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Production of RHIC-STAR TOF MRPC & collaboration with IPNL and LAL

Wang Yi
Department of Engineering Physics, Tsinghua University
Beijing,100084, China
yiwang@mail.tsinghua.edu.cn

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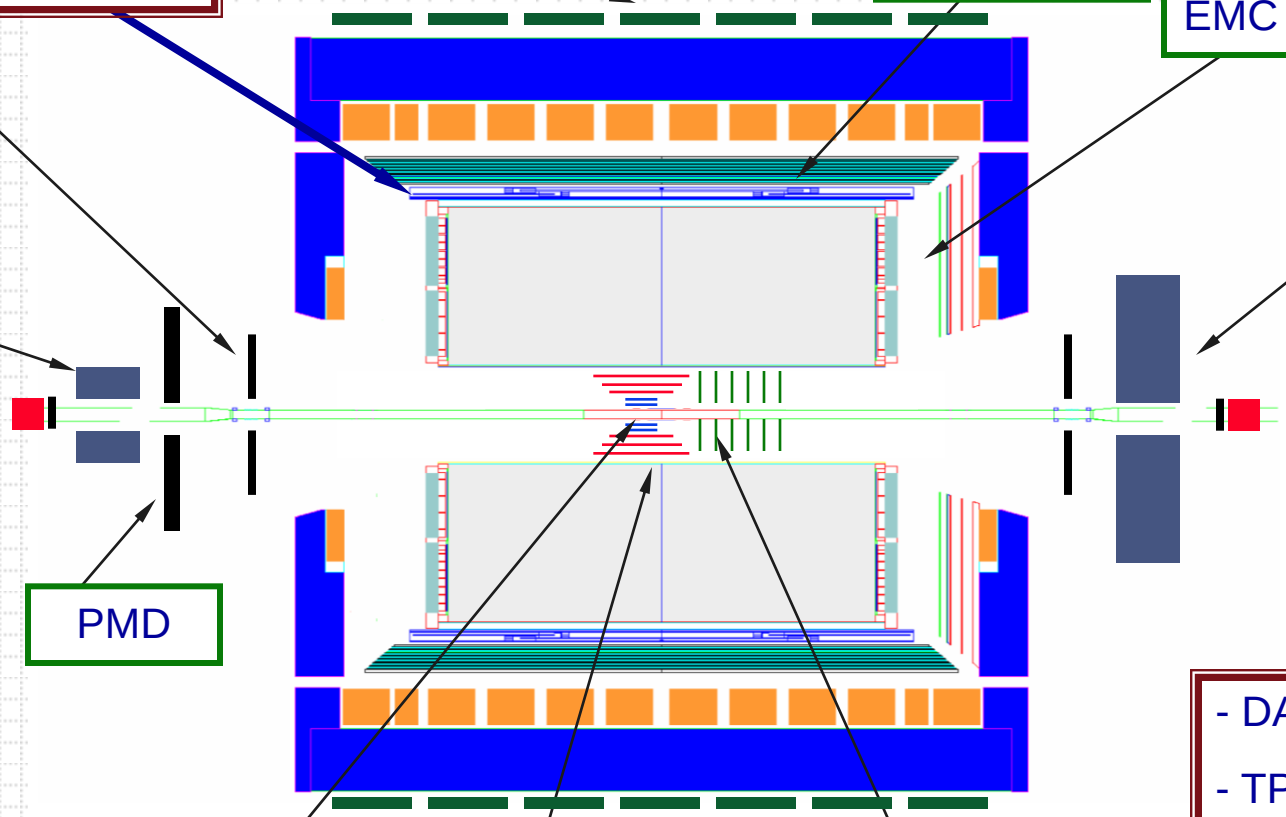
STAR Detector and Upgrades



MRPC ToF barrel

MTD

EMC barrel

EMC End Cap

RPSD

FMS

Fπ^0S

PMD

- DAQ1000
- TPC FEE
- MTD
- Soft γ

finished

ongoing

HFT: Si-pixels; IST: Si-strips; FGT: GEM-layers

Integrated Tracking Upgrades

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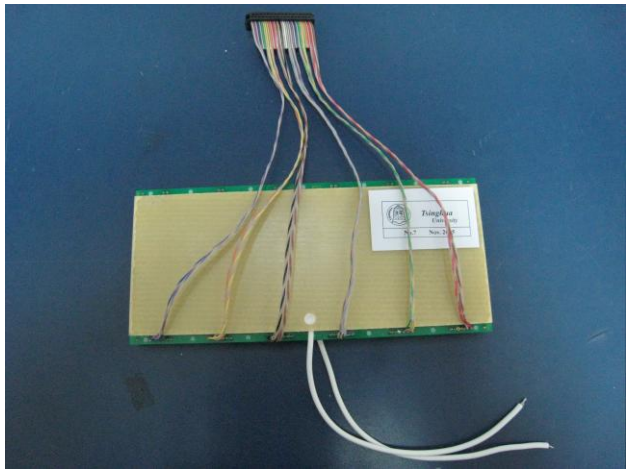
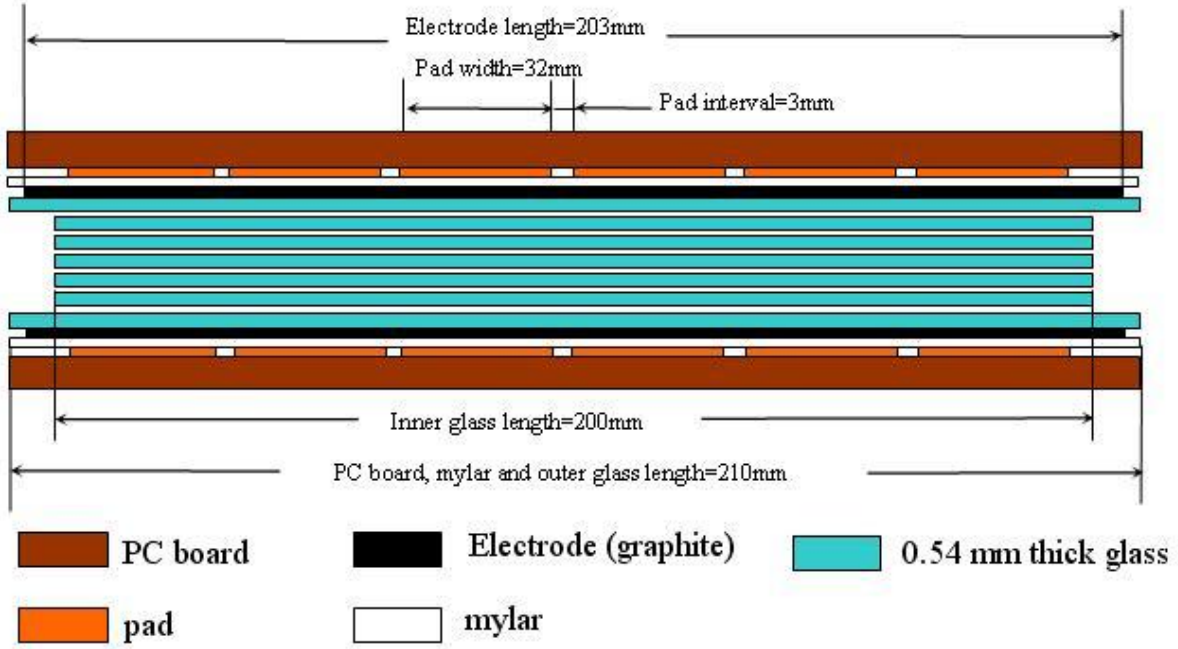
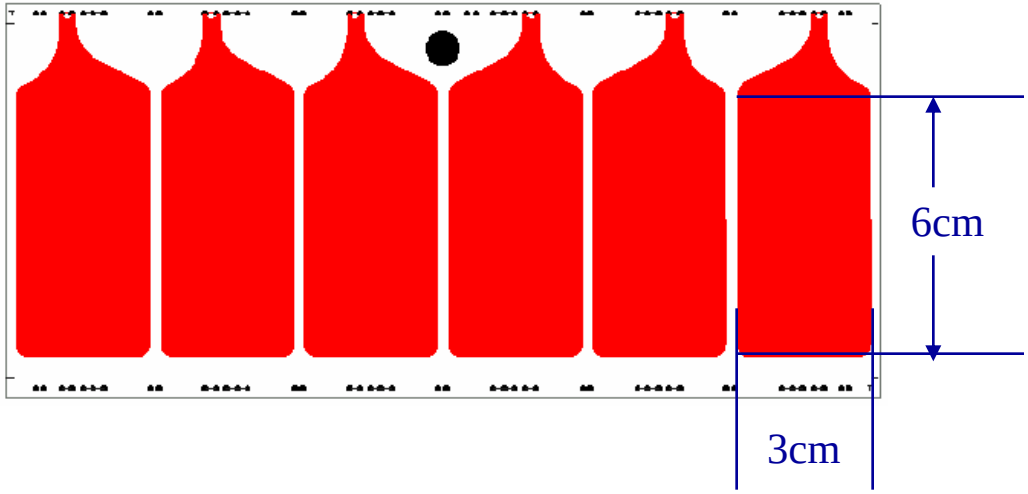
MRPC used in STAR barrel TOF





