Status of E14 preparation

G.Y.Lim
IPNS, KEK

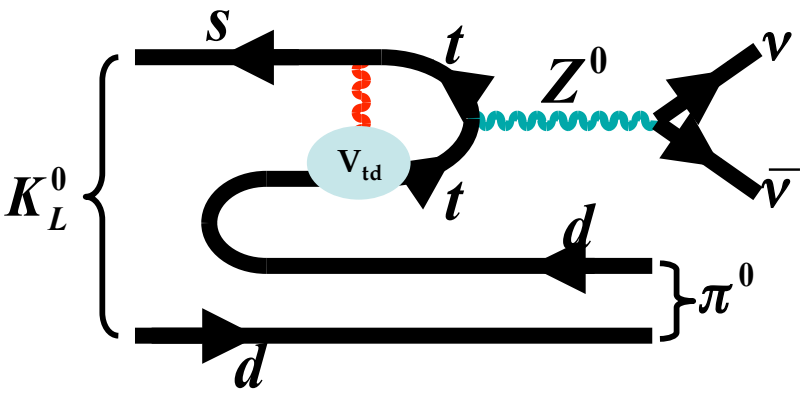
E14 Collaboration

- Arizona State Univ.
- U. of Chicago
- JINR
- KEK
- Kyoto Univ.
- National Defense Academy
- National Taiwan Univ.
- Osaka Univ.
- Pusan National Univ.
- Saga Univ.
- Tbilisi State Univ.
- TRIUMF
- Yamagata Univ.

13 Institutes from 7 countries

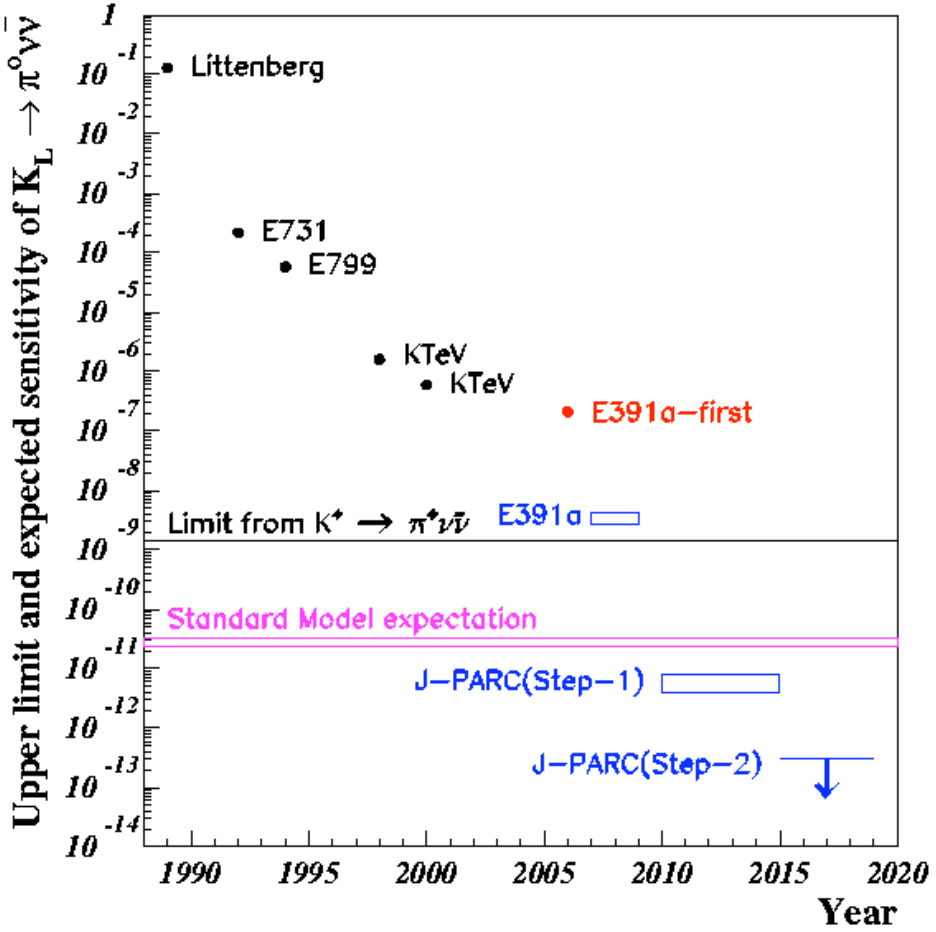
Newly Joined
University of Michigan, Ann Arbor

Measurement of Br($K_L \rightarrow \pi^o\nu\nu$)



$$A(K_L -> \pi^0\nu\bar{\nu}) \propto V_{td}^* V_{ts} - V_{ts}^* V_{td}$$
$$= 2 \times V_{ts} \times \mathrm{Im}(V_{td})$$
$$\propto \eta$$

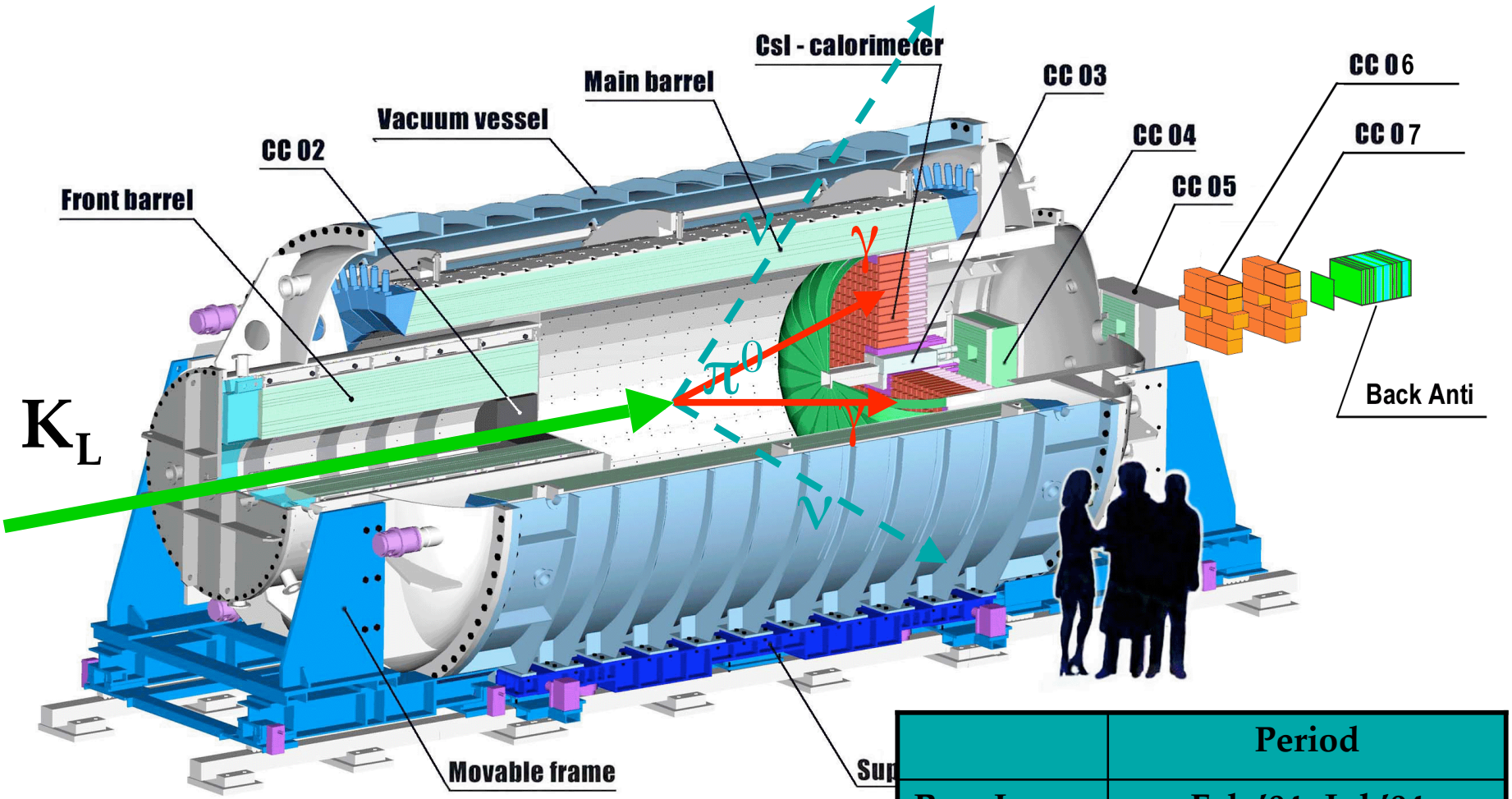
$$Br(K_L \rightarrow \pi^0\nu\bar{\nu})_{SM} = (2.8 \pm 0.4) \times 10^{-11}$$



