MEMO 14 February, 2003

To: John D'Auria cc: Shawn, Lothar, Sabine, DAH, and Art

From: Joel Rogers and Dario Gigliotti

Re: Revising the Uncertainty of the BGO Efficiency

We ran some checks on the GEANT simulation of BGO efficiency in hopes of reducing the error estimate in the latest PRL manuscript. This memo summarizes the results of these checks.

GEANT+user-code simulate the experiment + Midas-data-analysis, which was used by Shawn/Joel in deriving/checking the capture-yield and resonant-energy. The simulation emits 100K gamma rays in random directions from a point-source (or optionally a line-source) in the target. The energy deposited in the 30 BGO scintillators is computed for each event, and the above-threshold events are counted. The simulated efficiency is the ratio of counted- to emitted-gamma-rays. Cascade-gamma events are separately simulated by emitting 2 energies of gamma rays from the same point. The published branching ratios were used to weight the simulated-efficiencies.

Possible uncertainties in the simulation were considered: in specifying volumes' sizes and locations; and possible bugs in user-written code, which forms histograms from the output GEANT-event-lists. These uncertainties were estimated: globally, by measuring/simulating the efficiency in high-yield experiments; and microscopically, by simulating uncertainties in the detectors' positions and in the thickness of the lead shielding.

Global checks were performed on 21Ne(p,g)22Na data, as suggested by DAH in his 11 December memo, and also on the "822" keV (=TUDA resonance) data, which is to be published as Fig. 15 of the NIM facility-paper. Joel's analyses are shown in Figs. 1-3(attached), yielding efficiencies of 53+-1% and 46+-3%, for the gamma-energies of 7.5 and 6.5MeV, respectively, compared to 57 and 49-52% from the simulation. The range of values in the latter case is due to +-30% uncertainty in the branching ratio between the ground- and 1st-excited-states.

In the case of the more accurate 7.5MeV-simulation, the relative error between simulation and measurement is 7%, substantially less than the 20% uncertainty stated in the present PRL manuscript. Even 7% is an overestimate of the true error, because the 7.5MeV test-case is complicated by 7 competing branches contributing to the decay of the 22Na intermediate state. The simulation needed in the paper is simpler, involving only 2 branches, and therefore is certainly predicted more accurately than 7%.

These considerations suggest that the value of uncertainty in Table I of the paper should be revised downward from its present 20%.

Our checks revealed no bugs or omissions in the simulation. The central (z=0) prediction is 48%, = 0.87*47.1% + 0.13*53.2%, as presented by Dario at the DRAGON group meeting of December 10.

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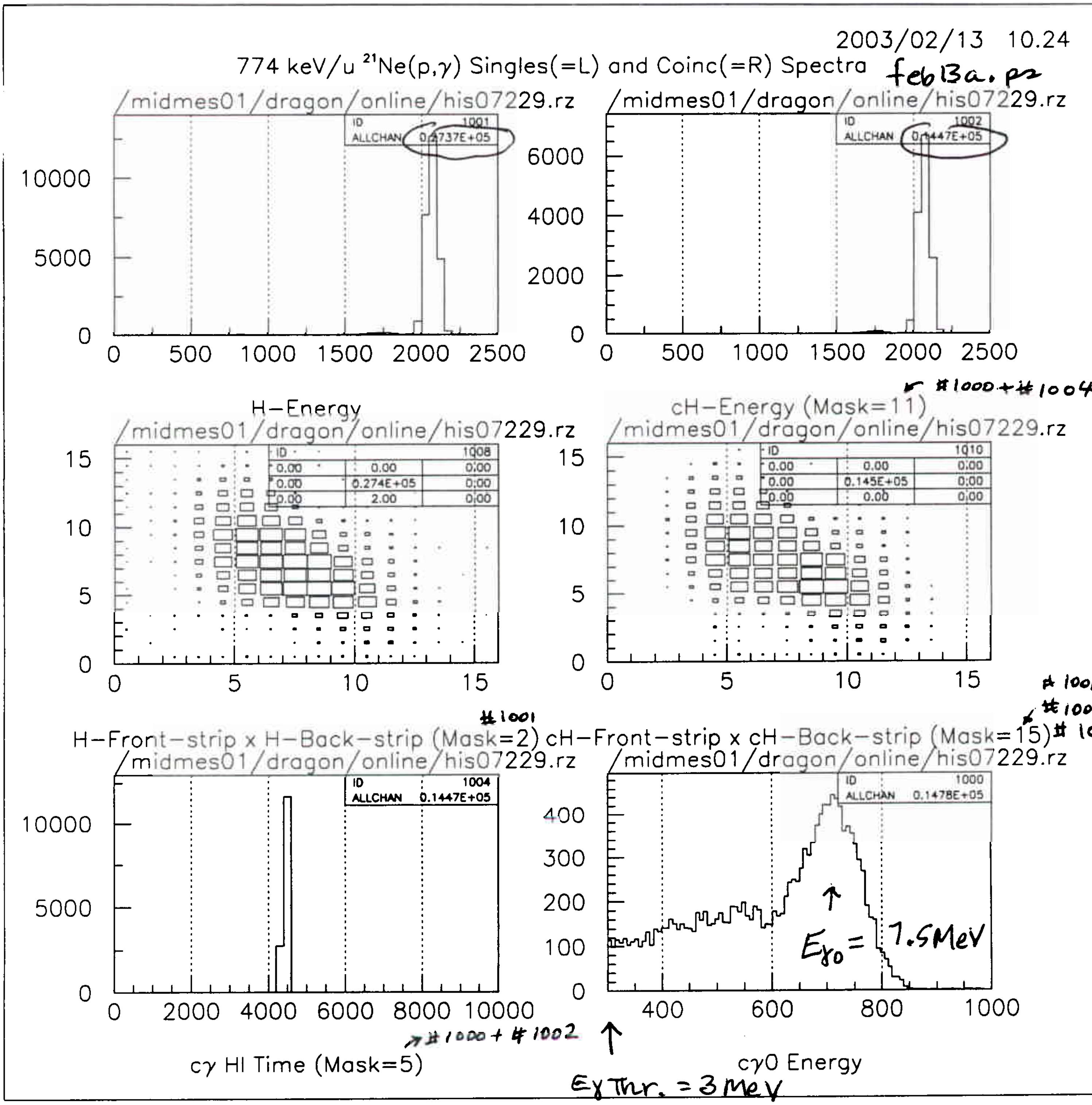
FIGURE 1

