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Application of micro-pattern gas detectors in the present and future experiments in Budker INP

L.Shekhtman

Budker INP SB RAS, Novosibirsk, Russia
Novosibirsk State University, Novosibirsk Russia

Outline

1. **Upgrade of the tracking system of CMD-3 with μRWELL technology**
   - **End-cap discs and large cylindrical chamber**
   - **First tests of μRWELL prototypes**

2. **MPGDs in the tracking system of the Super c-tau factory detector**
   - **Simulations of background particle rates in the SCTD**
   - **Simulations of different options of the Inner Tracker**
   - **Compact TPC, ion backflow issues**

VEPP-2000

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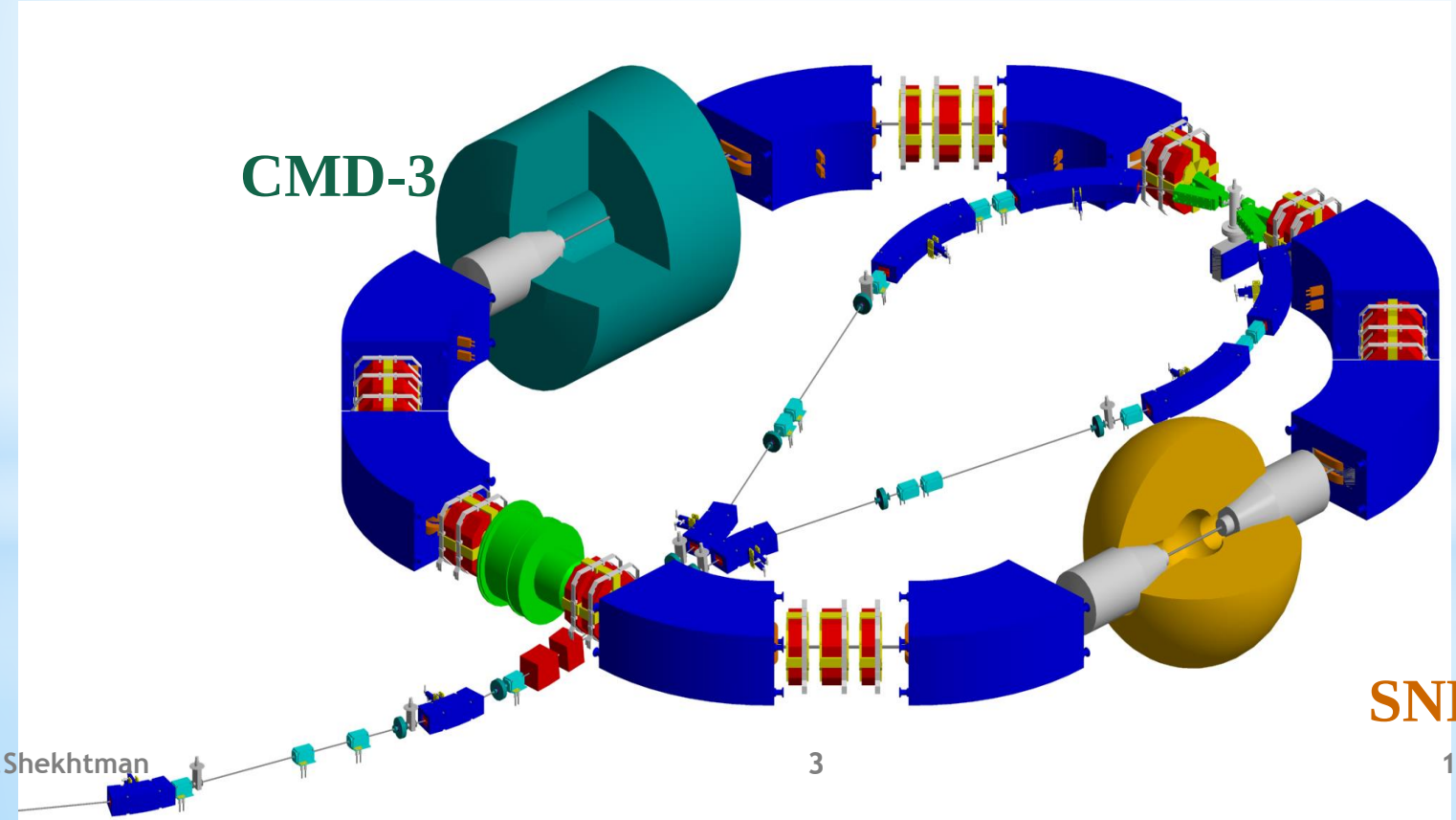
- beam length – 3.3 cm
- revolution time – 82 ns
- circumference – 24.4 m
- $L = 10^{32}$ $cm^{-2}s^{-1}$ at 2.0 GeV,

energy spread – 0.7 MeV
beam current – 200 mA
beta function in IP $\beta_x = \beta_z = 4.3$cm
$L = 10^{31}$ $cm^{-2}s^{-1}$ at 1 GeV



