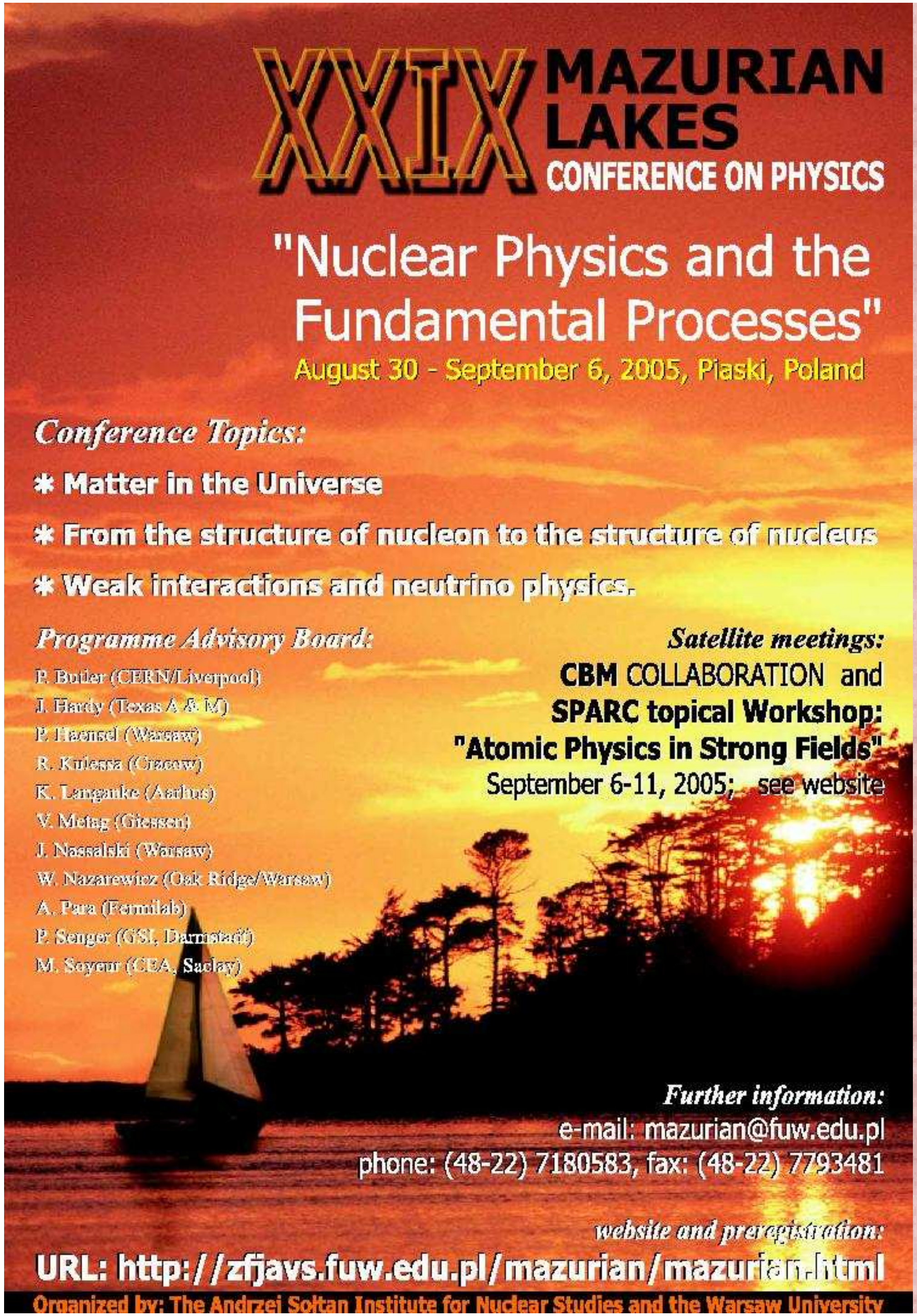

# XXIX MAZURIAN LAKES CONFERENCE ON PHYSICS

## "Nuclear Physics and the Fundamental Processes"

August 30 - September 6, 2005, Piaski, Poland

*Conference Topics:*

*** Matter in the Universe**

*** From the structure of nucleon to the structure of nucleus**

*** Weak interactions and neutrino physics.**

*Programme Advisory Board:*

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*Satellite meetings:*
**CBM** COLLABORATION and
**SPARC topical Workshop:**
**"Atomic Physics in Strong Fields"**
September 6-11, 2005; see website

*Further information:*
e-mail: mazurian@fuw.edu.pl
phone: (48-22) 7180583, fax: (48-22) 7793481

*website and preregistration:*
**URL: http://zfjavs.fuw.edu.pl/mazurian/mazurian.html**

Organized by: The Andrzej Sołtan Institute for Nuclear Studies and the Warsaw University

# Subiektywne impresje współorganizatora

*(nie sprawozdanie z konferencji)*

Światowy Rok
FIZYKI
2005

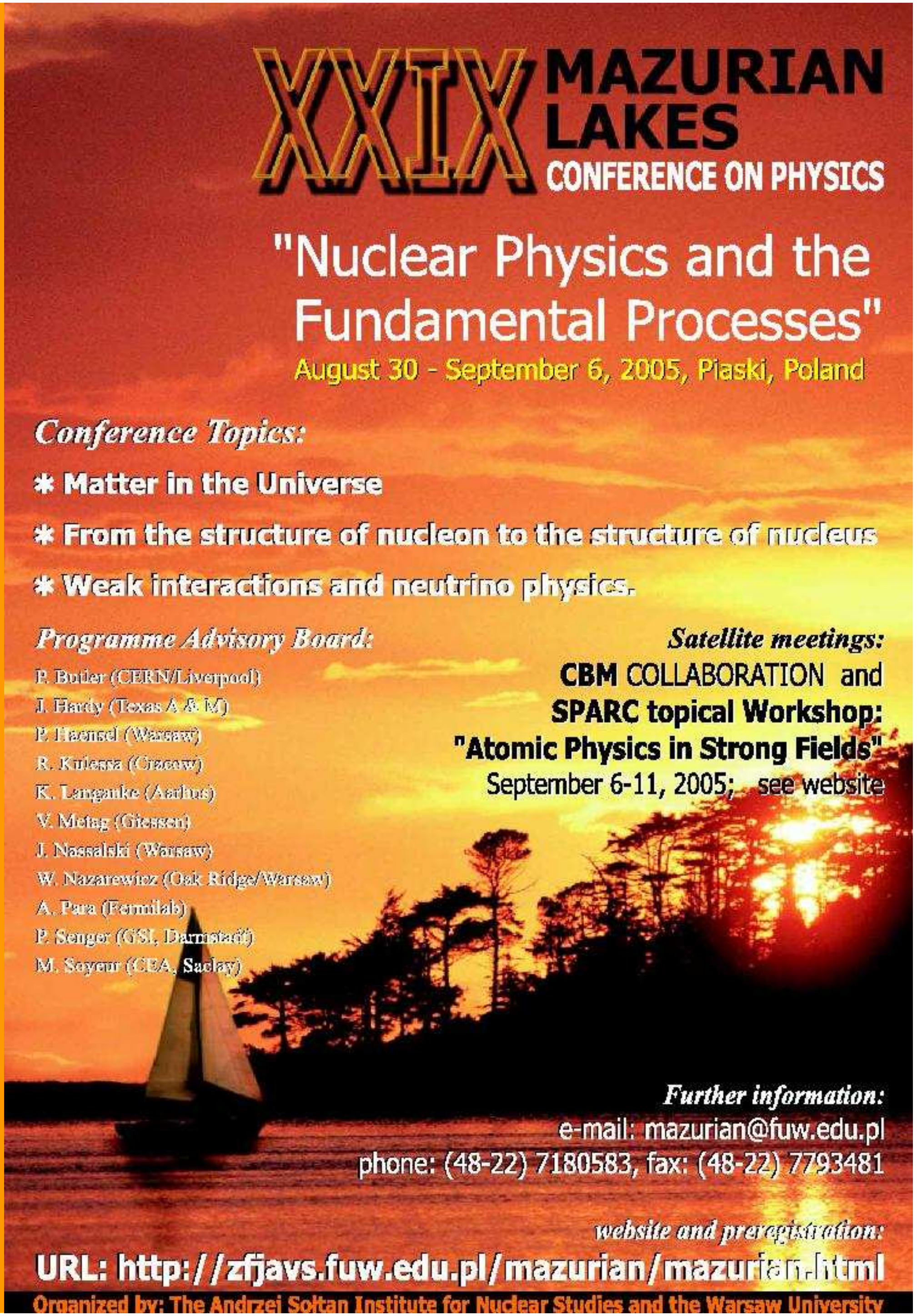
Tomasz Matulewicz

ZFJA IFD UW

14 X 2005

# plan

- Krzyże bye, bye; Piaski come back
- wybór programu i proces selekcji referatów
- subiektywne impresje z konferencji
- po konferencji: CBM i SPARC
- zapraszamy za 2 lata!
- wrażenia pozanaukowe



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# Piaski (www.exploris.pl) TP Edukacja i Wypoczynek Sp. z o.o.

# organizacja

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for Nuclear Studies

Warsaw University

Pro Physica Foundation

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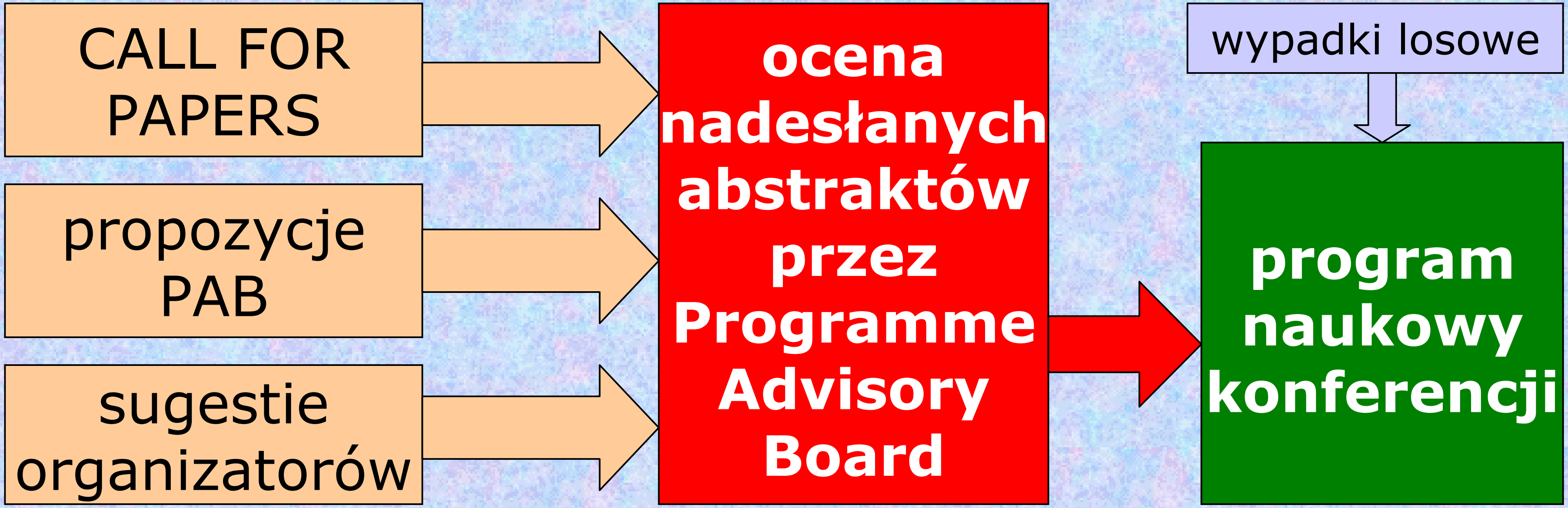
# program naukowy

„NUCLEAR PHYSICS AND THE FUNDAMENTAL PROCESSES”

**From the structure of nucleon
to the structure of nucleus**

**Matter in the Universe**

**Weak interactions and neutrino physics**



CALL FOR PAPERS

propozycje PAB

sugestie organizatorów

**ocena nadesłanych abstraktów przez Programme Advisory Board**

wypadki losowe

**program naukowy konferencji**

# XXXVIII ZFP vs XXIX MLC

## porównanie programów naukowych

***Einstein i fizyka 100 lat temu*** - prof. Andrzej Kajetan Wróblewski (UW)
***Neutrina – takie lekkie a takie ważne*** - prof. Agnieszka Zalewska (IFJ PAN)
***Kształt Wszechświata*** - dr hab. Stanisław Bajtlik (CAMK)

**Fizyka jądrowa i cząstek elementarnych** **Animator: prof. Maciej Nowak (UJ)**

***Supersymetria – fizyka cząstek powyżej granicy elektrosłabej***
**prof. Jan Kalinowski (UW)**

***Czterowymiarowy Wszechświat w lorentzowskiej kwantowej grawitacji***
**prof. Jerzy Jurkiewicz (UJ)**

***100 lat fotonu*, prof. Maria Krawczyk (UW)**

***Pentakwarki,* prof. Michał Praszałowicz (UJ)**

***Materia jądrowa w warunkach ekstremalnych*, prof. Jan Pluta (PW)**

***Hadrony w materii jądrowej – dokąd sięgają granice istnienia?***
**dr hab. Piotr Salabura (UJ)**

***Piękna fizyka mezonów pięknych w eksperymencie Belle*, dr Henryk Pałka (IBJ PAN)**

***Wiązki radioaktywne – teraźniejszość a przyszłość fizyki jądrowej*, dr Zenon Janas (UW)**

# SUPERSTRINGS

by Brian Foster, Oxford University
professor and leader of the particle physics department, as well as an amateur musician;

the concert features British violinist Jack Liebeck

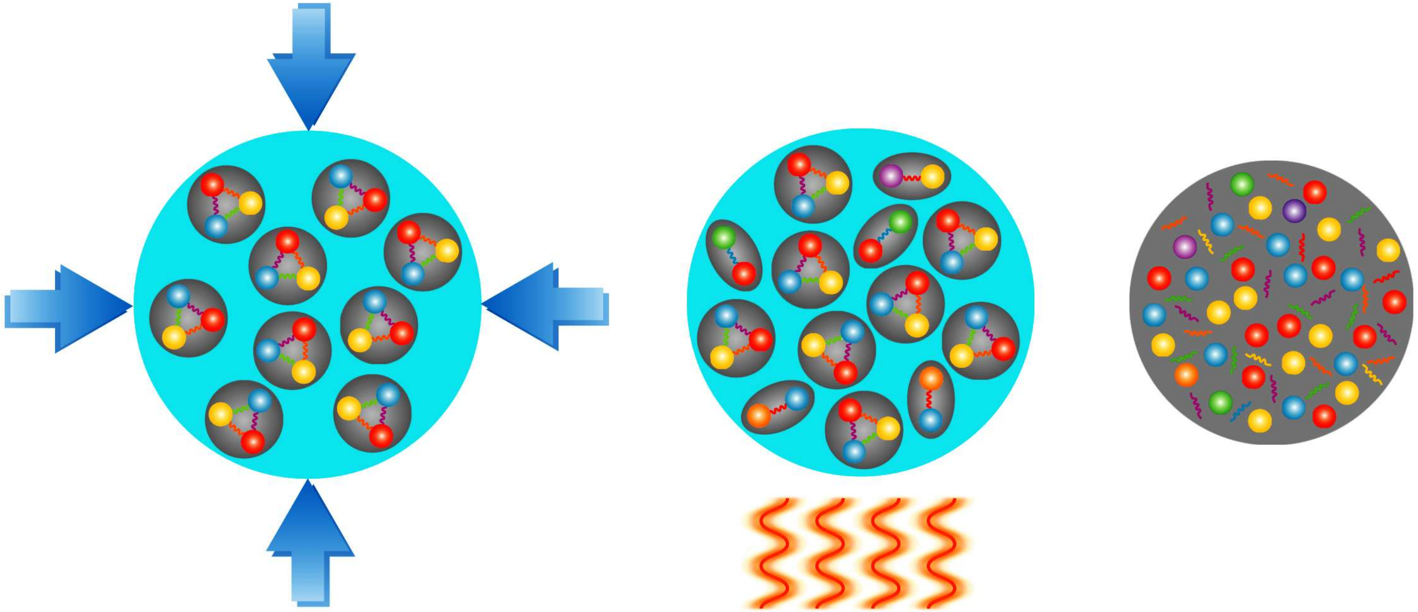
# Subiektywna selekcja tematów©™

- Hadrony w materii jądrowej - daleka droga...
- Degradacja pentakwarków!
- CKM unitarne?
- Neutrina: Sieroszowice-Polkowice?
- Impresje Witka Nazarewicza

# Hadrony w materii jądrowej

Wolfgang Kühn (Gießen)
Witold Przygoda (UJ Kraków)
Peter Senger (GSI Darmstadt)