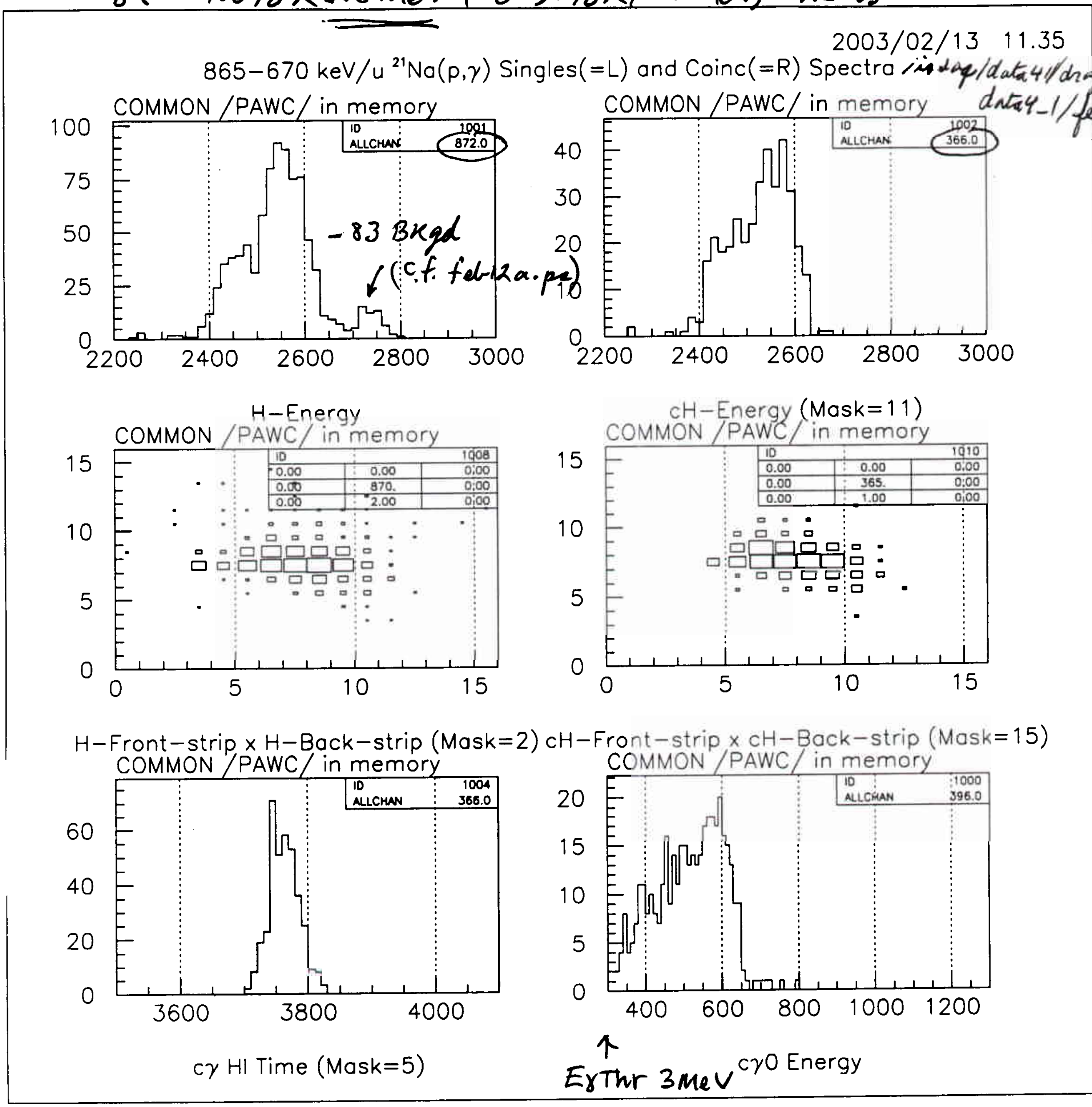
$e_\gamma(.78 \times 7.5\,MeV + .22 \times (cascades)) = \frac{14.4K}{27.4K} = 0.53$



