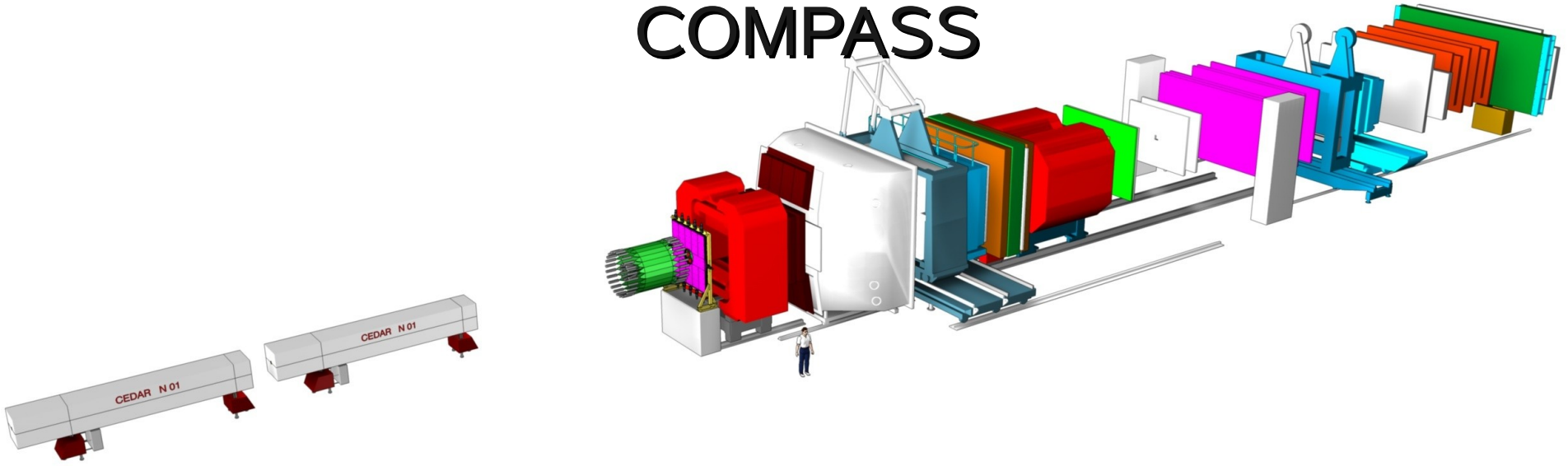
Hadron spectroscopy
in
diffractive and central production processes
at
COMPASS



Prometeusz Jasinski
for the COMPASS collaboration

- Diffraction 2010 -

bmb+f - Förderschwerpunkt
COMPASS
Großgeräte der physikalischen Grundlagenforschung

Beyond the $q\bar{q}$ model

Constituent quark model

Color neutral $q\bar{q}$ systems
Quantum numbers $(I^G)\ J^{PC}$
$P=(-1)^{L+1}$ $C=(-1)^{L+S}$ $G=(-1)^{I+L+1}$
J^{PC} multiplets: 0^{++}, 0^{-+}, 1^{--}, 1^{+-}, 1^{++}, 2^{++}, …
Forbidden: 0^{--}, 0^{+-}, 1^{-+}, 2^{+-}, 3^{-+}, …

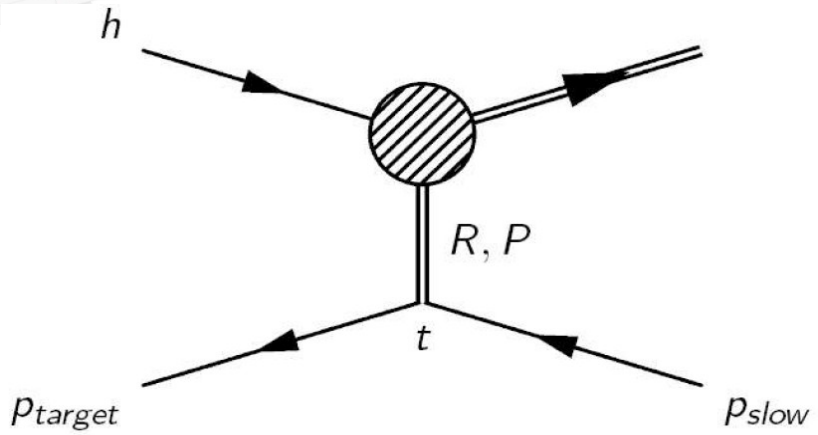
QCD prediction: meson states beyond

Hybrids: $q\bar{q}g$
Tetraquarks: $(q\bar{q})(q\bar{q})$

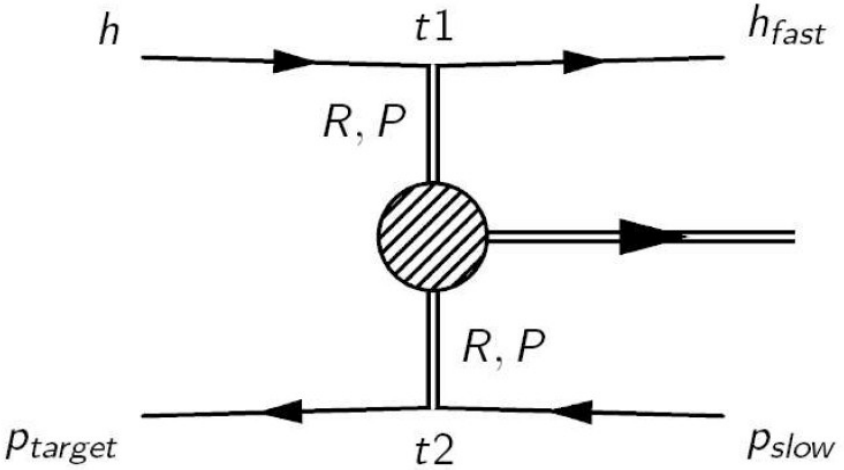
→ "Spin exotics"