The most clean process : 1-2 % theoretical uncertainty

- Brief introduction to E391a experiment
- Status of E391a analysis
- Progress on E14 preparation
  - Beam line design
  - New calorimeter (KTeV CsI)

E391 Detector setup

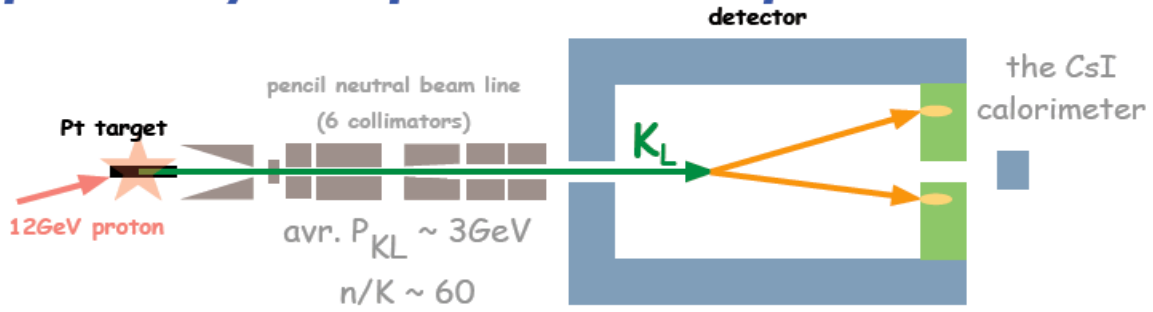


	Period
Run-I	Feb.'04~Jul.'04
Run-II	Mar.'05~Apr.'05
Run-III	Nov.'05~Dec.'05

Analysis Procedure

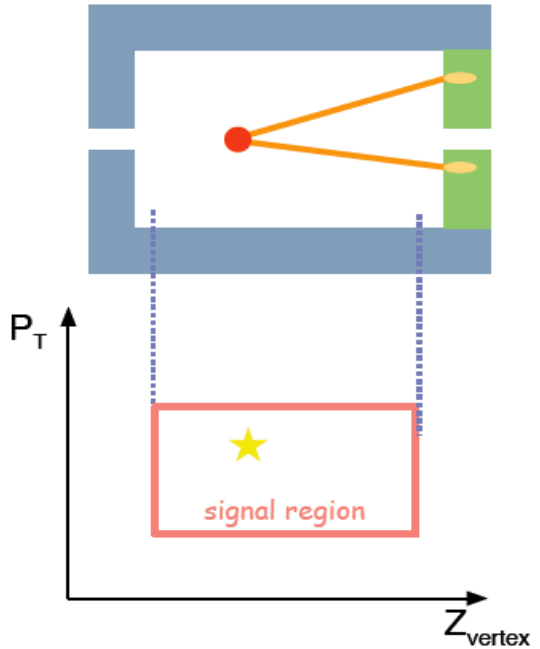
- ***detect 2g from pi0 decay + require no other particles***

(1) measure gamma hit position and energy

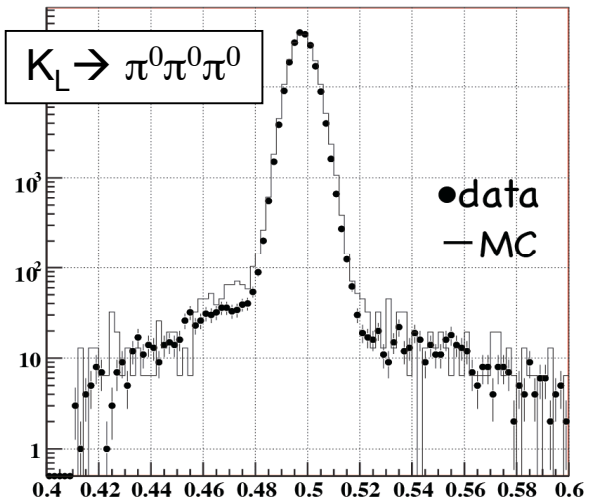


(2) reconstruct decay vertex assuming $M_{2g}=M_{pi0}$

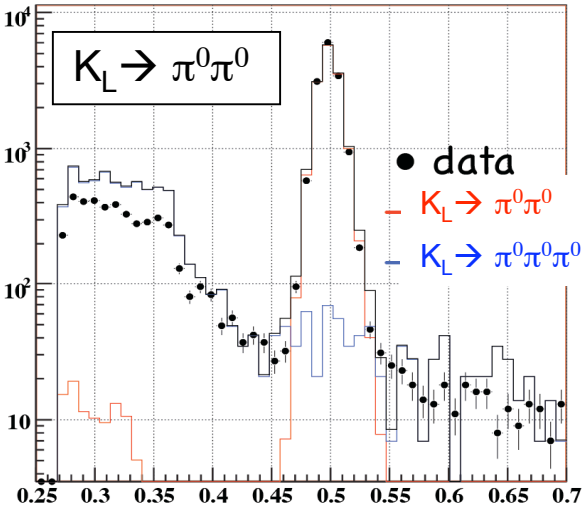
(3) require missing Pt and decay vertex in the fiducial region



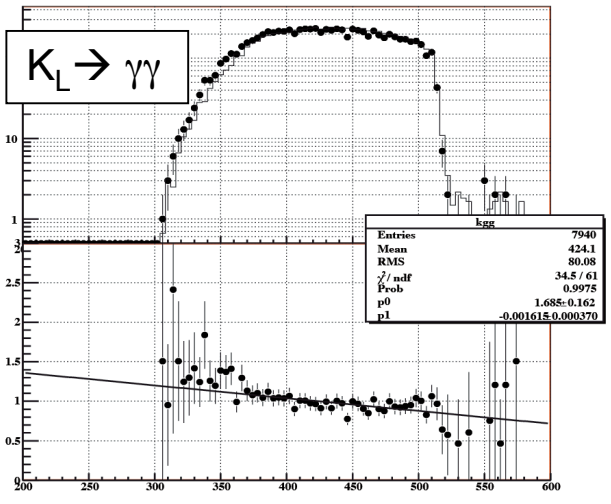
Well constrained decays



6-γ invariant mass (GeV/c²)



