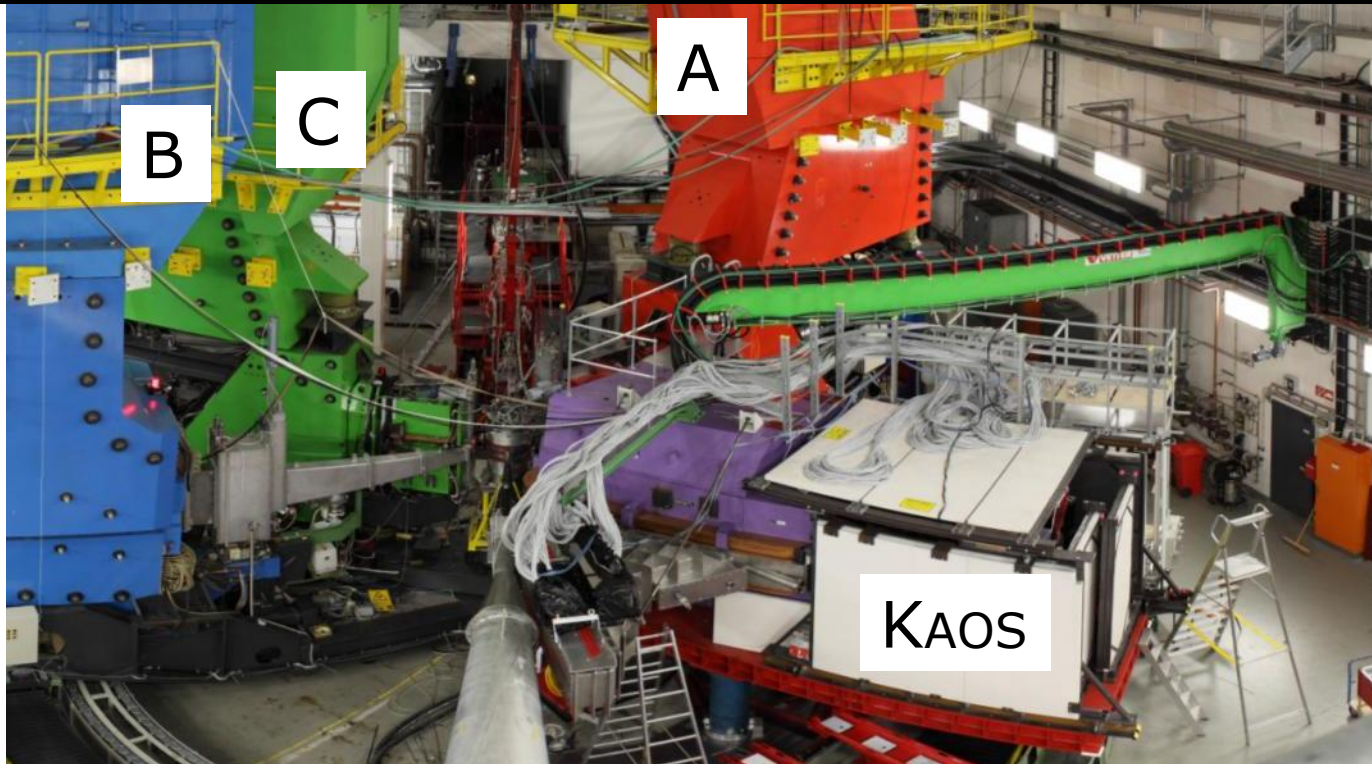


First measurements of Λ and Σ^0 hyperons in elementary electroproduction at MAMI



Patrick Achenbach
for the Collaboration A1 at MAMI

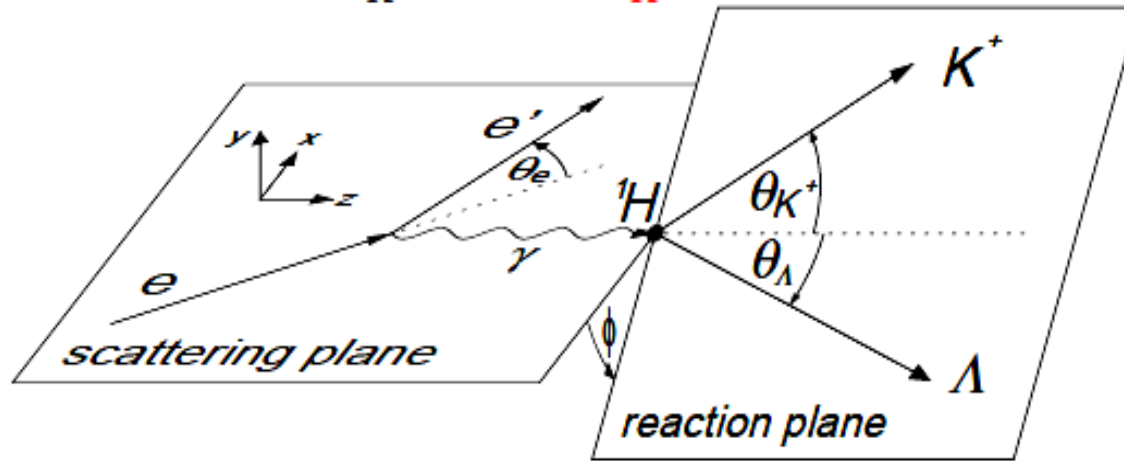
Sept. 2009

Kaon electro-production

Kinematics of the $p(e, e'K)\Lambda$ reaction

five-fold differential cross section separates into **virtual photon flux** and **virt. photoproduction cross section**:

$$\frac{d^5\sigma}{d\Omega dE' d\Omega_K^*} = \Gamma \frac{d\sigma_v}{d\Omega_K^*}(W, Q^2, \epsilon, \theta_K, \phi)$$

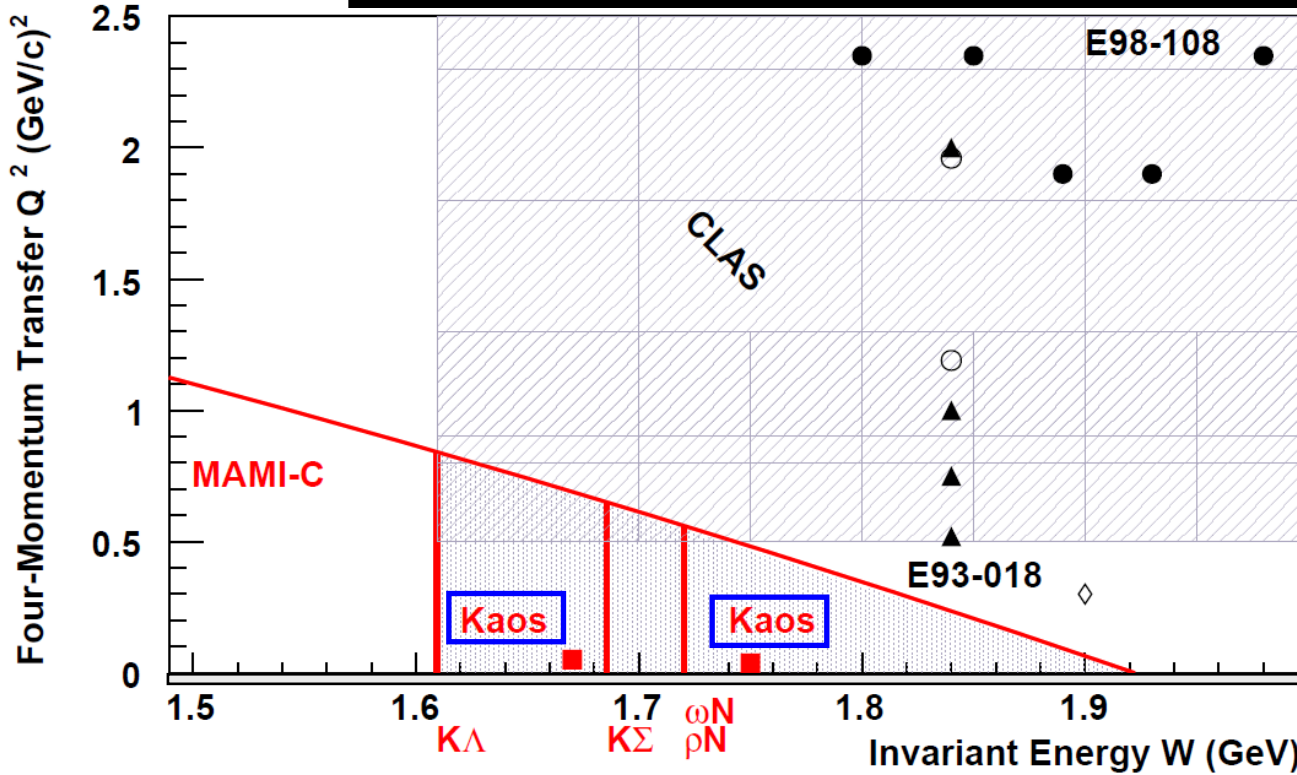


virtual photoproduction cross section is parameterised:

$$\frac{d\sigma_v}{d\Omega_K^*} = \frac{d\sigma_T}{d\Omega_K^*} + \epsilon_L \frac{d\sigma_L}{d\Omega_K^*} + \sqrt{2\epsilon_L(1+\epsilon)} \frac{d\sigma_{LT}}{d\Omega_K^*} \cos\phi + \epsilon \frac{d\sigma_{TT}}{d\Omega_K^*} \cos 2\phi$$

[E. Amaldi, S. Fubini, and G. Furlan, *Pion-Electroproduction*, 1979 ; A. Donnachie and G. Shaw, *Electromagnetic Interactions of Hadrons*, 1978.]

Kaon electro-production measurements



[E93-018: R. M. Moring *et al.*, *Phys. Rev. C* 67, 055205 (2003); reanalysis in G. Niculescu *et al.*, *Phys. Rev. Lett.* 81, 1805 (1998).

E98-108: M. Coman, PhD thesis, Florida International University, 2005 (unpublished).

CLAS: Ambrozewicz *et al.*, *Phys. Rev. C* 75, 045203 (2007).]

