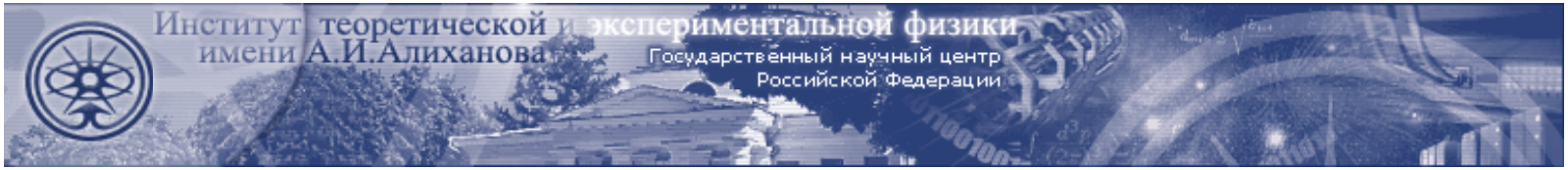



# *Investigation of Resonance Structure in the System of Two Ks-Mesons in the Mass Region around 1545 MeV*

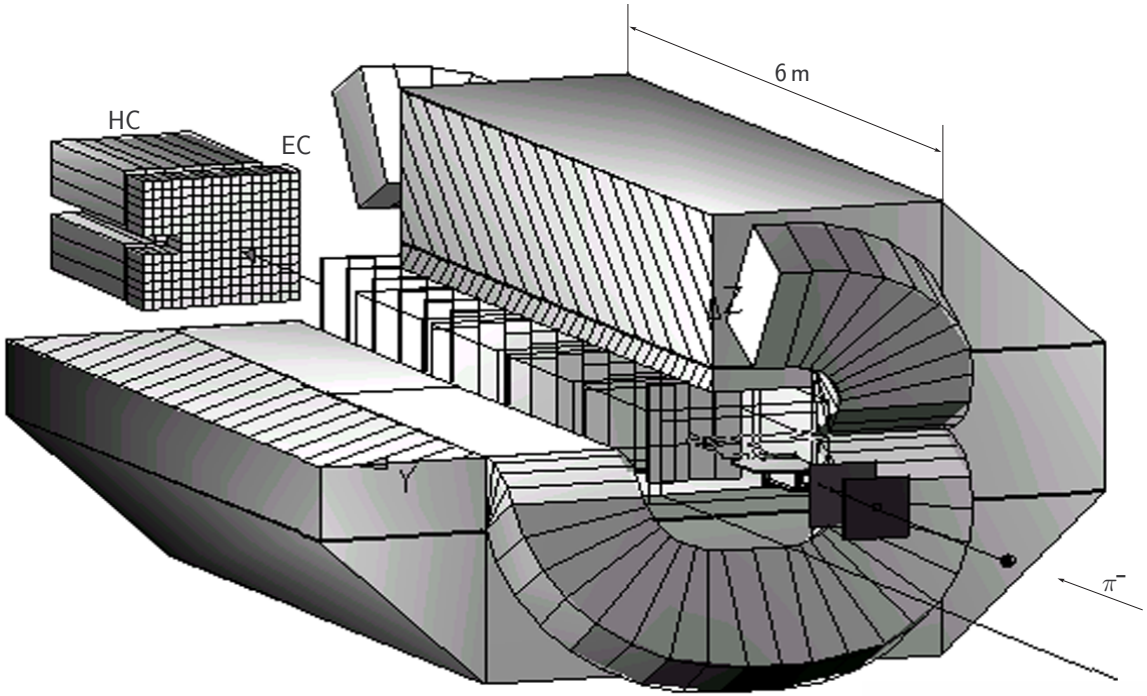
Ekaterina Fadeeva

*6-m MIS ITEP Collaboration*

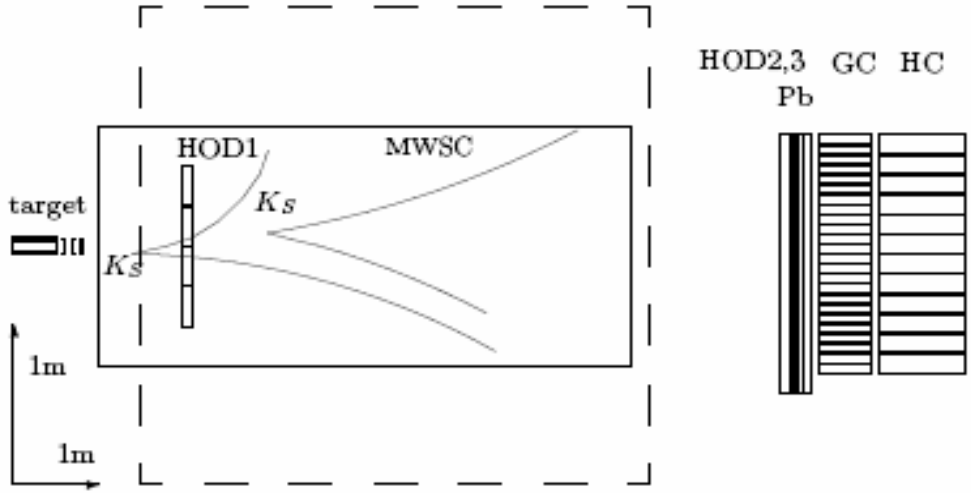
*Institute for Theoretical and Experimental Physics,*

*Moscow, Russia*

# 6-m MIS ITEP Spectrometer Overview




**MWSC—tracking detectors;**
**HOD 1,2,3– Hodoscopes;**
**GS– Gamma-calorimeter;**
**HC– Hadron calorimeter.**



# *Experimental data*

The experimental data on the production of *Ks* pairs were obtained in $\pi^- p$ interaction at 40 GeV by using a neutral trigger.

The system of two *Ks*-mesons that was recorded under the experimental conditions of 6-m spectrometer is produced in the following two reactions:

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

$$\pi^- p \to K_s K_s n + (n + m\pi^0, p + m\pi^-, \ldots)$$

About 40 000 events of these two reactions were accumulated!

***In the mass region near 1545 MeV***

The efficiency of registered *KsKs*-system is about 45% and

The precision of measurement of the effective mass of the *KsKs*-system is better than 3 MeV.

# Kinematical variables:

1. The effective mass $M_{KK}$ of the pair of $K_S$-mesons;

2. The missing mass squared $MM^2$ defined as the squared mass of particles that are produced together with the $K_SK_S$-system and which are not recorded in the spectrometer;

