Ties Behnke[2], Ralf Diener[1], Lea Hallermann[1], Matthias Enno Janssen[2], Nils Kanning[5]
Alexander Kaukher[4], Krzysztof Komar[2], Diana Linzmaier[3], Peter Schade[2], Oliver Schäfer[4]

1: University of Hamburg — 2: DESY Hamburg — 3: University of Halle
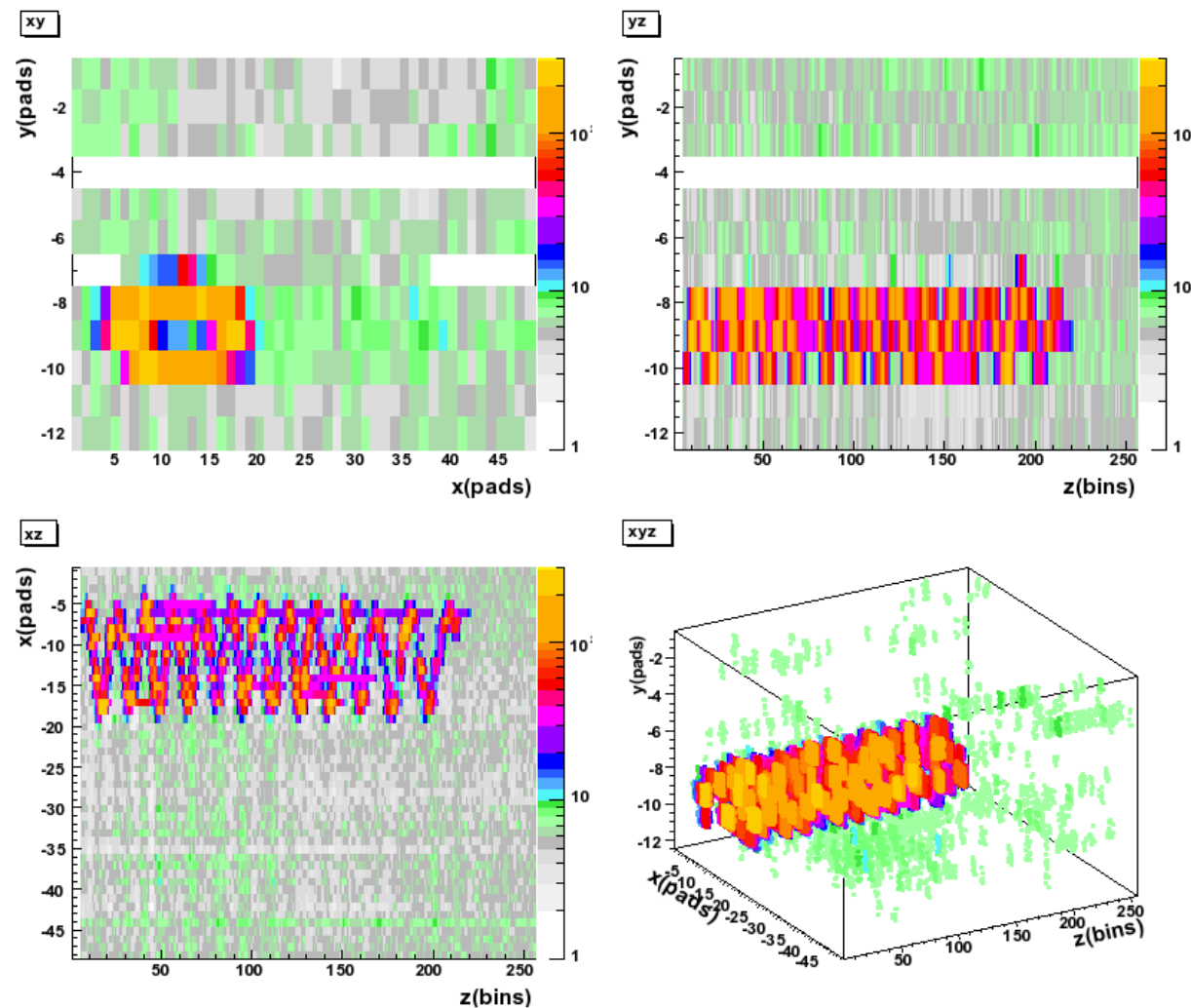4: University of Rostock — 5: University of Göttingen

First Results from New High Magnetic Field Measurements with the MediTPC Prototype

Overview:

