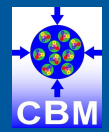
Ceramic Resistive Plate Chambers for High Rate Environments

RPC Workshop 2012, INFN

Alejandro Laso

9th February 2012



Overview of Ceramic Timing RPCs

- ceramic electrodes
- ceramic RPC @ HZDR
- ToF test with electrons: ELBE
- ToF test with protons: COSY
- detector results
- conclusion

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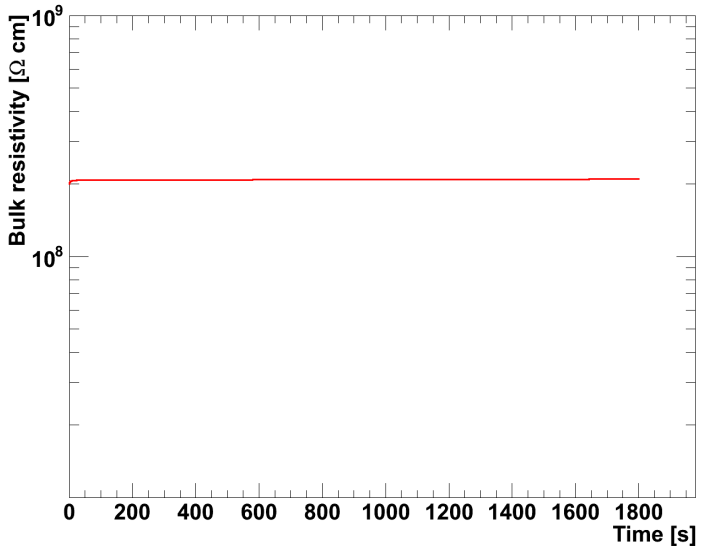
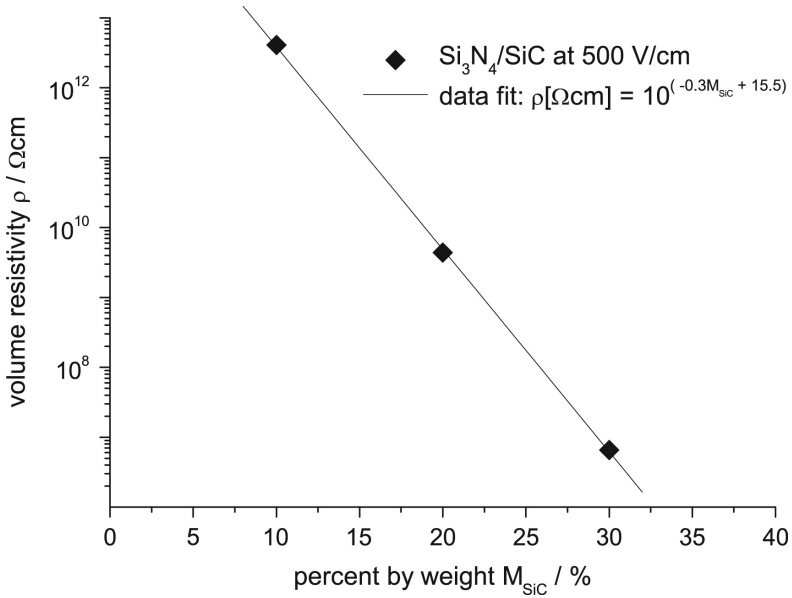
Ceramic Electrodes

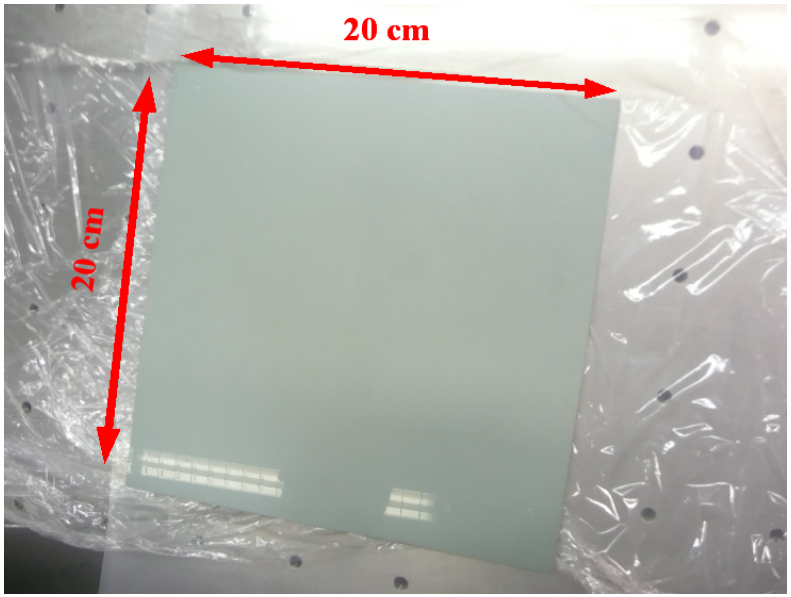
- Si_3N_4/SiC composite
- bulk resistivity range: 10^7-10^{12} Ω cm
- bulk resistivity selectable by modifying SiC component