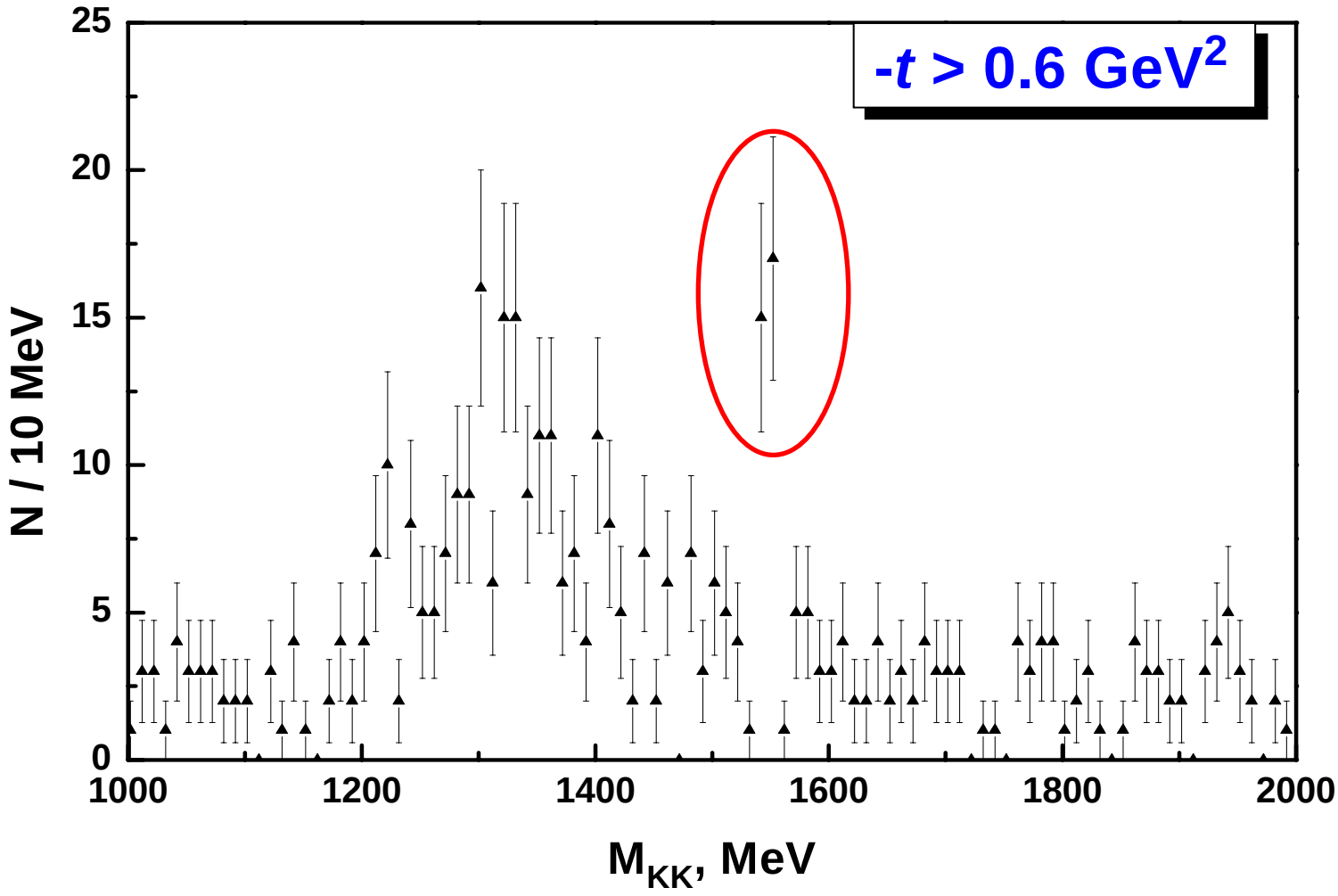
3. The 4-momentum transferred from the beam to the system being studied, t;