- Introduction

- Electron Attachment

- Resolution Studies
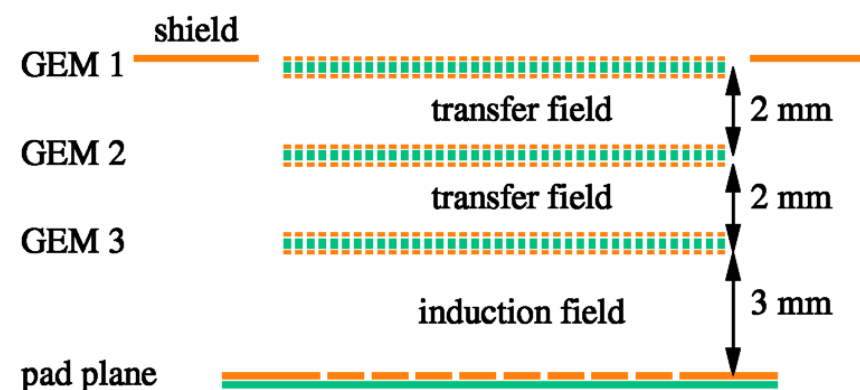
- Outlook

MeditTPC Protoype

- Length: 800mm (sensitive ~660mm), Diameter: 27 cm
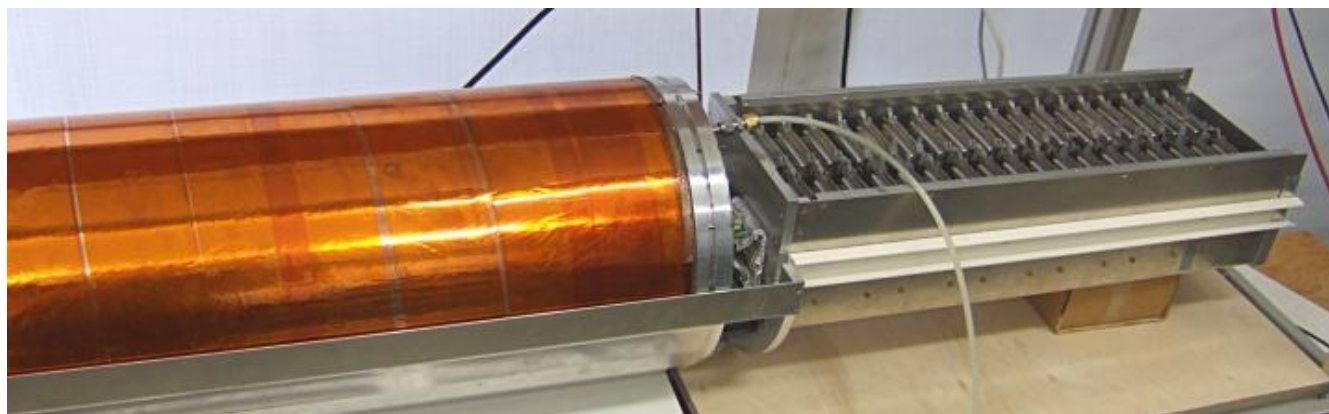
- Read out with ALEPH electronics

- Triple GEM amplification setup:
  - Transfer fields: 1500 V/cm
  - Induction field: 3000 V/cm
  - 320 - 330 V per GEM
    (depending on magnetic field)

- All measurements presented here taken with P5 gas (Ar:CH$_4$/95:5)

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4

Komag Magnet Test Stand

- Magnetic field up to 5.25 T (deviation<7%)

- Data Samples taken up to 4T
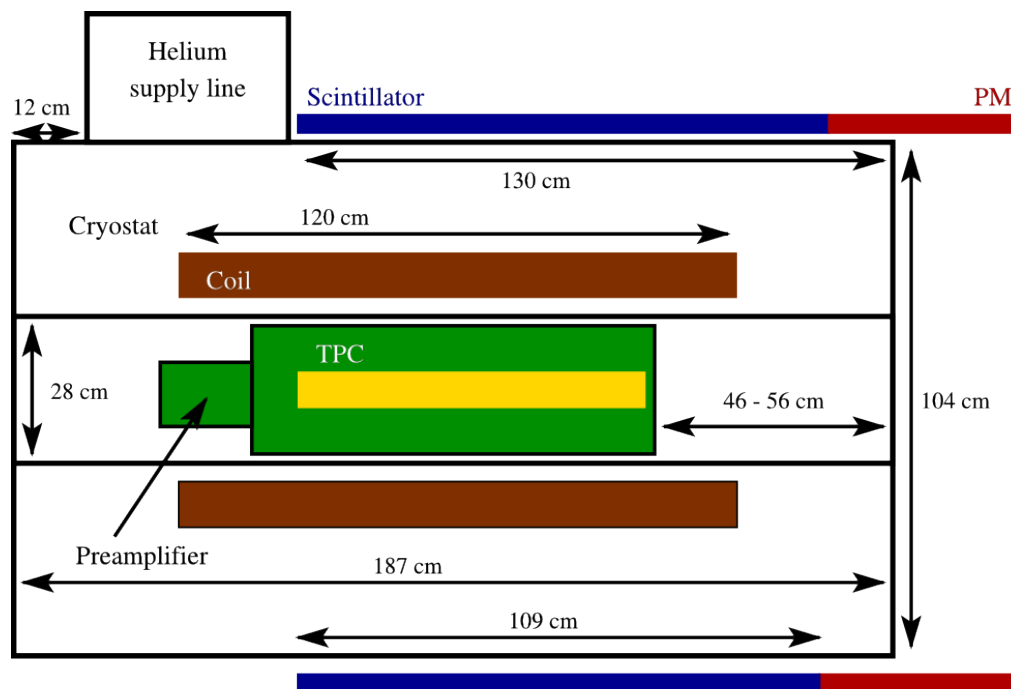
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Side view