Glueballs: gg, ggg

Production mechanisms

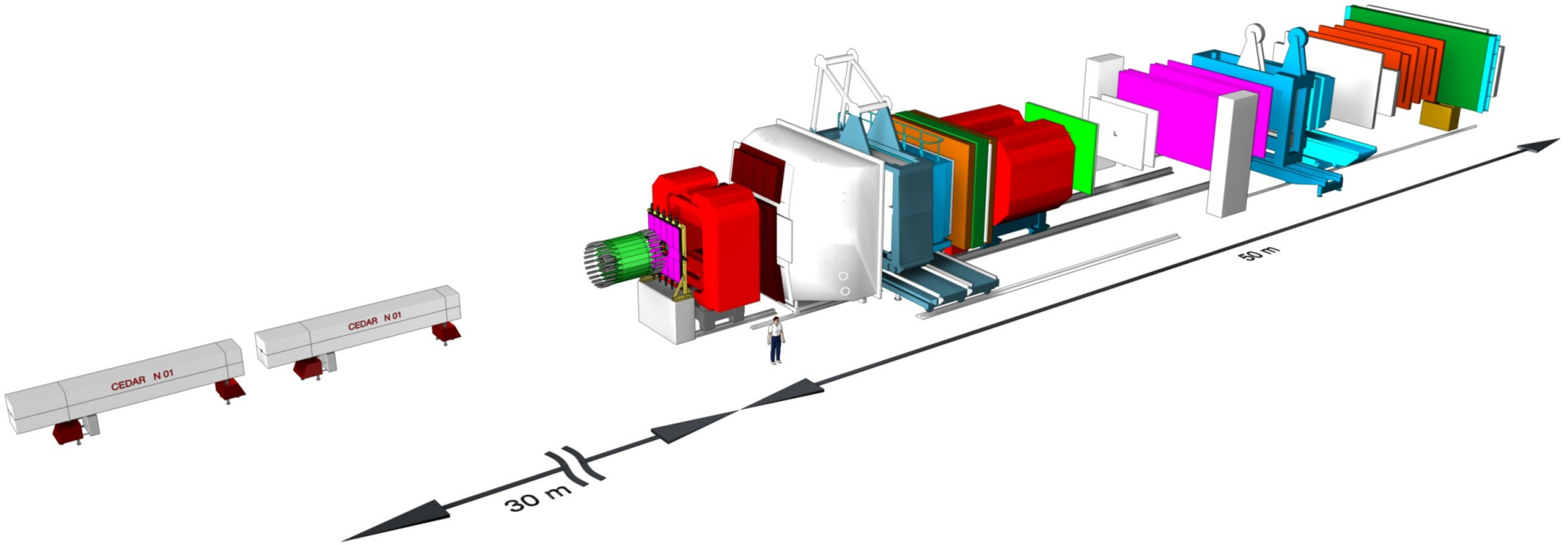


Diffractive Scattering



Central Production

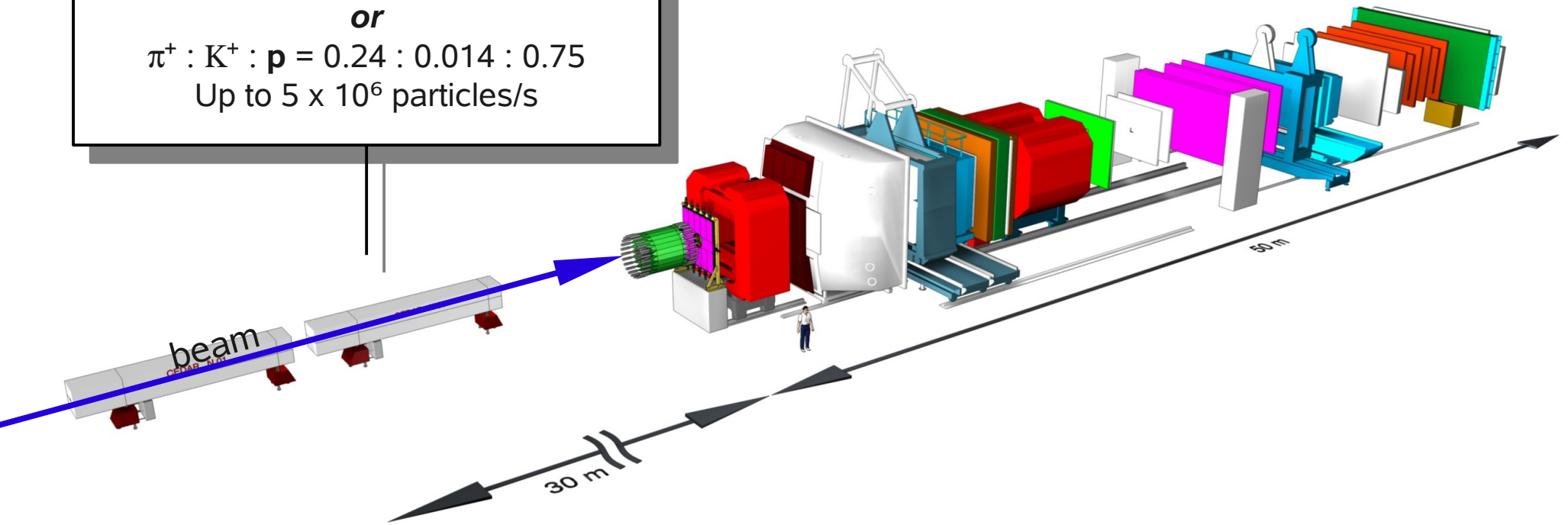
The COMPASS Spectrometer 2008/2009



The COMPASS Spectrometer 2008/2009

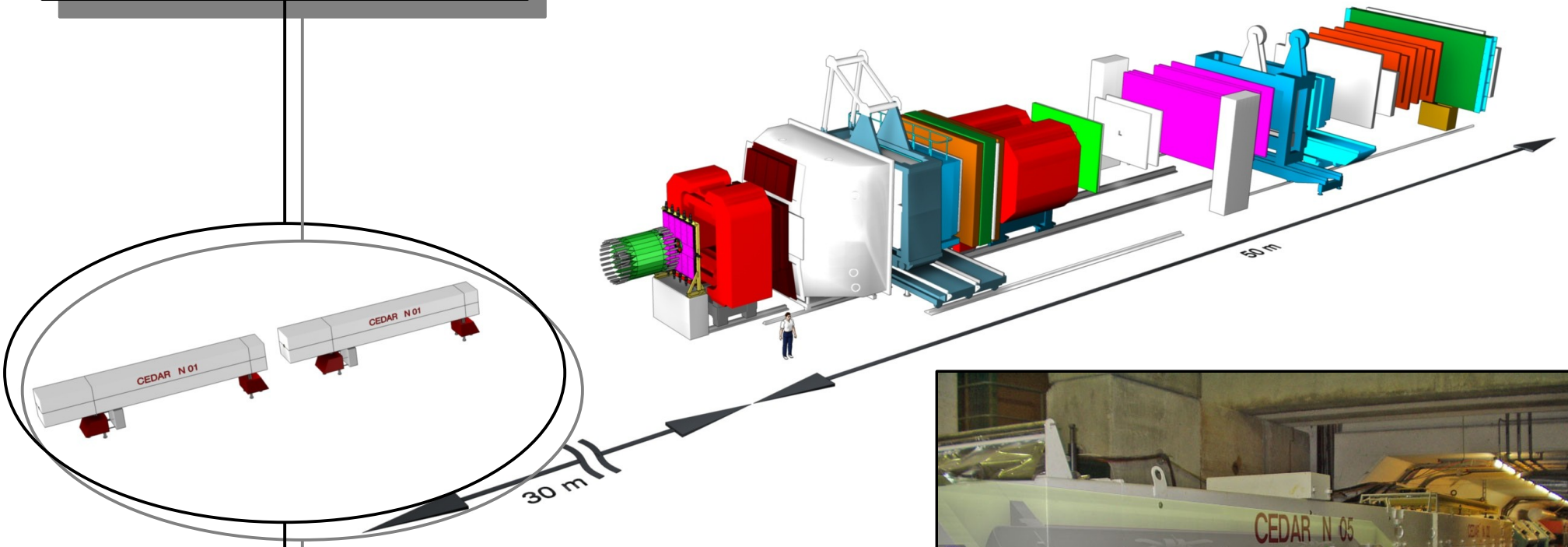
Beam properties

Beam energy 190 GeV/c²
Beam composition:
π^- : K^- : $\bar{p}$ = 0.97 : 0.024 : 0.008
or
π^+ : K^+ : **p** = 0.24 : 0.014 : 0.75
Up to 5 x 10^6 particles/s



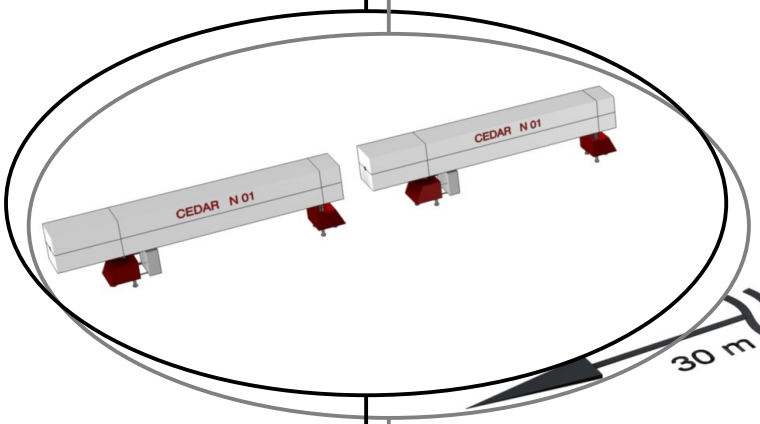
The COMPASS Spectrometer 2008/2009

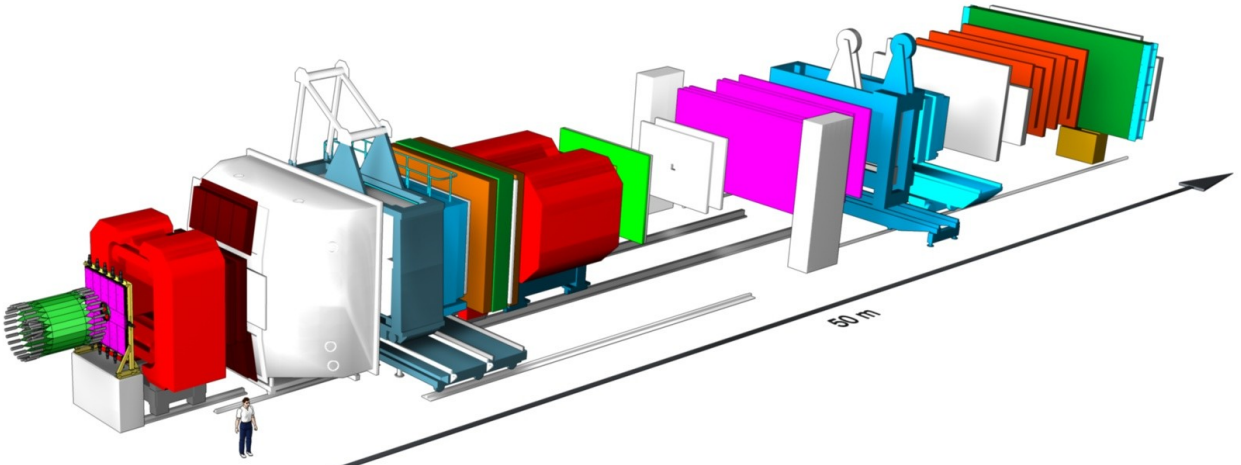
CEDAR detectors for beam particle identification



The COMPASS Spectrometer 2008/2009

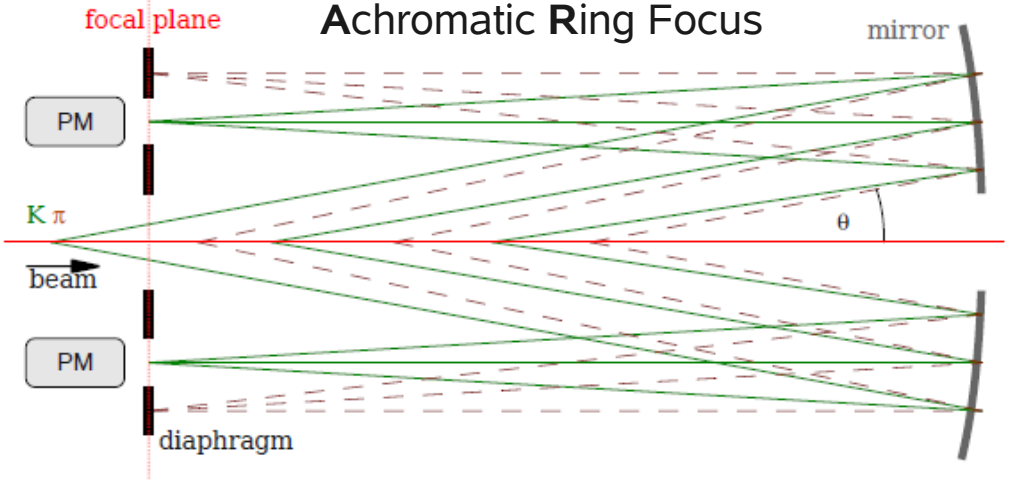
CEDAR detectors for beam particle identification