# Extreme states of strongly interacting matter



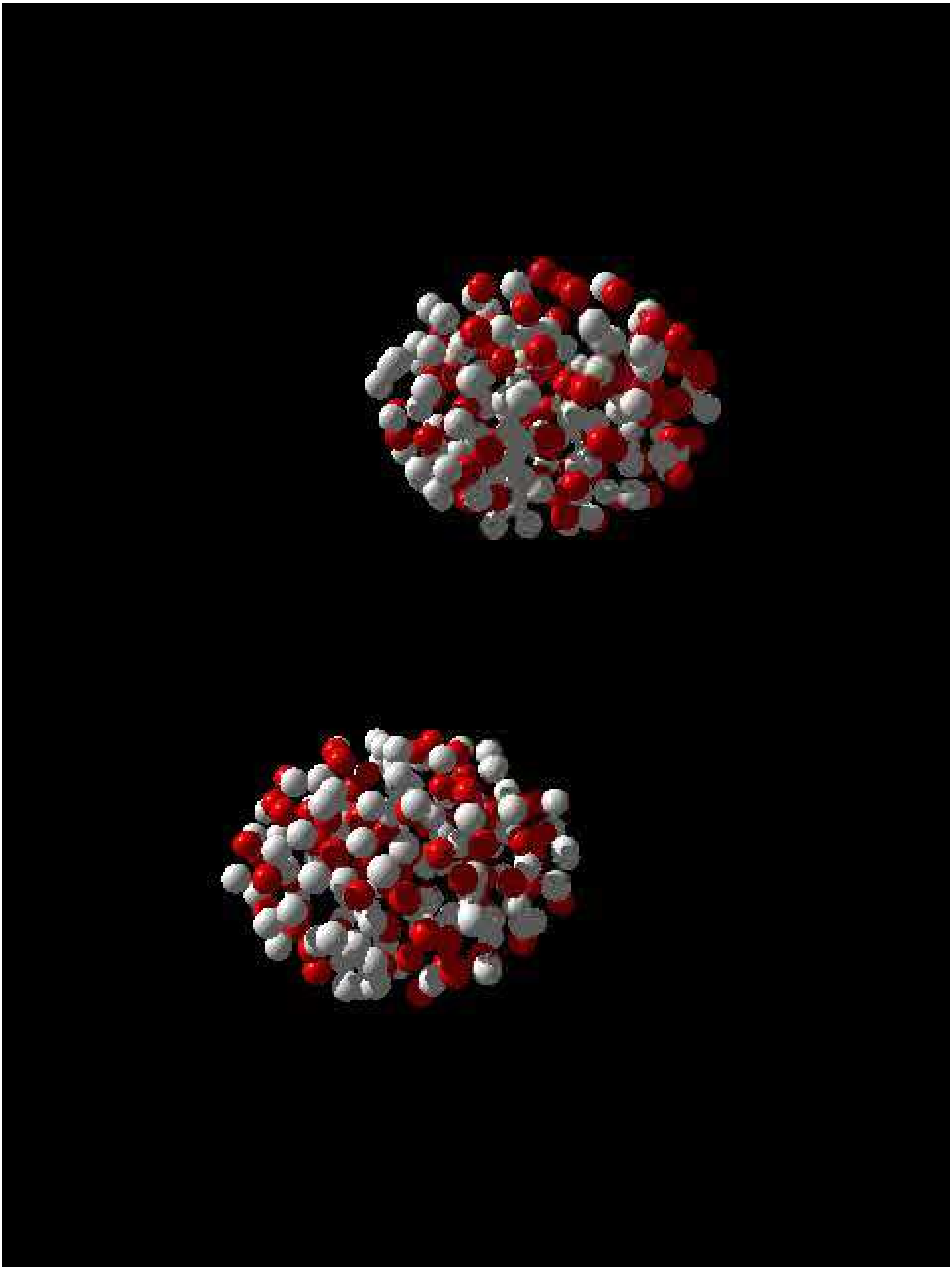
baryons hadrons partons

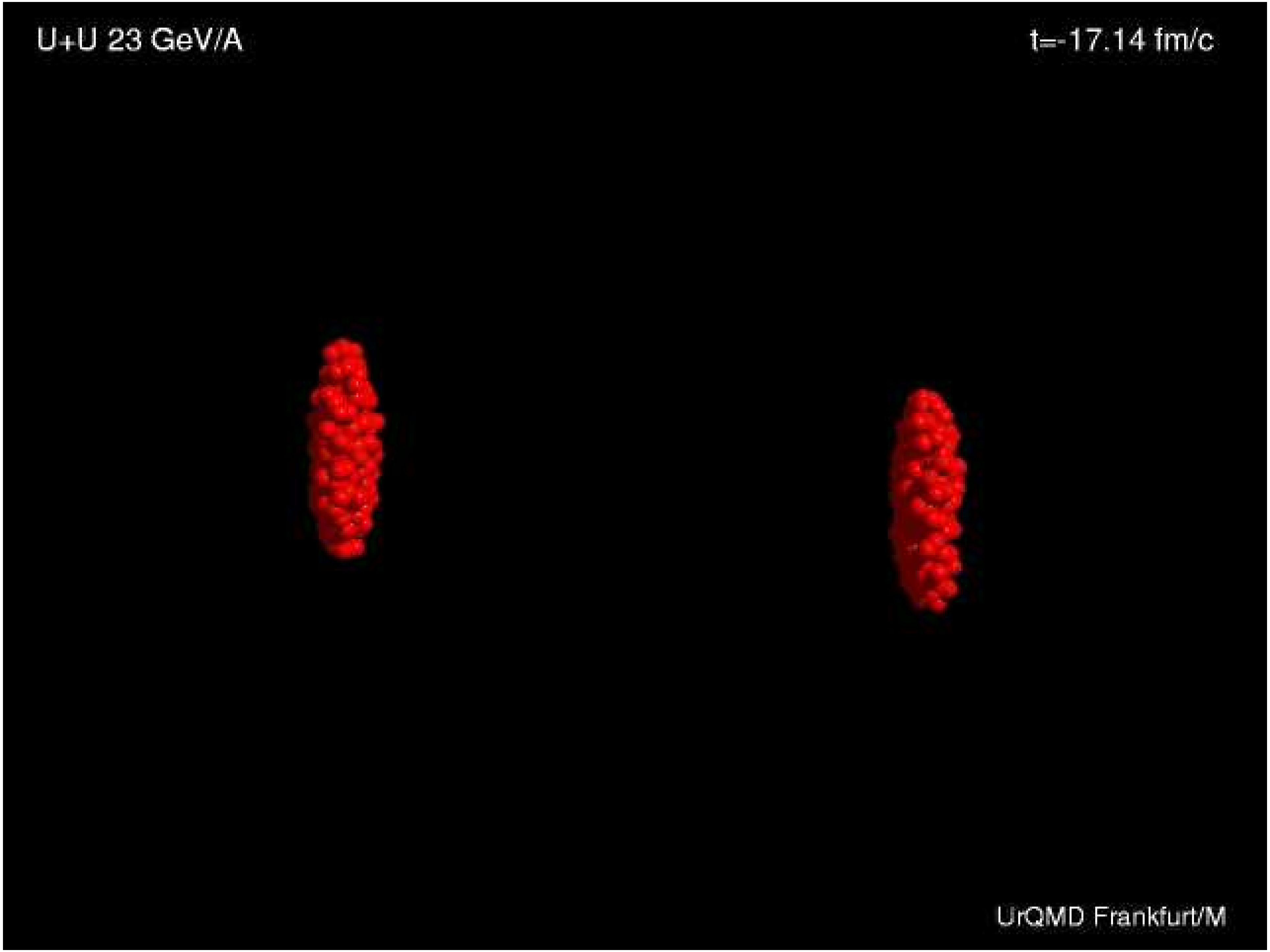
Compression + heating = quark-gluon matter

(pion production)

Au-nucleus: $R \approx 7$ fm, $V \approx 1400$ fm$^3$
Nucleon: $R \approx 0.8$ fm, $V \approx 2$ fm$^3$
200 Nucleons: $V \approx 400$ fm$^3$
At 3 – 4 $\rho^0$: nucleons overlap

rly universe

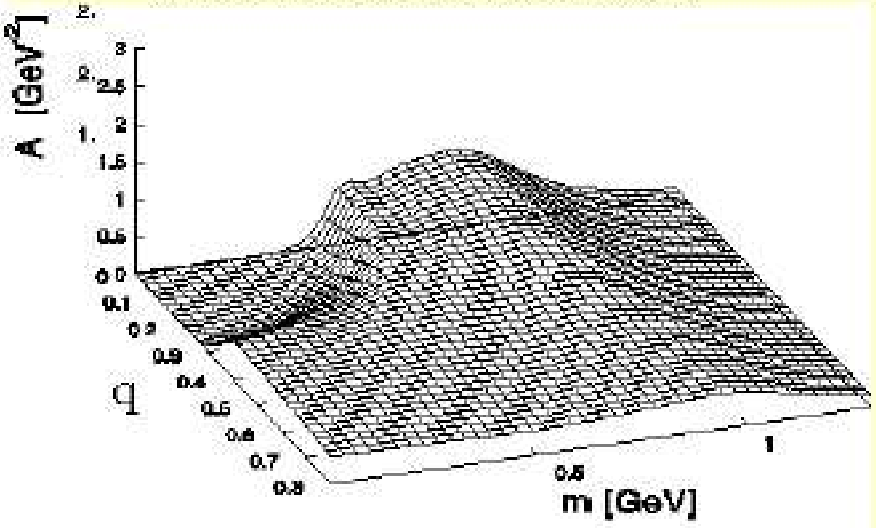


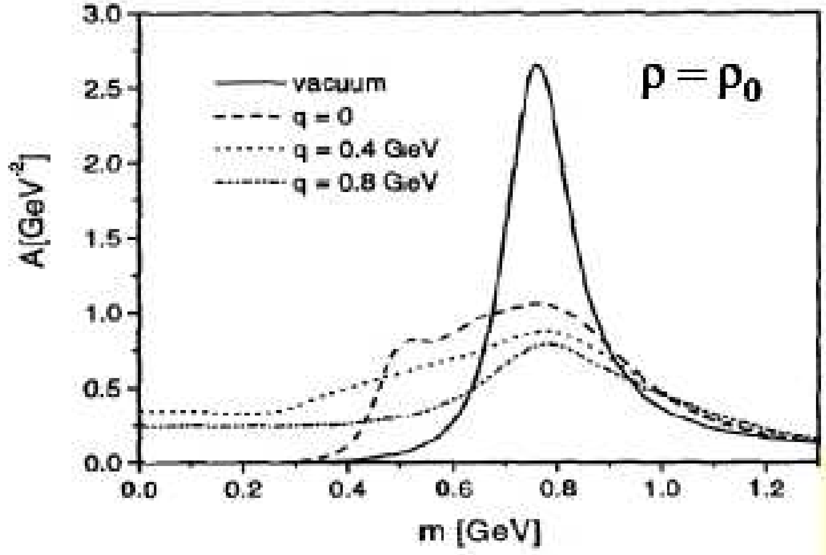

U+U 23 GeV/A
t=-17.14 fm/c
UrQMD Frankfurt/M

# Mesons in nuclear matter: hadronic scenario

W. Peters et.al. NPA 632(1998)109:

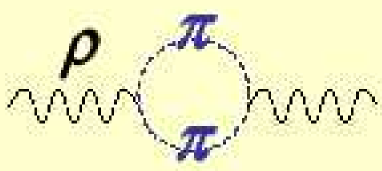
ρ meson spectral function A(q,m)





$$A_\rho(M) = -\frac{2\mathrm{Im}\Sigma_\rho(M)}{[M^2 - m_\rho^2 - \mathrm{Re}\,\Sigma_\rho(M)]^2 + [\mathrm{Im}\Sigma_\rho(M)]^2}$$

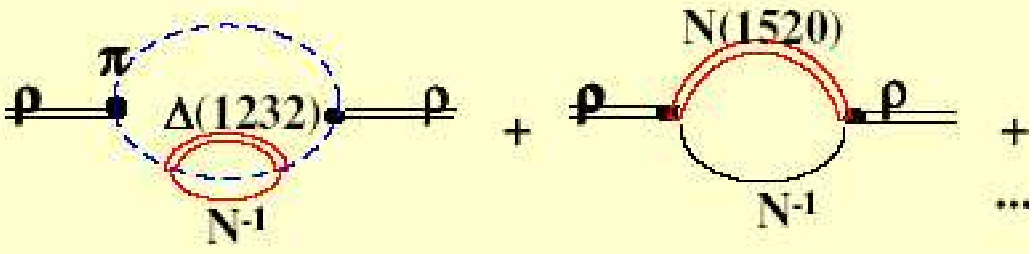
**Vacuum:**



$$\Sigma_\rho(M) = -im_\rho\Gamma_{\pi\pi}(m)$$

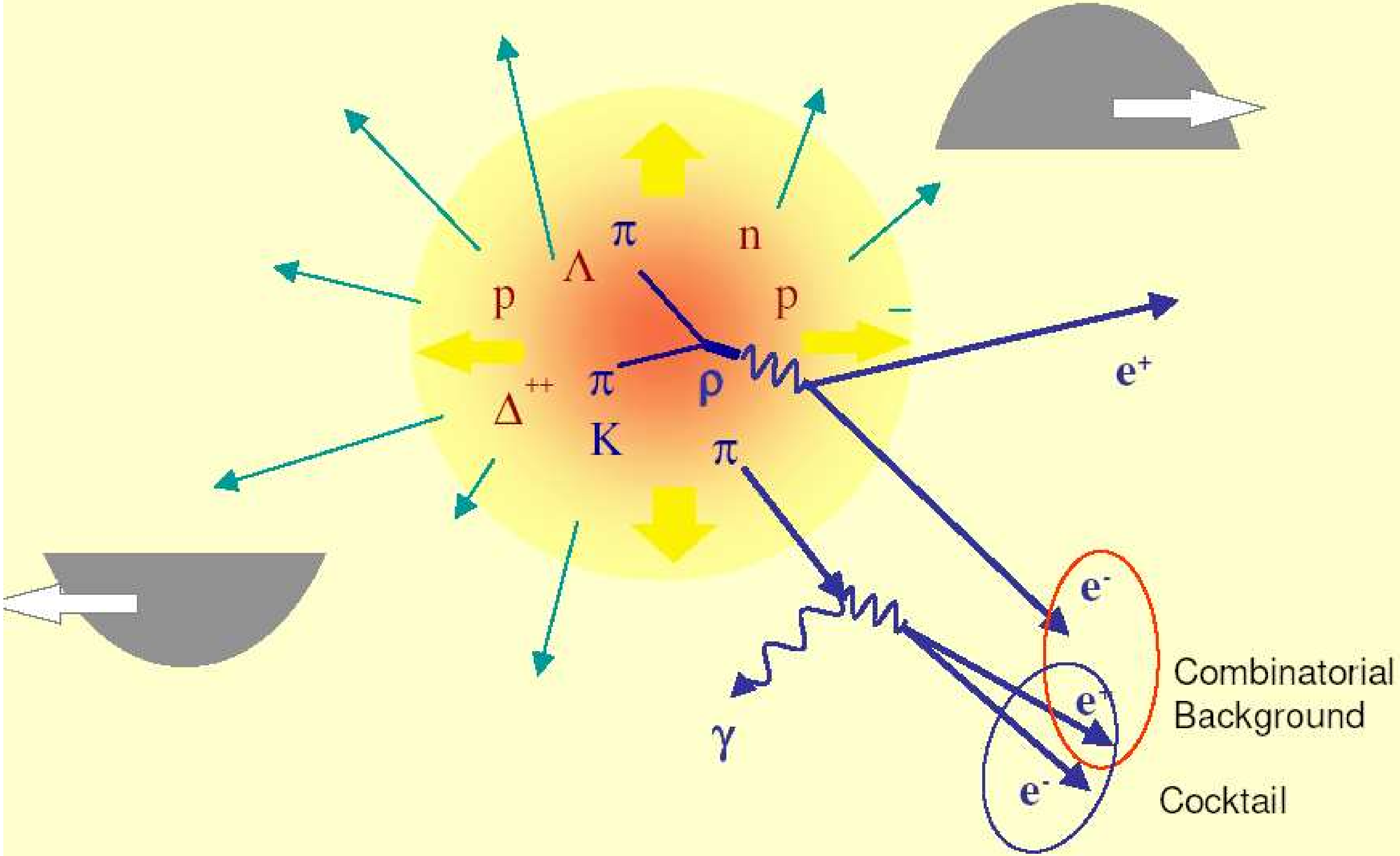
$$m_\rho = 0.77GeV$$

**In medium:**

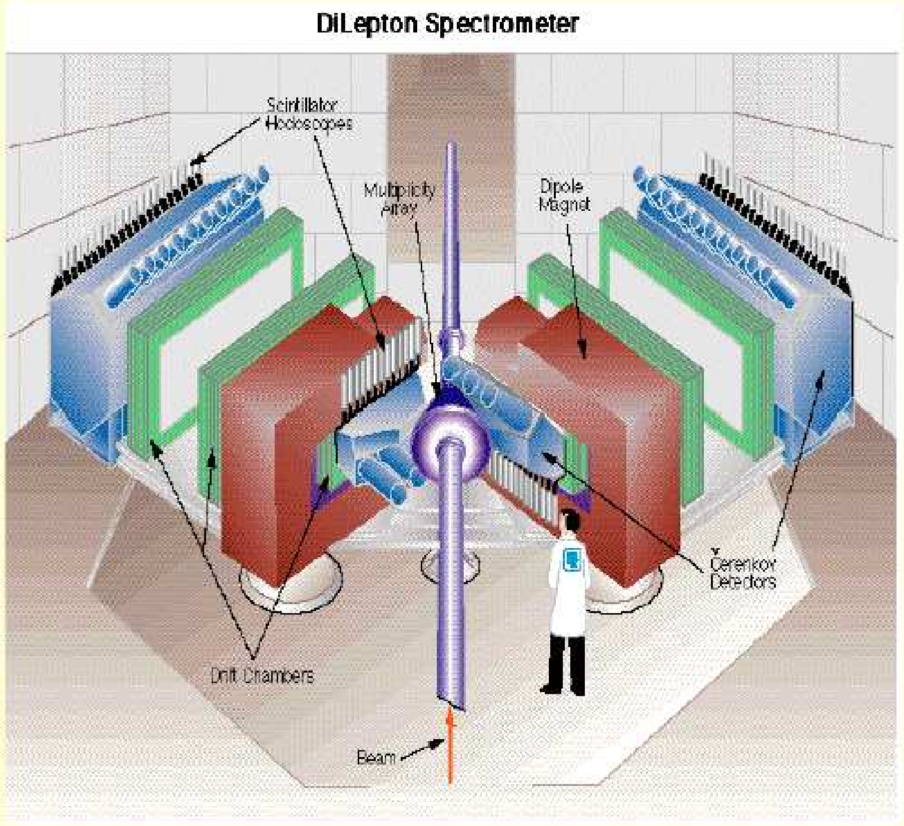


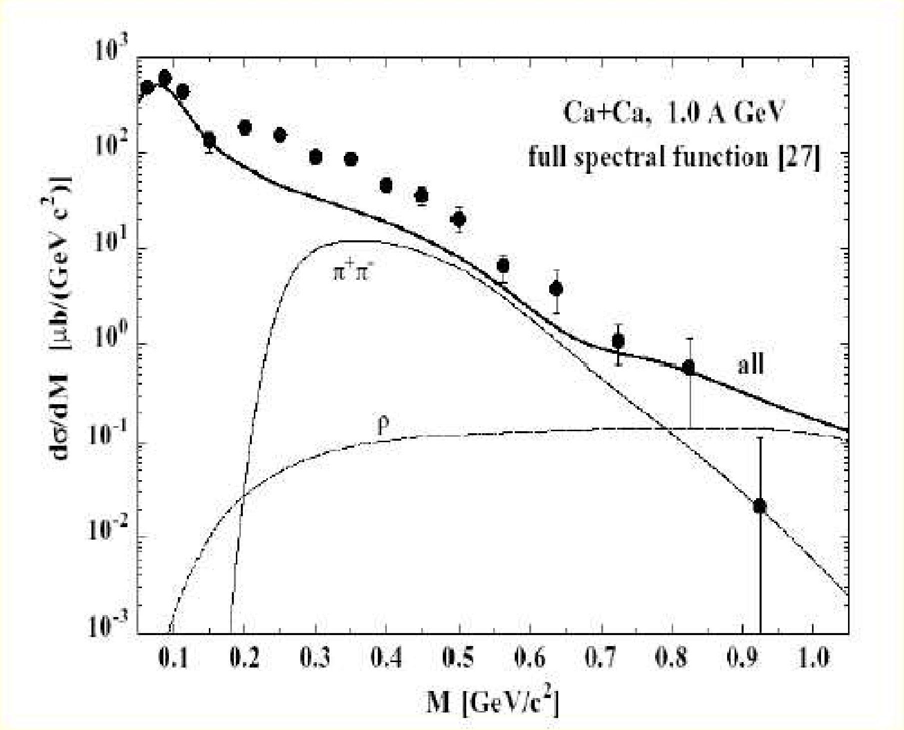
What is the right picture ?