Readout Pad Planes

Pitch 2.2x6.2 mm²
in use:
6x22 pads
(= 198 Channels)
3-5 dead channels
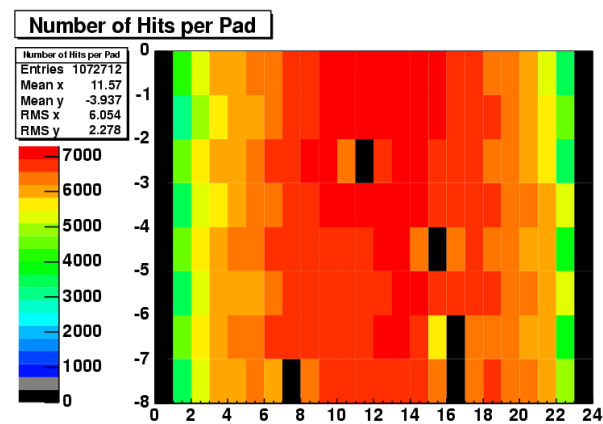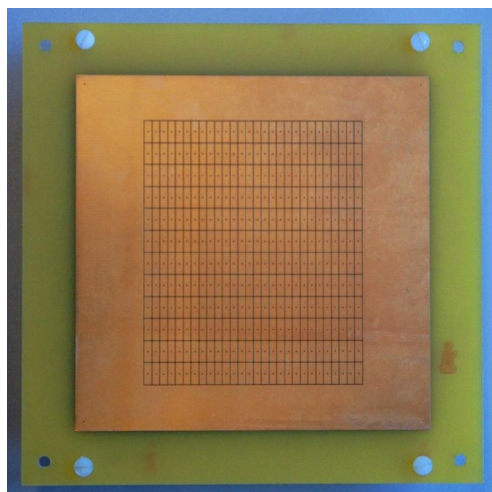
Pitch 1.27x7.0 mm²
in use:
12(11)x48 pads
(= 576 Channels)
3-5 dead channels
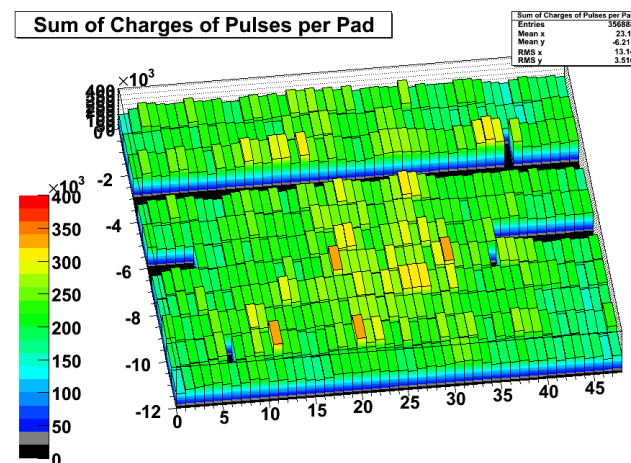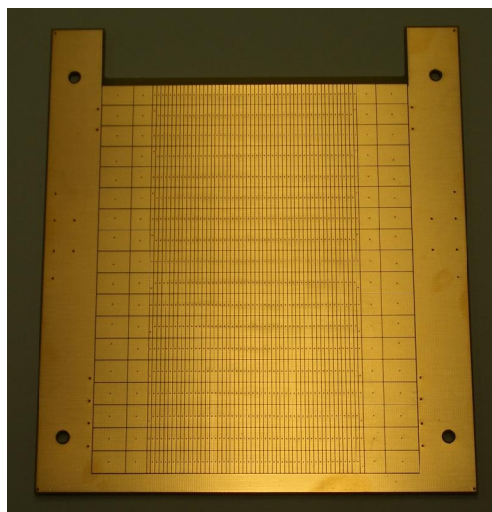
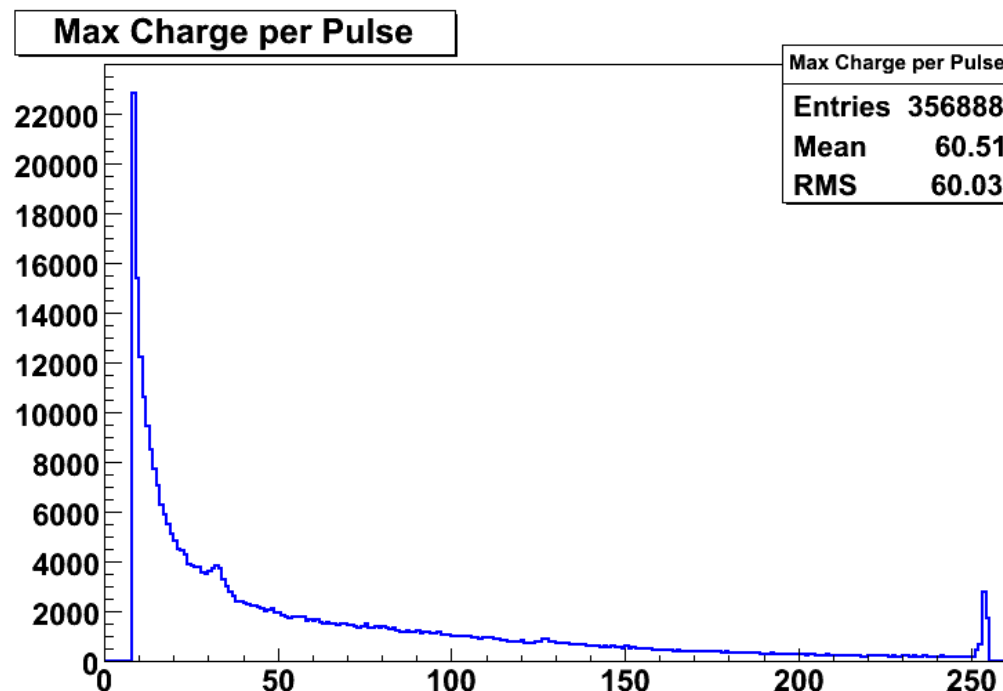Both sizes available with
non-staggered and staggered
pad layout
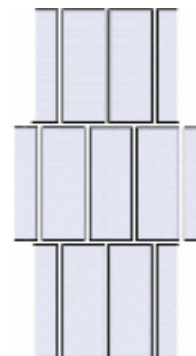
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Measurements Runs

