



## MWPC prototyping and testing for STAR inner TPC upgrade

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## Outline

□ Motivation of STAR-iTPC upgrade

**Contents of STAR-iTPC upgrade** 

**I** iTPC MWPC prototyping

□ iTPC MWPC testing with <sup>55</sup>Fe X-ray

**D** Summary

## **RHIC Beam Energy Scan (RHIC-BES)**



## **STAR detector upgrade for BES II**

# **Detector Developments for BES II** inner TPC upgrade **Event Plane Detector** TOF **Inner TPC upgrade :** Extend TPC acceptance $|\eta| < 1.0 - > \eta| < 1.5$ Improve dE/dx resolution

 $\checkmark$  Lower  $p_T$  limit 125MeV/c->60MeV/c

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#### **STAR TPC geometry**



#### Inner TPC upgrade

- Produce and replace all 24 inner sectors
- ✓ Increase readout channels
  - increase pad coverage 20%-100%
- ✓ Renew all three wire grids
- ✓ New electronics for inner sectors





- 1. Gain uniformity >90%
- 2. Detection efficiency >92%
- 3. Gas gain at operating anode voltage(1120V) : 2000

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## **Construction of iTPC MWPC prototype**

• PCB bonding

• Wire mounts installation





• Mounting wires



• Epoxying wires



• Soldering wires



• A full size prototype



### Wire winding and tension measurement



WireTensionDistribution\_02



#### □ Wire winding system

- ✓ Precise control wire tension
- ✓ General control wire pitch
- Wire tension and wire pitch measurement system
- Measure wires tension and pitch between two wires

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#### Wire pitch control and measurement

□ Wire comb and pitch control



#### **U** Wire pitch measurement results:





Wires pitch and height control schematic diagram



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#### Test system setup with <sup>55</sup>Fe X-ray





#### DAQ setup

 ✓ Trigger: random @2kHz
 ✓ Anode voltage: 1070-1320V

□ <sup>55</sup>Fe source ✓ Activity ~1mCi ✓ Φ 5mm

### Anode wire readout with <sup>55</sup>Fe X-ray







✓ Gain = 0.87 \* 6.24 \* 10<sup>6</sup>/225 = 24,280



- ✓ Gain and ratio of main/escape peak are reasonable agreement with STAR note
- Detailed study is planned to be done





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#### Gain measurements with different wires

Wire Num	Anode Vol	Temperature	Main Peak(PC)	Escape Peak(PC)	Ratio (M/E)	Gas Gain	Energy Resolution
105	1320 V	<b>20.7</b> °C	1.028	0.6065	1.69	28516	35.5%
106		<b>21.2</b> °C	1.092	0.6387	1.71	30292	33.9%
107		<b>21.6</b> °C	1.101	0.6448	1.71	30541	34.4%
108		21.7 °C	1.116	0.6505	1.72	30957	35.3%
109		<b>21.8</b> °C	1.118	0.6571	1.70	31013	34.1%
110		<b>21.4</b> °C	1.109	0.6632	1.67	30763	37.9%
111		20.5 °C	1.086	0.6124	1.77	30125	38.8%



- The difference between maximum and minimum is ~ 8.7%.
- The effects of temperature needs further investigation. Gain increase 2~3% if temperature increase 1 degree Celsius(from the previous study of STAR).

<sup>2/25/2017</sup> 

#### Pad readout with <sup>55</sup>Fe X-ray



**A Typical Pulse** 

 $\checkmark$ 

 $\checkmark$ 

 $\checkmark$ 

## **Pad signal ADC distribution**







- Pulse continued time bins VS pulse integral ADC
  <sup>55</sup>Fe X-ray spectrum in P10 gas
- ✓ There are two clear peaks after 2 cuts.
- Anode HV versus relative gain
- ✓ The ADC of peaks increase exponentially with increasing anode voltage
- ✓ It is similar to the previous measurement results(STAR note 263)

- **D** The 1<sup>st</sup> iTPC MWPC prototype was made
  - A laser based optical system was developed to check wire tension and pitch
- MWPC test system with <sup>55</sup>Fe source was set up, test results of 1<sup>st</sup> prototype was obtained.
- □ Mass production for STAR will start in April 2017.
- **Testing plan for iTPC mass production:**

(1) check the gain of all the anode wires, with MCA readout

(2) 3 point gain test over pads on each anode wire

## Thanks !

# Back up

## Data acquisition process



- ✓ Read out versus time bin (100ns each, 400 in total)
- $\checkmark$  2 time bins ADC in a row >3 counts