# Probing the interior of compressed matter



# The DLS results





**Data:** **R.J. Porter et al.:** PRL 79 (1997) 1229

**BUU model:** **E.L. Bratkovskaya et al.:** NP A634 (1998) 168,
in-medium spectral functions

→ **DLS puzzle!**

- The shape ($0.05 \leq M \leq 0.35$) can be explained by Dalitz decays of $\pi^0$ and $\eta$ if cross sections are scaled appropriately – but in contradiction with TAPS measurement...

# Efficiency-corrected mass spectrum

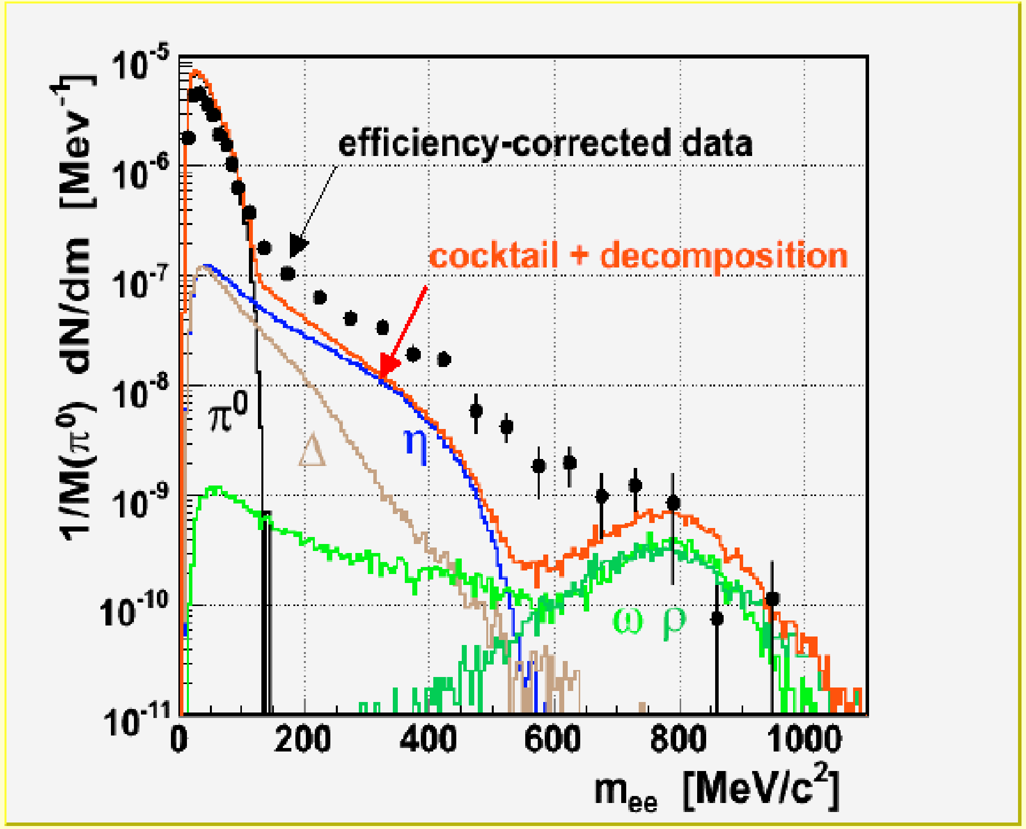
Efficiency correction applied to pair data (e$^-$ and e$^+$ legs):

accounts for

- detector inefficiencies
- reconstruction inefficiencies

Compared with a cocktail based on known or $m_t$-scaled meson multiplicities and their vacuum decay properties within HADES geometric acceptance.

pair opening angle >9°, $p_t > 100$ MeV/c



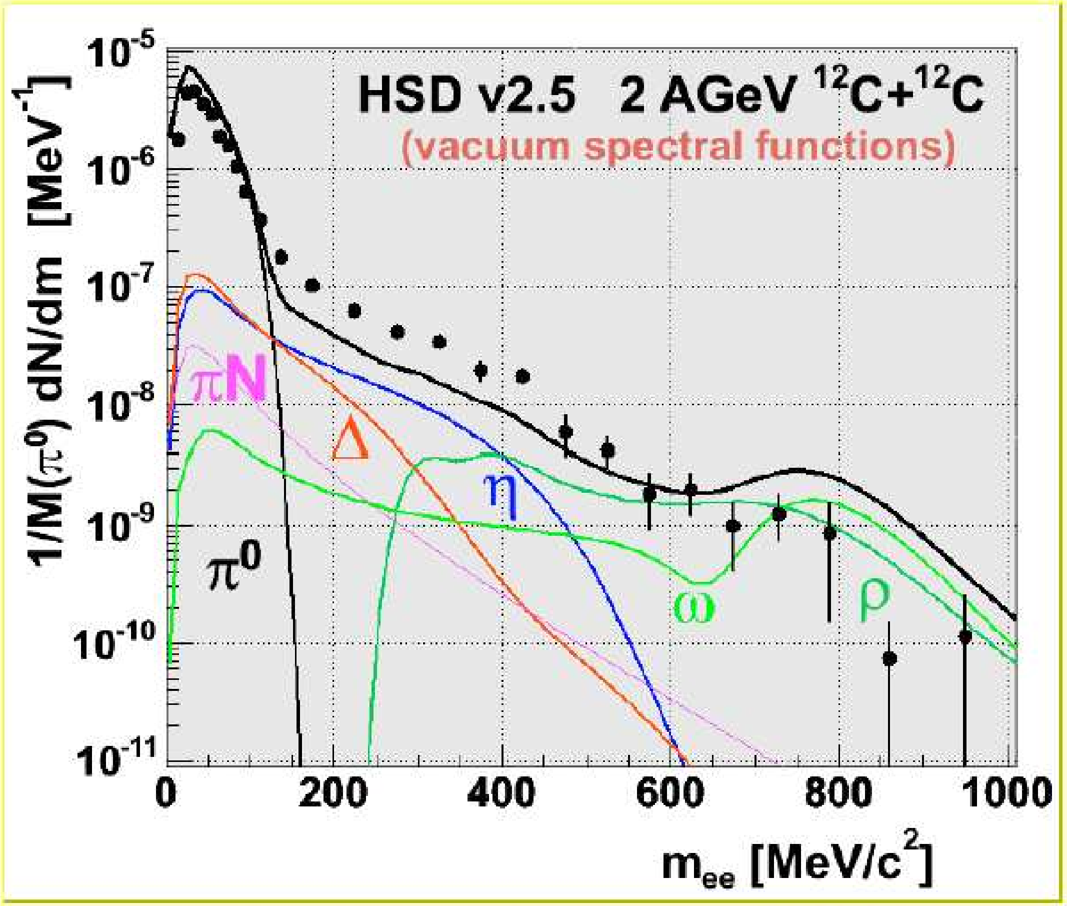
# Comparison with transport theory (I)

HSD v2.5 of May ´05, E. Bratkovskaya et al.

- Giessen HSD
- Tübingen RQMD
- Frankfurt UrQMD
- etc.

Comparison of efficiency-corrected data with theory folded with HADES filter:

- geometrical acceptance
- momentum resolution

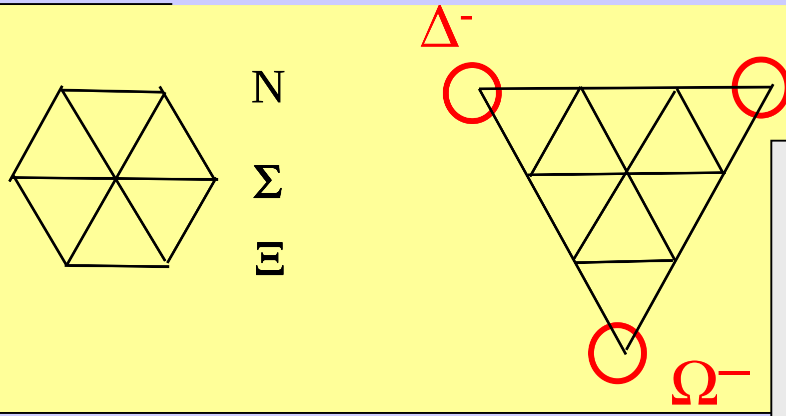


pair opening angle >9°, $p_t > 100$ MeV/c

# Degradacja pentakwarków

## Hartmuth Freiesleben (Dresden)

# Introduction to Pentaquarks



$\Theta^+$ : mass ≈ 1530 MeV/$c^2$

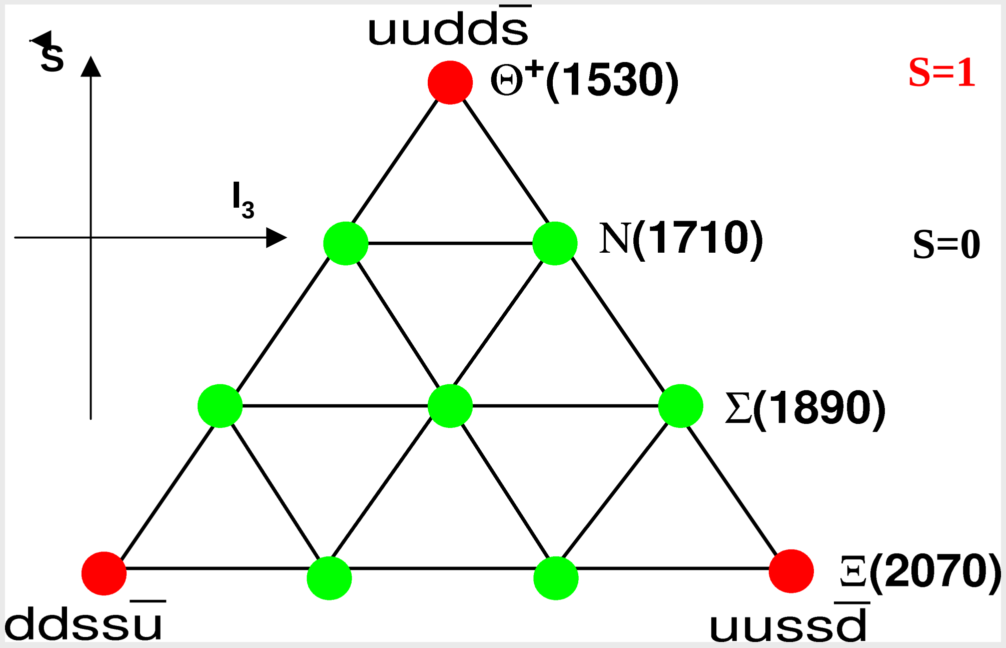
small width:

$\Gamma < 15$ MeV M.V. Polyakov et al. EPJA 9 (00) 115

$\Gamma \approx$ 2-4 MeV D. Diakonov et al. hep-ph/0505201

decay: $\Theta^+ \rightarrow K^0p$ and $K^+n$

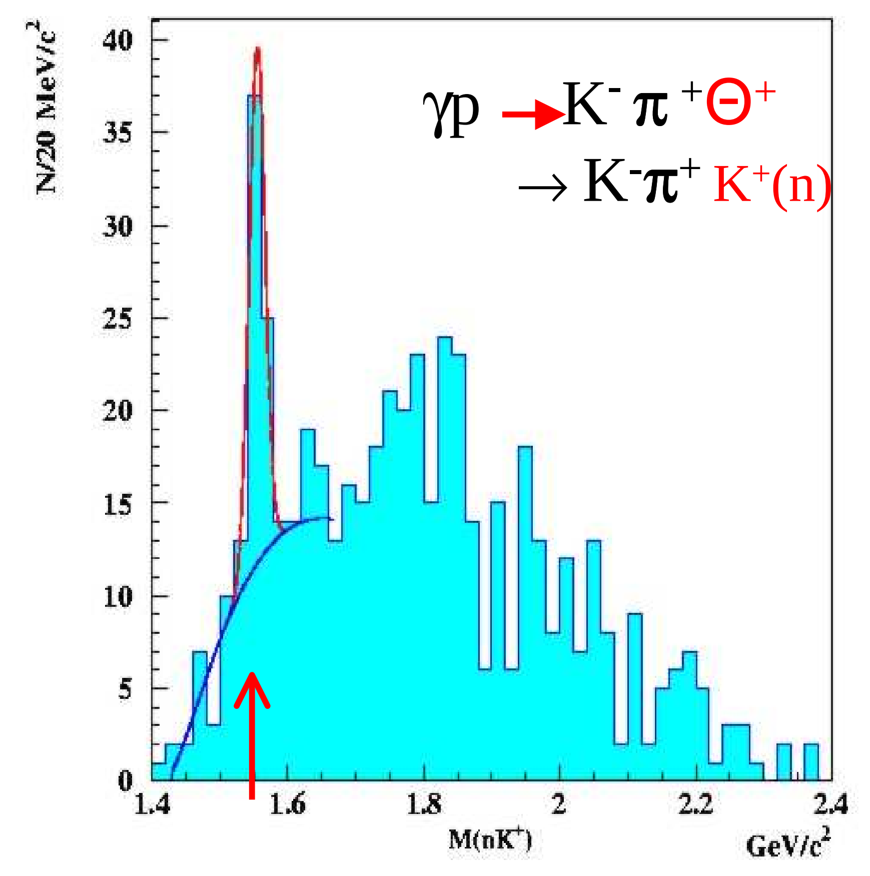
D. Diakonov, V. Petrov and M. Polyakov
Z. Phys. A 359 (97) 305



J = ½ - anti-decuplet of non-exotic pentaquarks (N, Σ, Ξ)
and exotic pentaquarks: $\Theta^+$, $\Xi^{--}$, $\Xi^+$

# Experimental evidence for $\Theta^+$ from electromagnetic probes (IV)

**CLAS/JLab**

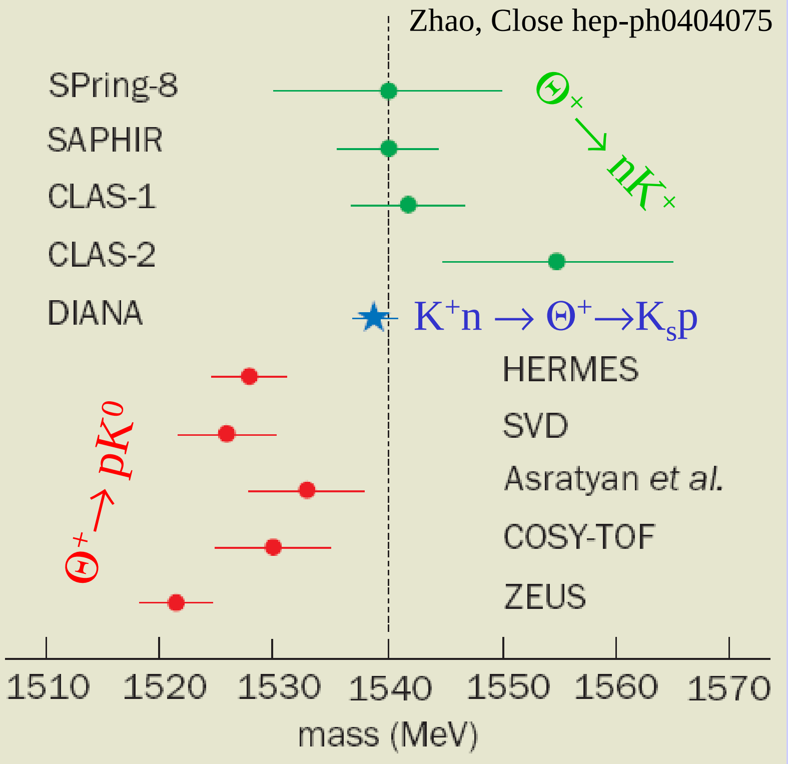


Phys. Rev. Lett 92(2004)032001

- CEBAF Large Acceptance Spectrometer
- $D_2$ and $H_2$ targets
- Tagged photon beam
- Particle tracking in drift chambers, PI by ToF
- $\gamma p \rightarrow K^- \pi^+ \Theta^+ \rightarrow K^- \pi^+ K^+ n$

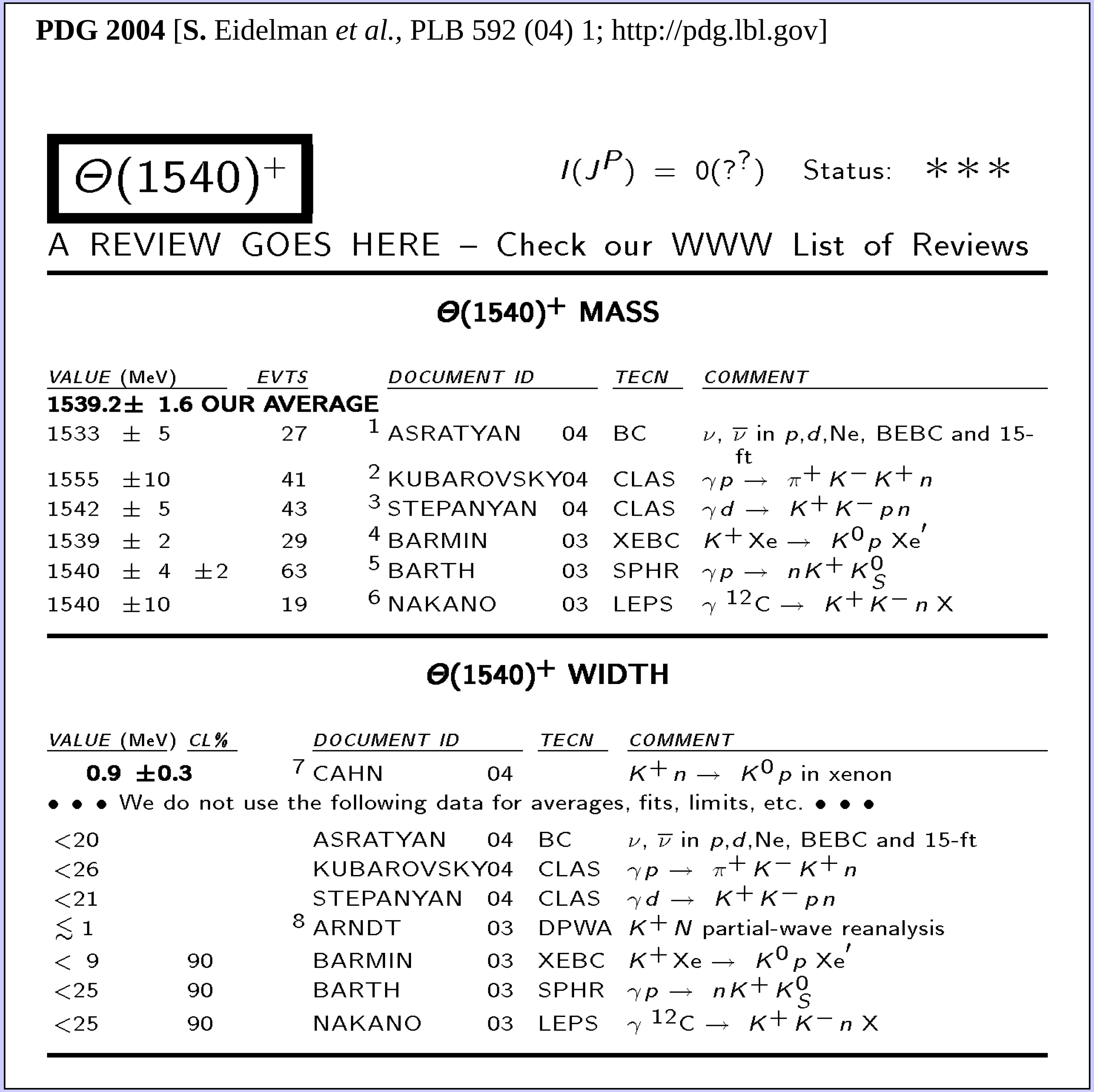
# Summary of Evidences

| | Reaction | Mass / MeV | Width/MeV | σ * |
|---|---|---|---|---|
| LEPS | $\gamma C \to K^+K^- X$ | 1540 ± 1 | | |
| CLAS-1 | $\gamma d \to K^+K^- p(n)$ | 1542 ± 5 | | |
| SAPHIR | $\gamma p \to K^+K_s(n)$ | 1540 ± 6 | | |
| CLAS-2 | $\gamma p \to p^+K^- K^+(n)$ | 1555 ± 1 | | |
| HERMES | $e^+d \to K_s p X$ | 1528 ± 3 | | |
| ZEUS | $e^+p \to e'K_s p X$ | 1522 ± 3 | | |
| ITEP | $\nu A, \bar{\nu} A \to K_s pX$ | 1533 ± 5 | | |
| DIANA | $K^+Xe \to K_s p X$ | 1539 ± 2 | | |
| SVD/ITEP | $pA \to K_s p X$ | 1526 ± 3 | | |
| COSY | $pp \to K_s p \Sigma^+$ | 1530 ± 5 | | |