← photo-production

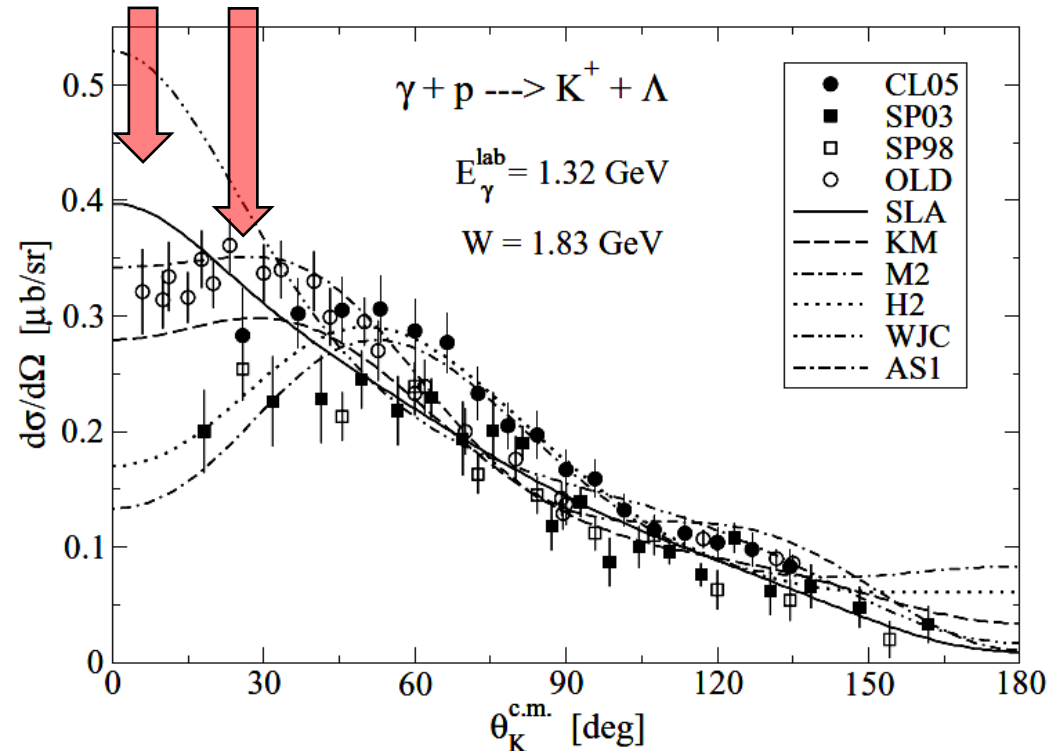
virt. photon beam electron arm kaon arm

$\langle Q^2 \rangle$ (GeV/c) ²	$\langle W \rangle$ GeV	$\langle \epsilon \rangle$ (trans.)	$\langle \omega \rangle$ GeV	E_e GeV	$\langle q_{e'}^{lab} \rangle$ GeV/c	$\langle \theta_{e'}^{lab} \rangle$ deg	$\langle p_K^{lab} \rangle$ GeV/c	$\langle \theta_K^{lab} \rangle$ deg
---	----------------------------	--	---------------------------------	--------------	---	--	--------------------------------------	---

0.050	1.670	0.540	1.044	1.508	0.455	15.8	Λ : 0.466	-31.5
0.036	1.750	0.395	1.182	1.508	0.318	15.5	Λ : 0.642	-31.5
							Σ : 0.466	

Kaon production at forward angles

measurements with Kaos at MAMI in 2009 and 2010



Name	Observable	Symbol
SAPHIR 2004	Differential cross section	$d\sigma/d\Omega$
	Recoil polarization	P
	Total cross section	σ_{tot}
CLAS 2006	Differential cross section	$d\sigma/d\Omega$
	Recoil polarization	P
	Total cross section	σ_{tot}
LEPS 2006	Differential cross section	$d\sigma/d\Omega$
	Photon asymmetry	Σ
OLD	Target asymmetry	T
	Total cross section	σ_{tot}
Total data		

From: [T. Mart and A. Sulaksono, *Phys. Rev. C* 74, 055203 (2006).]

Data points: [K. H. Glander *et al.*, *Eur. Phys. J. A* 19, 251 (2004).

R. Bradford *et al.* (CLAS Collaboration), *Phys. Rev. C* 73, 035202 (2006).

M. Sumihama *et al.* (LEPS Collaboration), *Phys. Rev. C* 73, 035214 (2006).

K. H. Althoff *et al.*, *Nucl. Phys. B* 137, 269 (1978).

M. Q. Tran *et al.* (SAPHIR Collaboration), *Phys. Lett. B* 445, 20 (1998).]

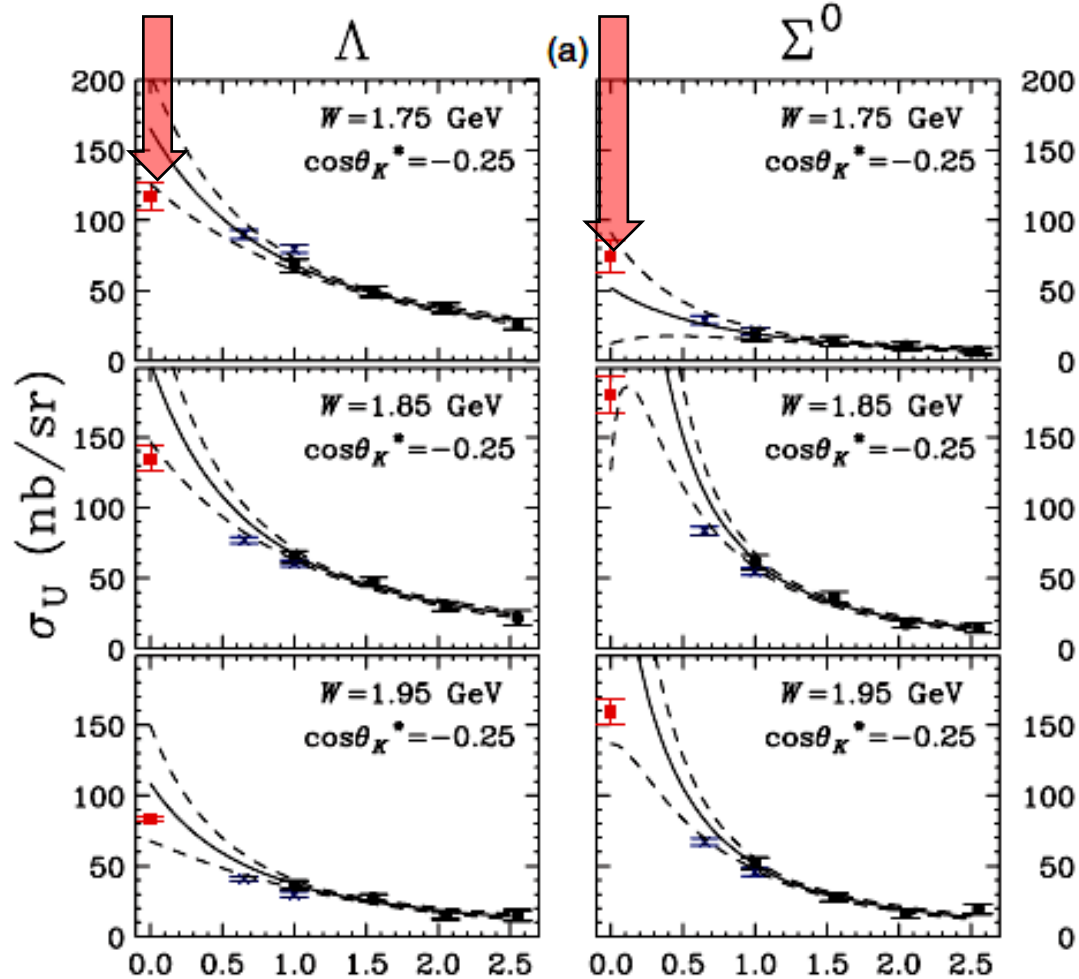
First measurements of Λ and Σ^0 hyperons in elementary electroproduction at MAMI

Sept. 2009

P Achenbach, U Mainz

Kaon production at low Q^2

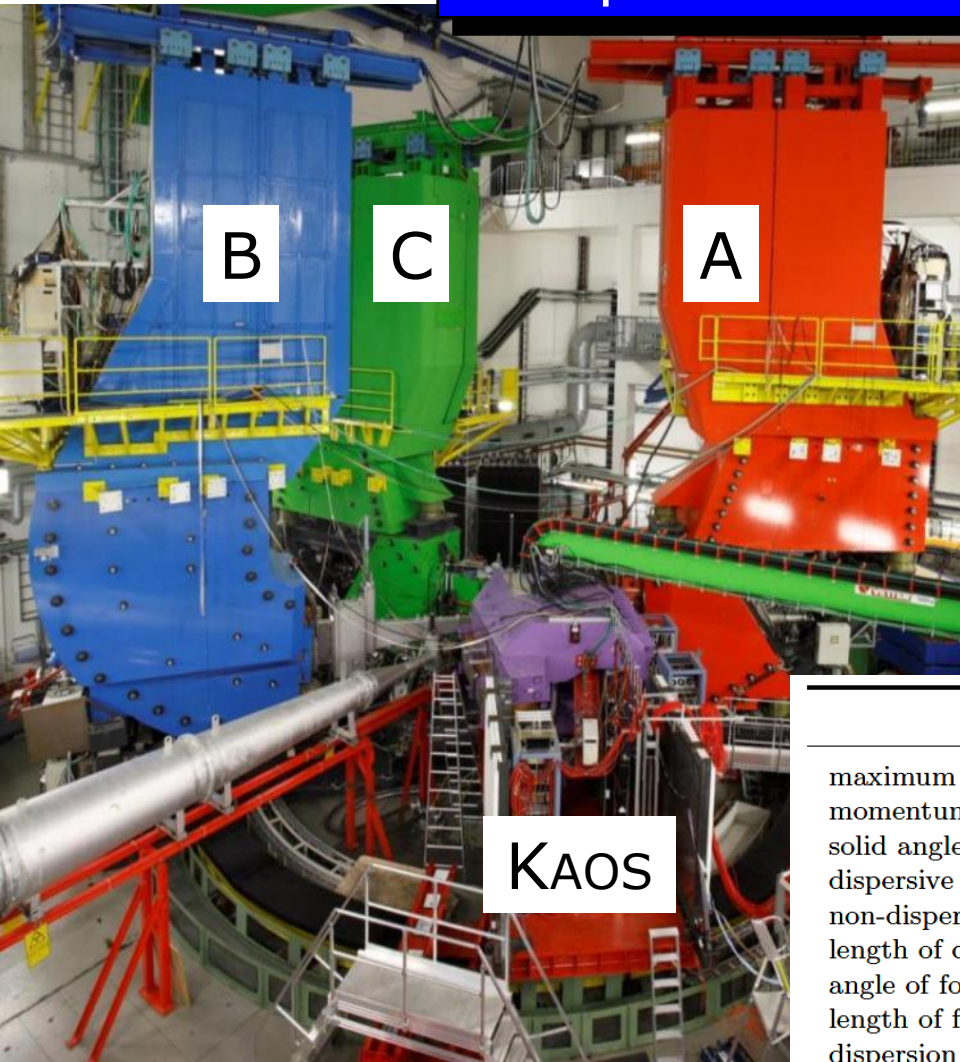
measurements with Kaos at MAMI in 2009 and 2010