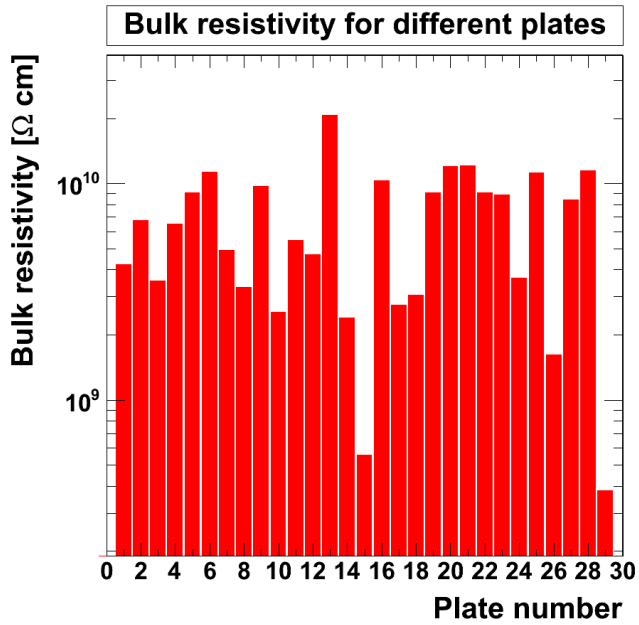




L. Naumann et al.,
NIM A 628(2011)138

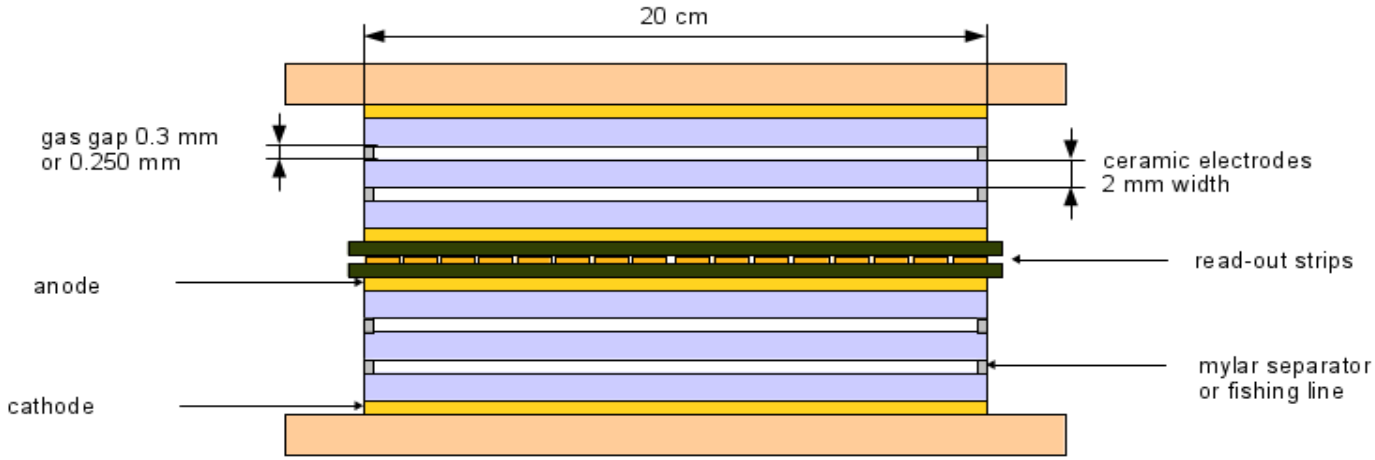
Ceramic Electrodes





$< \rho >$	$(6.89 \pm 0.84) \cdot 10^9\ \Omega\,\mathrm{cm}$
ϵ_{static}	25
ϵ (0.1<f<5 GHz)	12.2 ± 0.03
tan δ (0.1<f<5 GHz)	0.030

Ceramic RPC @ HZDR



schematic not to scale!

10x10 cm^2 prototype

- $\rho \sim 10^9\ \Omega\,cm$
- four gaps of 300 μm
- mylar separator

20x20 cm^2 prototype

- $\rho \sim 4{\cdot}10^9\ \Omega\,cm$
- four gaps of 250 μm
- fishing line

gas mixture 85% $C_2H_2F_4$ + 10 % SF_6 + 5 % iC_4H_{10}

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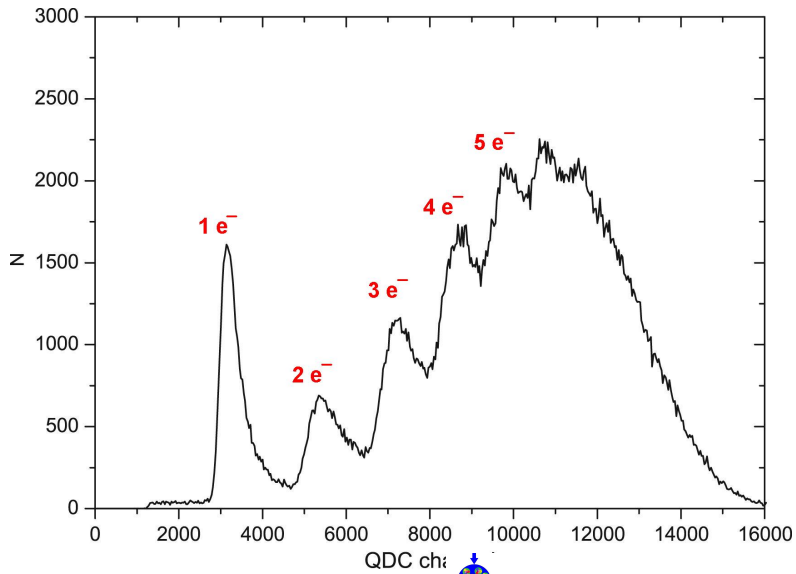
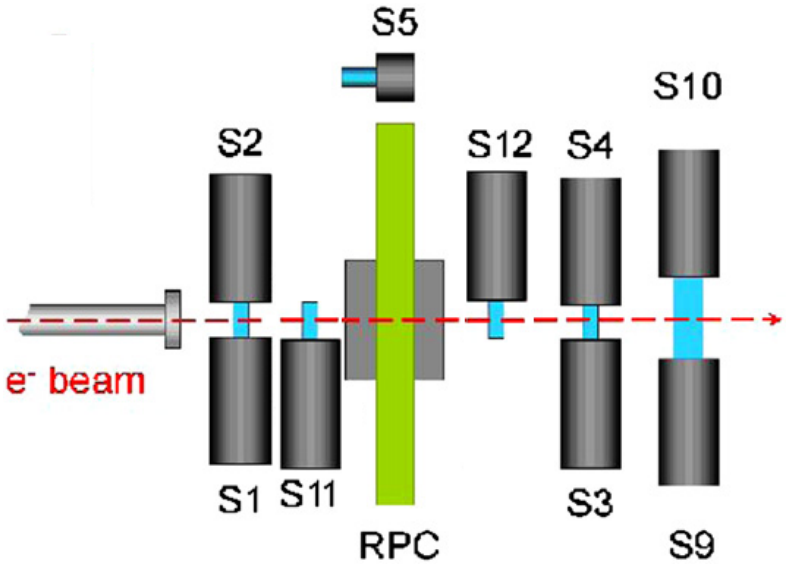
ToF Detector Test Facility: ELBE