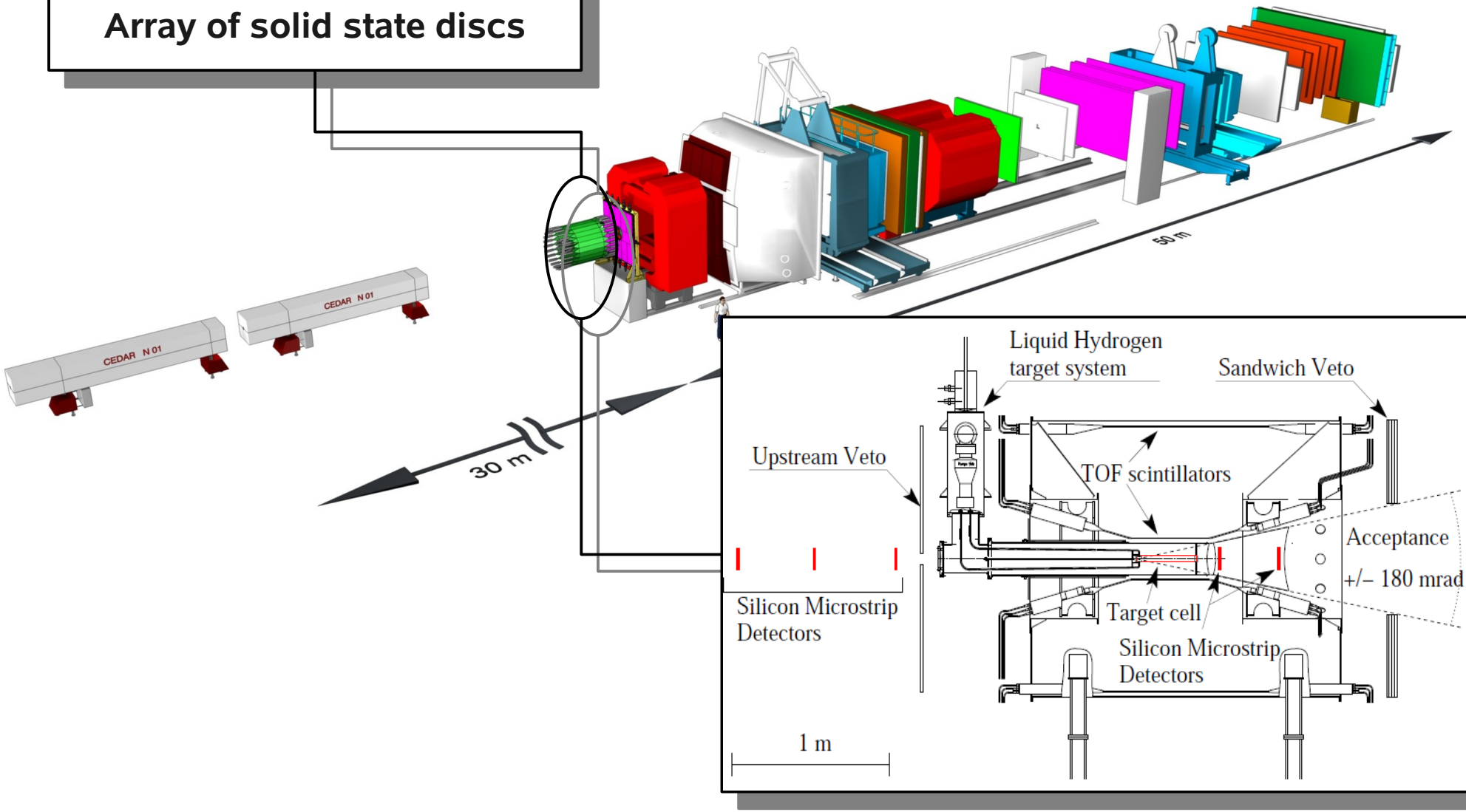
30 m

Cerenkov **D**ifferential counter with **A**chromatic **R**ing Focus

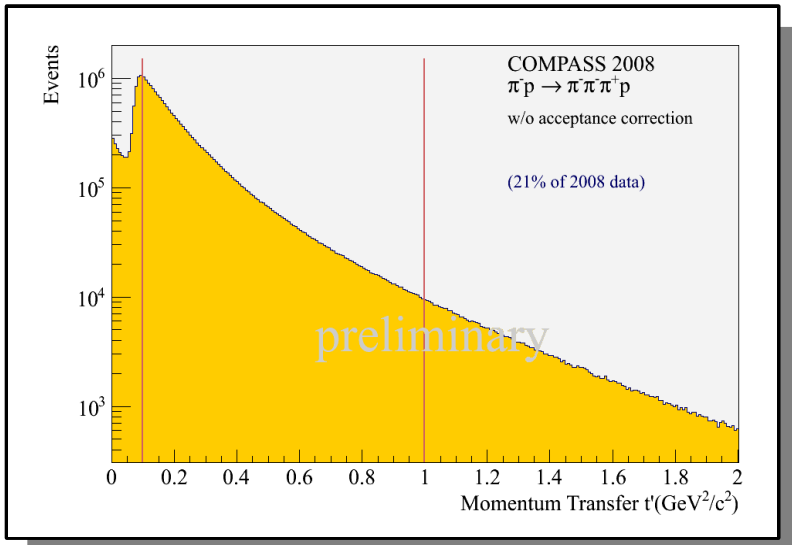


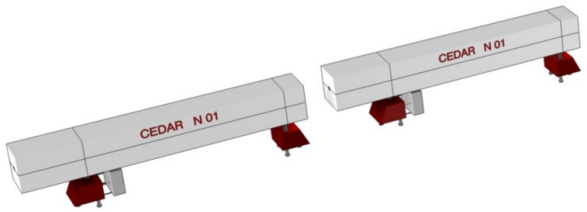
The COMPASS Spectrometer 2008/2009

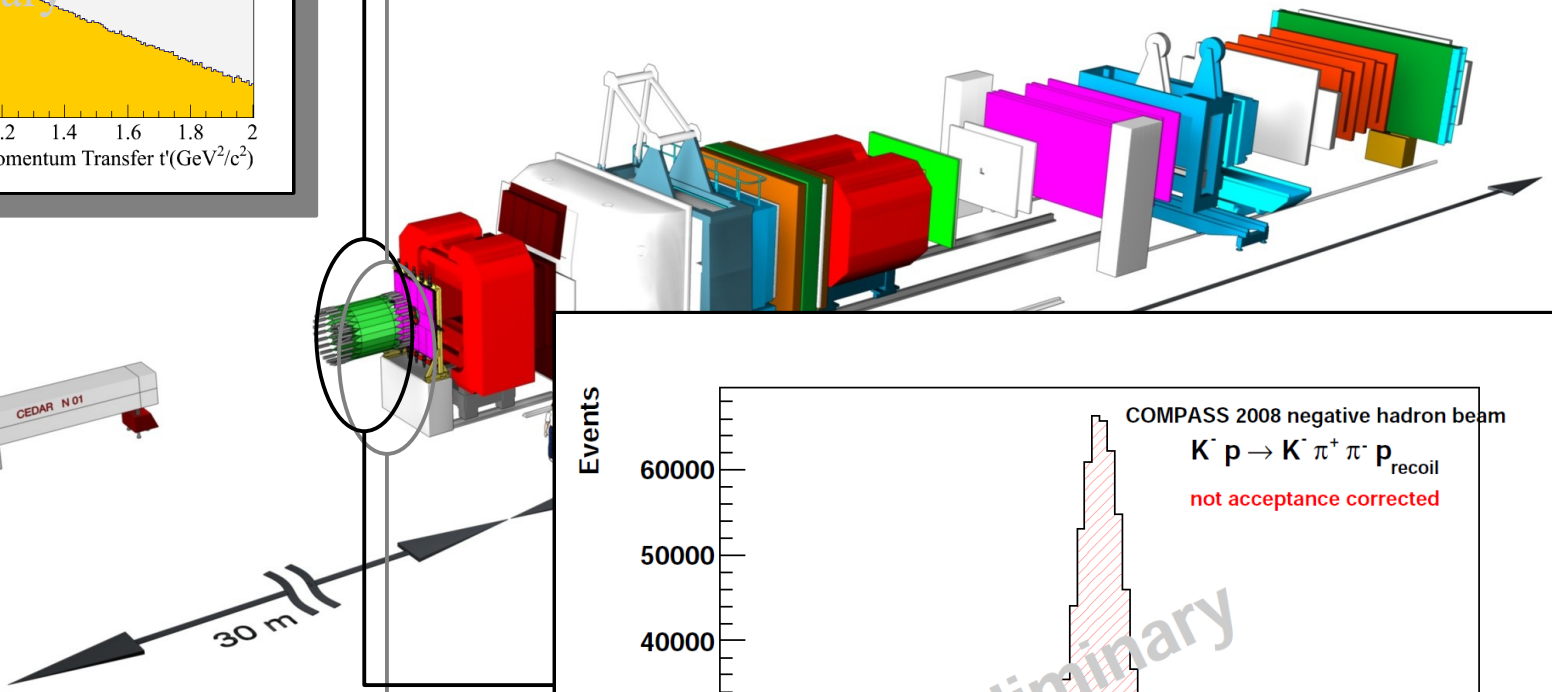
Recoil proton detector
around
40 cm long lH2 target
or
Array of solid state discs