4. The cosine of the Gottfried-Jackson angle, $cos\theta_{GJ}$;

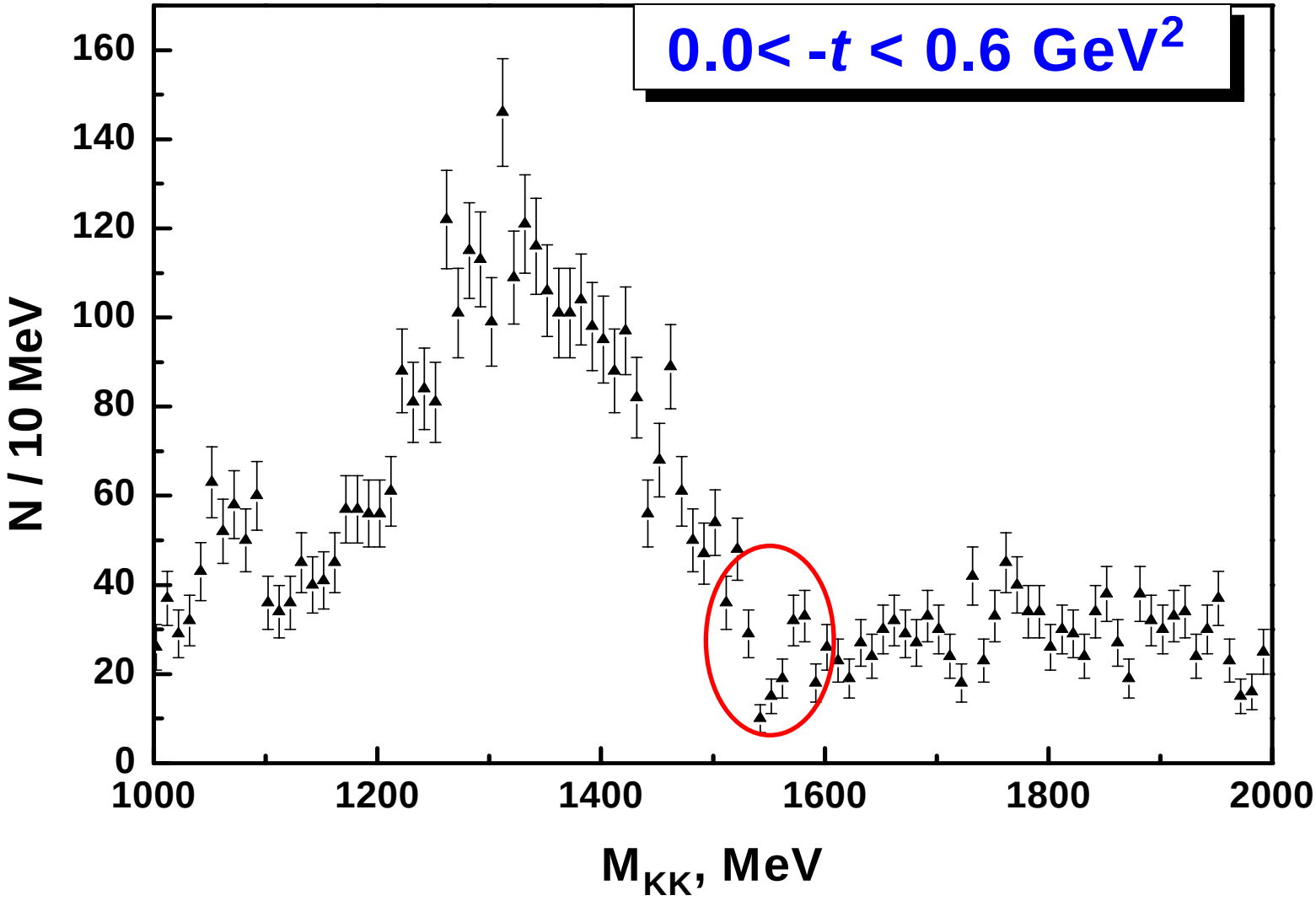
5. The Treiman-Yang angle, $\phi_{TY}$.