- Electron Linac for beams with high Brilliance and low Emittance
- electron beam energy: 30 MeV
- pulse duration: 5 ps
- pulse repetition rate: $26/2^n$ MHz
- single electron mode

L.Naumann et al.,
NIM A 635(2011)113
ELBE User Facility:
http://www.hzdr.de/db/Cms?pNid=145
See talk by M. Roder

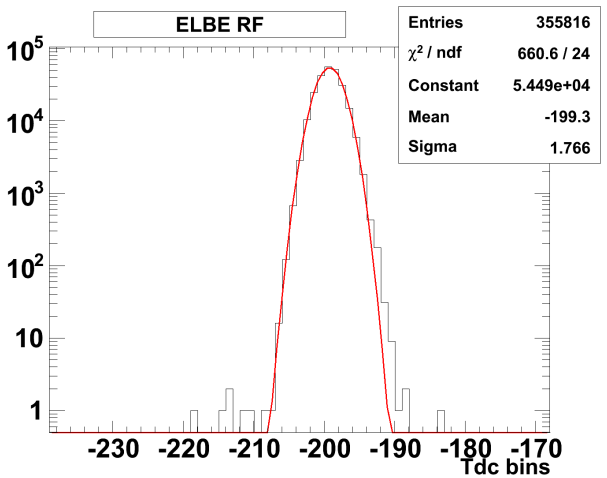


e^- Beams: Experimental Setup @ ELBE

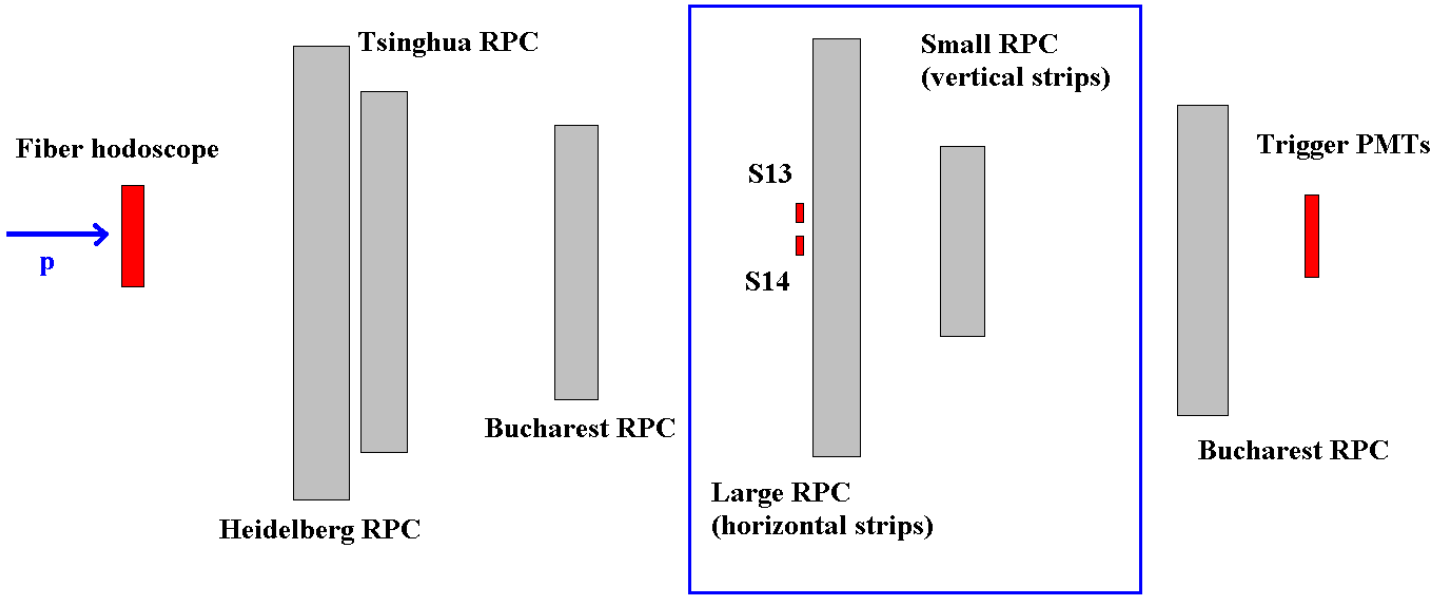


- RPC mounted on a moveable frame
- reference time given by RF signal from ELBE
- trigger by S1234RF

