

MAGIX Detectors Overview

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MAGIX Collaboration Meeting 2017

Topics

From Physics to Numbers

Spectrometers

Focal Plane Detectors

Trigger System

Other Detector Systems

Summary



MESA Numbers

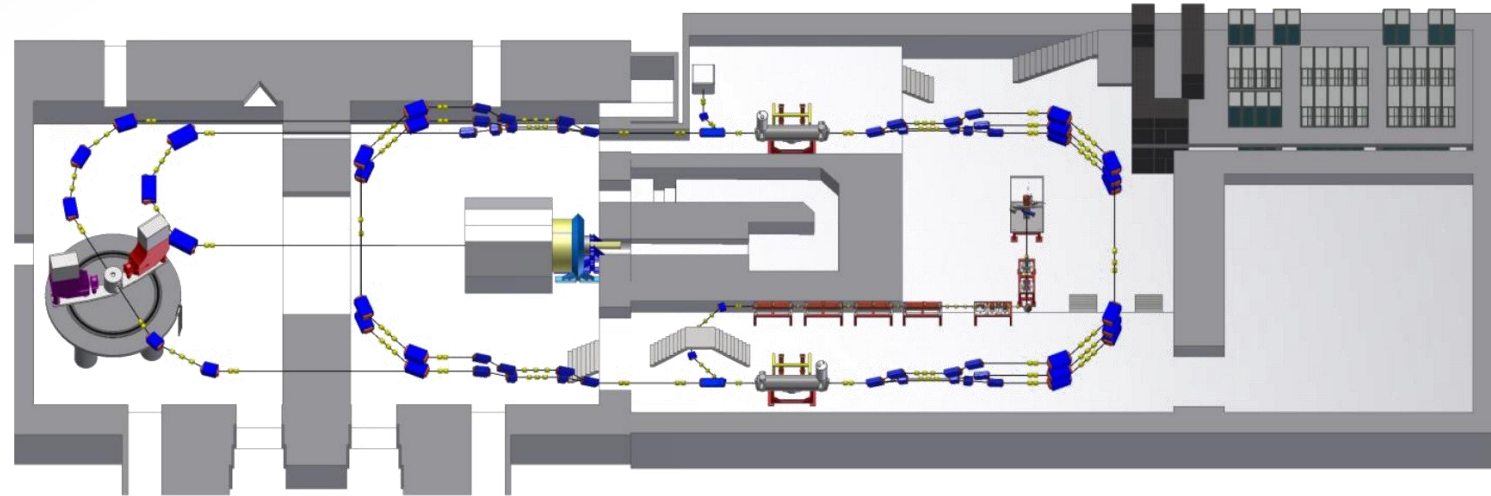
Energy Recovering

- External loop half-wave length
- Electron energy transferred back to cavity

MAGIX on the recirculating beam @105 MeV

- External loop after two recirculation
- Thin gas target on the beam path with a dedicated detector

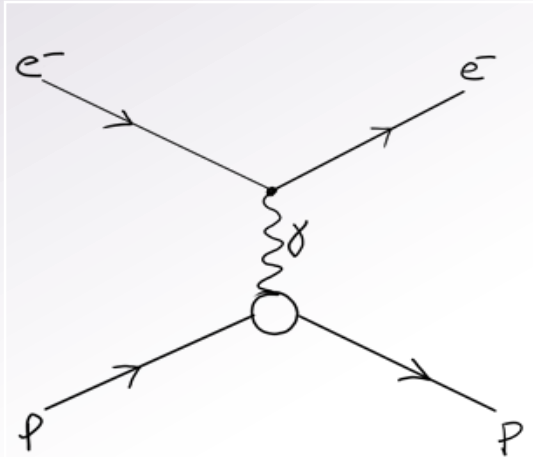
Beam current up to 1 mA



From Physics to Numbers

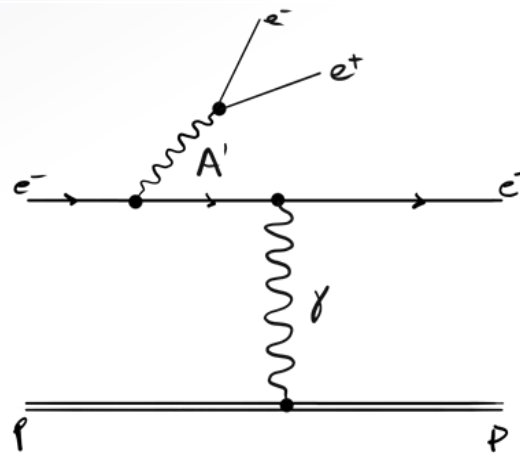


Electron Scattering



- Elastic or inelastic
- Form factor measurements
- Proton radius

Pair Production

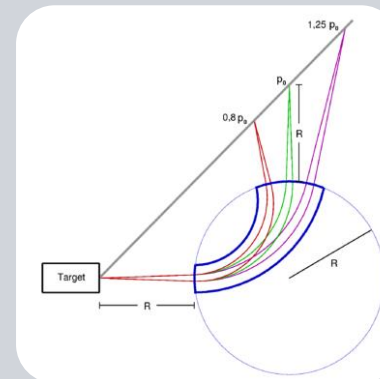
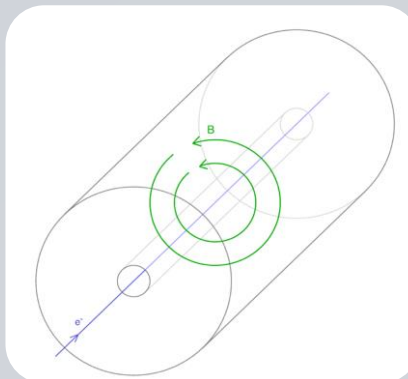
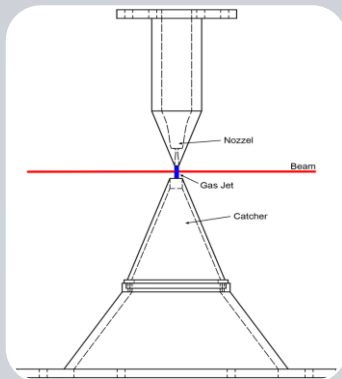


- e^+e^- coincidence
- With SM or dark U(1) photons



Momenta
Angles

How to get the numbers?