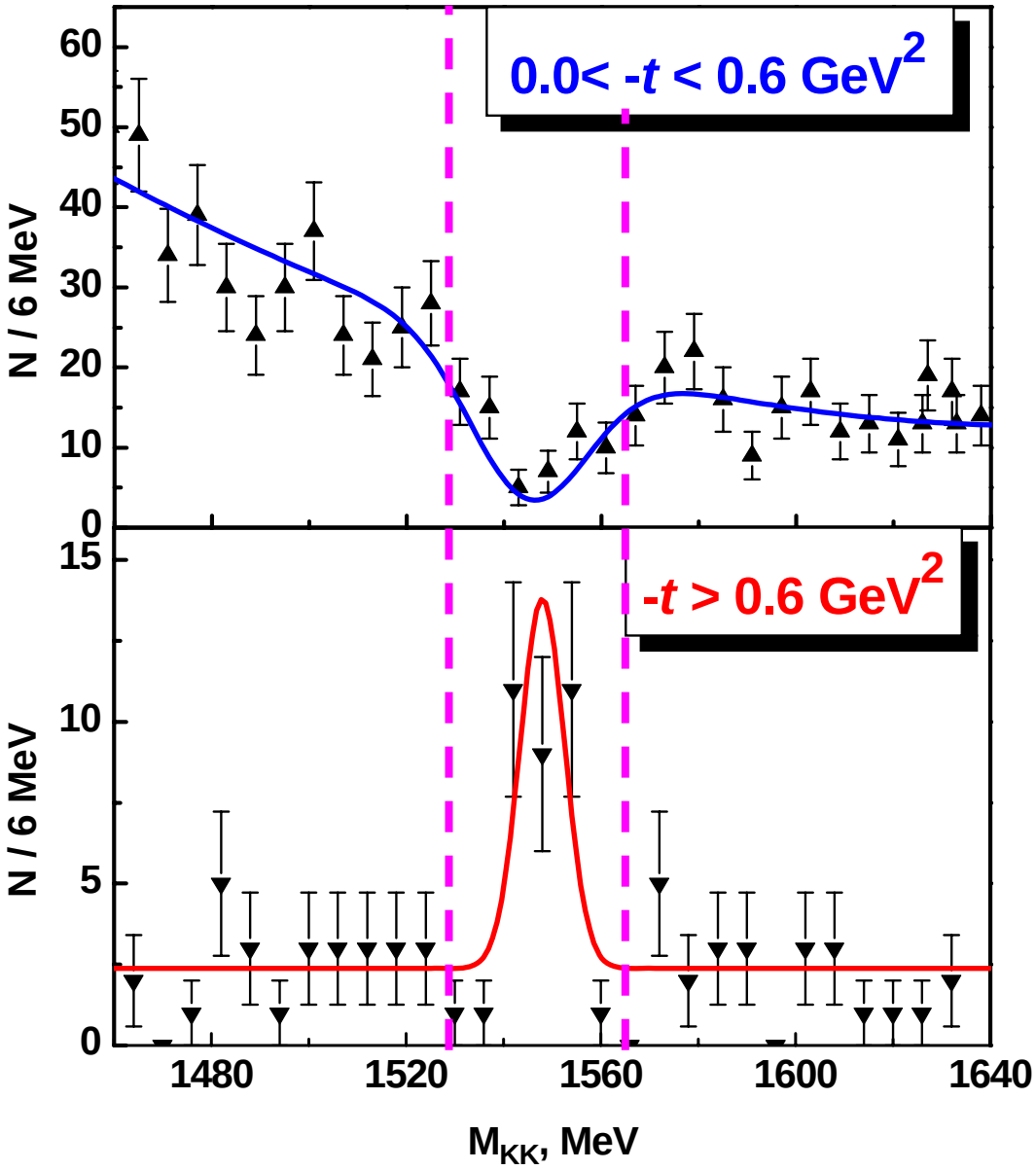
The angles are calculated in the rest frame of the pair of $K_S$-mesons, the beam axis direction in this system being taken for the polar axis. The plane from which the Treiman-Yang angle is reckoned is spanned by the momenta of the beam and of the target proton in this reference frame.