- Amplification settings optimized to minimize charge signals in overflow while maximizing amplification

- Noise level of about:

  - <6/256 ADC counts for large pads

  - <8/256 ADC counts for small pads

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Data Reconstruction

- Data reconstructed with MultiFit software
  (for compatibility with old results):

  - 3 step process:
    HitFinding → TrackFinding → TrackFitting

  - Two implemented track fit methods:

    - Chi Squared Fit
      with the option to use external diffusion and defocussing information
      for Pad Response Function (PRF) correction of hit positions

    - Global Fit with likelihood function
      with the option to use external diffusion and defocussing information
      for stabilizing fit by calculating charge cloud width instead of fitting this
      parameter

- Resolution Calculation with Geometric Mean Method:
  Two residuals calculated for track fit including the point
  and for track fit without the point
  Resolution σ calculated from geometric mean of the width of both residual
  distributions:

$$\sigma = \sqrt{\sigma_{incl.} \cdot \sigma_{excl.}}$$

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Electron Attachment due to Oxygen Contamination

- Drifting electrons can attach to oxygen impurities in the gas and hence the signal will be weaker ($\rightarrow$ loss of primary statistics)

- Number of free electrons: **N(t) = exp(-At)**

- Measured mean hit charge (MPV of Landau distributions) at various drift lengths and for several oxygen concentrations
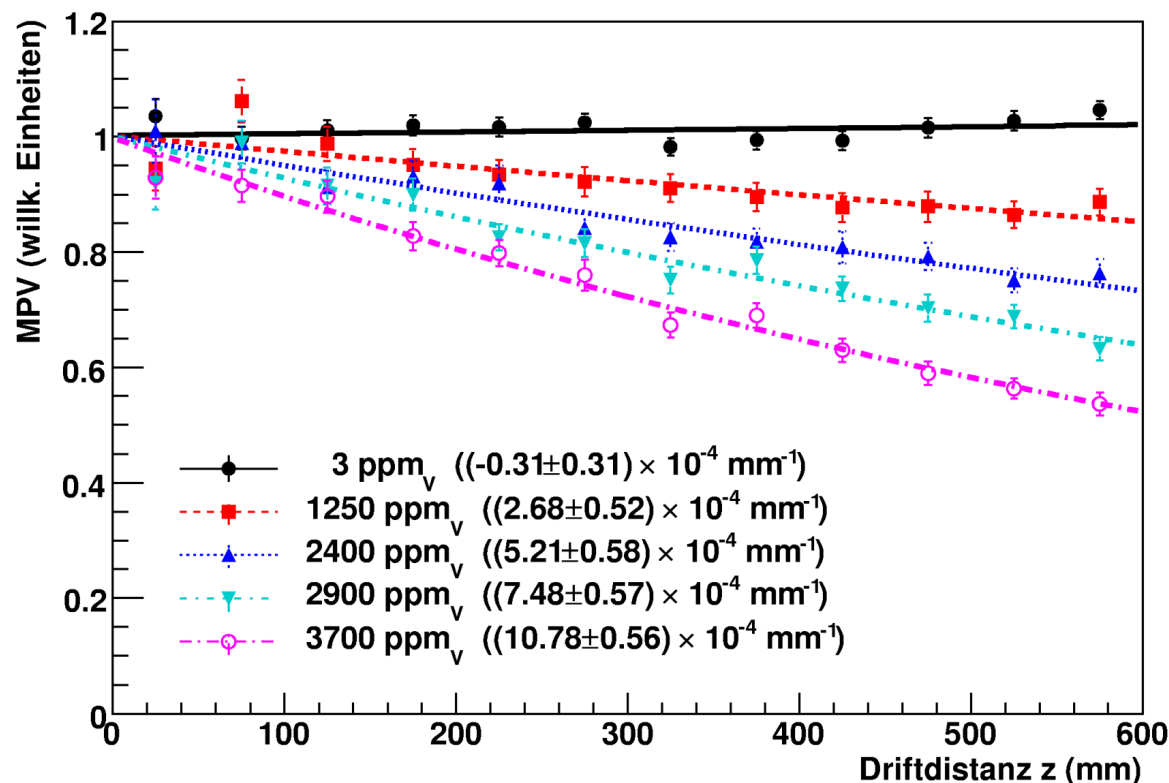
- Influence of oxygen only visible at rather high concentrations of a few hundred ppm$_V$