- 30 MeV electrons
- $A_{beam} \sim 10 - 20\,cm^2$
- Caen TDC 1290 N: 24.5 ps/bin
- $\sigma_{start} \sim 44\,ps$



p Beams: Experimental Setup @ COSY

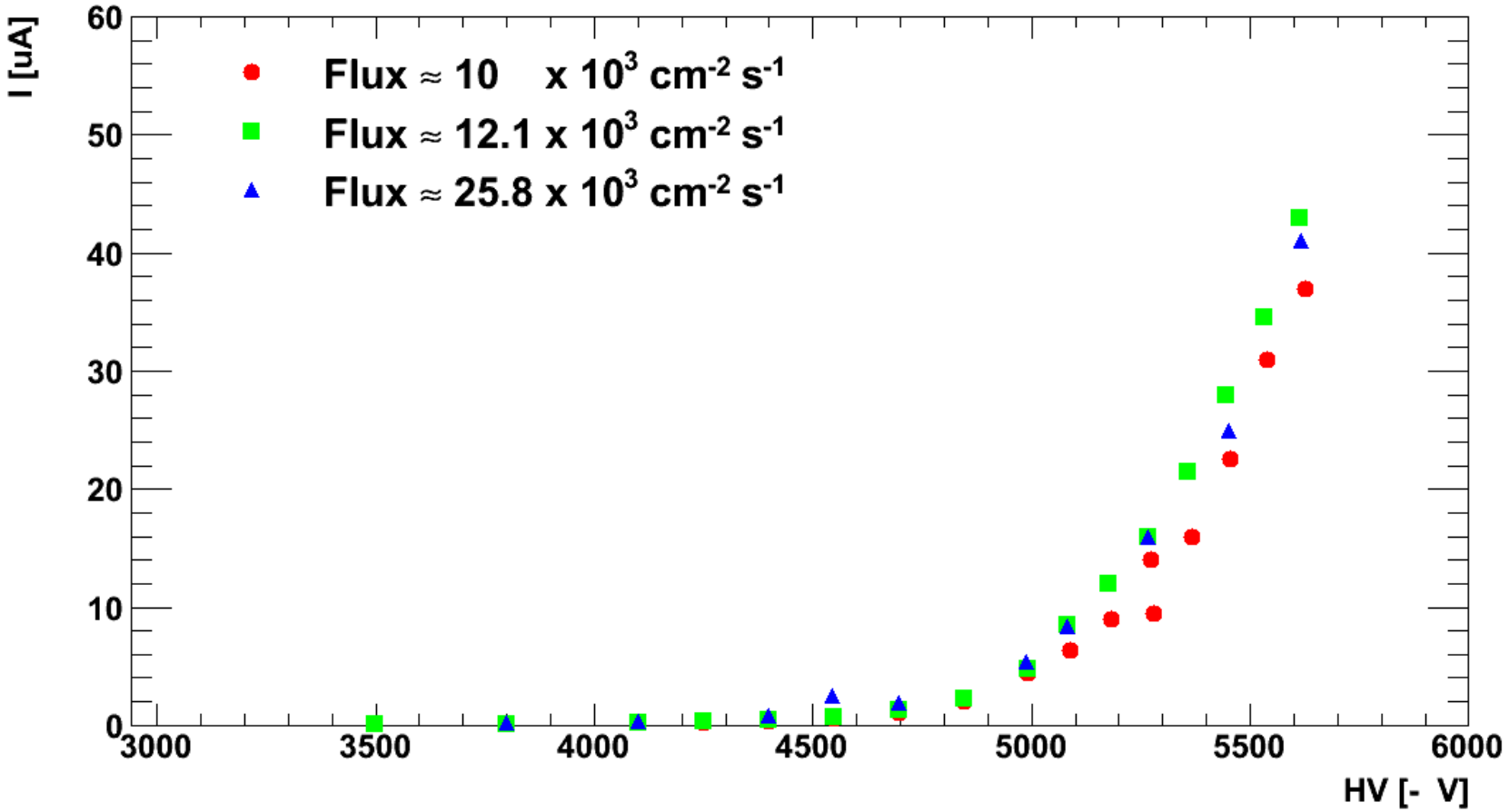


CBM ToF group.
See talks by:

- I. Deppner
- J. Wang
- M. Petrovici
- P-A. Loizeau

- ~ 2.5 GeV/c protons
- $\sigma_{start} \sim 55$ ps
- $A_{beam} < 1\,cm^2$
- S13, S14: 5x5x2 mm^3

e^- Beam - 20x20 cm^2 Prototype: Current



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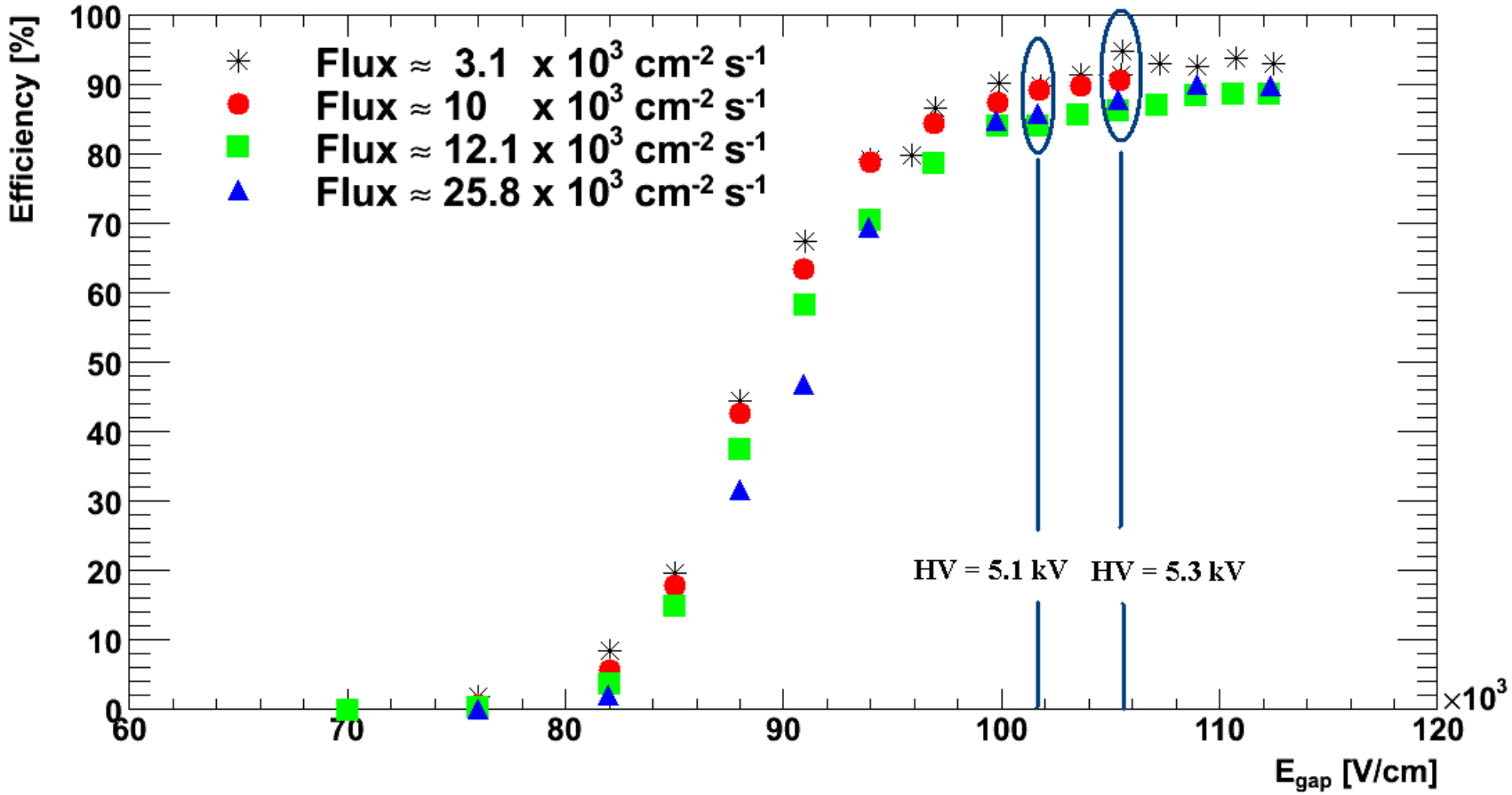
e^- Beam - 20x20 cm^2 Prototype: Working Curves