CMD-3 detector

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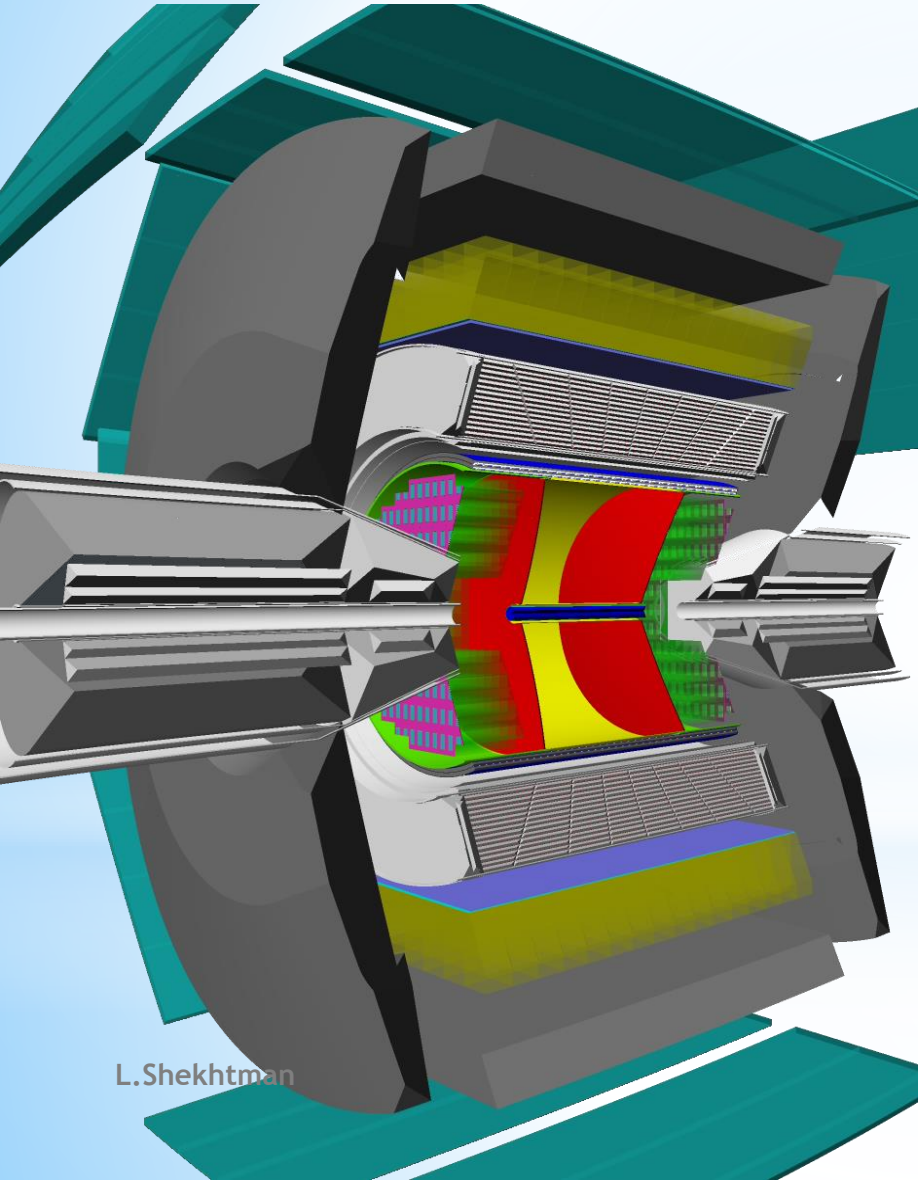


DC – 1218 hexagonal cells with sensitive wires, W-Re alloy, 15 μm in diameter.

Z-chamber – start FLT, precise determine z-coordinate ~ 500 μ (detector acceptance)

LXe calorimeter thickness $7X_0$, 196 towers & 1286 strips. Spatial resol. 1–2 mm.

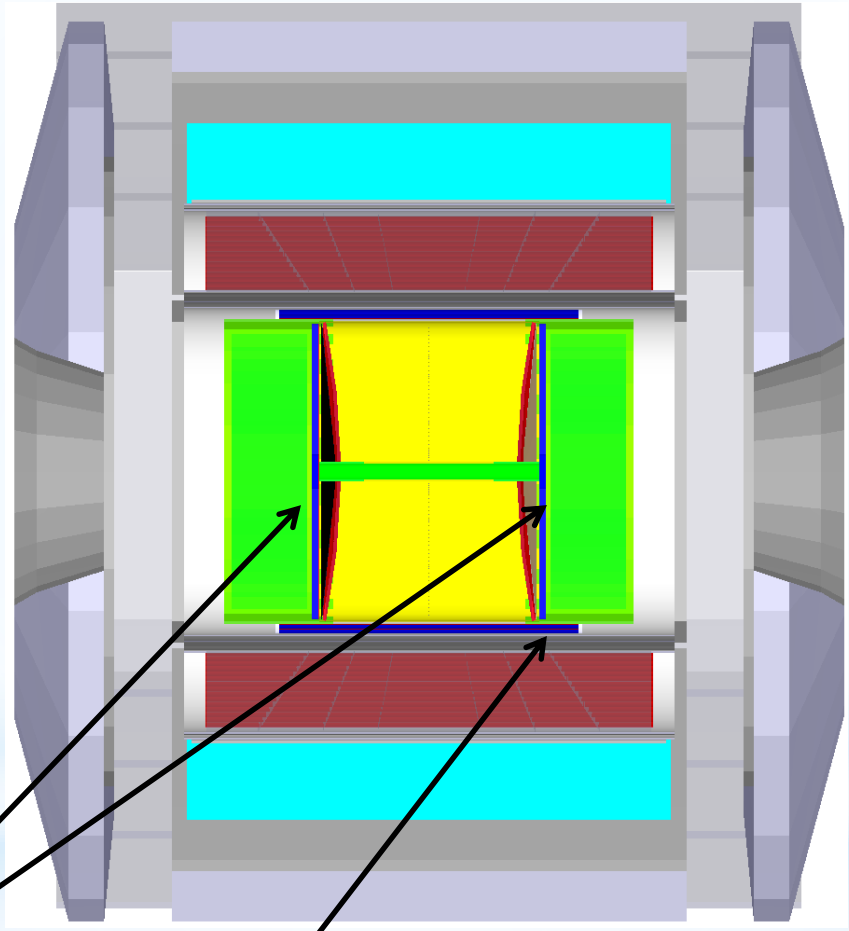
Calorimeter with CsI crystals (~3,5 t), 8 octants, number of crystals - 1152, 8 X_0.

TOF – 16 counters, time resolution ~ 1ns

MR system – 8 octants (cosmic veto, ~ 1ns)

Project magnetic field - 1,5 T
(current value 1.3 T while)

Proposal for the upgrade of the tracking system



End-cap discs

Cylindrical Z-chamber

Z-chamber CMD-3:

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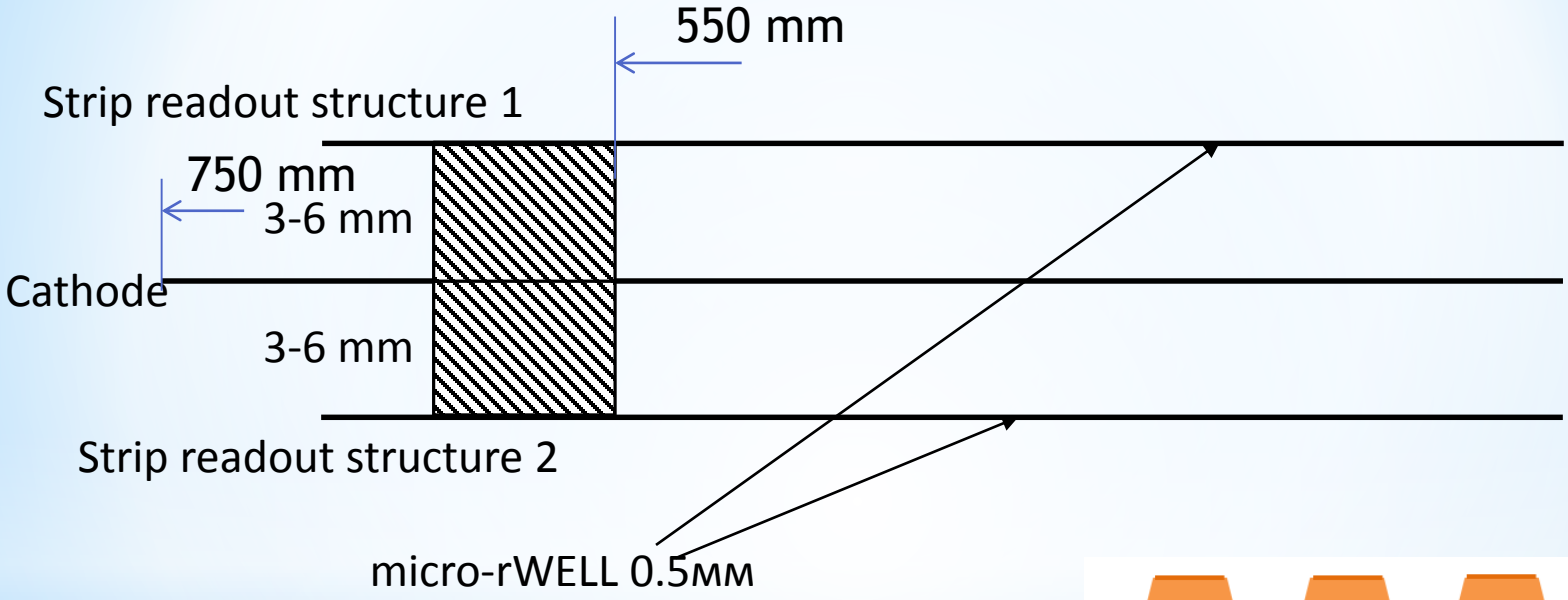
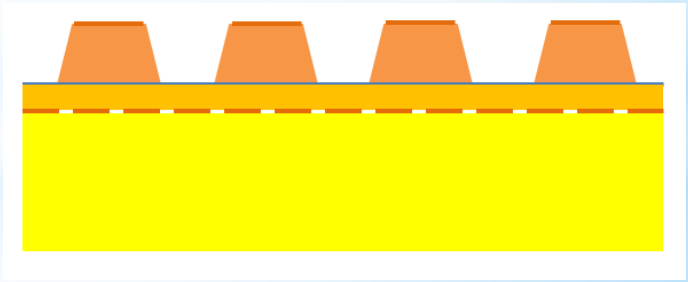
Cylinder diameter - 617-643 mm , length - 550 - 750 mm



Total thickness – 7.5 – 13.5 mm

Z-strips – 1536, 1.5mm x 1m, ~1nF

Φ-strips (trigger) – 256, 15x275mm^2, ~2 nF



G.Bencivenni, et.al., J. of Instrum., 10 (2015) P02008
G.Bencivenni, et.al, NIM A 824 (2016), p. 565-568
G.Bencivenni, et.al., J. of Instrum., 12 (2017) C06027

End-cap tracker for CMD-3 based on MPGD technology

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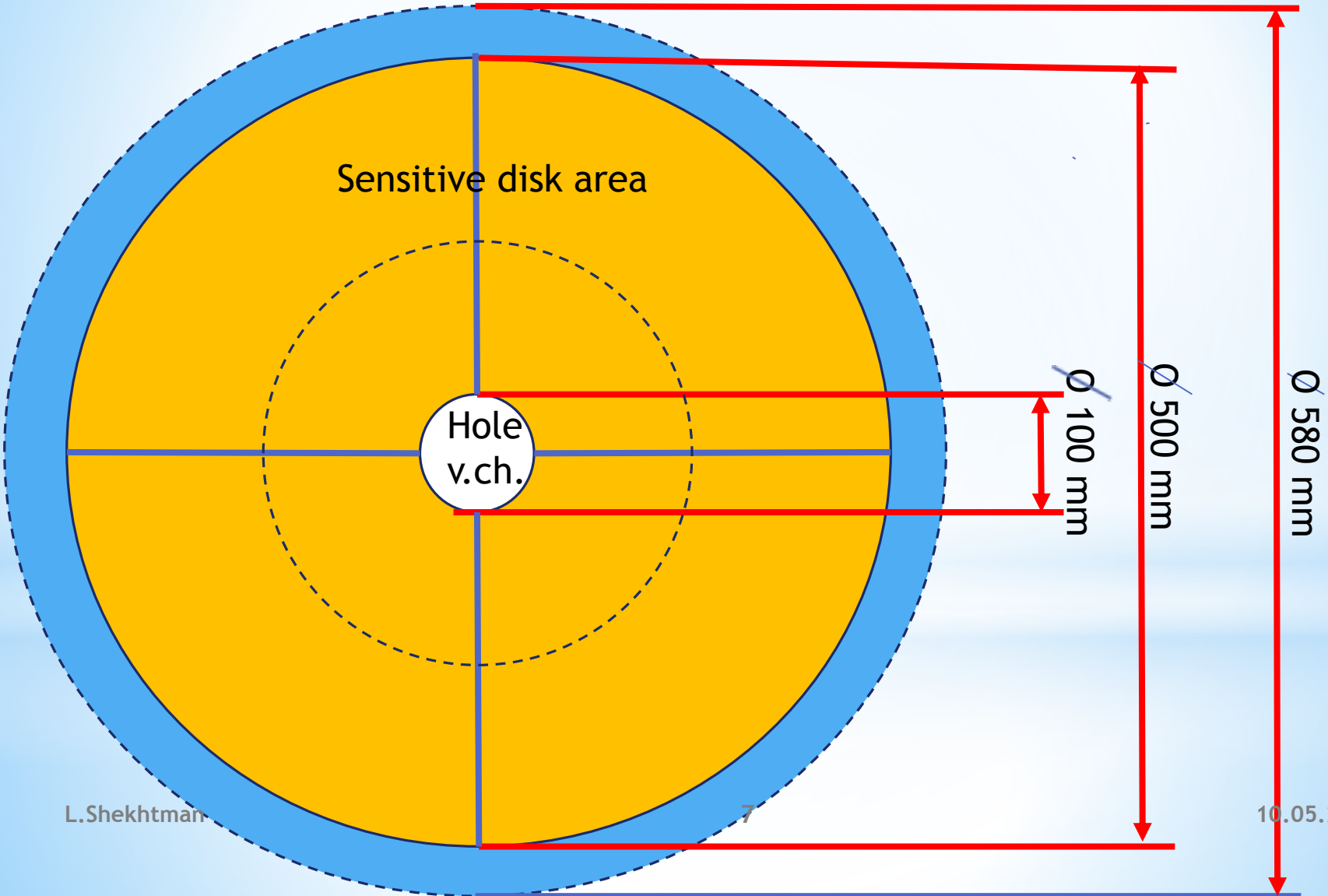