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Electron Attachment due to Oxygen Contamination

- Number of free electrons: $N(t) = \exp(-At)$

  with attachment rate $A = P(M) \times P(O_2) \times C_{O2,M}$

- Calculated attachment coefficient from measured attachment rate:

Oxygen content [ppmV]	Attachment Coefficient [μs^{-1} bar^{-2}]
3	0
1250	8.56 ± 1.92
2400	8.66 ± 1.08
2900	10.31 ± 0.90
3700	11.64 ± 0.68

- Results comparable to literature: (Ar:CH$_4$/90:10)

  M. Huk et al.,
  "Electron attachment to oxygen, water, and methanol, in various drift chamber gas mixtures",
  Nucl. Nstr. Meth., A267, 1988

[i-butane] [%]	E/P [V/cm bar]	v [cm/ μs]	A [μs^{-1}]	$C_{O_2,M}$ [μs^{-1} bar^{-2}]
0	100	5.36	0.048 ± 0.003	15.1 ± 1.5
	138	5.45	0.034 ± 0.003	10.5 ± 1.4
	163	5.32	0.029 ± 0.003	9.2 ± 1.4
	200	5.07	0.024 ± 0.003	7.4 ± 1.3
	250	4.70	0.019 ± 0.003	5.9 ± 1.1

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Electron Attachment due to Oxygen Contamination

- Comparison with Garfield/Magboltz simulation shows a huge deviation (factor of 100)

- Reason still unknown, but other publications show also deviations (but smaller) of measurement results and simulation
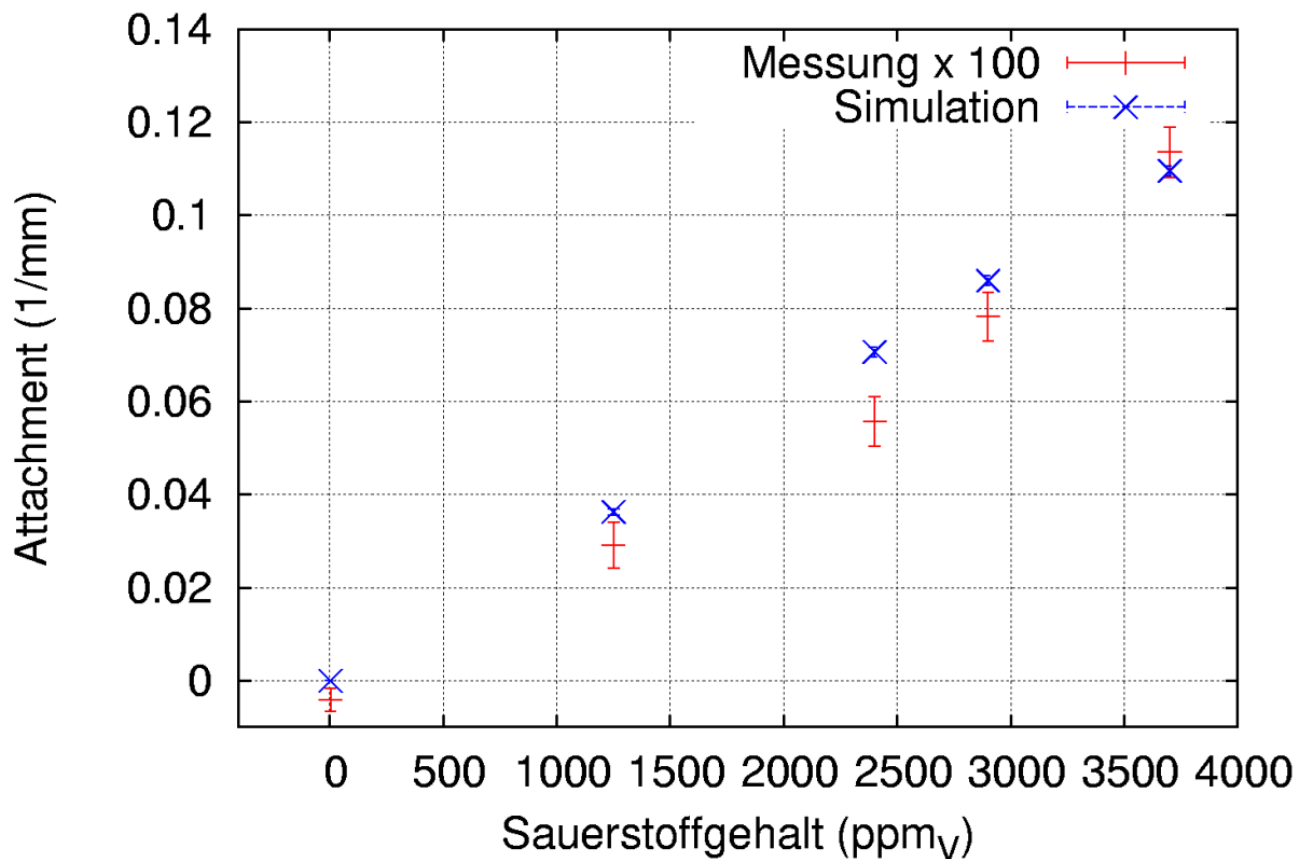
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First Resolution Results with Smaller Pads

