The Crystal Ball Program at BNL
Nucleon and Hyperon Spectrography

W.J. Briscoe

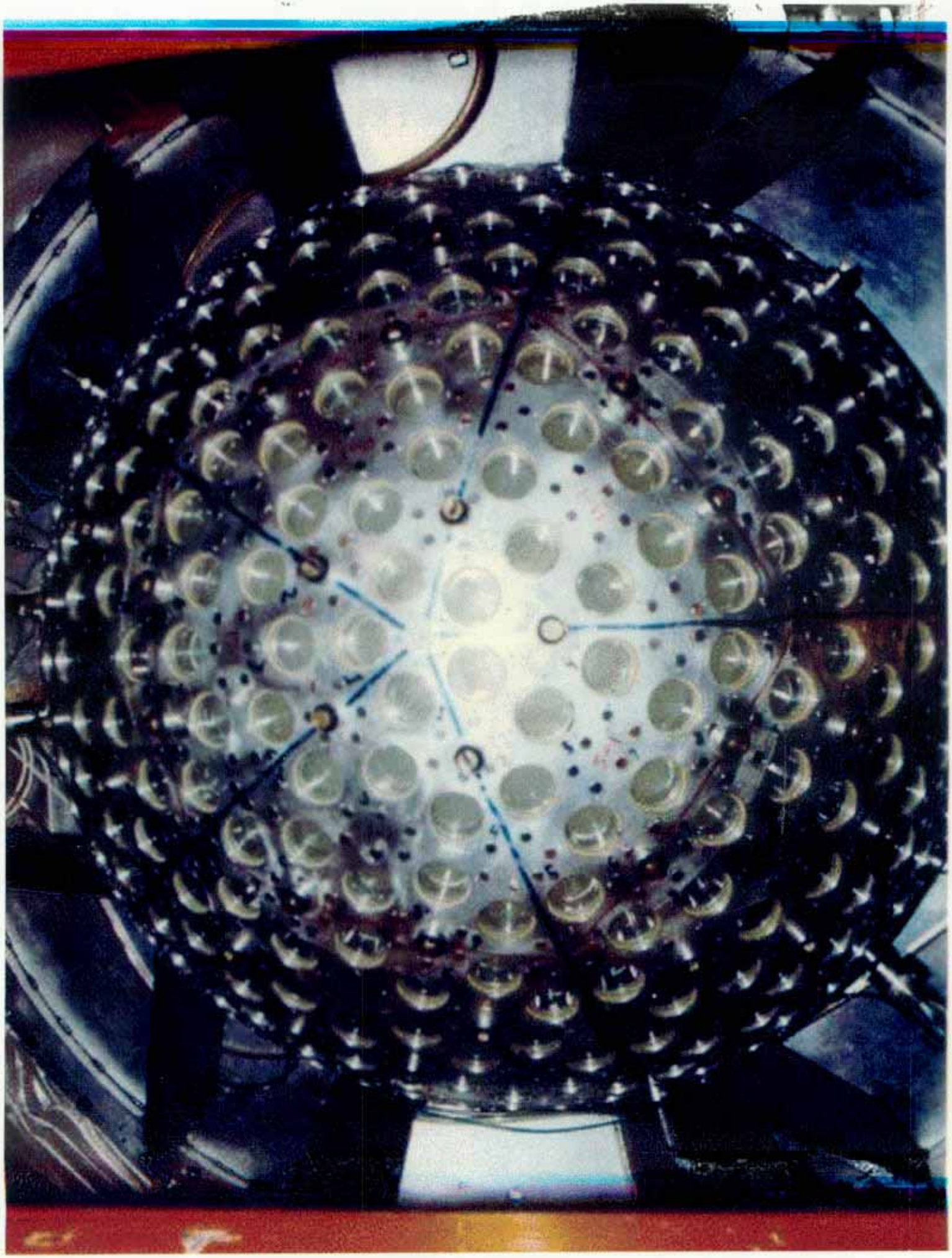
for the

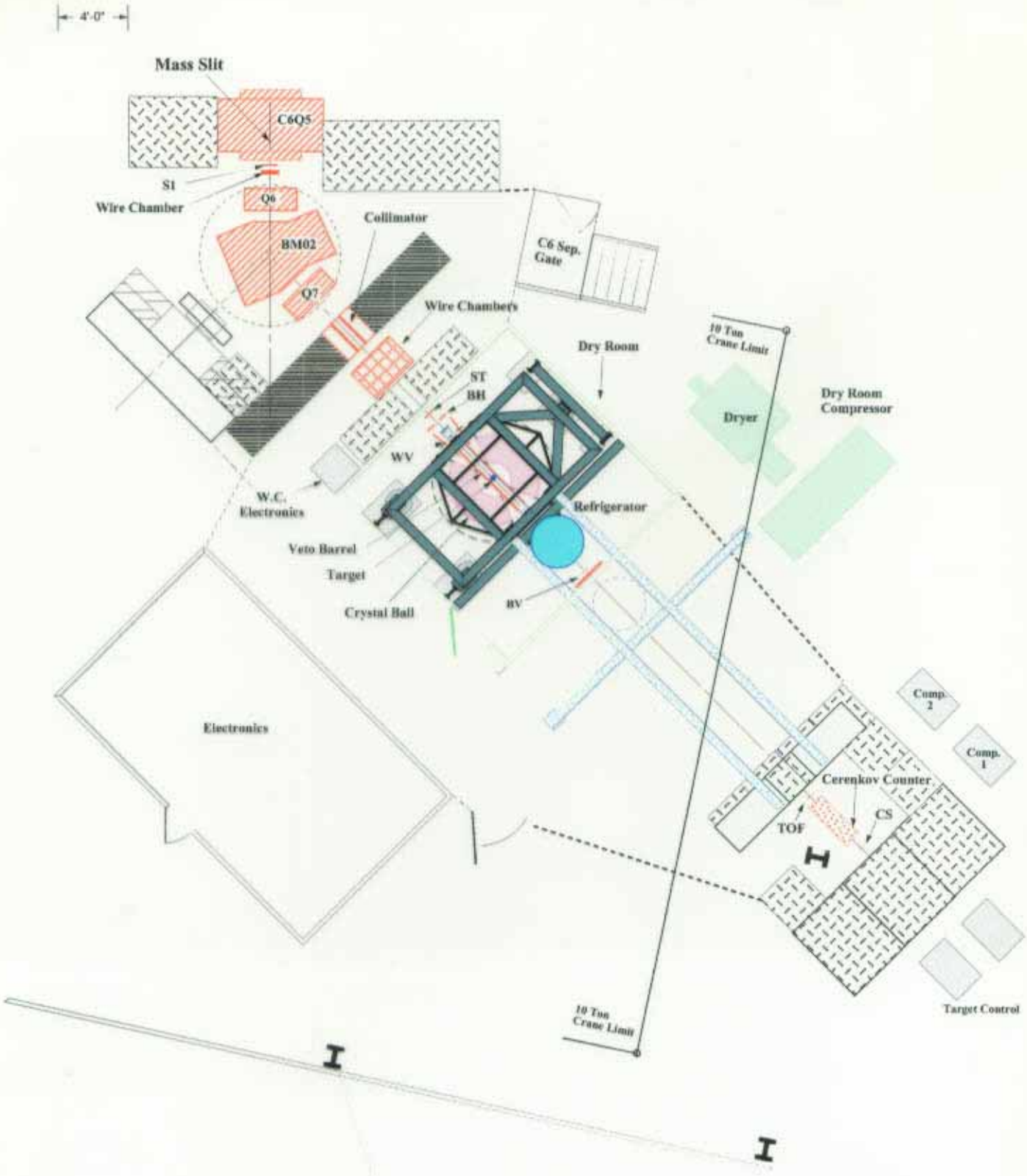
Crystal Ball Collaboration

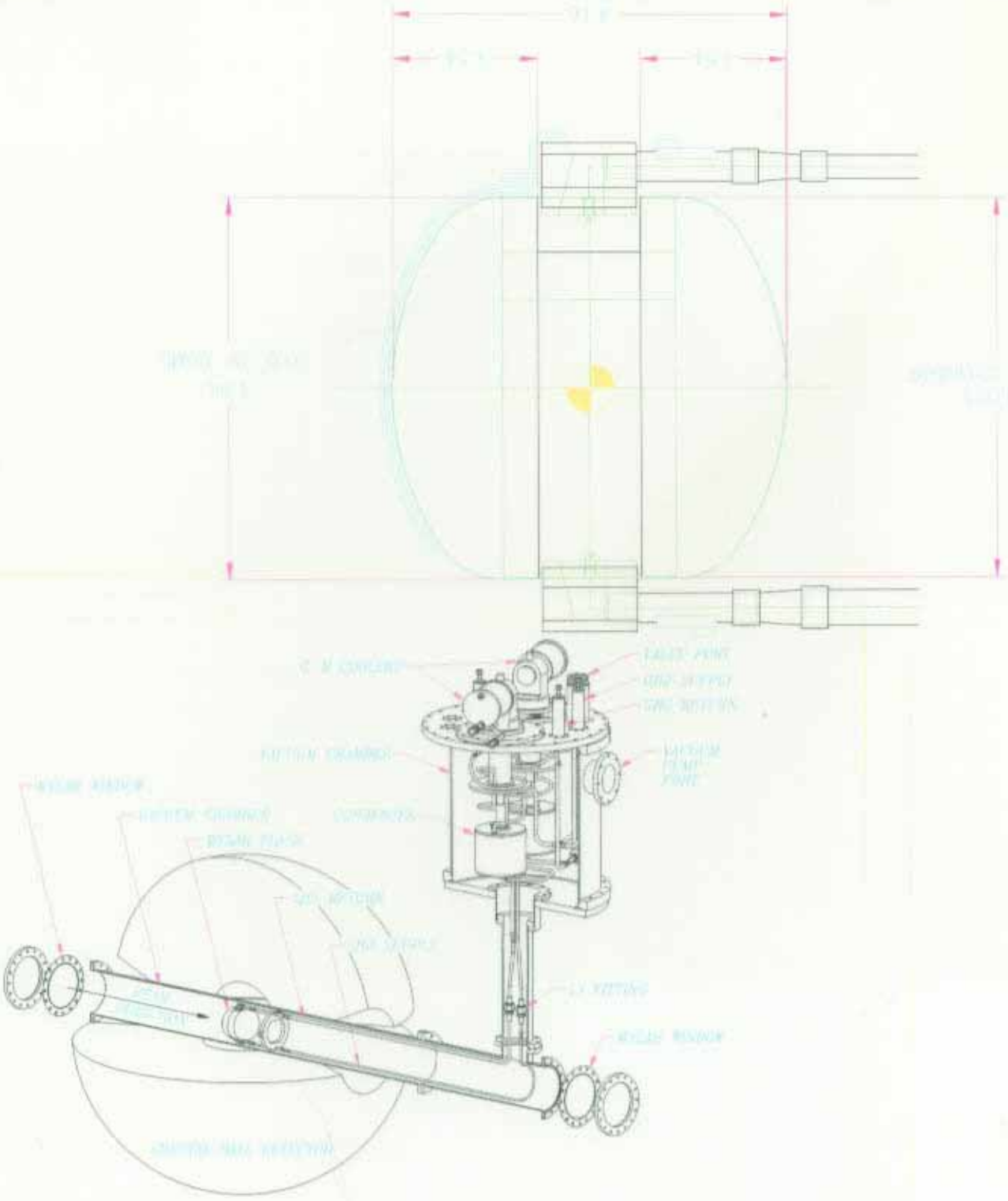
NSTAR 2002

Transparencies contributed by

Joe Comfort, Mark Manley and Mike Sadler




4'-0"
Mass Slit
C6Q5
S1
Wire Chamber
Q6
BM02
Q7
Collimator
C6 Sep. Gate
Wire Chambers
Dry Room
10 Ton Crane Limit
Dry Room Compressor
Dryer
ST
BH
WV
W.C. Electronics