End-cap discs

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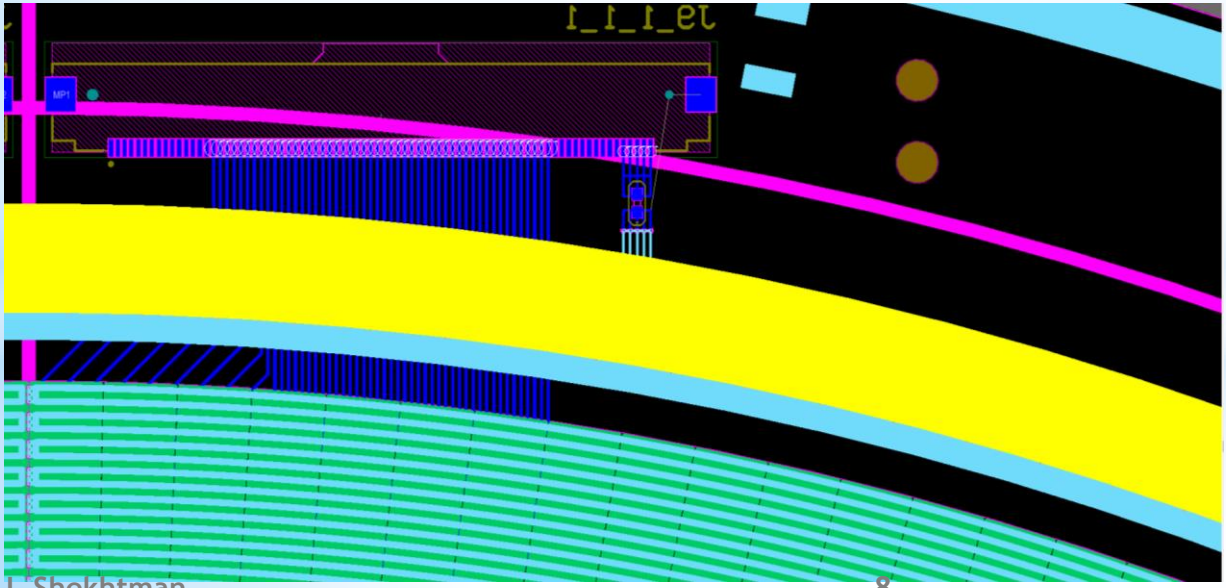
400 quarter-rings
144+288 sectors



Gain in μRWELL with different gas mixtures

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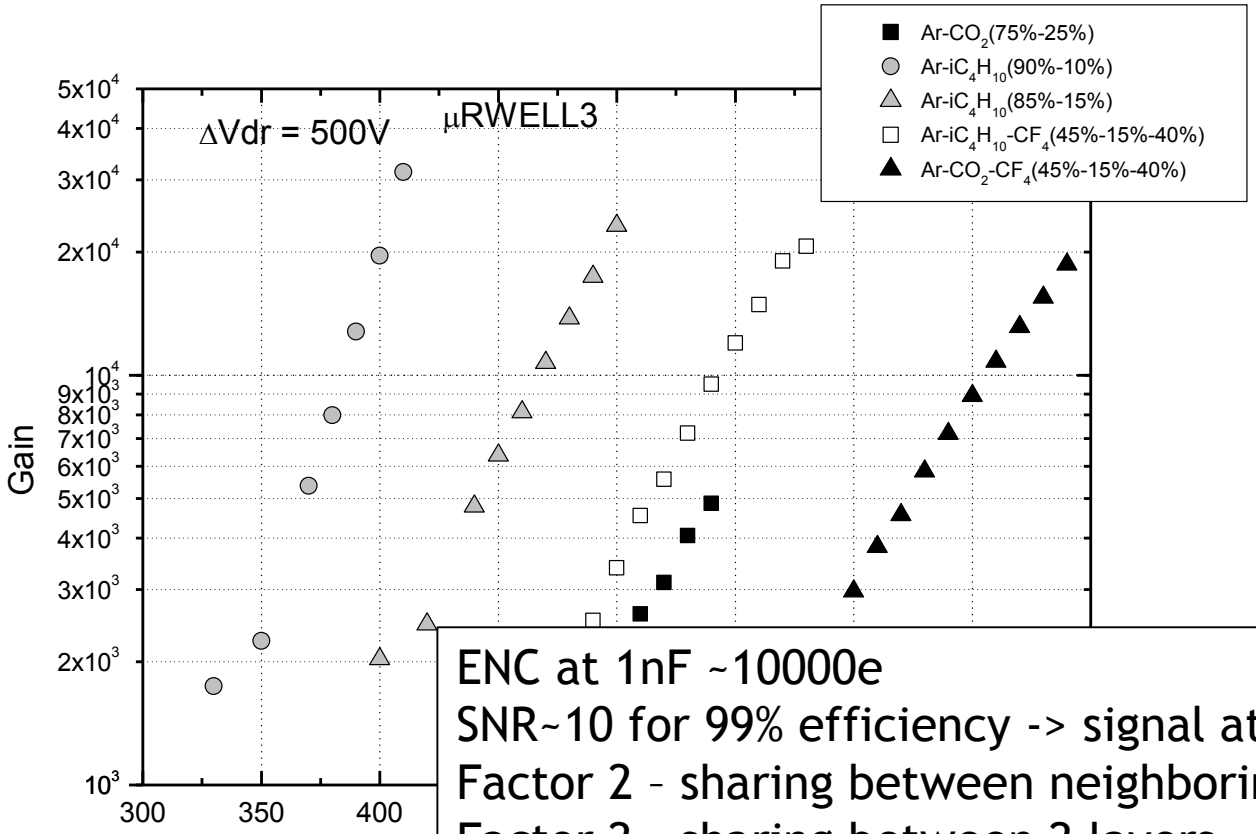

10x10 cm^2 prototype
8 keV photons
~150 MΩ/sq
3mm drift gap

ENC at 1nF ~10000e
SNR~10 for 99% efficiency -> signal at one strip ~100000e
Factor 2 – sharing between neighboring strips
Factor 2 – sharing between 2 layers
Total charge ~ 400000e
Primary charge in 3mm from MIP ~30e
Necessary gain ~ 13000
Primary charge in 6mm ~60e
Necessary gain ~7000

