# Effects of a 20 MeV Proton Beam on Drift-tubes with 15mm Diameter

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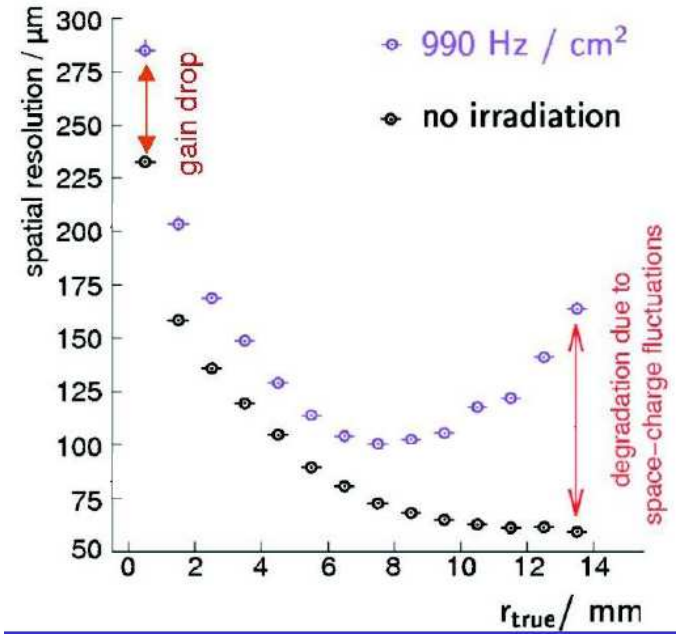
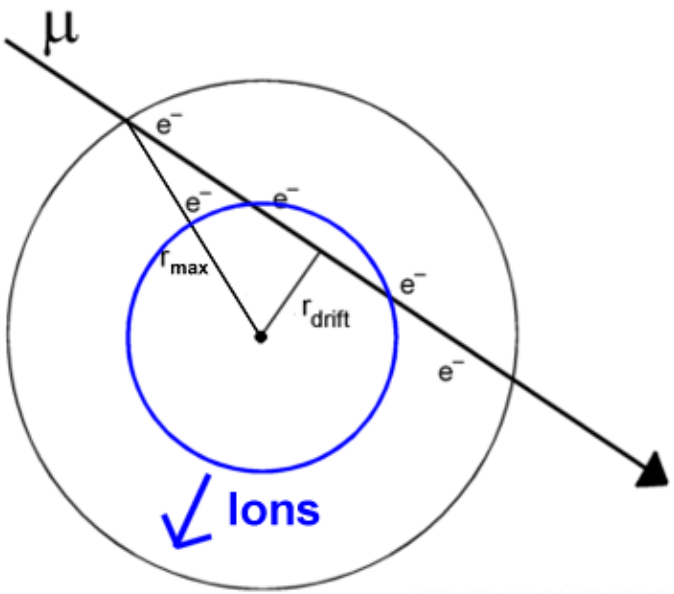
# Spatial Resolution at High Background Rates (High Luminosity LHC)

GIF 2005, 662 keV γ,
**30mm** tubes




Space Charge Effects

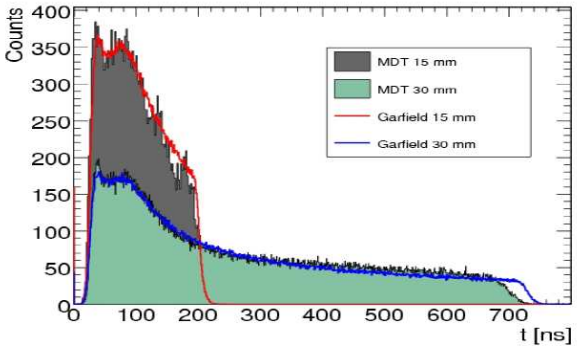


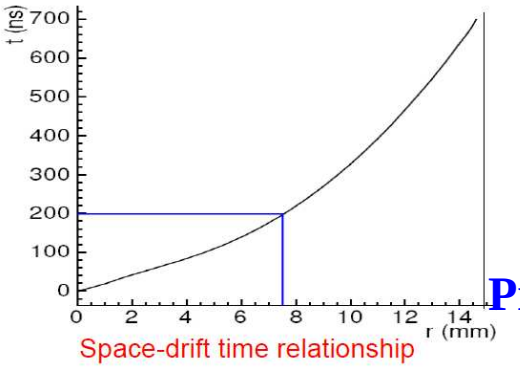

**15mm** tubes

- $D_{tube}$ = 15 mm
- $D_{anode}$ = 50 µm
- U = 2730 V
- Ar:$CO_2$ 93:7
- 3000 mbar
- $t_{max} \cong$ 180 ns
- $t_{Ion} \cong$ 1 ms

# 15mm Drift Tubes

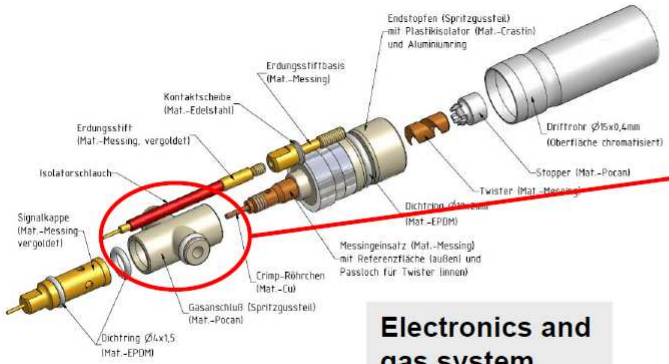
- Prototype chamber production at MPI Munich
- No mechanical or electrical problems with the higher tube density
- Full-scale prototype chamber with 1152 tubes successfully tested