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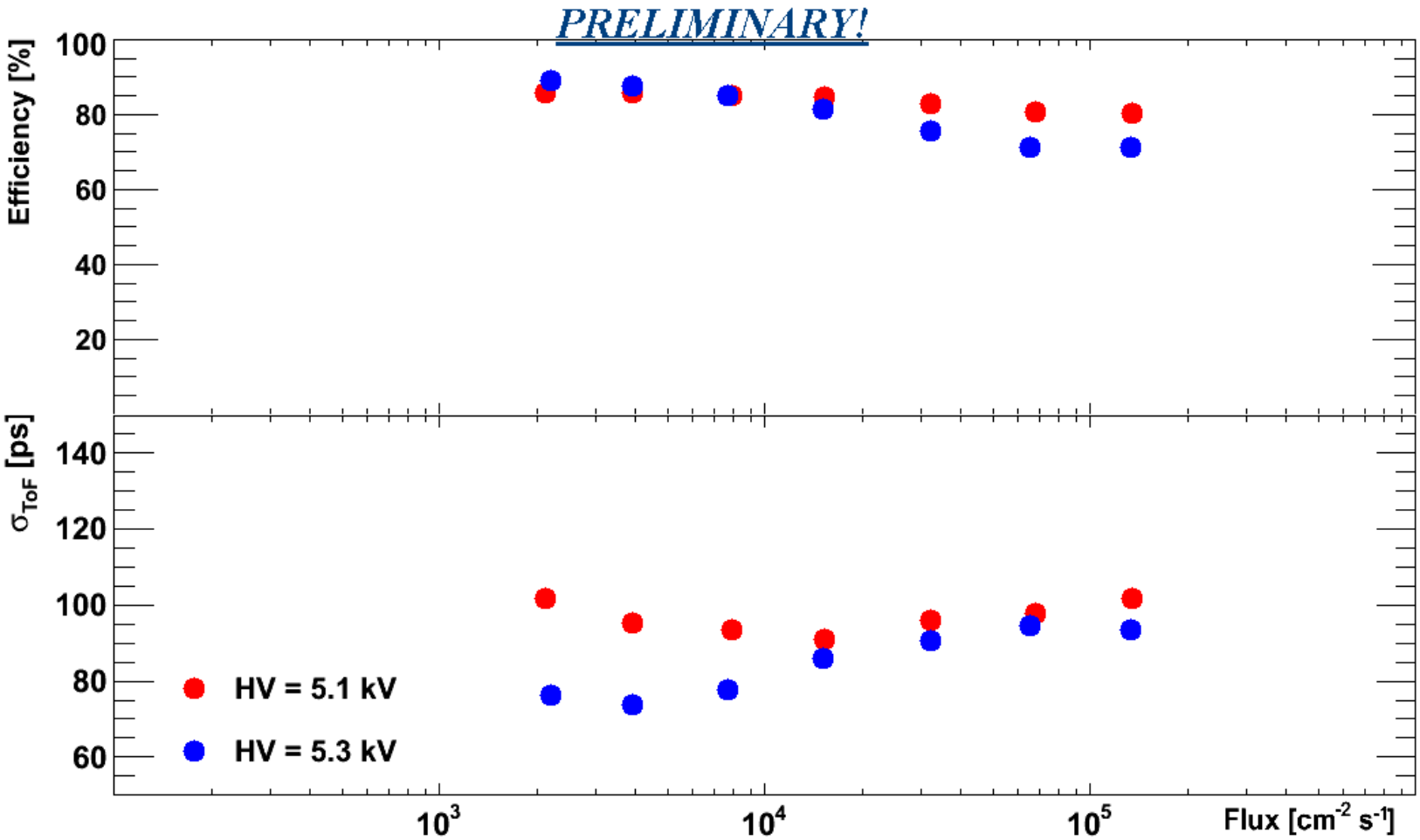
e^- Beam - 20x20 cm^2 Rate Capabilities