4-γ invariant mass (GeV/c²)



Reconstructed vertex (cm)

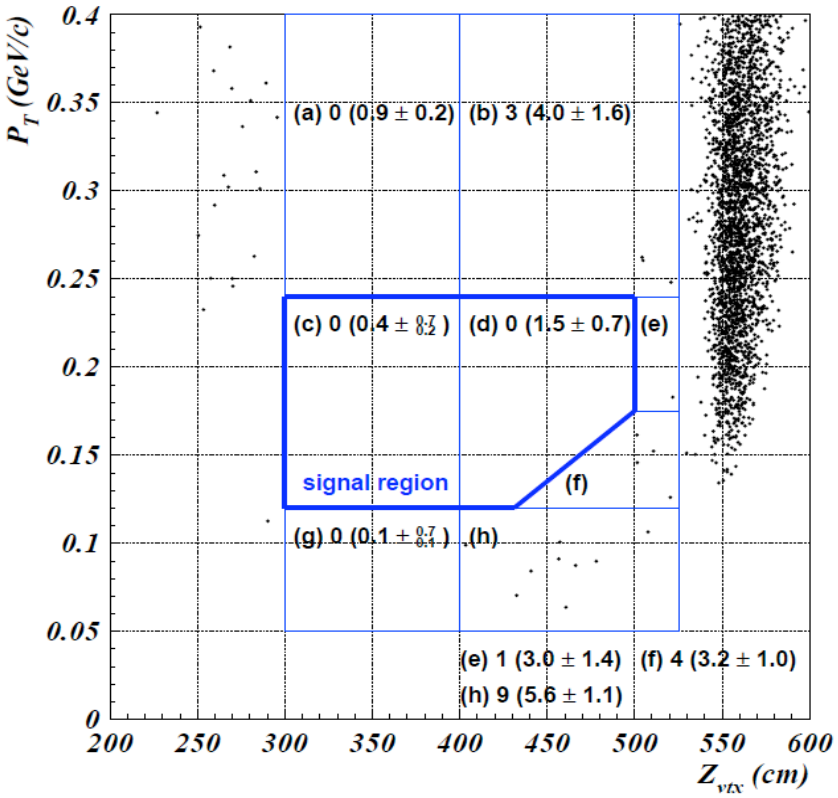
M.C. well reproduce data.

Low mass tail in 4-γ invariant mass : close to solve.

Finer M.C. tuning is being done.

