η and K photoproduction on the neutron at GRAAL: Some preliminary results

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- Motivation&Introduction
- Graal facility
- Applied method
- η photoproduction on the neutron
- $K^0\Lambda$ and $K^+\Sigma^-$ photoproduction on the neutron
- What's next…

All the data will be shown are VERY PRELIMINARY!

The goal of this talk is to present current state-of-art and to discuss further development.

By some reasons I had to prepare this talk last minutes. I apologize for possible mistakes , missed details, confusing pictures etc…

Second member of the antidecuplet

features: Non-strange S=0; quantum numbers of P11
Initially was associated with the P11(1710)*** resonance.

No experimental observation.

M.Polyakov and A.Rathke

``On photoexcitation of baryon antidecuplet"

Hep-ph/0303138; Eur.Phys.J. A18, 691-695(2003)

``...qualitative feature (of the second member of the antidecuplet, the P11) ... dominance of photoexcitation from the neutron target".

``...antidecuplet ``friendly" photoreactions...

$$\gamma n \rightarrow K^{+}\Sigma^{-}, \quad \gamma n \rightarrow \eta n$$

In these channels the antidecuplet part of the nucleon resonances should be especially enhanced, whereas in the analogous channels with the proton target the anti-10 component is relatively suppressed...."

R.Arndt, Ya.Azimov, M.Polyakov, I.Strakovsky, R.Workman

``Nonstrange and other flavor partners of the exotic θ^+ baryon"

Nucl-th/0312126 (accepted to PRC?)

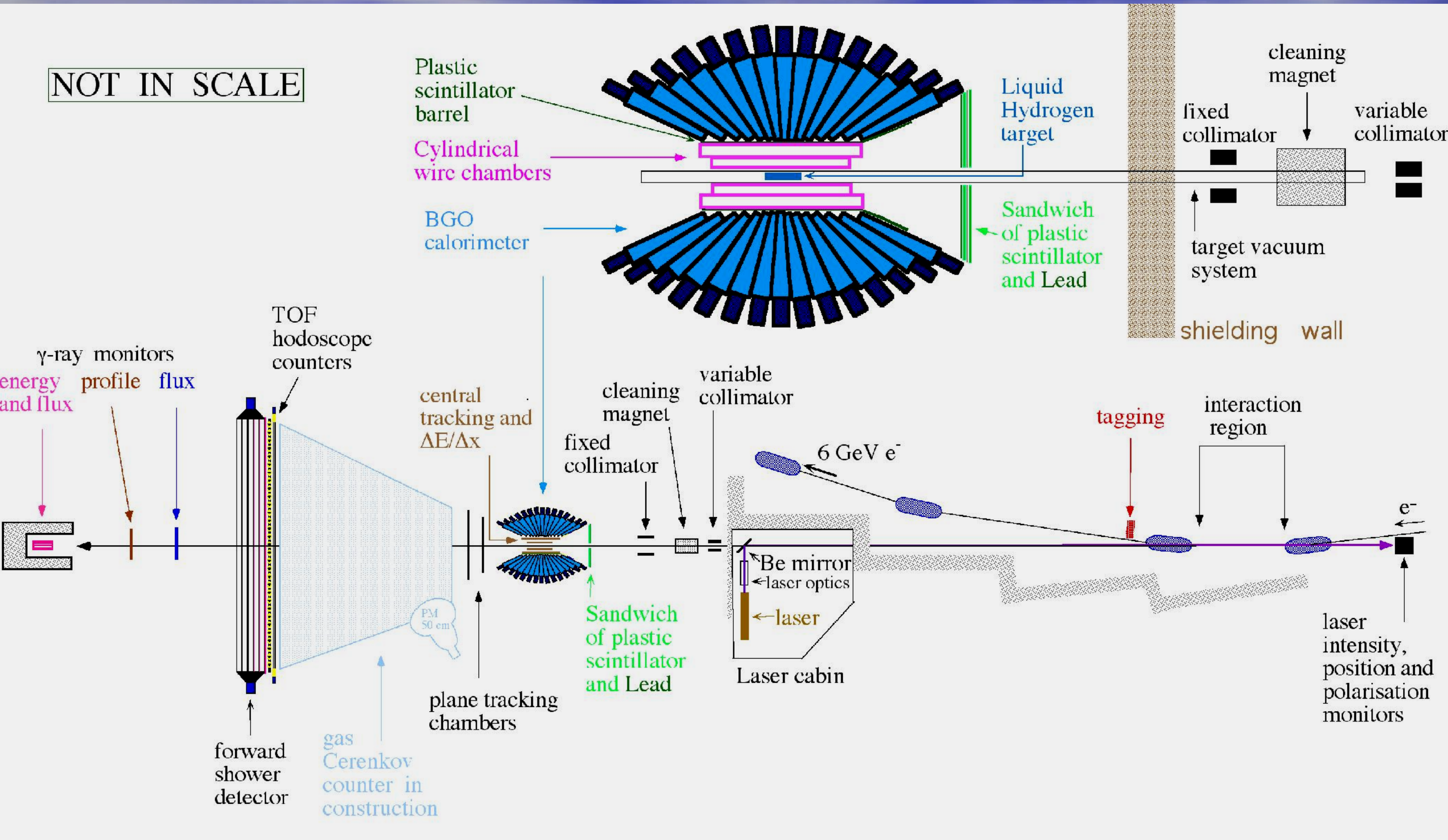
`` ... given our present knowledge of the θ^+, the state commonly known as the N(1710) is not the appropriate candidate to be a member of the antidecuplet. Instead we suggest candidates with nearby masses, N(1680) (more promising) and/or N(1730) (less promising, but not excluded). Our analysis suggests that the appropriate state should be rather narrow and very inelastic..."

