# NEW CAPABILITIES OF COORDINATE STRAW DETECTORS

ICHEP PARIS 2010

JINR

## GRANULATED STRAWS PROTOTYPE

**STRAW TRACKING DETECTORS:**

Using Technique

- Low Material Budget : $X/X_0 \approx 0.05\%$
- Spatial Resolution : ≥ 150 μm
- Straw length : any
  from 40 cm - TRT ATLAS; to 3.6 m - COMPASS
- Granulation : diameter x length
- Diameter: from 4 mm to 15 mm
- Gas mixture pressure : 1 bar

## NEW CAPABILITIES of COORDINATE DETECTORS on the BASIS of STRAWS


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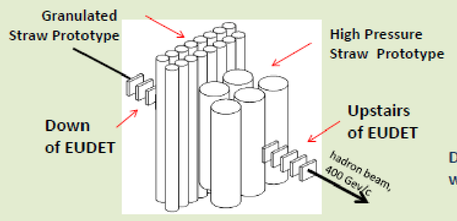
**motivation of R@D:** Novel Technique improve occupancy and resolution

Low Material Budget: is kept

Granulation: diameter x L of the anode segment

Gas mixture pressure : from 1 bar to 5 bars

### BEAM TESTS at the SPS, CERN (H6 BEAM LINE, July 2009)

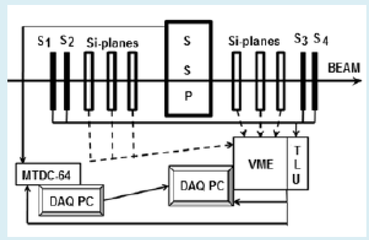



The prototypes were moving precisely both in the X and Y directions.

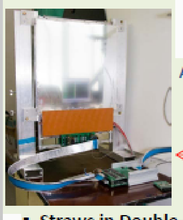
Data from the prototypes' DAQ were sent into DAQ of the EUDET.

EUDET pixel telescope was used as the track detector:

- 3 + 3 Si-pixel plates
- 2+2 Scintillation counters
- Sensitive area - 6 x 6 mm²
- Spatial resolution ~ 5 μm



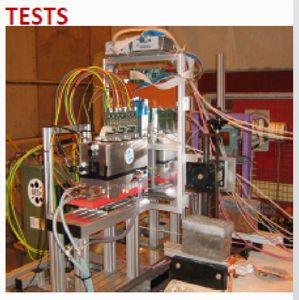

### PROTOTYPES for the BEAM TESTS



A PROTOTYPE COORDINATE DETECTOR BASED on the GRANULATED STRAWS

bench test in JINR

beam test at SPS



- Straws in Double-Layers (1/2 diameter offset), L = 420 mm, $Ø_{in}$ = 4 mm
- Gluing of 48 straws close-packed together per layer
- Four segmented anodes, $L_{segm.}$ ≈ 100 mm, Ø = 30 μm
- Total 360 segments, granularity is 4 cm²
- One low mass cable per 2 straws (11 x 0.85 x 405 mm³, 8 lines)
- signal & power supply over the same line (2kV) through
- Gas leak - diffusion through the straw walls

A HIGH PRESSURE STRAW PROTOTYPE

- Straws in Double-Layers ( 3 and 2) (1/2 diameter +0,5 mm offset), L = 100 mm, $Ø_{in}$ = 9.53 mm
- Reinforced straws like the TRT ATLAS straws
- Gas leak - diffusion through the straw walls (tests with straws 1.55 m long were done early)