Measurements of gain in μRWELL+GEM

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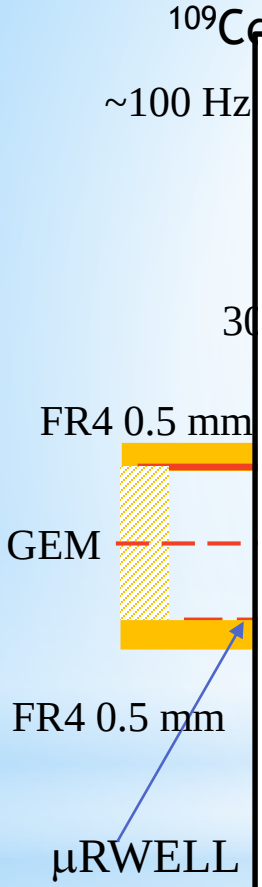

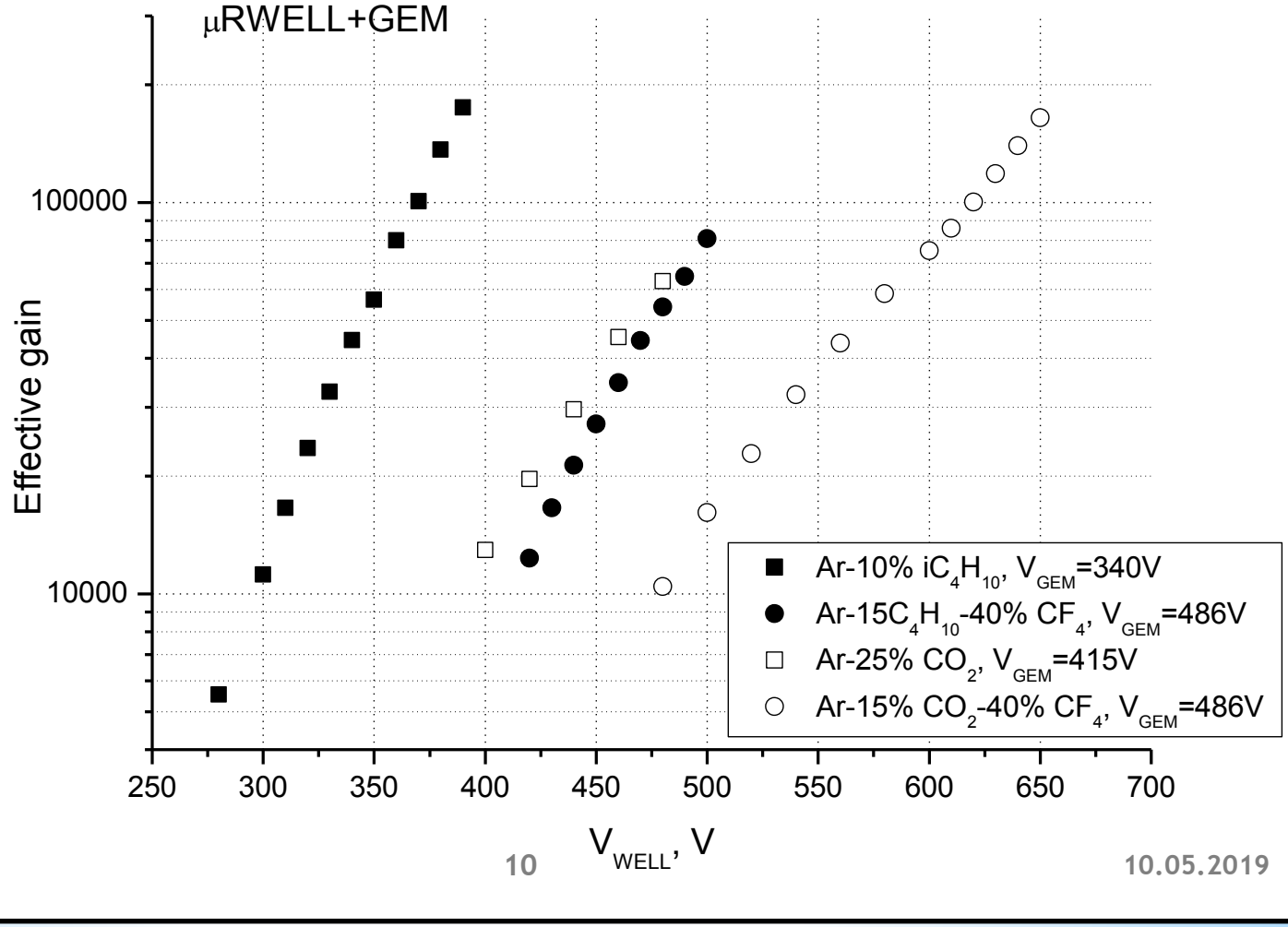

Current status and next steps

- Two end-cap μRWELL discs and GEMs are in production
- Two VMM3a SRS hybrids (2x128 channels) plus necessary infrastructure will be available in summer 2019
- First mold for central cathode of Z-chamber has been produced
- Two central cathodes of Z-chamber have been produced
- Mounting of two prototypes of the end-cap discs before the end of 2019

Novosibirsk Super Charm-Tau Factory

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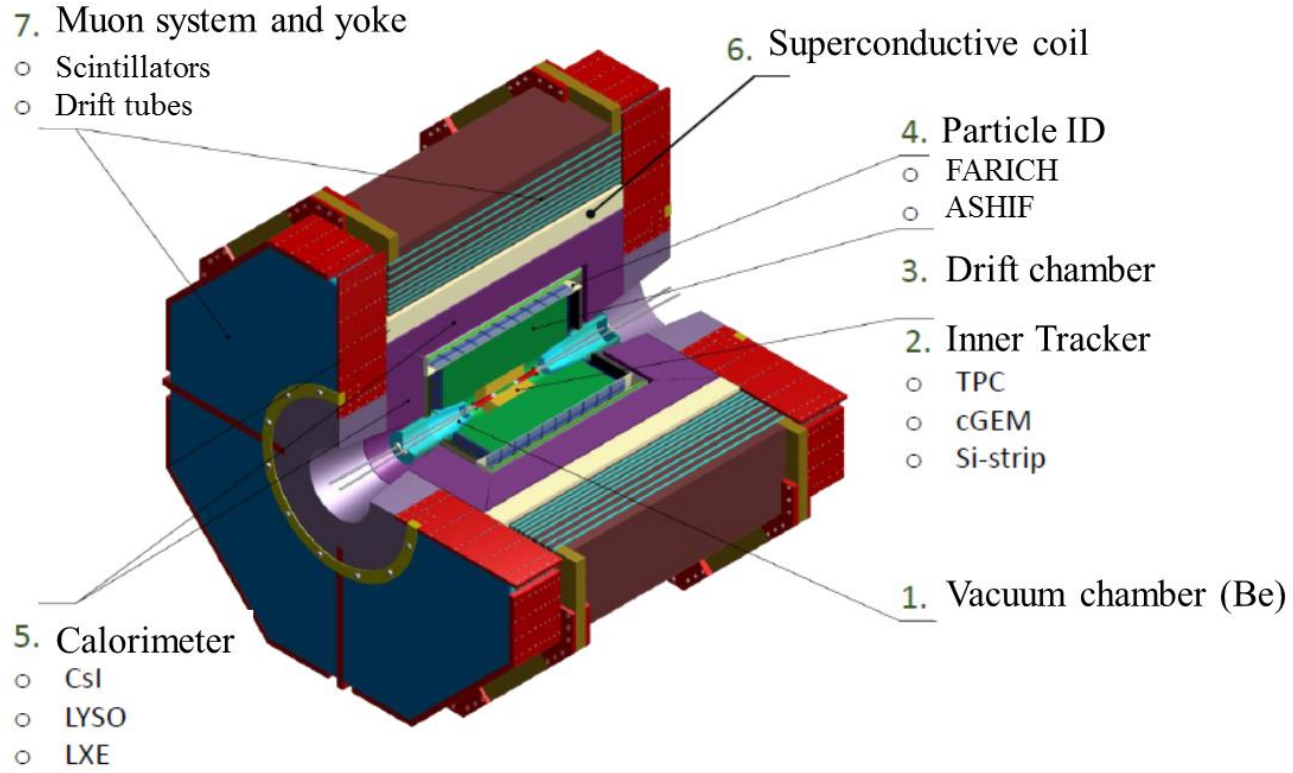