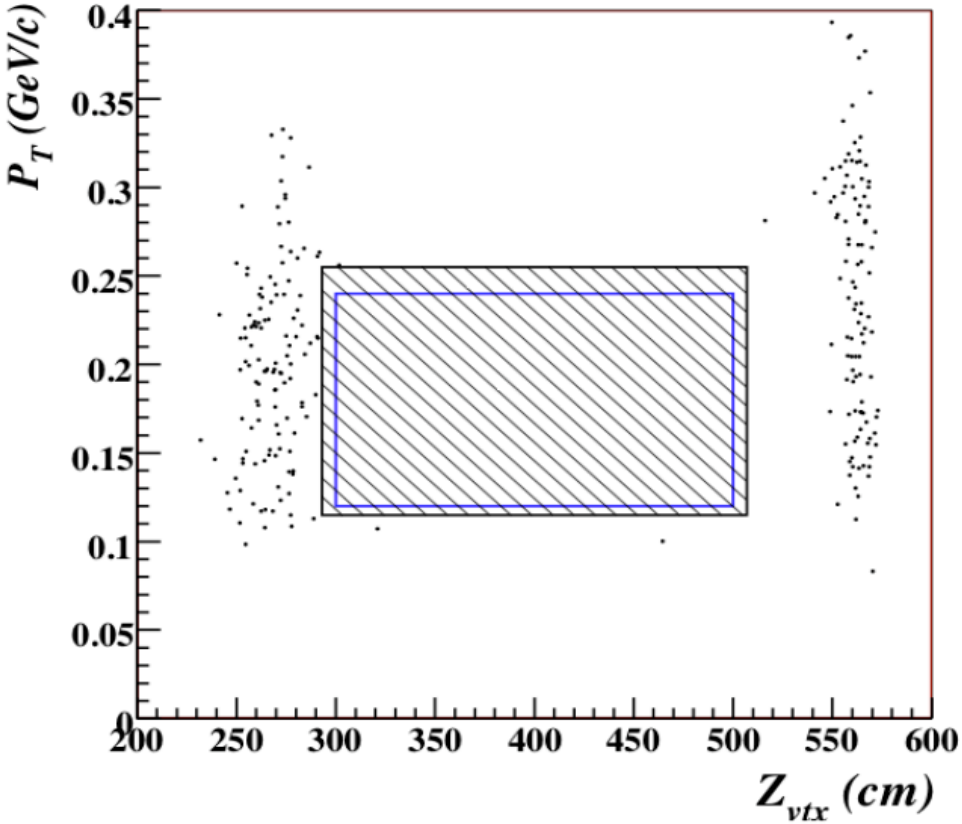
Run-I & Run-II Data

Run-I 1-week



Published in PRD.
Membrane problem.
S.E.S = 9.1X10^{-8}

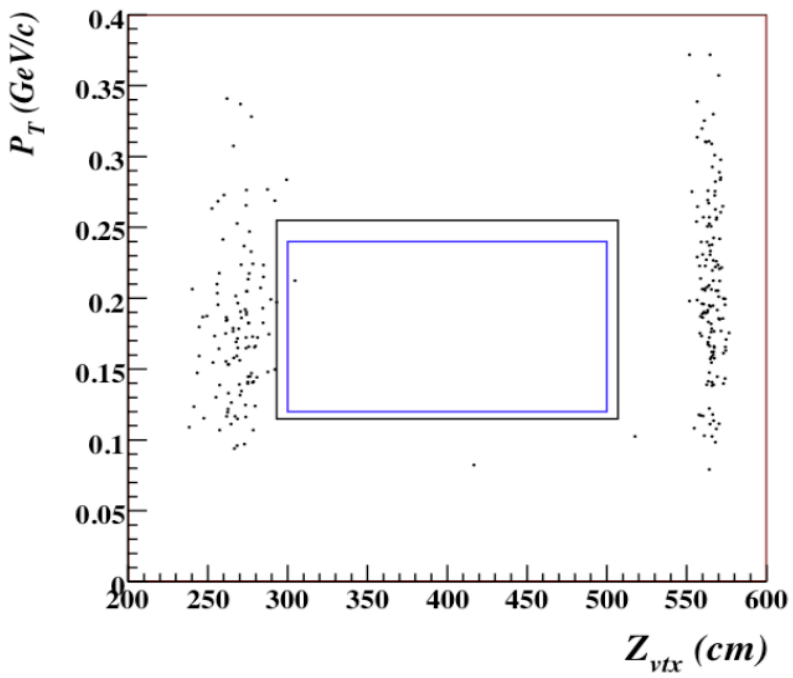
Run-II 1/3

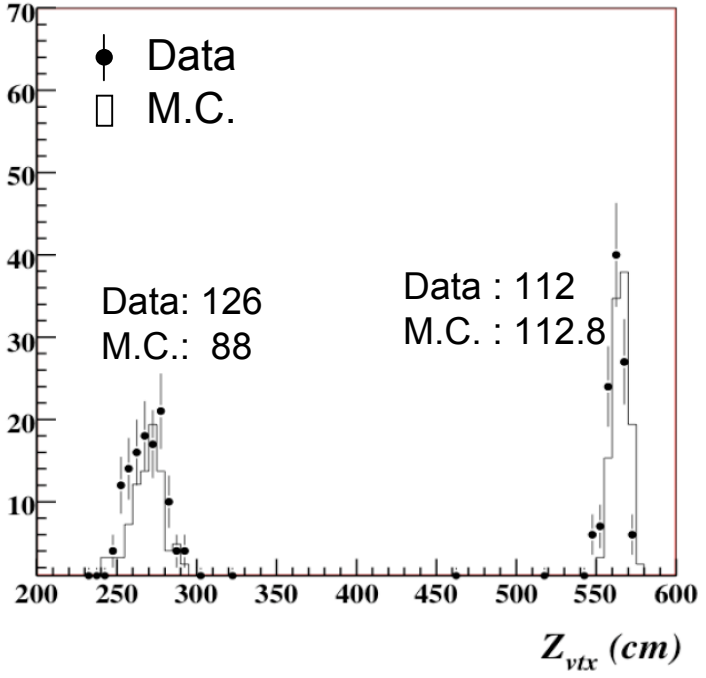


Cleaner sample.
Under study.
S.E.S.=1X10^{-8} (full sample)

M.C. reproduces halo neutron B.G.

M.C. corresponds to 1.2 times the one-third data sample.

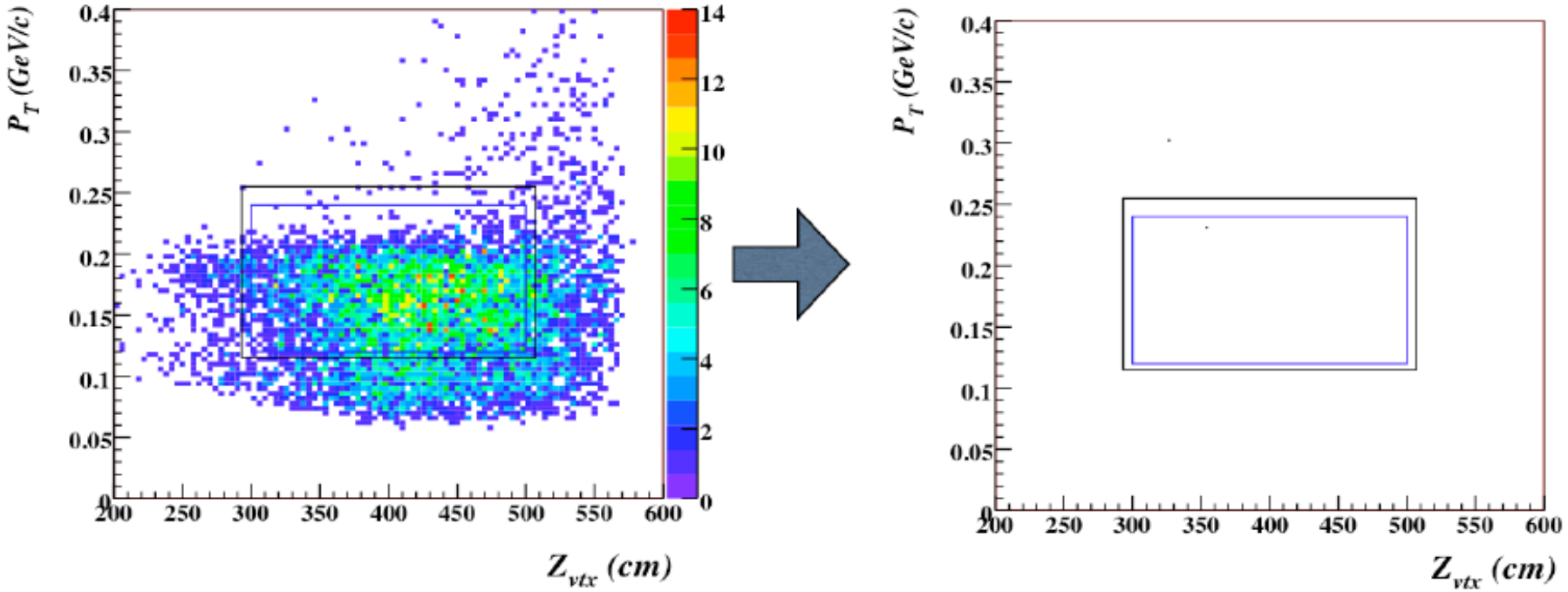




$K_L \rightarrow \pi^0\pi^0$ Background (M.C.)

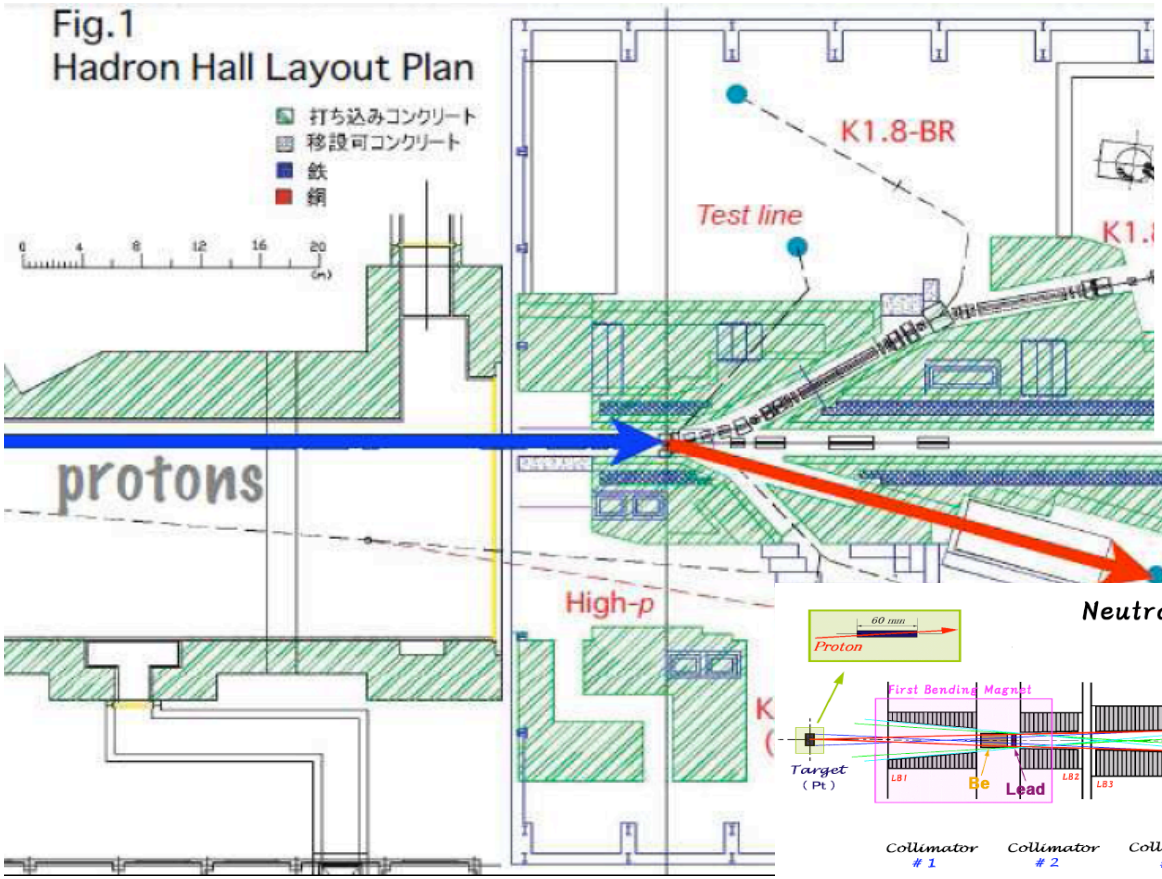
M.C. corresponds to 36 times the one-third data sample.