GRAAL Facility(ESRF, Grenoble, France)

- Highly-polarized low-background photon beam
- Tagging range: 0.6-1.1 GeV (green laser)

  0.7-1.5 GeV (UV laser)

- A powerful close to 4π detection system for neutral and charged particles

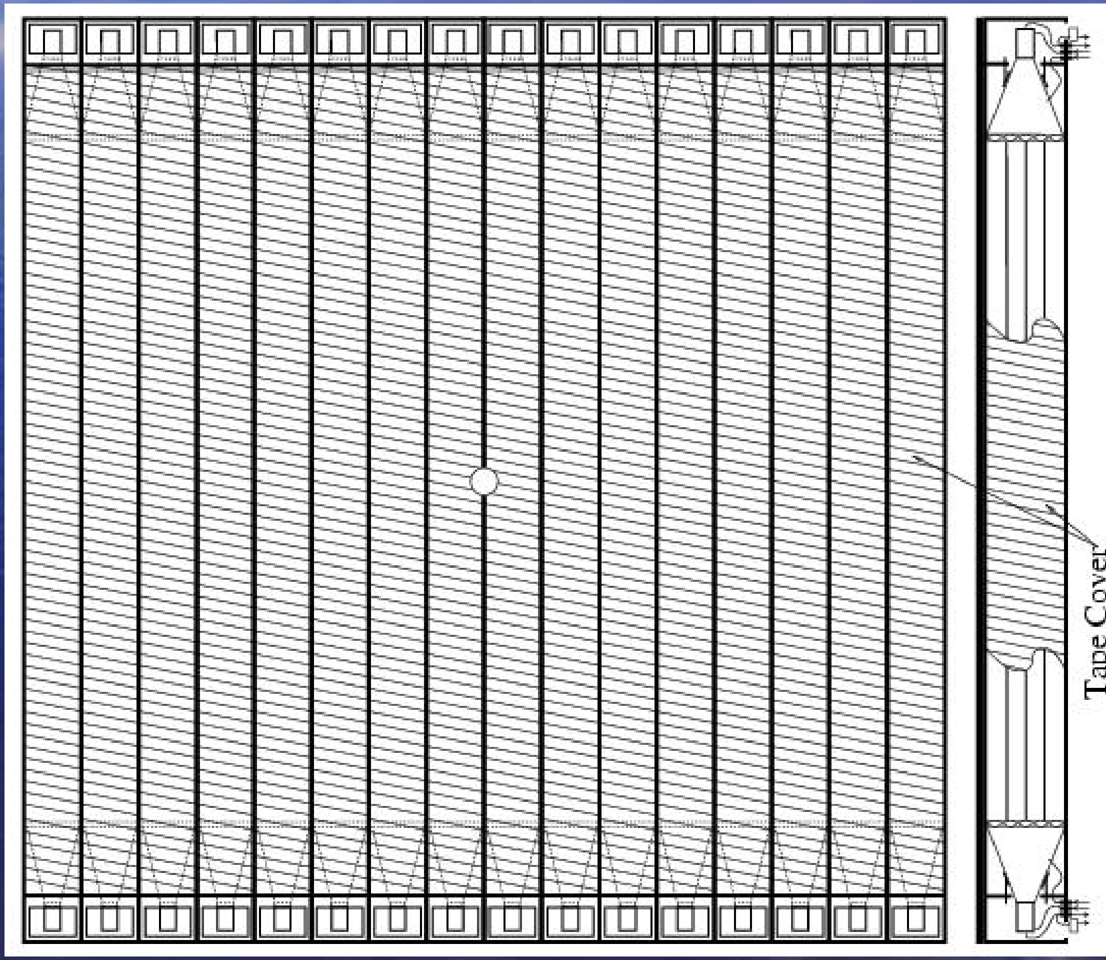


NOT IN SCALE
Plastic scintillator barrel
Cylindrical wire chambers
BGO calorimeter
Liquid Hydrogen target
Sandwich of plastic scintillator and Lead
fixed collimator
cleaning magnet
variable collimator
target vacuum system
shielding wall
γ-ray monitors
energy and flux
profile
flux
TOF hodoscope counters
central tracking and ΔE/Δx
cleaning magnet
variable collimator
fixed collimator
tagging
interaction region
6 GeV e-
e-
Be mirror
laser optics
laser
Laser cabin
Sandwich of plastic scintillator and Lead
plane tracking chambers
forward shower detector
gas Cerenkov counter in construction
laser intensity, position and polarisation monitors

GRAAL forward lead-scintillator wall (``Russian Wall")

V.Kouznetsov et al., NIM A **487** (2002) 396.

An assembly of 16 modules. Each module is a sandwich of four 3000x40 mm2 bars with 3 mm thick lead plates between them. A 25 mm thick steel plate at the front of the module acts as a main converter and as a module support.