*Gaussian statistical significance: estimated background fluctuation

**PDG 2004** [**S.** Eidelman *et al.*, PLB 592 (04) 1; http://pdg.lbl.gov]



## $\Theta(1540)^+$

$I(J^P) = 0(?^?)$ Status: ∗∗∗

A REVIEW GOES HERE – Check our WWW List of Reviews

### $\Theta(1540)^+$ MASS

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **1539.2± 1.6 OUR AVERAGE** | | | | |
| 1533 ± 5 | 27 | [1] ASRATYAN 04 | BC | $\nu$, $\overline{\nu}$ in $p$,$d$,Ne, BEBC and 15-ft |
| 1555 ±10 | 41 | [2] KUBAROVSKY 04 | CLAS | $\gamma p \rightarrow \pi^+ K^- K^+ n$ |
| 1542 ± 5 | 43 | [3] STEPANYAN 04 | CLAS | $\gamma d \rightarrow K^+ K^- p n$ |
| 1539 ± 2 | 29 | [4] BARMIN 03 | XEBC | $K^+ \mathrm{Xe} \rightarrow K^0 p \mathrm{Xe}'$ |
| 1540 ± 4 ±2 | 63 | [5] BARTH 03 | SPHR | $\gamma p \rightarrow n K^+ K^0_S$ |
| 1540 ±10 | 19 | [6] NAKANO 03 | LEPS | $\gamma\, {}^{12}\mathrm{C} \rightarrow K^+ K^- n \mathrm{X}$ |

### $\Theta(1540)^+$ WIDTH

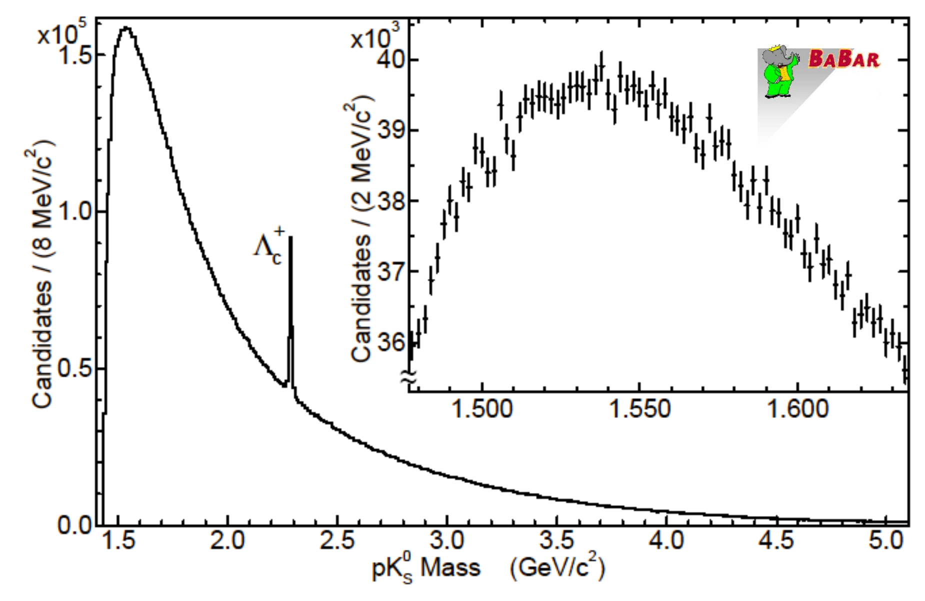
| *VALUE* (MeV) | *CL%* | *DOCUMENT ID* | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **0.9 ±0.3** | | [7] CAHN 04 | | $K^+ n \rightarrow K^0 p$ in xenon |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| <20 | | ASRATYAN 04 | BC | $\nu$, $\overline{\nu}$ in $p$,$d$,Ne, BEBC and 15-ft |
| <26 | | KUBAROVSKY 04 | CLAS | $\gamma p \rightarrow \pi^+ K^- K^+ n$ |
| <21 | | STEPANYAN 04 | CLAS | $\gamma d \rightarrow K^+ K^- p n$ |
| $\lesssim 1$ | | [8] ARNDT 03 | DPWA | $K^+ N$ partial-wave reanalysis |
| < 9 | 90 | BARMIN 03 | XEBC | $K^+ \mathrm{Xe} \rightarrow K^0 p \mathrm{Xe}'$ |
| <25 | 90 | BARTH 03 | SPHR | $\gamma p \rightarrow n K^+ K^0_S$ |
| <25 | 90 | NAKANO 03 | LEPS | $\gamma\, {}^{12}\mathrm{C} \rightarrow K^+ K^- n \mathrm{X}$ |

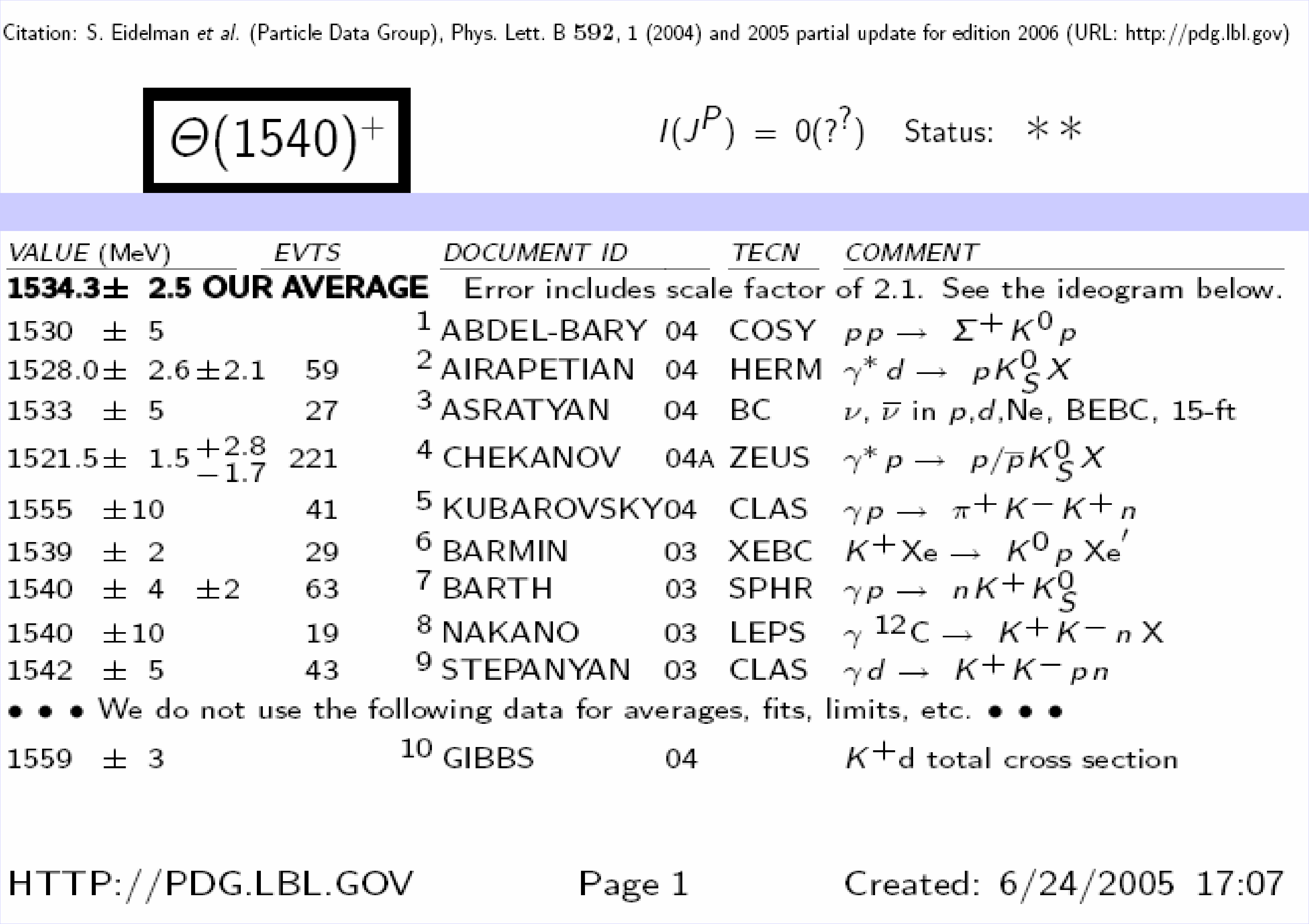
# Lack of experimental evidence

BaBaR, Delphi, BES,
CDF, HyperCP, E690,
HERA-B, Aleph, Phenix

Common features:

- large data samples
- excellent resolution
- high energy
- inclusive
- $e^+e^-$ or hadronic probes





Citation: S. Eidelman *et al.* (Particle Data Group), Phys. Lett. B **592**, 1 (2004) and 2005 partial update for edition 2006 (URL: http://pdg.lbl.gov)

## $\Theta(1540)^+$

$I(J^P) = 0(?^?)$ Status: $**$

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **1534.3± 2.5 OUR AVERAGE** | | Error includes scale factor of 2.1. See the ideogram below. | | |
| 1530 ± 5 | | [1] ABDEL-BARY 04 | COSY | $pp \rightarrow \Sigma^+ K^0 p$ |
| 1528.0± 2.6±2.1 | 59 | [2] AIRAPETIAN 04 | HERM | $\gamma^* d \rightarrow pK^0_S X$ |
| 1533 ± 5 | 27 | [3] ASRATYAN 04 | BC | $\nu, \overline{\nu}$ in $p,d$,Ne, BEBC, 15-ft |
| 1521.5± $1.5^{+2.8}_{-1.7}$ | 221 | [4] CHEKANOV 04A | ZEUS | $\gamma^* p \rightarrow p/\overline{p} K^0_S X$ |
| 1555 ±10 | 41 | [5] KUBAROVSKY 04 | CLAS | $\gamma p \rightarrow \pi^+ K^- K^+ n$ |
| 1539 ± 2 | 29 | [6] BARMIN 03 | XEBC | $K^+\mathrm{Xe} \rightarrow K^0 p\,\mathrm{Xe}'$ |
| 1540 ± 4 ±2 | 63 | [7] BARTH 03 | SPHR | $\gamma p \rightarrow nK^+ K^0_S$ |
| 1540 ±10 | 19 | [8] NAKANO 03 | LEPS | $\gamma\, ^{12}\mathrm{C} \rightarrow K^+ K^- n X$ |
| 1542 ± 5 | 43 | [9] STEPANYAN 03 | CLAS | $\gamma d \rightarrow K^+ K^- p n$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 1559 ± 3 | | [10] GIBBS 04 | | $K^+$d total cross section |

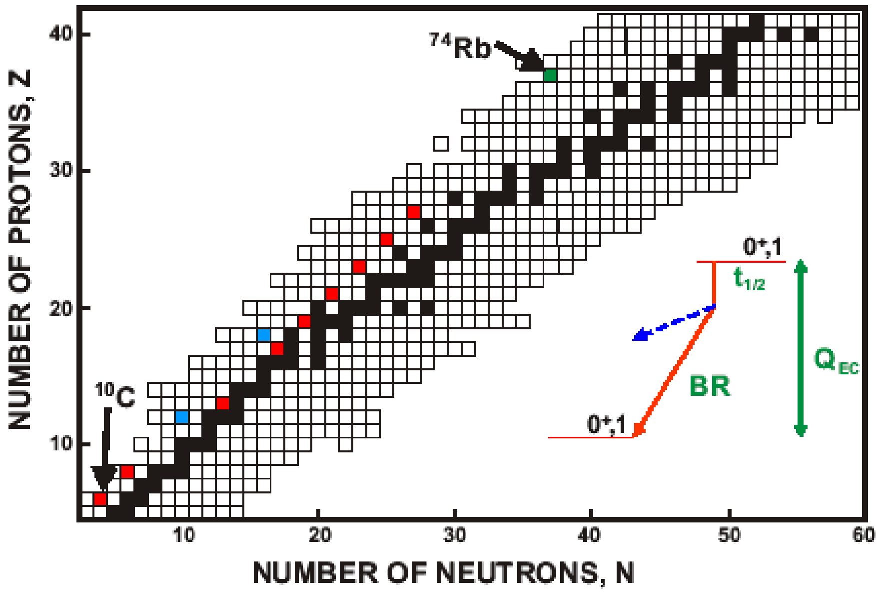
# CKM unitarne?

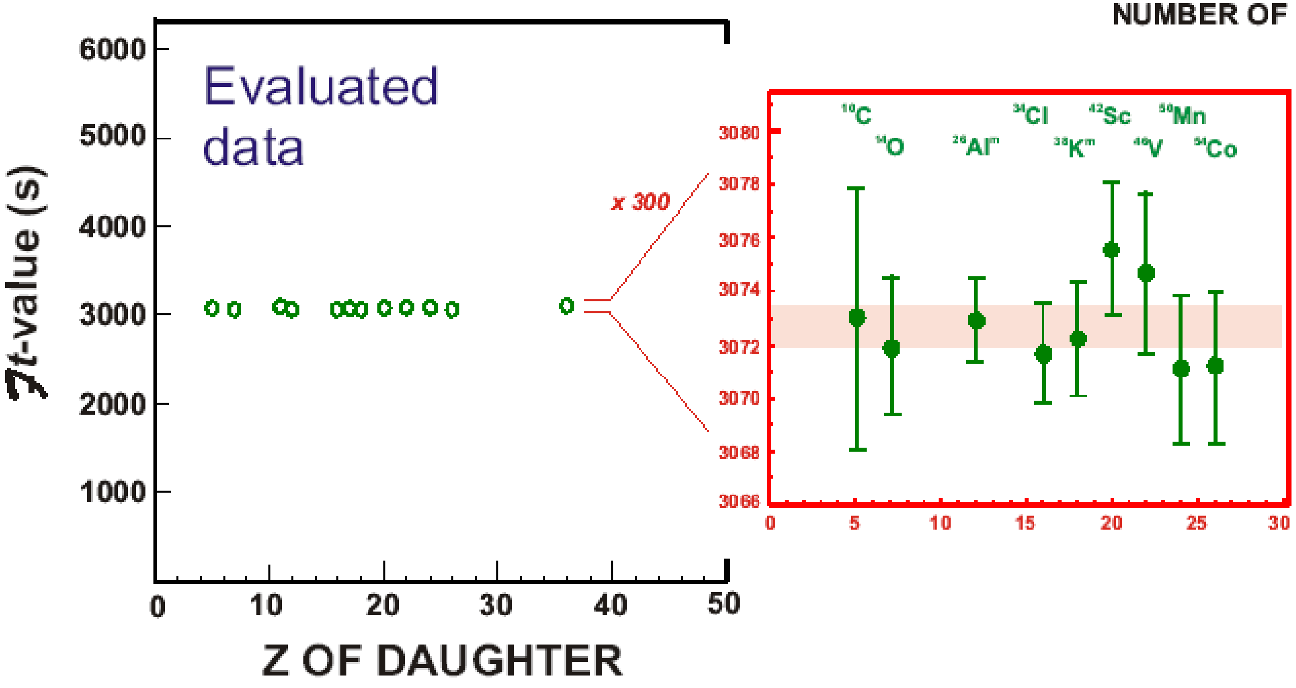
John Hardy (Texas AM)

# WORLD DATA FOR $0^+ \rightarrow 0^+$ DECAY, 2005

- 9 cases with *ft*-values measured to ~0.1% precision; 3 more cases with <0.4% precision.
- ~125 individual measurements with compatible precision

$$\mathcal{F}t = ft\,(1 + \delta'_R + \delta_{NS})(1 - \delta_C) = \frac{K}{2G_V^2\,(1 + \Delta_R)}$$





$\overline{\mathcal{F}t} = 3072.7(8)$

$G'_V/(\hbar c)^3$
$= 1.14950(15)$
$\times 10^{-5}\ \mathrm{GeV}^{-2}$

$\chi^2/\nu = 0.4$

## CABIBBO-KOBAYASHI-MASKAWA QUARK-MIXING MATRIX

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

weak eigenstates

mass eigenstates

This is the most demanding test available!

## THREE-GENERATION UNITARITY

$$\boxed{V_{ud}^2 + V_{us}^2 + V_{ub}^2 = 1}$$

$|V_{ud}| = G_V / G_\mu$

nuclear (n & $\pi$) decays
muon decay

**0.9738 ± 0.0004**
± 0.0001 exp't

$|V_{us}|$

$K^+ \longrightarrow \pi^0 e^+ \nu_e$

$K_L^0 \longrightarrow \pi^\pm e^\mp \nu_e$

**0.2200 ± 0.0026**

**or**

**0.2264 ± 0.0022**

$|V_{ub}|$

B decays

**0.0037 ± 0.0005**

## WORLD DATA, 2005

$$\boxed{\begin{array}{r} V_{ud}^2 + V_{us}^2 + V_{ub}^2 = 0.9966 \pm 0.0014 \\ 0.9995 \pm 0.0012 \end{array}}$$

# SUMMARY

1. New superallowed $\beta$-decay survey yields reduced limits on new physics: CVC verified to 0.026%; $|C_s/C_v| < 0.0013$.