Refrigerator
Veto Barrel
Target
Crystal Ball
BV
Electronics
Comp. 2
Comp. 1
Cerenkov Counter
TOF
CS
Target Control
10 Ton Crane Limit



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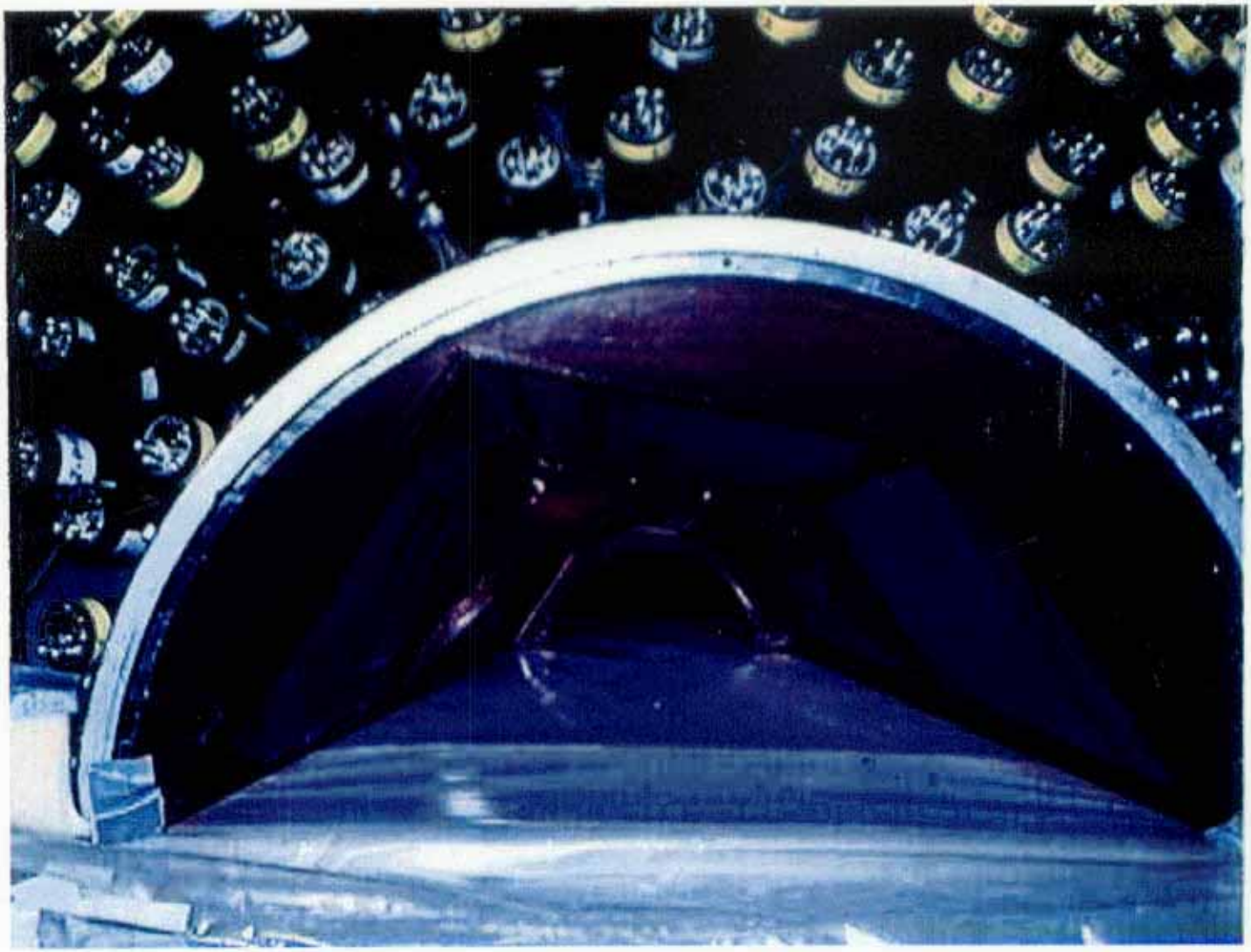
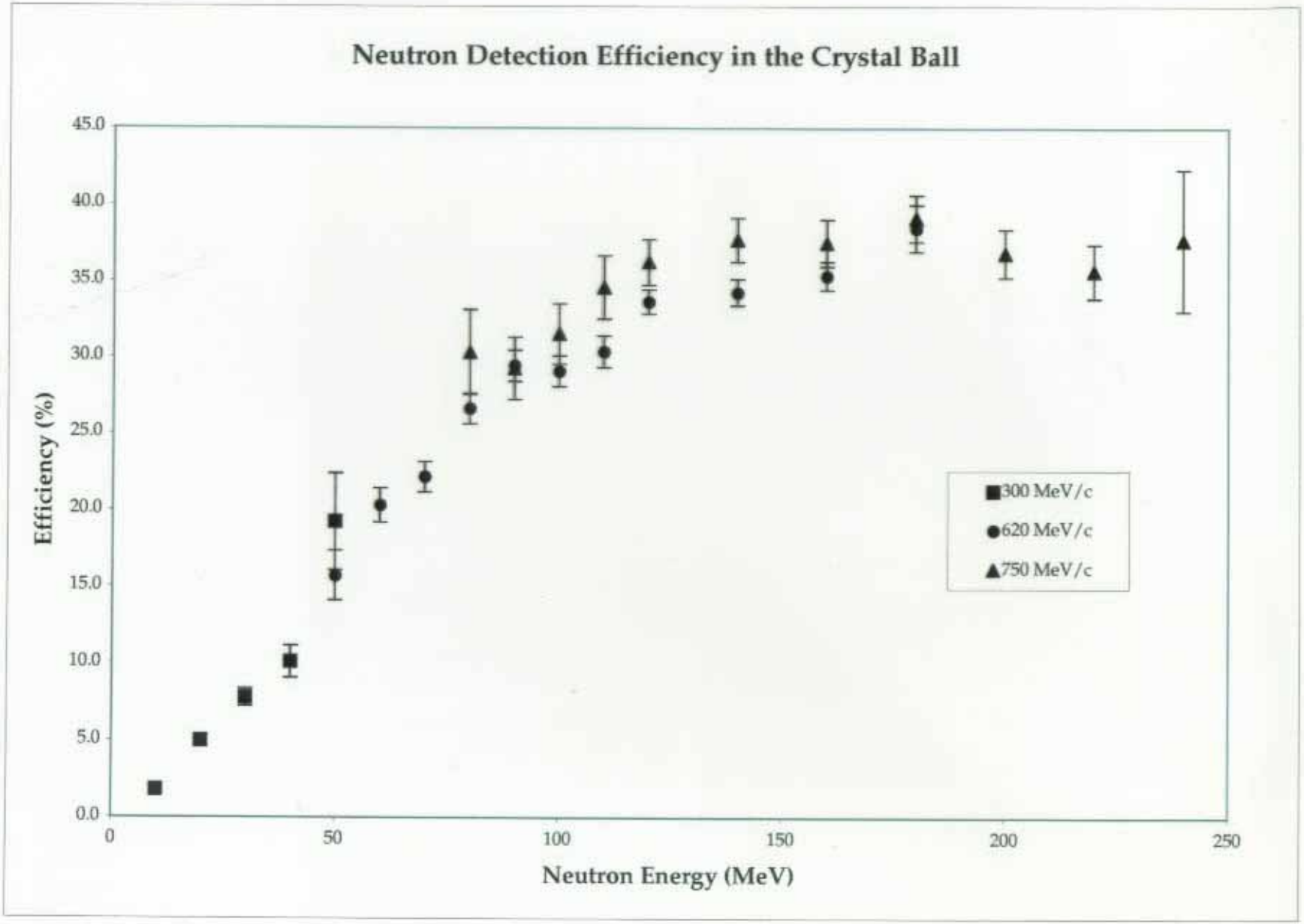
AGS CRYOGENIC GROUP




Neutron Detection Efficiency in the Crystal Ball
Efficiency (%)
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
50
100
150
200
250
Neutron Energy (MeV)
300 MeV/c
620 MeV/c
750 MeV/c

