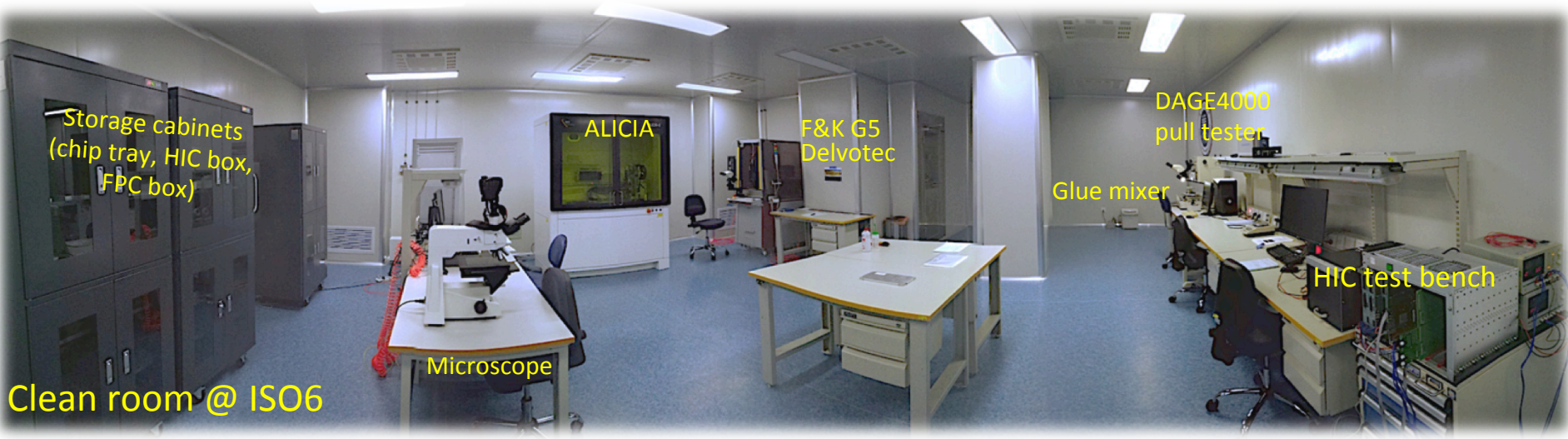
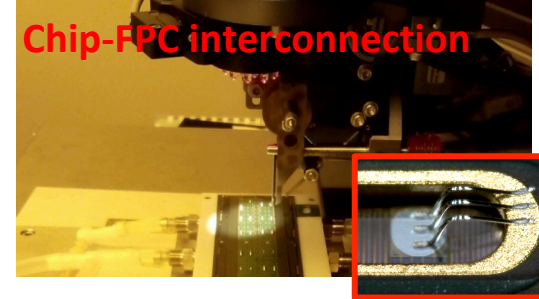
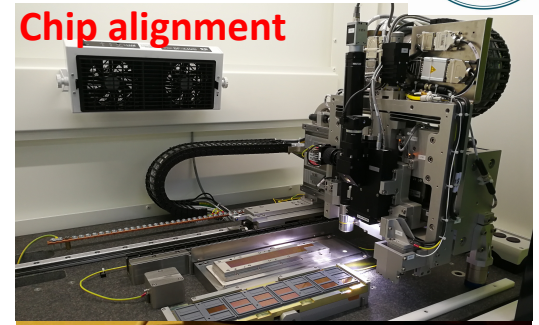
Effort & Plan on MVTX – Feasibility



ALICE/ITS Chip Design/ Testing (CCNU) :
Chaosong, Ping, Mangmang, Shuguang



ALICE/ITS OB HIC Assembly Team (CCNU) :
Biao, Jun, Daming, Kai, Peipei, Wenjing



Clean room @ ISO6

Storage cabinets
(chip tray, HIC box,
FPC box)