Space-drift time relationship

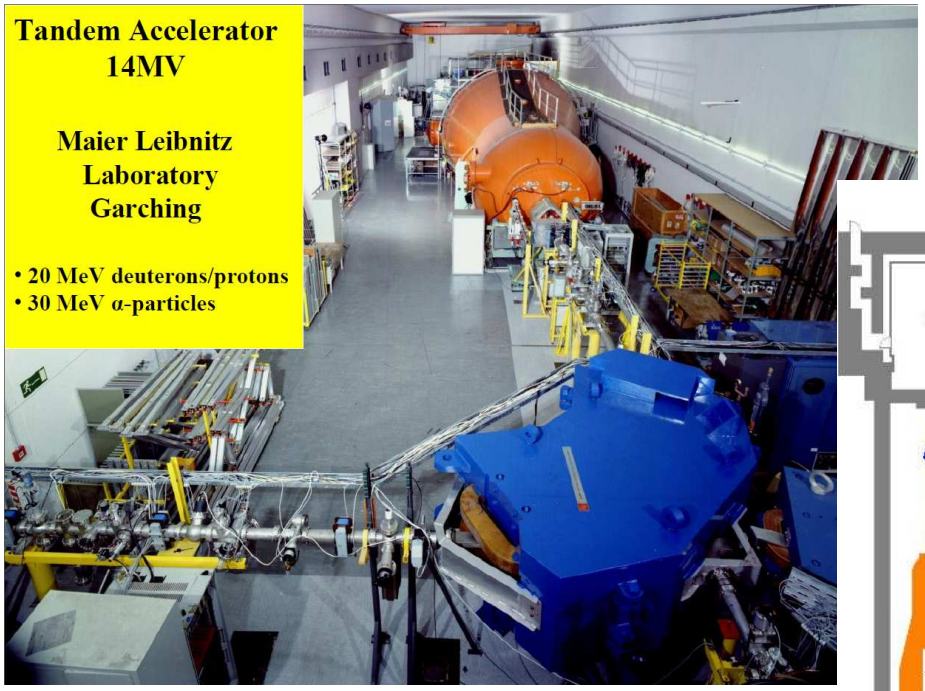
**Pictures: H. Kroha, MPI Munich**



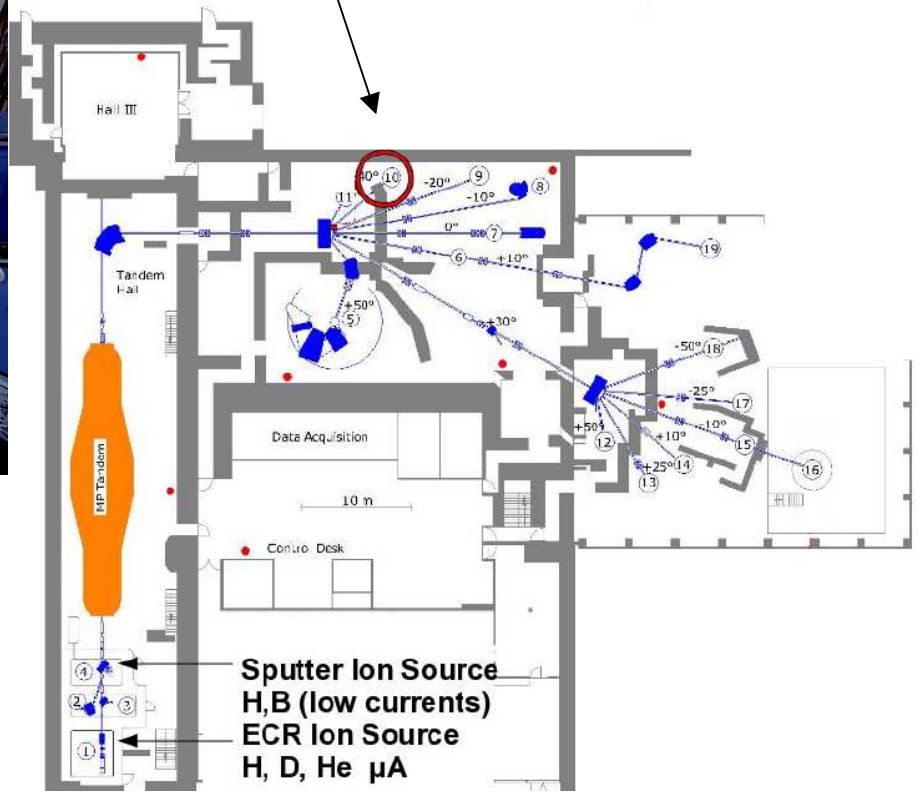

**Electronics and gas system interfaces**

**Gas distribution system**

# MLL Tandem Accelerator



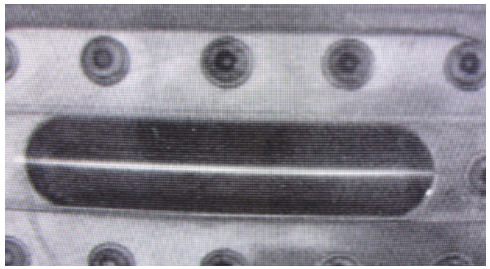

Experiment location

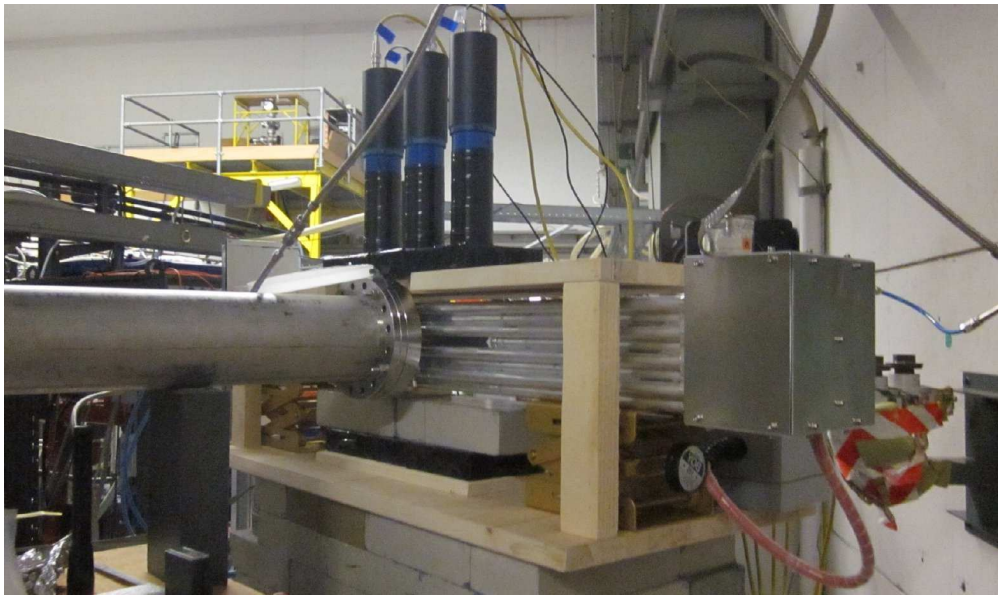