Target

- Thin (internal) target
- But get max luminosity
- Different gases

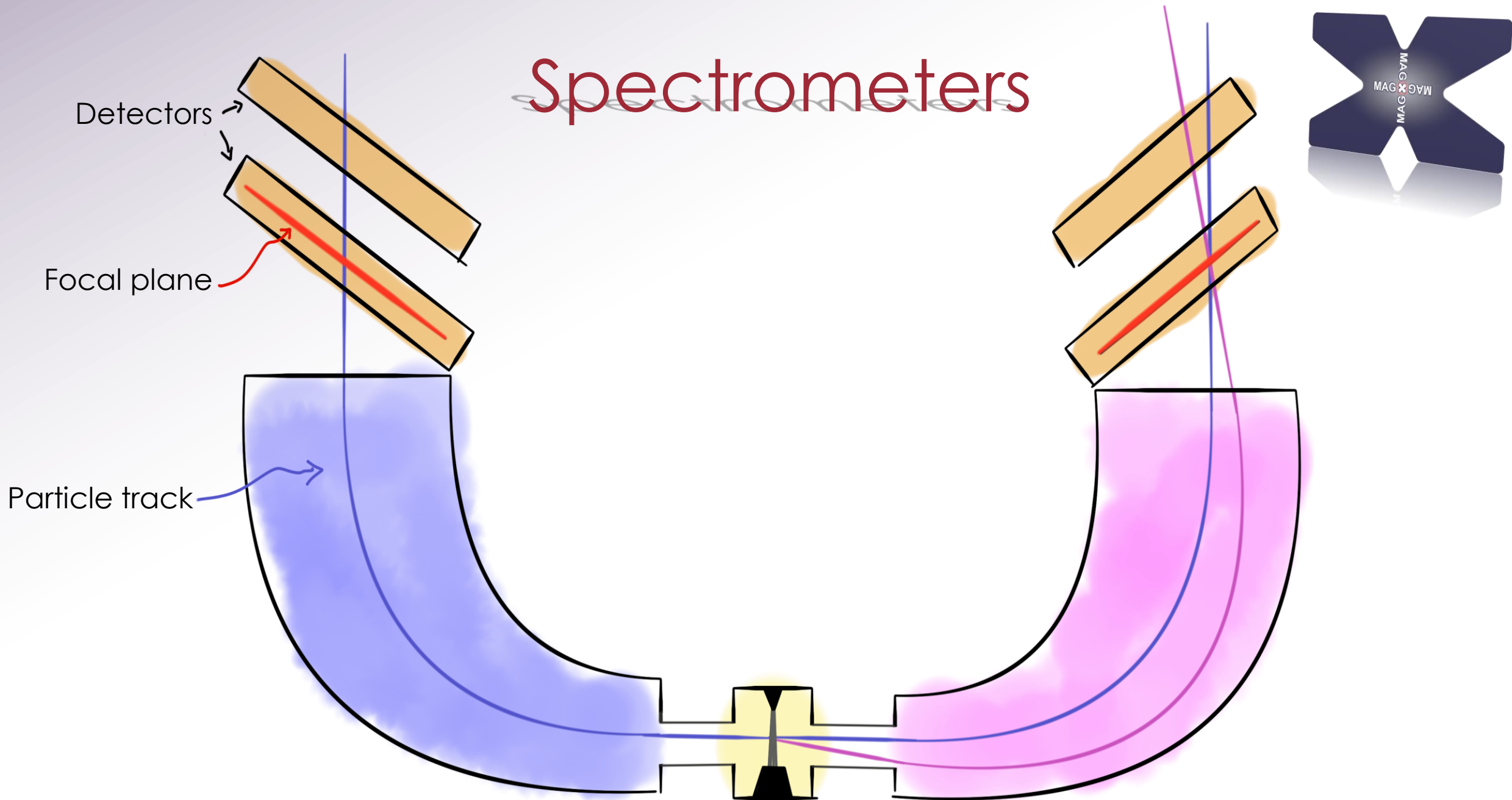
4π

- Solenoid or toroid
- Far better acceptance

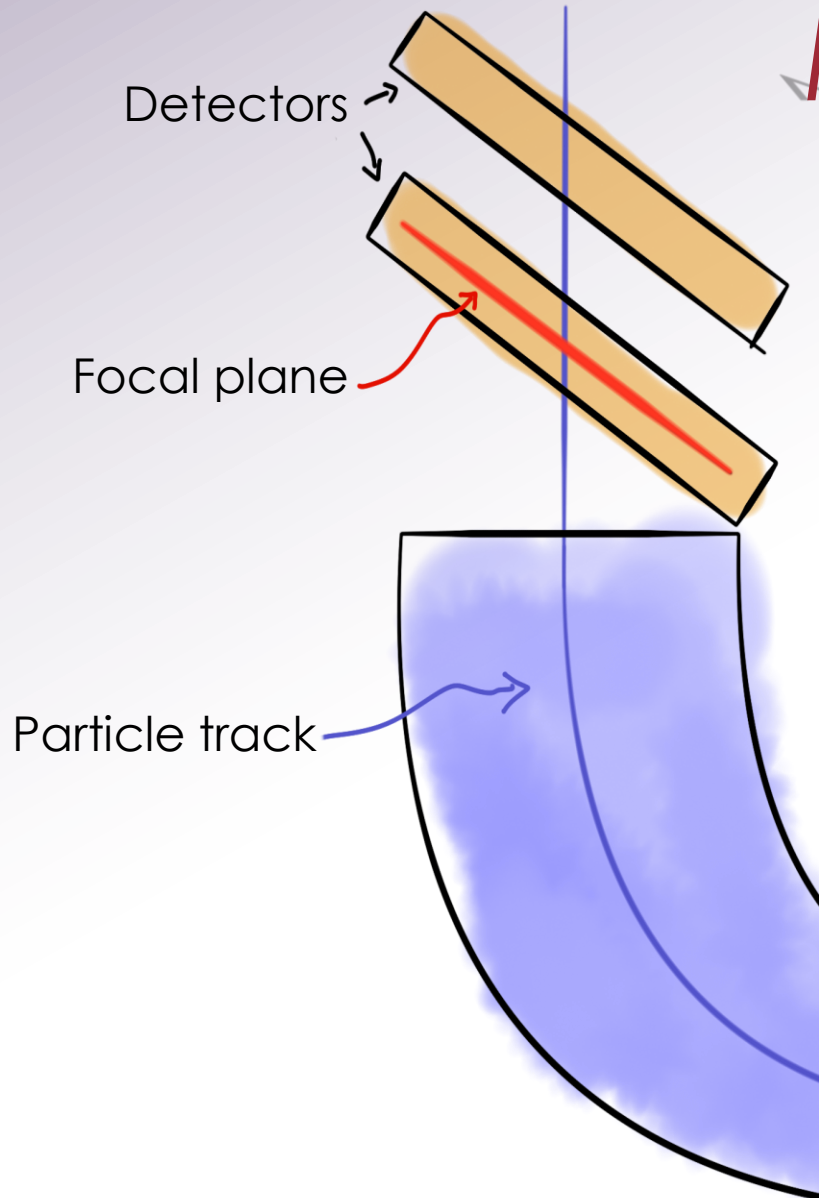
Spectrometer

- Far better resolution (2 orders of magnitude)
- Like A1
- Worse acceptance
- 2 for coincidence

Spectrometers



Magnet Optics

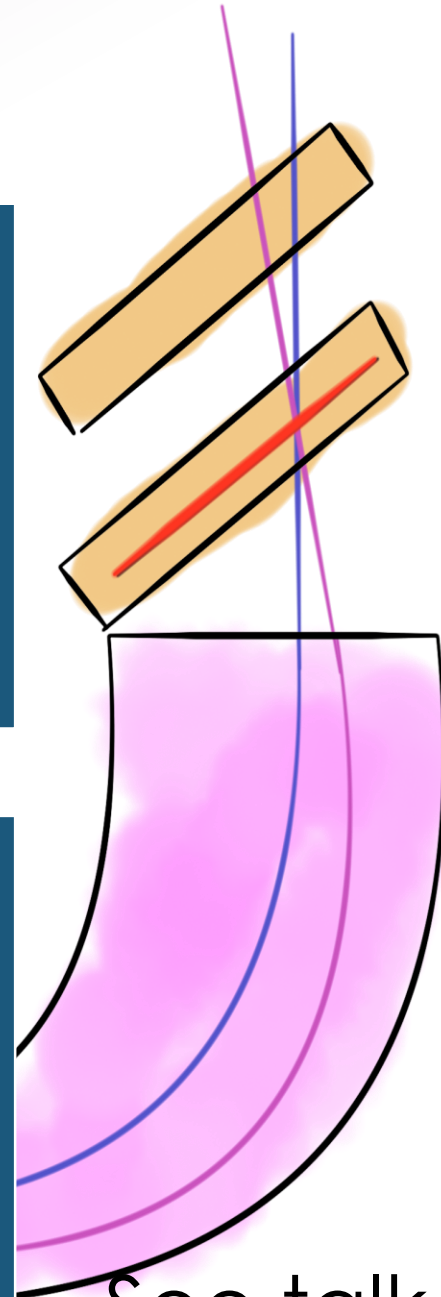


Momentum focusing

- Particles of different momenta at different positions
- Mapping of momenta to position

Angular focusing

- Parallel-to-point focusing
- Mapping of angles to position



See talk by Julian

Design



Detectors

Focal plane

Particle track

Acceptance

- 200 MeV maximum momentum
- 90 MeV momentum acceptance @ 200 MeV

Momentum resolution

- 10^{-4} relative momentum resolution
- Assuming **50 μm** resolution @ focal plane