# *Effective-mass spectrum of two K_S-mesons*



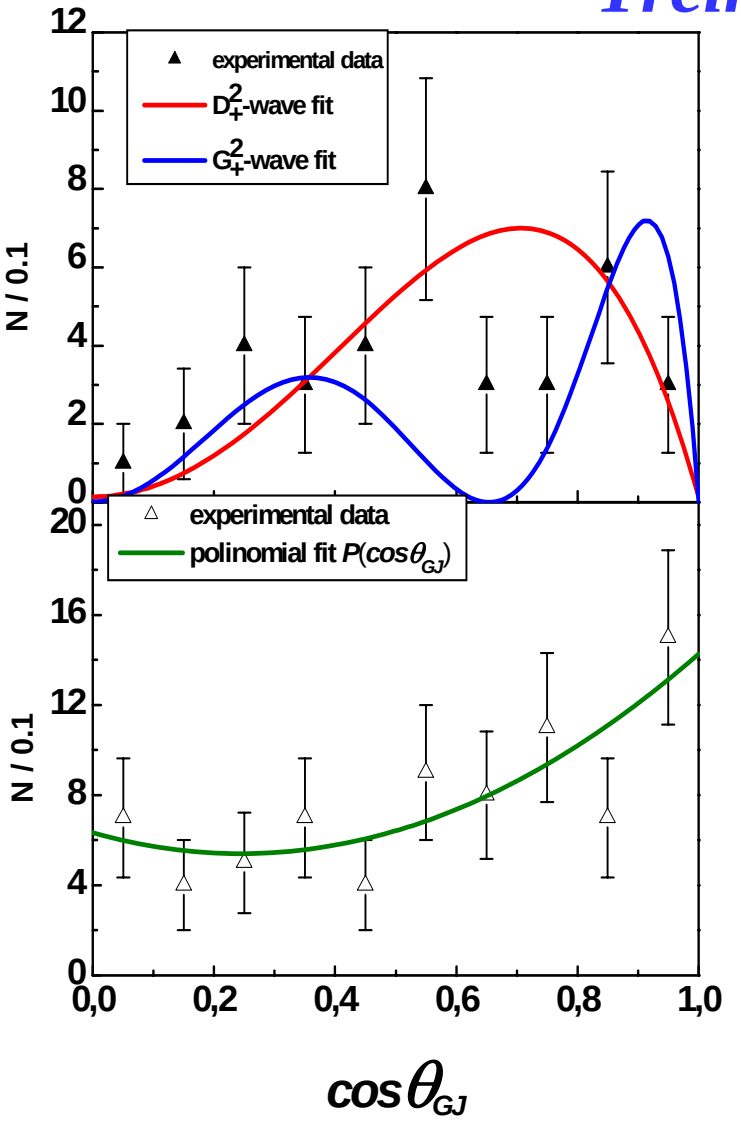
# *Effective-mass spectrum of two K_S-mesons*

