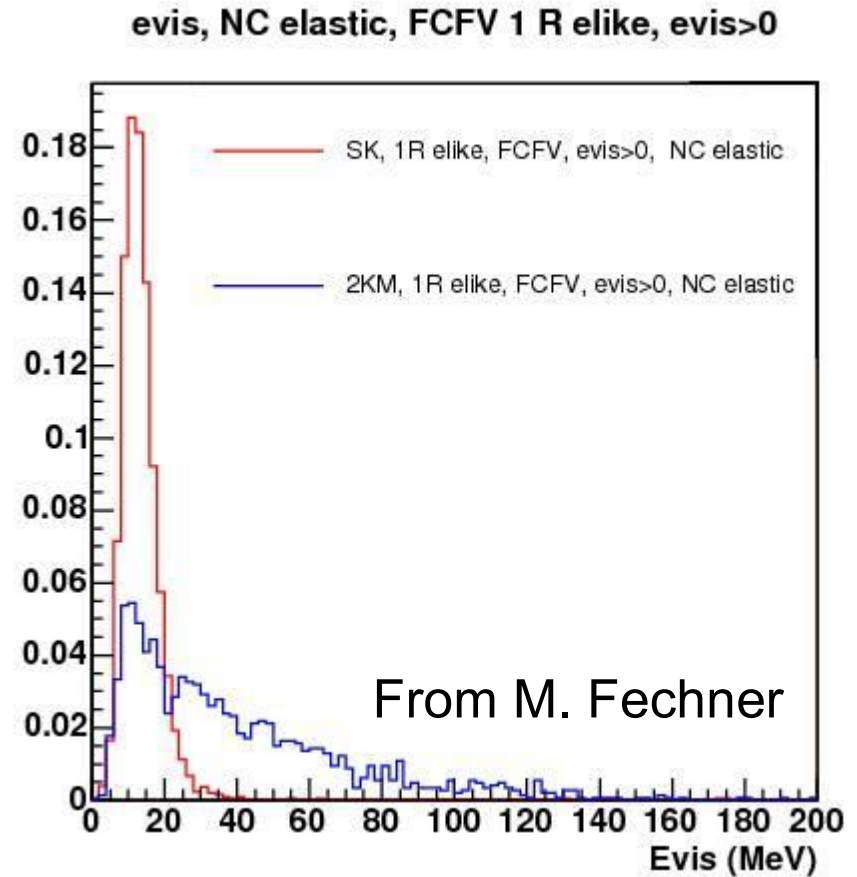
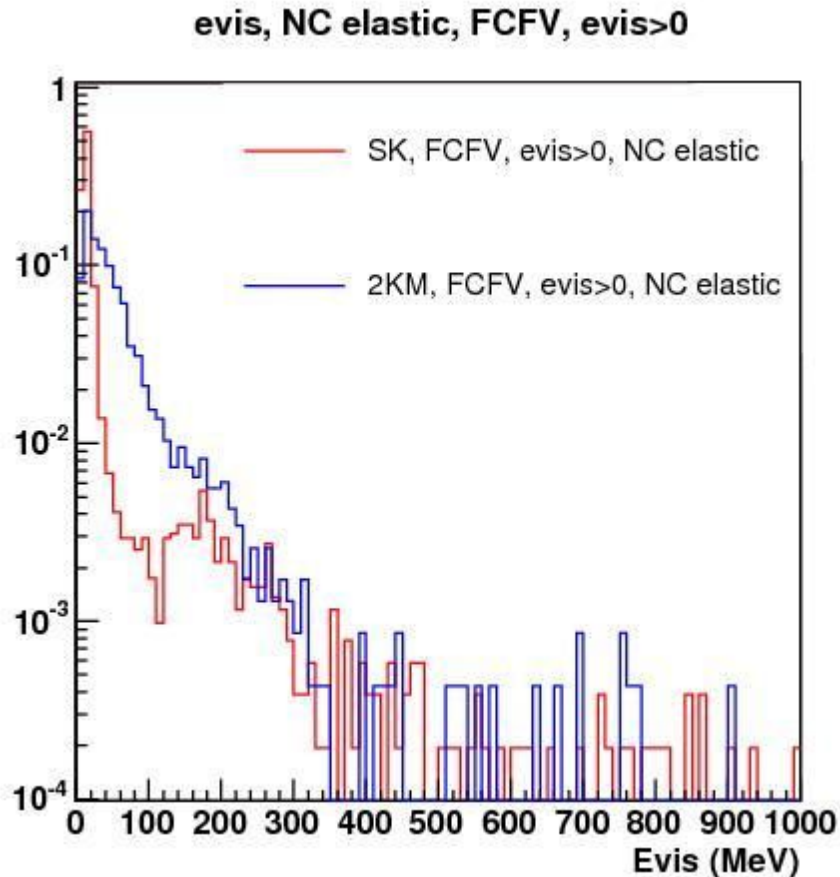