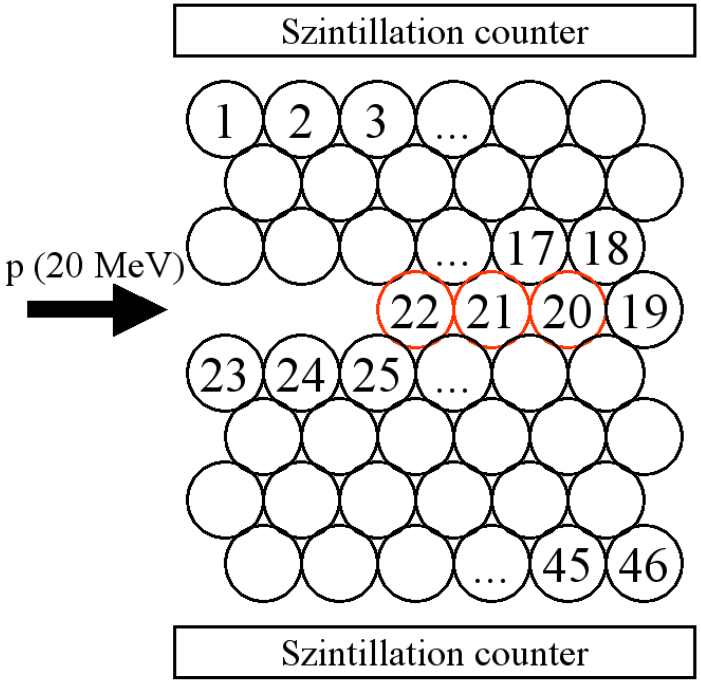
# Experimental Setup at Garching Tandem Accelerator

- Beam Spot 7 x 0.5 cm² @800 Hz (Wobbler)
- $\Delta E_{proton} \cong 200$ keV/tube
- $Rate_{proton} \cong 0$ Hz, ~200 kHz, ~1100 kHz, ~1300 kHz /tube
- $Rate_{proton} \cong 0 \frac{kHz}{cm^2}, 19 \frac{kHz}{cm^2}, 105 \frac{kHz}{cm^2}, 124 \frac{kHz}{cm^2}$