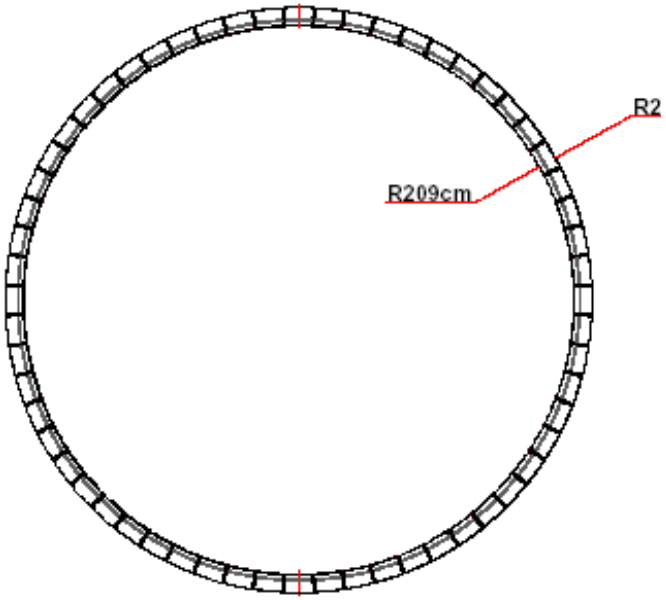


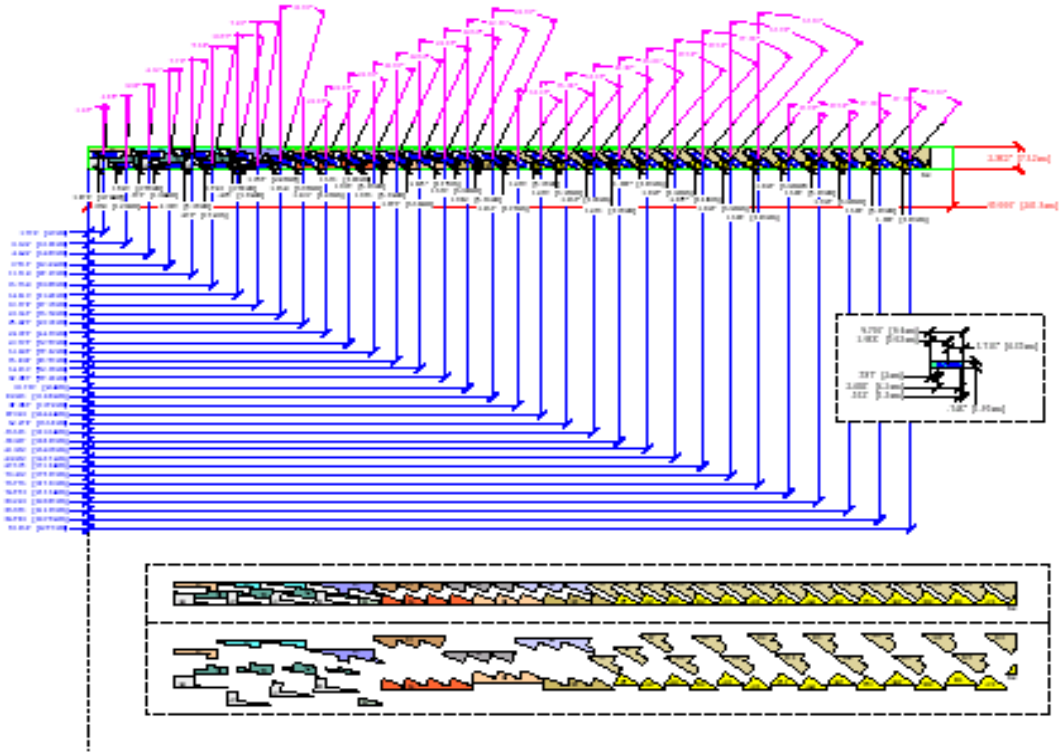
Glass: 10^{12}-10^{13} Ω.cm
Carbon tape: 100k Ω/□
Gas gap: 6×0.22mm
Working gas: 95% F134a+5% iso-butane
Time resolution: 80 ps
Efficiency >90%

Rates capability: <1kHz/cm^2 !