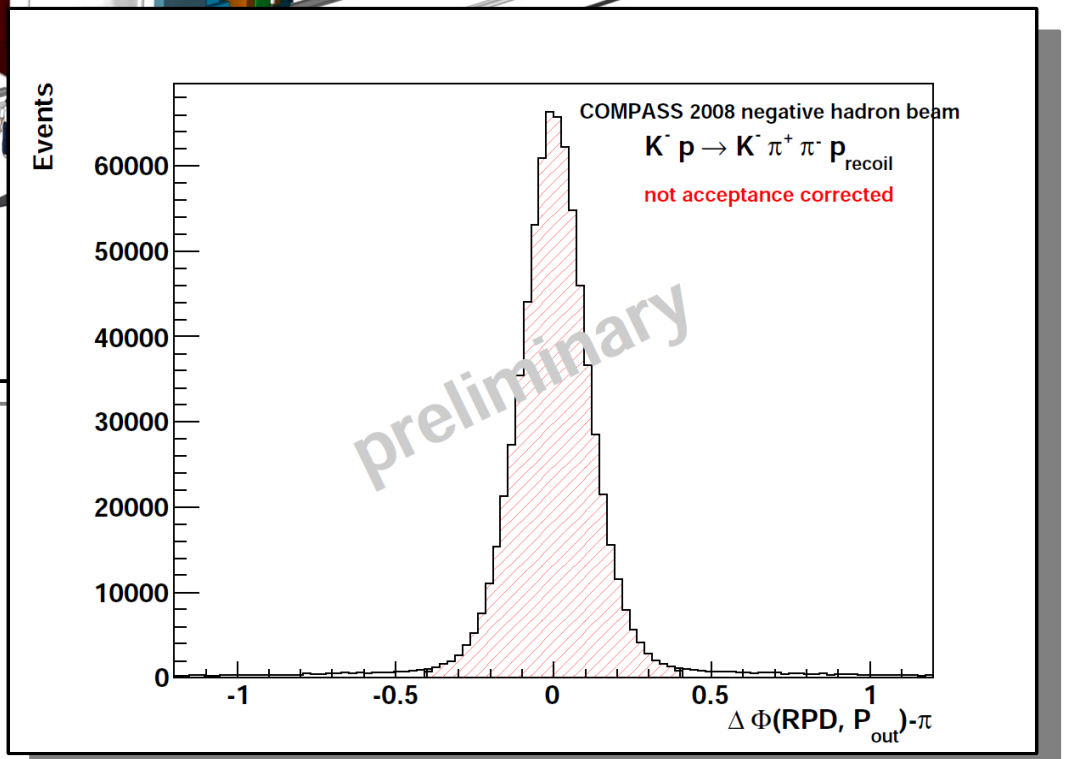


The COMPASS Spectrometer 2008/2009







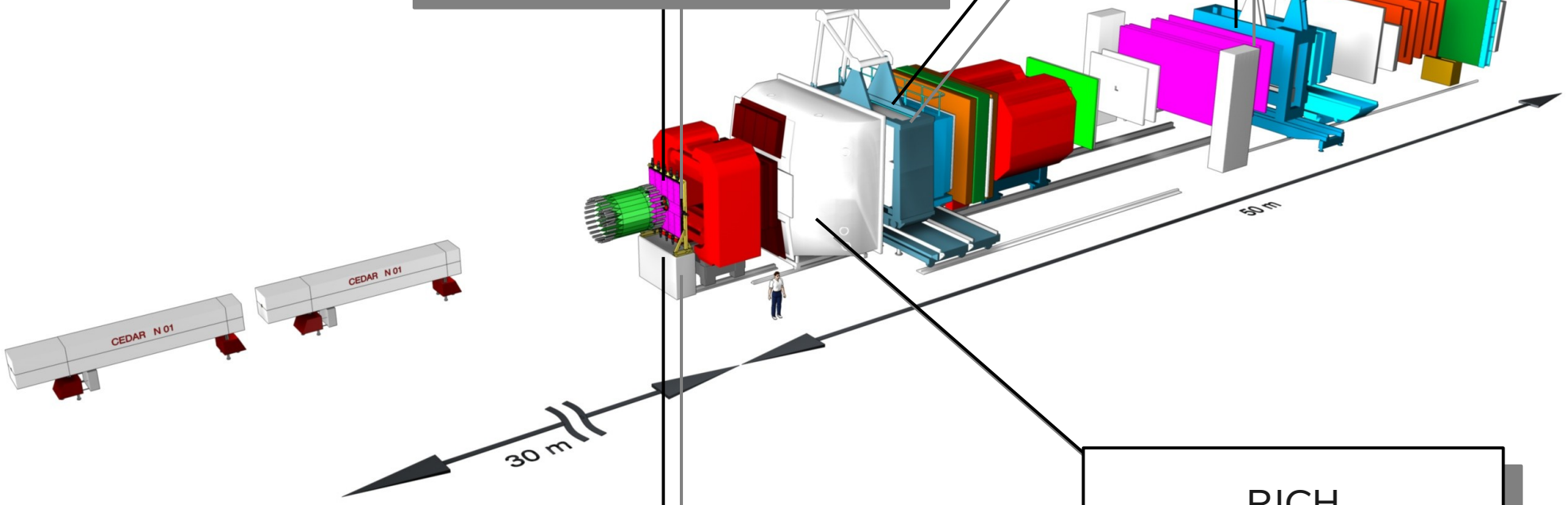


The COMPASS Spectrometer 2008/2009

Further important upgrades

ECAL Laser monitoring system, radhard glass, shashlik modules

Sandwich veto matching the spectrometer acceptance

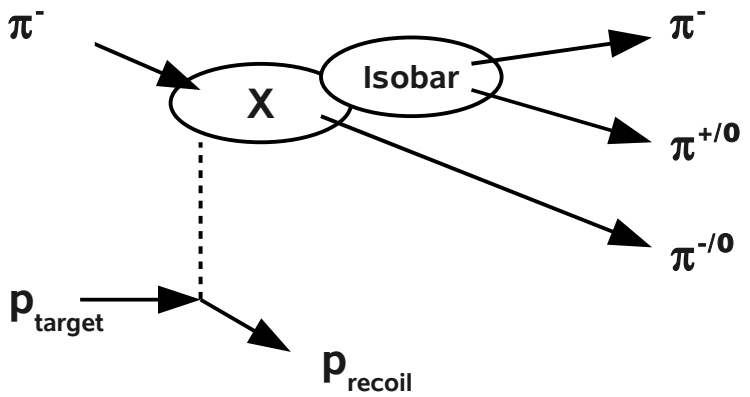


RICH upgrade in 2006

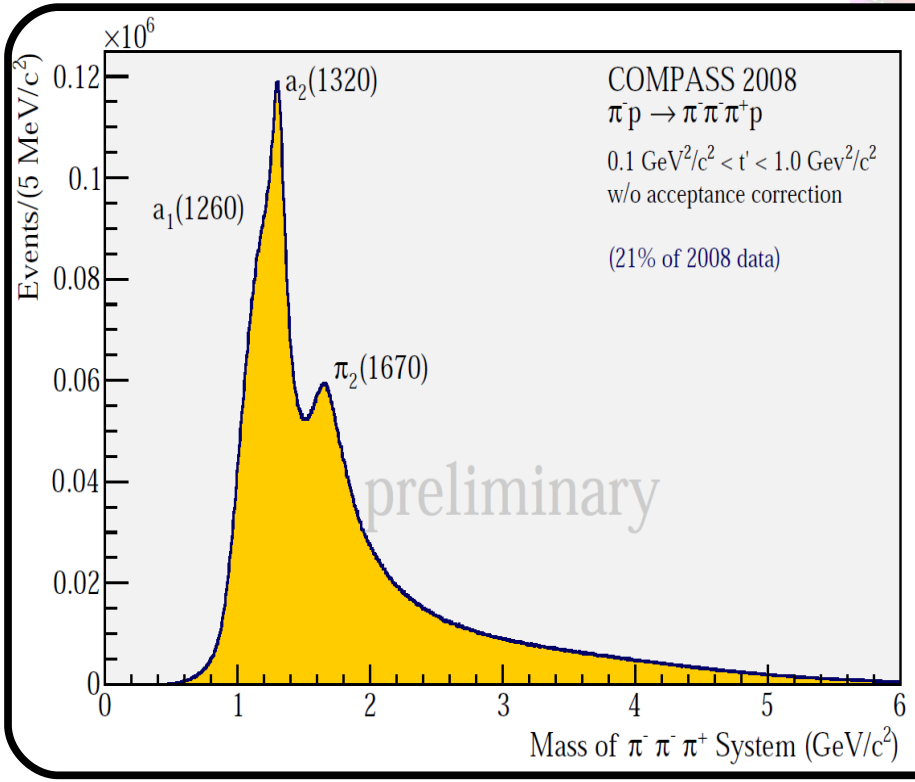
Several tracking detectors upgraded: cold Silicon stations, Pixel GEMs, Micromegas, ...

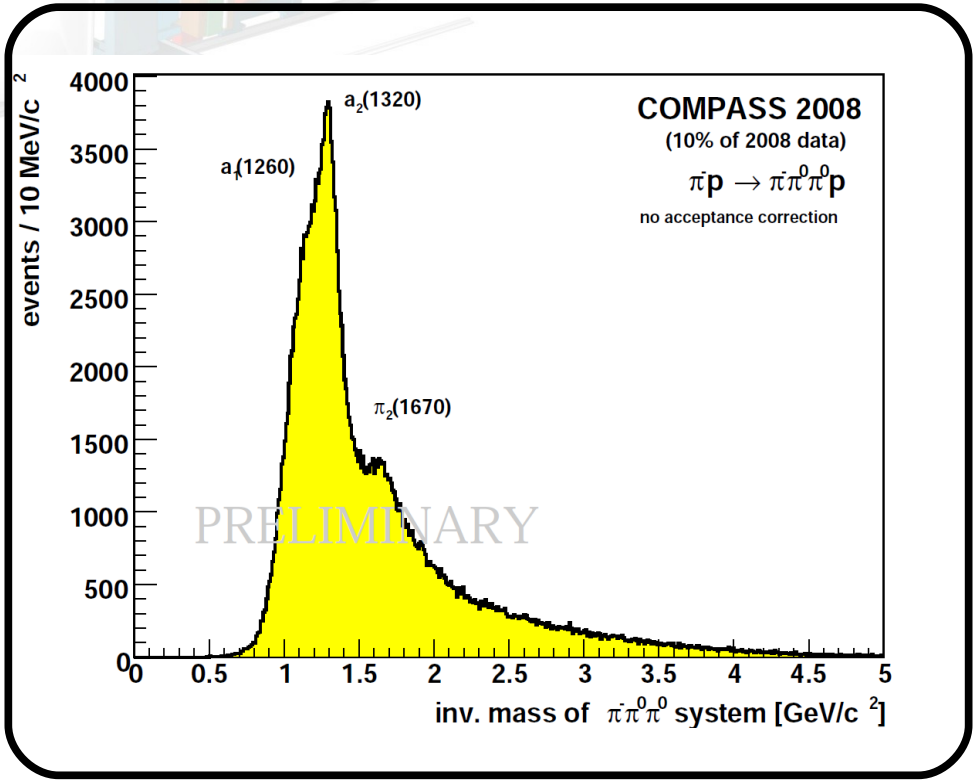
And much more not mentioned here.

Some results of $\pi^- p \rightarrow \pi^- \pi^{+/0} \pi^{-/0} p_{recoil}$

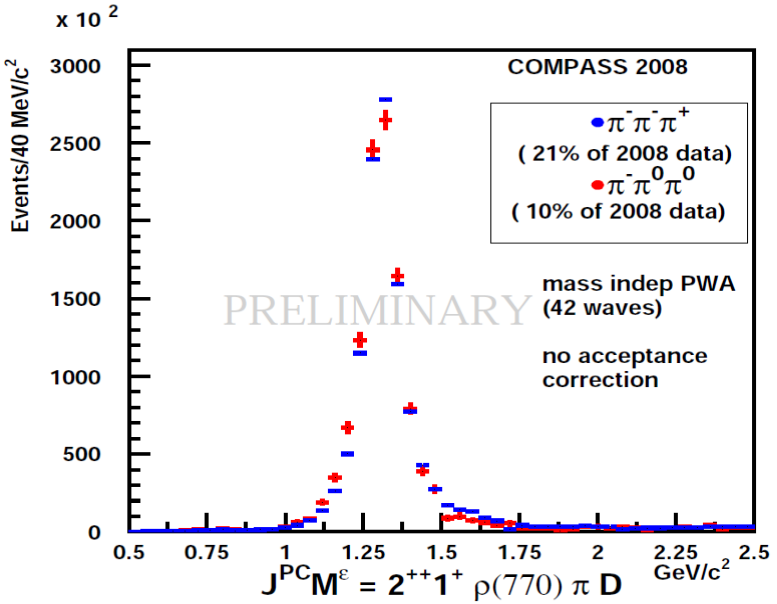


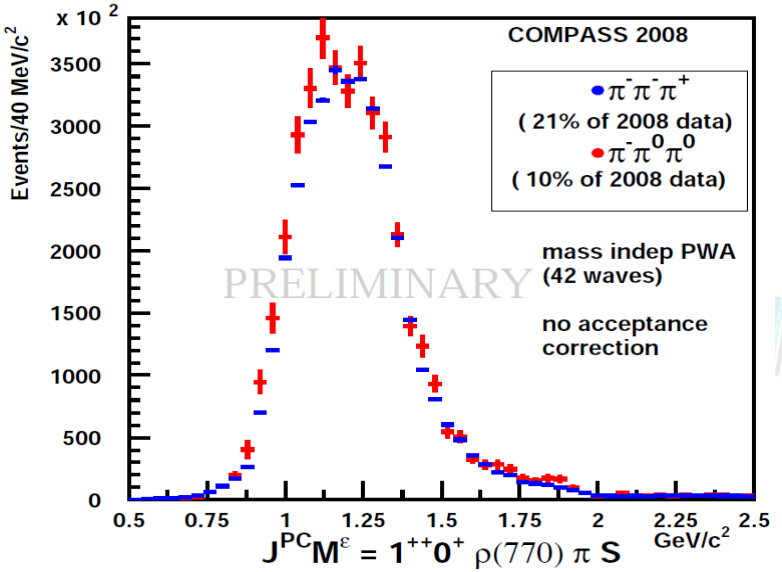
- Visible well established $a_1(1260)$, $a_2(1320)$ and $\pi_2(1670)$
- COMPASS observed in 2004 data the exotic ($J^{PC}=1^{-+}$) $\pi(1600)$ (see next talk)
- The hadron run will exceed world's statistics by a factor of 100