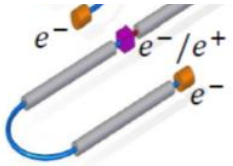

Inner Tracker of the SCTD

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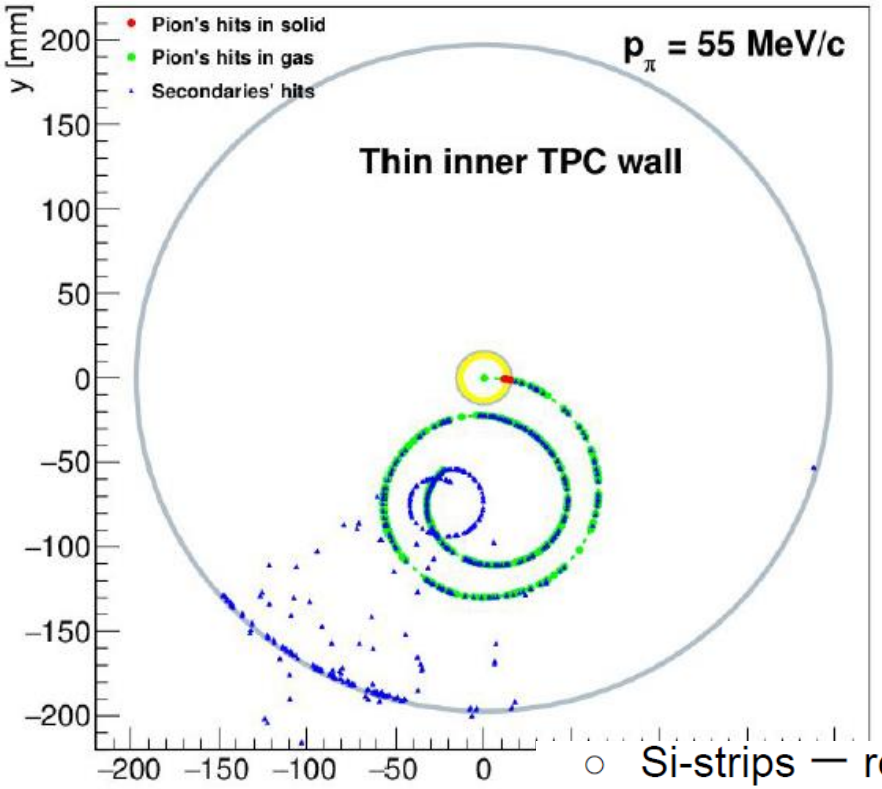
- Cy
- Cy
- Ti