2. CKM unitarity test still inconclusive at 0.1%. Main problem now is $V_{us}$, but $V_{ud}$ will soon become critical again.

3. Superallowed $\beta$ decay yields most precise value for $V_{ud}$. Much activity now focused on reducing its uncertainty by tests of structure-dependent correction terms.

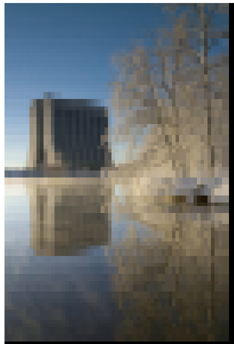
4. New measurements of Q-values (masses), half-lives and branching ratios are appearing regularly.

5. So far, most measurements confirm the validity of the calculated correction terms, but new Q-value results are raising questions about possible experimental systematics.

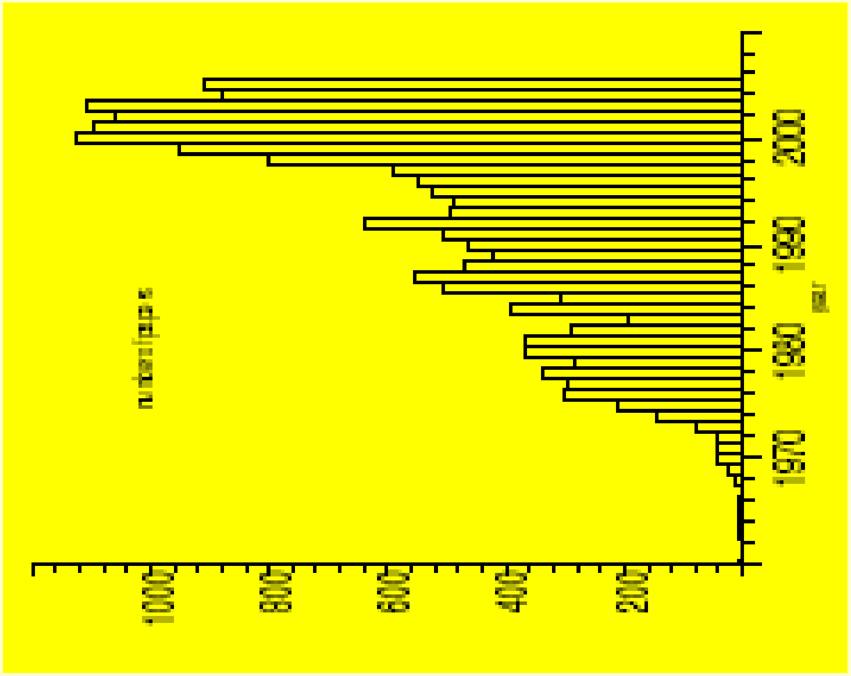
6. The nuclear result for $V_{ud}$ can still be improved.

# Neutrina: Sieroszowice-Polkowice?

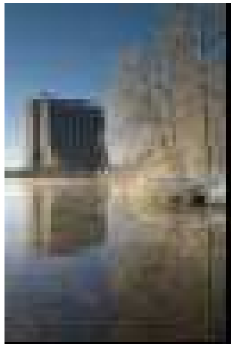
P.M. Decowski (Berkeley)
J. Kisiel (Katowice)
A. Para (Fermilab)
S. Wycech (IPJ Świerk)
A. Zalewska (IFJ Kraków)



# *Are Neutrinos Interesting?*



- Number of papers in SPIRES database with the word 'neutrino' in title: ~ 3 papers per day, lately
- Field driven primarily by experimental results:
  - Mid-70ties: advent of powerful neutrino beams (Fermilab, CERN)
  - Mid-90-ties: discovery of neutrino oscillations (SuperK)
- Proliferation of Conferences, Workshops, Committees, Panels, Advisory Boards and declarative statements



# There is Something Special about Neutrinos

Quarks and charged leptons

- Light, medium to heavyweight
- members of SU(2) doublets (left-handed) and singlets (right handed)
- Electric charges 1/3, 2/3, 1
- 4-component Dirac spinors
- Have antiparticles distinct from particles

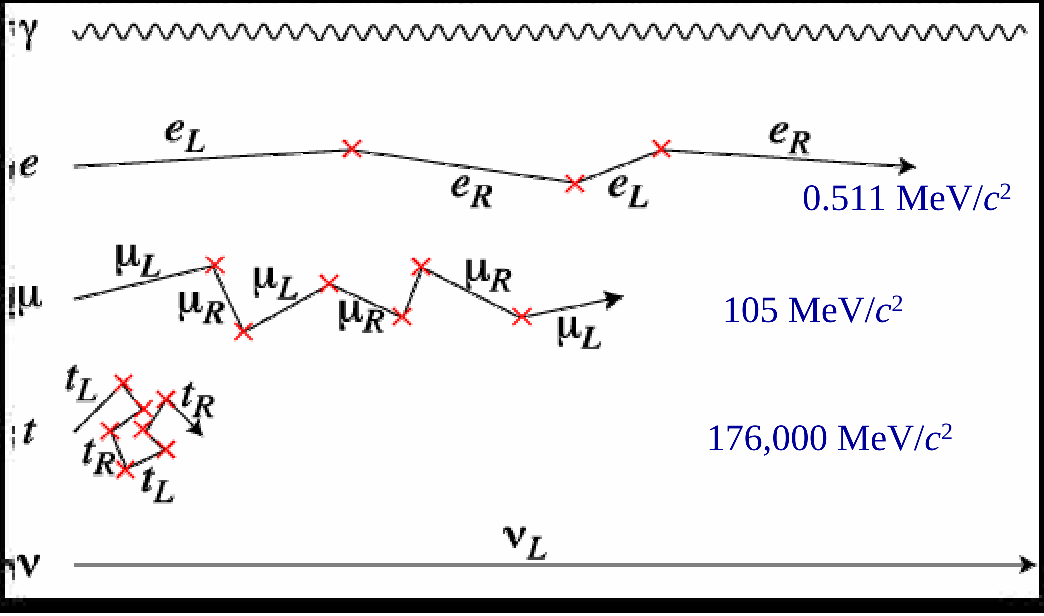
Neutrinos

- Extremely light (formerly massless)
- Members of SU(2) doublets (left-handed), no singlets (SM)
- Electric charge = 0
- 2-component Weyl spinors?
- Do they have anitparticles? Are they self-conjugate?
- Magnetic moments?

Are these facts/questions related?

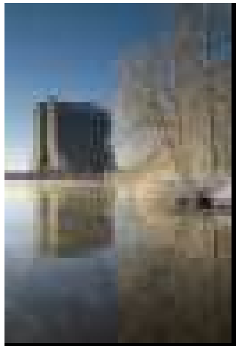
# Masses Come from the Higgs Field

- Space is filled with Higgs field
- Massless particles traveling with speed of light scatter off the Higgs field.
- These collisions slow them down and flip their helicity => mass.



- In the Standard Model there is no right-handed neutrino ⇒ neutrinos must be massless

- SuperK: neutrinos have mass ⇒ physics beyond the Standard Model

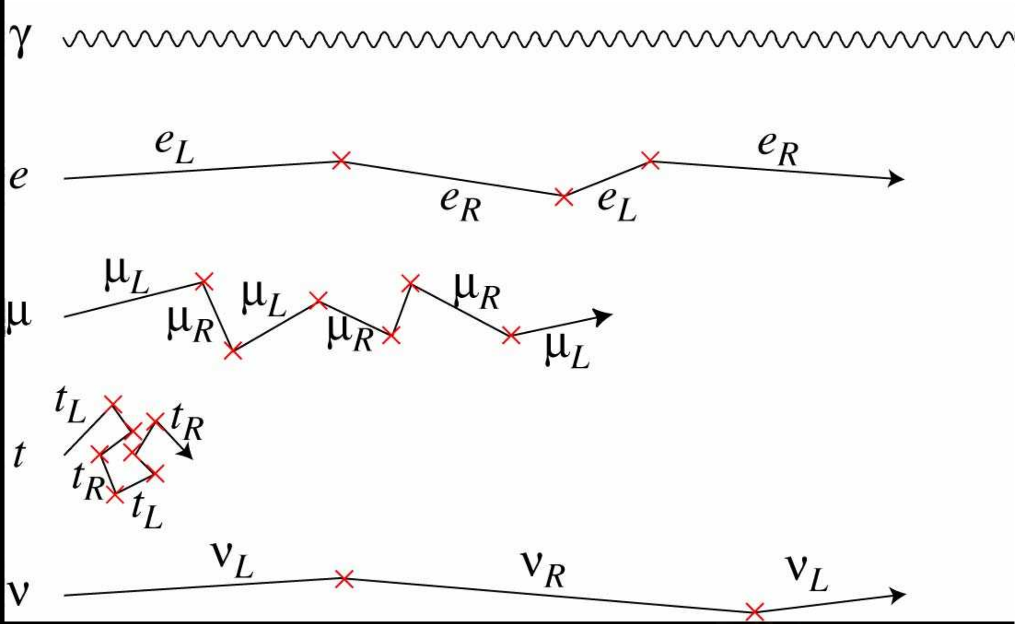


# Beyond the Standard Model, Version 1?

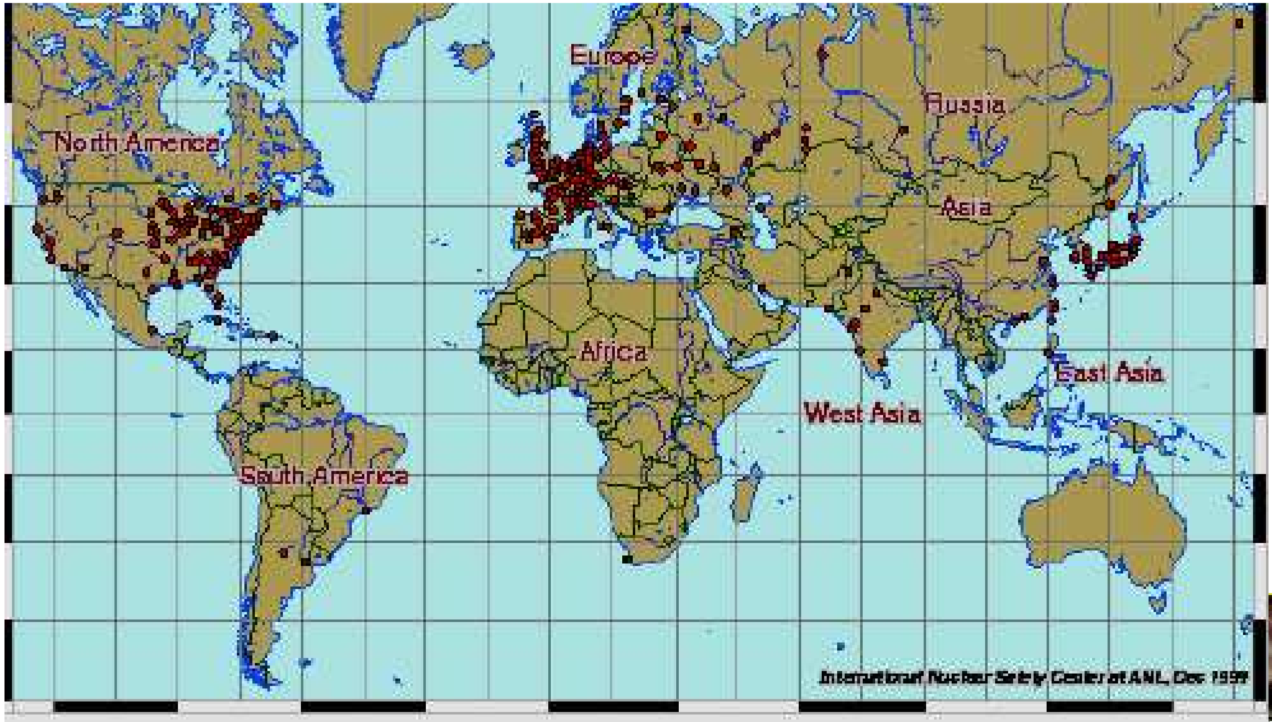
Add right-handed neutrino:

- gives mass to neutrinos
- has no interactions (beyond gravitational) – does not spoil the agreement with observations

But: why neutrino mass so small??



# Reactor antineutrinos



International Nuclear Safety Center at ANL, Dec 1997

Long tradition, started by the first observation of neutrino interactions by Reines and Cowan

Typical power station gives $6x10^{20}$ anty-ν/s and 3GW of power

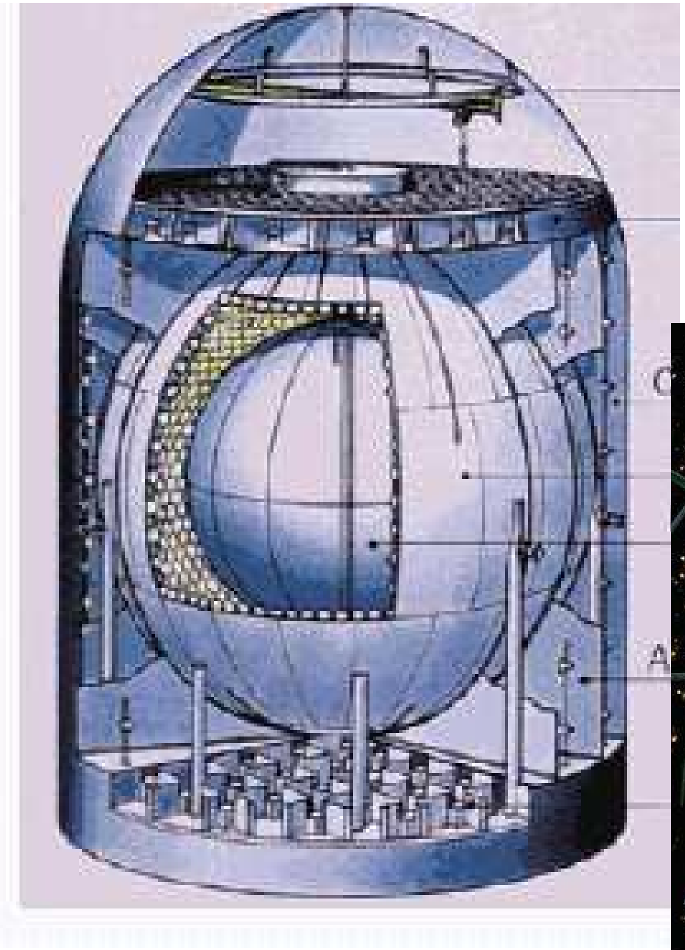
The Palo Verde reactor experiment

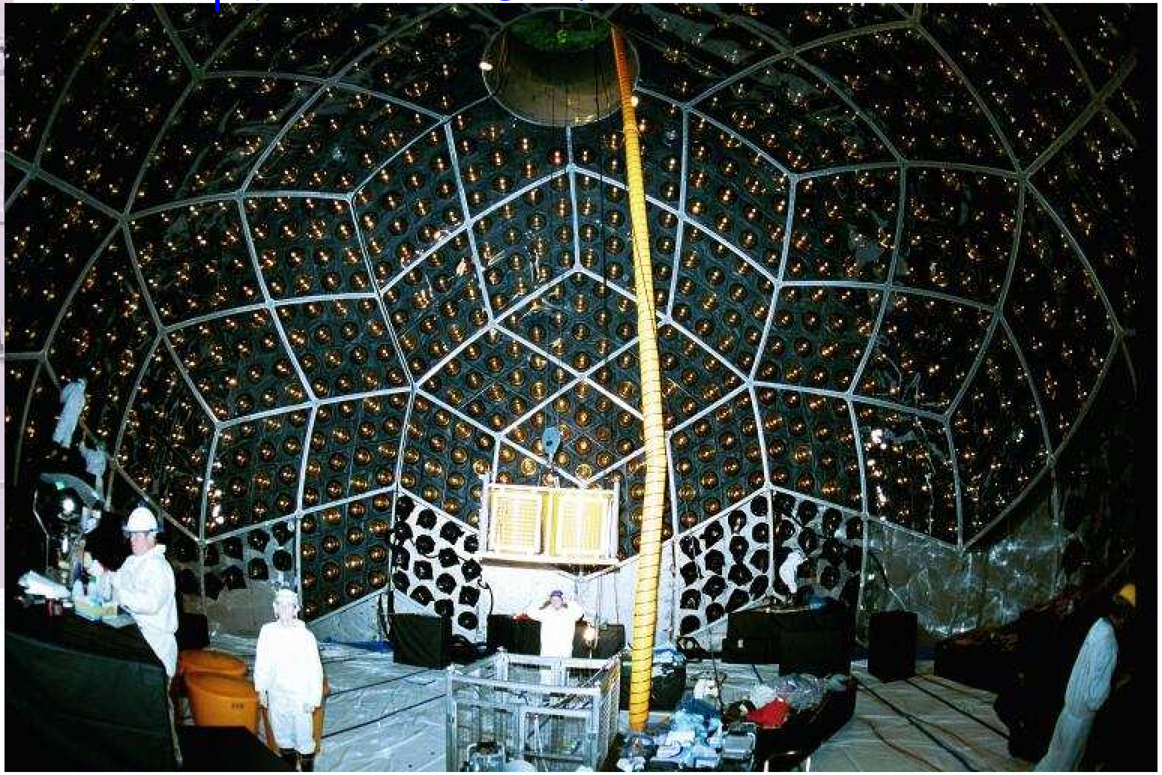
# KamLAND - very long baseline reactor experiment

Detector: inner detector - 1 kton of liquid scintillator, light registered by about 2000 photomultipliers, outer detector filled with oil, veto part filled with water,

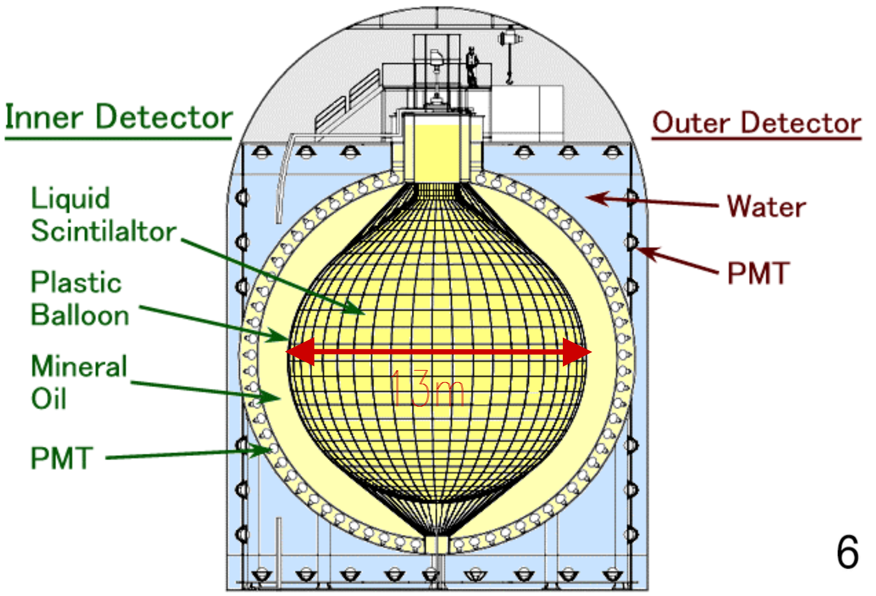
Detector “looks” at more than 30 reactors in Japan and Korea at average distance of 180 km