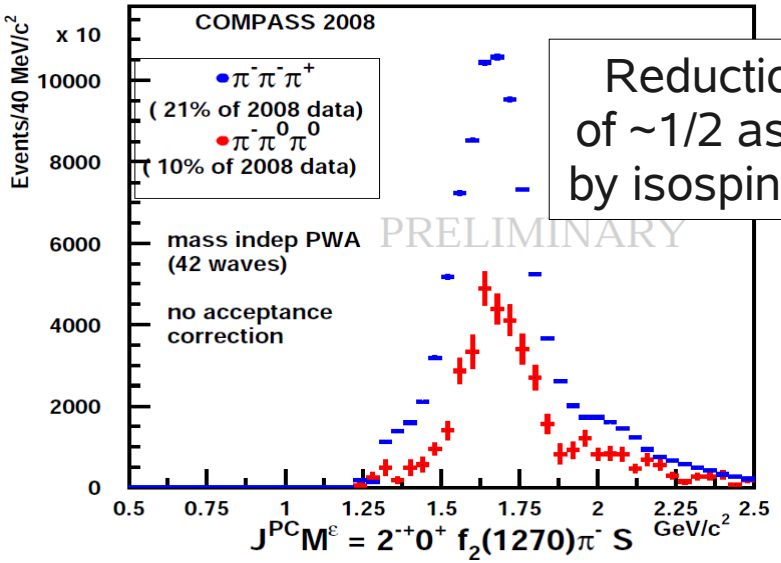




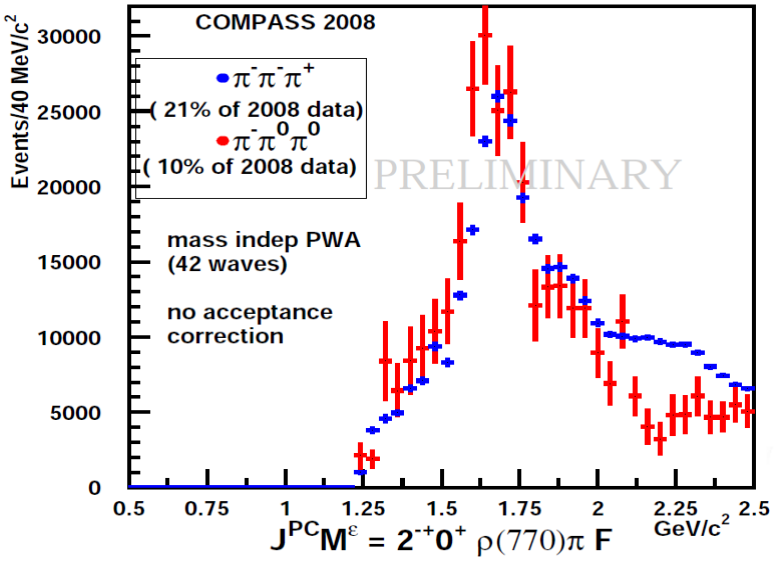
First PWA results of $\pi^- p \rightarrow \pi^- \pi^{+/0} \pi^{-/0} p_{recoil}$





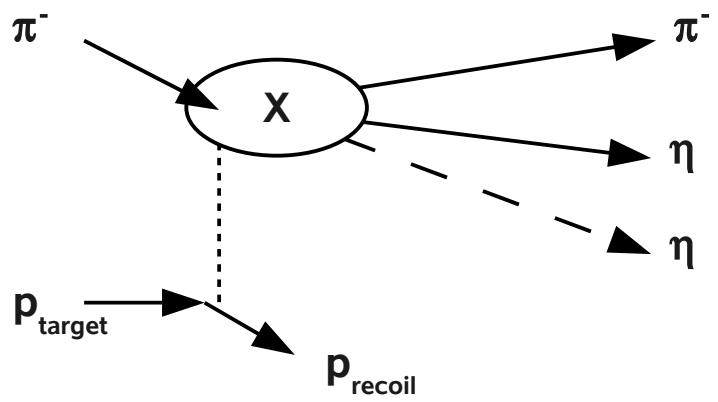


Reduction factor of ~1/2 as expected by isospin symmetry

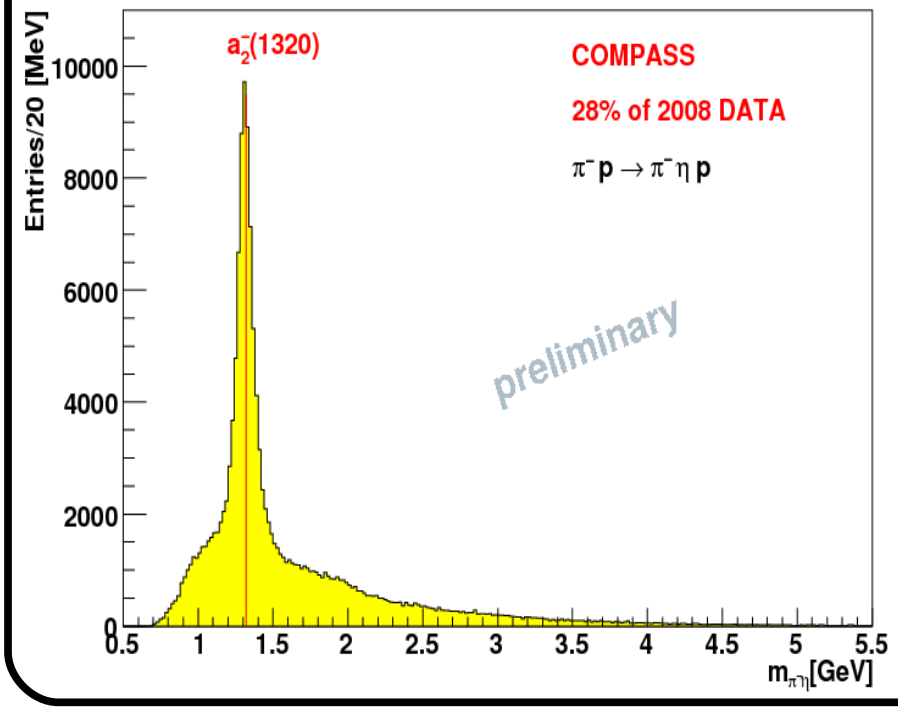


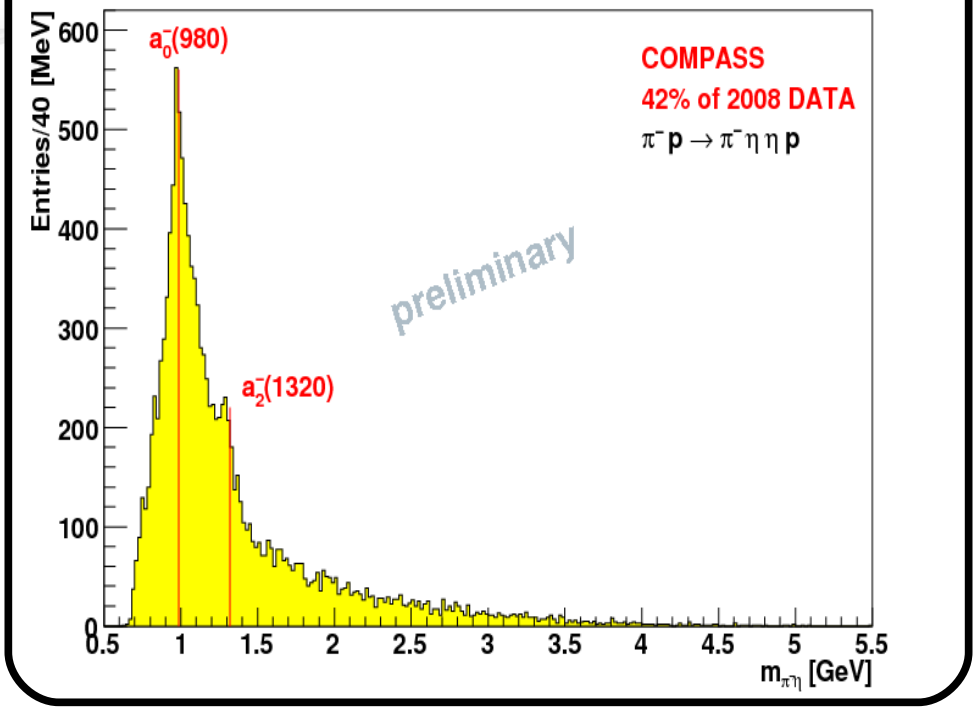
Isobar model, 42 waves including background, mass independent fit, comparison of neutral and charged modes with normalization to a_2

Selected results of $\pi^- p \rightarrow \pi^- \eta (\eta) p_{recoil}$

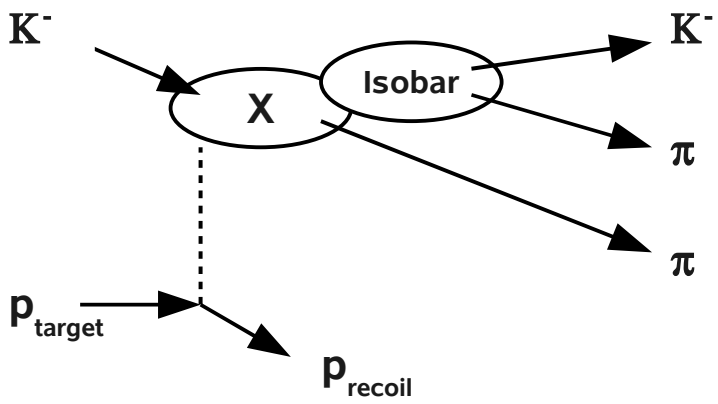


Analysis of diffractively produced
$\pi \eta (\eta)$ systems
PWA currently being performed
More results expected soon