Resolution X Total - 1T
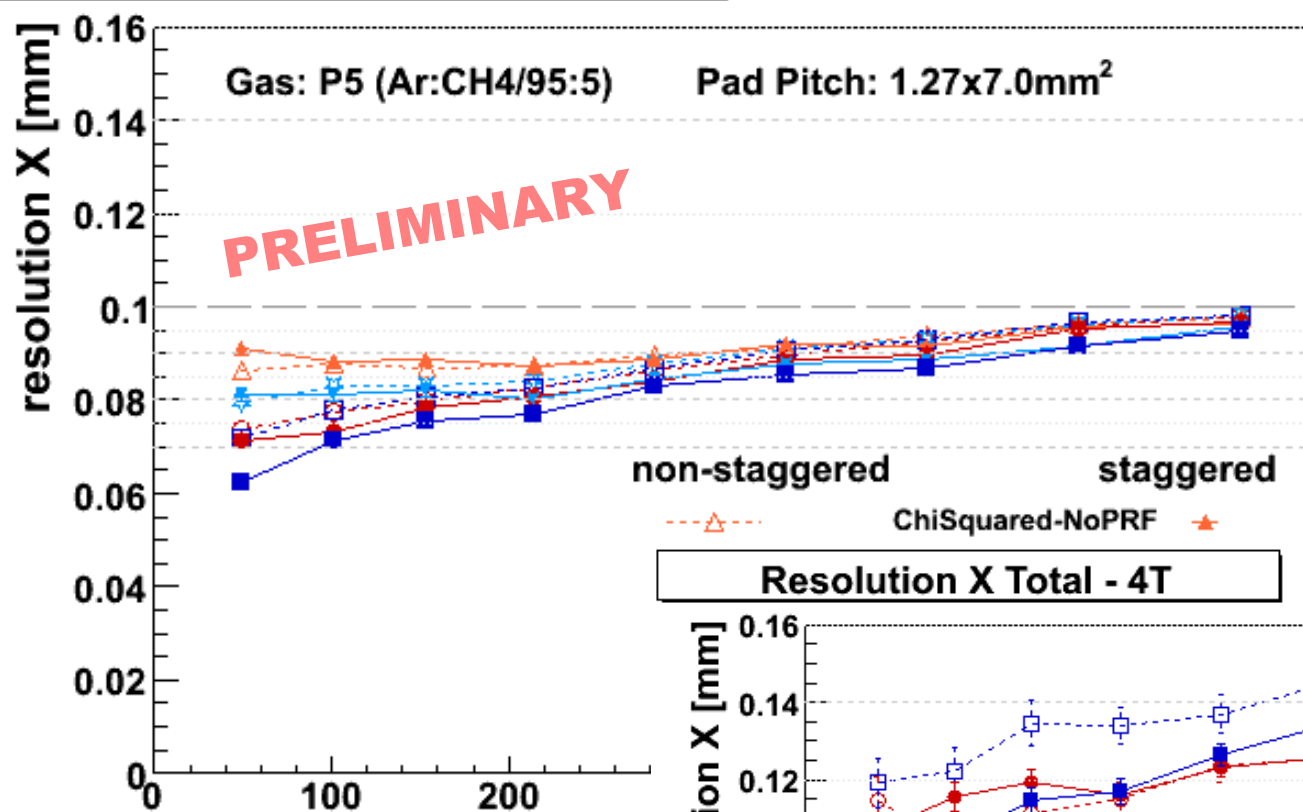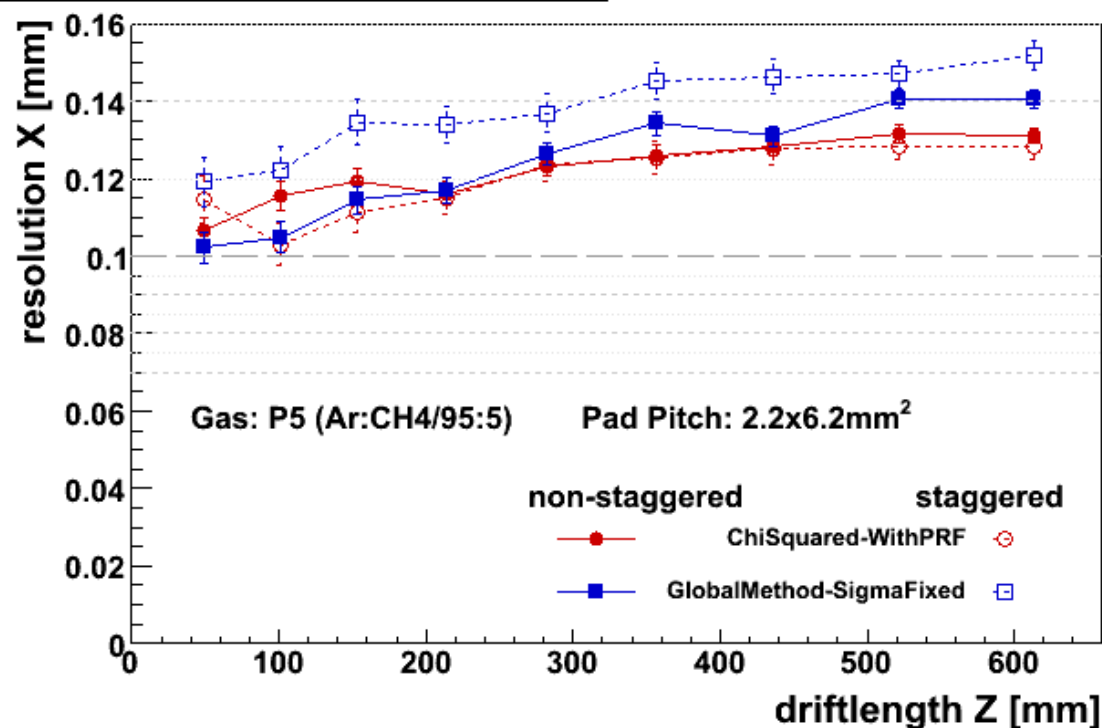
Gas: P5 (Ar:CH4/95:5)   Pad Pitch: 1.27x7.0mm^2