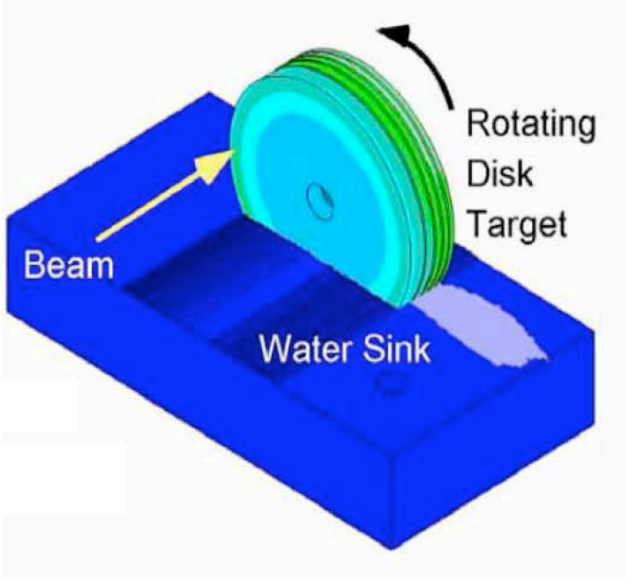
0.03 background events.

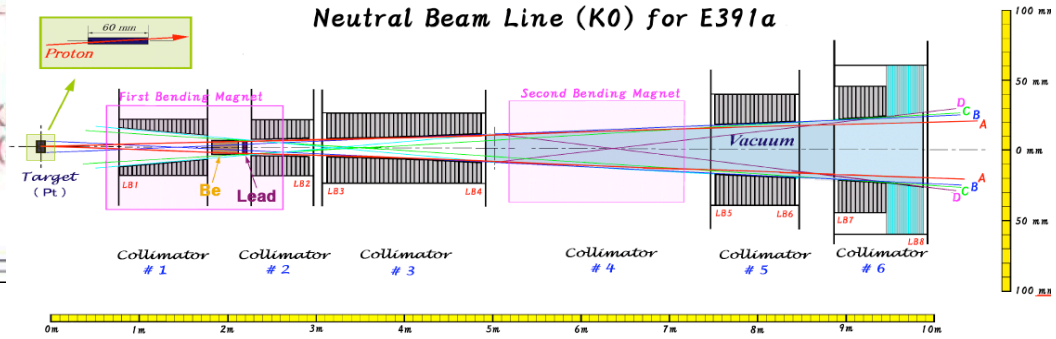



Progress on E14 preparation

Beam Line at step-1



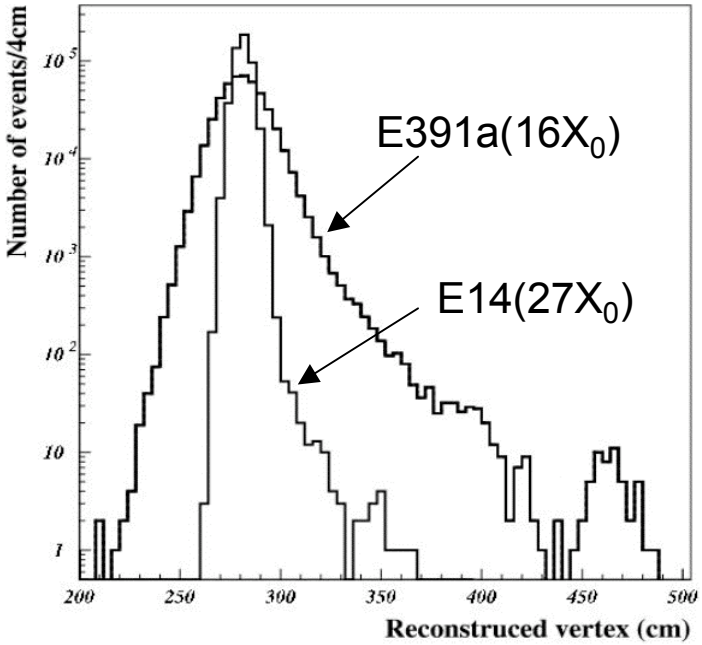




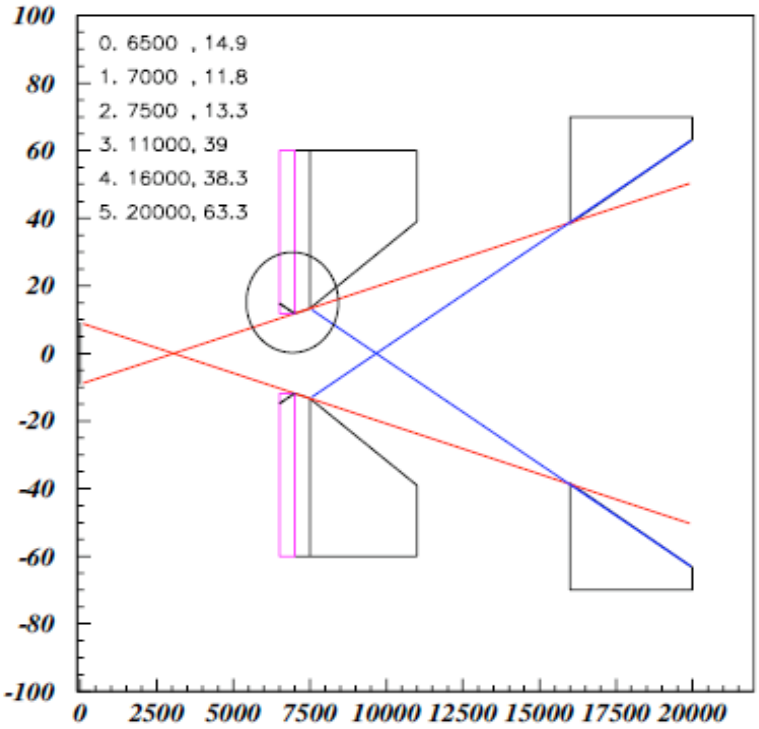
Requirement of beam line

- To reduce CC02 events
- At E391a (Run-II)
  - $N_{nhalo\_cc02}/N_{coren} = 5.5X10^{-4}$
  - ~100 events w/o vertex cuts.
- At the step-1
  - Vertex cut : $3.7X10^{-5}$
    ($4X10^{-2}$ @ Run-I 1-week)
  - Softer momentum:0.13
  - N_{coren} (E_n>1.GeV) = $6.2X10^{14}$
  - For N_{BG}=0.1
    - $N_{halo\_cco2}/N_{coren} = 3.4X10^{-4}$