CBC Baryon Program

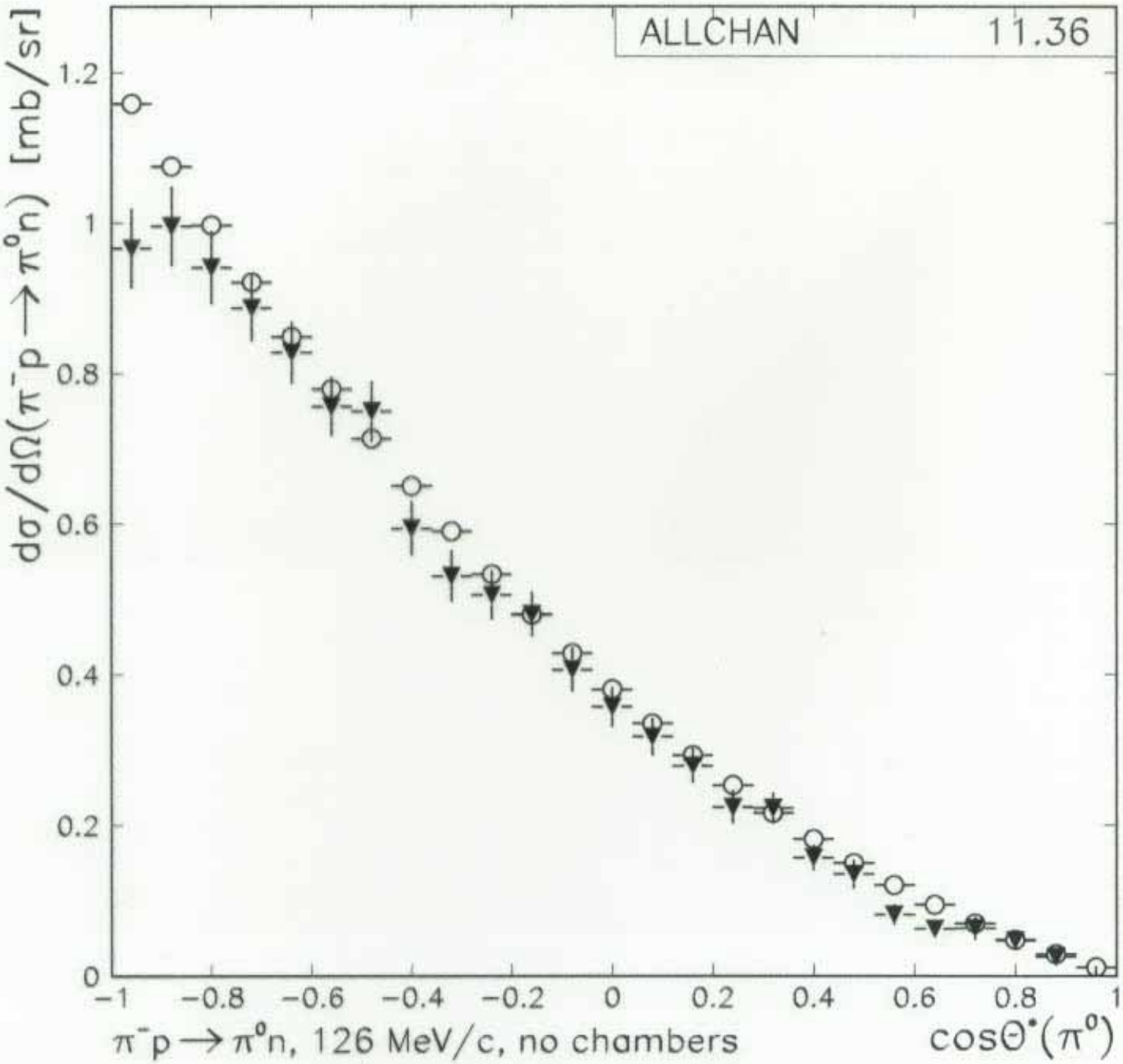
π^- p $\rightarrow$ n γ
n π^0 $\rightarrow$ n 2γ
n η $\rightarrow$ n 2γ
n π^0 π^0 $\rightarrow$ n 4γ
etc.

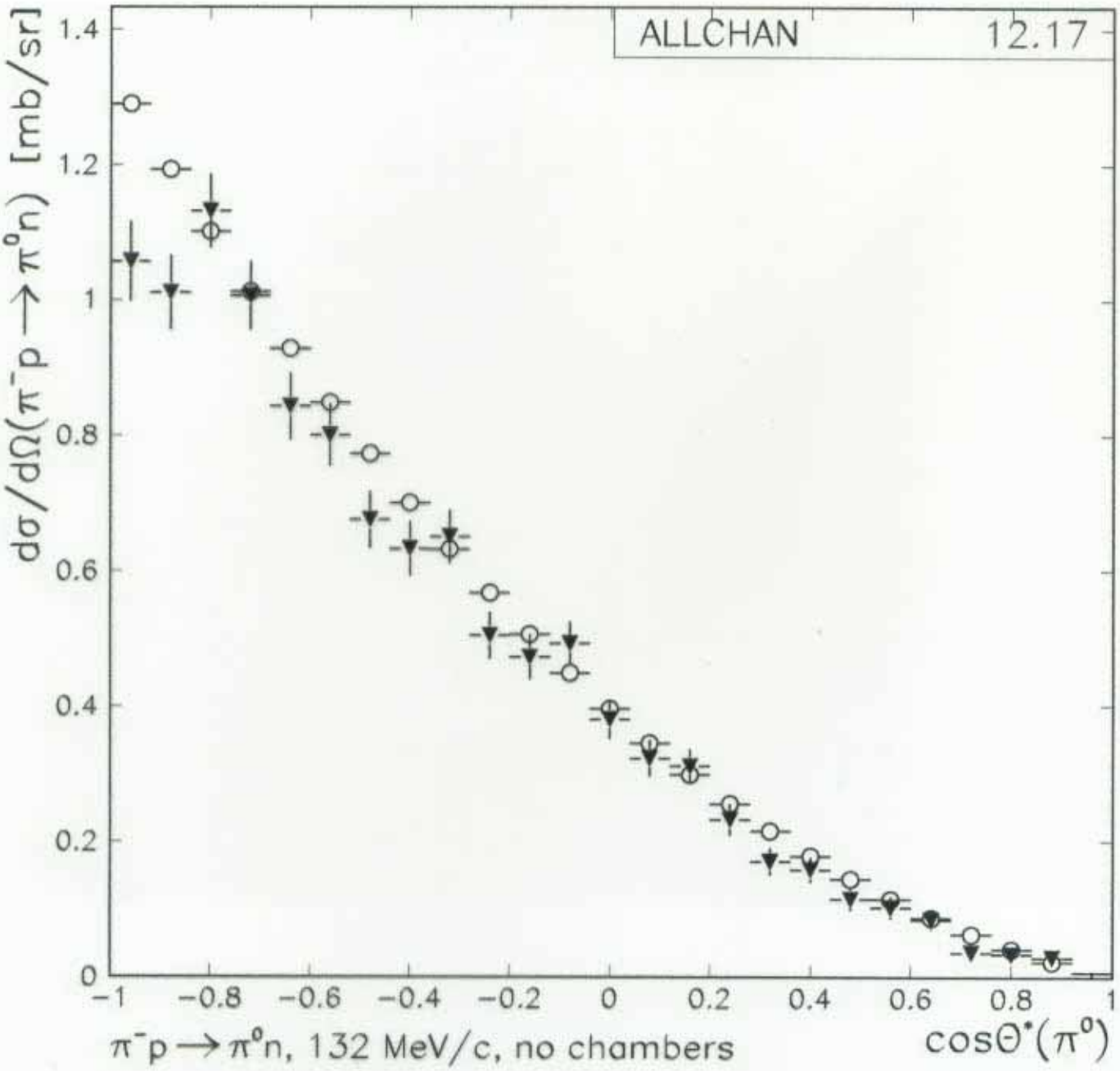
K^- p $\rightarrow$ Λ γ $\rightarrow$ n π^0 γ $\rightarrow$ n 3γ
Λ π^0 $\rightarrow$ n π^0 π^0 $\rightarrow$ n 4γ
Λ η $\rightarrow$ n π^0 η $\rightarrow$ n 4γ
Λ π^0 π^0 $\rightarrow$ n $3\pi^0$ $\rightarrow$ n 6γ
etc.

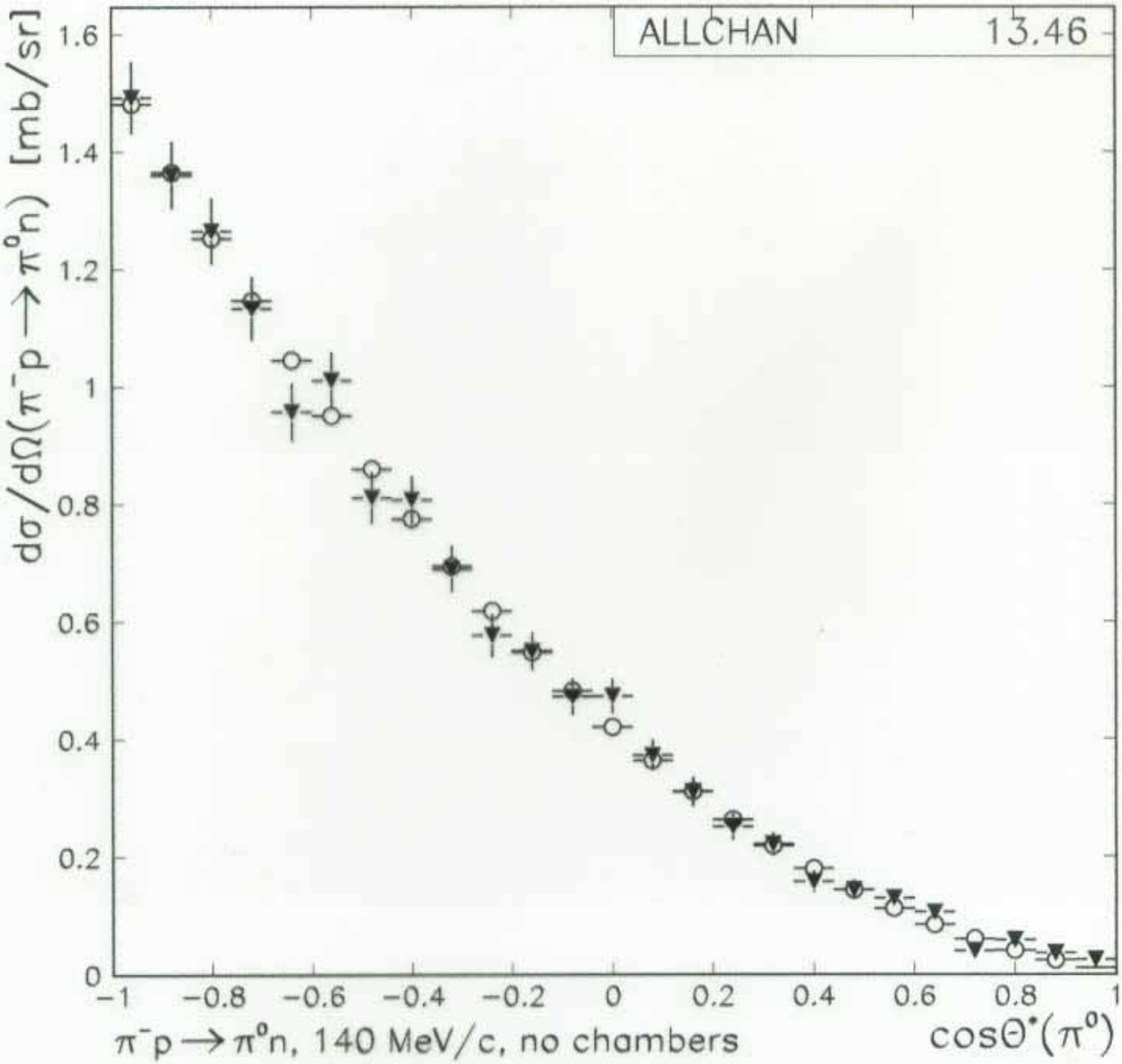
Σ^0 γ $\rightarrow$ Λ γ γ $\rightarrow$ n 4γ
etc.