Microscope

ALICIA

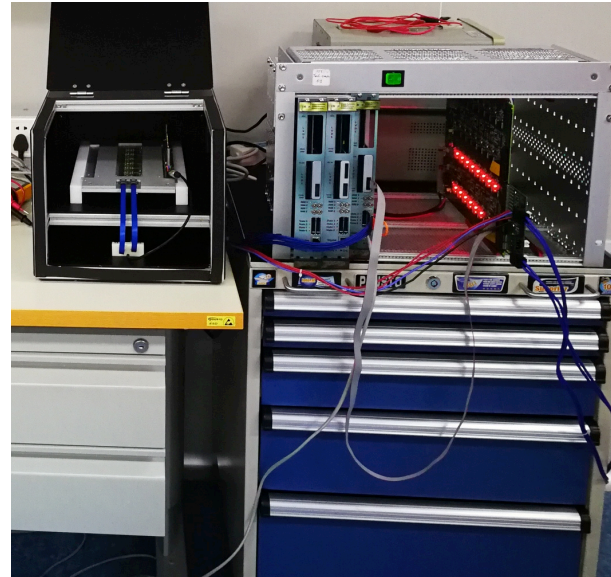
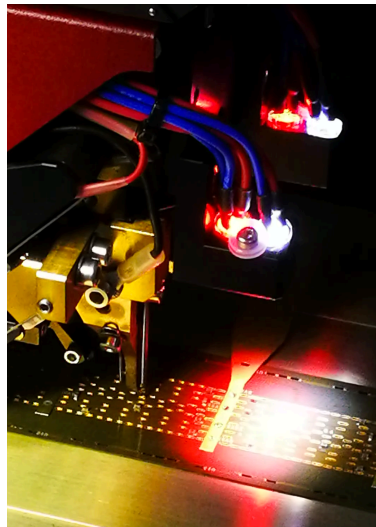
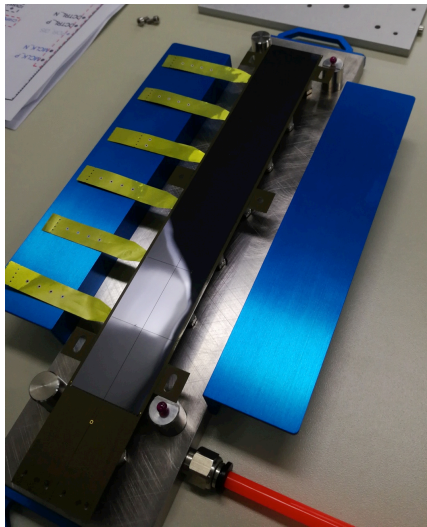
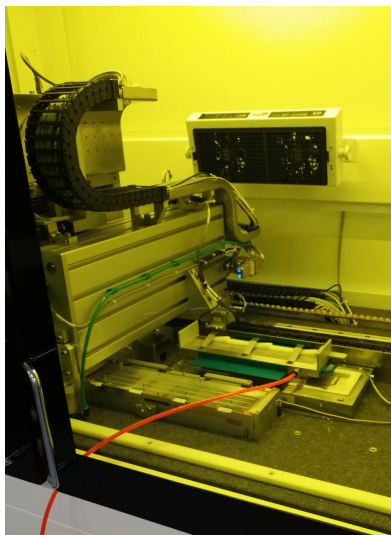
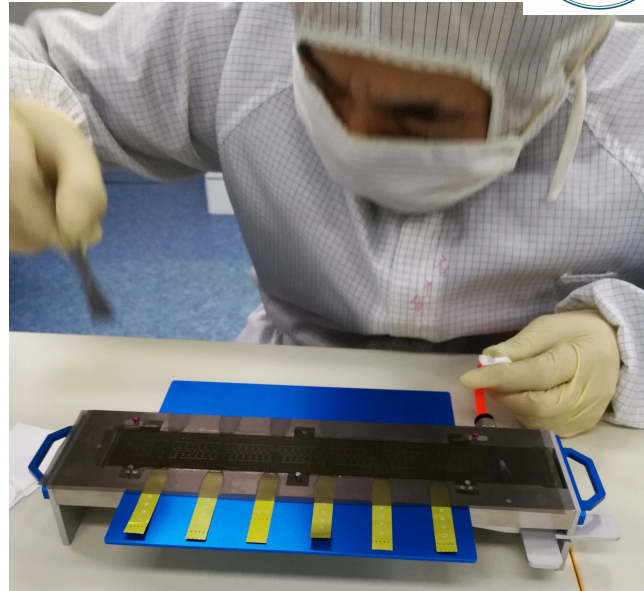
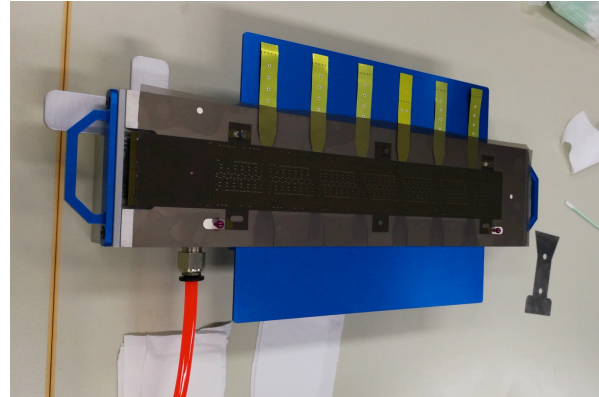
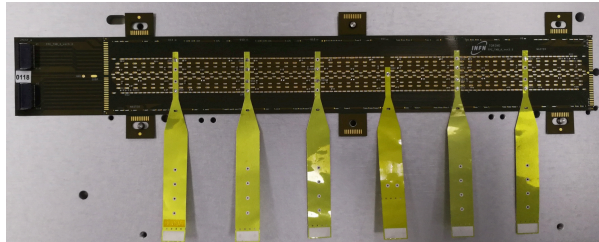
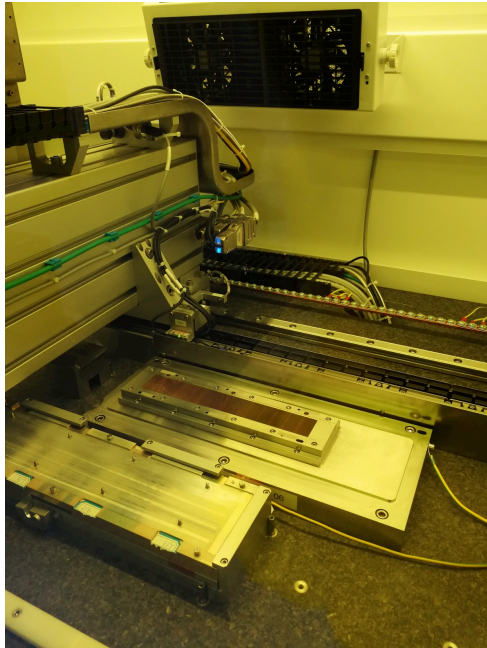
F&K G5
Delvotec