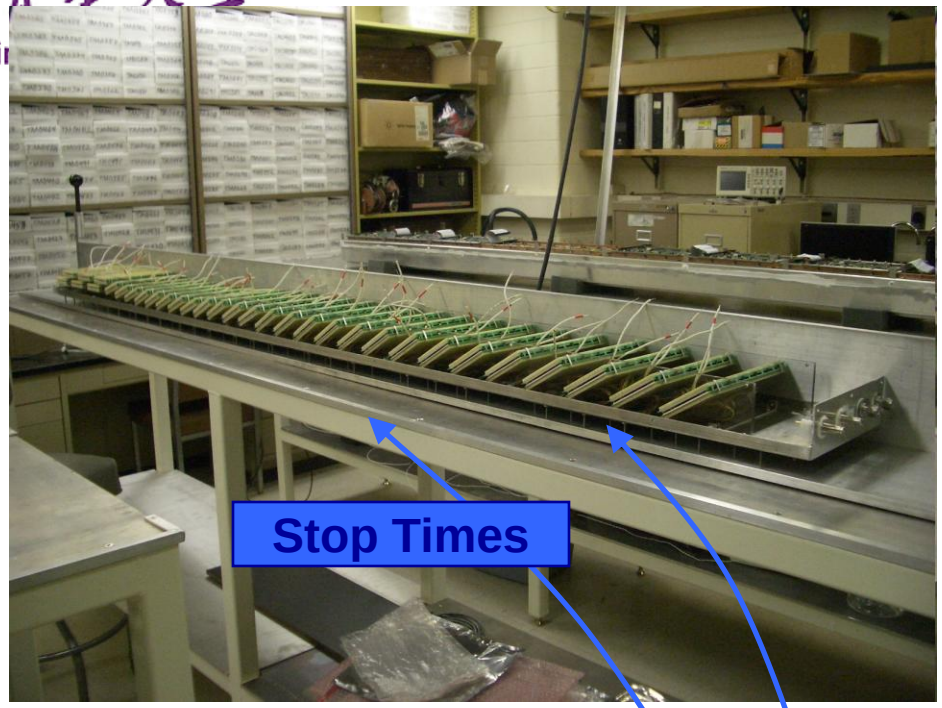
Layout of STAR barrel TOF

STAR-TOFr 在φ方向有 120 个 Tray（其中正负
各 60 个），每个 Tray 所张的φ角为 60 度。



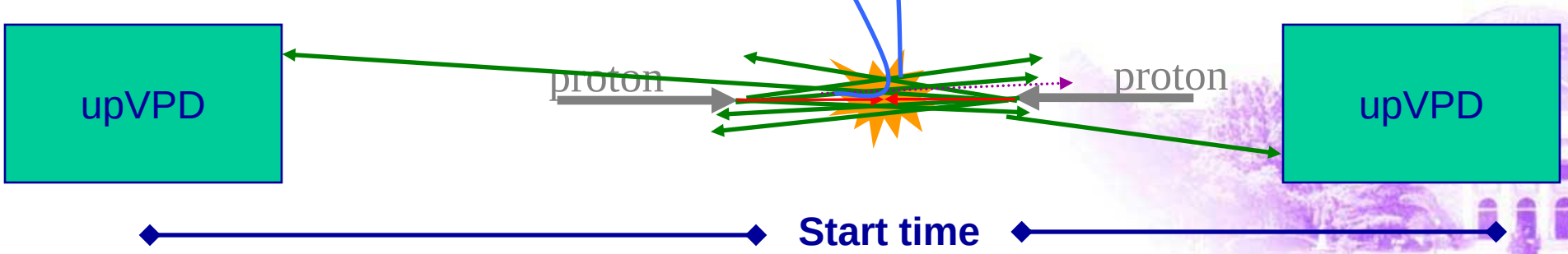


Each tray consists of 32 MRPCs, total number of MRPCs of 126 trays is about 4032.

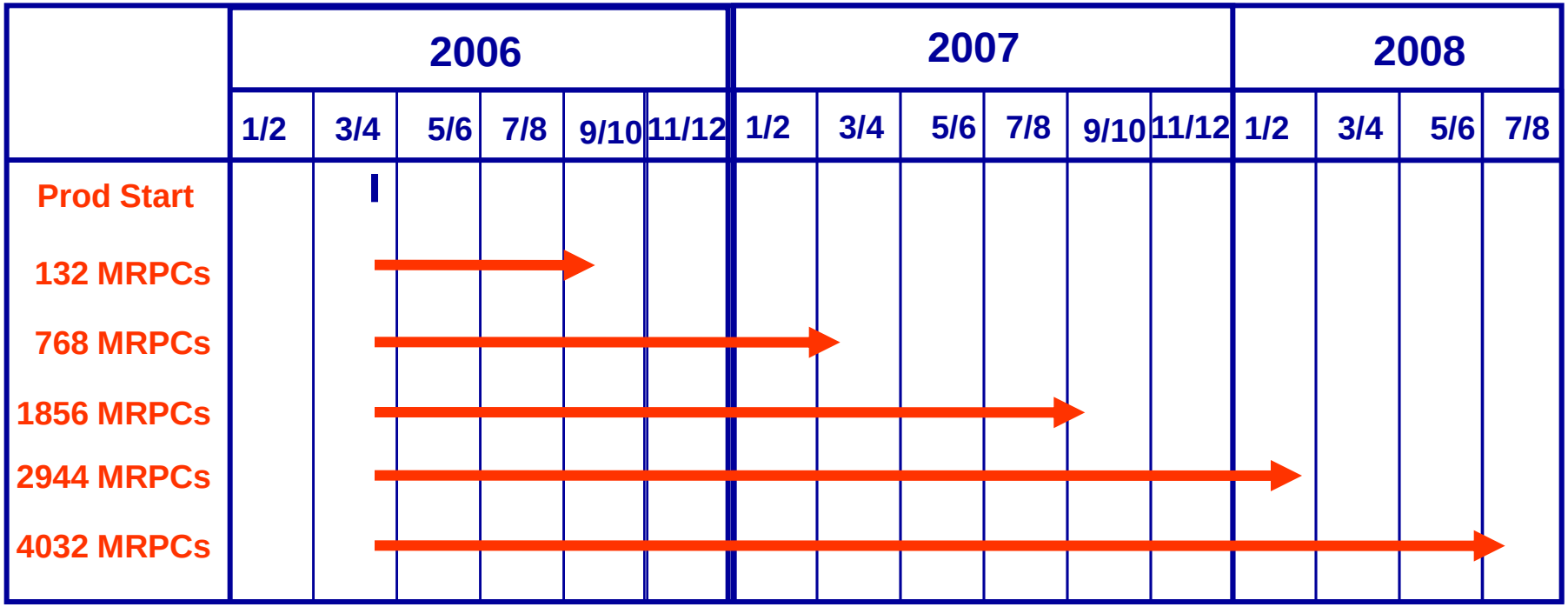


32 modules / tray

This kind of alignment for better efficiency



MRPC Production Milestones



Beijing, Tsinghua University: 70% of total 4032 modules.
Hefei, USTC: the other 30% modules.