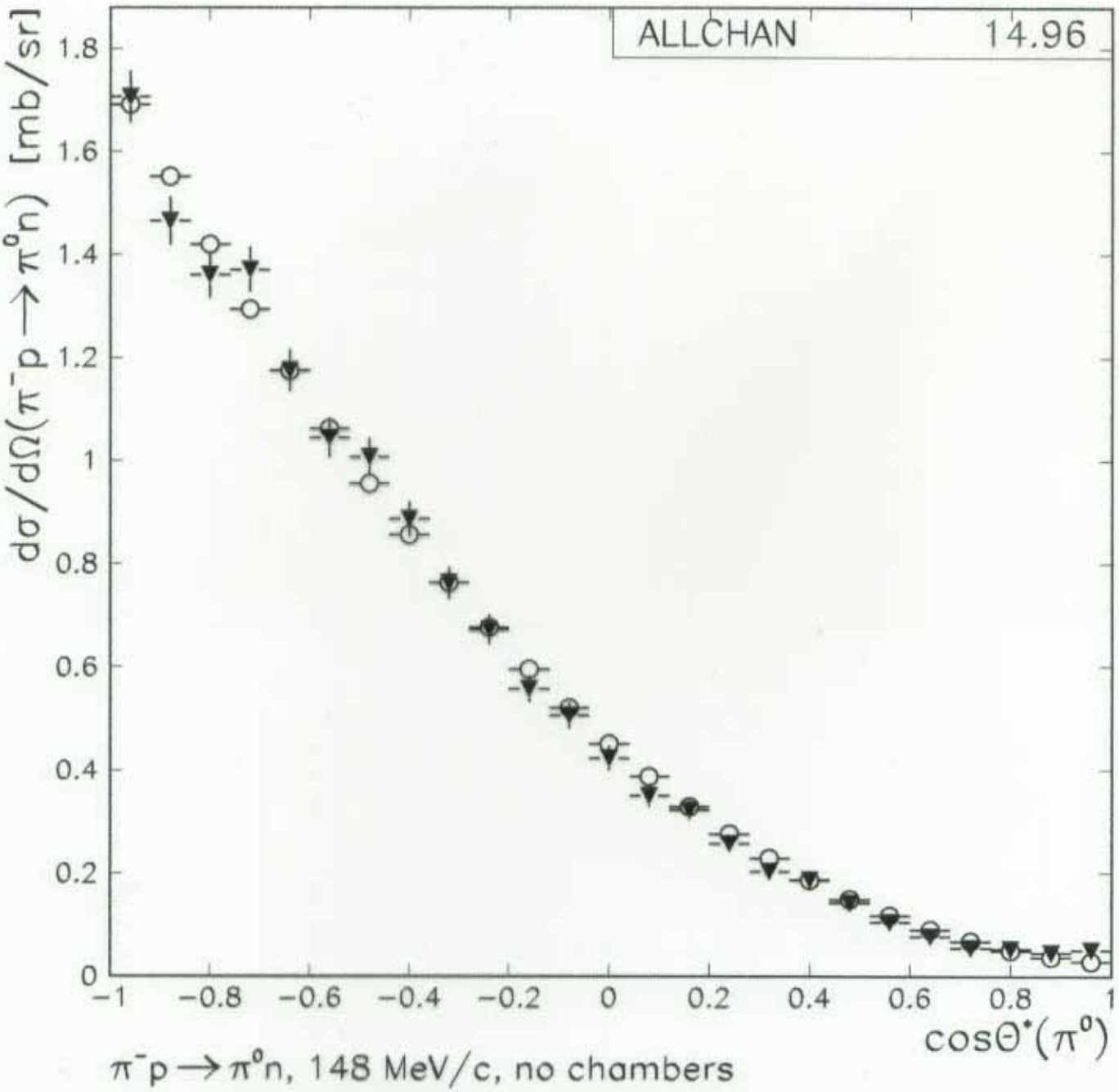
Goal–

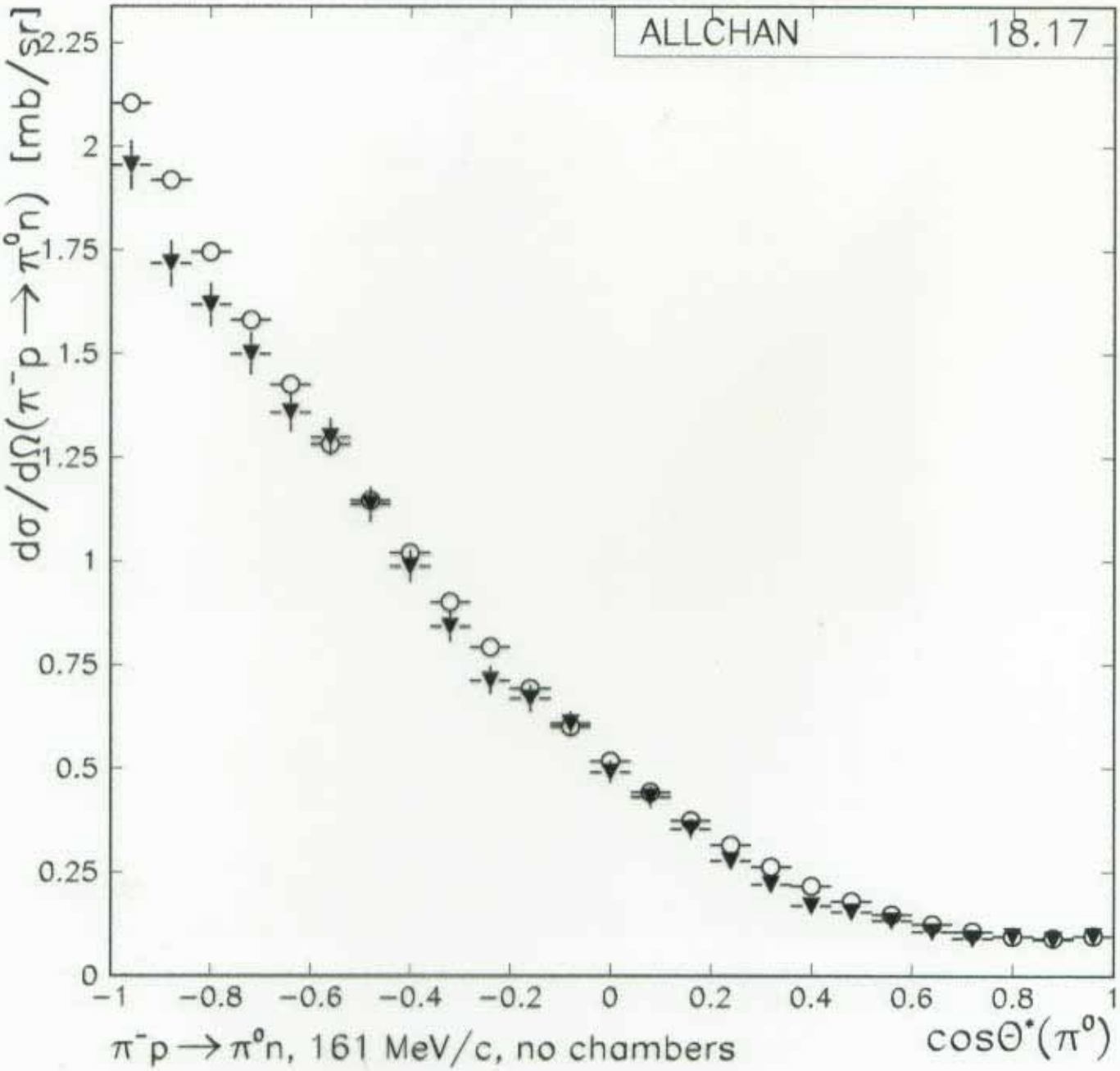
Obtain thorough knowledge of baryon spectrum for neutral (photon) final states.