Angular range

- $\Delta\theta \cong 0.05^\circ$
- $\Delta\phi \cong 0.2^\circ$

See talk by Julian

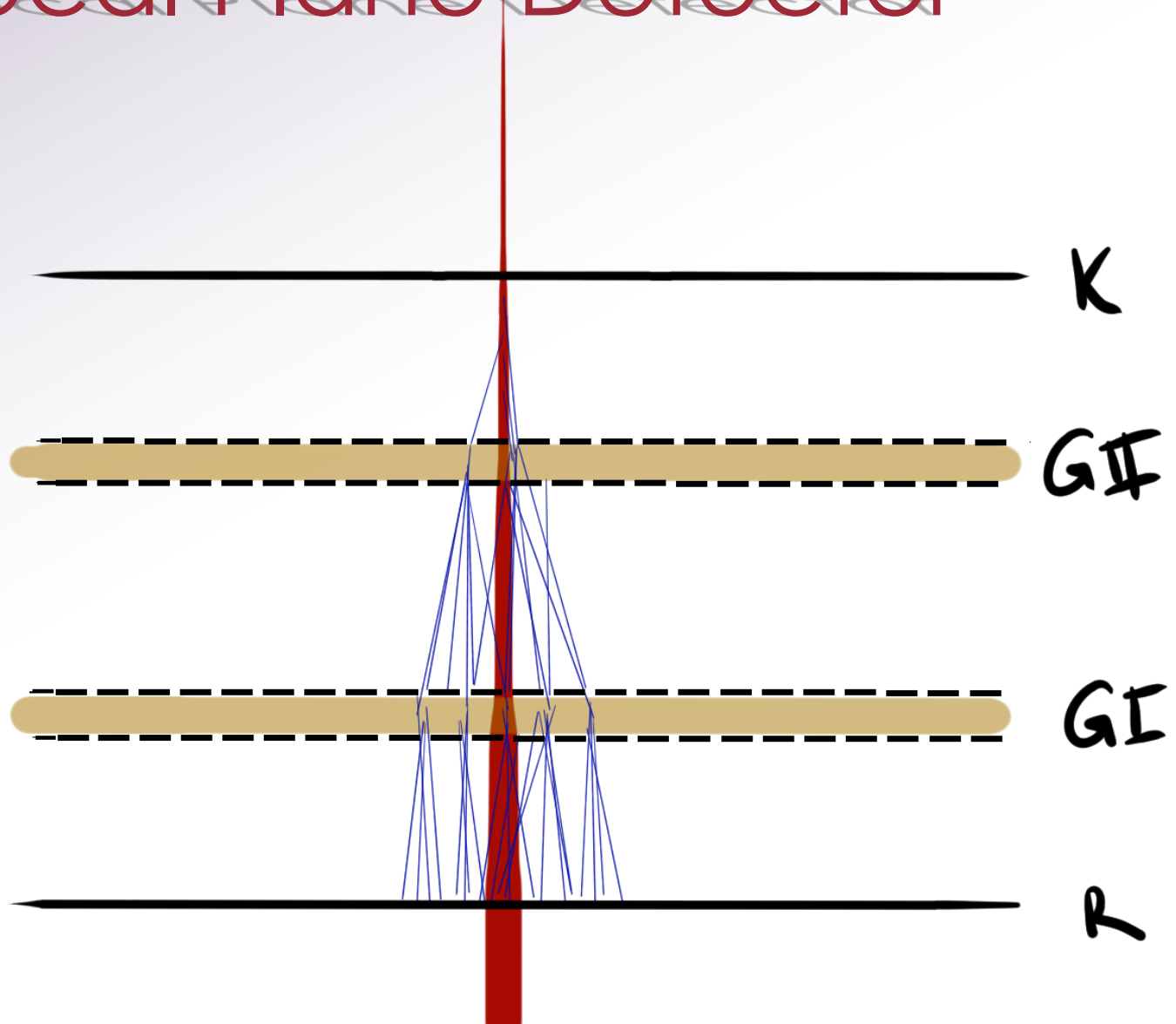
Detector Requirements



Needs

- 120 x 30 cm²
- 50 um spatial resolution
(in given environment)

Focal Plane Detector



X 2



Focal Plane Detector Concept



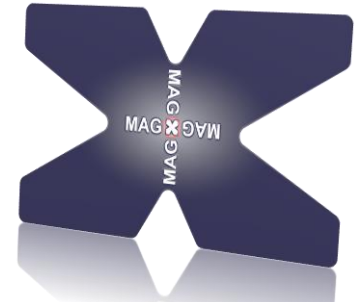
GEM based hodoscope

- Radiation length is crucial
-> thin GEMs
- Better for high rates
- Only 2 points per track
- No gaps allowed
-> big foil
- Dedicated readout