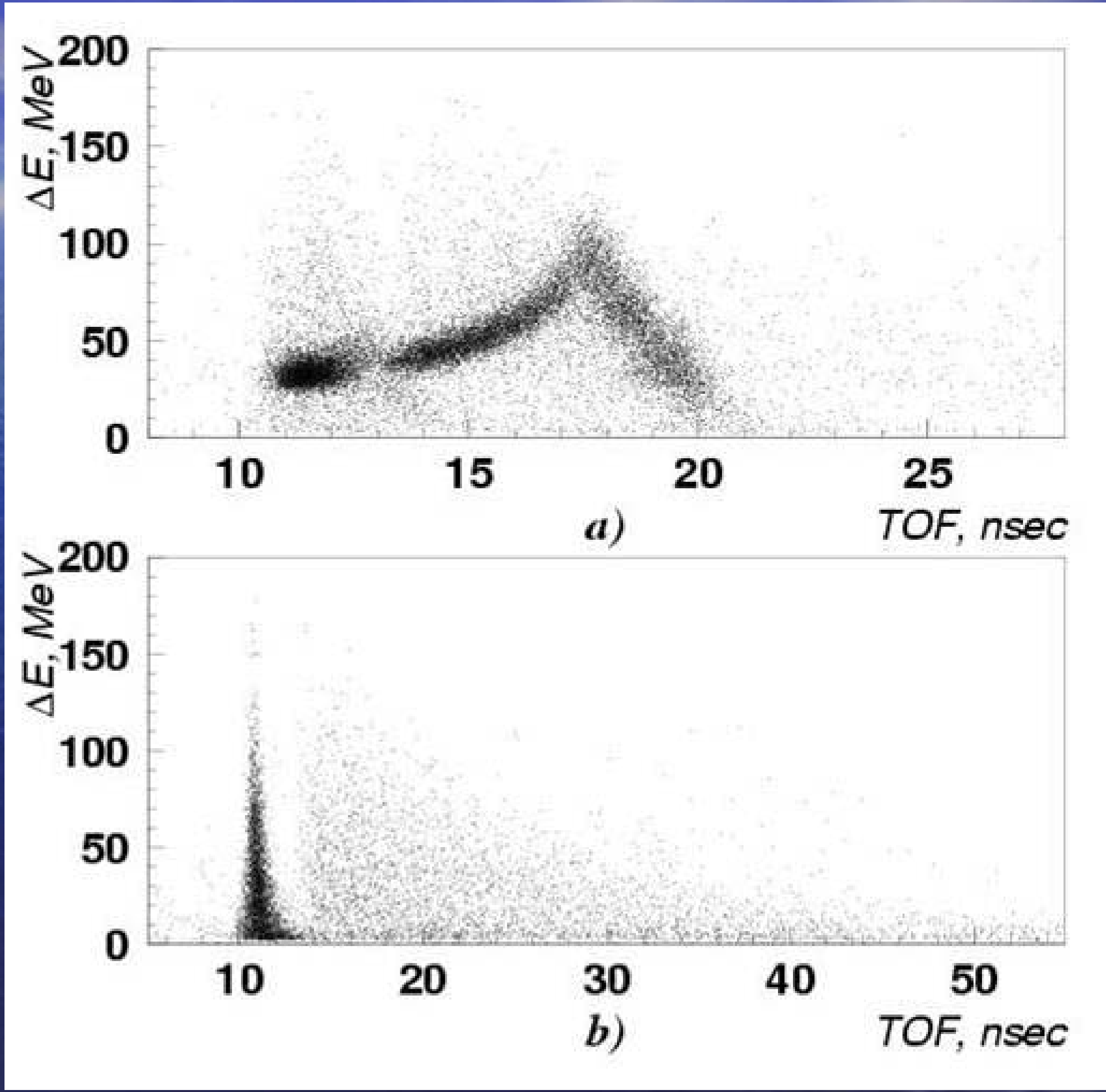


Particle identification and performance

- Typical performance of TOF detectors:

- TOF resolution 0.4-0.8 ns (FWHM);
- Coordinate resolution 5-15 cm (FWHM).

- Performance of the Russian Wall at GRAAL:
- TOF resolution – 0.6 ns
- Angular resolution – 2-3 deg
- Photon efficiency – 95%
- Neutron efficiency – 22%



Method

The P11 is non-strange → direct photoexcitation is possible:

$$\gamma N \to P11 \to \text{Meson+Baryon}$$

Cm energy W is defined by the photon energy:

$$W^2=(E\gamma+m_n)^2-E\gamma^2$$

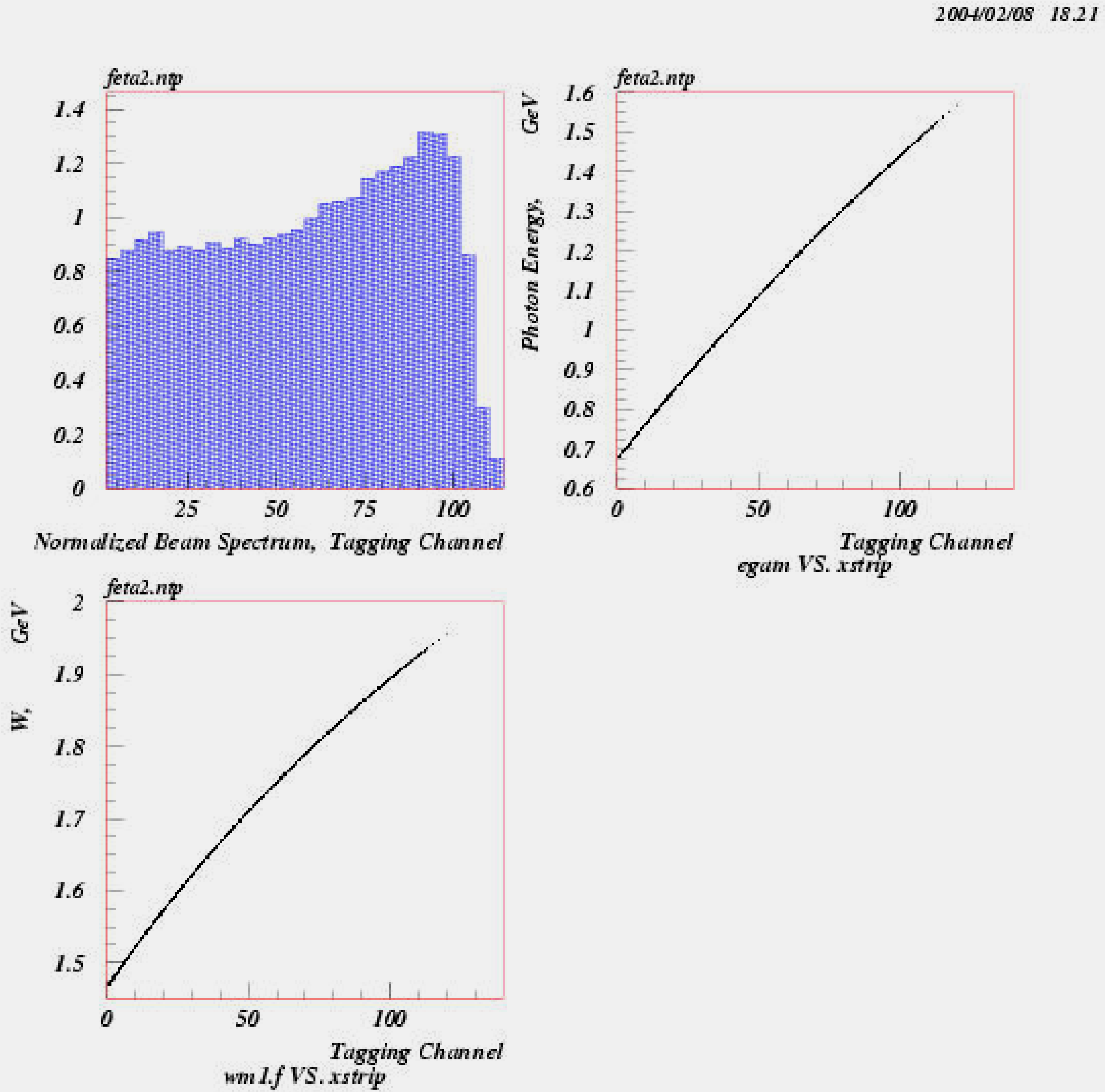
For the reaction under study, the yield Y of selected events

$$Y(E\gamma)=Const*B(E\gamma)*Eff(E\gamma)*\sigma(E\gamma)$$

where Const is related to the dose, B is the tagged beam spectrum, Eff is detection efficiency (normally a smooth function of energy), σ is cross section.

The ratio Y/B ~Eff*σ may show a signal of a narrow state if it exists.

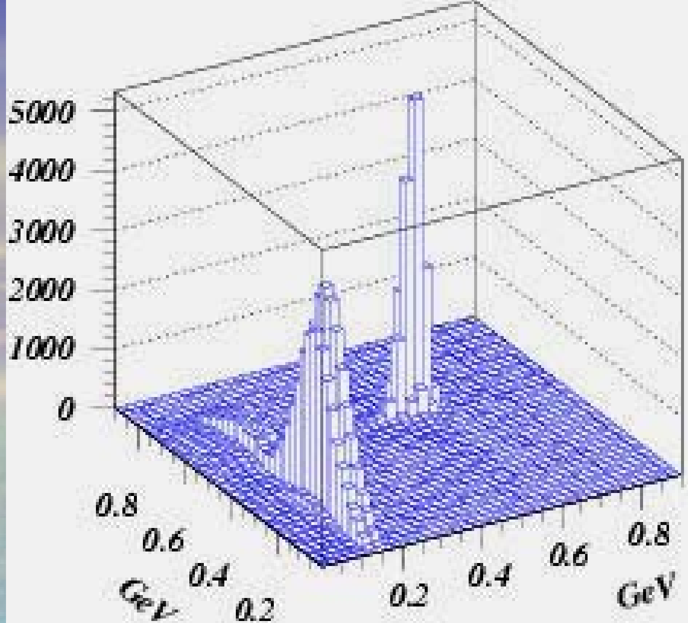
By technical reasons, instead of Eγ and W, at the moment I have to use tagging channels. I apologize….



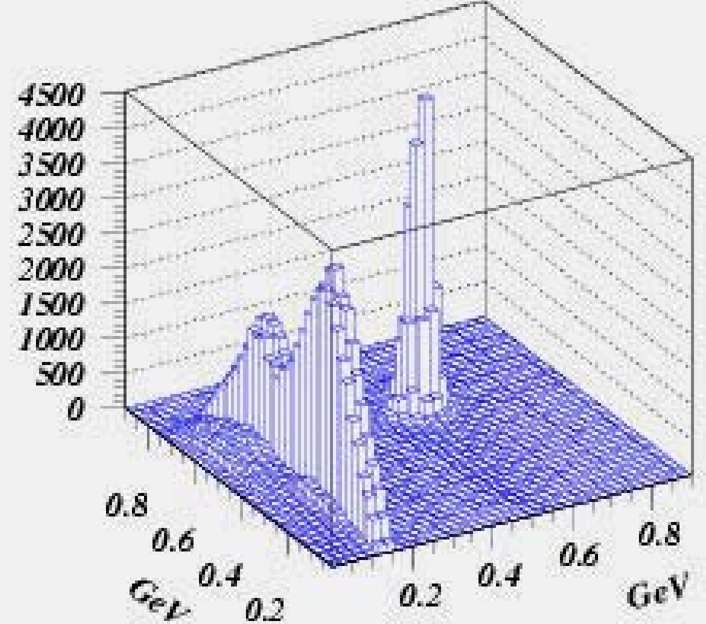
2004/02/08 18.21
feta2.ntp
Normalized Beam Spectrum, Tagging Channel
feta2.ntp
Photon Energy, GeV
Tagging Channel
egam VS. xstrip
feta2.ntp
W, GeV
Tagging Channel
wm1.f VS. xstrip