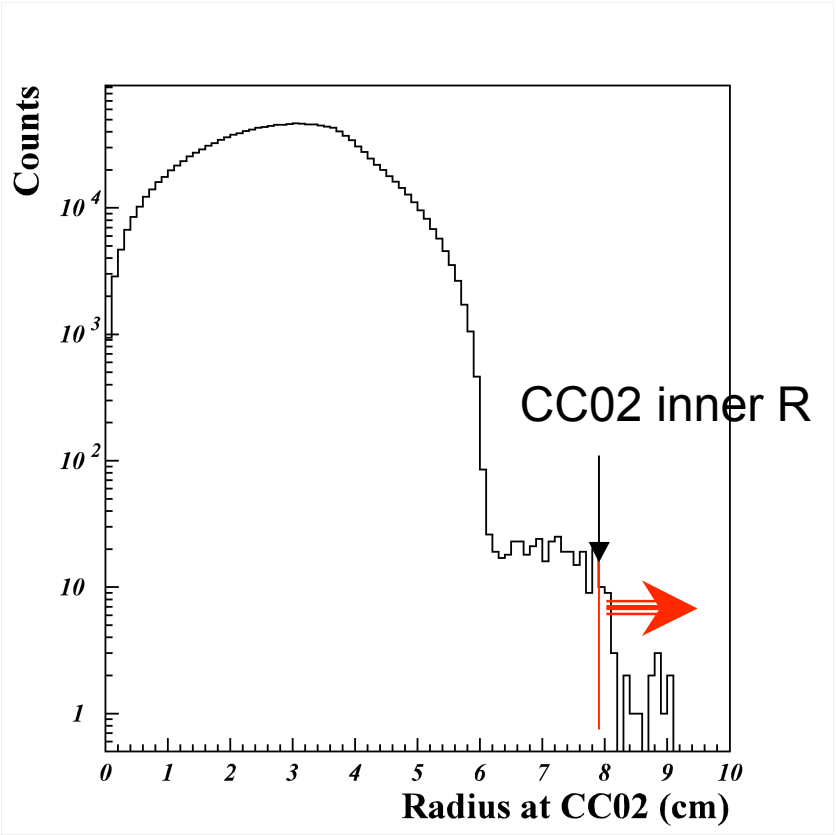
Reconstructed vertex of π^0 produced at fixed target (M.C.)



Collimator design #32



Geant4 Simulation with QGSP



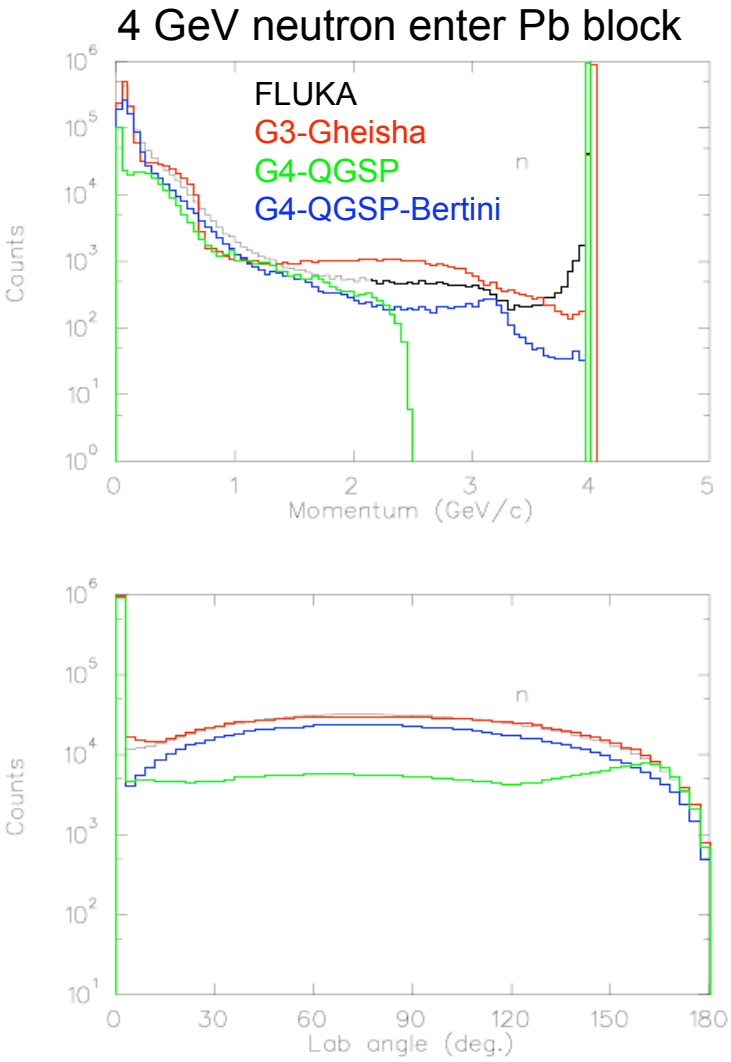
37 halon / 1.47X10^6 core n

→ 2.5 X10^{-5}/core n (En>1GeV)

Under studying

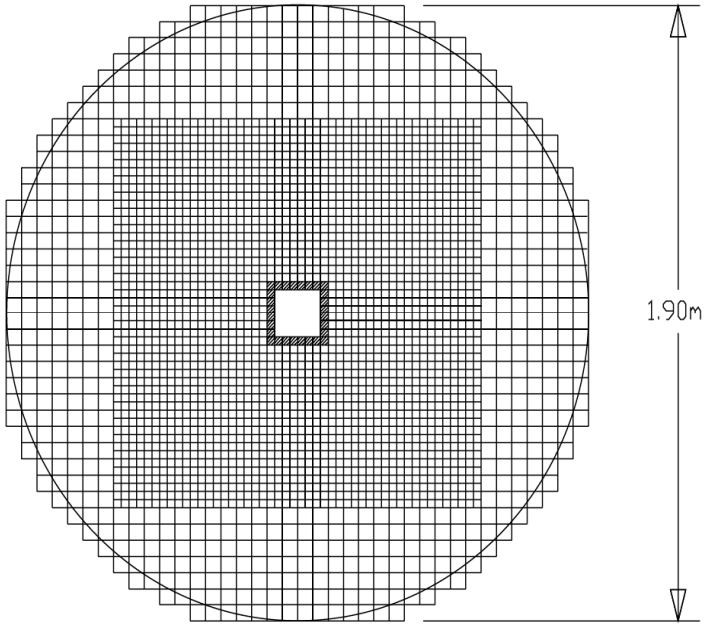
- Optimization of collimation, dete
  - Yamagata Univ., KEK, Kyoto Univ
- Comparison between hadronic
  - Arizona Univ.
- Large statistics of target simulat
  - NDA, Arizona Univ., Kyoto Univ.
- Momentum spectrum of halo ne
  - Yamagata Univ., KEK