Glue mixer

DAGE4000
pull tester

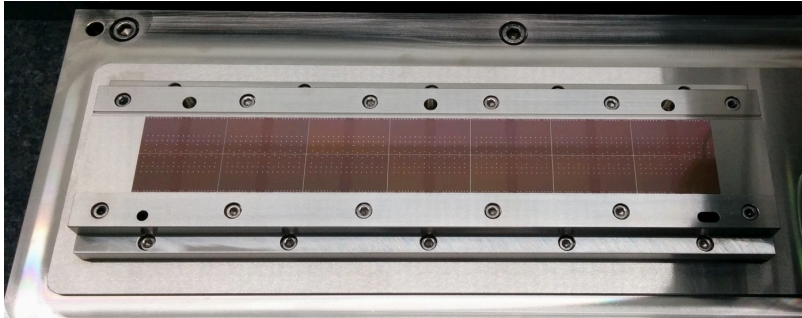
HIC test bench

Effort & Plan on MVTX – Feasibility



Effort & Plan on MVTX – Feasibility

- ALPIDE chips (dimension of 3cmx1.5cmx100μm) can be automatically aligned with positioning accuracy of better than 5 μm@3σ by the **ALICIA machine**.

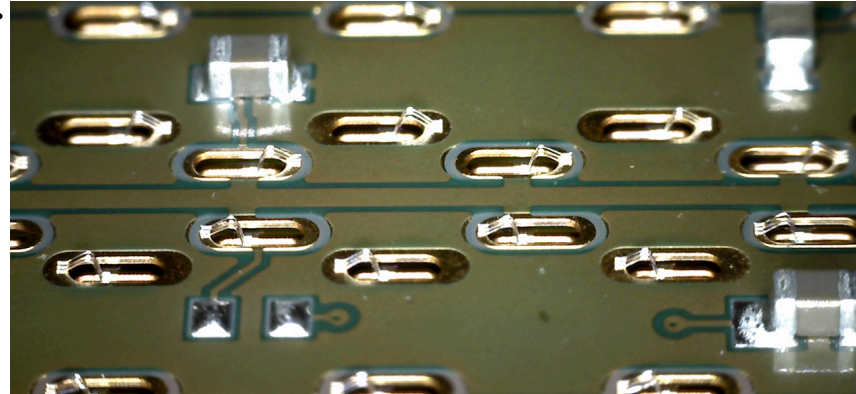
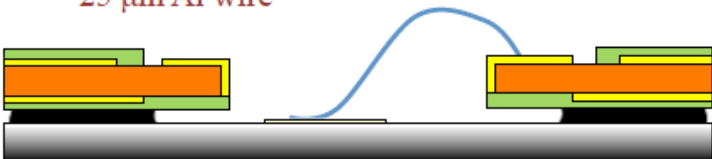