η photoproduction on the quasi-free neutron and on the quasi-free proton

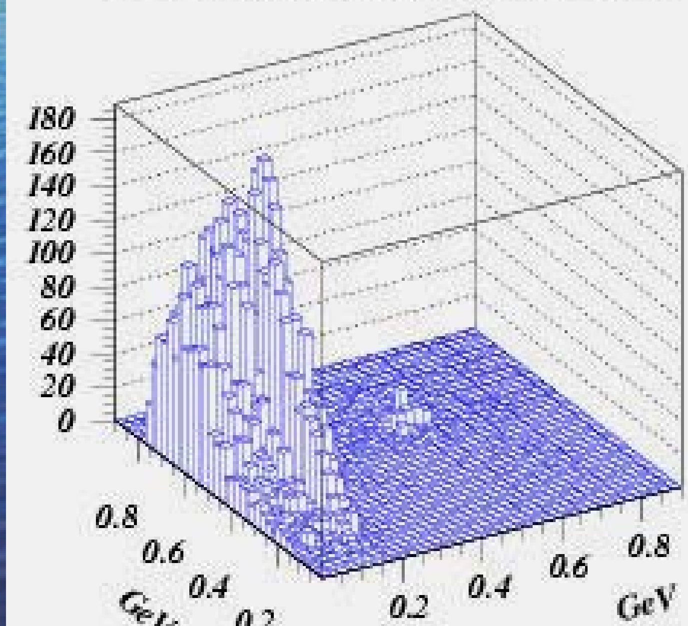
- Detection of two photons from $\eta \rightarrow 2\gamma$ decay in the BGO ball; η identification through the invariant mass of two photons;
- Detection of recoil neutrons and protons in the forward direction;
- Simultaneous measurements on the neutron and on the proton in the same experimental run;