T2K 2KM Meeting
Nov. 10, 2005
J. Raaf

π^0 's from Hadronic Interactions in Water

Geant4 vs. skdetsim
Geant4 model options
Implementation
Outlook

Geant4 vs. skdetsim



Problem seen in visible energy distribution:

Traced back to π^0 's produced in secondary interactions of nucleons from NC elastic events

Different hadronic interaction models in skdetsim and G4

Geant4 Hadronic Interaction Models

G4 has several built-in models for low energy hadronic interactions

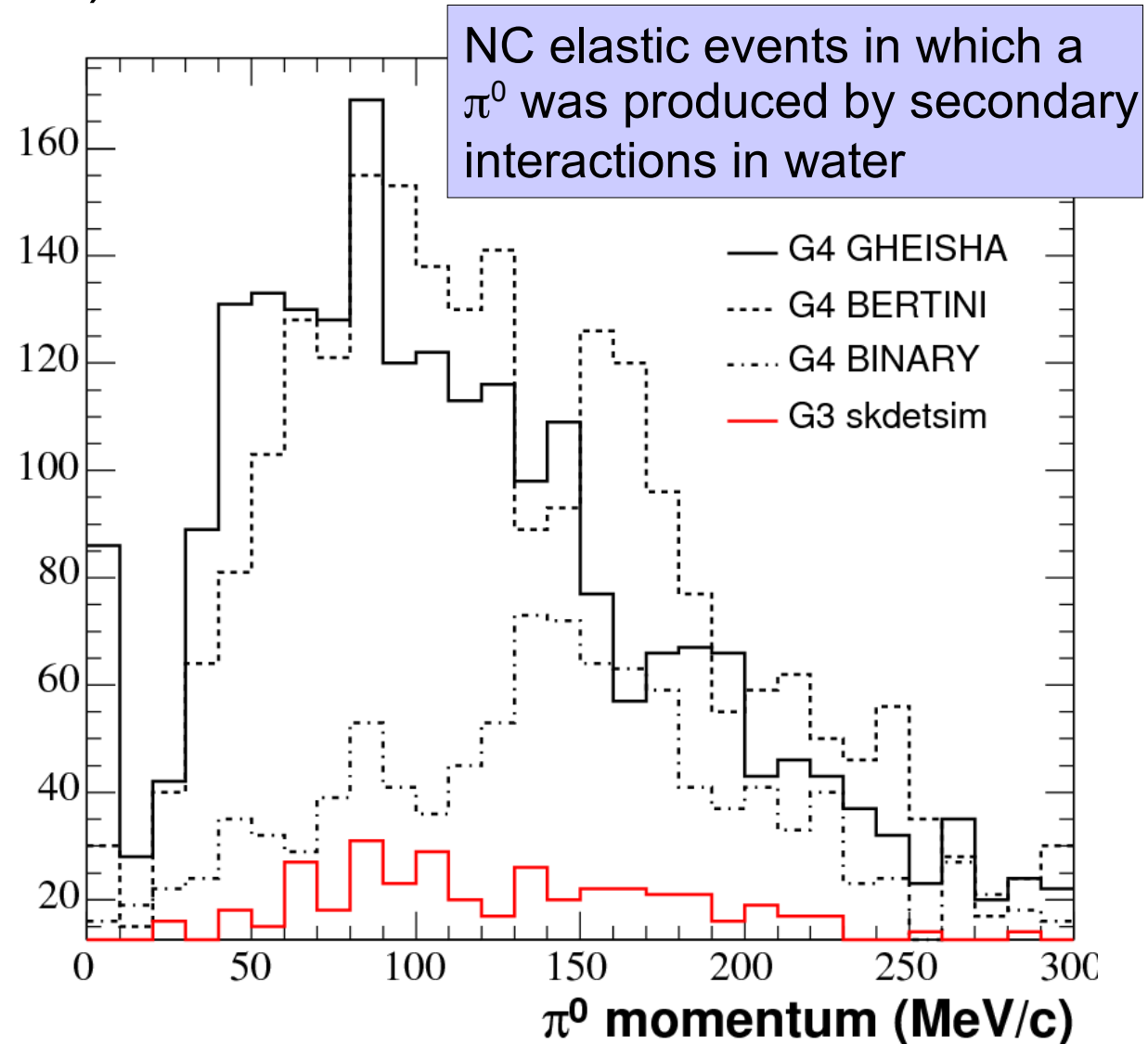
GHEISHA (original default)