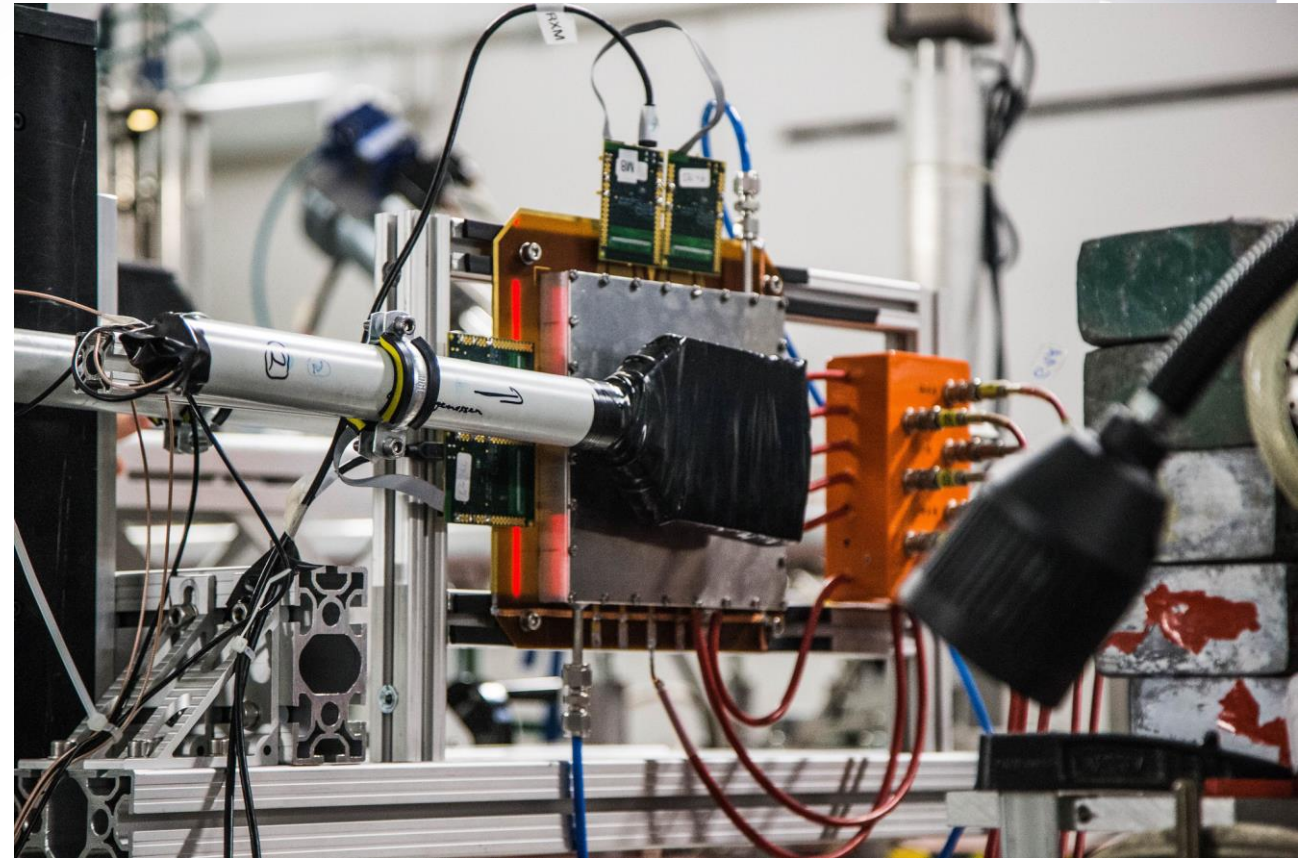
Electronics

- 10k Channels per module
- O(MHz) rate
- See my talk about electronics & DAQ

High Rates



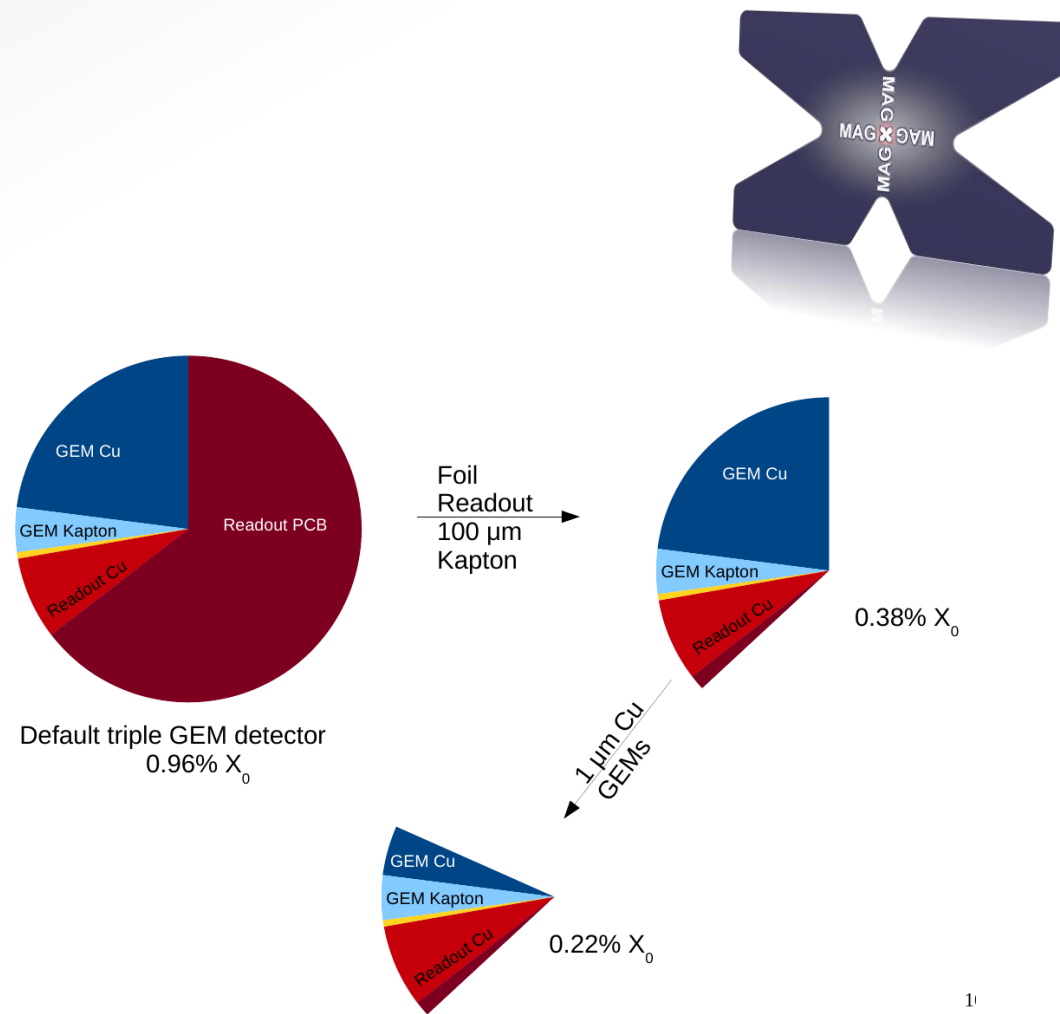
- Rate $O(1\text{MHz}/\text{cm}^2)$
- MAMI BT tests with prototype
 - > up to 2.2 MHz
 - > see talk by Mirco
- Data tacking needs new electronics
 - > see my talk about DAQ
- Needs to be tested with bigger prototype



NIKLAUS BERGER

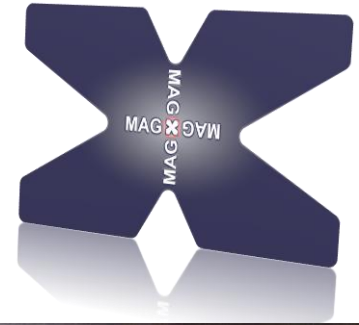
Material Budget

- Crucial for hodoscope
- Make readout structure thinner
-> see talk by Yasemin
- Make copper coating thinner
or skip it totally
-> Chromium GEMs
- Need BT to measure radiation thickness
- Design Goal? $0.2\% X_0$?