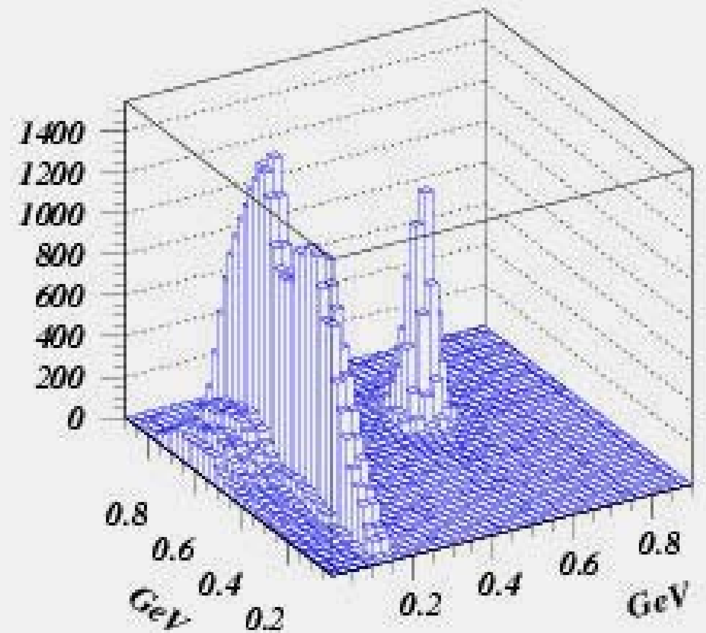
Recoil proton, proton target



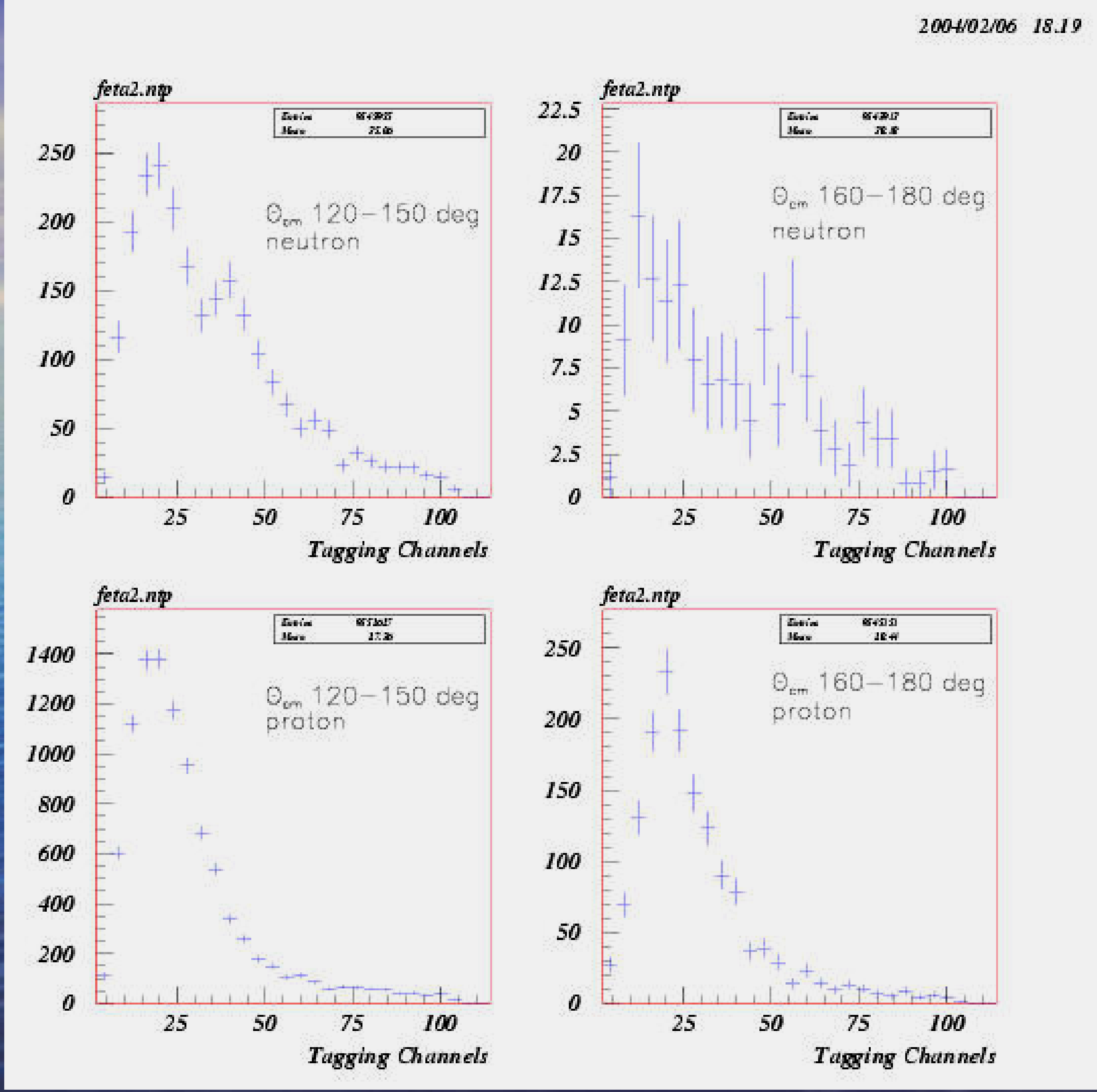
Recoil proton, deuteron target



Recoil neutron, proton target

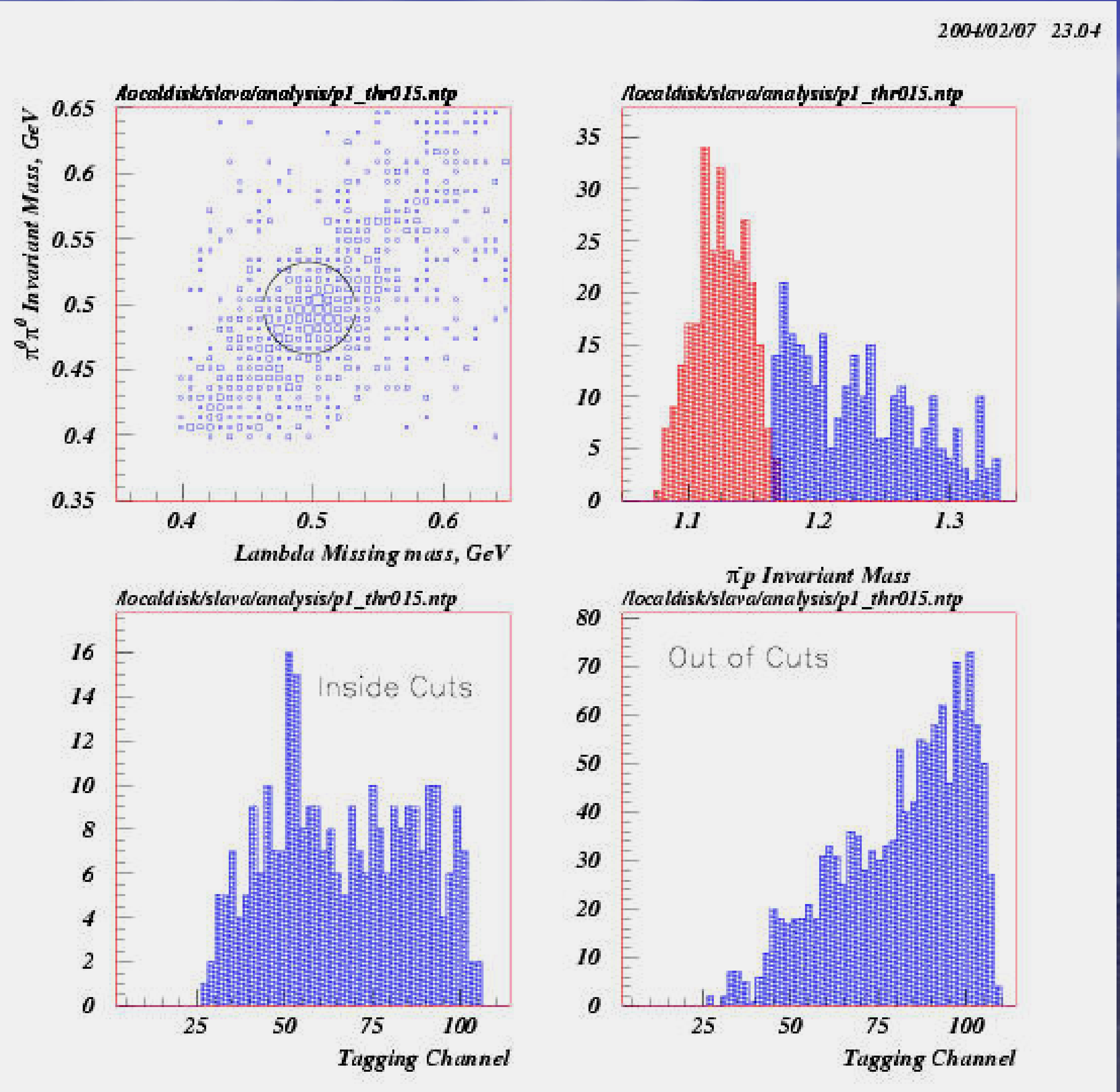


Recoil neutron, deuteron target


2004/02/06 18.19
feta2.ntp
Θcm 120−150 deg
neutron
Tagging Channels
feta2.ntp
Θcm 160−180 deg
neutron
Tagging Channels
feta2.ntp
Θcm 120−150 deg
proton
Tagging Channels
feta2.ntp
Θcm 160−180 deg
proton
Tagging Channels

$\gamma n \rightarrow K^0 \Lambda \rightarrow (\pi^0 \pi^0)\ (\pi^- p)$

- Detection of four photons from $\pi^0 \rightarrow 2\gamma$ decays in the BGO. Identification of the kaon through the invariant mass of two photons;
- Detection and identification of the proton in the forward walls;