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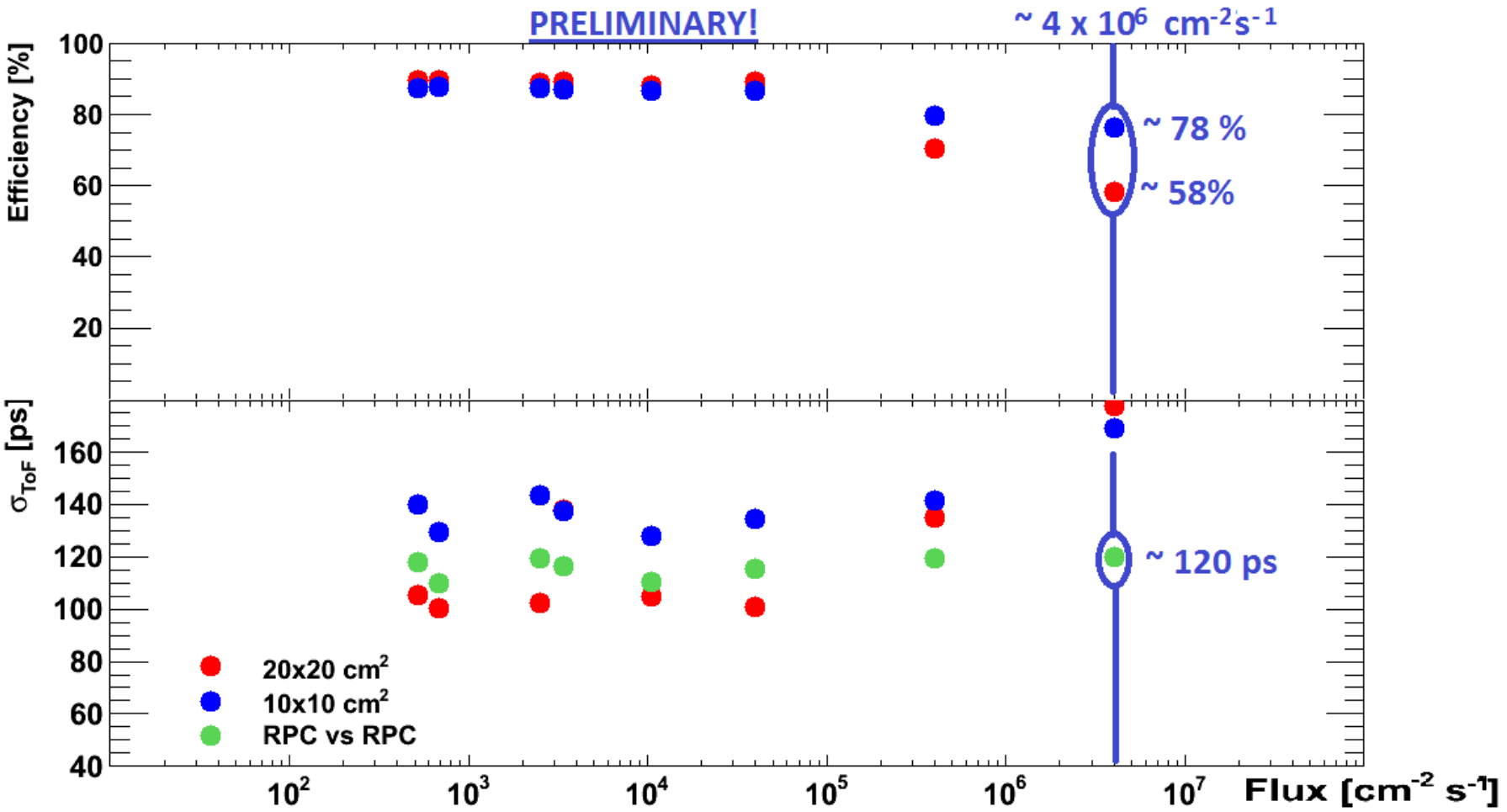
p Beam - Rate Capabilities