STAR MRPC workshop

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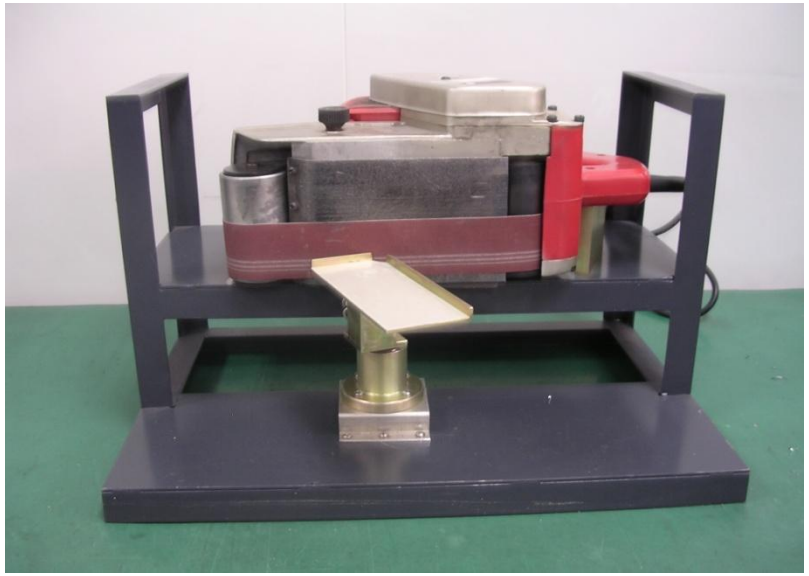
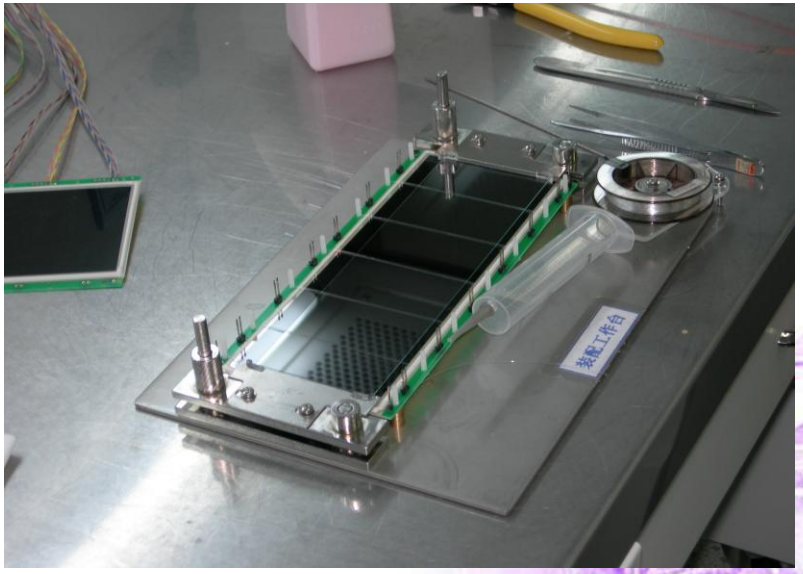
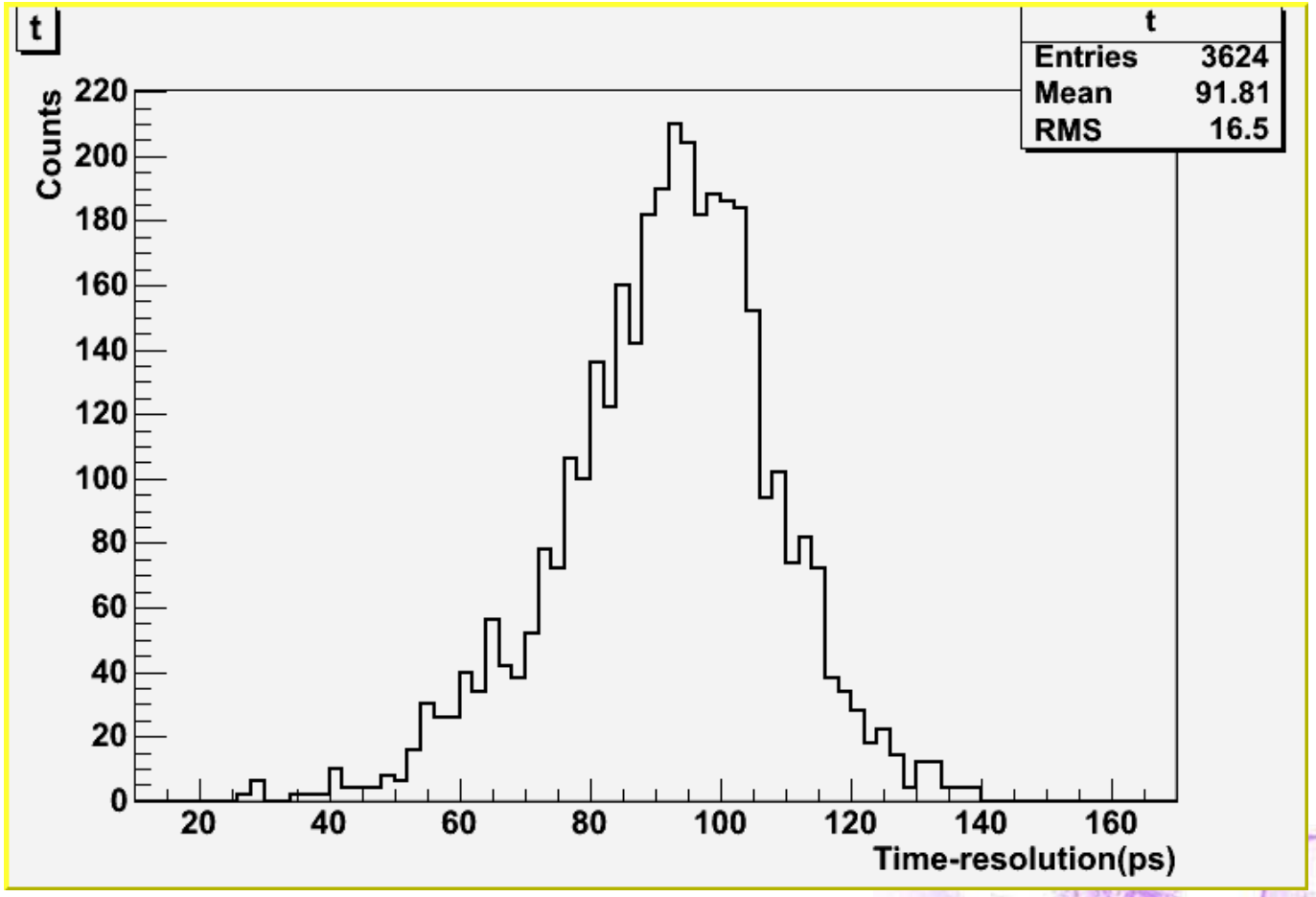
Production tools





Time resolution 0f 604 modules



Average time resolution is about 92ps.

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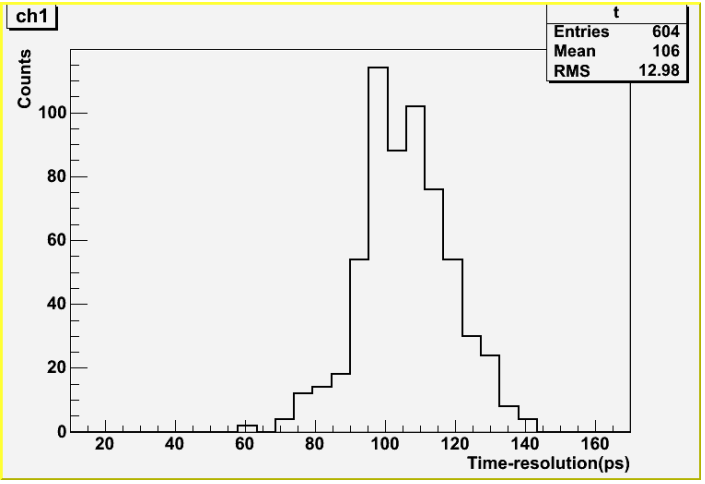
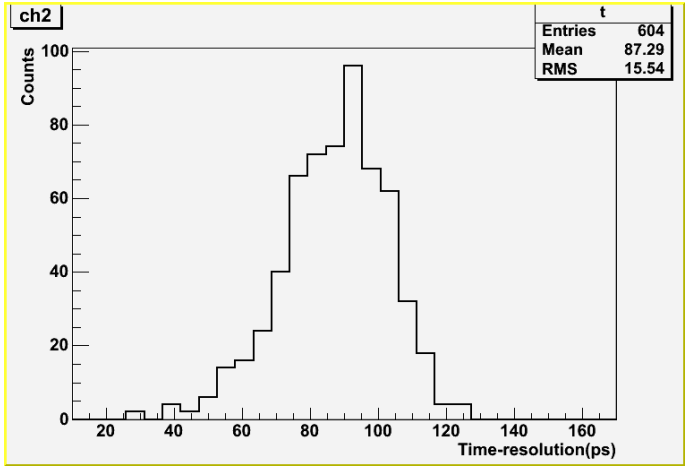
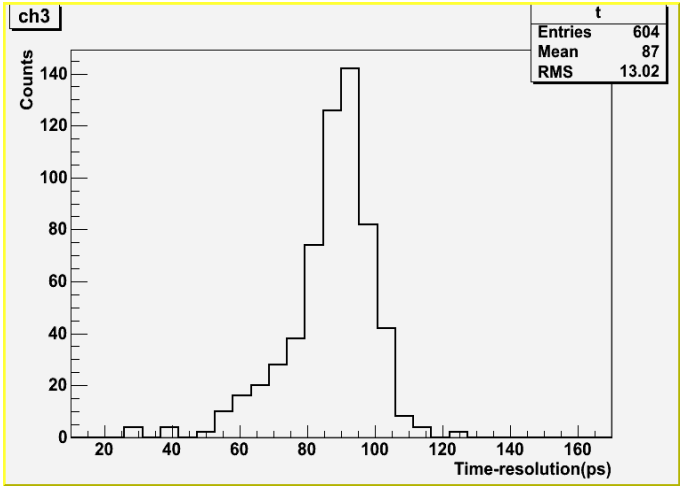
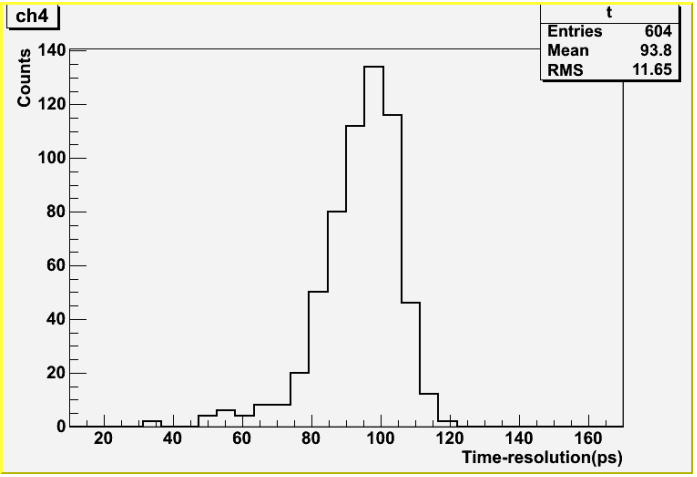
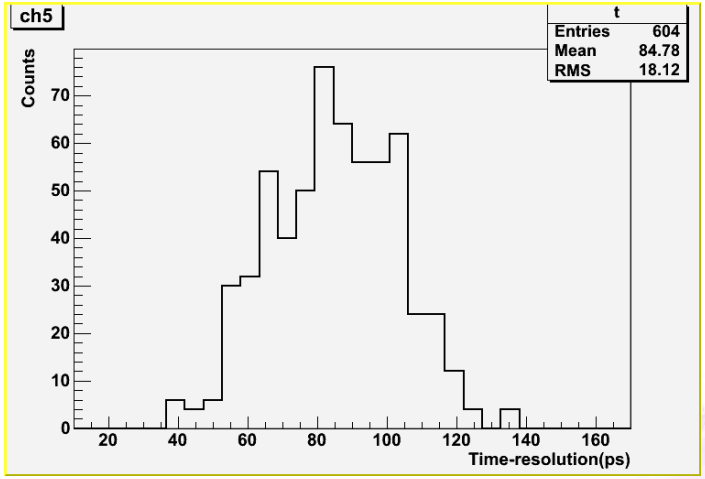
Time resolution of each channel