70 mm, 800 Hz

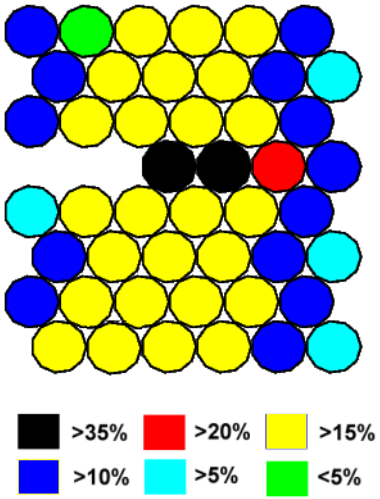


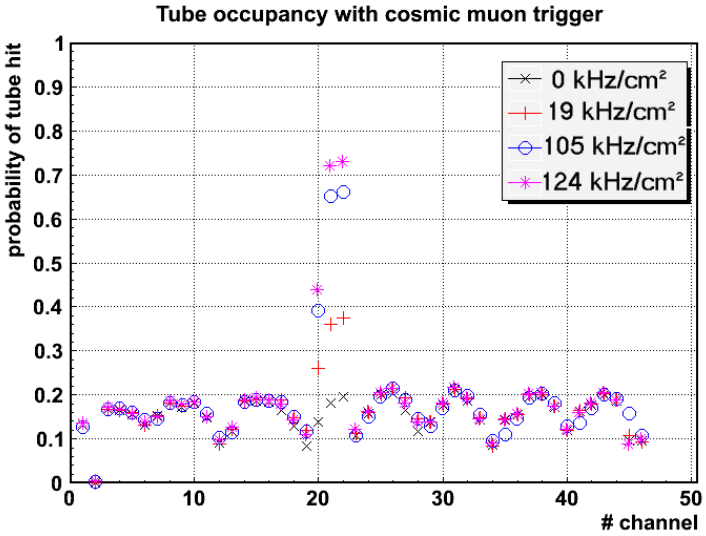


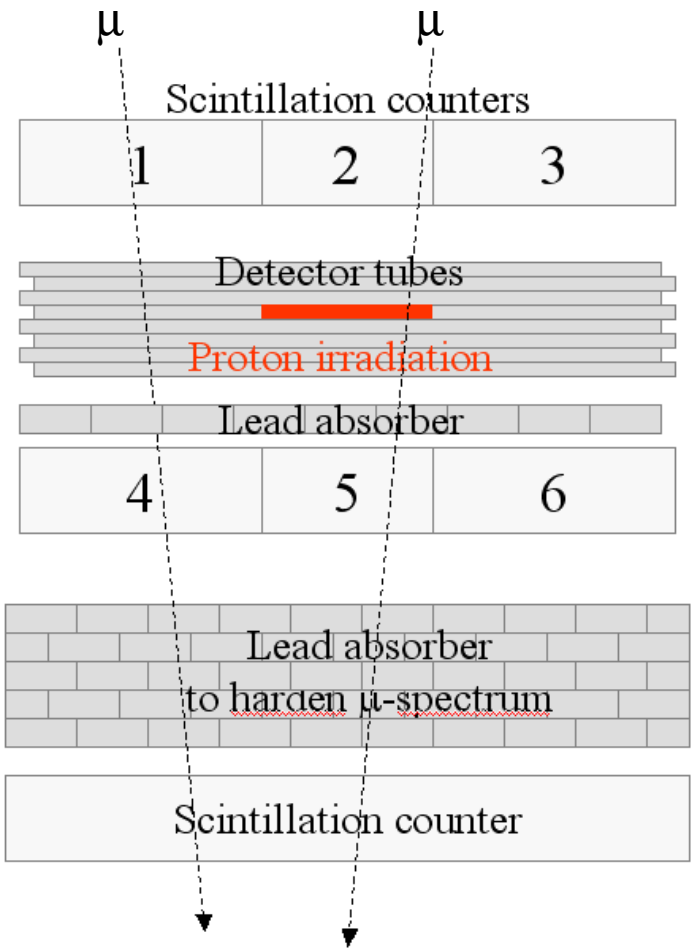


# Experimental Occupancy Distributions

- Three-fold muon trigger scintillators to identify tracks through the irradiated area (Scintillator combinations 1-6, 2-5, 3-4)
- Only the fourth layer is hit by protons