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Spatial Resolution $< 50 \mu\text{m}$

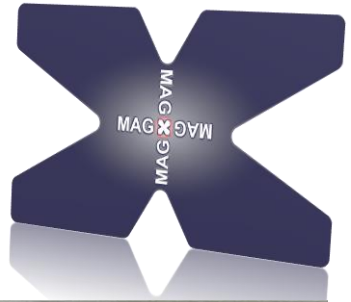


- Routinely achieved with $400 \mu\text{m}$ pitch readout
-> see talk by Yasemin
- Working on hit reconstruction software
-> Diploma thesis Matthias
- Measurements done with reference detectors
-> HVMaps Nick Berger

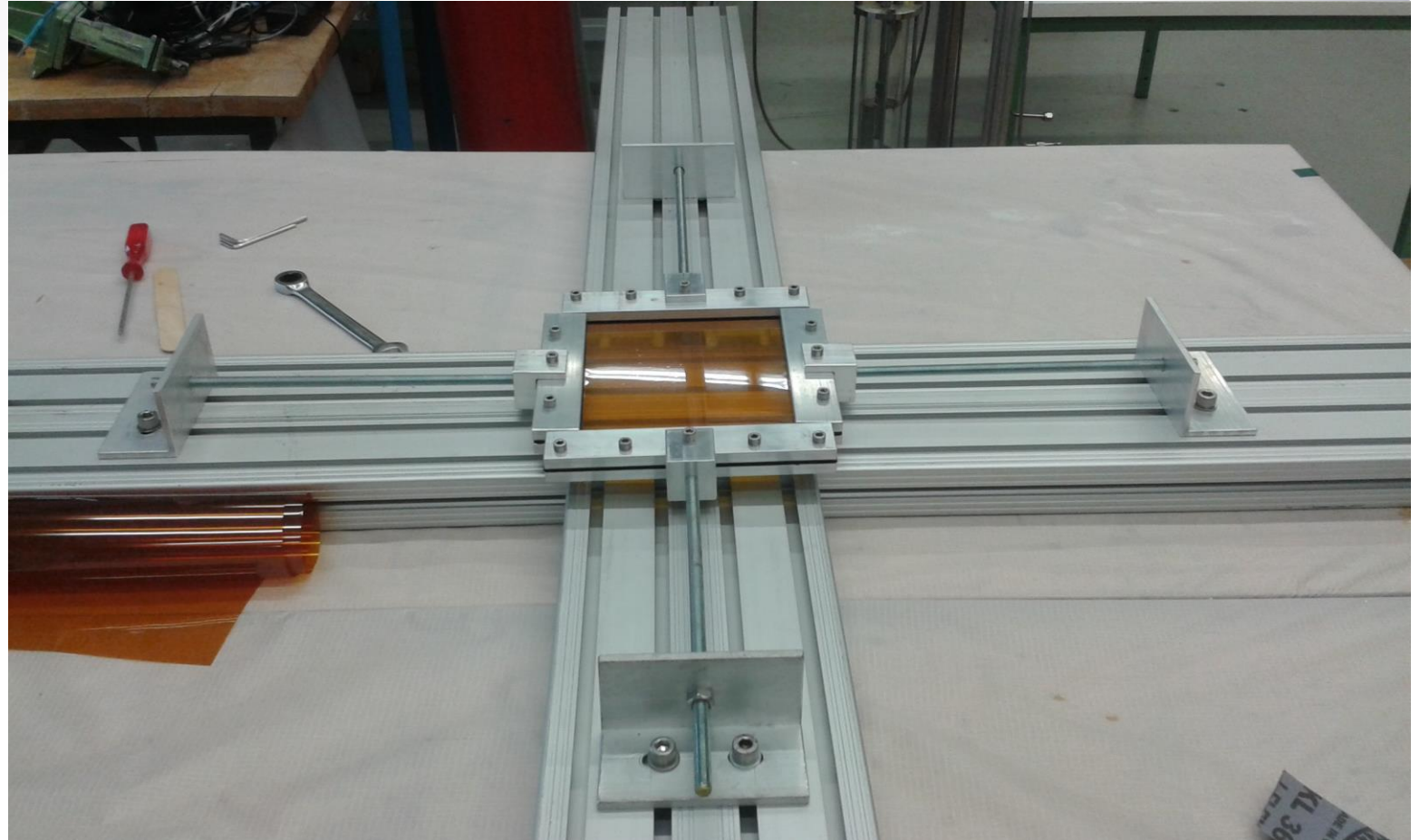


NIKLAUS BERGER

Large Area Detector: 1.2 x 0.3 m²



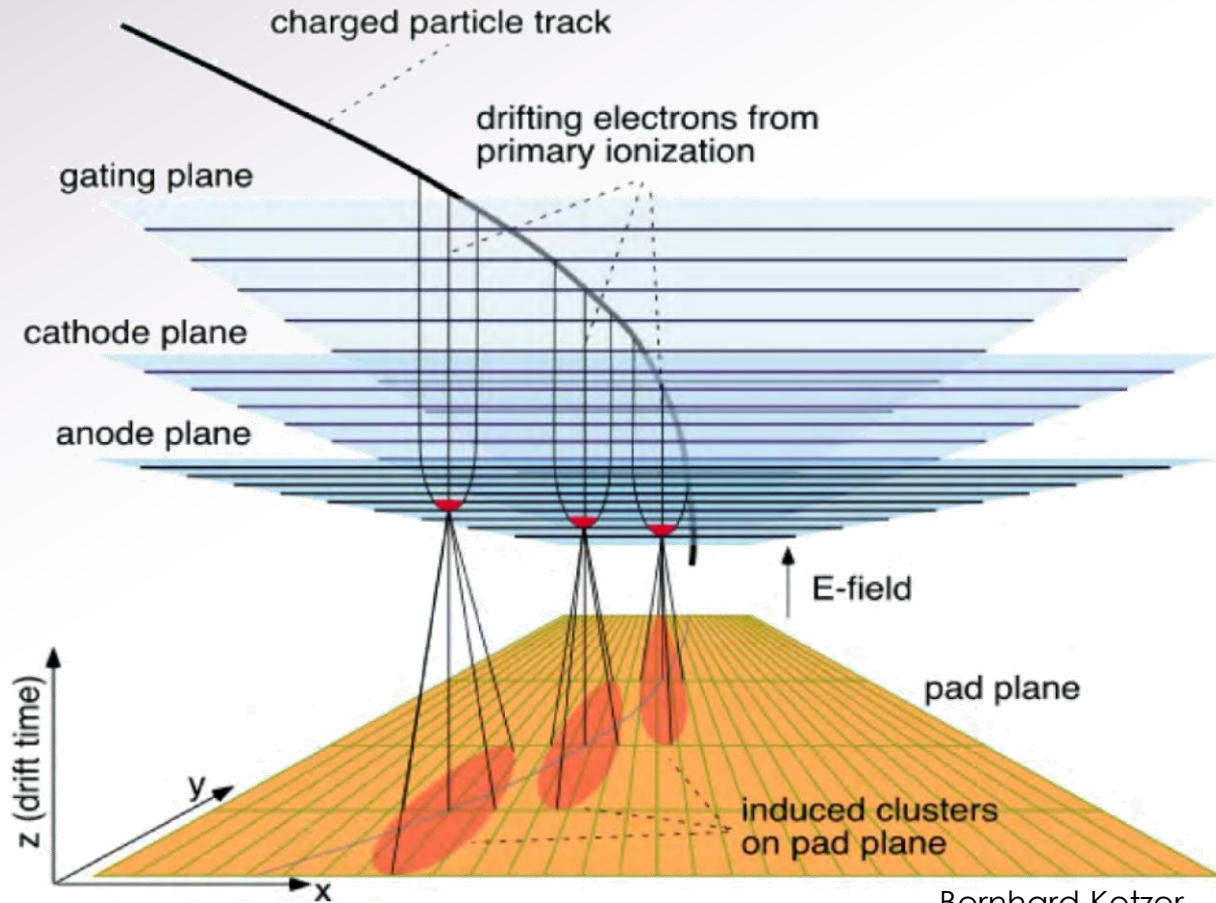
- Foil stretching seems achievable
- Readout is more problematic
- No gaps allowed



Plan B?



Plan B – Short Drift TPC