Experiment started in January 2002, first results published in Dec. 2002





# *Kamland: detecting reactor antineutrinos*



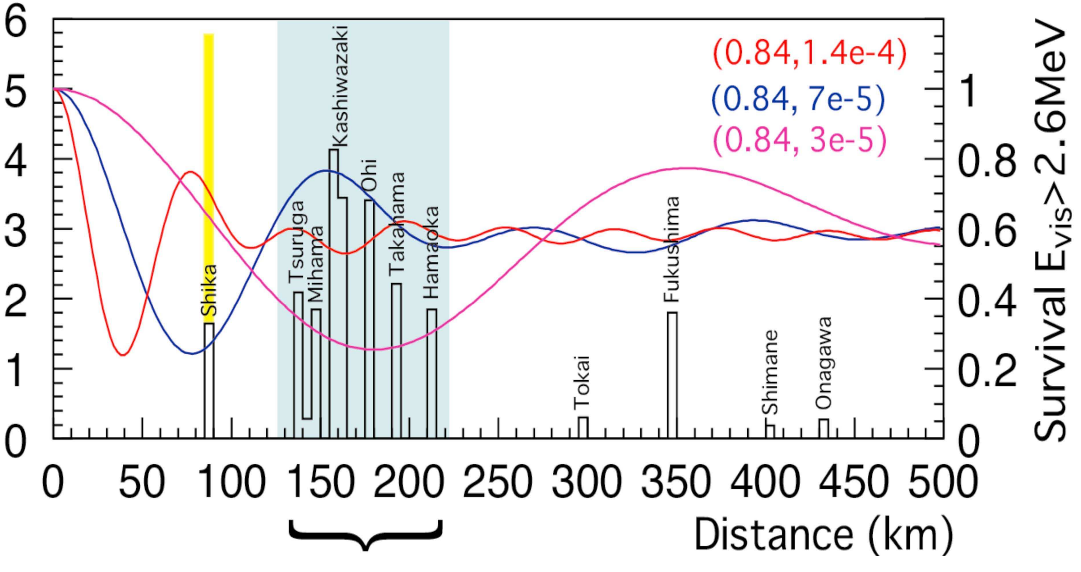
20m

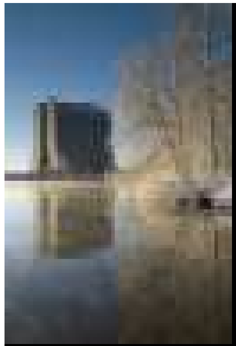
1000ton of liquid scintillator

$\bar{\nu}_e + p \rightarrow e^+ + n$

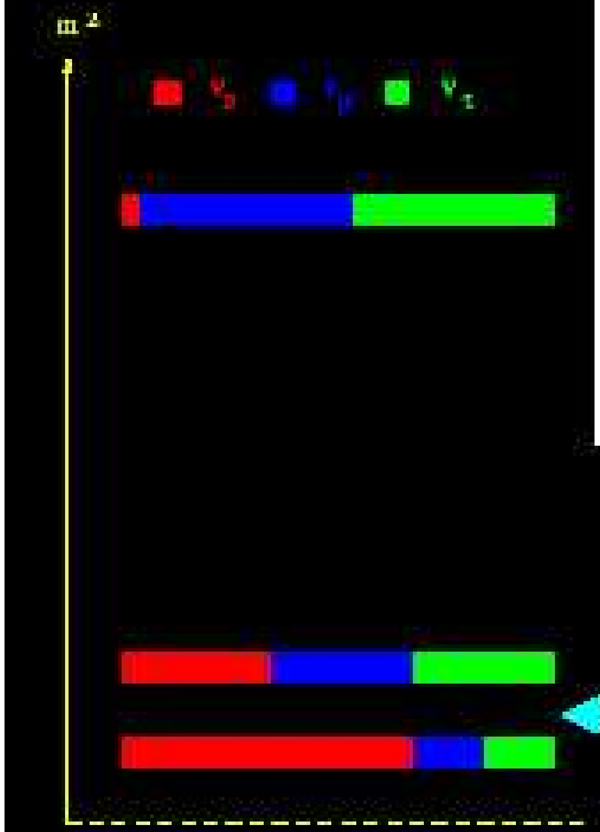
followed by $(\sim 210\mu s)$

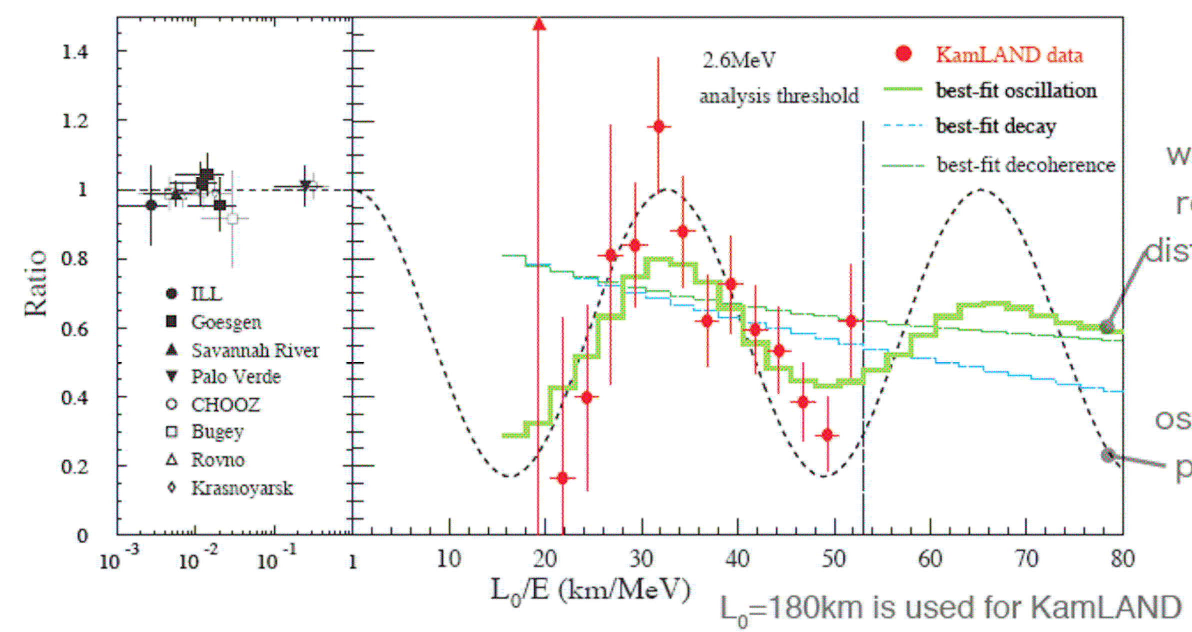
$n + p \rightarrow d + \gamma$ (2.2MeV)





# *Kamland: 'solar' $\Delta m^2(=\Delta m^2_{12})$*





with real reactor distribution

ideal oscillation pattern

$L_0$=180km is used for KamLAND

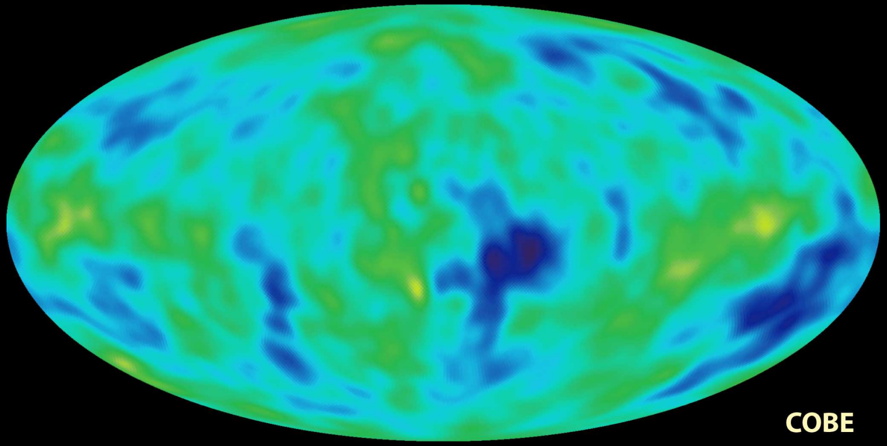
$$\Delta m^2_{12} = 7.9^{+0.6}_{-0.5} \times 10^{-5}\ \mathrm{eV}^2$$

oscillation $P_{ee} = 1 - \sin^2 2\theta \sin^2(\frac{\Delta m^2}{4}\frac{L}{E})$

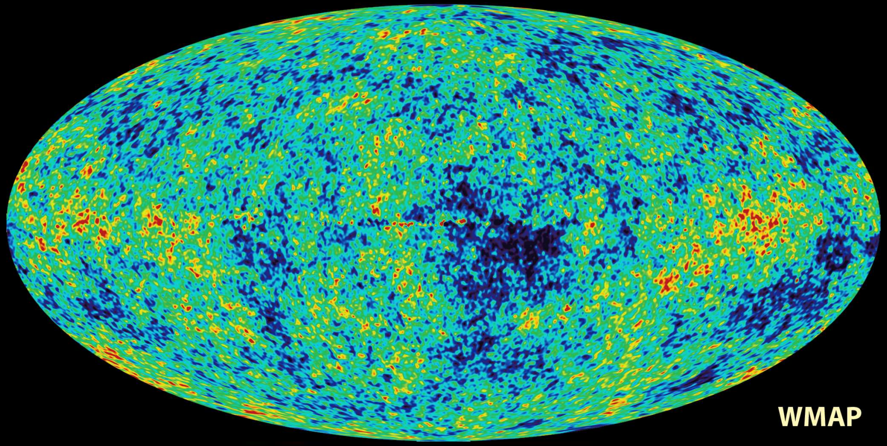
decay $P_{ee} = (\cos^2\theta + \sin^2\theta \exp(-\frac{m_2}{2\tau}\frac{L}{E}))^2$

decoherence $P_{ee} = 1 - \frac{1}{2}\sin^2 2\theta(1 - \exp(-\gamma\frac{L}{E}))$

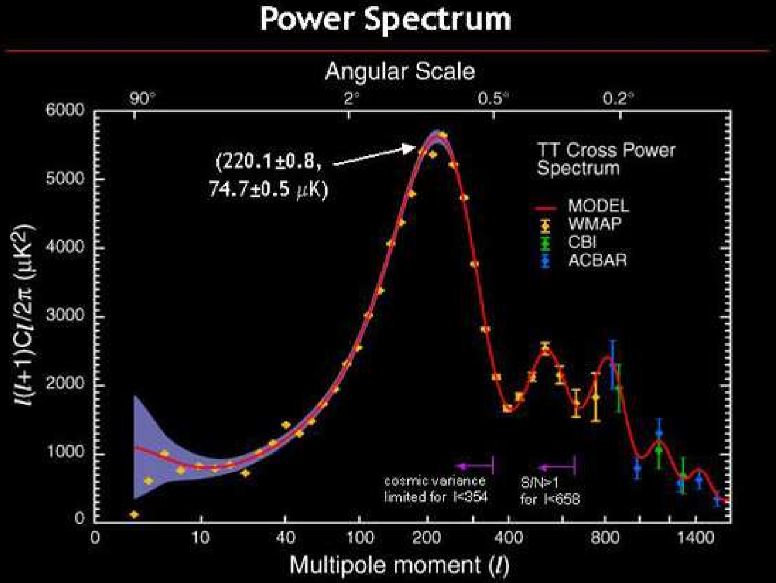
# Help from the Heaven: CMB



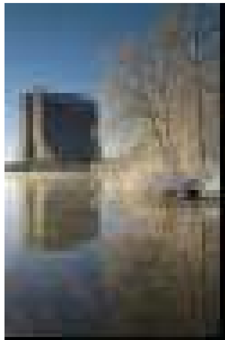
**COBE**



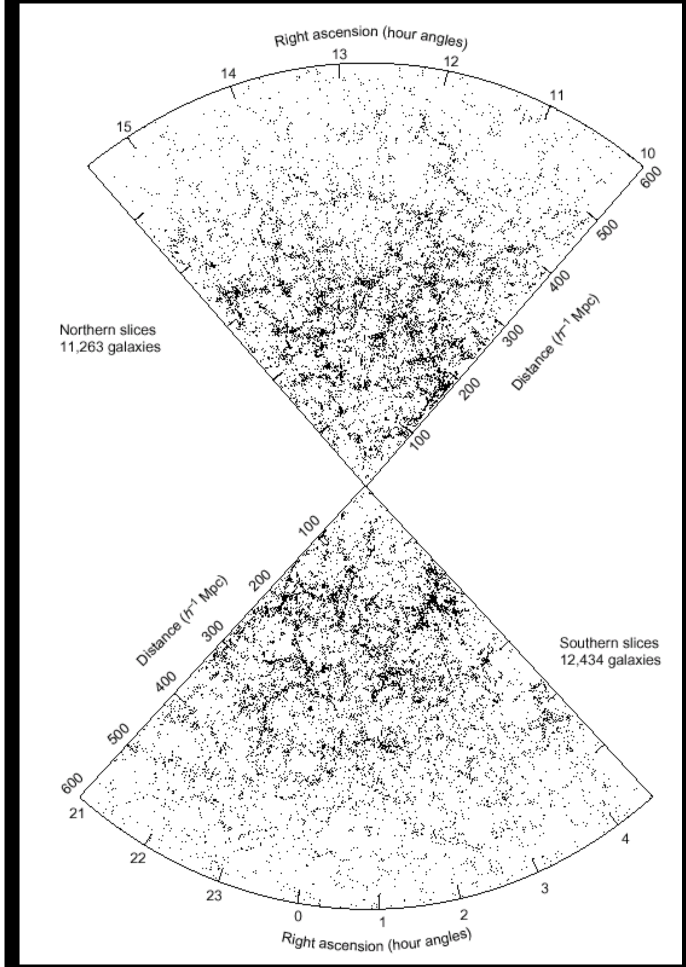
**WMAP**

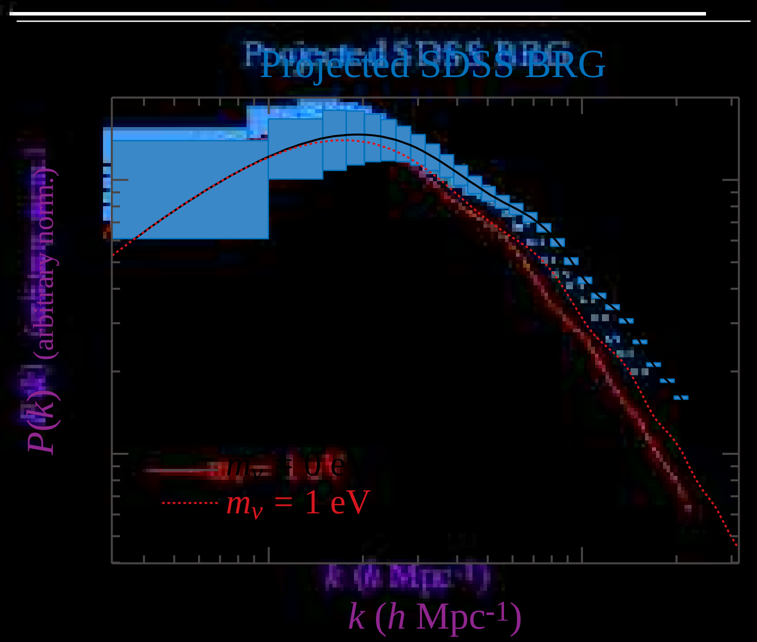


Size and the evolution of the density fluctuations in the early Universe depend on the <u>gravitational</u> pull of neutrinos



# Help from the Heaven: Large Scale Structures

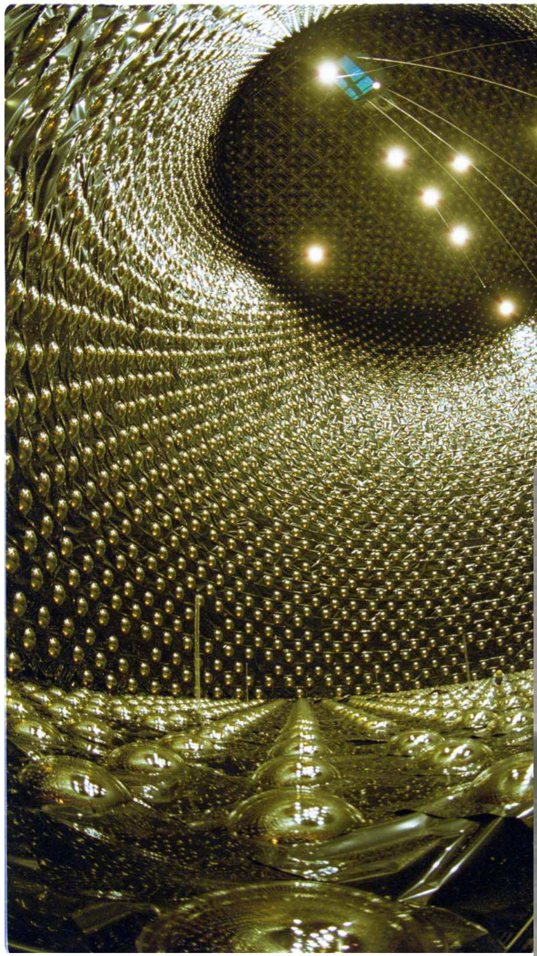




Gravitational pull of neutrinos would 'wash-out' large clumps of matter. Hint: they may be light, but there are a LOT of them. $10^{10}$ times more than protons

# Super Kamiokande-II

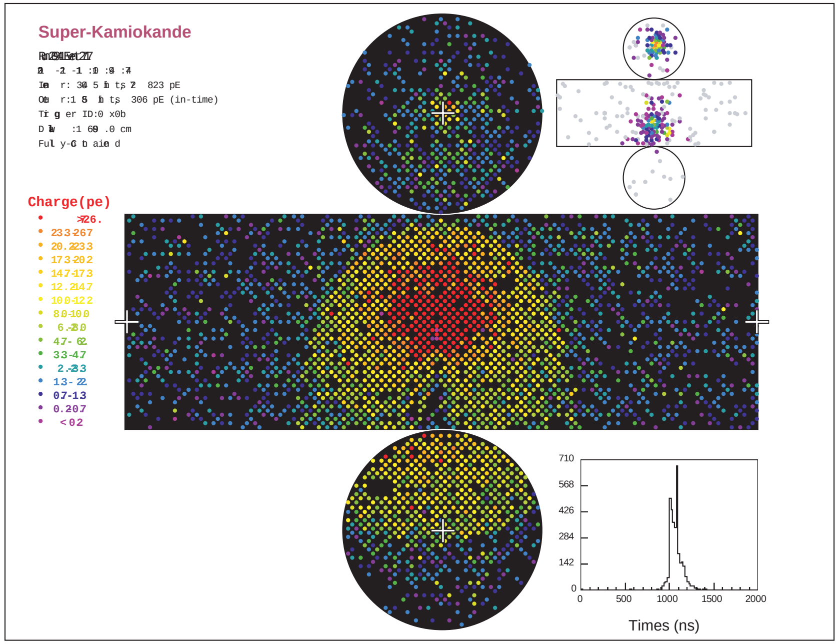
from Hayato at EPS2003



20inch PMT with Acrylic + FRP vessel

the detector rebuilt successfully
and
resumed data taking in Dec. 2002.