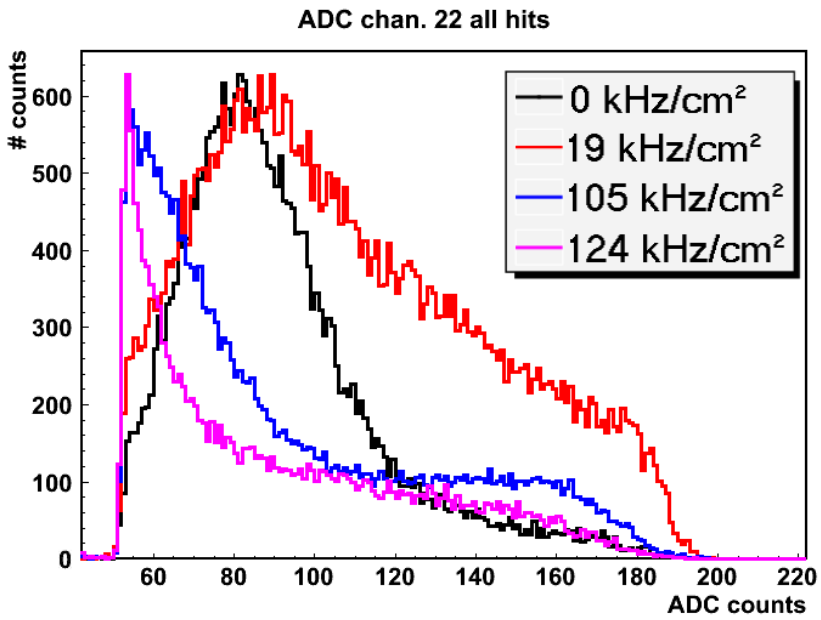



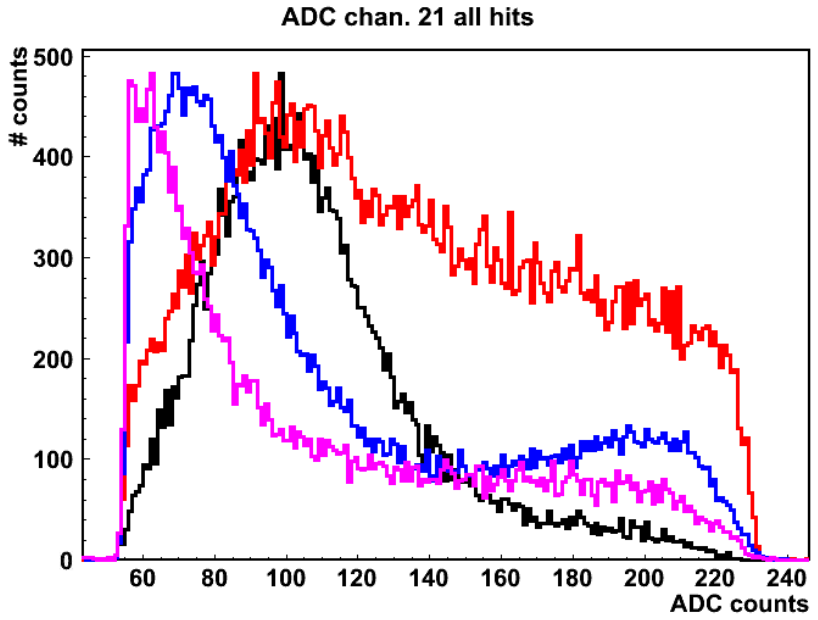
# Pulse Height under Irradiation

• Landau-like Signal height distribution for muons @no irradiation

• High proton signals at 19 kHz/cm² kHz irradiation (non-linear ADC-scale), muon peak position unchanged

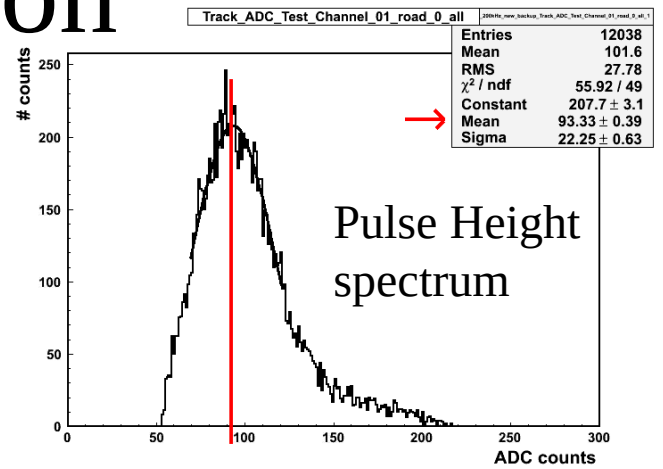
• Shift of whole spectrum at highest rates, drop of gas amplification due to **space charge effects**

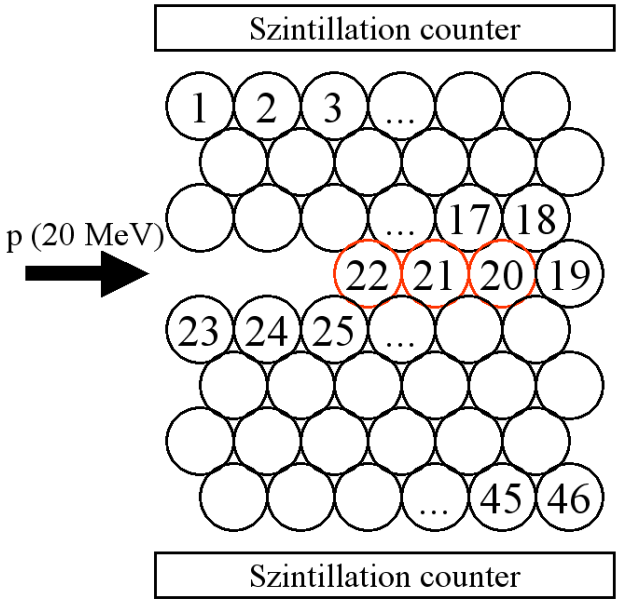


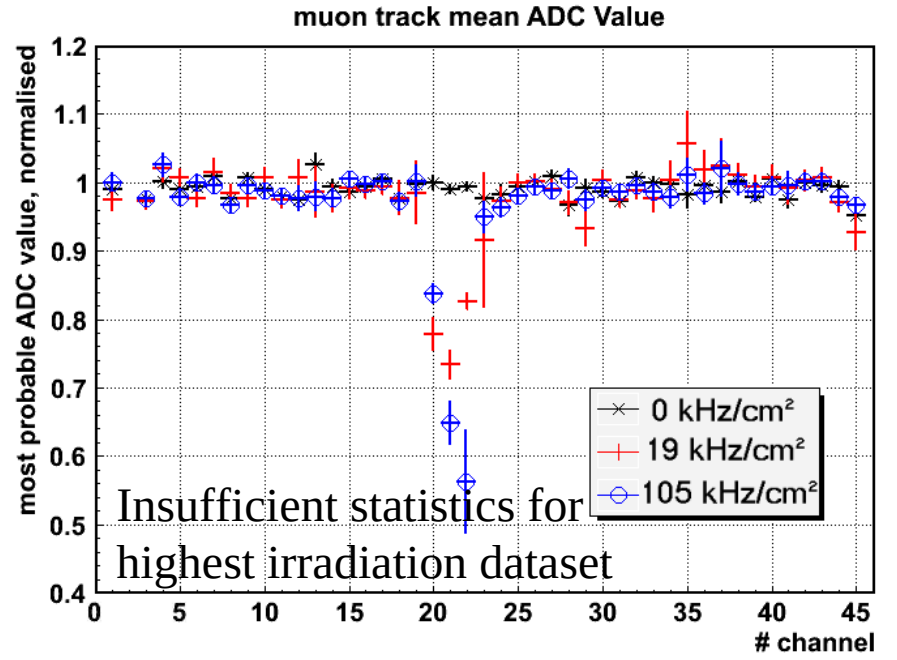



# μ-ADC Values for μ-Tracks under Irradiation

- ADC Values for reconstructed muon tracks
- Position of most probable value in ADC spectrum defines gas gain
- Normalised to non-irradiated tube section