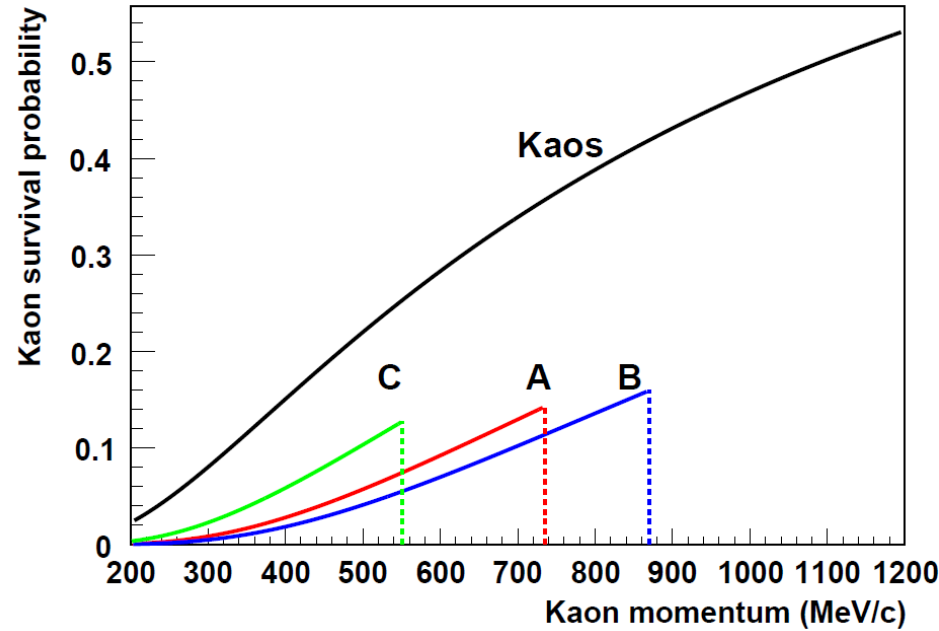
[Ambrozewicz *et al.*, Q^2 (GeV^2)
Phys. Rev. C 75, 045203 (2007).]

Experimental aspects

Adaption of the spectrometer facility



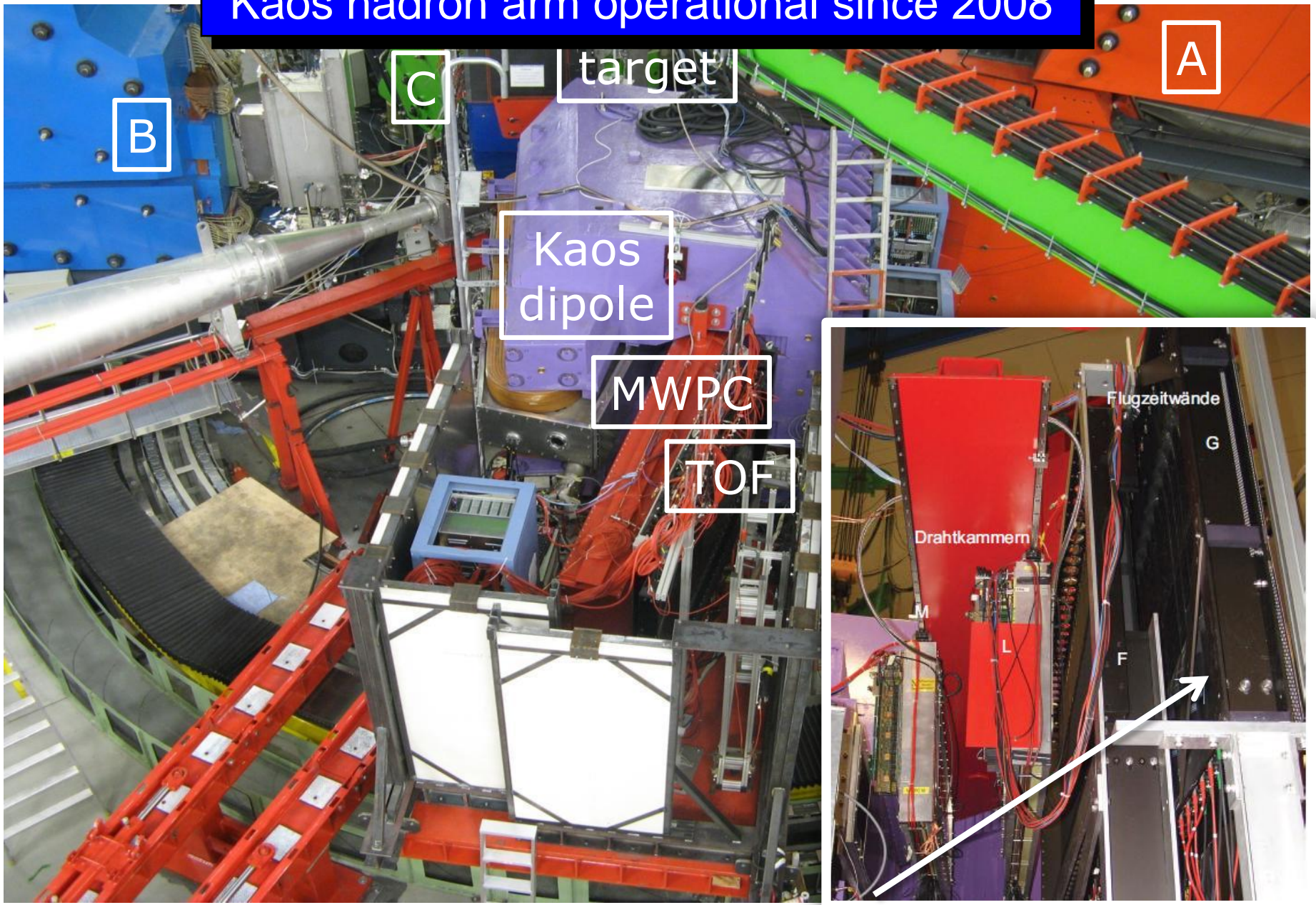
KAOS



max momentum and path length limit
kaon survival probability < 15% in A/B/C

	spectrometer B	KAOS hadron arm
maximum momentum	870 MeV	2 100 MeV
momentum acceptance	15 %	50 %
solid angle acceptance	5.6 msr	10.4 msr
dispersive angle acceptance	± 70 mrad $\approx \pm 4^\circ$	± 185 mrad $\approx \pm 10.5^\circ$
non-dispersive angle acceptance	± 20 mrad $\approx \pm 1.15^\circ$	± 14 mrad $\approx \pm 0.8^\circ$
length of central trajectory	12.03 m	5.3 m
angle of focal plane	47°	$\sim 45^\circ$
length of focal plane	1.8 m	~ 1.2 m
dispersion at central trajectory	8.22 cm/%	2.4 cm/%
magnification at central trajectory	0.85	2.0
dispersion to magnification	9.64 cm/%	1.2 cm/%
1st order resolving power	19 000	2 400
1st order momentum resolution	$< 10^{-4}$	$\sim 10^{-3}$