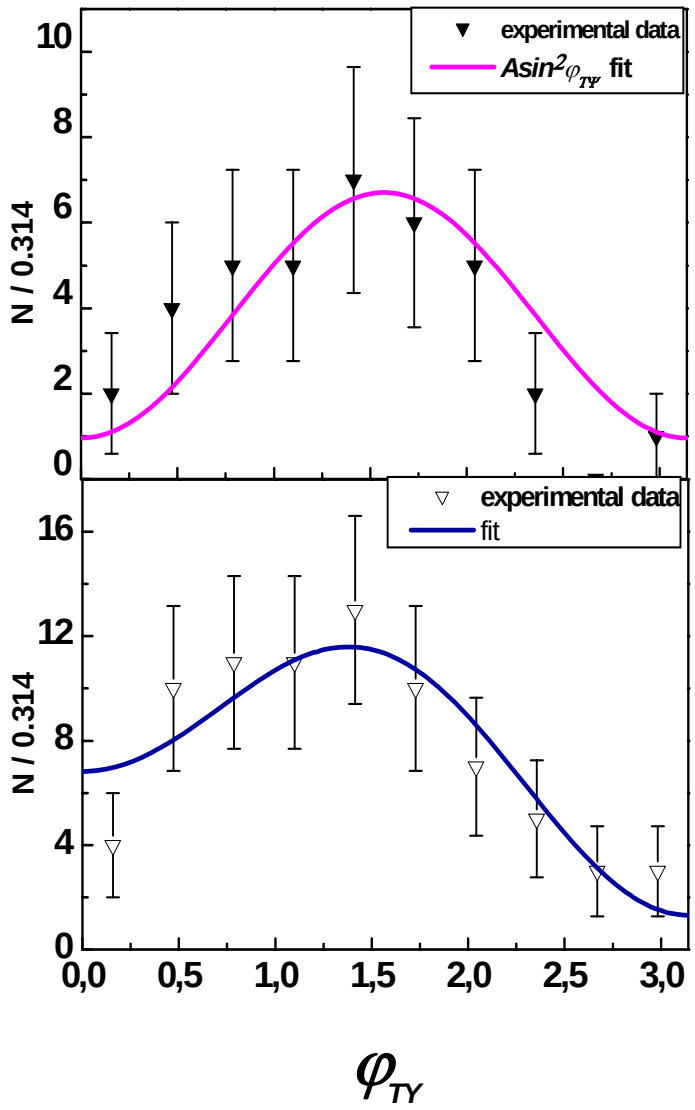



0.0< -t < 0.6 GeV2
-t > 0.6 GeV2
N / 6 MeV
N / 6 MeV
MKK, MeV
0
10
20
30
40
50
60
0
5
10
15
1480
1520
1560
1600
1640

# $X(1545)$

# Cosine of Gottfried-Jackson angle and Treiman-Yang angle




**1535<*Mkk*<1555, MeV**

**1440<*Mkk*<1535, 1555<*Mkk*<1640, MeV**

# The Method of Maximum Likelihood

$F(P;\Omega)$ –the probability-density function, where $P$ is the set of the following parameters:

1. The amplitude of the resonance,
2. The mass $M$ of the resonance,
3. The width $\Gamma$ appearing in the Breit-Wigner function,
4. The coefficients of the squared amplitudes of the angular distributions.

Elements of the phase space $\Omega$ are

1. Effective mass of two $K_S$-mesons,
2. The cosine of the Gottfried-Jackson angle $\theta_{GJ}$,
3. The Treiman-Yang angle $\phi_{TY}$.

In order to obtain the most probable values of the parameters, we minimized the functional:

$$L = \int_{\Omega} \epsilon(\Omega) F(P;\Omega) d\Omega - \sum_{i=1}^{N} \ln F(P;\Omega_i). \quad (1)$$

where $\epsilon(\Omega)$ is the event-detection recording, $N$ being the number of events. To compare the probabilities of experimental-data description with different parameter set, we calculated $\chi^2$ by the formula:

$$\chi^2 = -2 \ln L + const. \quad (2)$$

# *Different sets of minimization for X(1545)*

| | Background, $N_{events}$ | | | Resonance, $N_{events}$ | | | | Parameters, MeV | | $\chi^2 - N_{d.f.}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | $S$ | $D_0$ | $D_+$ | $S$ | $D_0$ | $D_+$ | $G_+$ | $M \pm \Delta M$ | $\Gamma \pm \Delta\Gamma$ | |
| 1 | 62 | 49 | 82 | – | – | – | – | – | – | 100 |
| 2 | 51 | 38 | 70 | 12 | 8 | 14 | – | 1544.6±3.5 | 10.4 ±3.3 | 77 |
| 3 | 60 | 47 | 51 | – | – | 37 | – | 1544.7±3.0 | 10.3 ±3.0 | 56 |
| 4 | 66 | 37 | 58 | – | – | – | 32 | 1545.8±3.0 | 10.0 ±3.0 | 60 |
| 5 | 68 | 39 | 47 | – | – | 23 | 16 | 1545.1±3.1 | 11.0 ±3.0 | 52 |

# Conclusion

Statistical significance is better than 6 st.dev.

$M$=1545.1 ± 3.1 MeV

$\Gamma$=11.0 ±3.0 MeV

$J^{PC}$= $2^{++}$ or $4^{++}$

$\sigma \cdot \mathrm{Br}(K_S K_S) \sim$ 6 nb.