**SK-II Cosmic ray muon sample**

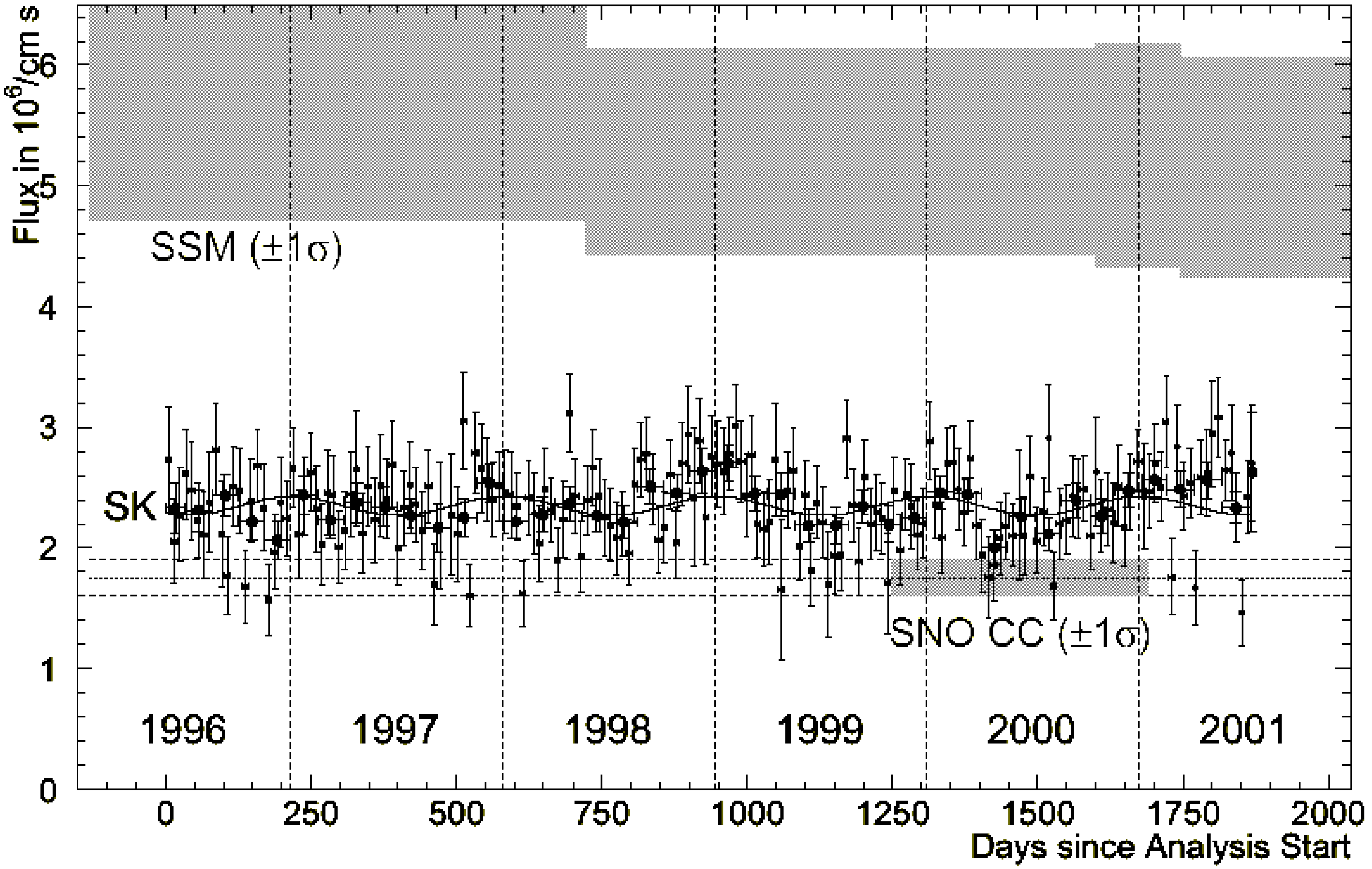


Inner detector

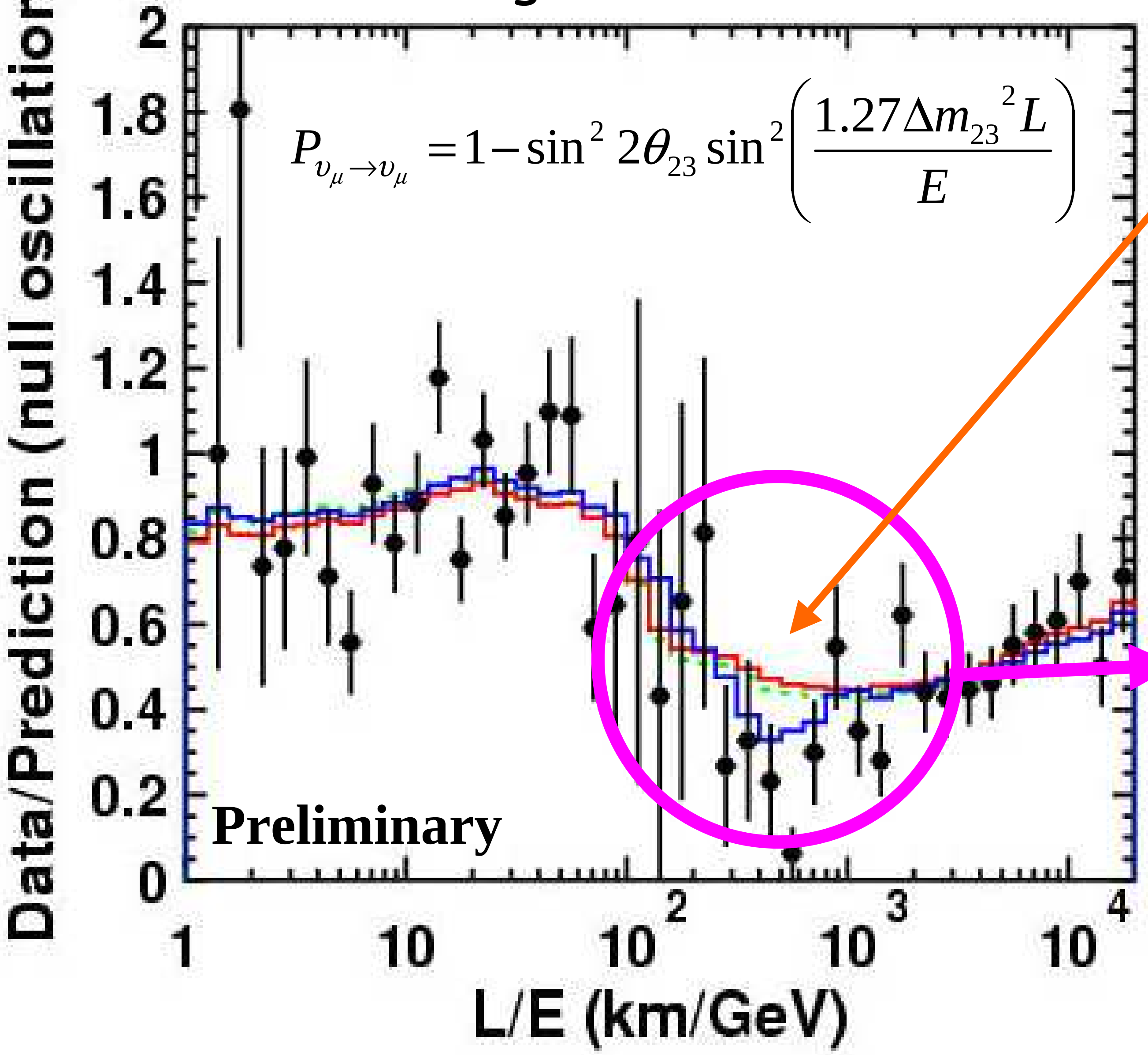
- ~5200 20inch PMTs with covers

Outer detector :1885 8inch PMTs

# SuperKamiokande - solar neutrinos flux modulation in time



# ➢ Testing the Model: L/E Behavior



$$P_{\upsilon_\mu \to \upsilon_\mu} = 1 - \sin^2 2\theta_{23} \sin^2\left(\frac{1.27\Delta m_{23}{}^2 L}{E}\right)$$

New (S-K II Data)

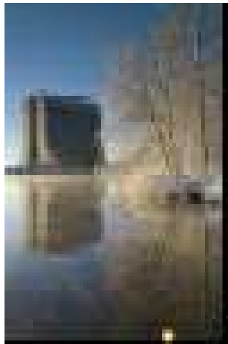
decoherence

decay

best-fit osc
(favored by >3 σ)

"the dip"

*K. Scholberg, WIN05*



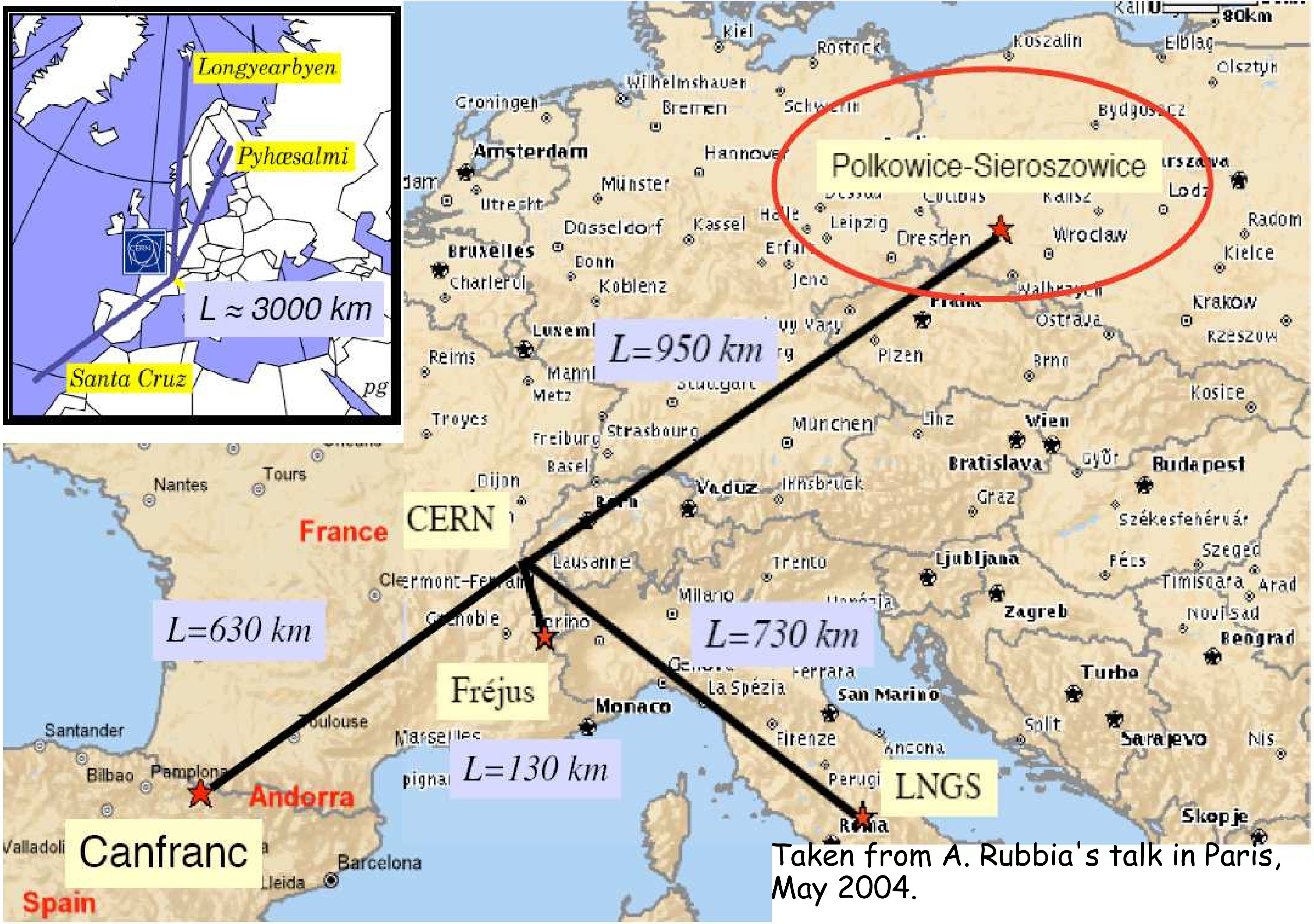
# Summary

- Neutrinos are weird
  - They are unbearably light
  - They mix a lot
- We are making a fantastic progress in learning about neutrinos, yet there are still many fundamental open questions:
  - Are they their own particles?
  - Are their masses hierarchical? What kind of hierarchy?
  - What their mass is?
  - Is $\theta_{13}$ not zero? How large/small is?
  - Are there new hereto unknown symmetries at work here?
  - Is CP violated in the neutrino sector?
- Neutrinos may be a key to many unsolved problems:
  - Physics at the unification energy scale
  - Baryon number of the Universe (a.k.a. our own existence)
- Progress in our understanding of neutrinos is possible thanks to contributions from different branches of science: high energy physics, nuclear physics, cosmology. Technology plays a very important role, too.

# What is the motivation here?

- first idea: A. Rubbia (ETH Zurich) (hep-ph/0402110) - A location needed for an ultimate neutrino detector. 100ktons of LAr as an alternative to 1 Mton of $H_2O$.
- Also for proton decay search and astrophysics.
- The Polish Neutrino Group began a feasibility study in 2004.

# Possible underground sites in Europe ?



Taken from A. Rubbia's talk in Paris, May 2004.

# Example: salt mine in Poland (Sierozowice)

**Example**: Salt mine in Europe: Copper mines (owned by KGHM, one of the largest producers of copper and silver in the world). Salt layer at 1000 underground (dry) **Very large caverns already exist** (from mine exploitation). Possibility to host ≈80'000 m³ detector in salt cavern under study.

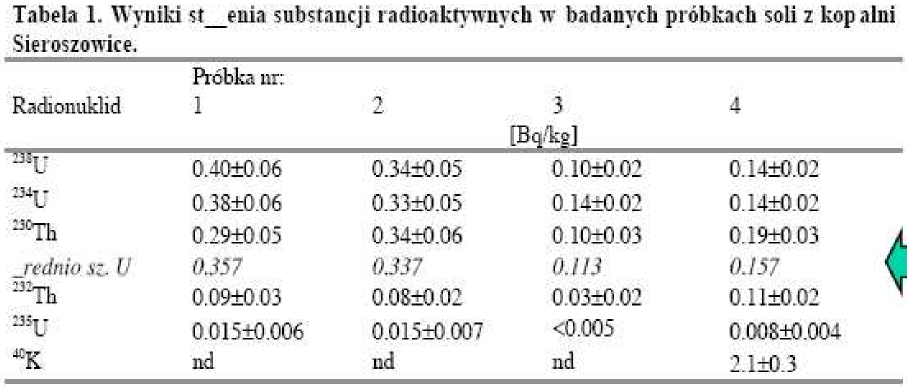
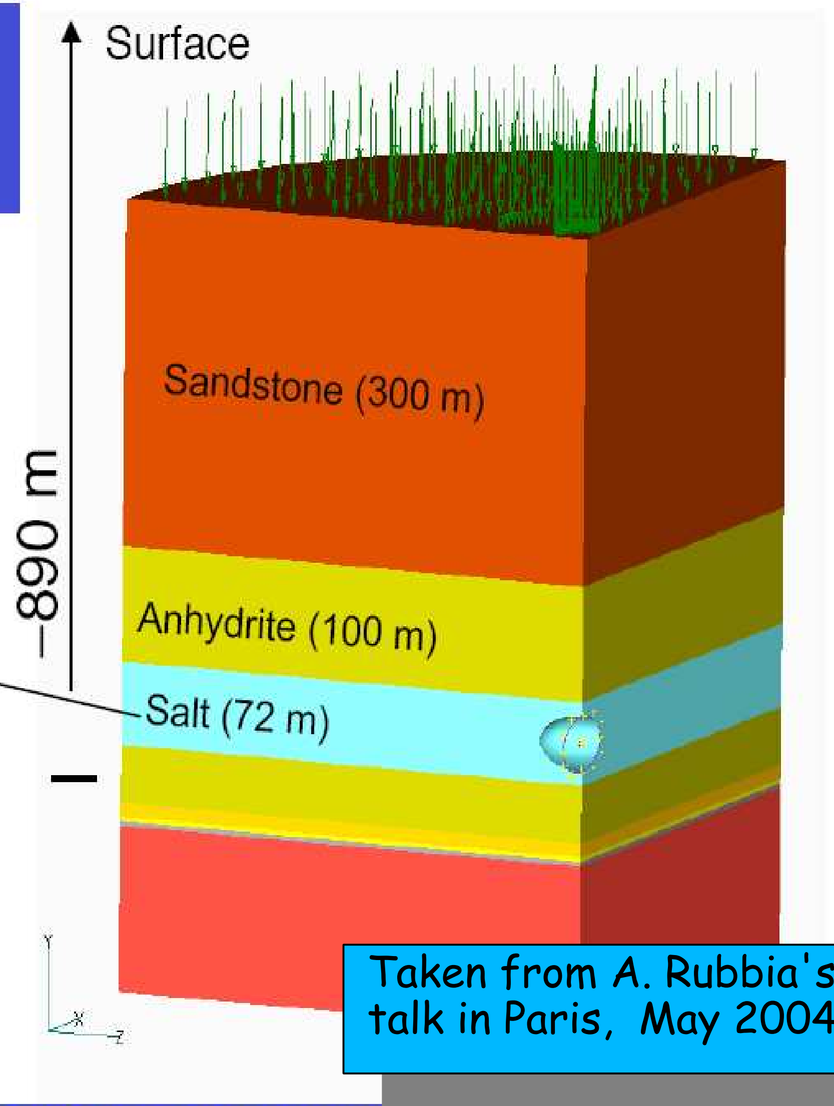


Tabela 1. Wyniki st__enia substancji radioaktywnych w badanych próbkach soli z kopalni Sieroszowice.

| Radionuklid | Próbka nr:<br>1 | 2 | 3<br>[Bq/kg] | 4 |
|---|---|---|---|---|
| $^{238}U$ | 0.40±0.06 | 0.34±0.05 | 0.10±0.02 | 0.14±0.02 |
| $^{234}U$ | 0.38±0.06 | 0.33±0.05 | 0.14±0.02 | 0.14±0.02 |
| $^{230}Th$ | 0.29±0.05 | 0.34±0.06 | 0.10±0.03 | 0.19±0.03 |
| *_rednio sz. U* | *0.357* | *0.337* | *0.113* | *0.157* |
| $^{232}Th$ | 0.09±0.03 | 0.08±0.02 | 0.03±0.02 | 0.11±0.02 |
| $^{235}U$ | 0.015±0.006 | 0.015±0.007 | <0.005 | 0.008±0.004 |
| $^{40}K$ | nd | nd | nd | 2.1±0.3 |



Taken from A. Rubbia's talk in Paris, May 2004.