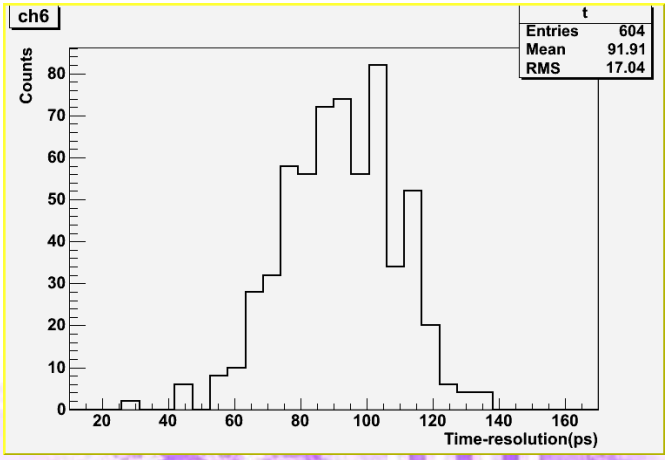












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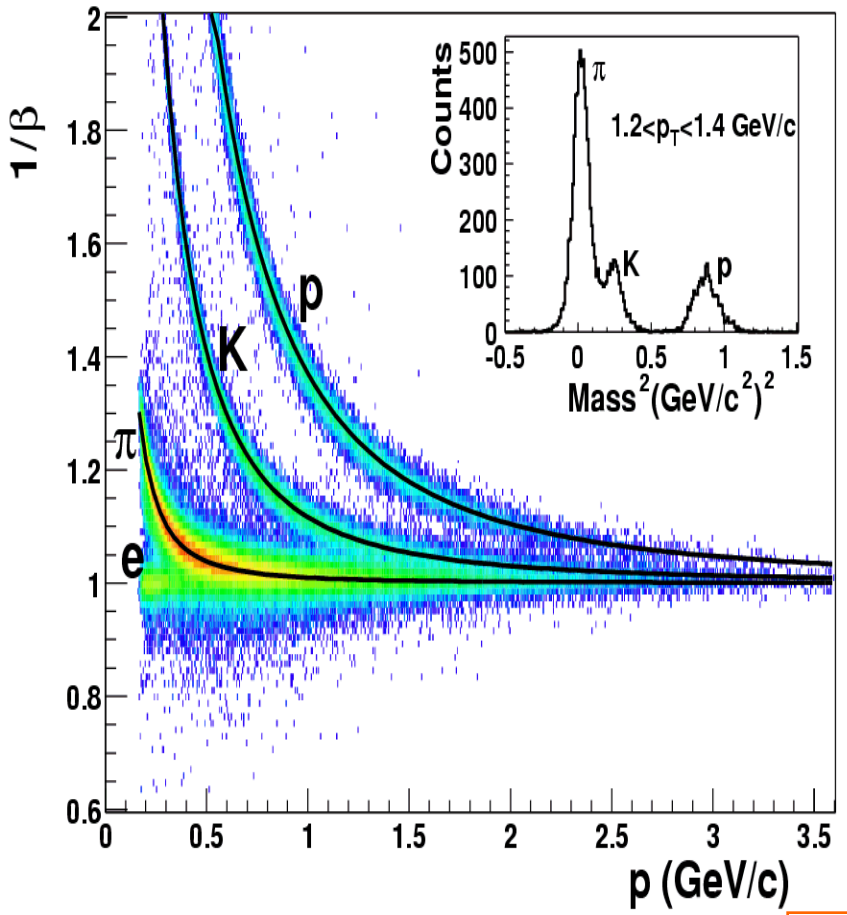
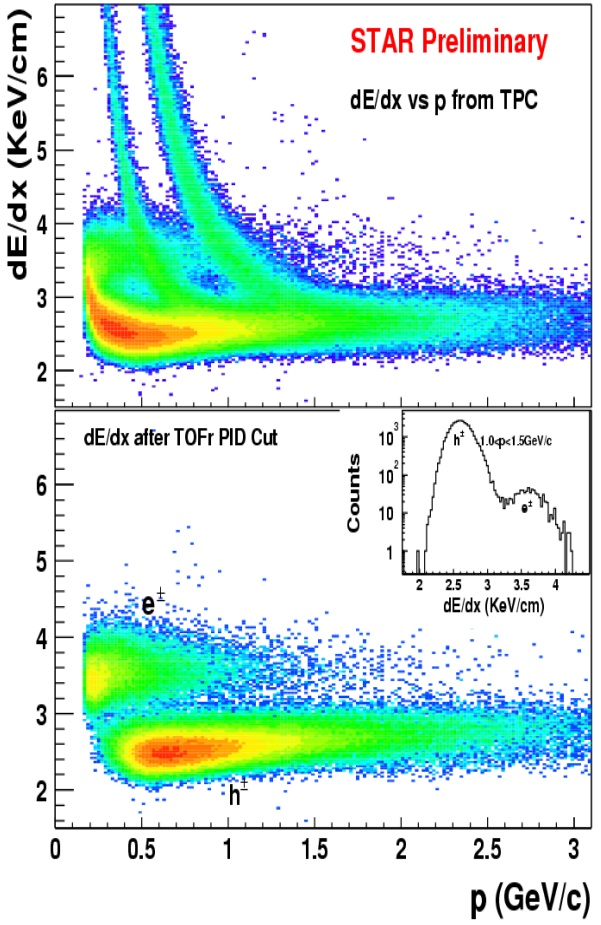
STAR-TOF PID





PID:

π/K/p: 1.7 GeV/c

p.vs.(π+K): 3 GeV/c

Clean electron PID can be obtained up to P_T< 3 GeV/c. →

This is used to measure the semileptonic decay of open charm.