The same FEE and DAQ were used for the both prototypes

### Granulated Prototype Beam Tests on the H6 Beam Line of the SPS

INNER DIAMETER of the STRAWS – 4 mm

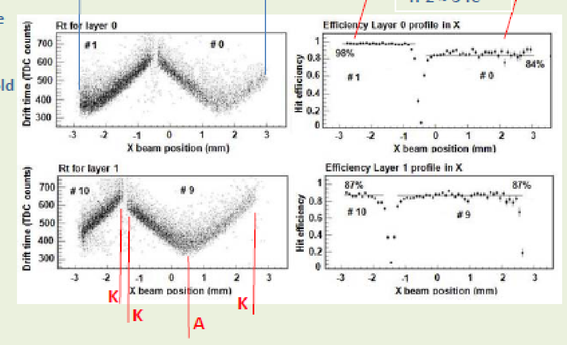
Sensitive size of the EUDET, 6 mm

K – straw catode

A– straw anode

Tr – FEE threshold

Tr 1 ≈ 4.5 fC
Tr 2 ≈ 3 fC




1-st straw layer

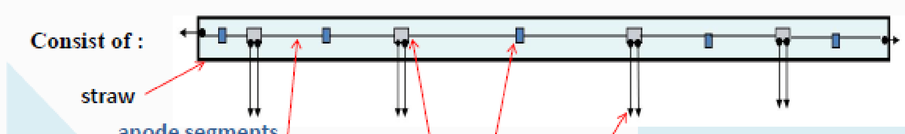
2-d straw layer

R-T DEPENDENCES

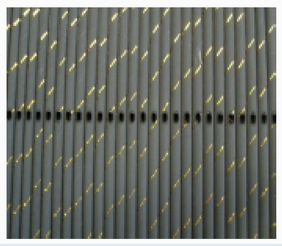
EFFICIENCY of the LAYER

- Gas mixture Ar/$CO_2$ (70/30)
- Gas gain ~ 6 x 10⁴

### Granulated Thin-Walled Drift Tubes




JOINTS: L – 5 mm (or 4), $Ø_{in}$ - 0.1 mm, $Ø_o$ - 0.25mm mass is negligible



STRAW PLANE (fragment)

STRAW


Inner Diameter – 4 mm

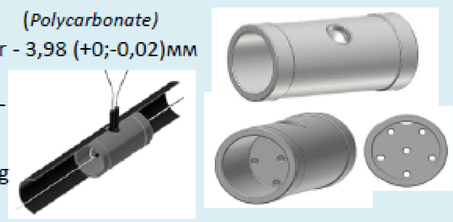
SPACER (Polycarbonate)

Outer Diameter - 3,98 (+0;-0,02)мм

Length – 8 mm

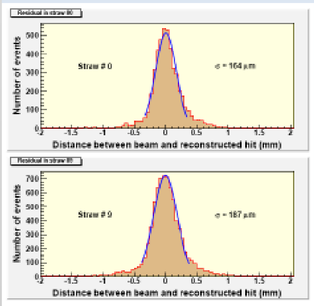
Wall thickness – ~0.2 mm

Weight is 80 mg



### Granulated Prototype Beam Tests on the H6 Beam Line of the SPS

Different irradiation along the Straw Radius:

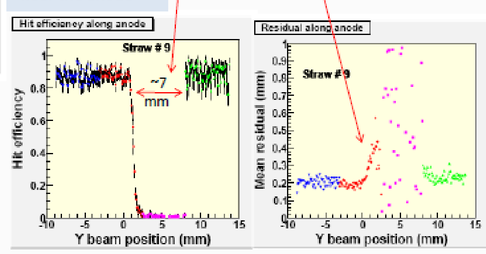



the larger contribution is given by the region near the cathode

The larger contribution is given by the region near the anode

INSENSITIVE STRAW LENGTH for the SPACER LOCATION < 7 mm

SPATIAL RESOLUTION NEAR the SPACER




SPATIAL RESOLUTION of the STRAWS (residual)

σ = 164 187 μm

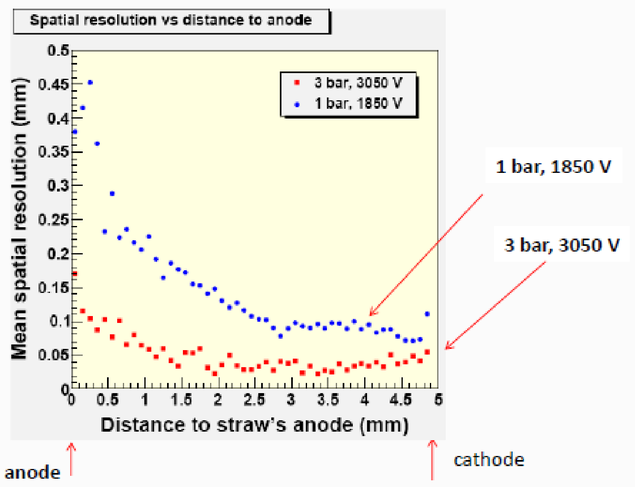
Gas pressure – 1 bars
Anode voltage - 1.5 kV

Insensitive length (6-7 mm) can be reduced

## HIGH PRESSURE STRAW PROTOTYPE

### High Pressure Prototype Beam Tests on the H6 Beam Line of the SPS

Typical Spatial Resolution (~ 180 μm) and Efficiency ( ≤99% )




SPATIAL RESOLUTION along the STRAW RADIUS

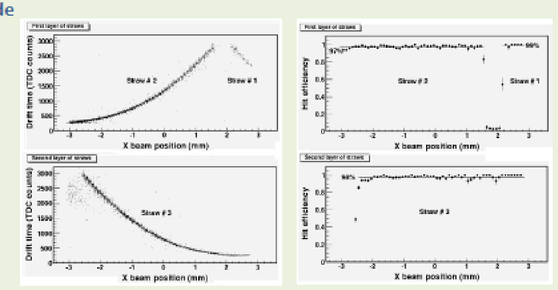
### High Pressure Prototype Beam Tests on the H6 Beam Line of the SPS