PRELIMINARY

non-staggered	staggered
ChiSquared-NoPRF	
ChiSquared-WithPRF	
GlobalMethod-SigmaFree	
GlobalMethod-SigmaFixed	

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First Resolution Results with Smaller Pads

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First Resolution Results with Smaller Pads
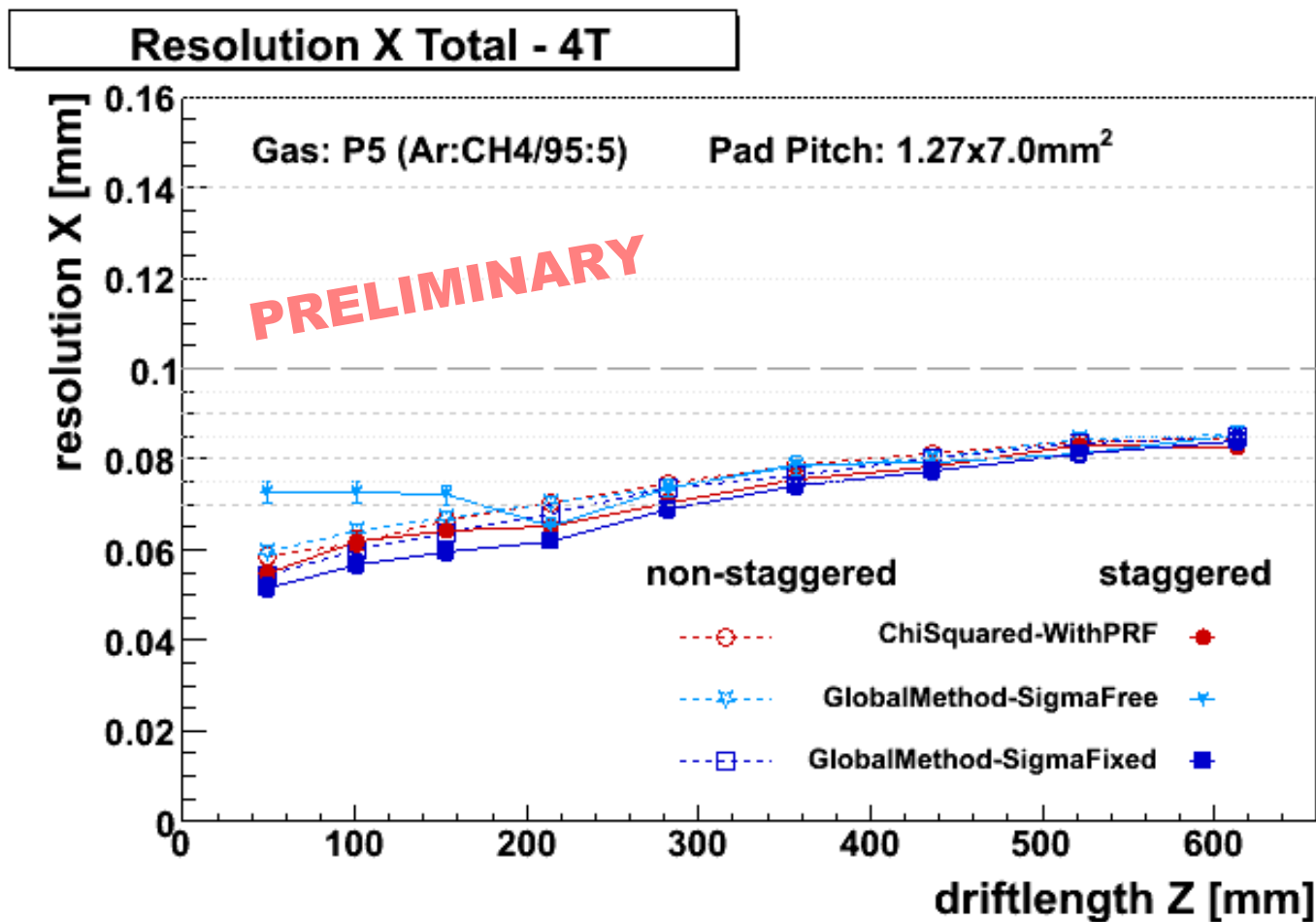
Angle Cut at $|\varphi| < 1.0°$ instead of $|\varphi| < 0.1$ rad (5.73°)