joel

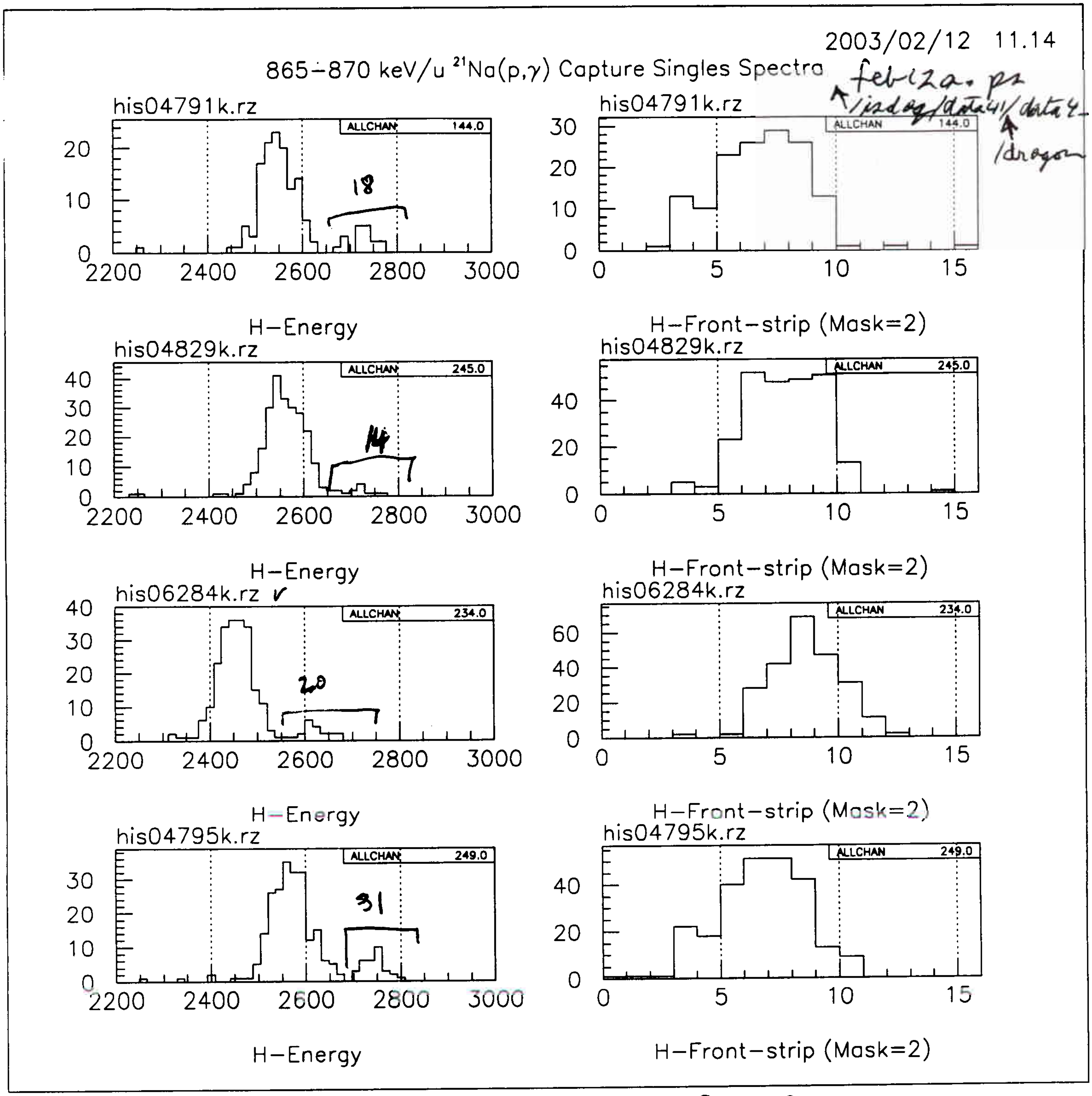
FIGURE 2

ϵ_γ (50-100% × 6.3 MeV + 0-50% × 1.25 MeV) = $\frac{366}{872-83}$ = 0.46



Joel

FIGURE3



Leaky Bkgd = 18 + 14 + 20 + 31 = 83 Bkgd