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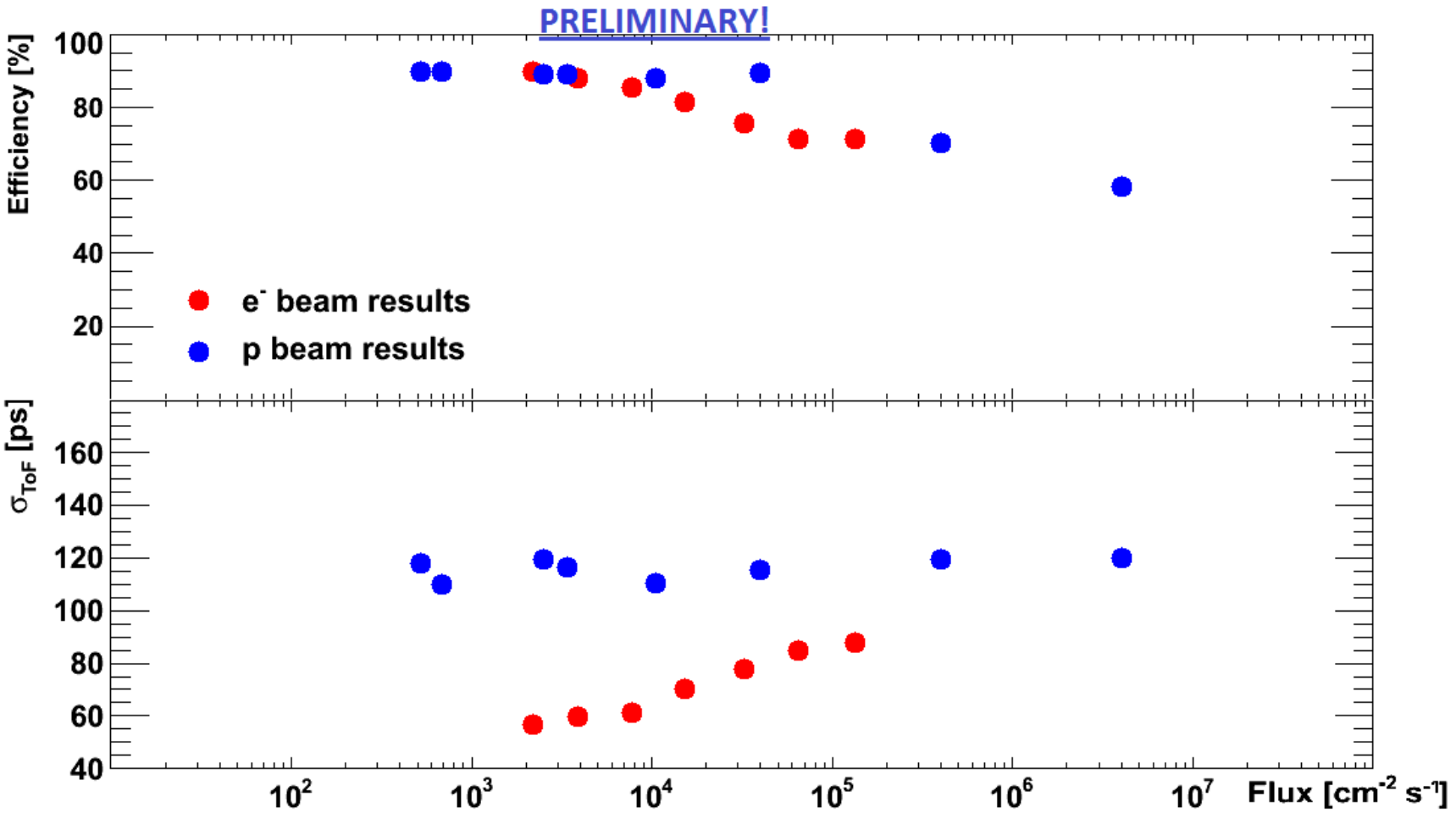
Proton and electron beam: 20x20 cm^2 RPC



Conclusions and Outlook

- Ceramic RPC are suitable for extreme high rate environments
- Attained efficencies at fluxes of $\sim 4 \cdot 10^6$ cm^{-2} s^{-1}:
  - 10x10 cm^2 prototype: $\sim$78%
  - 20x20 cm^2 prototype: $\sim$58%
- high rate performance confimed in both electron and proton beams

Next steps:

- optimize read-out (differential, impedance)
- optimize gas distribution and mixture
- increase number of gaps

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The People from CRPC@HZDR

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ROLAND KOTTE, LOTHAR NAUMANN, RICHARD PESCHKE,
DANIEL STACH, CHRISTIAN WENDISCH, JÖRN WÜSTENFELD

Grazie per l'attenzione

"*Lasciate ogni spranza voi ch'intratte*"

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Bonus slides

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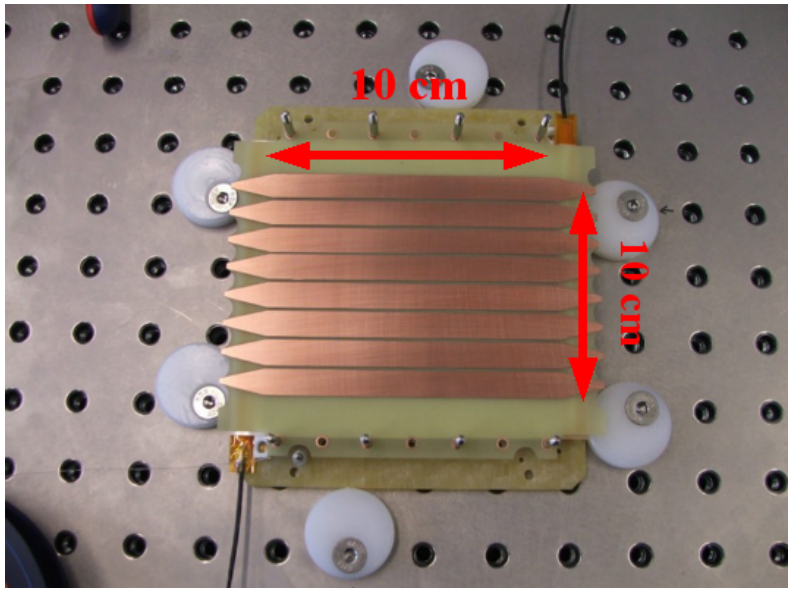
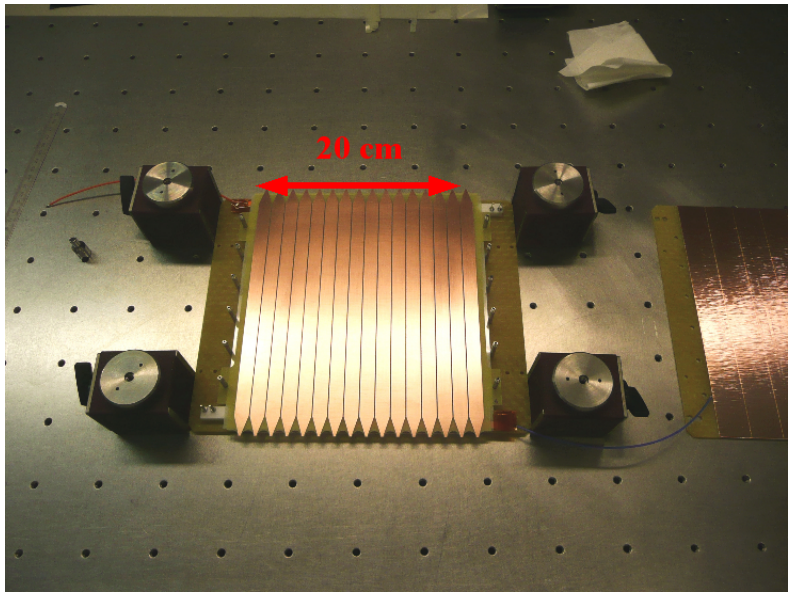
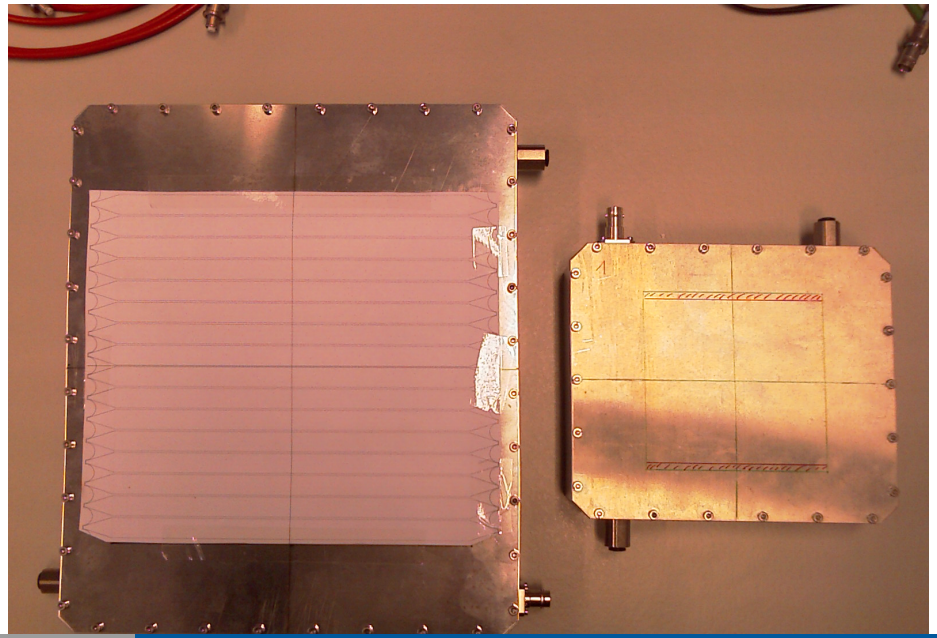
Ceramic RPC @ HZDR