G4 Binary Cascade

G4 Bertini Cascade

None of these 3 models agree extremely well with skdetsim

Binary Cascade goes in the “right” direction



Implementation of G4 Models

(excerpt from JHF2km.cc)

```
int main()
{
    //Construct the default run manager
    G4RunManager* runManager = new G4RunManager;

    // get the pointer to the UI manager
    G4UImanager* UI = G4UImanager::GetUIpointer();
        .
        .
        .

    runManager->SetUserInitialization(new JHF2kmPhysicsList);
    UI->ApplyCommand("/control/execute jobOptions.mac");
        .
        .
        .
}
```

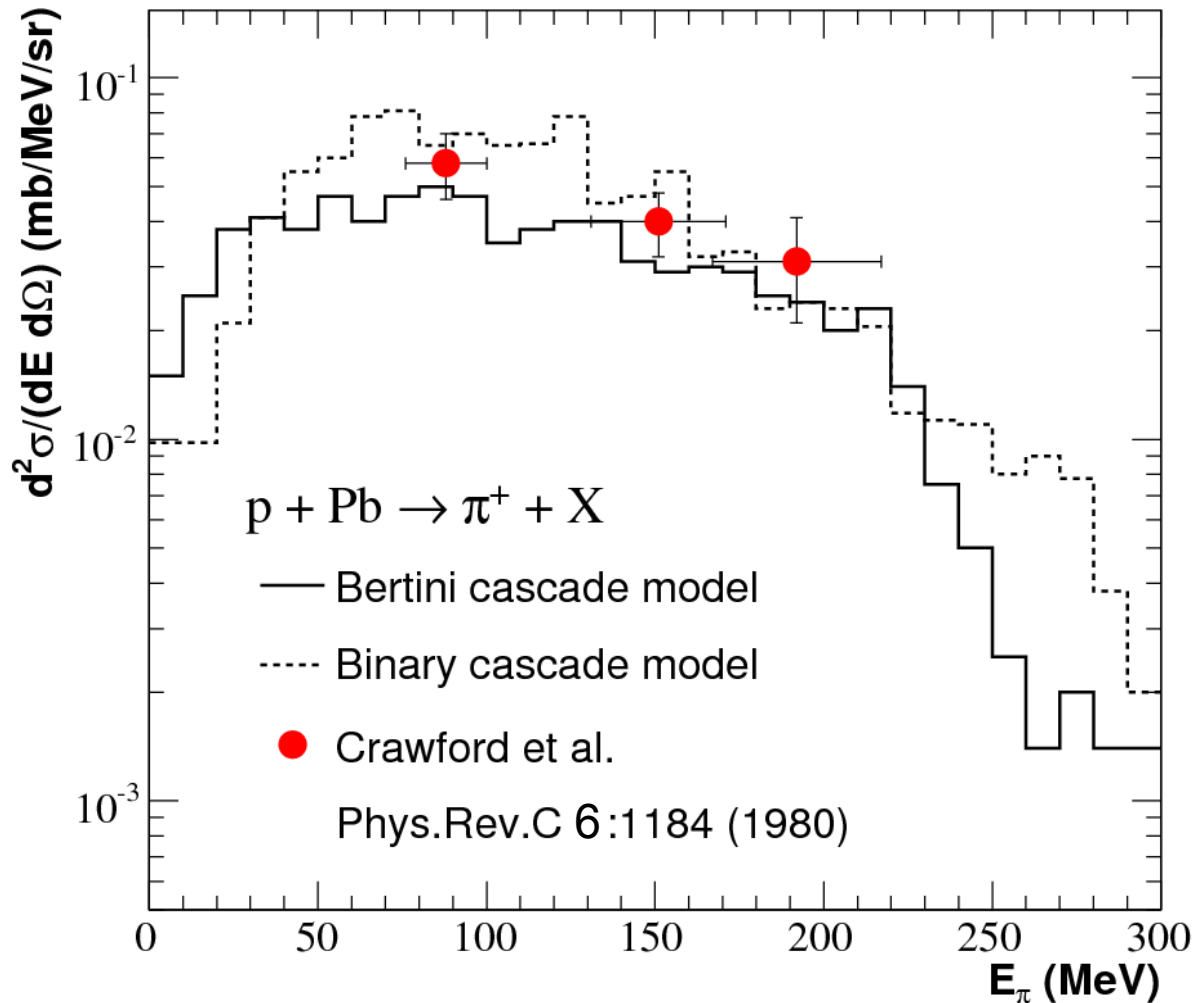
(sample jobOptions.mac)

```
#Choose secondary interaction model
#Options:
#  GHEISHA      (original G4 default)
#  BINARY       (Binary Cascade, new default)
#  BERTINI      (Bertini Cascade)
/JHF2km/physics/secondaries/model BINARY
```

If the jobOptions.mac file is not found,
the **BINARY** model is chosen by default.