OB		OB				
X: -0.2 Y: -1.8 Rz: -0.01 Total: 1.8	X: -0.4 Y: -1.4 Rz: 0.07 Total: 1.5	X: -0.6 Y: -1.9 Rz: -0.00 Total: 1.9	X: -0.3 Y: -1.5 Rz: 0.00 Total: 1.5	X: -0.3 Y: -0.6 Rz: -0.01 Total: 0.7	X: -1.1 Y: -1.7 Rz: 0.11 Total: 2.0	X: -0.2 Y: -0.6 Rz: 0.09 Total: 0.7
X: -0.7 Y: -2.3 Rz: 0.03 Total: 2.4	X: 0.0 Y: -0.9 Rz: 0.02 Total: 0.9	X: -0.3 Y: -1.3 Rz: -0.02 Total: 1.3	X: -0.4 Y: -2.3 Rz: -0.04 Total: 2.4	X: -0.0 Y: -1.9 Rz: -0.02 Total: 1.9	X: -0.9 Y: -2.1 Rz: -0.04 Total: 2.2	X: -0.6 Y: 0.9 Rz: 0.07 Total: 1.1

- The chip-FPC interconnections are realized with wire-bonding method, which is done fully automatically by the **F&K G5 64000 machine** with positioning accuracy ~ 5 μm@3σ (large working area).

FPC-to-ALPIDE interconnection

Wire-bonding through vias
25 μm Al wire



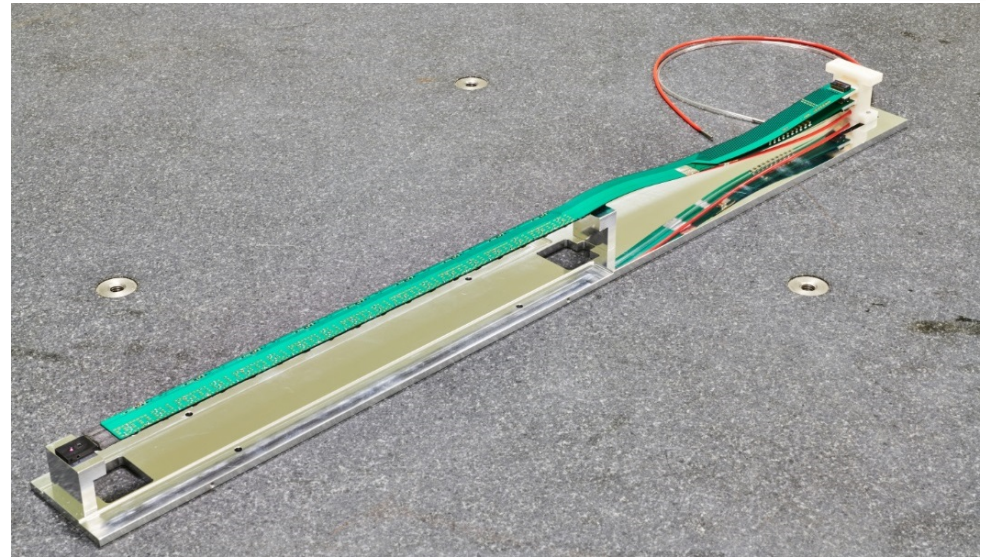
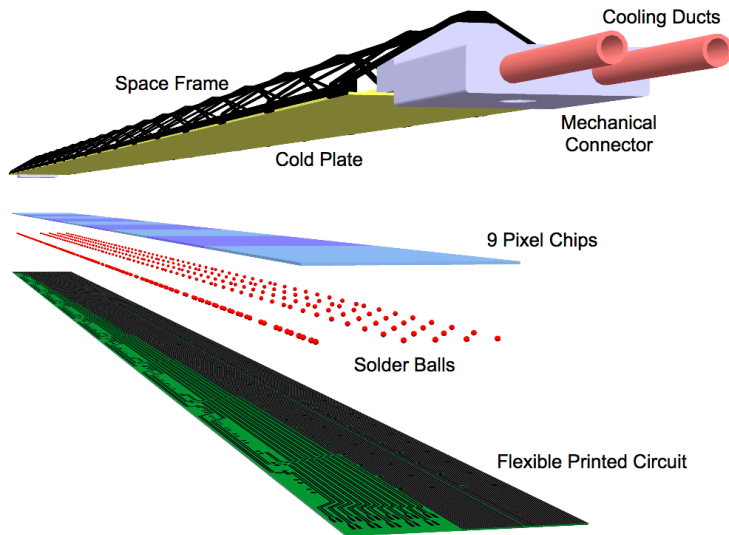
- R&D on chip-FPC interconnections technology, such as laser bonding.