een vacuum chamber and drift chamber

cm

eter 6-10 cm

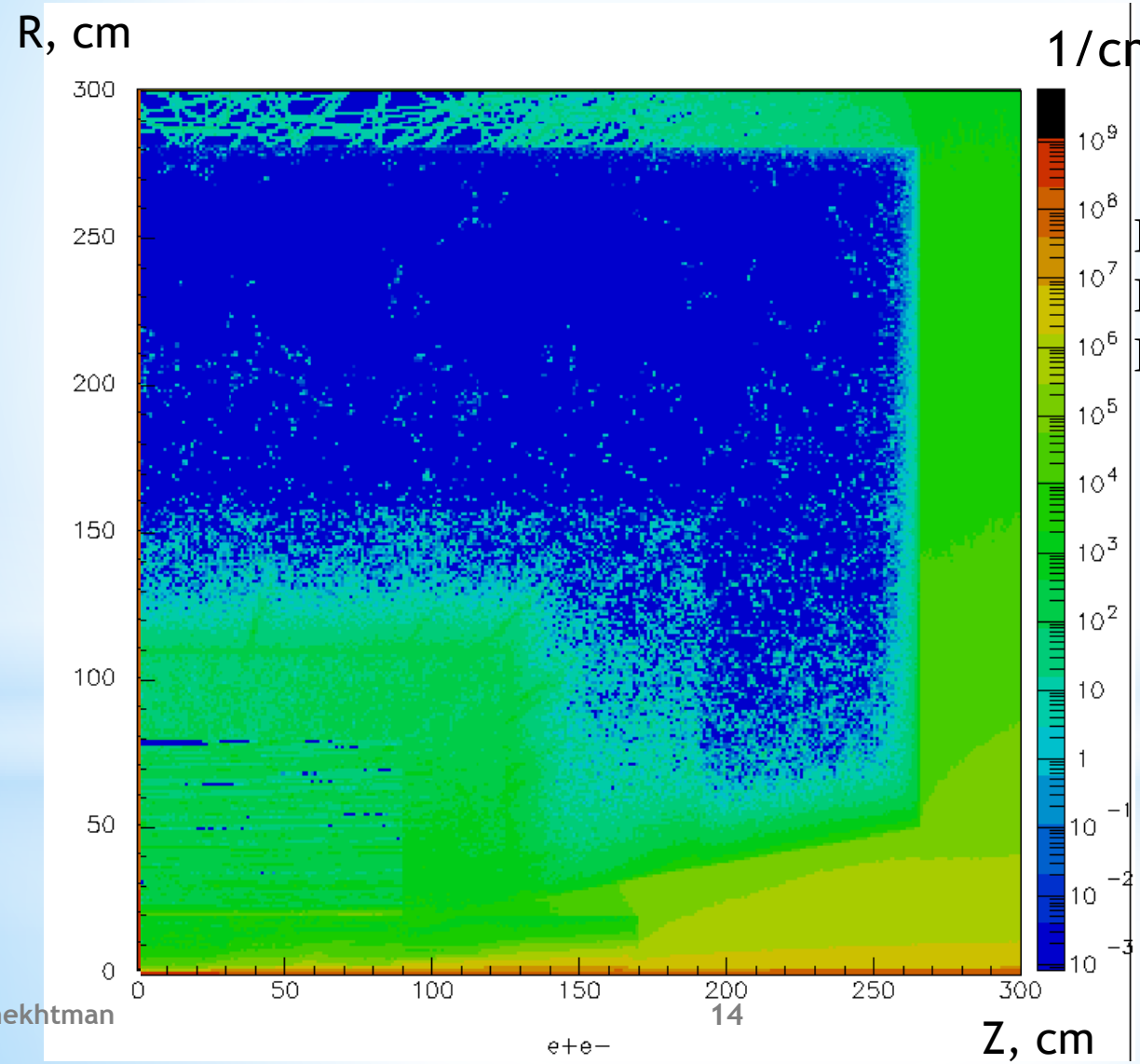
eter 40 cm

- Si-strips — reconstruction for p_π > 65 MeV/c
- CGEM — reconstruction for p_π > 60 MeV/c
- TPC
  - Standard wall — reconstruction for p_π > 60 MeV/c
  - Thin wall — reconstruction for p_π > 55 MeV/c

Electrons & positrons (TPC)

Source: Two-photon processes $e^+e^- \rightarrow \gamma^*\gamma^* \rightarrow e^+e^-e^+e^-$