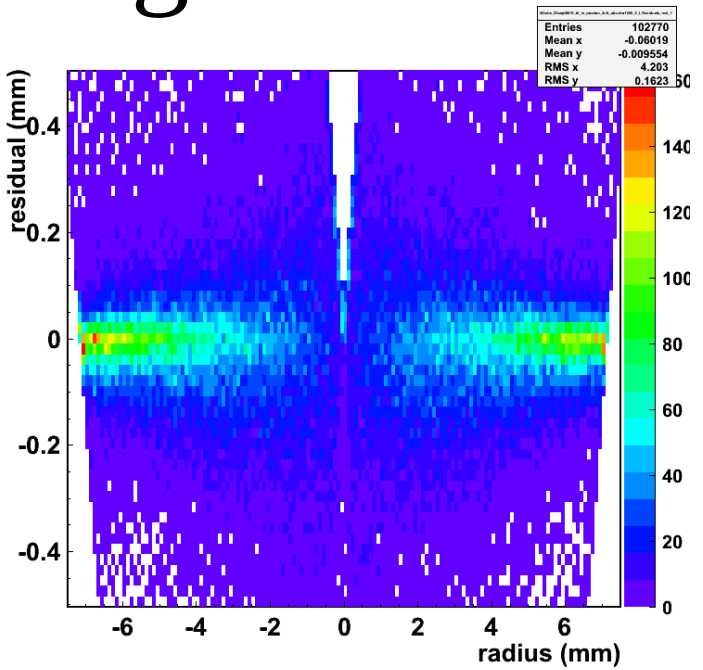


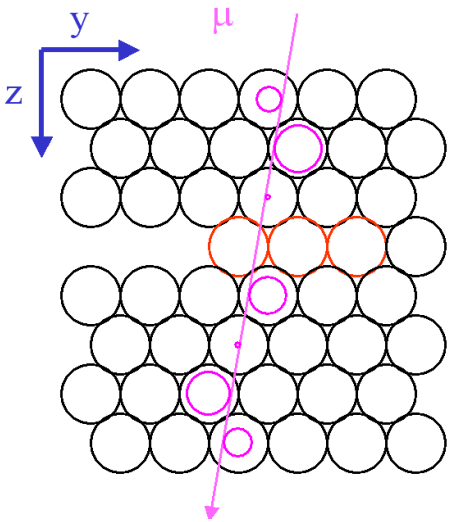



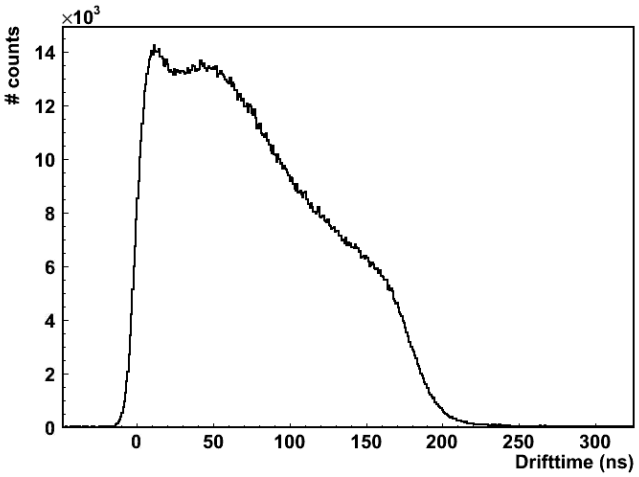



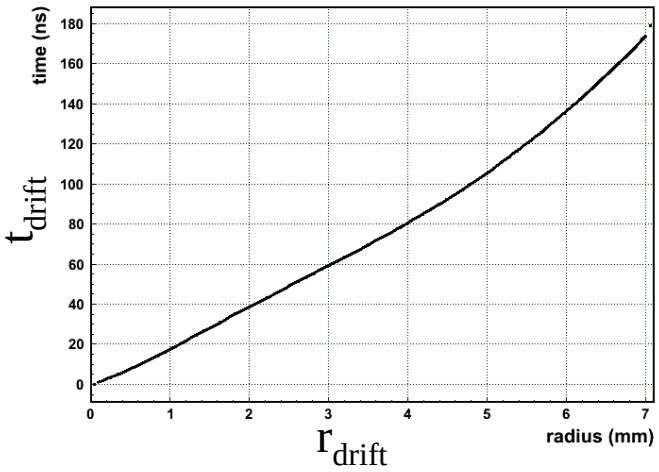
# Muon Tracking

- no proton irradiation
- y = a * z + b
- Track: 7 layers in Fit, $chi^2/N_{df} < 10$
- Residual = (track distance - measured radius)