- Aim at finishing by fall, 2007



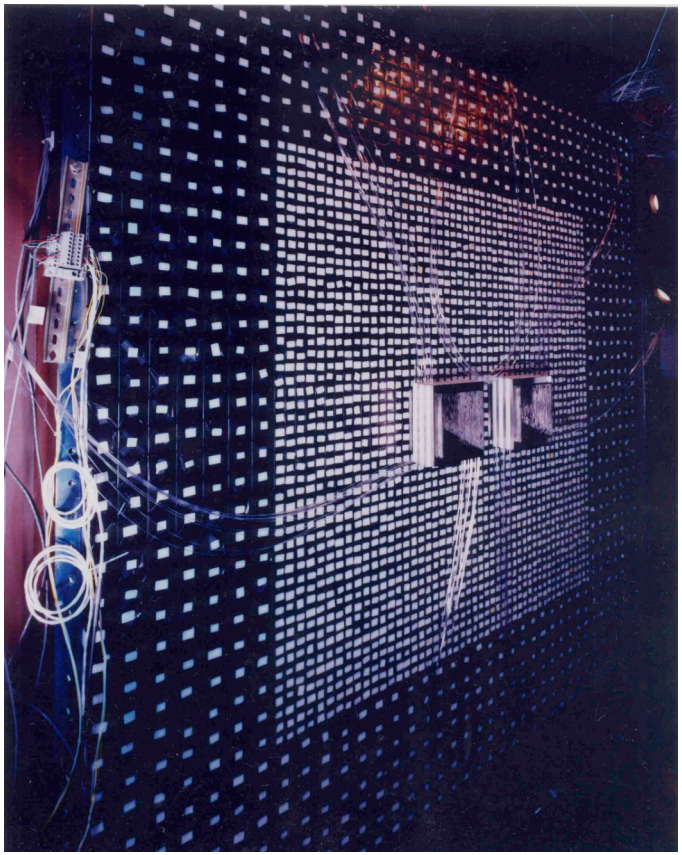
New Calorimeter

- Use KTeV CsI
  - Finer segmentation and longer
    - 7cmX7cmX30cm →
      2.5cmX2.5cmX50cm
      5cm X 5cm X 50cm
    - 576 ch. → 2816 ch.
- Equip 125 MHz-14 bit FADC
  - Wave form digitization
  - Dynamic range : 1 MeV ~ 2 GeV

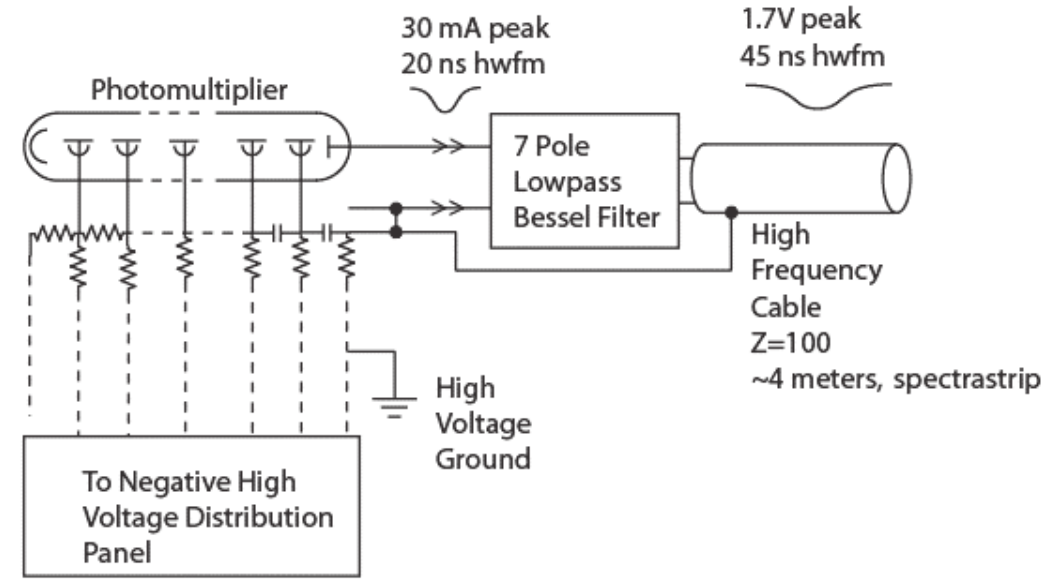


KTeV CsI Loan

- Fermilab Director visited KEK and had a tour of E391a experiment on Nov 21st.
- We were being told on Dec 1st by Dr. Oddone that “There is no reason why we can't have the KTeV CsI for E14" and he urged us to work with KEK/Fermilab to initiate the proper transfer.

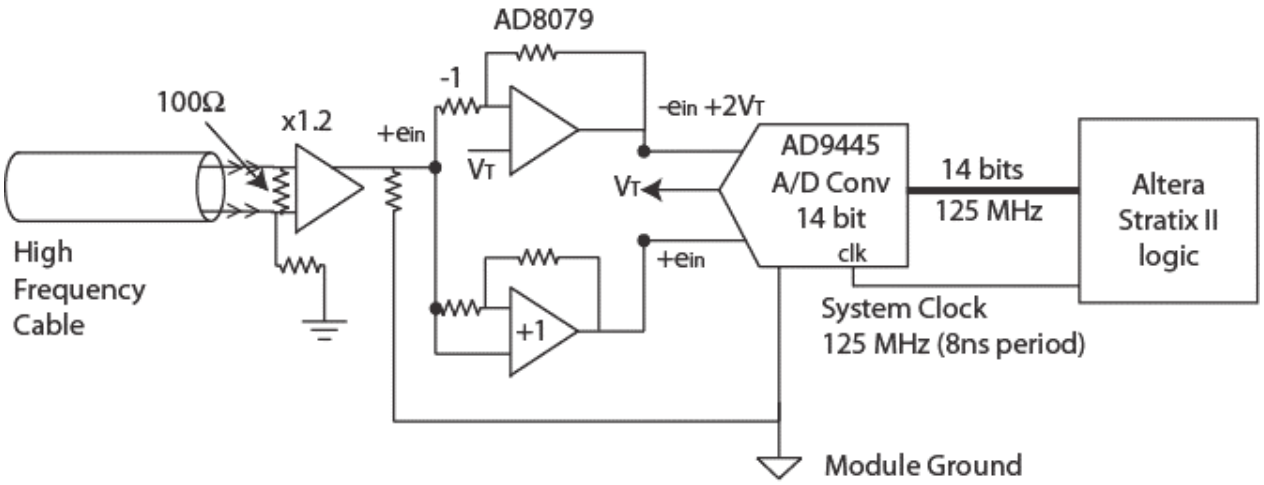


Calorimeter Read-out



125 MHz sampling with Bessel Filter

- cost effective, low noise
- Well defined Gaussian pulse
  - Good timing resolution
  - Two pulse separation



Gaussian shaper (M.C.)

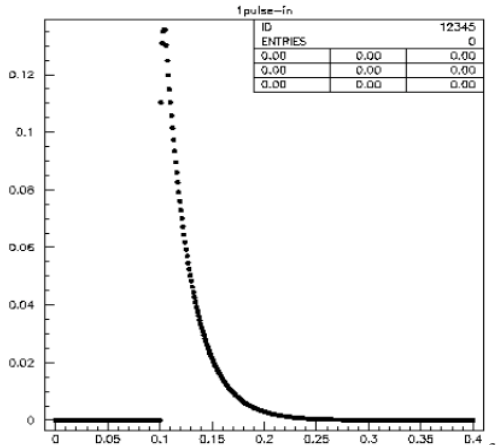
Timing resolution : 1.2 ns

Two pulse separation :
20 – 40 ns

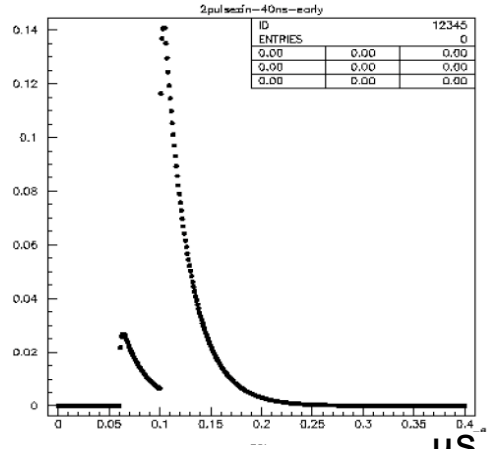
We are checking whether this performance matches experimental requirement.