Kaos hadron arm operational since 2008



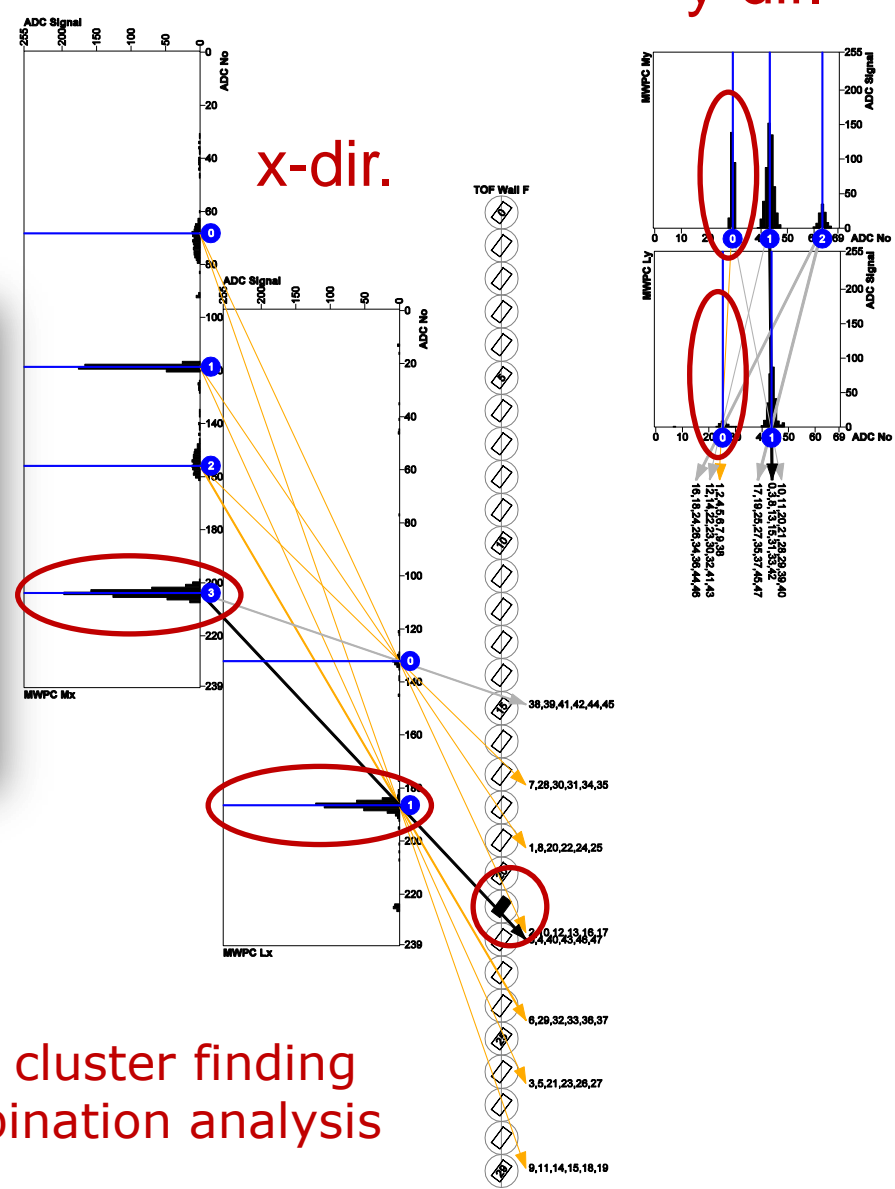
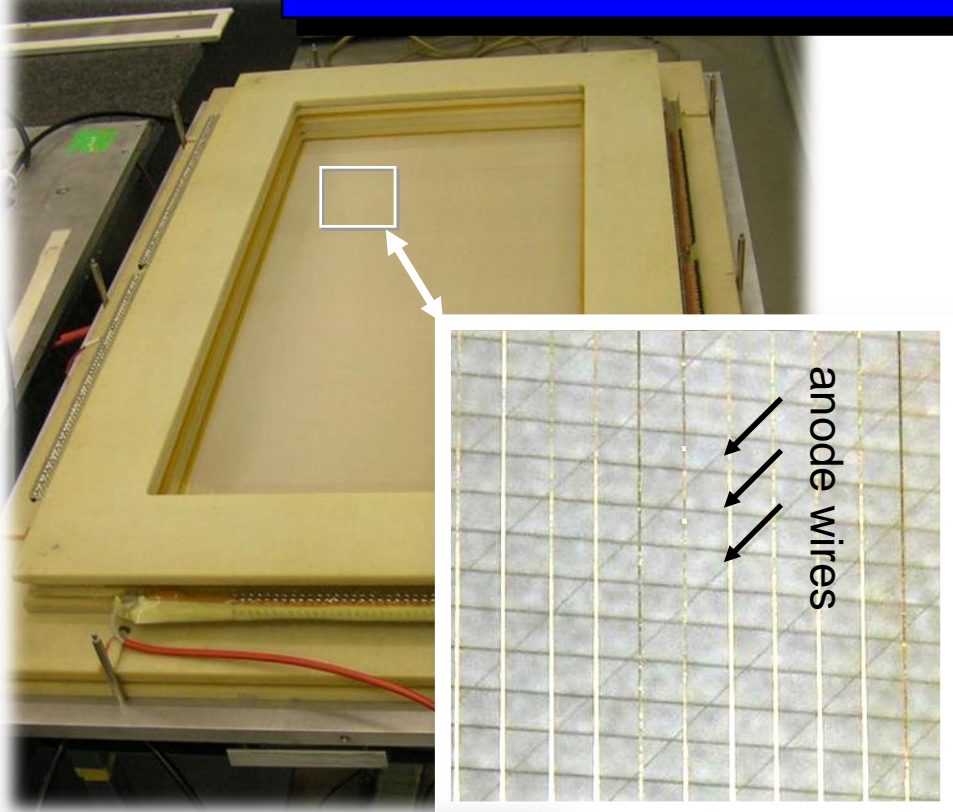
First measurements of Λ and Σ^0 hyperons in elementary electroproduction at MAMI

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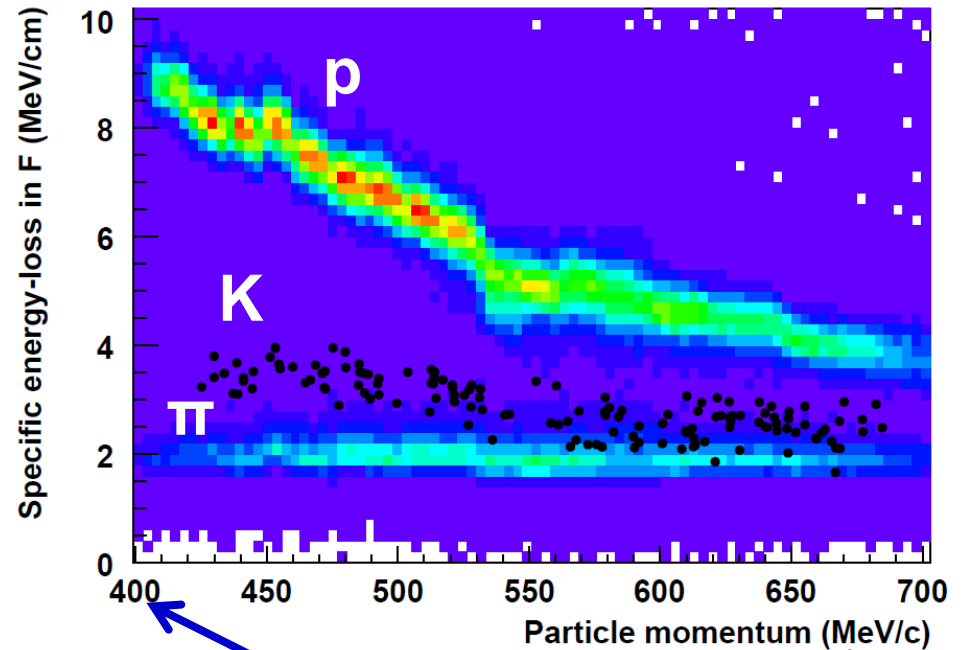
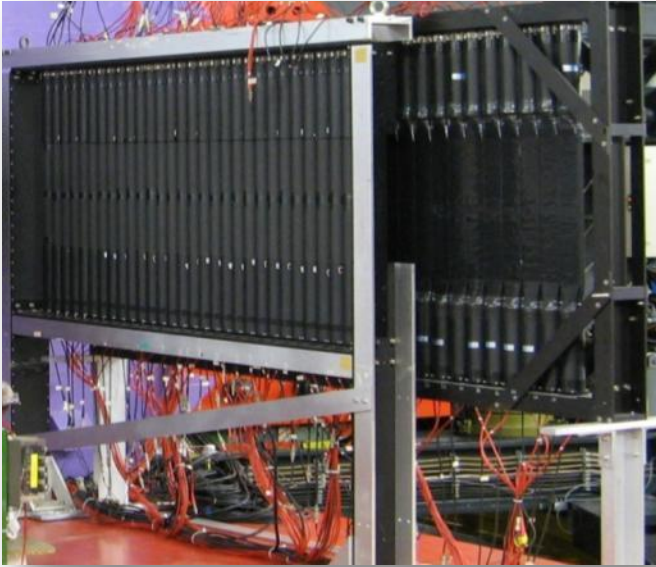
Particle detection and ID

Track reconstruction with two MWPCs



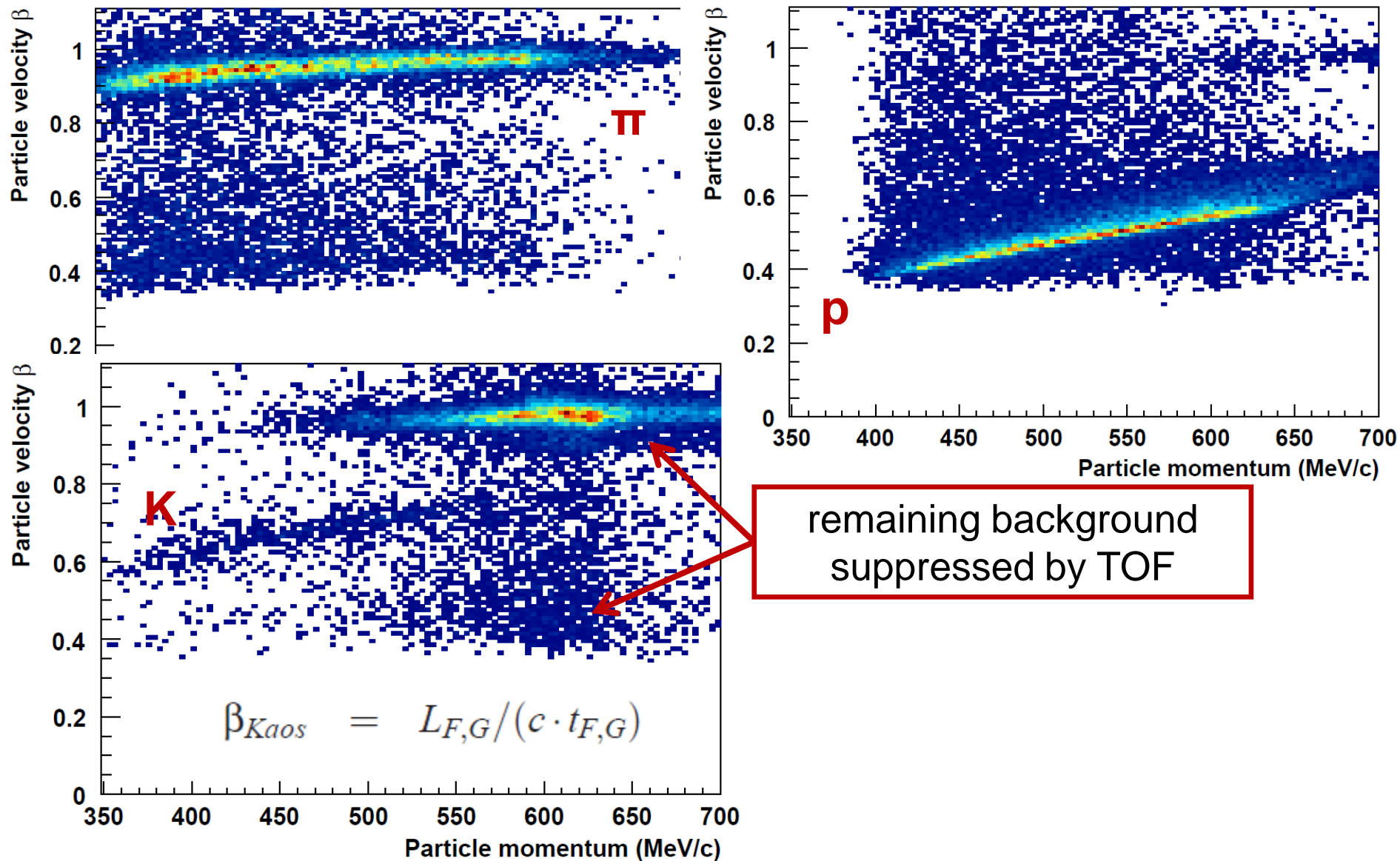
complex cluster finding and combination analysis