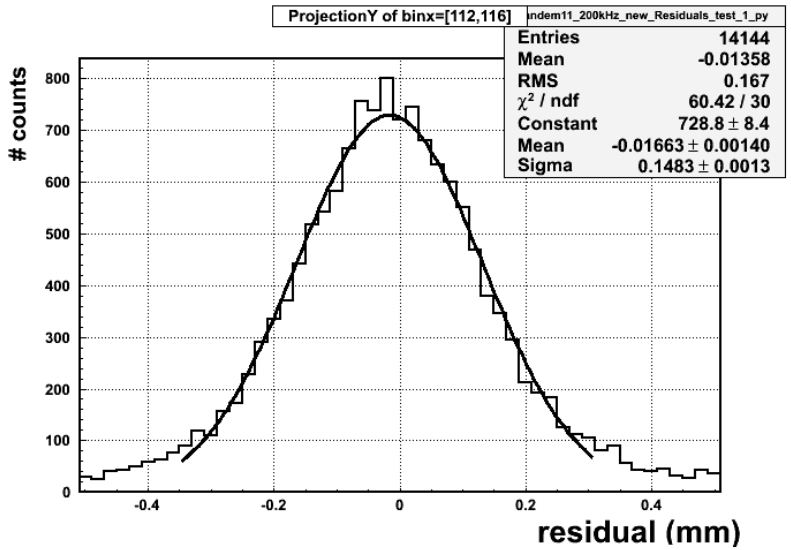



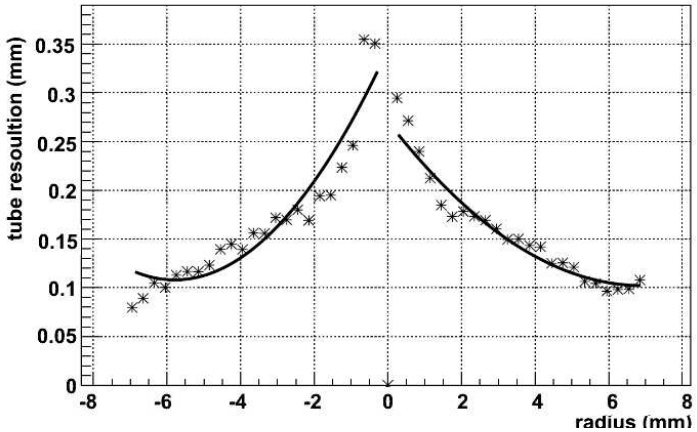



# Spatial Resolution

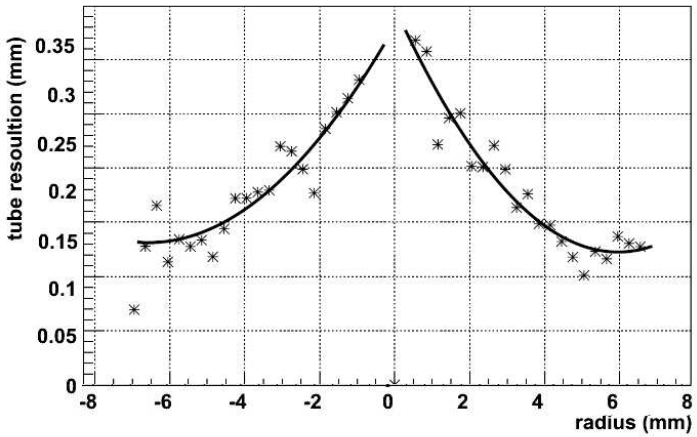
- Determination of spatial resolution:
  - Slice in residual distribution
  - Gaus fit to slice -> Sigma
  - subtract error of track prediction
- No significant change in spatial resolution with and without irradiation




Tube resolution @0 kHz/cm²




Tube resolution @19 kHz/cm²



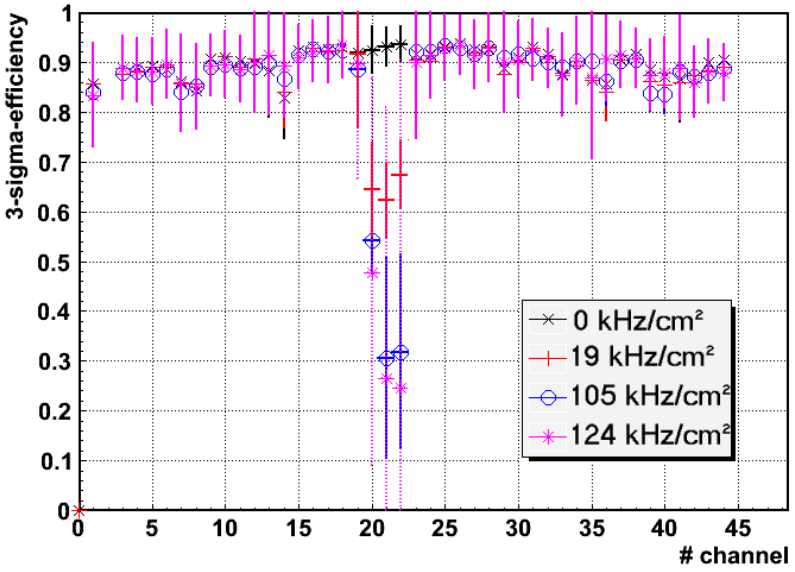
# Efficiency of irradiated tubes

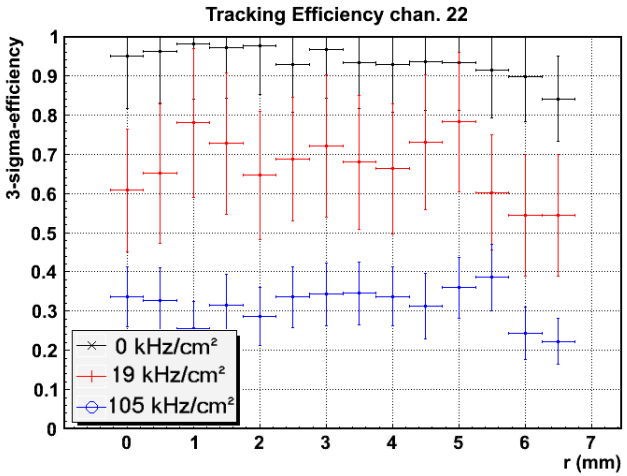
• Compare μ-Track prediction through 7 non-irradiated layers with driftradius in irradiated layer