- Detection of π^- in the BGO;



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/localdisk/slava/analysis/p1_thr015.ntp
$\pi^0\pi^0$ Invariant Mass, GeV
Lambda Missing mass, GeV
/localdisk/slava/analysis/p1_thr015.ntp
$\pi^- p$ Invariant Mass
/localdisk/slava/analysis/p1_thr015.ntp
Inside Cuts
Tagging Channel
/localdisk/slava/analysis/p1_thr015.ntp
Out of Cuts
Tagging Channel

$\gamma n \rightarrow K^+ \Sigma^- \rightarrow K^+ \pi^- n$

- Detection and identification of the kaon in the forward walls;
- Detection and identification on the neutron in the Russian Wall;
- Detection of the pion in the BGO;

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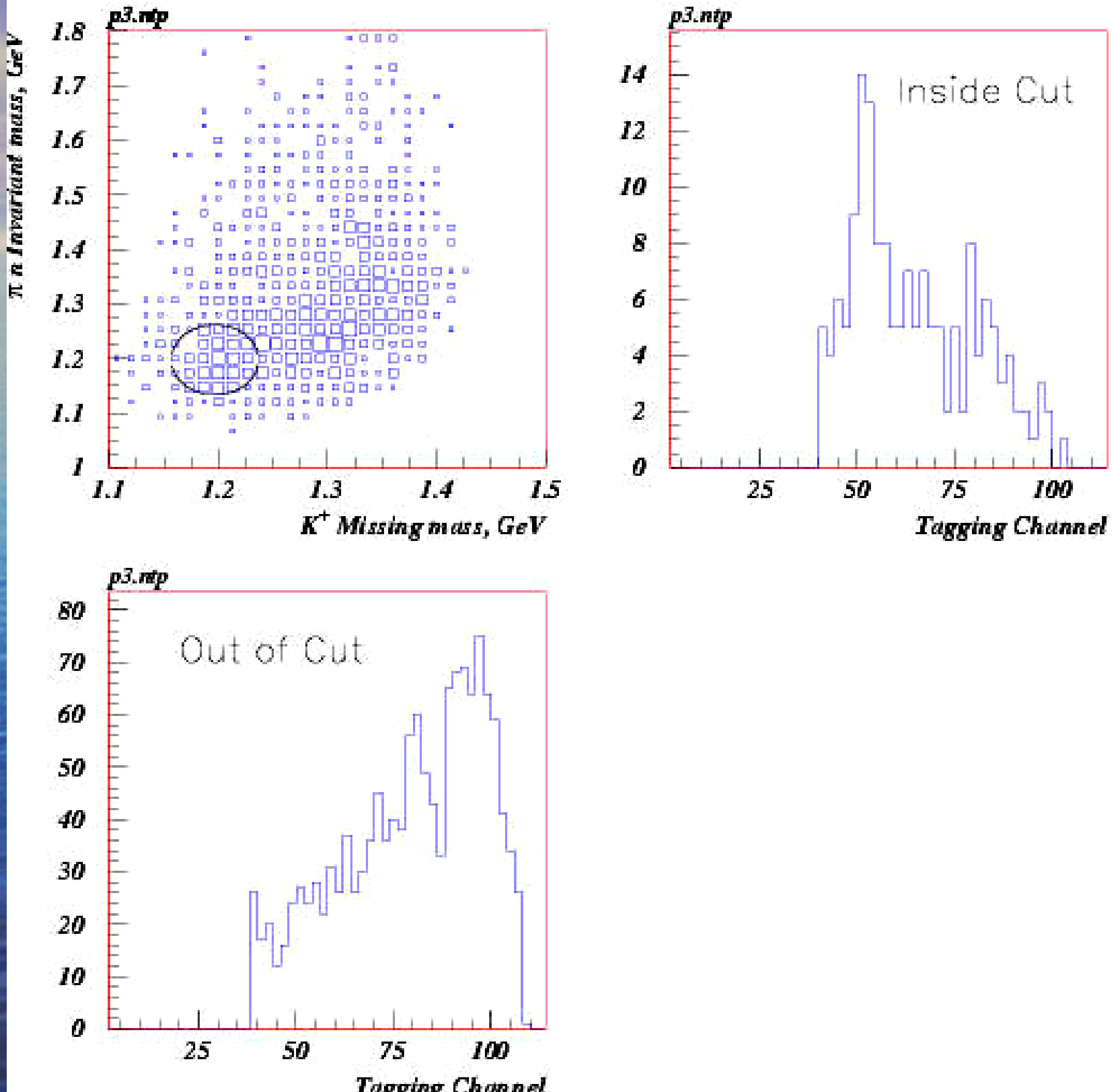