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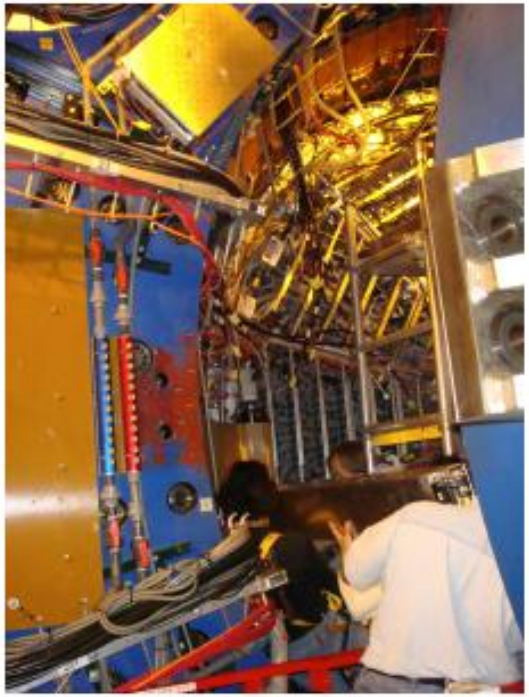
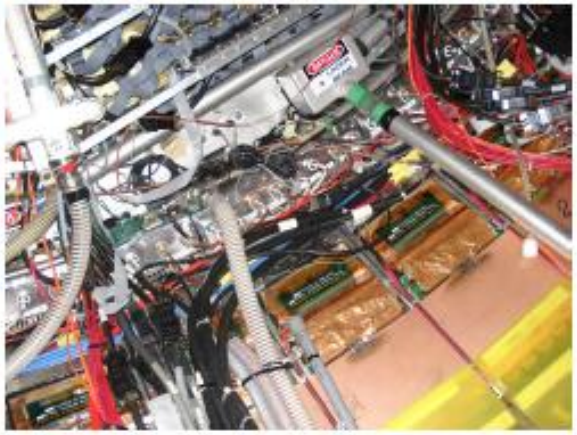
TOF Time Resolution Summary

Run-III to run-V

Operation conditions			Time Resolution (ps)		
			pVPD	TOFr (overall)	TOFr (stop)
Run III	200GeV d+Au		~85	~120	~85
	200GeV p+p		~140	~160	~80
Run IV	62GeV (Au+Au)		~55	~105	~89
	200GeV (Au+Au)	FF/RFF	~27	~86	~82
		HF	~20	~82	~80
Run V	200GeV Cu+Cu (ToT)		~ 50	~92	~75
	62GeV Cu+Cu (ToT)		~ 82	~125	~94

STAR ToF Installation (Fall 2008)





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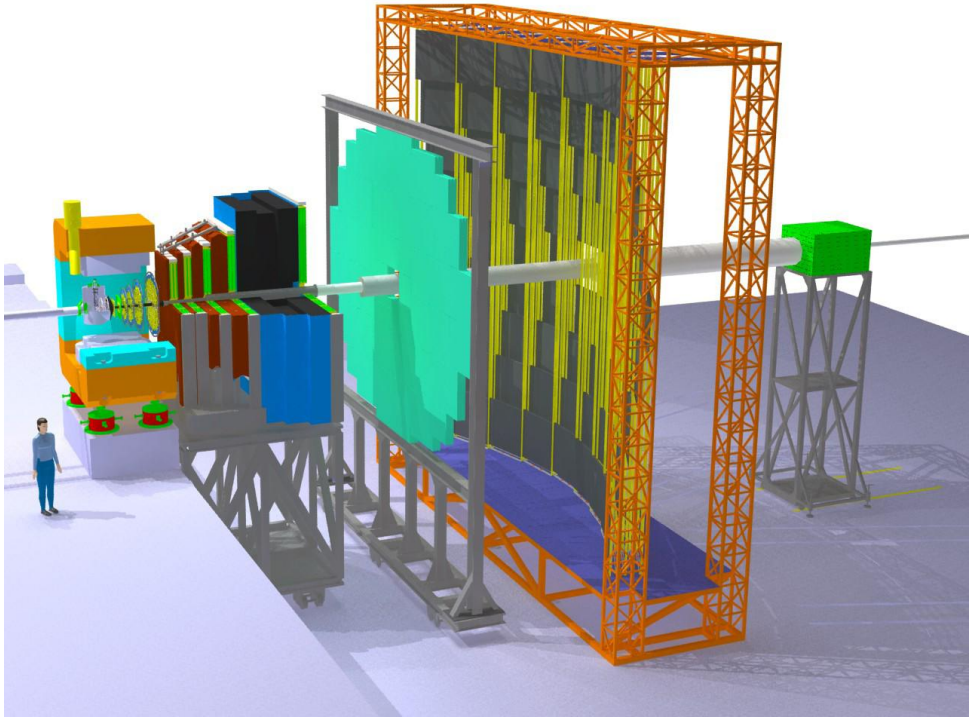
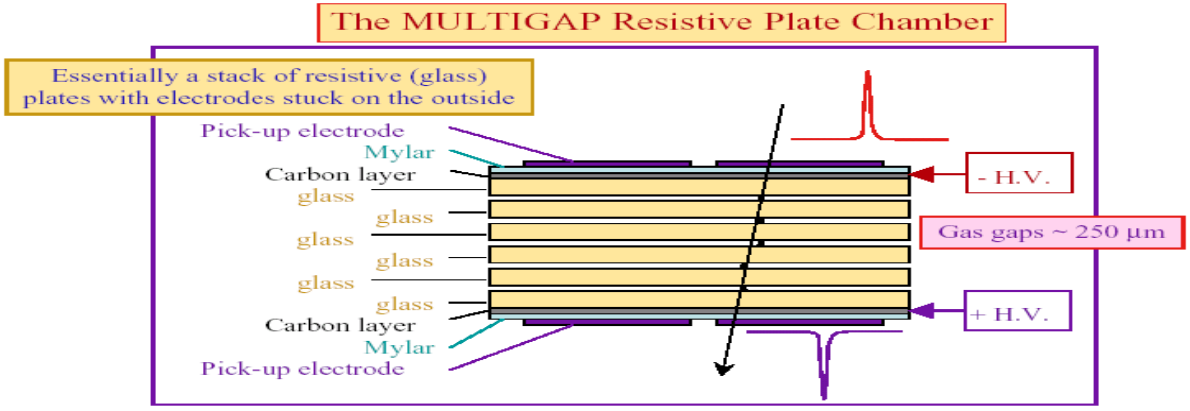
Compressed Baryonic Matter @ FAIR