TOF wall "along" the focal plane

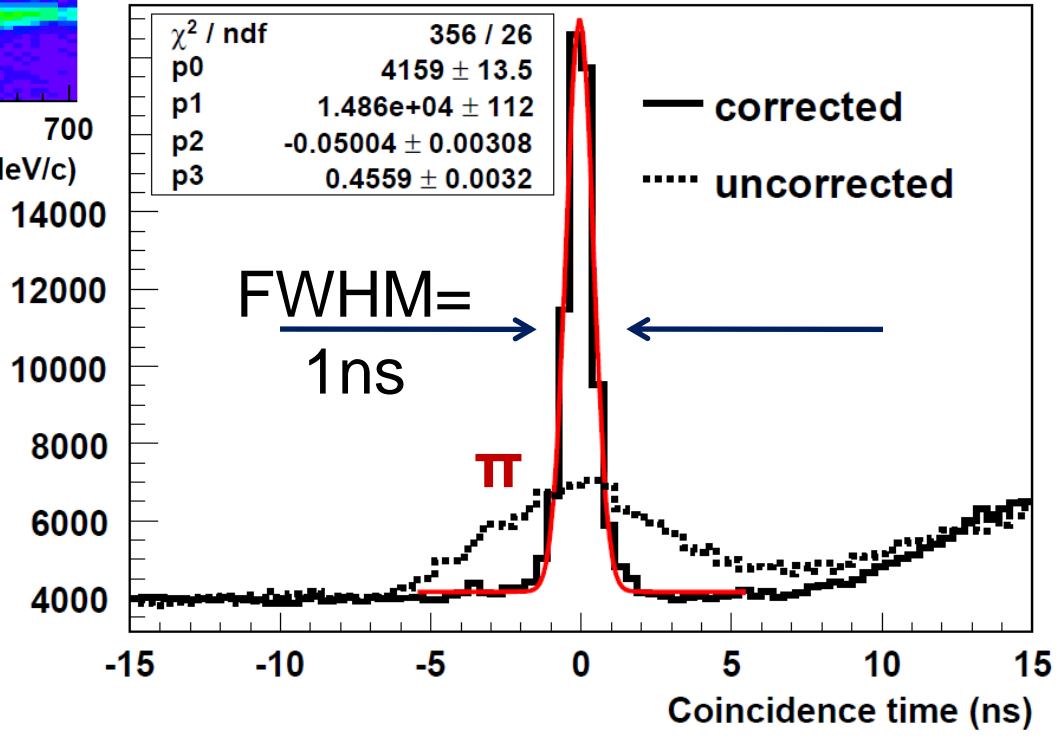
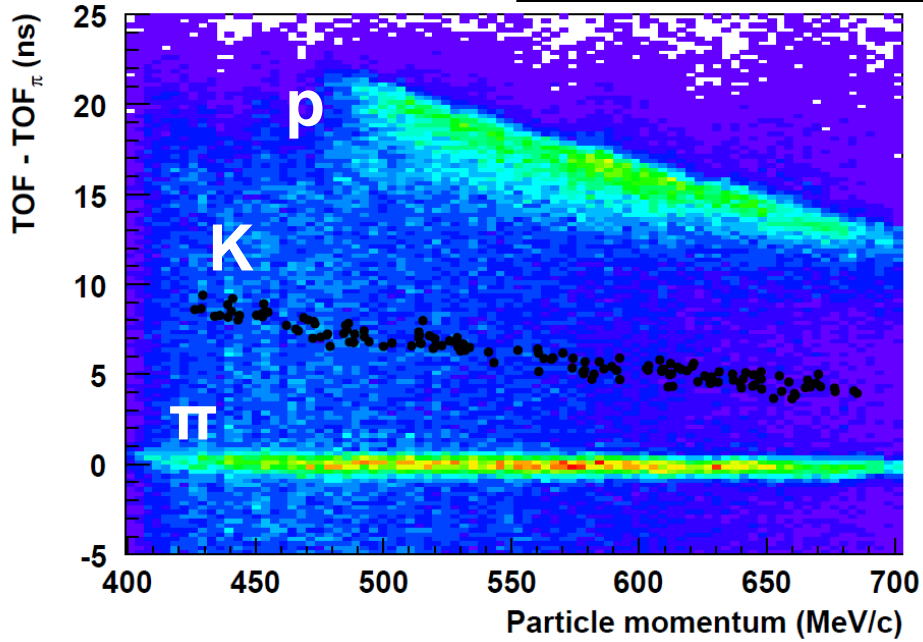