We started to fabrication of prototype modules and plan a beam test within this year.

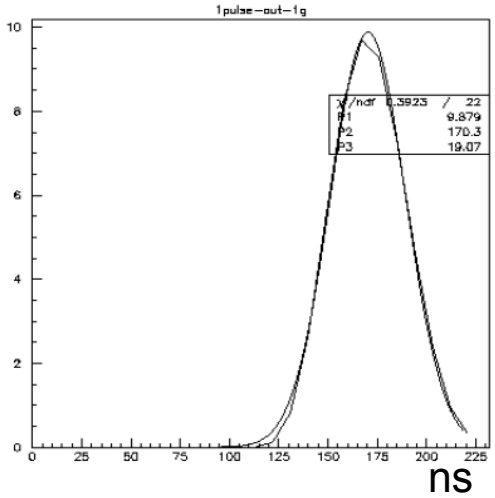
Input

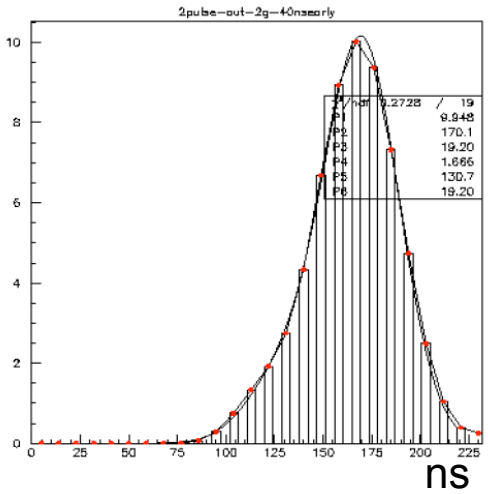


Two pulses input

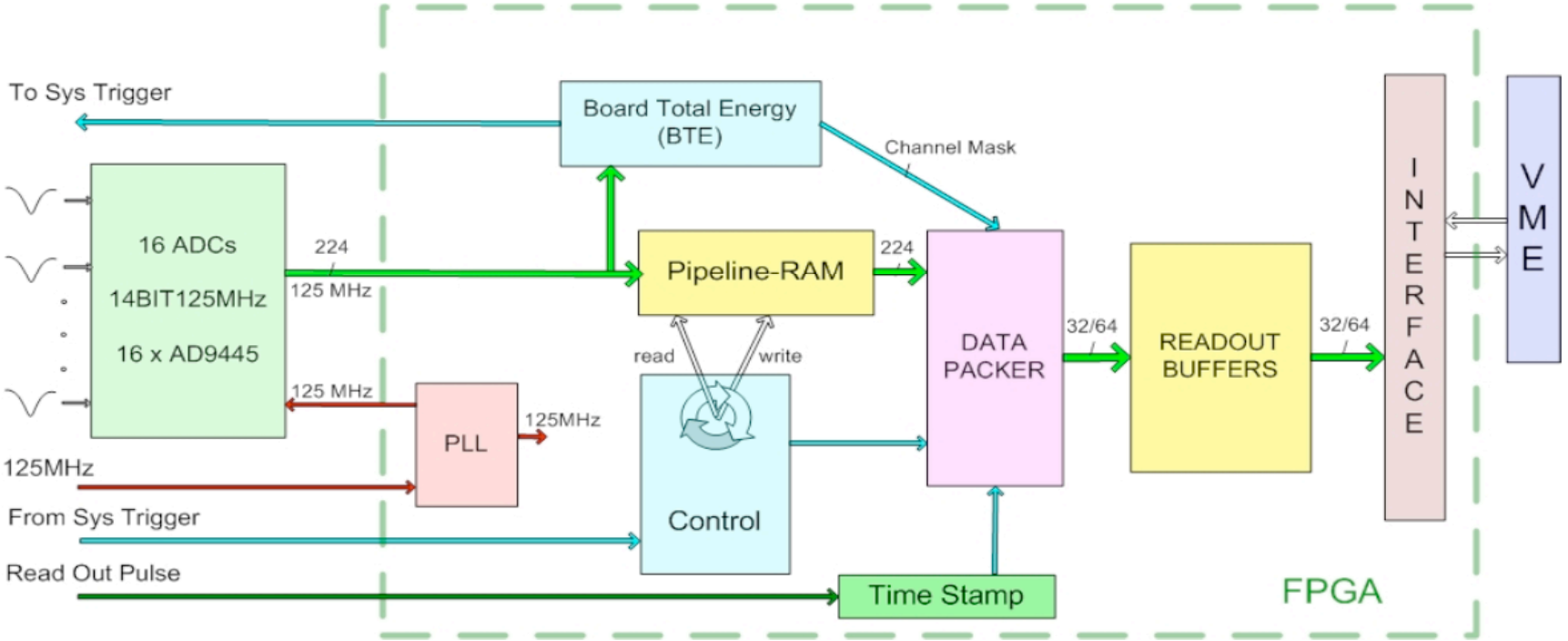


Output





14-Bit, 125MHz ADC Board – Block Diagram



Each ADC channel - one AD9445 chip: 14 bits/125MHz;
One STRATIX II FPGA can service 16 ADC channels:

- **Logic design and memory - similar to 500MHz FADC without SERDES;**
- **Trigger rate: 10kHz, 32 samples/trigger (256ns);**
- **Input Pipeline: 25 -100us max depth (3,200 – 12,800 samples);**
- **Two VME readout buffers - max 128 triggers, (10 ms);**
- **Read Out Pulse in sync with VME, generate trigger time stamp;**
- **FPGA device migration possible to increase/decrease max pipeline size;**

New PMT for KTeV CsI ?

- Current KTeV PMT : 6k gain
  - Excellent linearity but low gain.
- In order to achieve 8 ch/1 MeV
  - We need one order higher gain.
    - 60k gain PMT.
      - Contacted Hamamatsu.
    - X10 amplifier ?
      - Expected S/N would be 5 at the best.
  - We are going to study both options.

Schedule

* 2006
  * Design collimators ⟹ Fall, 2007
  * Prepare transferring KTeV CsI ⟹ Green Light !
  * Start designing new readout ⟹ Design is under way. Prototype and test will be done in 2007.
* 2007
  * Move KTeV CsI, upgrade detector
* 2008
  * Build K0 beamline => First beam survey
  * Assemble detecto

Low intensity beam is good enough.
New environment – need time for feed-back.

* 2009
  * More beam survey and detector tuning
* 2010: PHYSICS DATA

Summary

- E391a results show no big problem.
  - Halo neutrons are main source of background.
  - We are working on
    - Finer tuning of M.C..
    - B.G. estimation method.
- Preparation of E14
  - Beam line design is under going.
    - Aim at beam survey in 2008.
  - Green light for KTeV CsI.
  - Design of read-out scheme is under way.