Geant4 Hadronic Verification Suite

G4 Binary and Bertini models compare to experimental charged pion production cross section data for validation
(also compare to neutron production cross sections, not shown here)



Histograms reproduced from:
arXiv:nucl-th/0306008
arXiv:physics/0306016

Reasonable agreement
with charged pion data.

No comparisons to
neutral pion data.
(Neutral pion data scarce.)

Why you should care!

Need to have consistent model for interactions in SK and 2KM!

- Different models produce different numbers of π^0 's

$$\text{skdetsim/Binary} = 0.82 \pi^0\text{'s}$$

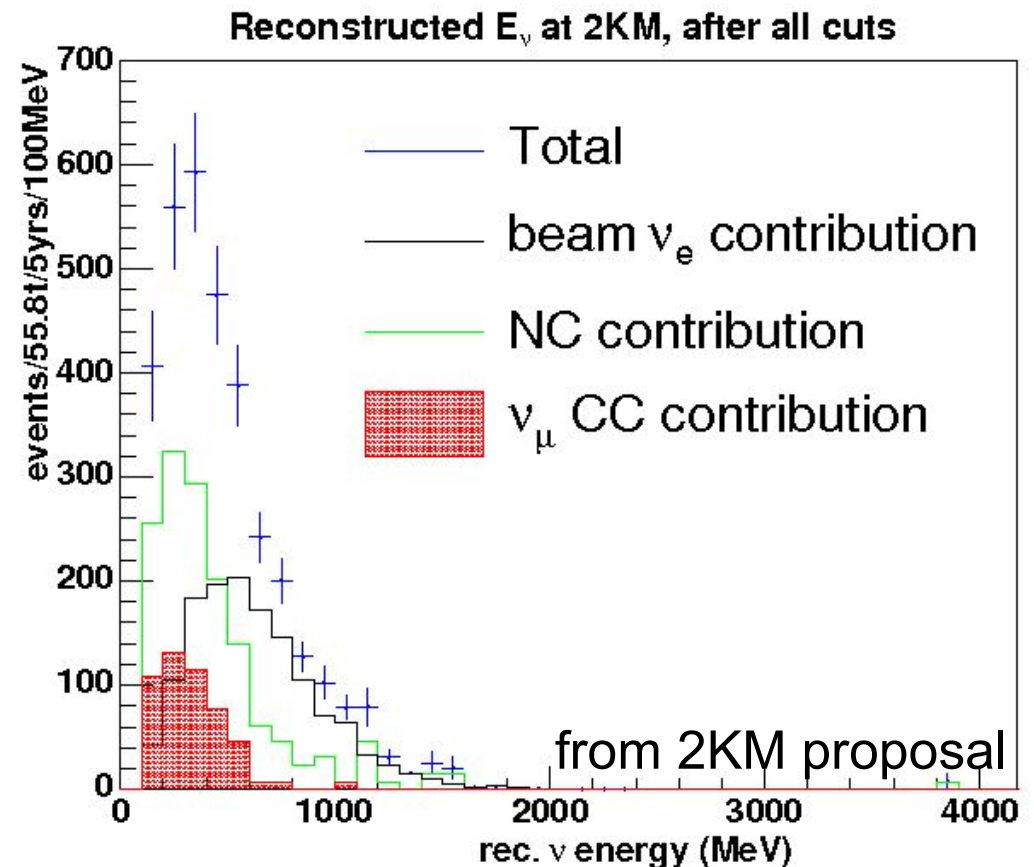
$$\text{skdetsim/GHEISHA} = 0.45 \pi^0\text{'s}$$

$$\text{skdetsim/Bertini} = 0.42 \pi^0\text{'s}$$

- The π^0 energy distributions are also not similar

2KM detector will measure overall shape of the ν_e background

Fit for 3 background contributions
-- use the different model predictions for systematic error on NC background shape



Outlook

Working on quantifying model differences

(i.e., numbers of events expected to pass standard ν_e analysis cuts)

Looking into comparisons with existing neutrino data:

K2K 1kt π^0 's

Older cross section experiments

(Hirt *et al.* (1969), Gugelot *et al.* (1972), Borie *et al.* (1974))

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