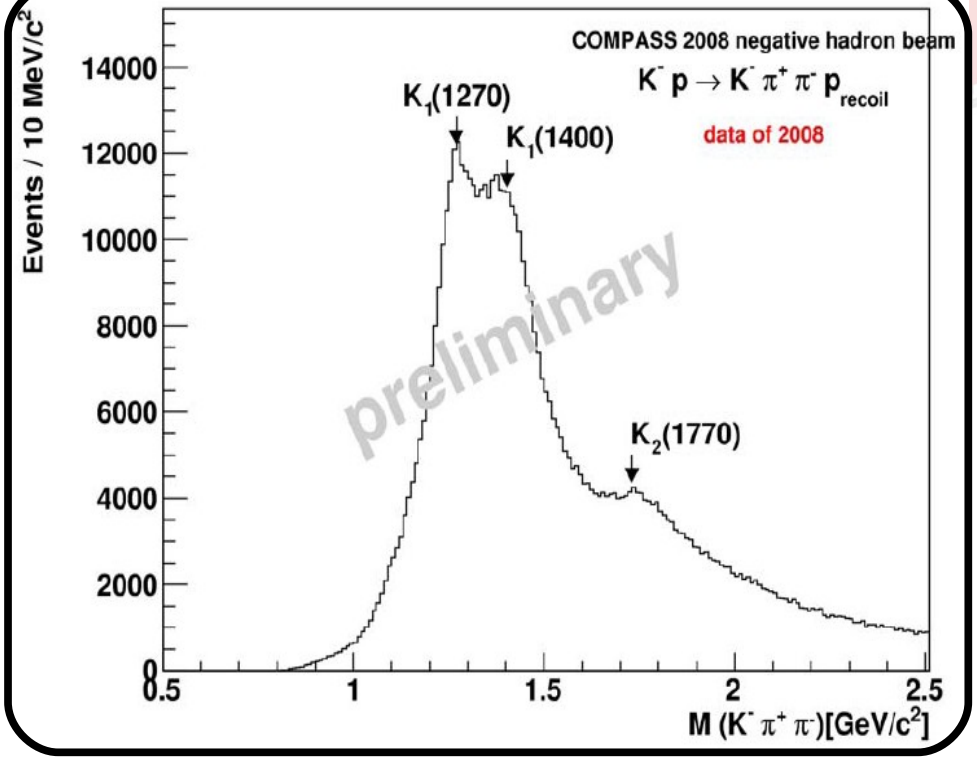


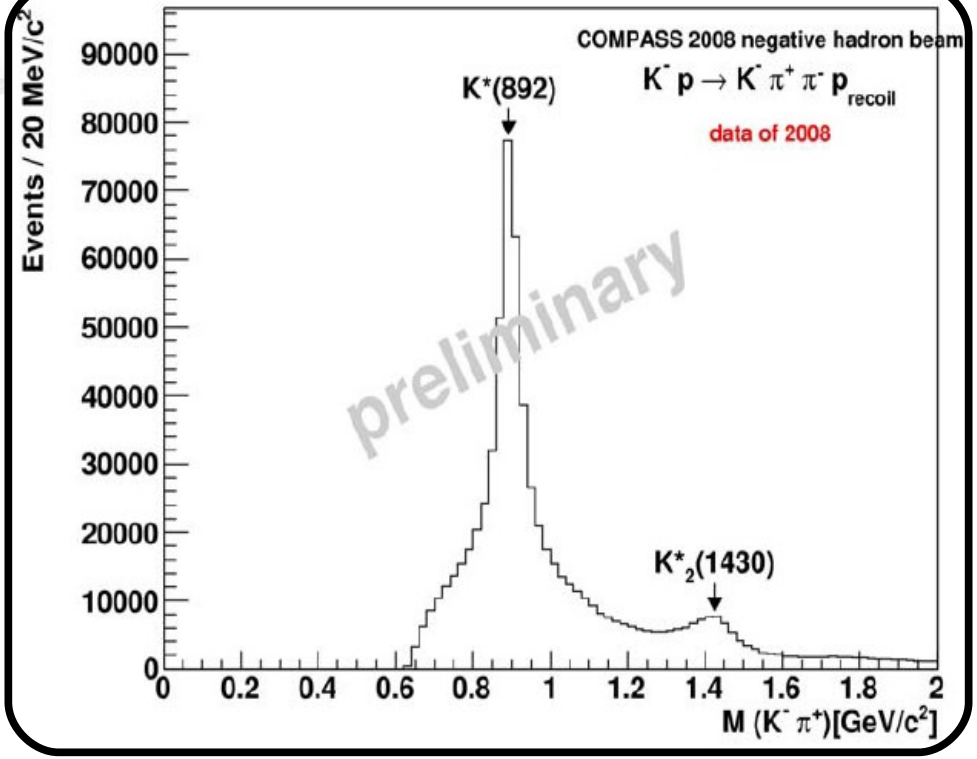


Selected results of $K^- p \to K^- \pi^+ \pi^- p_{recoil}$

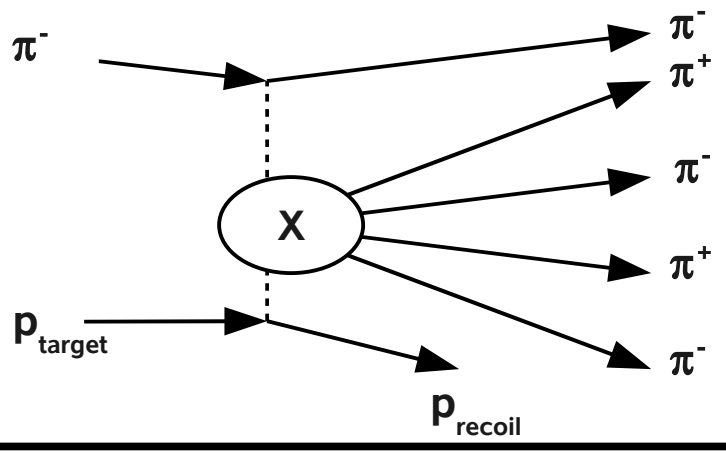


- Tagging incoming beam Kaons
- Many states in the $K \pi \pi$ system need confirmation
- Outnumbering previous results by a factor of ~3

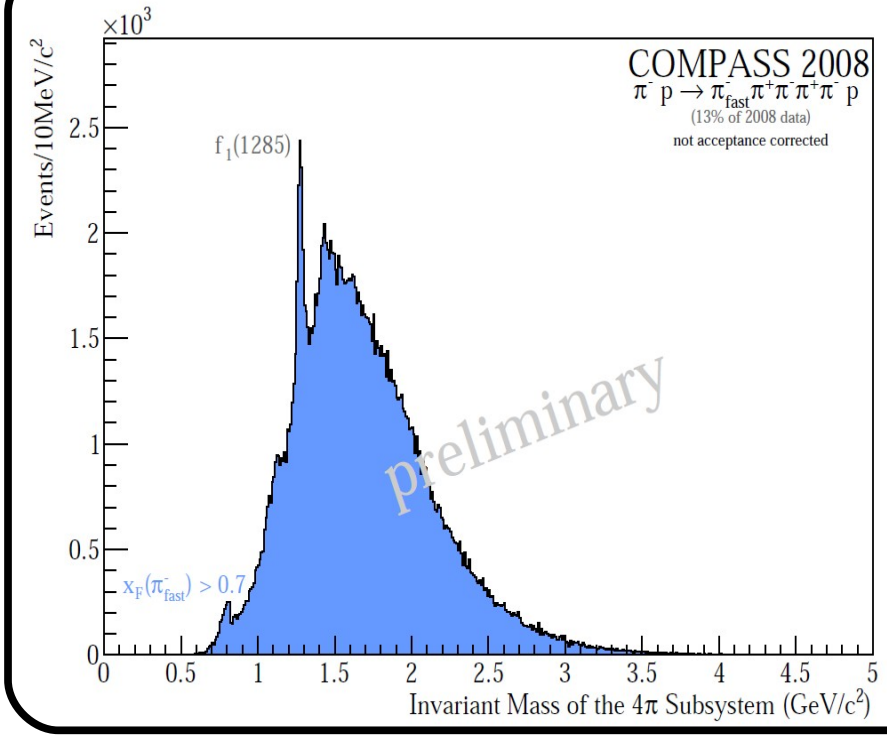


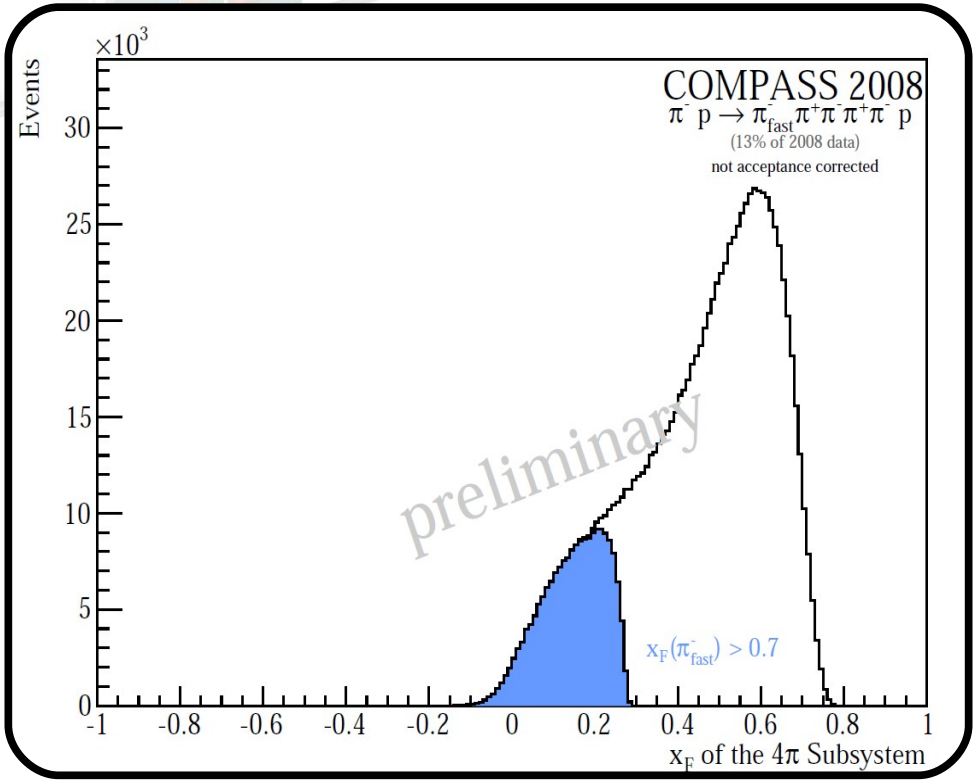


Selected results of $\pi^- p \rightarrow \pi^-_{fast} \pi^+ \pi^- \pi^+ \pi^- p_{recoil}$

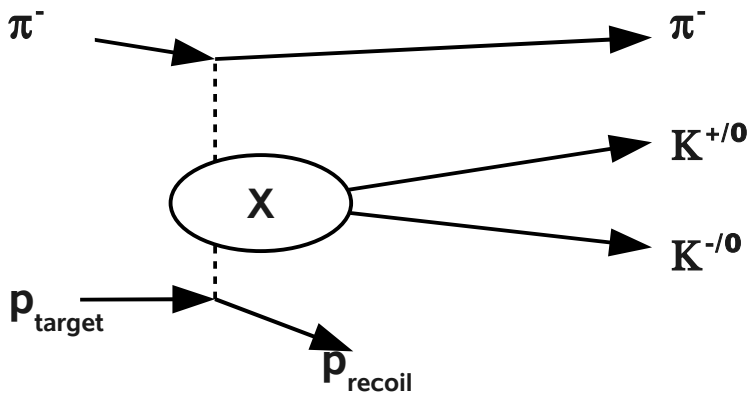


- Analysis of 4 pion central production demonstrates the spectrometer's excellent acceptance and resolution
- Looking at the region around $f_0(1500)$ to study the previously quoted existence of more than one resonance