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Conclusion and Outlook

- Electron attachment due to oxygen contamination has been measured and visible effects occur only at contaminations well above the usual amount (up to a few 10 ppm$_V$)

- Understand the reason for the discrepancy in measured and simulated attachment rates

- Small pad size is essential to reach resolution goal at 4T

- Resolution goal of less than 100µm over whole drift length of final TPC is in reach
  (it has been reached for the 660mm length of the prototype)

- Finish the measurements with the small pads

- Get a better understanding of the measured data and optimize reconstruction (especially regarding angle effects)

- Reconstruct data with MarlinTPC and compare results
  $\rightarrow$ testing, improvement and further development of MarlinTPC

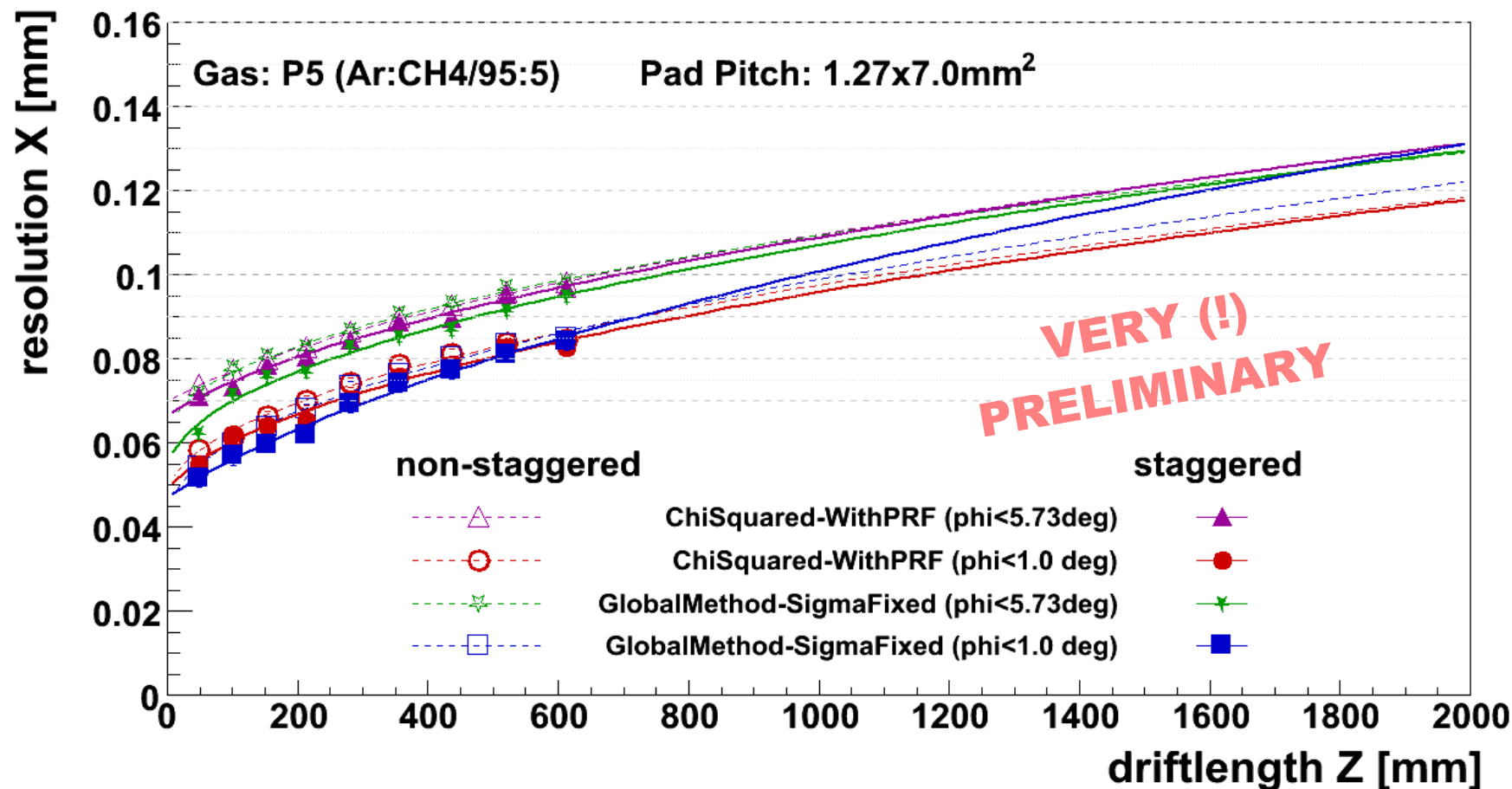- Examine the possibilities to limit drift length dependent diffusion (gas mixture, field settings)

Appendix:
First Resolution Results: Extrapolation to 2m Drift

Angle Cut at |φ| <1.0° and |φ| < 0.1rad (5.73°)

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