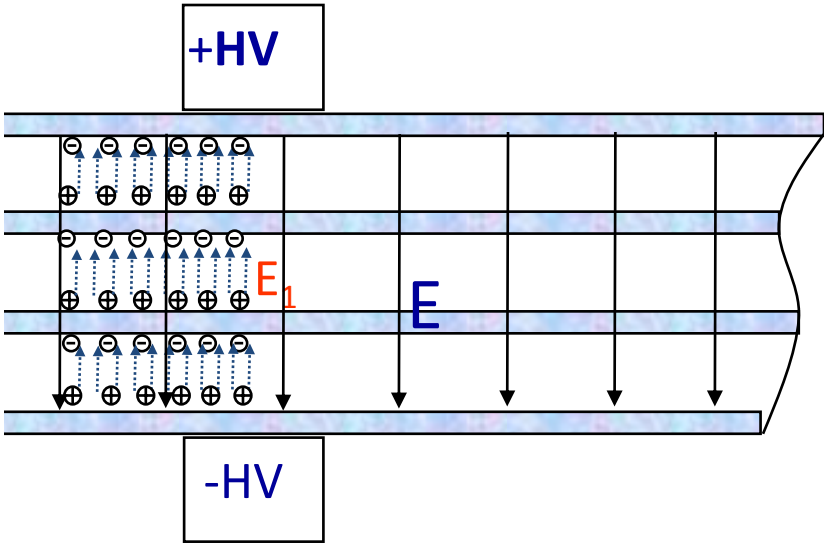


- Challenges:
  - high rate ≈ 20 kHz/cm^2
  - good time resolution < 100 ps
  - economic (price!)
- Possible solution:
  - low resistivity glass < 10^{10} Ωcm
- Problems:
  - large quantity of glass needed, detector area ≈170m^2
  - constant resistivity over whole plate
  - surface quality like float glass needed

Bulk resistivity of electrodes determine the rate capability of MRPC



Note 1: internal glass plates electrically floating - take and keep correct voltage by electrostatics and flow of electrons and ions produced in gas avalanches
Note 2: resistive plates transparent to fast signals - induced signals on external electrodes is sum of signals from all gaps



Lower resistivity accelerates the neutralisation of charge on the glass, so it speed up the recovery of electric field in gas gap.

$$k = k_0 / \rho d$$

ρ-resistivity d-glass thickness

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Semiconductive glass

Semiconductive glass

300mm*85mm*0.7mm

Bulk resistivity: ~$10^{10}\Omega$.cm

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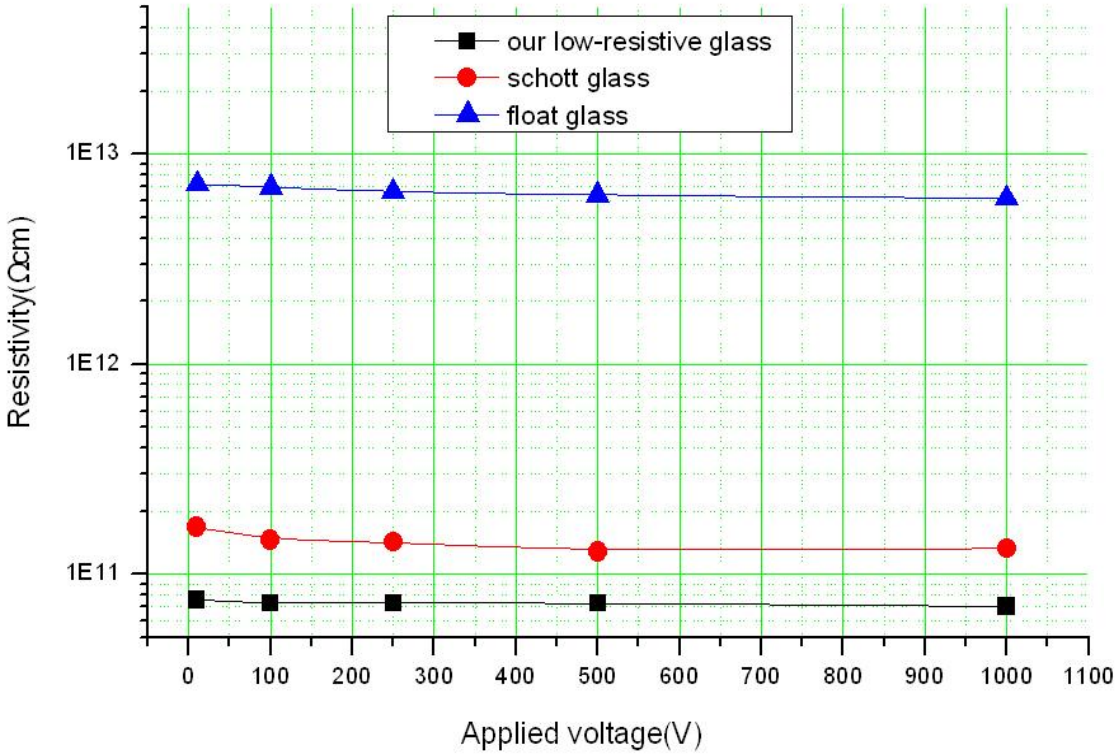
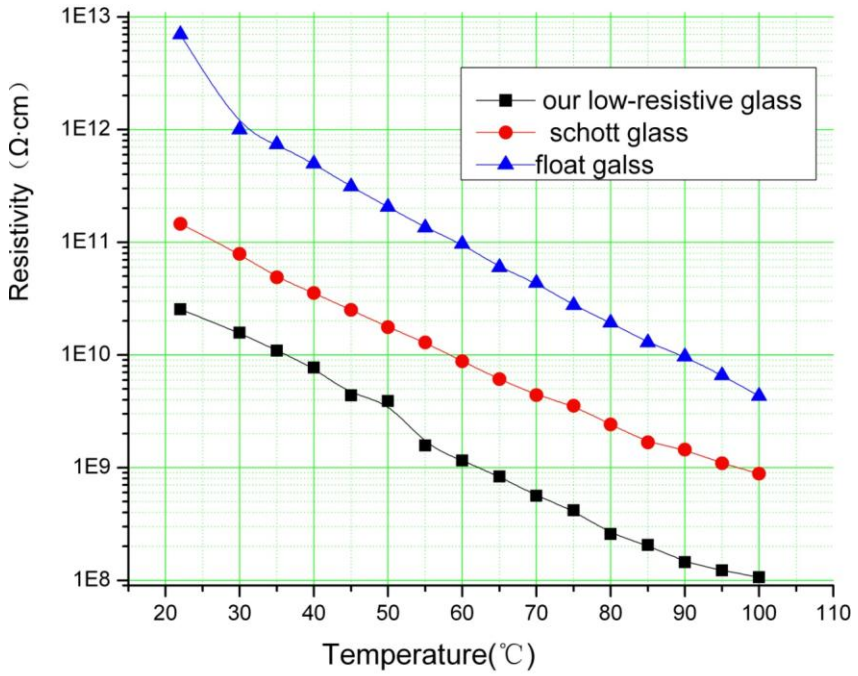
Resistivity changes with temperature