$\Delta p/p > 50\%$
momentum acceptance
350–700 MeV/c

Particle identification by dE/dx and TOF



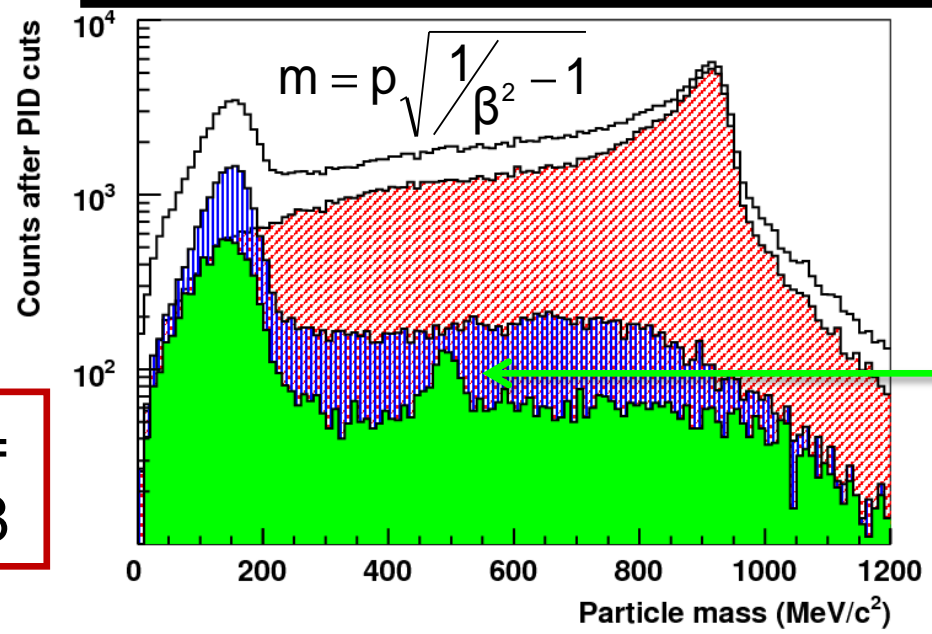
Coincidence time resolution



Reaction ID

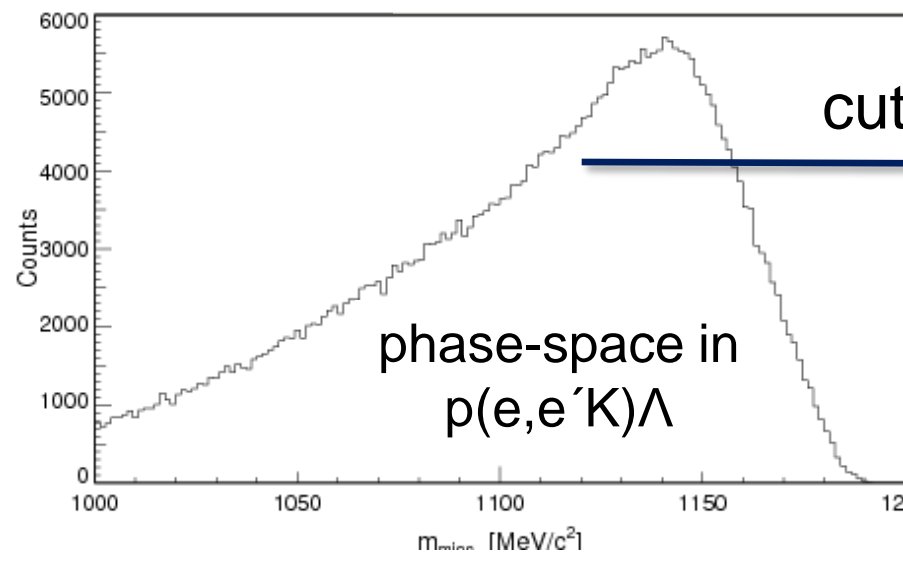
Missing Mass reconstruction

$\pi : K : p =$
 $1 : 0.03 : 1.38$

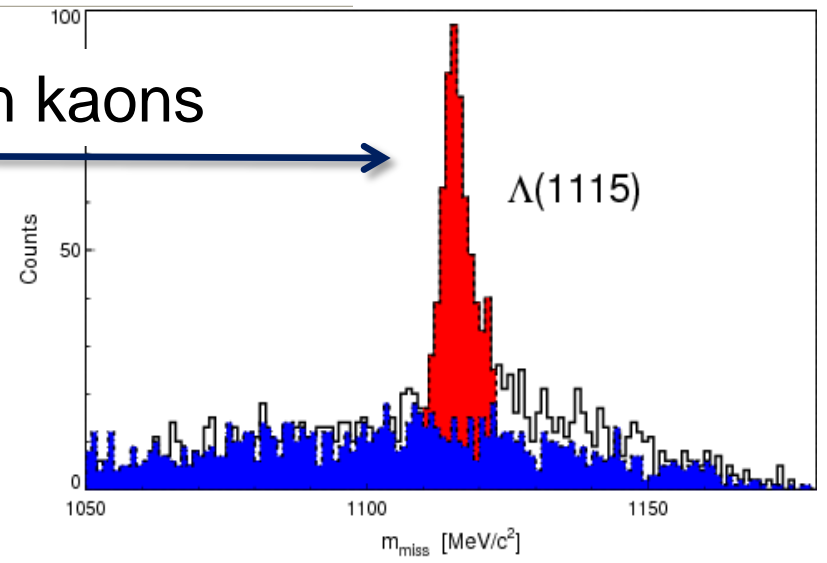


kaon peak after
dE/dx cut

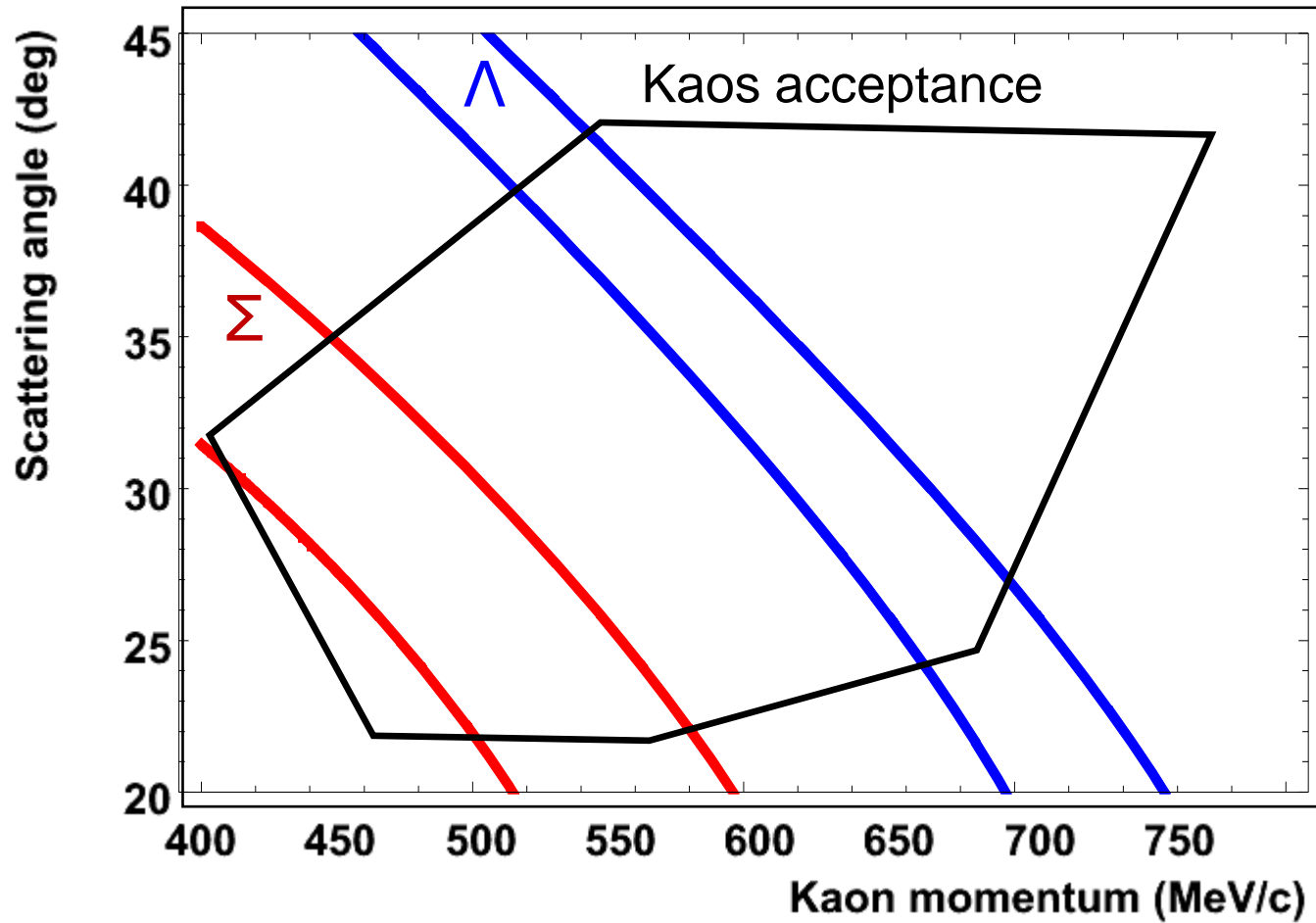
[Kaon at MAMI:
preliminary analysis]



cut on kaons



Λ - and Σ -hyperons in a single kinematic setting

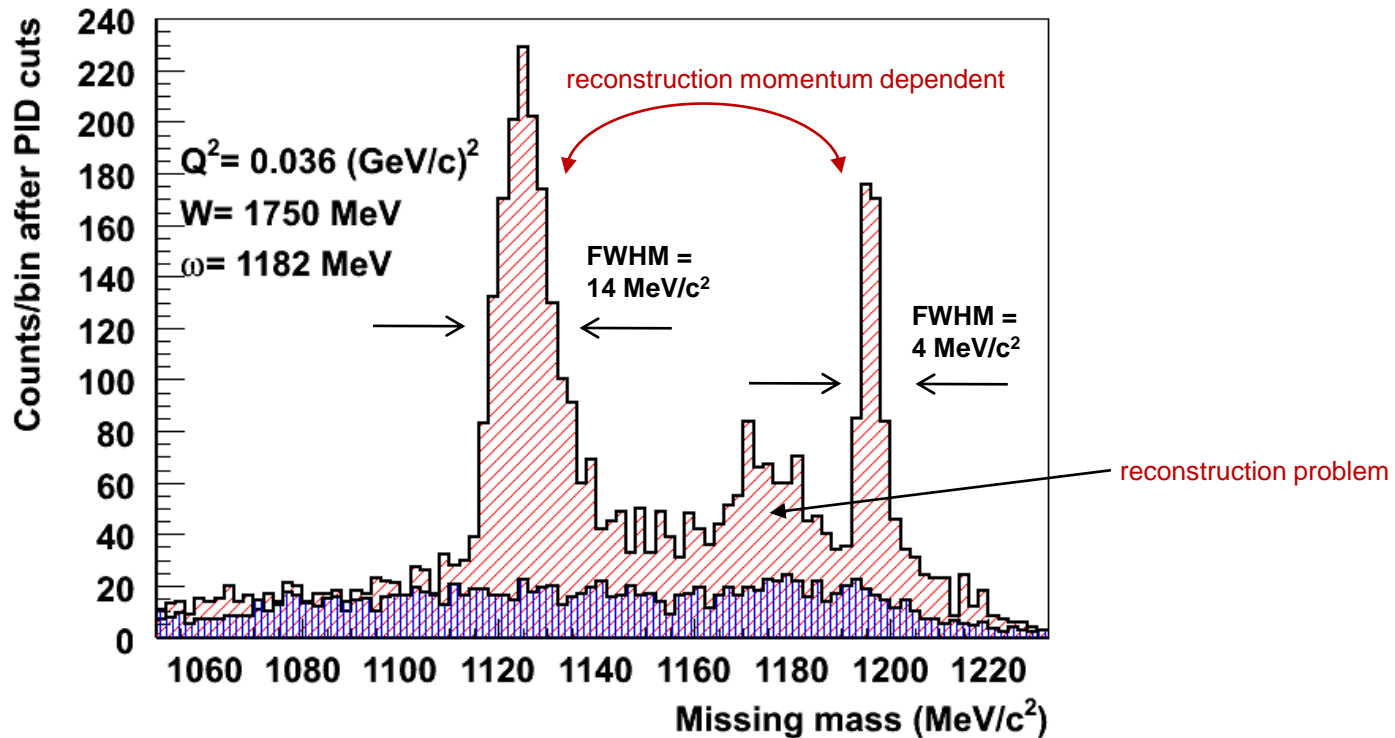


$$\langle p_K \rangle = 466 \text{ MeV}/c$$

$$\langle p_K \rangle = 642 \text{ MeV}/c$$

Λ and Σ yield extraction

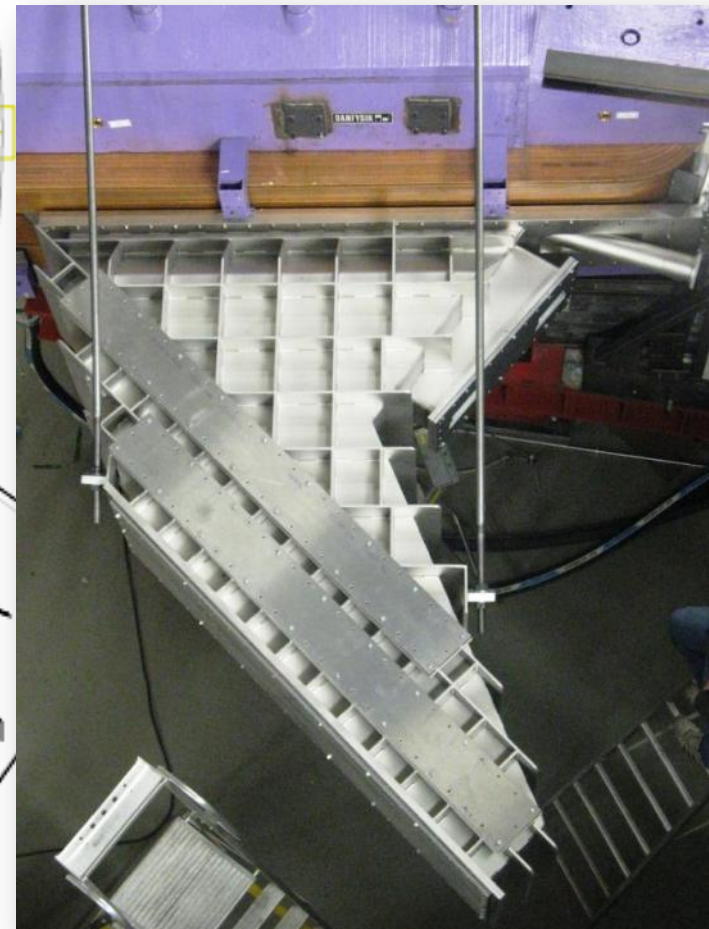
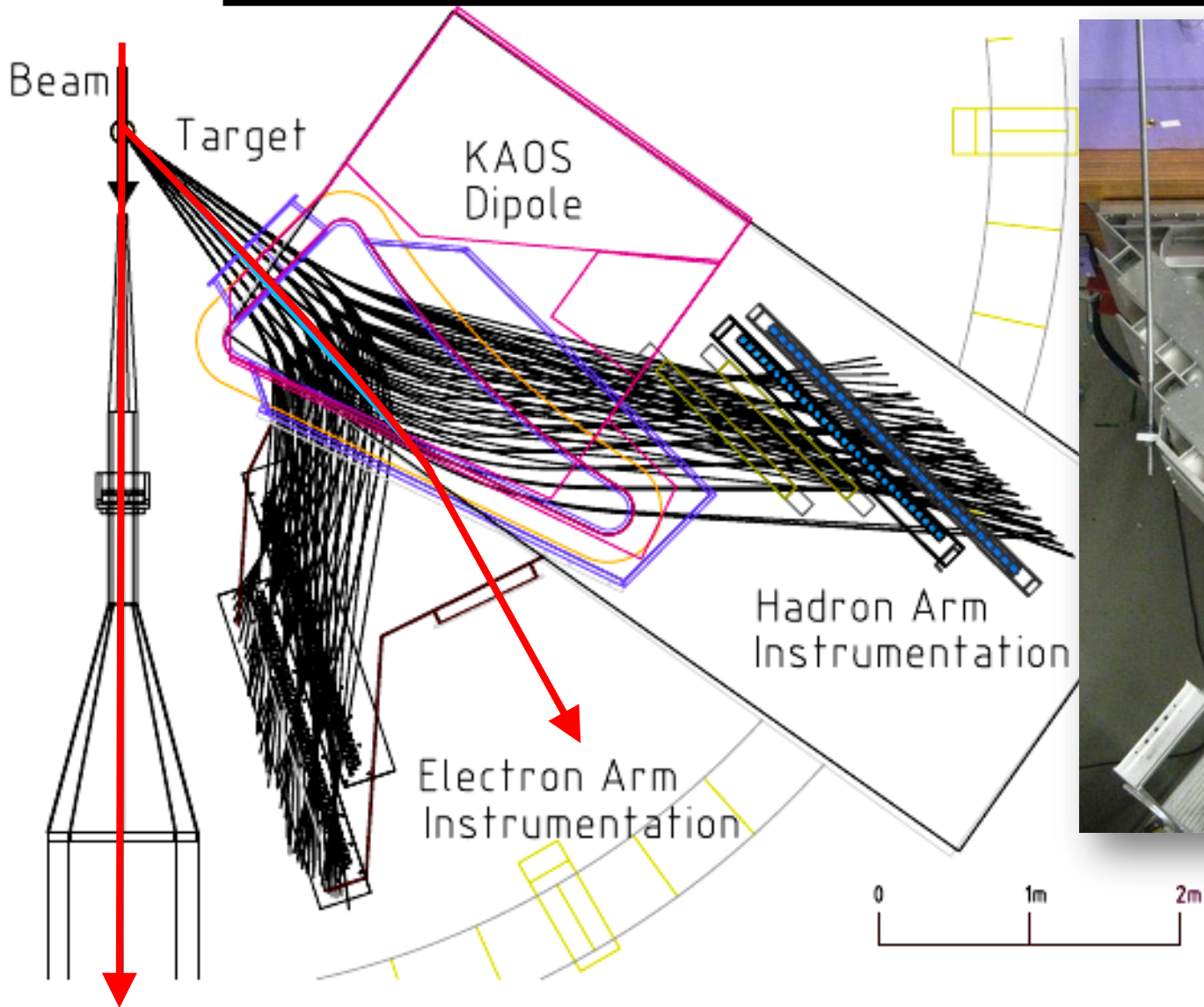
[Kaos at MAMI:
preliminary analysis]