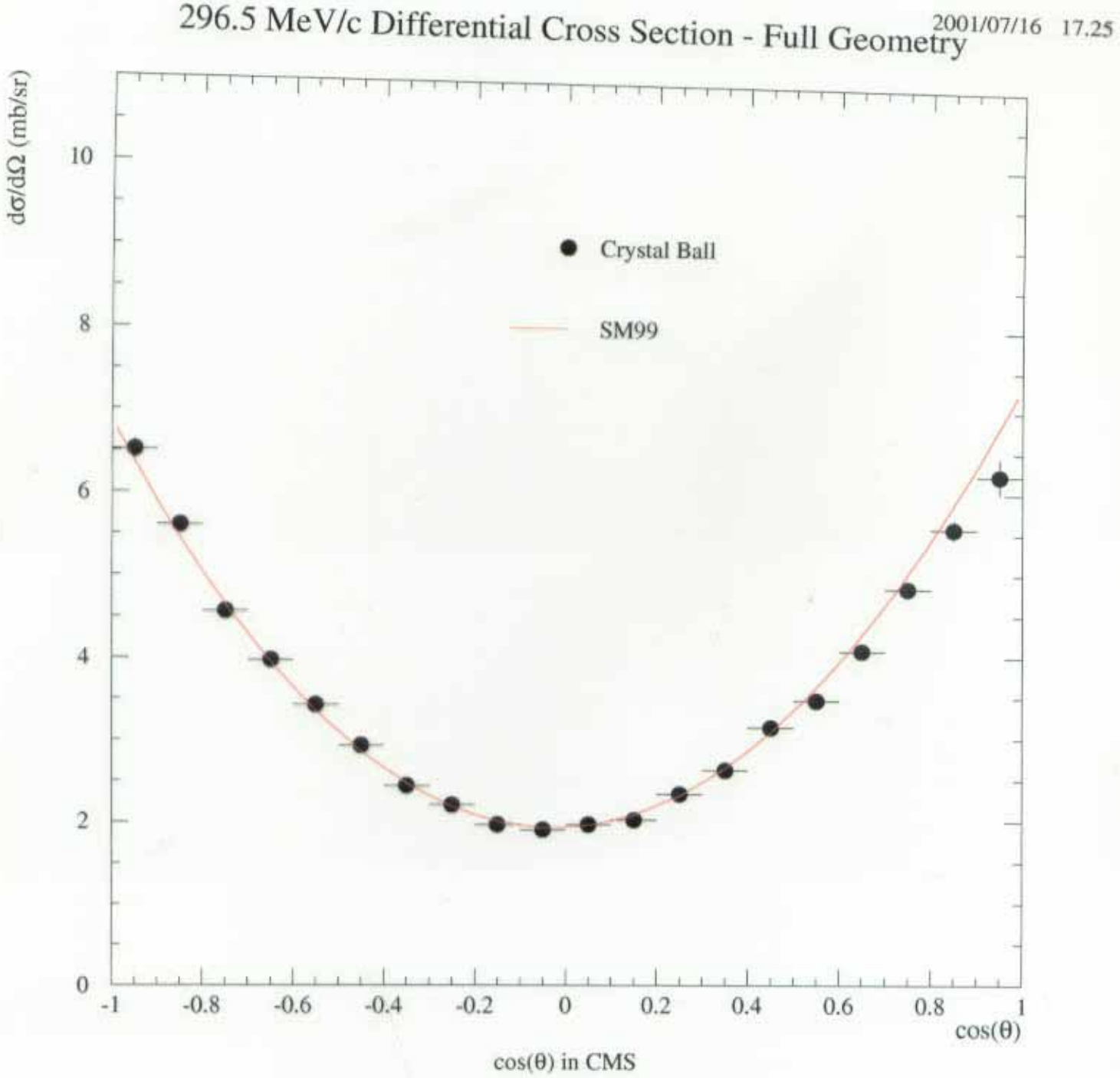

ALLCHAN 11.36
dσ/dΩ(π⁻p → π⁰n) [mb/sr]
1.2
1
0.8
0.6
0.4
0.2
0
−1 −0.8 −0.6 −0.4 −0.2 0 0.2 0.4 0.6 0.8 1
π⁻p → π⁰n, 126 MeV/c, no chambers
cosΘ*(π⁰)


ALLCHAN 12.17
dσ/dΩ(π⁻p → π⁰n) [mb/sr]
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−1 −0.8 −0.6 −0.4 −0.2 0 0.2 0.4 0.6 0.8 1
π⁻p → π⁰n, 132 MeV/c, no chambers
cosΘ*(π⁰)

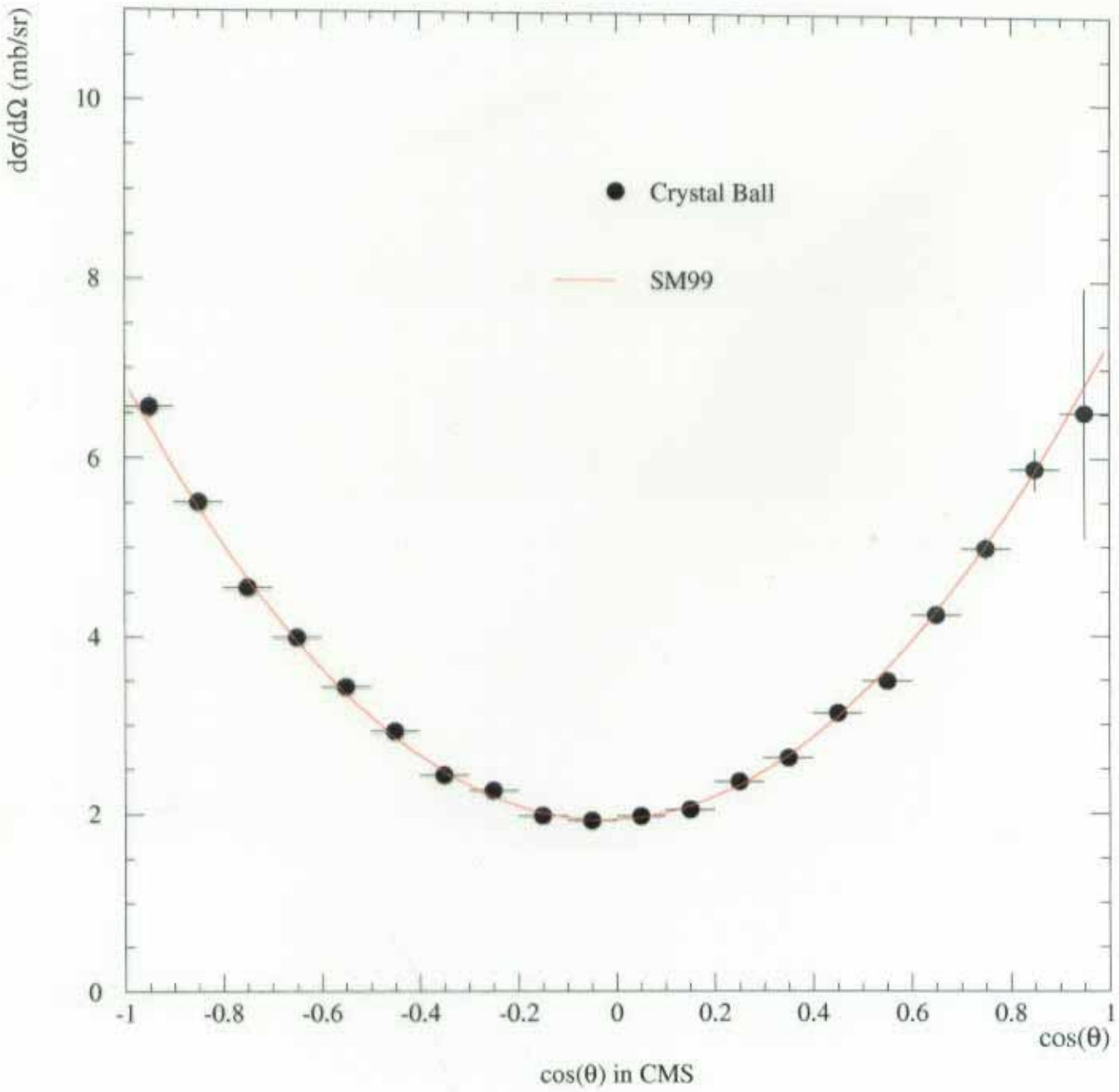

ALLCHAN 13.46
dσ/dΩ(π⁻p → π⁰n) [mb/sr]
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
π⁻p → π⁰n, 140 MeV/c, no chambers
cosΘ*(π⁰)


ALLCHAN 14.96
dσ/dΩ(π⁻p → π⁰n) [mb/sr]
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
cosΘ*(π⁰)
π⁻p → π⁰n, 148 MeV/c, no chambers

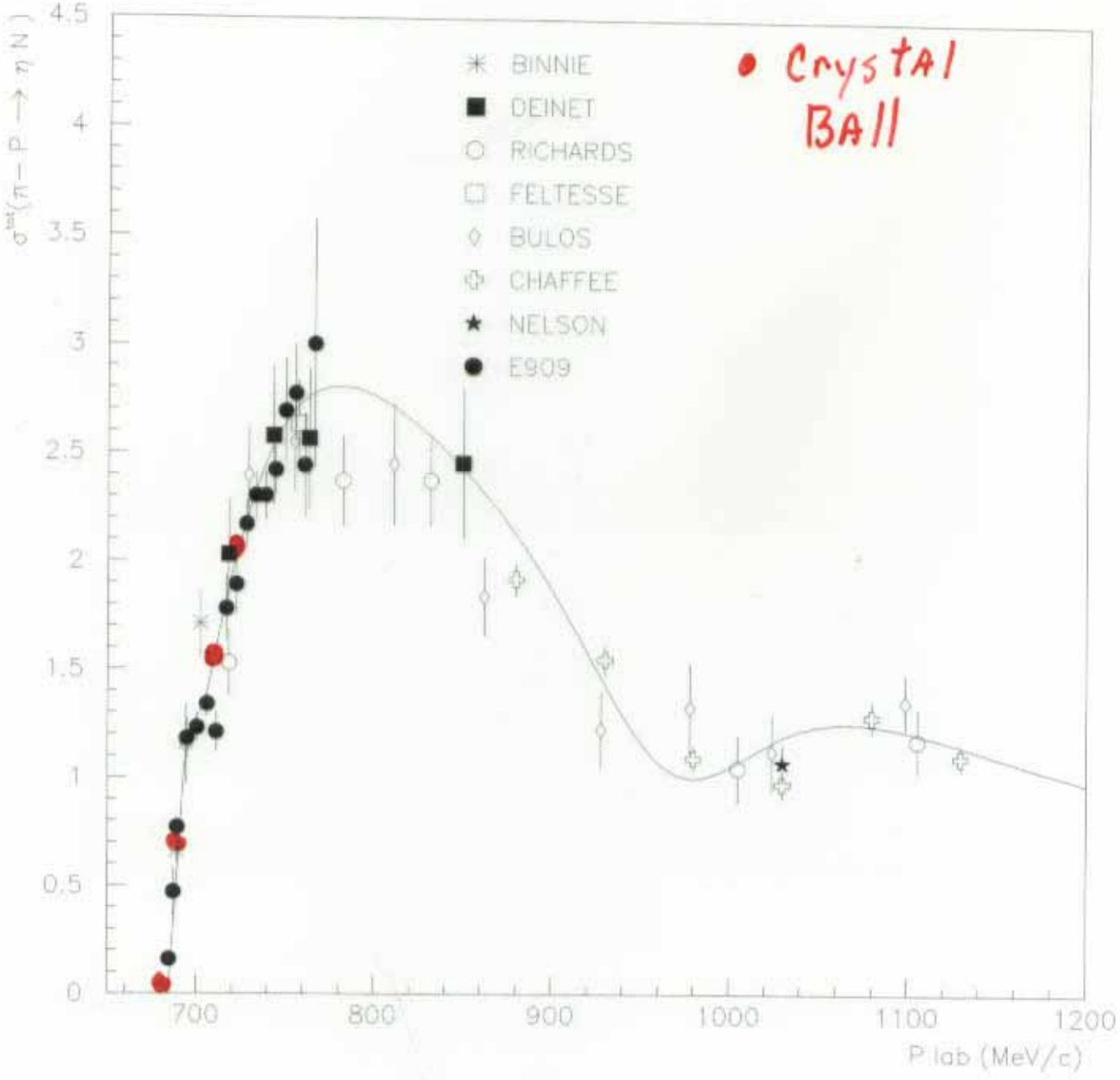

ALLCHAN 18.17
dσ/dΩ(π⁻p → π⁰n) [mb/sr]
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
−1 −0.8 −0.6 −0.4 −0.2 0 0.2 0.4 0.6 0.8 1
π⁻p → π⁰n, 161 MeV/c, no chambers
cosΘ*(π⁰)