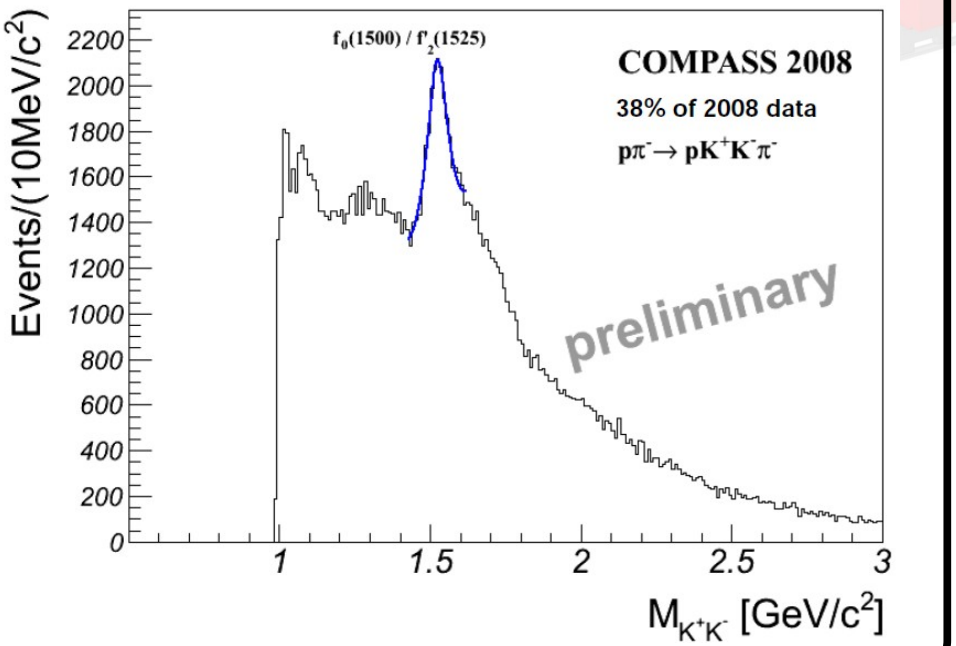


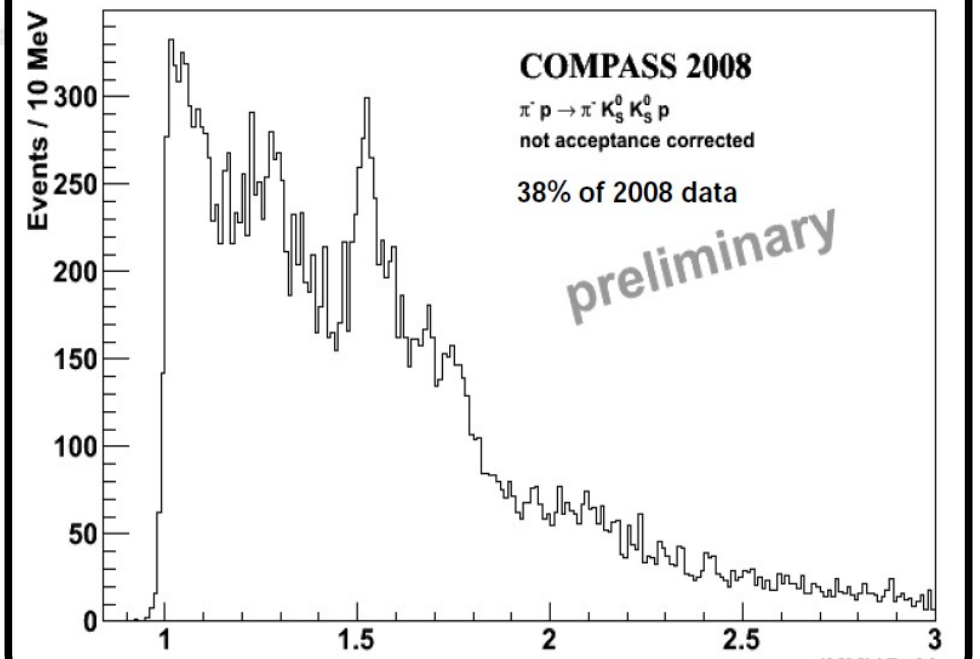


Selected results of $\pi^- p \rightarrow \pi^- K^{+/0} K^{-/0} p_{recoil}$

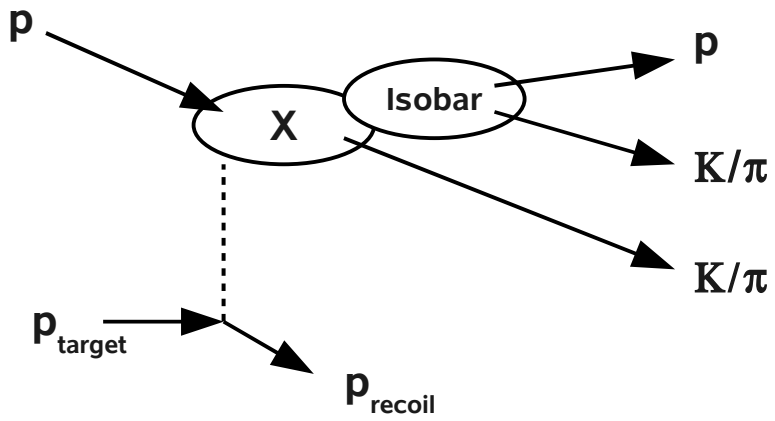


- π K K final state analysis
- PID of charged Kaons by RICH
- K_s identified by decay vertex
- separation of centrally and diffractively produced systems by rapidity gap
- Analysis of disputed branching ratios of resonances such as $f_0(1370)$

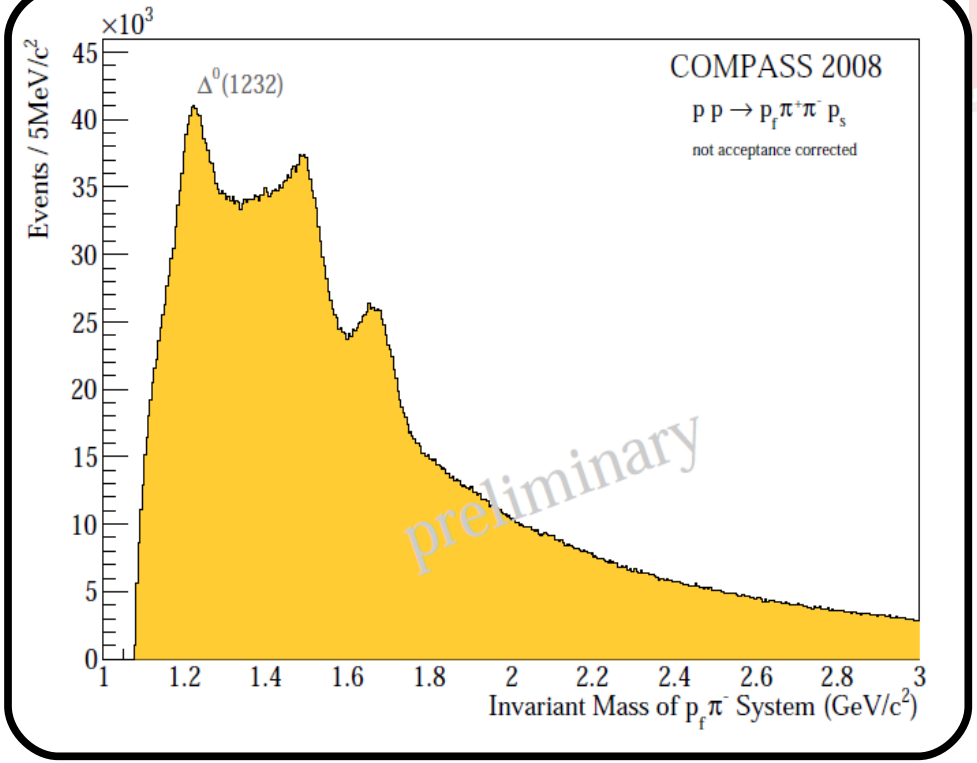


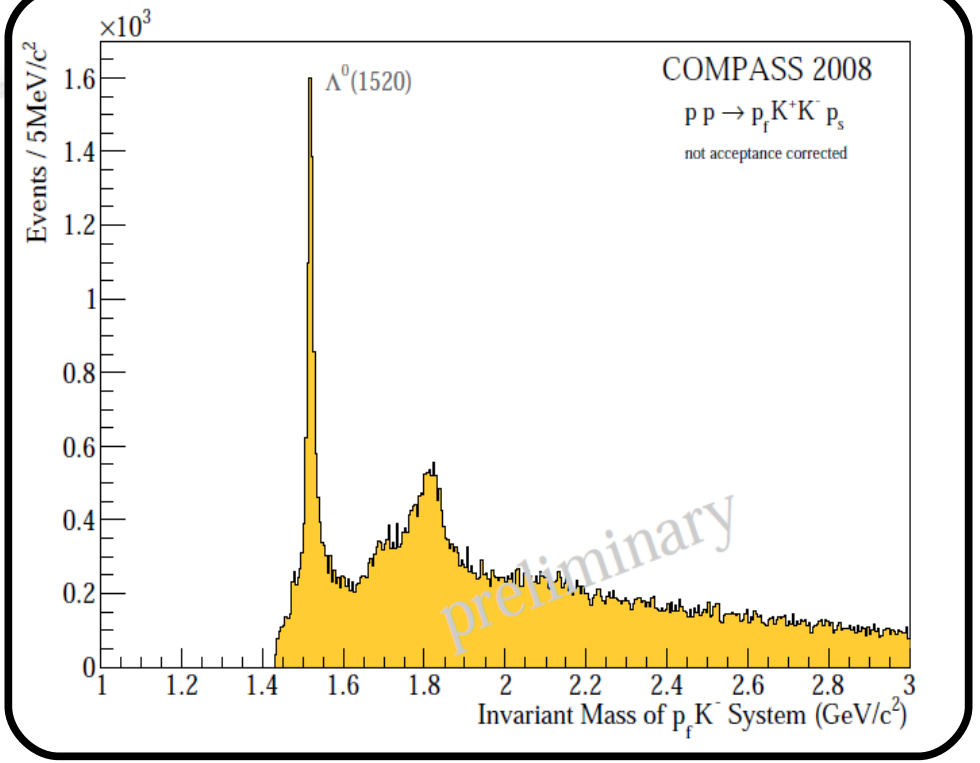


Selected results for p p → p $\pi^+(K^+)$ $\pi^-(K^-)$ p_{recoil}



- Tagging the proton in the h+ beam →
- Hadro-produced baryon spectroscopy
- Accessing regions of high masses and angular momenta
- Rich baryon spectrum to be distinguished