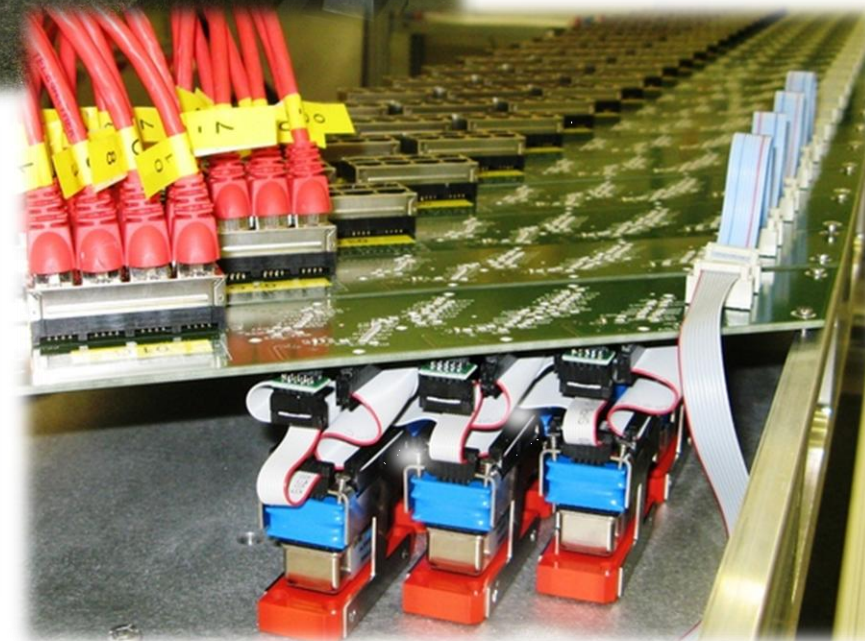
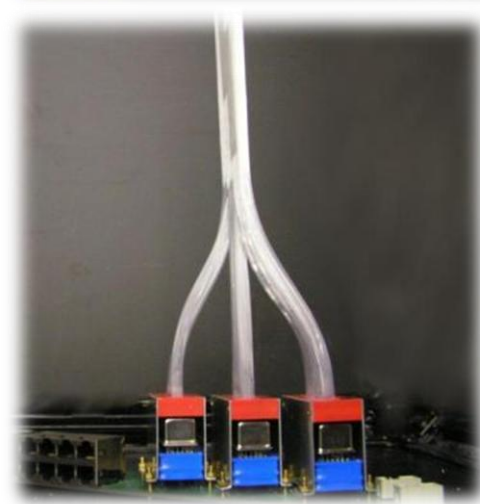
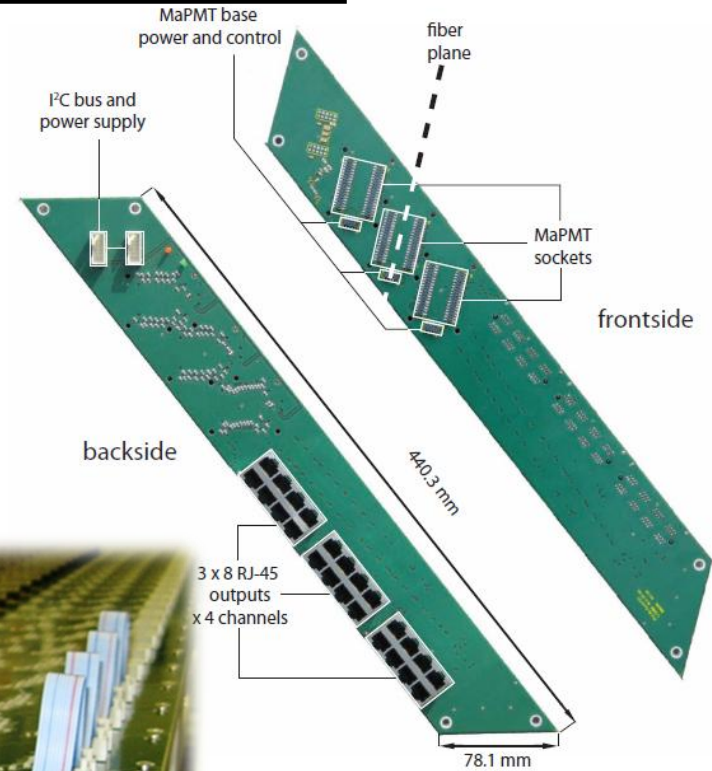
integrated luminosity extraction: $3000 \text{ femtobarn}^{-1}$
→ cross-section extraction expected end of 2009

Towards a zero-degree experiment at MAMI

Realisation of Kaos as a double spectrometer



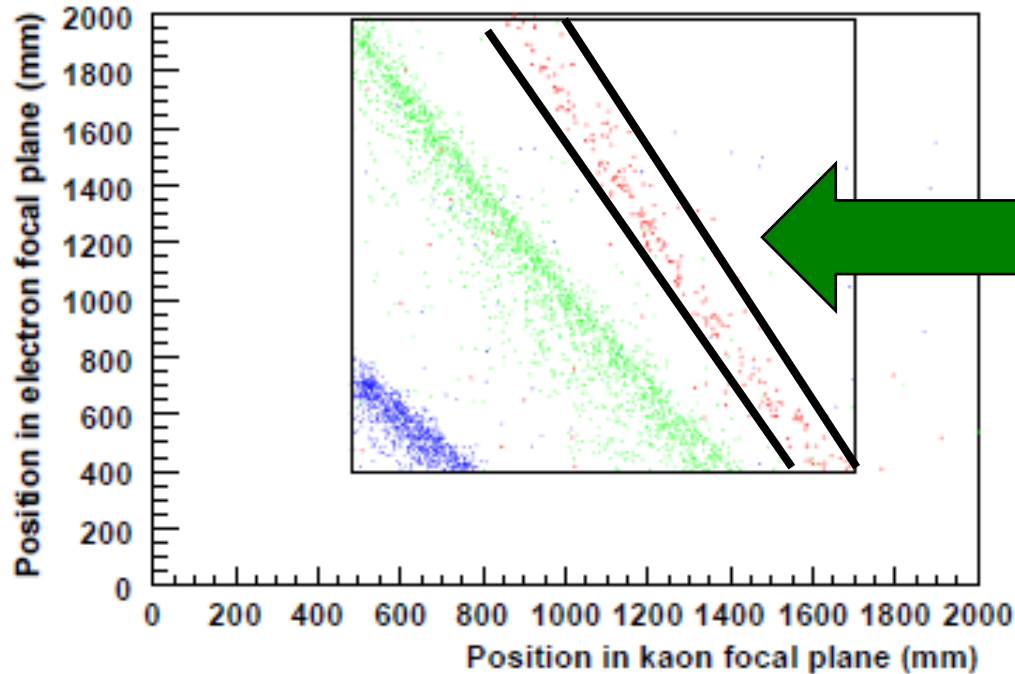
Status of the detector for the electron arm



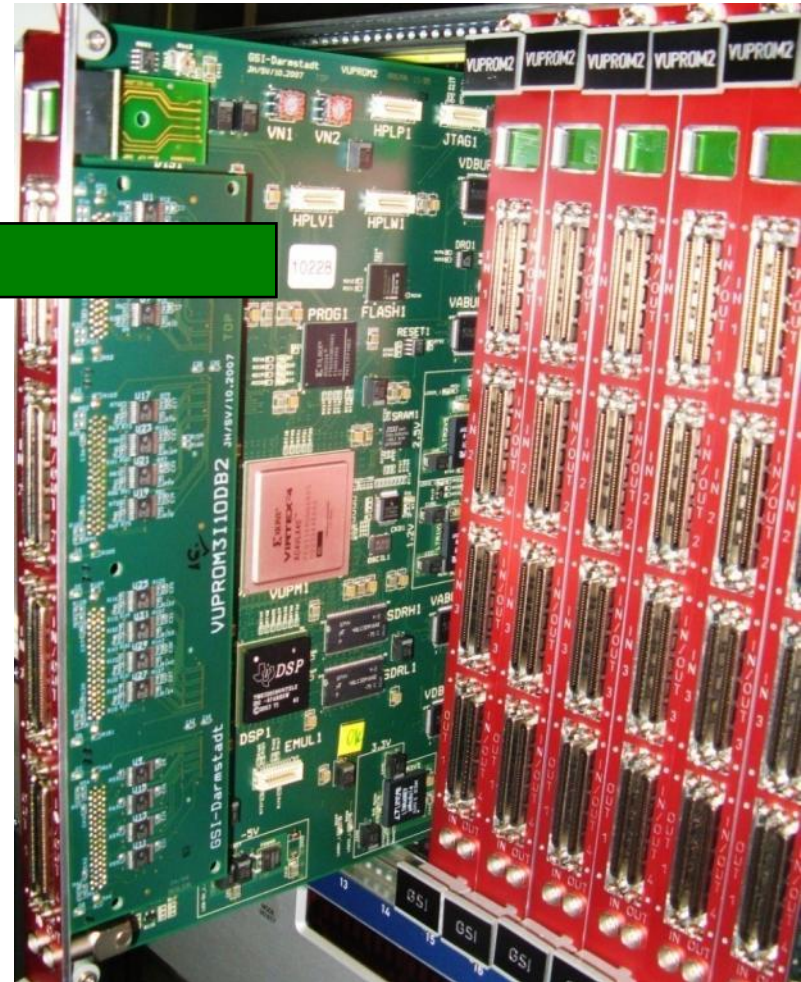
[P. Achenbach, et al.,
Front-end electronics for
the Kaos spectrometer
at MAMI, IEEE Trans.
Nucl. Sci. 56 (2009)]