Radiative Bha Bha $e^+e^- \rightarrow e^+e^-\gamma(n\gamma)$

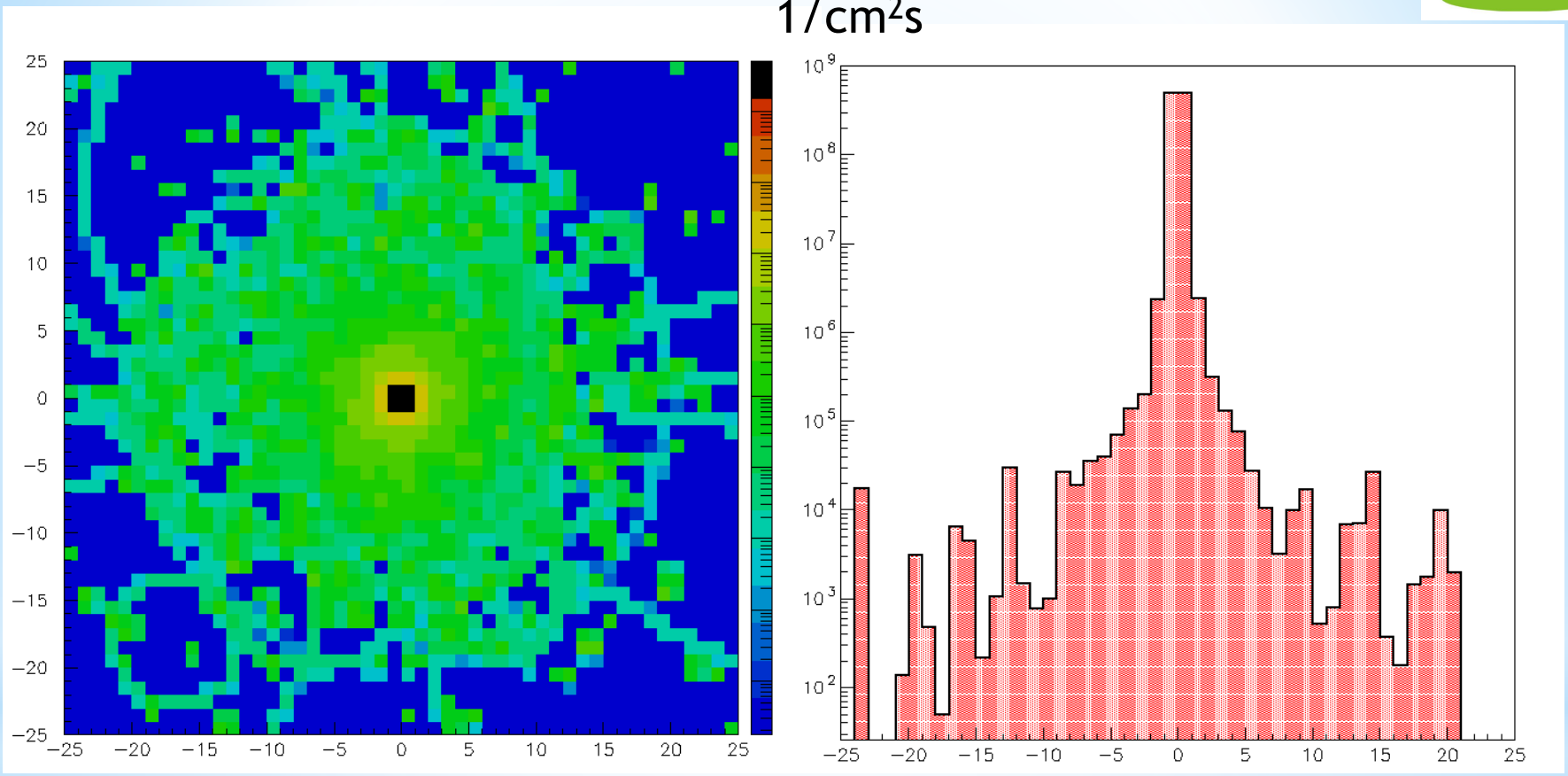


Beam energy – 3 GeV

Luminosity–10^{35} $cm^{-2}s^{-1}$

Magnetic field – 1.5 T

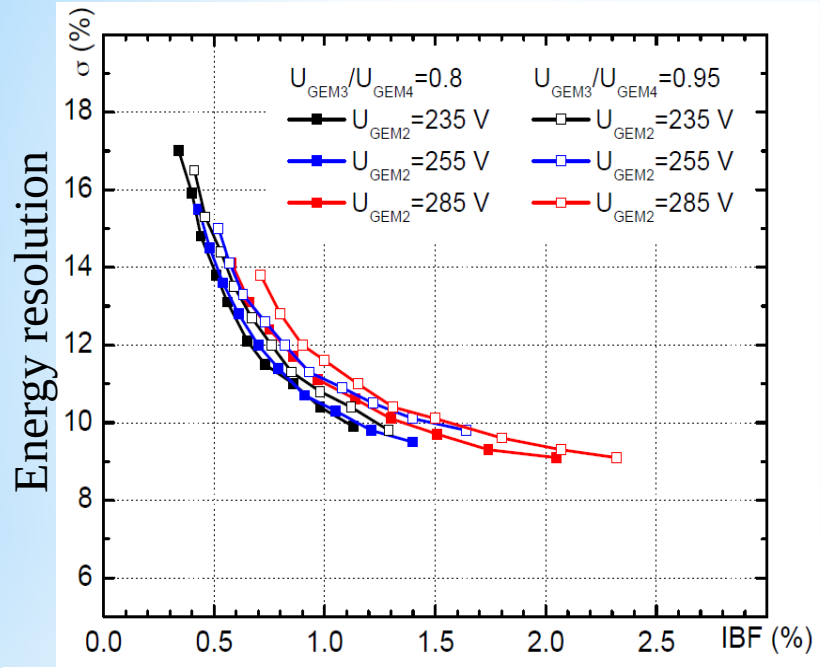
TPC, rates e+e-



10^5- 10^3 particles/cm^2

Ion back flow

ALICE TPC upgrade



2014-03-03 TDR for the Upgrade of the ALICE TPC

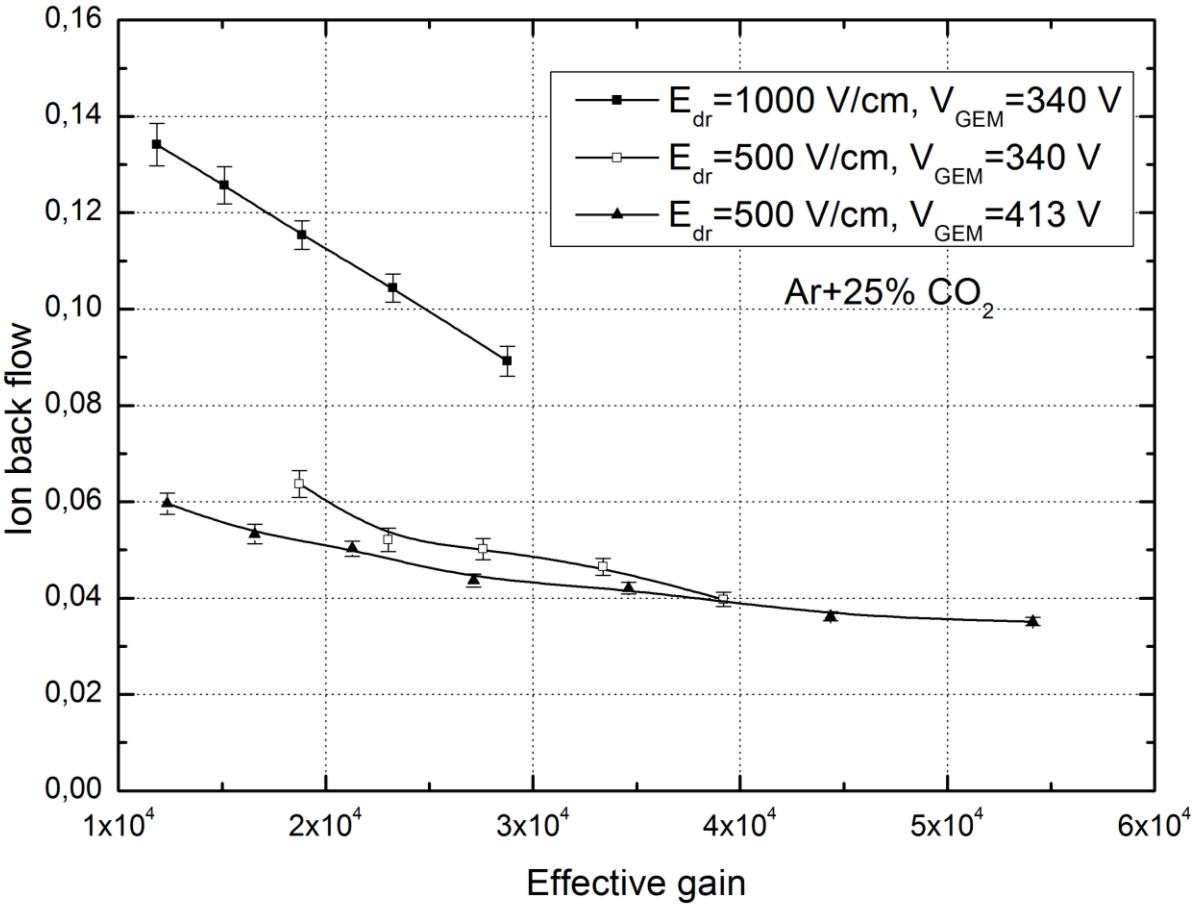
	ALICE TPC	SCTD TPC
Drift path	250 cm	30 cm
Voltage	100 kV	15 kV
Electron drift	100 μs	10μs (500 V/cm)
Ion drift	160 ms	16 ms(500 V/cm)

Estimates of field distortions for:
Flux 10^5 part/cm^{2}s, gain 2000, IBF 1%,
primary charge 50 e/cm, ion drift time 16 ms.

ΔE_Z ~ 75 V/cm
ΔE_R ~ 2.5 V/cm → ΔR ~ 1.5 mm

Quad-GEM, eff.gain = 2000, IBF~1%
Ne-10%CO_2-(N_2), Drift field – 400 V/cm
100 kV at central electrode

Ion back flow in μRWELL+GEM



E_{tr}=3500÷4200 V/cm

Summary

- Two MPGD options are under discussion for the Inner Tracker of Super Charm-Tau Factory Detector: Cylindrical GEM detector and TPC with MPGD-based readout; End-cap discs of ~2 m diameter before the PID system are being discussed.

- First simulations of luminosity generated background show that charged particle rate in the IT region is $10^5 – 10^3$ particles/cm^{2}s.

- Estimates of field distortions and subsequent coordinate displacement in the TPC show that IBF must be further reduced compared to ALICE TPC regime. Field calculations with ion space charge will be performed.

- First measurements of IBF with μRWELL-GEM structure demonstrates that IBF~5% can be obtained at a gain of 10000. Further optimization work will be continued.

Next Conference on
Instrumentation for colliding beams physics
INSTR2020
will be held in Novosibirsk
on February 24 – 28, 2020