**Salt radiopurity test samples:**

J.W.Mietelski, E.Tomankiewicz, S.Grabowska

# Salt Caverns in the Sieroszowice Mine

- temp. 37°C
- salt aerozol
- depth ~950 m
- salt layer 72 m
- chambers
  100x15x15m

- too small for a 100kton detector.

# Sieroszowice vs Gran Sasso

- ***in situ* gamma-ray measurements with the HPGe portable detector (crystal length 59mm and diameter 58mm) in the „one-meter" geometry: detector mounted 1m above the surface, gamma emitters recorded from the area in a radius of about 10m, to the depth of about 30cm depending on ground and photon energy.**

| | $^{226}$Ra [Bq/kg] | $^{214}$Pb [Bq/kg] | $^{214}$Bi [Bq/kg] | $^{212}$Pb [Bq/kg] | $^{228}$Ac [Bq/kg] |
|---|---|---|---|---|---|
| Sieroszo- wice | <8 | 4.2±2.3 | 2.5±0.9 | 0.8±0.4 | 0.7±0.3 |
| Gran Sasso | 35±3 | 32±1 | 29±1 | 7.9±0.2 | 7.2±0.5 |

# Impresje Witka Nazarewicza

W. Nazarewicz (Oak Ridge)

# Philip Bredesen, Governor of Tennessee, PAC05 welcome address

## We are doing an inadequate job of explaining “outside” of our community why what we do is important

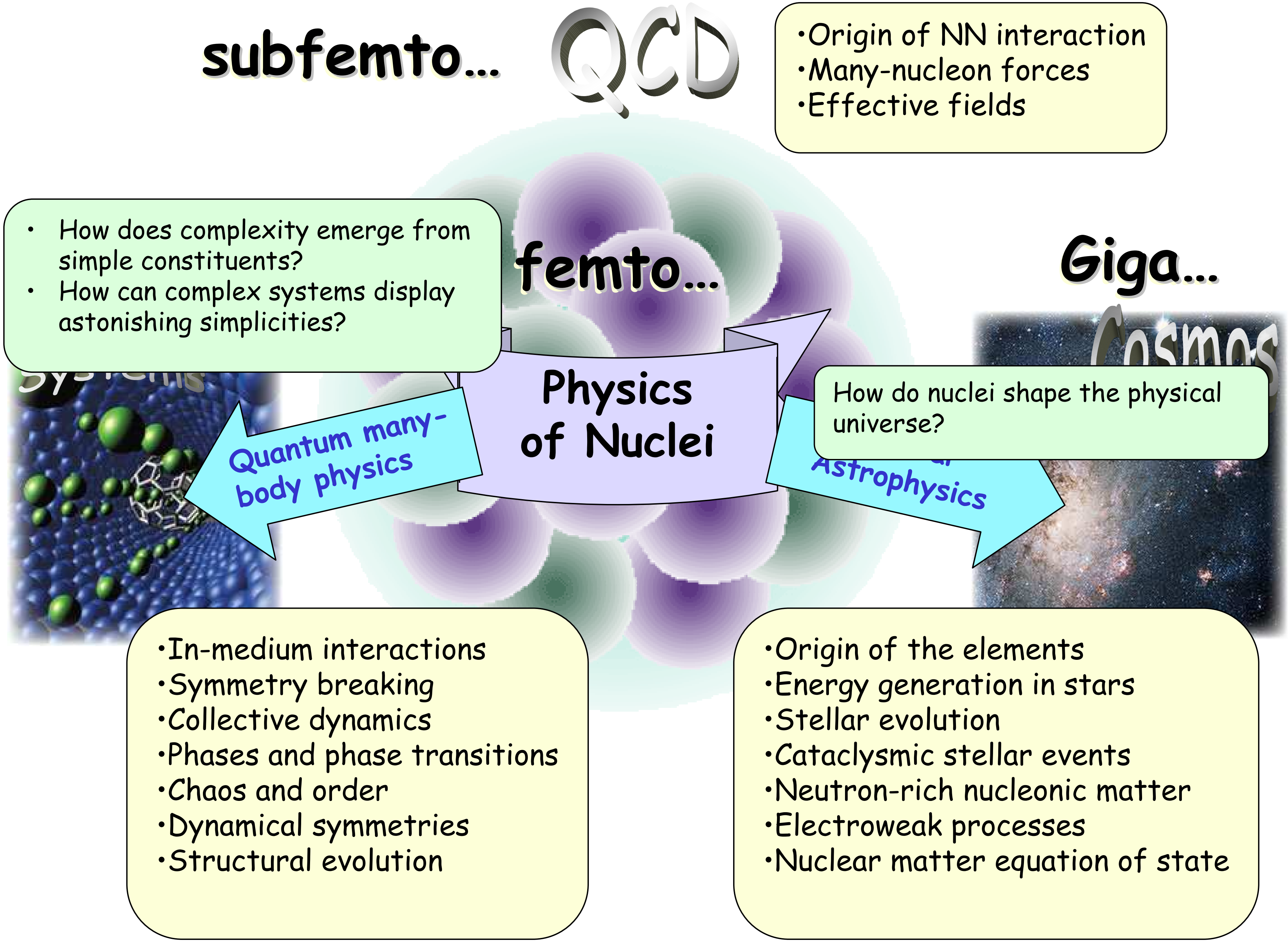
“People who truly understand something, who truly have command of a subject, can explain it at some level to anyone who asks and is willing to try to understand an answer. The point is that if you were asked about something and had to resort to that's all very complicated and until you take a course in differential equations and then give me a blackboard I can't possibly make you understand, that that was more often a signal of a failure of the physicist to have a real command of the issue than of the failure of the person asking the question.

I have adapted it to my own life is the **"Wal-Mart Test."** When I propose to take some course of action in the public sector, I do a thought experiment and imagine how I will explain it to the Wal-Mart checkout person. Let me clear that I don't mean in any way dumbing-down the idea, I mean taking the principle that if I understand well enough what I am doing, I can cogently explain it to another human being with a different reference point. If I can successfully do this thought experiment, I have the makings of a plan.”

# Nuclear Science: Three Frontiers

- QCD
- Nuclei and Nuclear Astrophysics
- Fundamental Symmetries & Neutrinos

**Eleven Questions**



**subfemto…** **QCD**

- Origin of NN interaction
- Many-nucleon forces
- Effective fields

- How does complexity emerge from simple constituents?
- How can complex systems display astonishing simplicities?

**femto…**

**Giga…**

**Physics of Nuclei**

Quantum many-body physics

How do nuclei shape the physical universe?

- In-medium interactions
- Symmetry breaking
- Collective dynamics
- Phases and phase transitions
- Chaos and order
- Dynamical symmetries
- Structural evolution

- Origin of the elements
- Energy generation in stars
- Stellar evolution
- Cataclysmic stellar events
- Neutron-rich nucleonic matter
- Electroweak processes
- Nuclear matter equation of state

# Questions from the Science

## 125 Questions:
## What don't we know?

- What is the universe made of?
- Can the laws of physics be unified?
- Where do ultra-high energy cosmic rays come from?
- Why is there more matter than anitmatter?
- Are there building blocks smaller than quarks?
- Are neutrinos their own antiparticle?
- Are there stable high-atomic number elements?

- Is there a unified theory explaining all correlated electron systems? [hadron systems? quark systems?]

# Philip Bredesen, Governor of Tennessee, PAC05 welcome address

Big science has had a great run for the last 60 years: Manhattan project, Sputnik and space exploration, the explosion and excitement of particle physics and accelerator; the rationale was obvious and easy. But those rationales are getting long in the tooth now, and need to be reinvigorated.

(...) the reality is that resources are scarce, the reality is that big science needs resources that only the government can supply, and the reality is that those scarce resources will go to those things that ordinary citizens think are important to themselves and to their children and to our nation. That's our job, to remake that connection in the 21st century.

There's nothing wrong or demeaning in this; even Michelangelo had patrons who had a seat at the table and needed to be satisfied.

# We need to be more effective…

# … when explaining "our stuff" to

Our students (who often do not see the forest from the trees)

Our nuclear science colleagues

This conference!

Other physicists (CMP and HEP in particular)

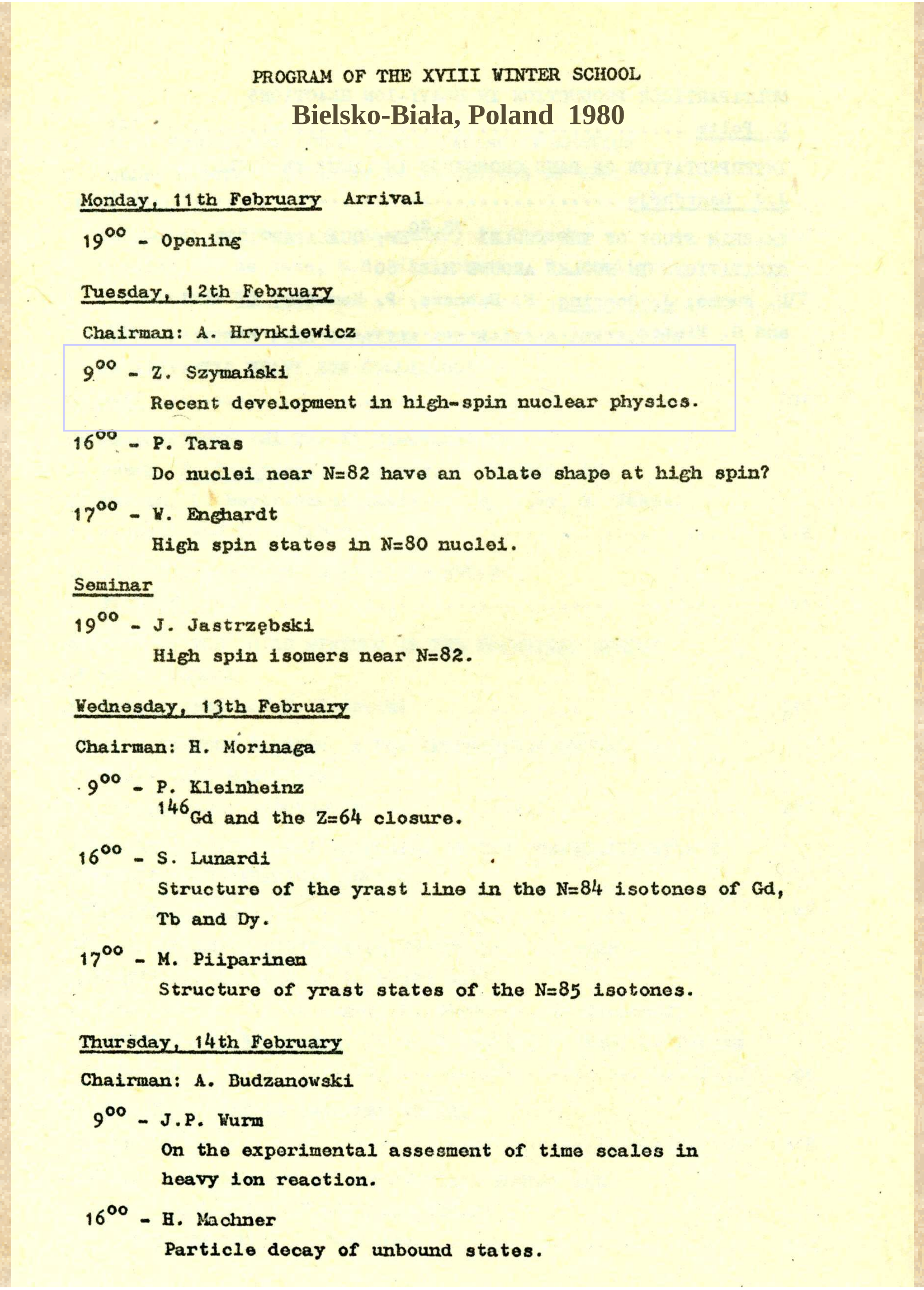
Sponsors

Family and friends

… and this friendly Wal-Mart checkout person

Laureat za rok 2004:

**dr hab. Bogdan Fornal** (IFJ PAN Kraków)



PROGRAM OF THE XVIII WINTER SCHOOL

## Bielsko-Biała, Poland 1980

**Monday, 11th February** Arrival

$19^{00}$ - Opening

**Tuesday, 12th February**

Chairman: A. Hrynkiewicz

$9^{00}$ - Z. Szymański
Recent development in high-spin nuclear physics.

$16^{00}$ - P. Taras
Do nuclei near N=82 have an oblate shape at high spin?

$17^{00}$ - W. Enghardt
High spin states in N=80 nuclei.

**Seminar**

$19^{00}$ - J. Jastrzębski
High spin isomers near N=82.

**Wednesday, 13th February**

Chairman: H. Morinaga

$9^{00}$ - P. Kleinheinz
$^{146}$Gd and the Z=64 closure.

$16^{00}$ - S. Lunardi
Structure of the yrast line in the N=84 isotones of Gd, Tb and Dy.

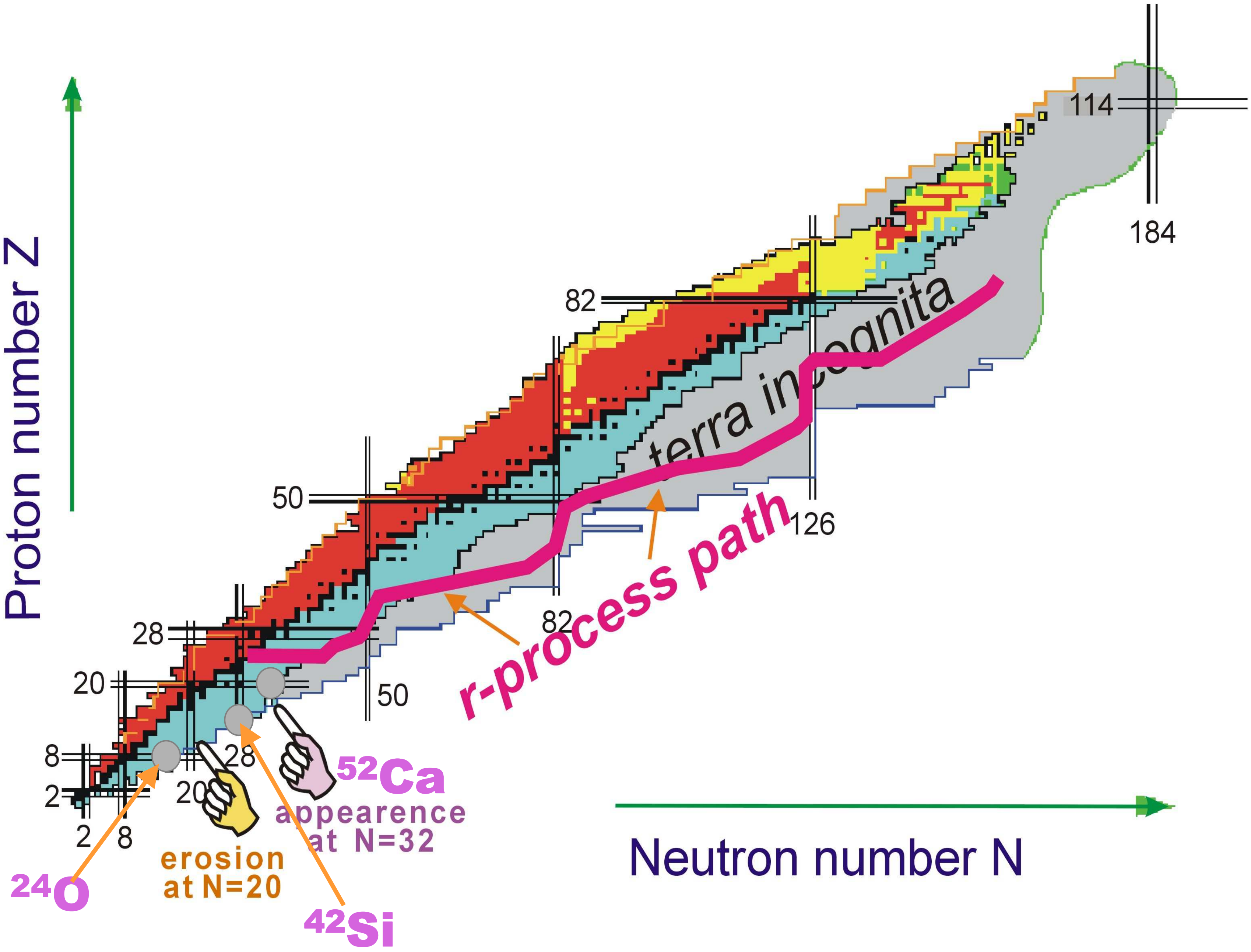
$17^{00}$ - M. Piiparinen
Structure of yrast states of the N=85 isotones.

**Thursday, 14th February**

Chairman: A. Budzanowski

$9^{00}$ - J.P. Wurm
On the experimental assesment of time scales in heavy ion reaction.

$16^{00}$ - H. Machner
Particle decay of unbound states.


Proton number Z
Neutron number N
2
8
20
28
50
82
114
2
8
20
28
50
82
126
184
terra incognita
r-process path
$^{24}$O
erosion at N=20
$^{42}$Si
$^{52}$Ca
appearence at N=32

conference photo

# REGATY


Zwycięska załoga

Sternik - zwycięzca

# Zwycięska załoga

# Po konferencji...

**Spotkanie współpracy CBM (Compressed Baryonic Matter)**

**~60 uczestników**

**SPARC Workshop „Atomic Physics in Strong Fields”**

**~80 uczestników**


sierpień/wrzesień 2007
ZAPRASZAMY!