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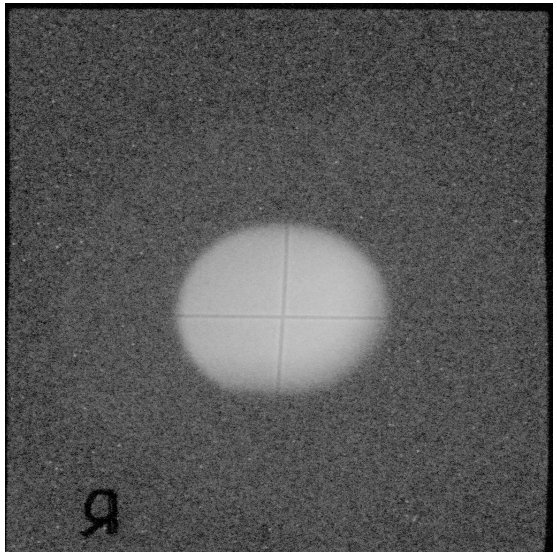
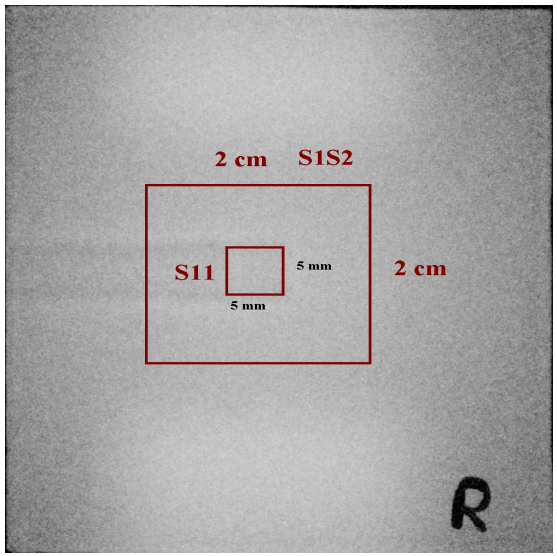
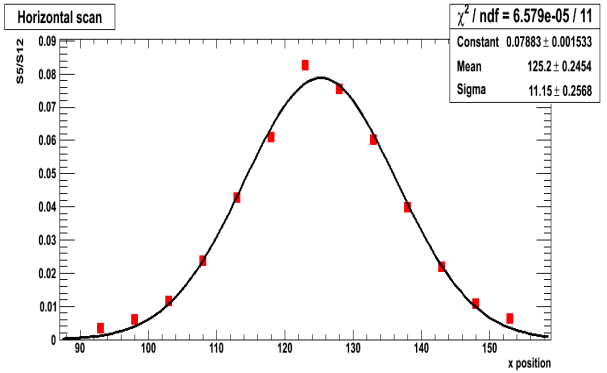
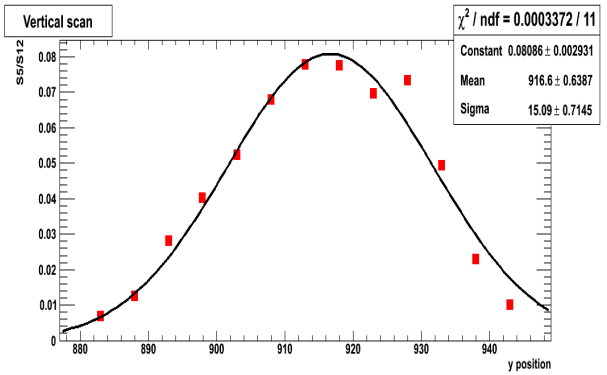
Experimental Setup @ ELBE









Beam profile dimensions:

$\sigma_x \sim 1.1\,\text{cm}$ $\sigma_y \sim 1.5\,\text{cm}$