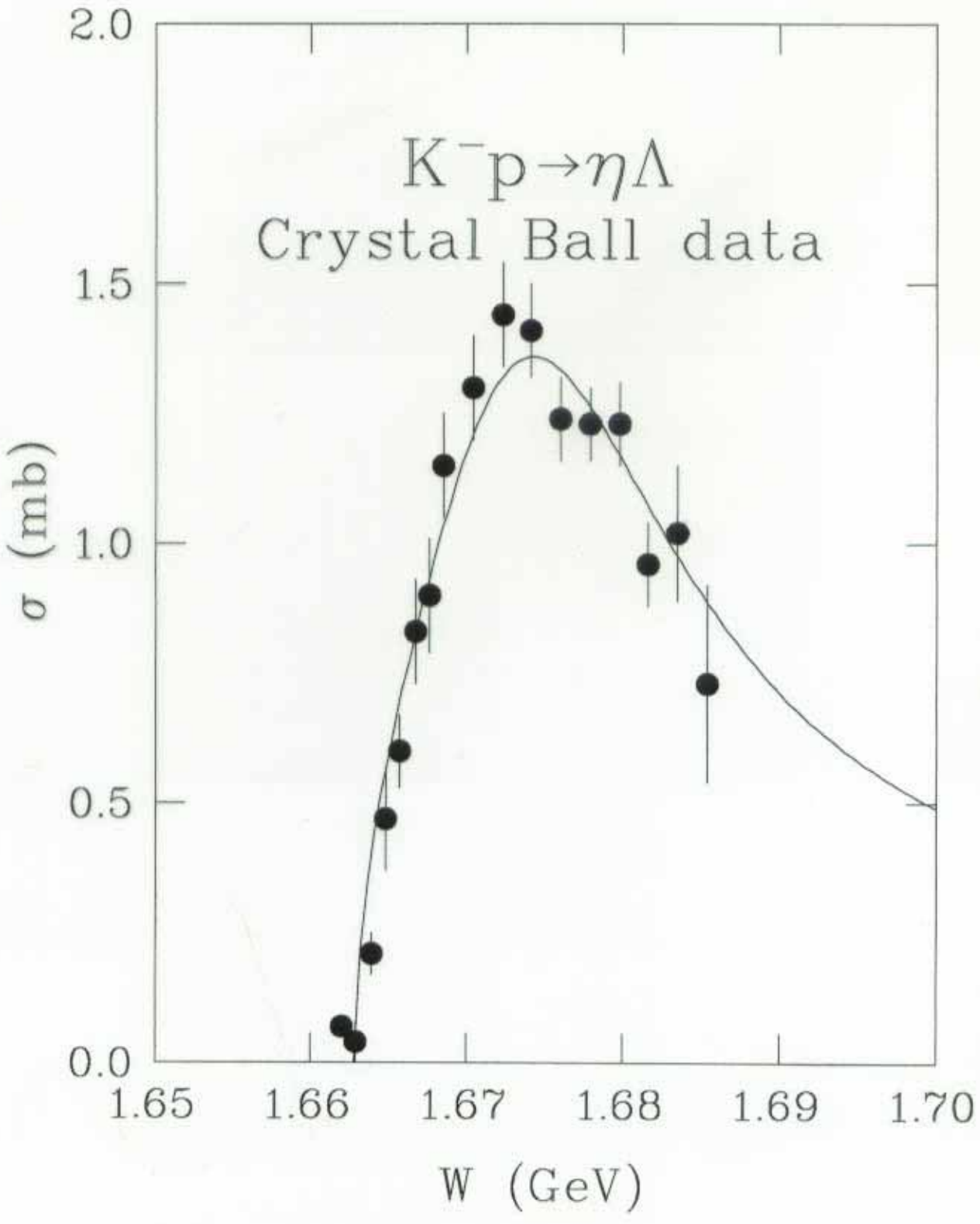

296.5 MeV/c Differential Cross Section - Full Geometry
2001/07/16 17.25
dσ/dΩ (mb/sr)
Crystal Ball
SM99
0
2
4
6
8
10
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
cos(θ)
cos(θ) in CMS

296.5 MeV/c Differential Cross Section - with Near-Edge Cut



$\pi^- p \to \eta n$


$\sigma^{tot}(\pi^- p \to \eta N)$
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
700
800
900
1000
1100
1200
P lab (MeV/c)
BINNIE
DEINET
RICHARDS
FELTESSE
BULOS
CHAFFEE
NELSON
E909
• Crystal Ball

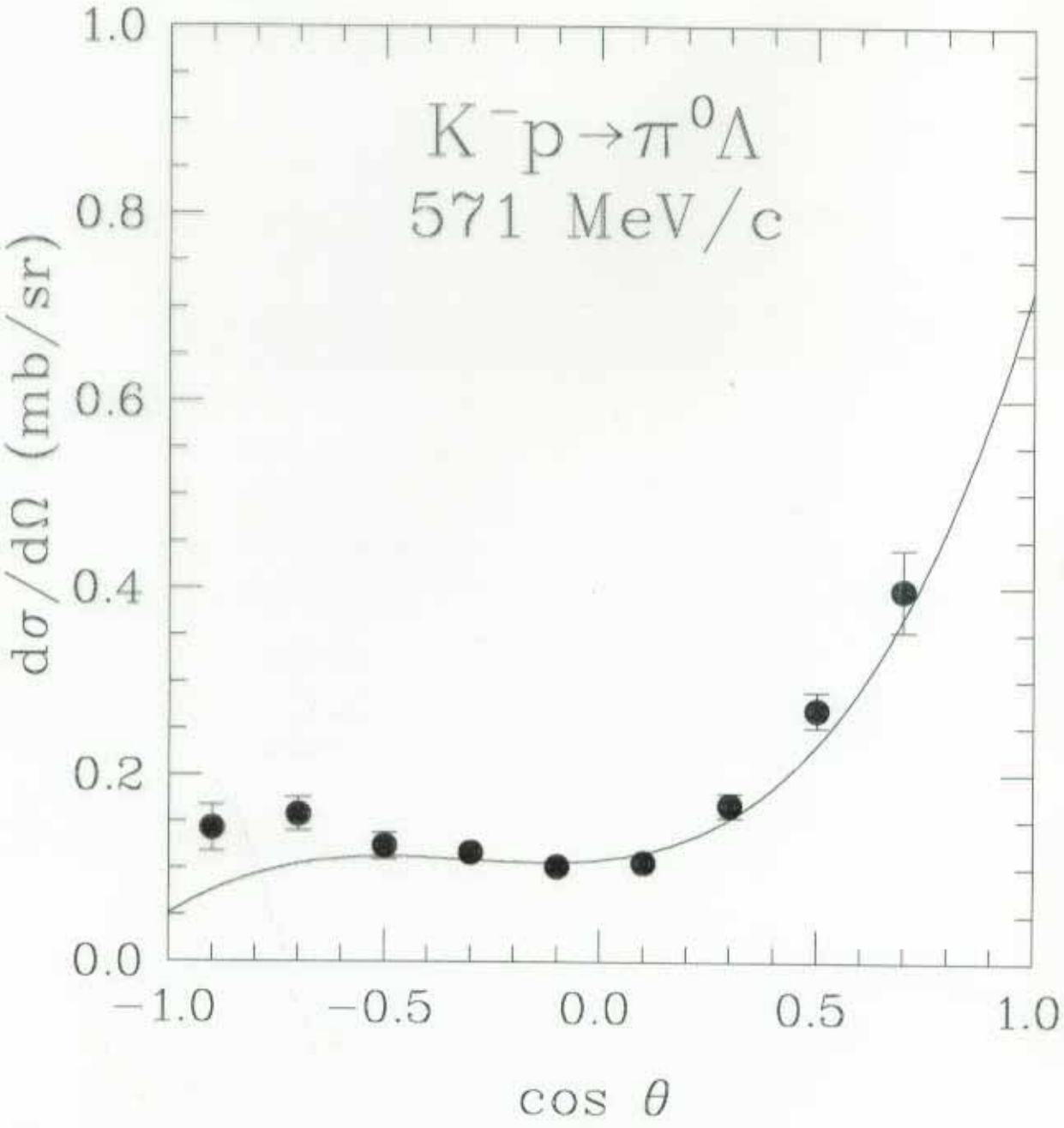

$K^-p \to \eta\Lambda$
Crystal Ball data
σ (mb)
W (GeV)
2.0
1.5
1.0
0.5
0.0
1.65
1.66
1.67
1.68
1.69
1.70