INNER DIAMETER of STRAWS – 9.53 mm

Sensitive size of the EUDET, 6 mm

K – straw cathode

A– straw anode



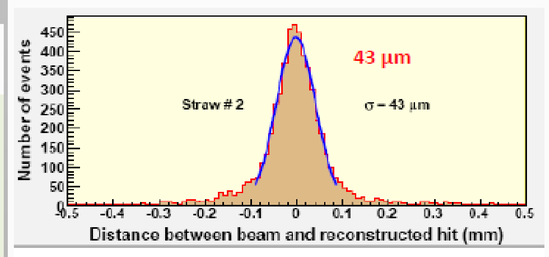

1-st straw layer

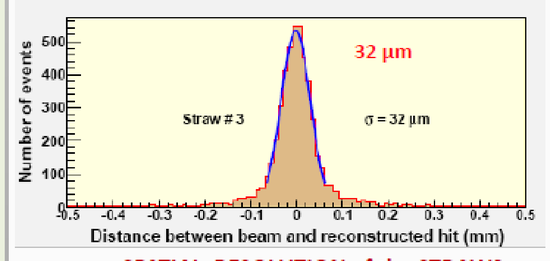
2-d straw layer

R-T DEPENDENCES

EFFICIENCY of the LAYER

Gas pressure – 3 bars
Anode voltage - 3.05 kV




SPATIAL RESOLUTION of the STRAWS (residual)

Different Irradiation along the Straw Radius:

The larger contribution is given by the irradiation of the anode region

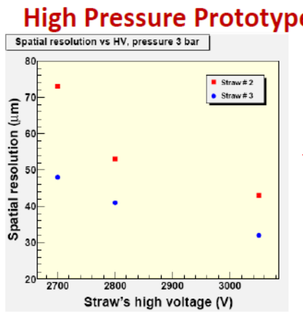
The larger contribution is given by the irradiation of the cathode region

Gas pressure – 3 bars
Anode voltage - 3.05 kV

## Spatial resolution ~ 30 μm Efficiency 99% Pressure 3 bars

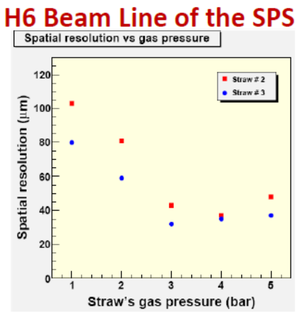
**Detectors based on granulated high pressure straws are feasible**

### High Pressure Prototype Beam Tests on the H6 Beam Line of the SPS

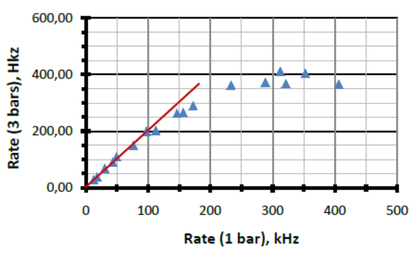



SPATIAL RESOLUTION vs on the anode voltage

SPATIAL RESOLUTION vs on the gas pressure




### High Pressure Prototype Bench Tests in JINR




The straw was irradiated by X-rays through the slit collimator. Zone of irradiation is ~1.3 mm along the radius.

X-axis: rate of the straw with 1 bar of the pressure, threshold of the FEE is Tr-1.

Y-axis: rate of the straw with 3 bar of the pressure, threshold of FEE is 3 x (Tr-1).

U is 3.05 kV.

Rate capability is kept.

## Summary and Outlook

ADVANTAGES OF GRANULATED STRAW DETECTORS:

- Least radiation thickness (~0.1%$X_0$ per straw)
- Typical spatial resolution (<200 μm)
- Good rate performance (degradation beyond 100 kHz/mm of anode length)
- Min. value of granularity can be ≥ 1.5 cm²
- Small insensitive area (insensitive length of straw with granularity 4 cm² is less than 5%)

ADVANTAGES OF HIGH PRESSURE STRAW DETECTORS:

- Smallest radiation thickness (~0.1%$X_0$ per straw)
- Good gas tightness
- Good spatial resolution for the pressure > 2.5 bars (~30 μm)
- Good rate performance

DRAWBACK: the detectors requre more sophisticated gas manifolds

Gas as interaction material for detectors of charged particles had good advantages. New trackers based on granulated straw s with gas pressure about 3 bars may be considered as remote detector for a middle distance from the collision.


REFERENCE

[1]. K. Davkov et al., Physics of Particles and Nuclei, Vol.4, No.4, (2007), pp. 54-551.
[2]. K. Davkov, V. Davkov, R. Geyer et al., Nucl. Instr. Meth. in Phys. Res. A 584 (2008) 285-290
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[5]. Yu.V. Gusakov et al., Physics of Particles and Nuclei, 2010, Vol.7, No. 12, pp. 132–137.
[6]. G.Kekelidze et al.,. *Physics of Particles and Nuclei Letters, 2010, Vol. 7, No. 3, pp. 209–211*