SD TPC

- Worse point resolution
- Better track resolution
- May consist of different modules
- Radiation length not a problem
- Spec design has to be adjusted

Ongoing

- Make it bigger
 - Go to 30 x 30
- Make it thinner
 - Foil-based readout
 - Chromium GEMs
- We joined the RD51 (more or less)
- Work on reconstruction software



Other Detectors



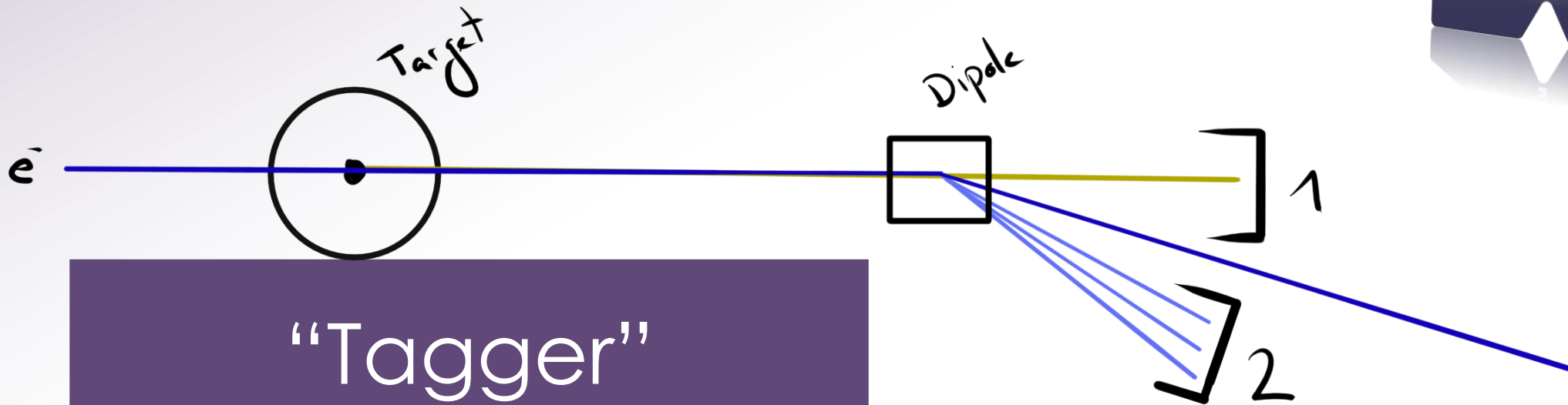
Silicon Strip

- Recoil Protons
- Inside Scattering Chamber

Trigger

- Segmented -> ROI
- ToF

Other Detectors



"Tagger"

- Measure Luminosity
- After first Dipole





THANK YOU FOR YOUR ATTENTION!