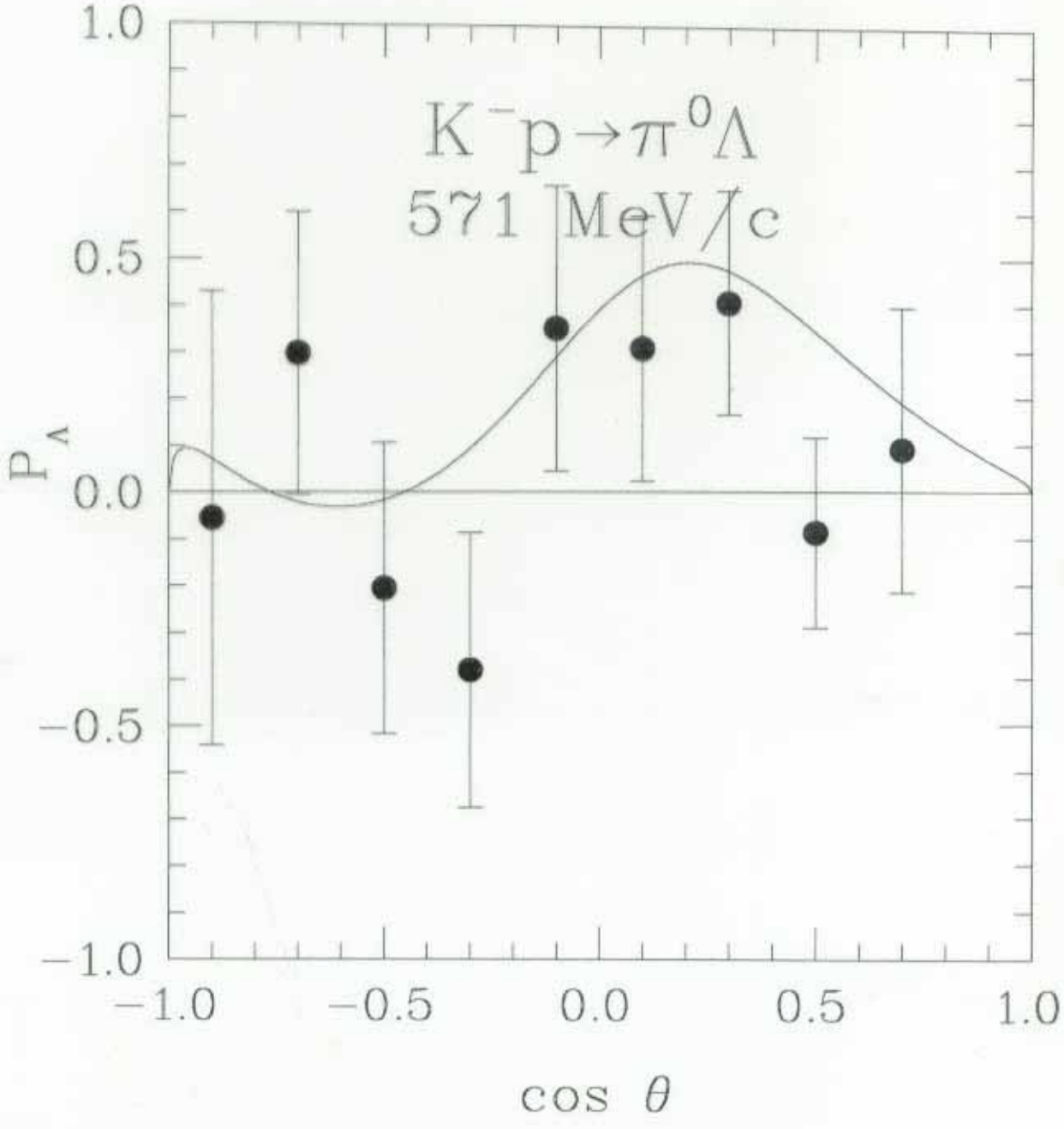
Hyperon Resonances

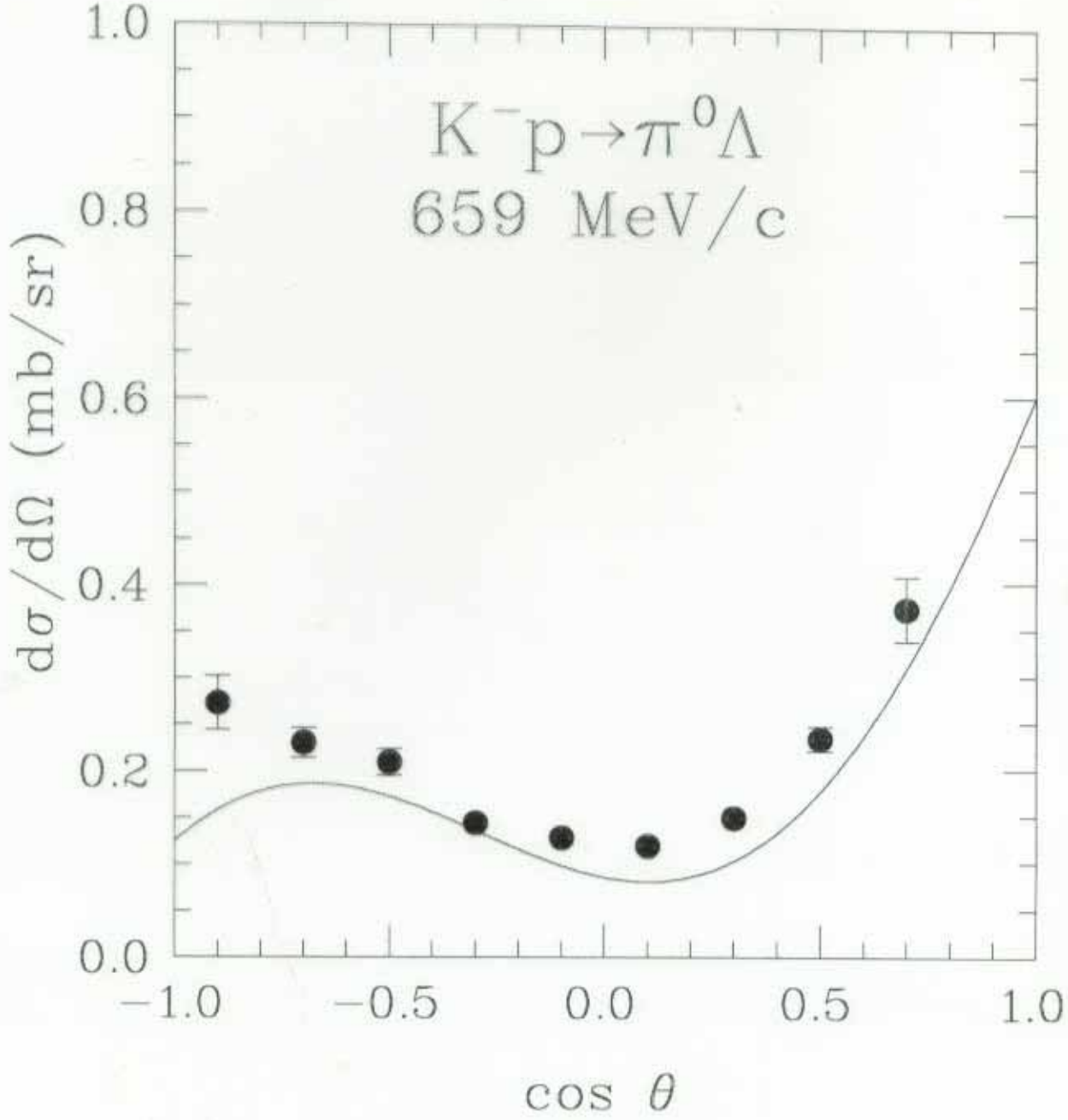
Resonance	$2J^P$	PDG	P_{K^-}	Mass	Width
$\Lambda(1405)$	1^-	****	—	1406±4	50±2
$\Lambda(1520)$	3^-	****	390	1520±1	16±1
$\Lambda(1600)$	1^+	***	580	1560-1700	50-250
$\Lambda(1670)$	1^-	****	740	1660-1680	25-50
$\Lambda(1690)$	3^-	****	780	1685-1695	50-70

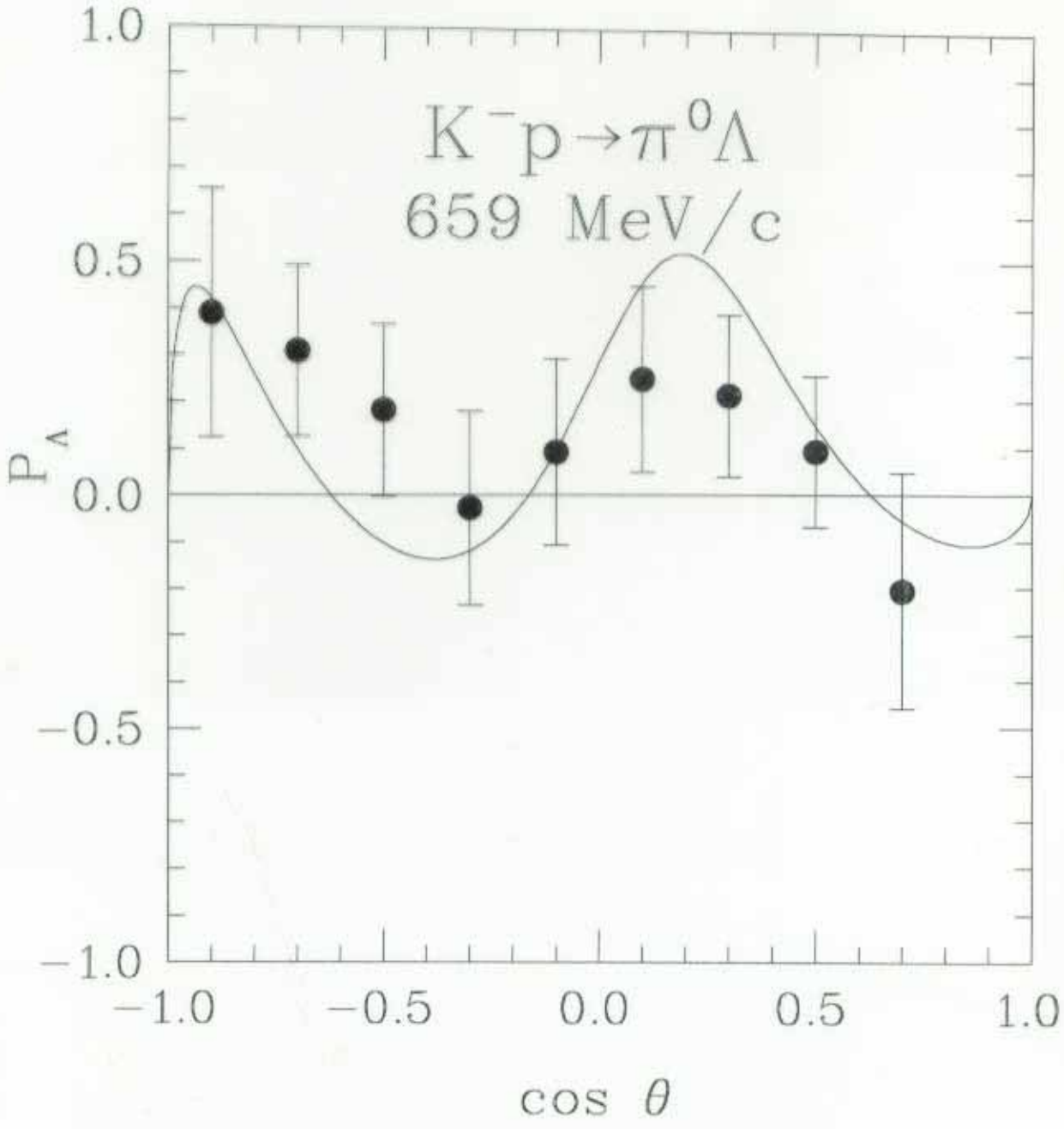
Resonance	$2J^P$	PDG	P_{K^-}	Mass	Width
$\Sigma(1385)$	3^+	****	—	1384±1	36±5
$\Sigma(1480)$	??	*	280	∼1480	∼50
$\Sigma(1560)$	??	**	490	∼1560	∼50
$\Sigma(1580)$	3^-	**	540	∼1580	∼15
$\Sigma(1620)$	1^-	**	630	∼1620	20-85
$\Sigma(1660)$	1^+	***	720	1630-1690	40-200
$\Sigma(1670)$	3^-	****	740	1665-1685	40-80
$\Sigma(1690)$	??	**	780	∼1690	30-150