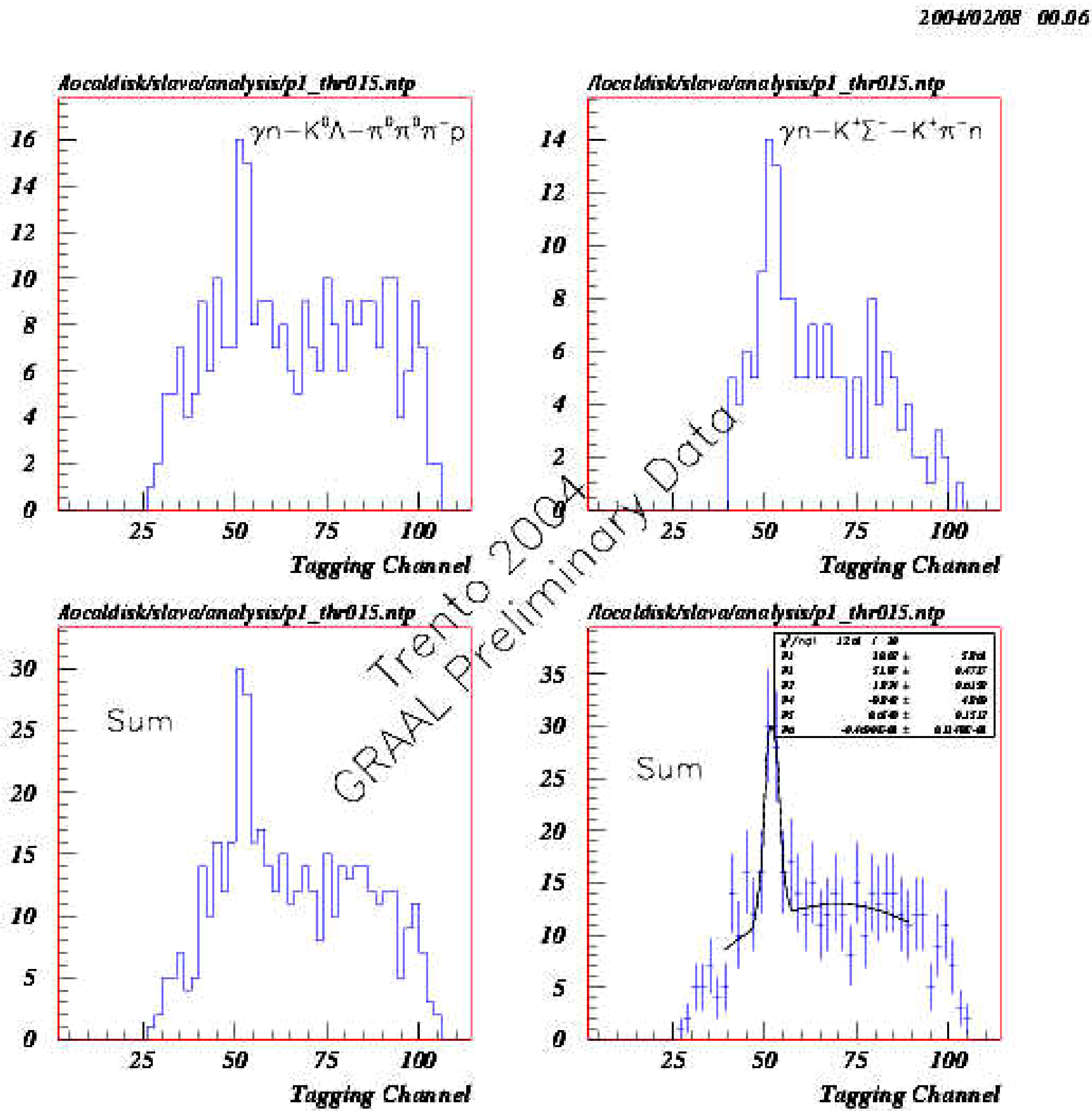
2004/02/08 00.06
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γn→K⁰Λ→π⁰π⁰π⁻p
γn→K⁺Σ⁻→K⁺π⁻n
Sum
Sum
Tagging Channel
Trento 2004
GRAAL Preliminary Data

Summary&Perspectives

(Very preliminary) signals of two states at W=1.673 and W=1.727 GeV are going to be observed in eta and kaon photoproduction on the neutron. If confirmed, these states may be considered as candidates for the second member of the antidecuplet, the P11.

Next steps:

- More clear reaction identification, background rejection;
- Doubling of statistics.
- Next presentation: NSTAR2004, Grenoble, March 24-27. You are welcome to attend!

Thank you for your attention!

Thanks a lot to the Organizers!