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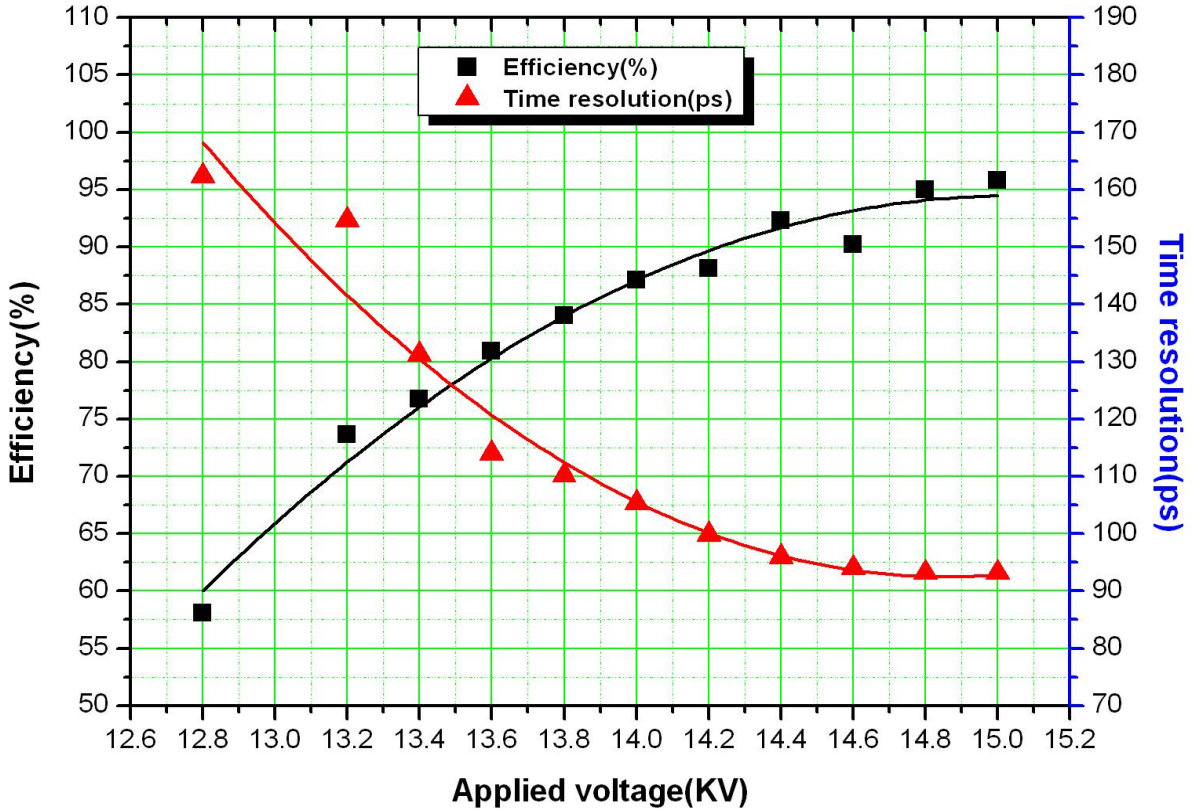
Efficiency and time resolution as a function of the applied voltage



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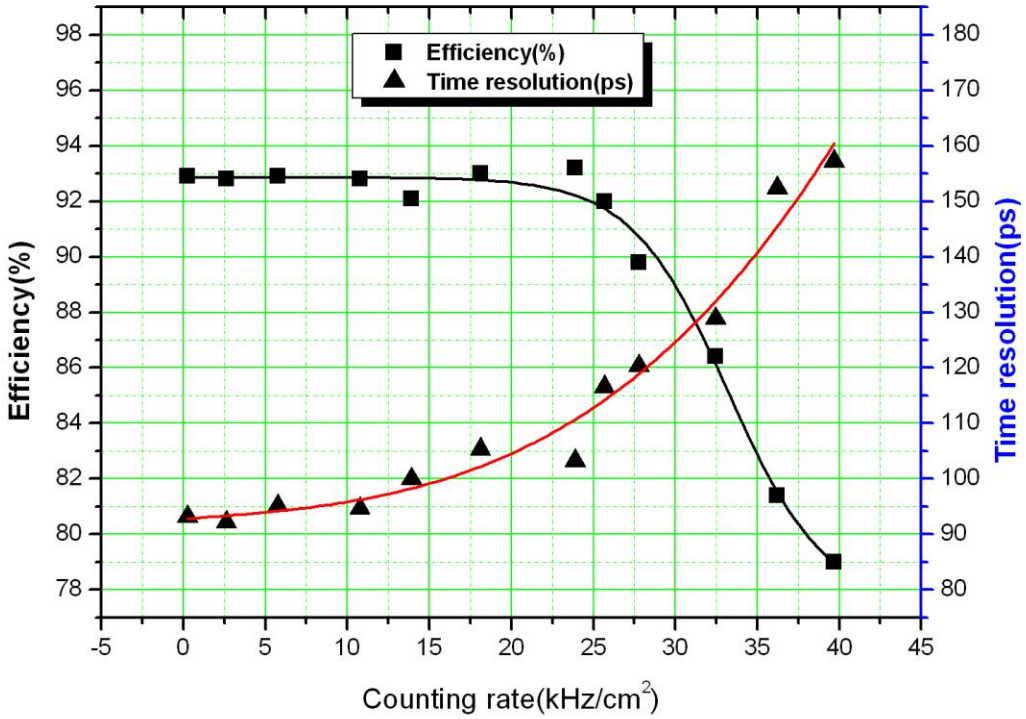
Efficiency and time resolution of MRPC



The rate capability can reach up to 28kHz/cm^2, while keeping an efficiency larger than 90% and a time resolution below 120ps.

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HDCAL collaboration

- **Development of high rate digital hadronic calorimeter**
- **Tsinghua’s work:**

  Study and production of semiconductive glass

  Development of detector

  Beam test and data analysis

  electronics board designing

- **This kind of development is very important since it enables the GRPC to be an ideal detector for both the barrel and end-cap regions of the future HCA L**

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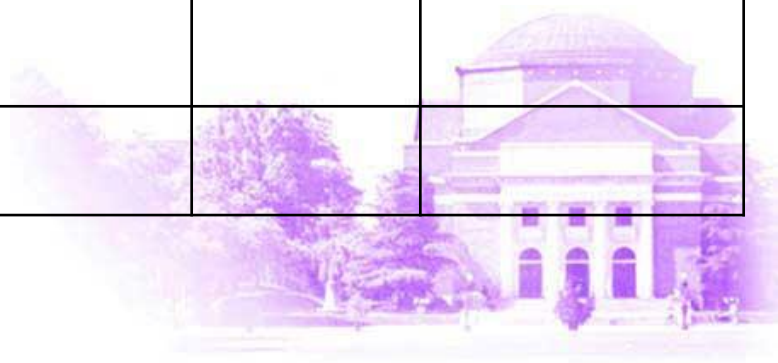
ID: Title	ILC-TSU-IPNL-CALICE: Development of high rate digital hadronic calorimeter					
Members	French Group			Chinese Group		
	Name	Title	Affiliation	Name	Title	Affiliation
	Leader: Imad Laktineh	Prof.	IPNL/IN2P3	Leader: Yi Wang	Prof.	Tsinghua U
	Muriel Vander Knockt	Dr	IPNL/IN2P3	Qian Yue	Prof.	Tsinghua U
	Robert Kieffer	student	IPNL/IN2P3	Zhi Deng	Lecture	Tsinghua U
	Nick Lumb	Eng.	IPNL/IN2P3			
	Christope de la Taille	Eng.	LAL/IN2P3	Jin Ye	student	Tsinghua U
	Hervé Mathez	Eng	IPNL/IN2P3	Jingbo Wang	student	Tsinghua U



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Funding from France				
Description	**Euro/unit**	**Nb of units**	**Total (euros)**	**Requested to:**
Student stay in France	1000/month	6 months	6000	IN2P3
Visit to China	150/day	36 days	5400	
Travels	1000	6 travel	6000	
Total			17400	

Funding from China				
Description	**Yuan/Unit**	**Nb of units**	**Total (Yuan)**	**Requested to:**
Travel cost (Yi Wang, Qian Yue, Zhi Deng)	10000	5 travel	50000	Tsinghua
Stay cost (Yi Wang, Qian Yue, Zhi Deng)	1200/day	5*7days	42000	Tsinghua
Total			92000	

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Thank you !!