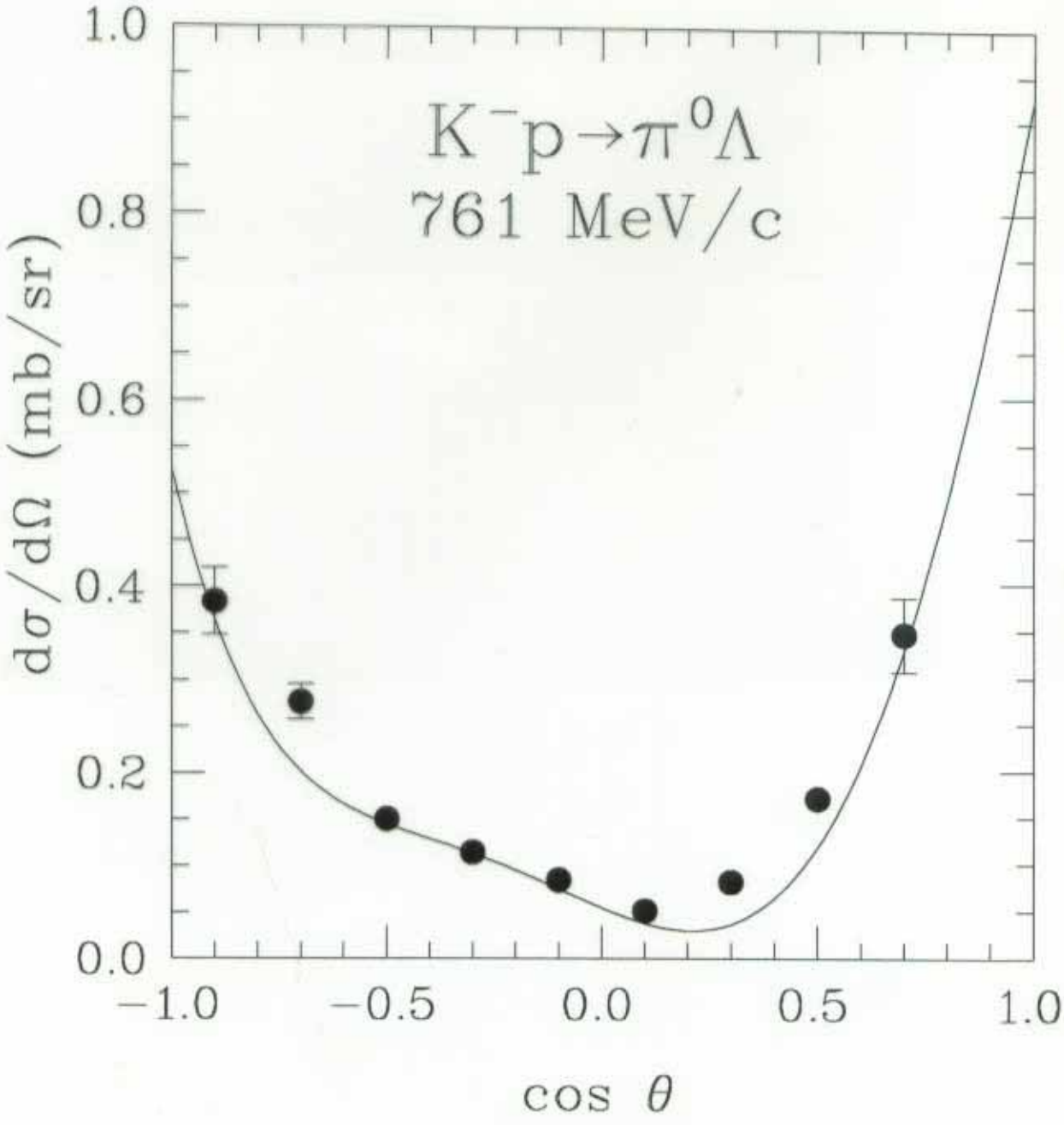
Data for 18 K^- momenta: 492 – 761 MeV/c.

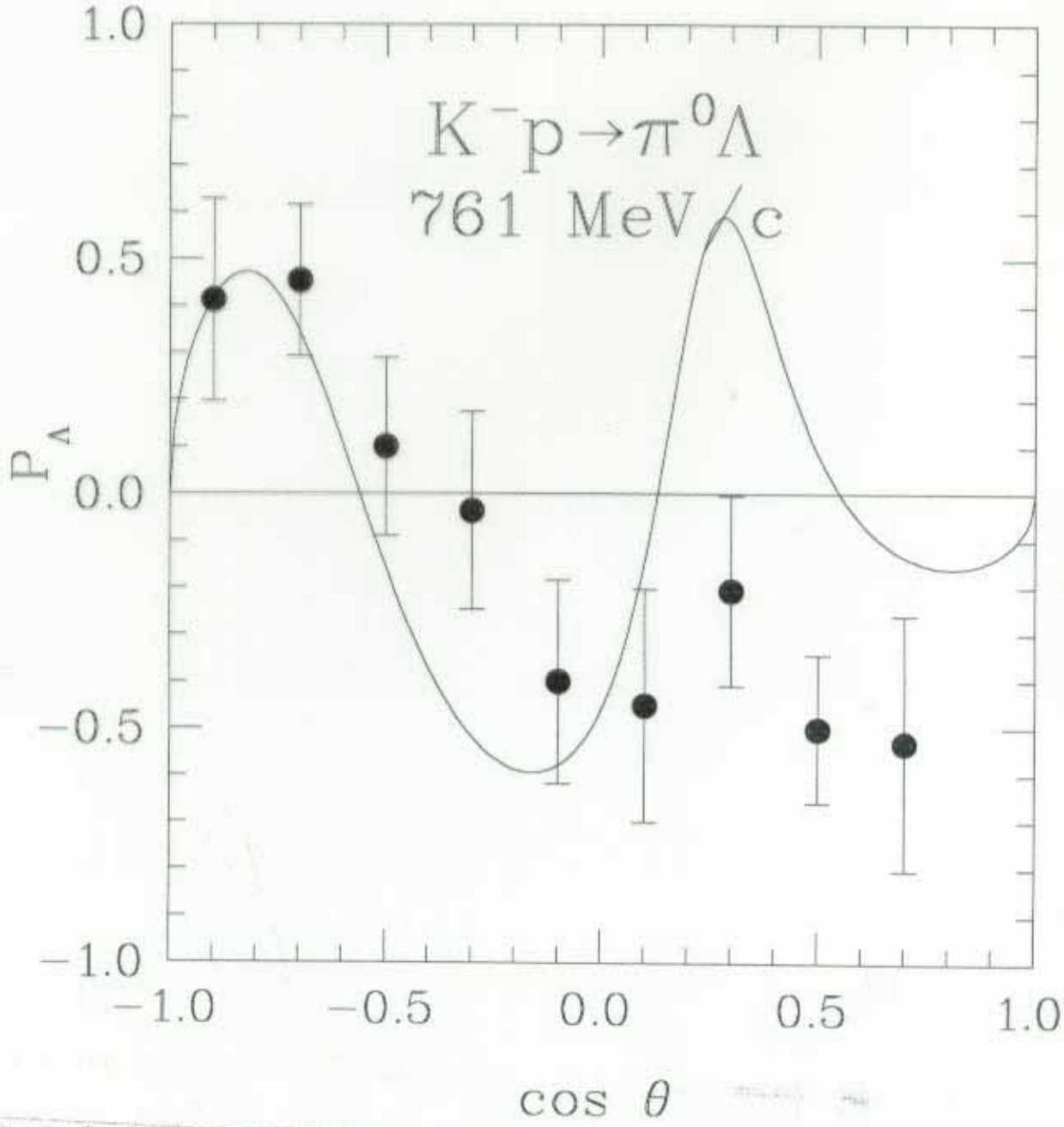

$K^- p \to \pi^0 \Lambda$
571 MeV/c
$d\sigma/d\Omega$ (mb/sr)
1.0
0.8
0.6
0.4
0.2
0.0
−1.0
−0.5
0.0
0.5
1.0
cos θ


$K^- p \to \pi^0 \Lambda$
571 MeV/c
P_Λ
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
cos θ


$K^- p \rightarrow \pi^0 \Lambda$
659 MeV/c
$d\sigma/d\Omega$ (mb/sr)
cos θ
1.0
0.8
0.6
0.4
0.2
0.0
−1.0
−0.5
0.0
0.5
1.0


$K^- p \to \pi^0 \Lambda$
659 MeV/c
P_Λ
cos θ
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0


$K^- p \to \pi^0 \Lambda$
761 MeV/c
dσ/dΩ (mb/sr)
cos θ
1.0
0.8
0.6
0.4
0.2
0.0
−1.0
−0.5
0.0
0.5
1.0


$K^- p \to \pi^0 \Lambda$
761 MeV/c
P_Λ
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
cos θ