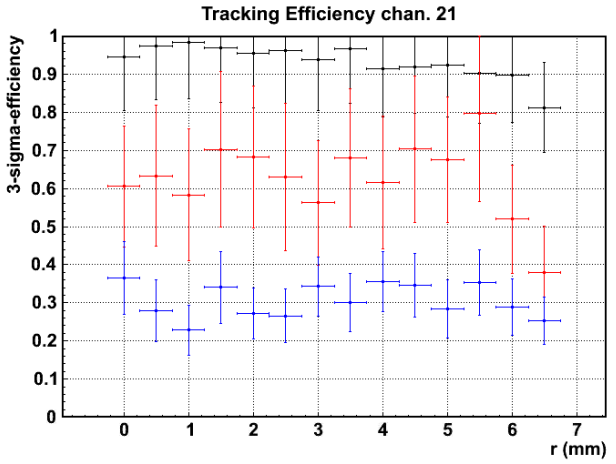
•3-sigma-efficiency: percentage of hits with residual smaller than 3 times the spatial resolution

• Efficiency drops with higher proton rates

• Possible reasons: space charge fluctuations, electronic deadtime



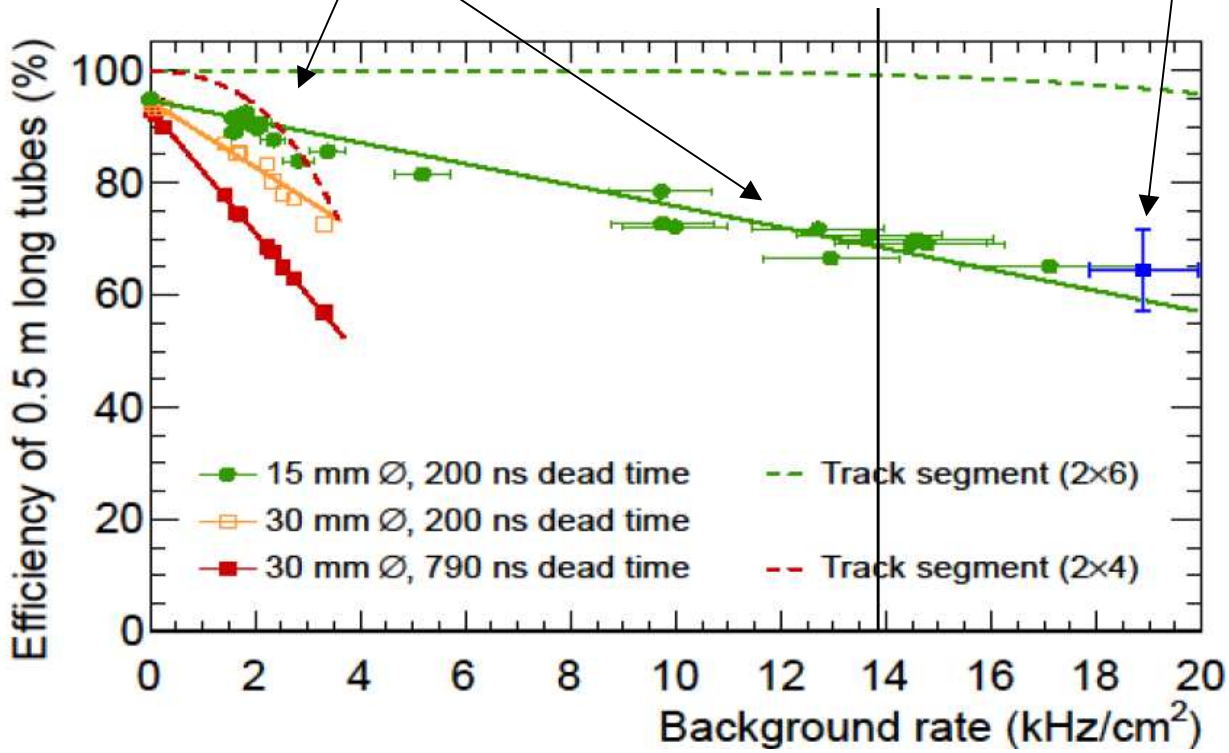



# Comparison of measurements

2010/11 GIF measurements

2011 Tandem measurement
100cm tubes, 200kHz proton beam




**Picture: H. Kroha, MPI Munich**

# Summary

• Garching MLL Tandem accelerator: 20 MeV proton beam to simulate high luminosity LHC environments.

• 200 kHz irradiation equals ~19 kHz/cm², about two times the expected hitrate expected at high luminosity LHC. The higher irradiations used exceed this rate by a factor of 10 – 12.

• Irradiation shifts ADC spectrum to lower values due to space-charge effects.
19 kHz/cm²: ~20 % effect.

• Minor effect on spatial resolution at 19 kHz/cm².

• A chamber of eight layers of 15mm tubes delivers a sufficient muon tracking efficiency for ATLAS.
Track segment efficiency > 95 % @19 kHz/cm²
> 99 % @10 kHz/cm² (High luminosity LHC)

• The results are in agreement with the results of measurements
at the Gamma Irradiation Facility @CERN.