Flexible trigger concept

- e.g. strong correlation between momenta/positions

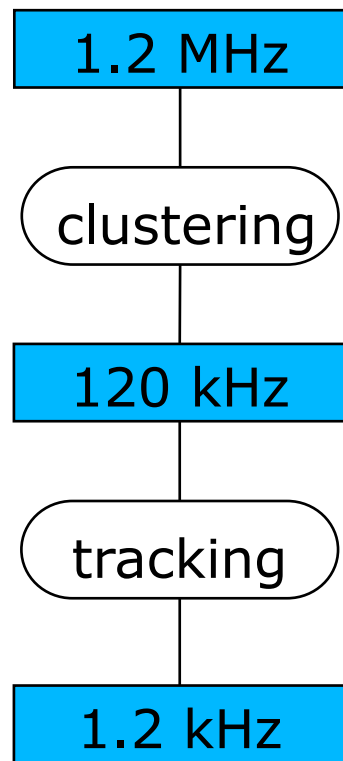


- goal: suppression of background on trigger level
- requirements:
 - 1) correlation of $> 60 \otimes 4000$ channels
 - 2) tracking information (clustering)
 - 3) flexibility (different beams, magnet settings...)
→ programmable, fast trigger decision

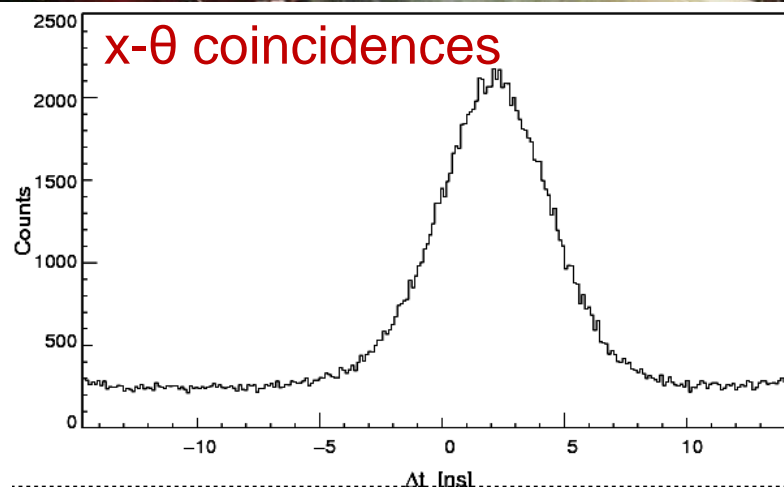
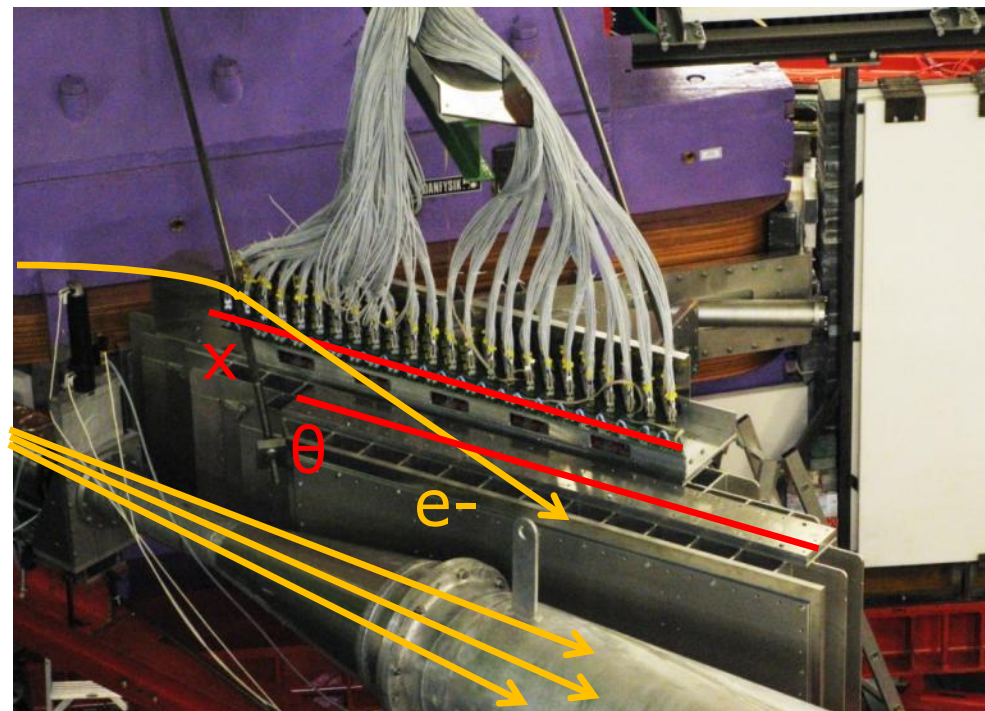


First electron arm beam-test

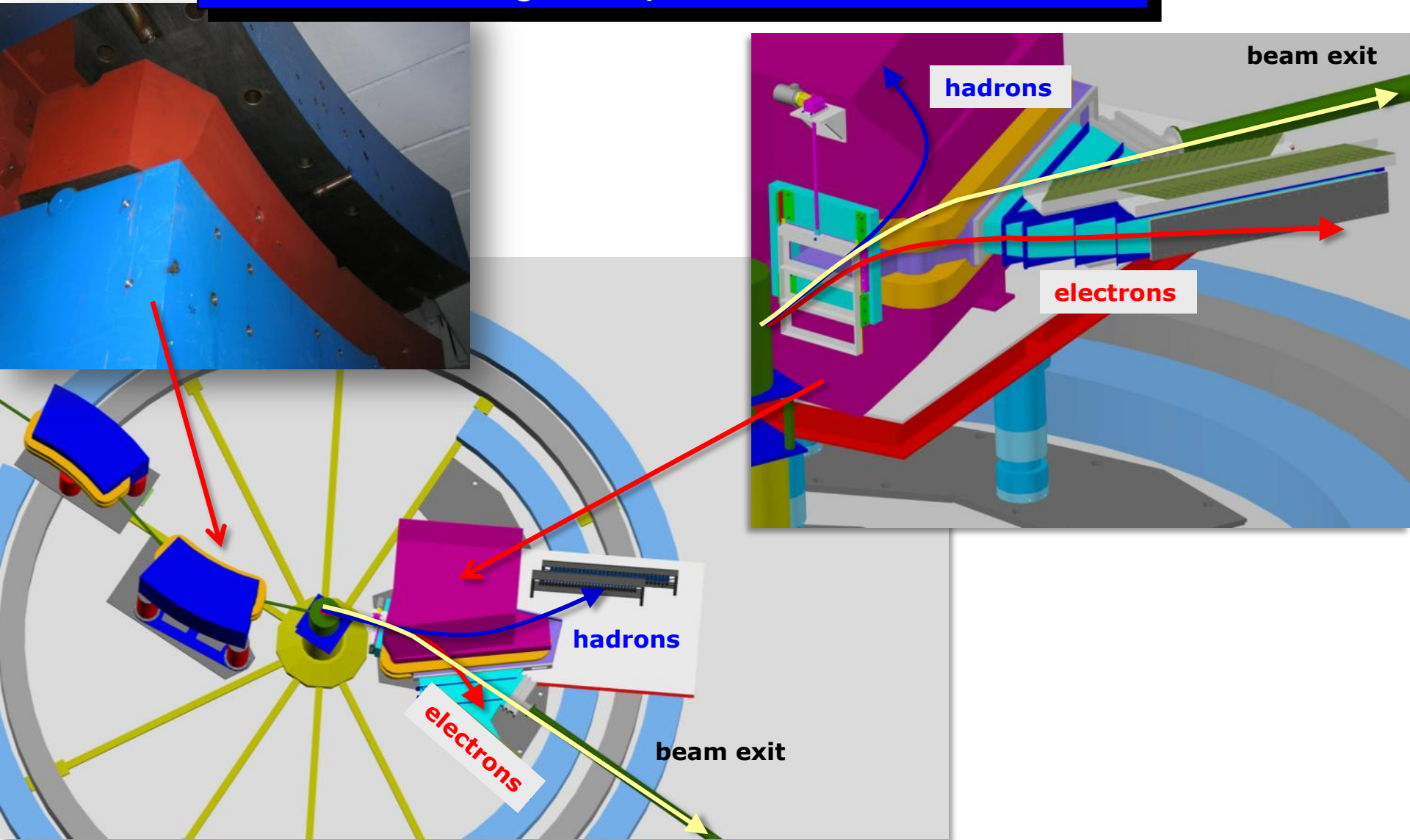
beam-test of trigger system
under high background rates
@ $I = 0.1 \mu\text{A}$:



→ future applications
at $I \geq 1 \mu\text{A}$ scheduled.



Installation of a beam chicane for a zero-degree operation of KAOS



Conclusion

1a) The strangeness physics programme at MAMI is progressing with KAOS operational since Oct 2008

1b) a first physics campaign dedicated to low Q^2 kaon electro-production was run in June 2009

2a) the extension of the KAOS spectrometer towards a two-arm operation under zero degree is progressing

2b) first physics campaigns dedicated to hypernuclear physics are expected to come in 2010