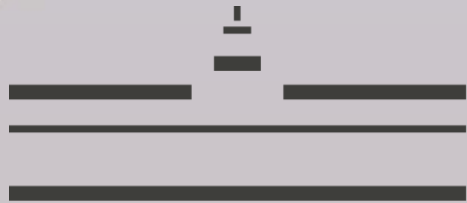
<http://magix.kph.uni-mainz.de>



**Massachusetts
Institute of
Technology**



University of Ljubljana



**WESTFÄLISCHE
WILHELMS-UNIVERSITÄT
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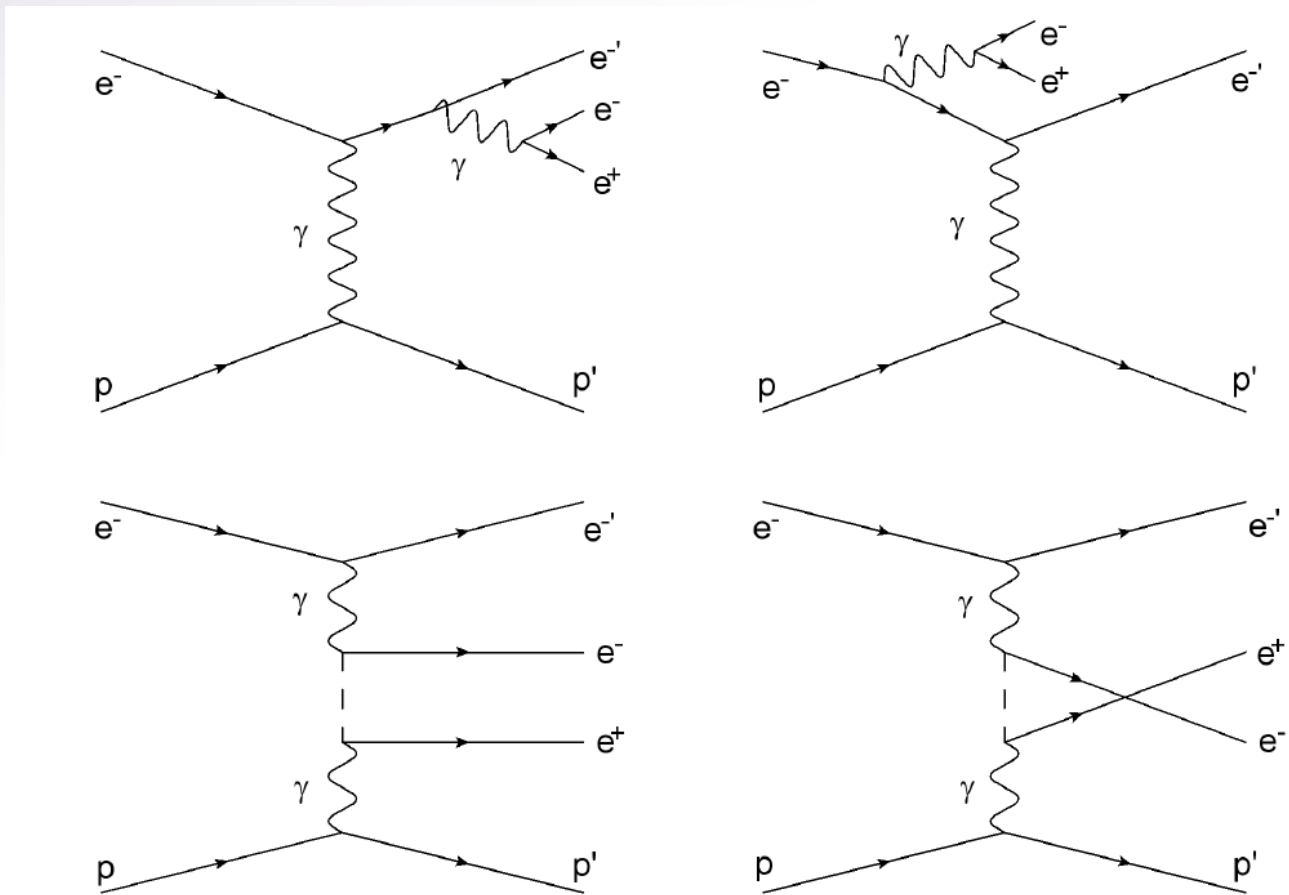
**JOHANNES GUTENBERG
UNIVERSITÄT MAINZ**



Backup



Backup – Background Processes



Backup – Spectrometer Numbers



| | MAMI/A1 | | | MESA |
|-------------------------------------|------------------|------------------|------------------|---------------------------------|
| Spectrometer | A | B | C | S ₁ , S ₂ |
| Configuration | QSDD | D | QSDD | QD |
| Height [mm] (without detectors) | 5500 | 5160 | 4750 | 1830 |
| Length [mm] | 7865 | 8400 | 6400 | 2800 |
| Central momentum [MeV/c] | 665 | 810 | 490 | 200 |
| minimum angle | 18° | 15.1° | 18° | 14° |
| Momentum acceptance | 20% | 15% | 25% | 45% |
| Solid angle [msr] | 28 | 5.6 | 28 | 6.8 |
| Rel. momentum resolution | 10 ⁻⁴ | 10 ⁻⁴ | 10 ⁻⁴ | <10 ⁻⁴ |
| angular resolution at target [mrad] | <3 | <3 | <3 | <0.9 |