Summary and outlook

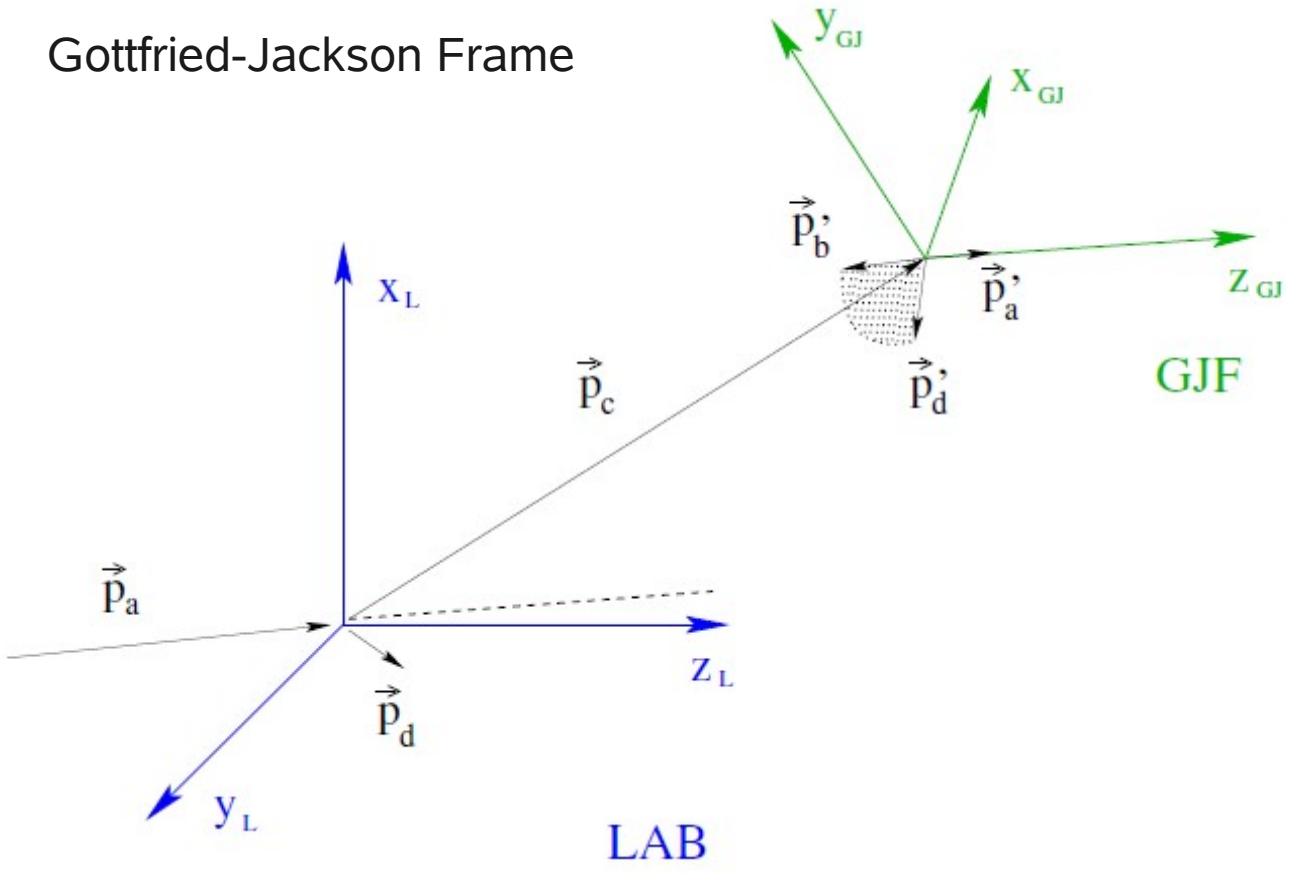
- After the spectrometer upgrade COMPASS took data with different hadron beams in 2008 and 2009
- both, charged and neutral, final state particles accessible →
- COMPASS has access many interesting channels in Meson and Baryon spectroscopy
- COMPASS statistics exceeds the one by previous experiments by a factor of up to 100
- Analyses using PWA techniques are ongoing
- We are expecting much more interesting results very soon
- interesting results expected very soon, also with nuclear targets
- Collaborators are very welcome!

Thank you

Backup slides

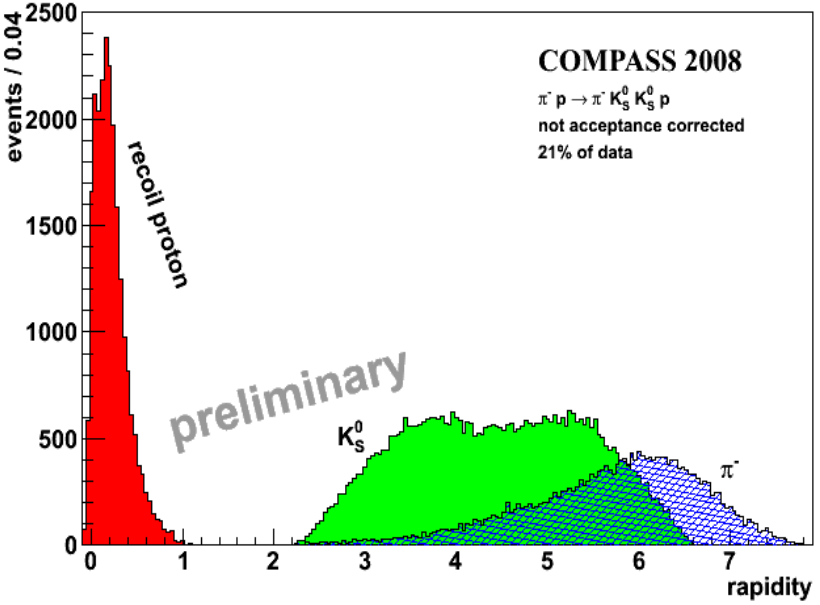
Details of PWA for 3 pi final state

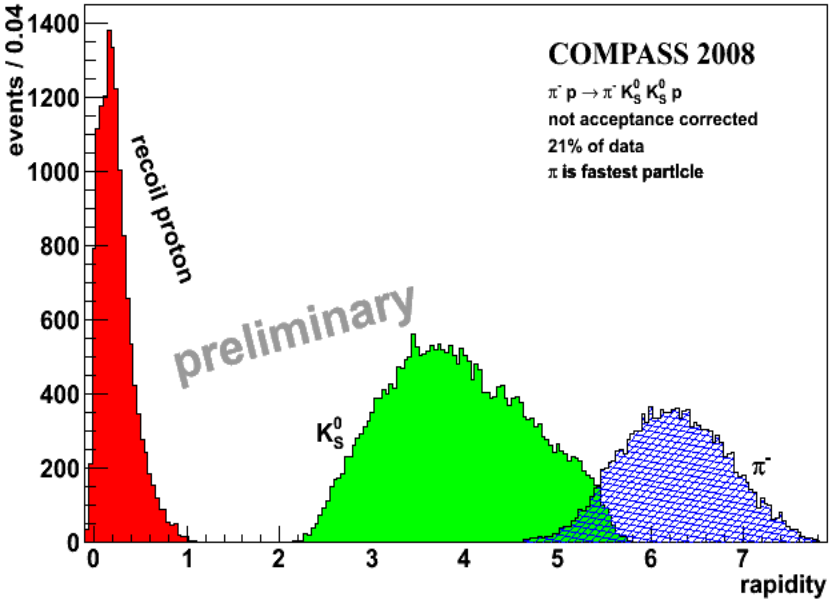
Gottfried-Jackson Frame

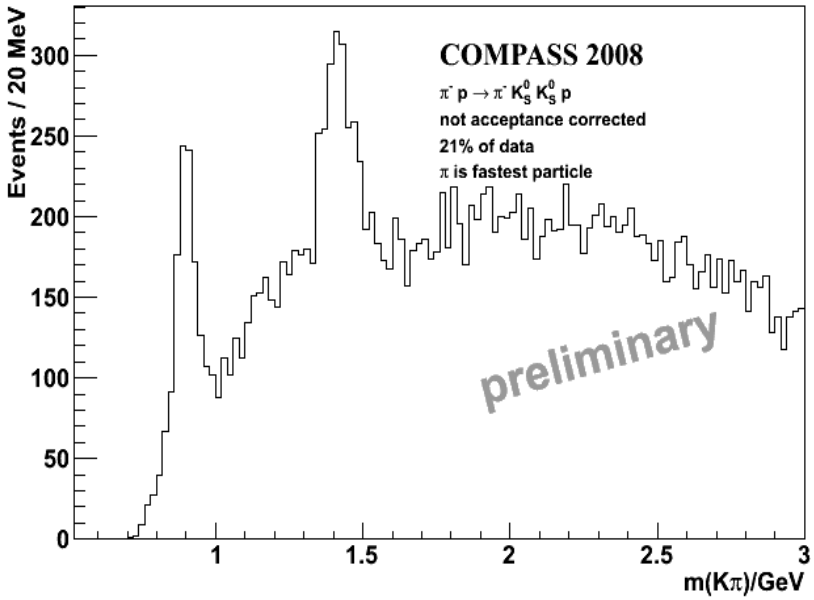


$J^{PC}M^{\epsilon}$	L	Isobar π	Treshold (GeV/c^2)
$0^{-+}0^{+}$	S	$f_0(980)\pi$	1.25
$0^{-+}0^{+}$	S	$(\pi\pi)_s\pi$	-
$0^{-+}0^{+}$	P	$\rho\pi$	-
$1^{-+}1^{+}$	P	$\rho\pi$	-
$1^{++}0^{+}$	S	$\rho\pi$	-
$1^{++}0^{+}$	P	$f_2\pi$	1.20
$1^{++}0^{+}$	P	$(\pi\pi)_s\pi$	0.94
$1^{++}0^{+}$	D	$\rho\pi$	1.30
$1^{++}1^{+}$	S	$\rho\pi$	-
$1^{++}1^{+}$	P	$f_2\pi$	1.40
$1^{++}1^{+}$	P	$(\pi\pi)_s\pi$	1.20
$1^{++}1^{+}$	D	$\rho\pi$	1.40
$2^{-+}0^{+}$	S	$f_2\pi$	1.20
$2^{-+}0^{+}$	P	$\rho\pi$	0.80
$2^{-+}0^{+}$	D	$(\pi\pi)_s\pi$	0.80
$2^{-+}0^{+}$	D	$f_2\pi$	1.50
$2^{-+}0^{+}$	F	$\rho\pi$	1.20
$2^{-+}1^{+}$	S	$f_2\pi$	1.20
$2^{-+}1^{+}$	P	$\rho\pi$	0.80
$2^{-+}1^{+}$	D	$(\pi\pi)_s\pi$	1.20
$2^{-+}1^{+}$	D	$f_2\pi$	1.50
$2^{-+}1^{+}$	F	$\rho\pi$	1.20
$2^{++}1^{+}$	P	$f_2\pi$	1.20
$2^{++}1^{+}$	D	$\rho\pi$	-
$3^{++}0^{+}$	S	$\rho_3\pi$	1.76
$3^{++}0^{+}$	P	$f_2\pi$	1.20
$3^{++}0^{+}$	D	$\rho\pi$	1.20
$3^{++}1^{+}$	S	$\rho_3\pi$	1.76
$3^{++}1^{+}$	P	$f_2\pi$	1.20
$3^{++}1^{+}$	D	$\rho\pi$	1.50
$4^{-+}0^{+}$	F	$\rho\pi$	1.00
$4^{-+}1^{+}$	F	$\rho\pi$	1.20
$4^{++}1^{+}$	F	$f_2\pi$	1.60
$4^{++}1^{+}$	G	$\rho\pi$	1.40
$1^{-+}0^{-}$	P	$\rho\pi$	-
$1^{-+}1^{-}$	P	$\rho\pi$	-
$1^{++}1^{-}$	S	$\rho\pi$	-
$2^{-+}1^{-}$	S	$f_2\pi$	1.20
$2^{++}0^{-}$	P	$f_2\pi$	1.30
$2^{++}0^{-}$	D	$\rho\pi$	-
$2^{++}1^{-}$	P	$f_2\pi$	1.30
FLAT			

Additional plots for Ks Ks







The diffractive process is still clearly visible in the invariant mass of Kpi as resonances.

Additional distributions for pKK