Effort & Plan on MVTX – Interests

- **Physics interests on the sPHENIX/MVTX at RHIC**
 - B-jets & B-hadrons
 - HF-jet correlations
 - ...
- **MVTX stave assembly and test**
 - sPHENIX MVTX effort can be started after the ALICE ITS upgrade project (around May, 2019)
 - Facilities and technical resources of CCNU and other institutes are available for HIC production (replace assembly jigs + short-time training)
 - Infrastructures and tooling need to be constructed for stave assembly & test + technical training
 - Estimated production period: 1 year for 84 staves (~4 months for HIC assembly/test + ~8 months for stave assembly/test incl. training)
- **MVTX detector and physics simulations**

Effort & Plan on MVTX – Stave Assembly and Test



Radius (mm) 23, 31, 39
 Nr. Staves: 12, 16, 20
 Nr. Chips/ layer: 108, 144, 180

Length in z (mm): 271.2 mm
 Nr. chips/ Stave: 9
 Material thickness: $\sim 0.3\% X_0$

Coolant Single-phase H_2O leak-less
 Pixel operational temperature $< 30^\circ C$
 Pixel max temperature non-uniformity $< 5^\circ C$
 Chip Power dissipation $< 50mW/cm^2$

- Facility and technical resources are ready at CCNU for **HIC assembly**, and only replace assembly jigs
- Infrastructures need to be prepared for **stave assembly** (deploy a Coordinate Measurement Machine with identical tooling), and technical training is necessary
- HICs & Staves test setups

Effort & Plan on MVTX – Organization & Time Schedule

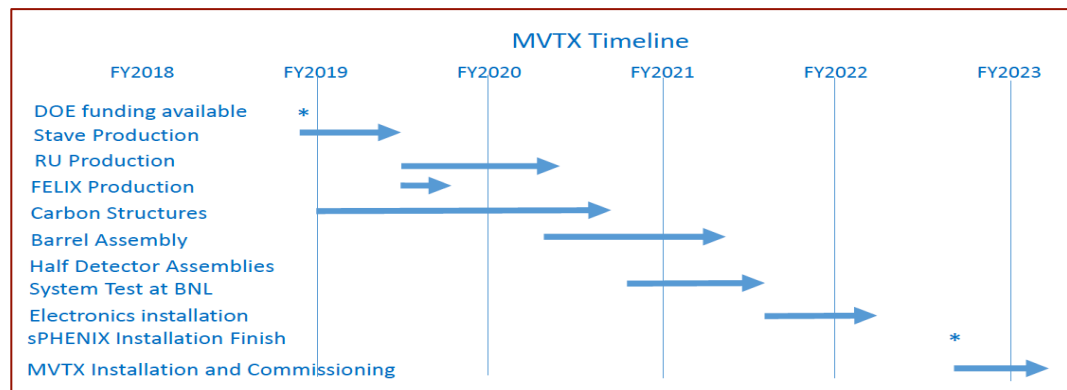
Participants from China side:

- 1) Central China Normal University (CCNU): stave assembly & test
- 2) Institute of Modern Physics (IMP/CAS): stave assembly & test (collaborated with CCNU)
- 3) University of Science and Technology of China (USTC): chip & stave test, simulations
- 4) Sun Yat-Sen University (SYSU): MVTX detector and physics simulations

Manpower:

- 2 FTE + few students from CCNU (additional postdoc in due time)
- 2 FTE + few students from IMP/CAS
- Other institutes?

Production can be started since May 2019 after ALICE ITS upgrade:





Summary and Outlook

- The MAPS-based MVTX detector at sPHENIX will extend the HF studies beyond the reach of current RHIC experiments, and is complementary to the HF program at the LHC.
- Chinese team is interested in the MVTX project, and the facilities and resources from CCNU and other institutes will be available for MVTX detector construction after ALICE ITS production (~ May 2019).
- Assembly jigs & test setups for both HIC and stave production to be purchased from CERN; Infrastructures (a CMM & other support equipment) need to be constructed
- The Chinese team will work on both the advanced large-area pixel integration and open-bottom physics at RHIC.

Thanks for your attention!