

# Dual-readout beam test plans

John Hauptman, ALCPG Fermilab, 22-26 October 2007

- Fiber DREAM:** many measurements (9 NIM papers)
- PbWO<sub>4</sub>:** a single crystal and an array of 19 crystals  
(borrowed from ALICE)
- BGO:** a single crystal (borrowed from L3)
- Fiber DREAM:** reconfigured to measure neutrons in  
space and time
- PbWO<sub>4</sub>+Fiber DREAM:** first attempt at a dual-  
readout calorimeter 'system'
- BGO array:** test a 'crystal dual-readout calorimeter'  
with as large an array as possible (money and time)
- BGO+Fiber DREAM:** do everything, including  
neutrons by time in conjunction with EM BGO.

We are going after everything in dual-readout: fibers, crystals, EM,  
hadronic, new particle ID methods, ...

Next beam test: most likely Summer 2008

- CERN H4 beam line
  - pions 20-300 GeV; muons 40-200 GeV
  - electrons 20-200 GeV
  - last run (June-July 2007) was exceptionally efficient
  - x-y table to mm precision

The essential limiting factor in all critical tests is the small size of the original, 5-year-old, inexpensive, proof-of-principle DREAM module. Should we ever see funding to build its successor, then ...

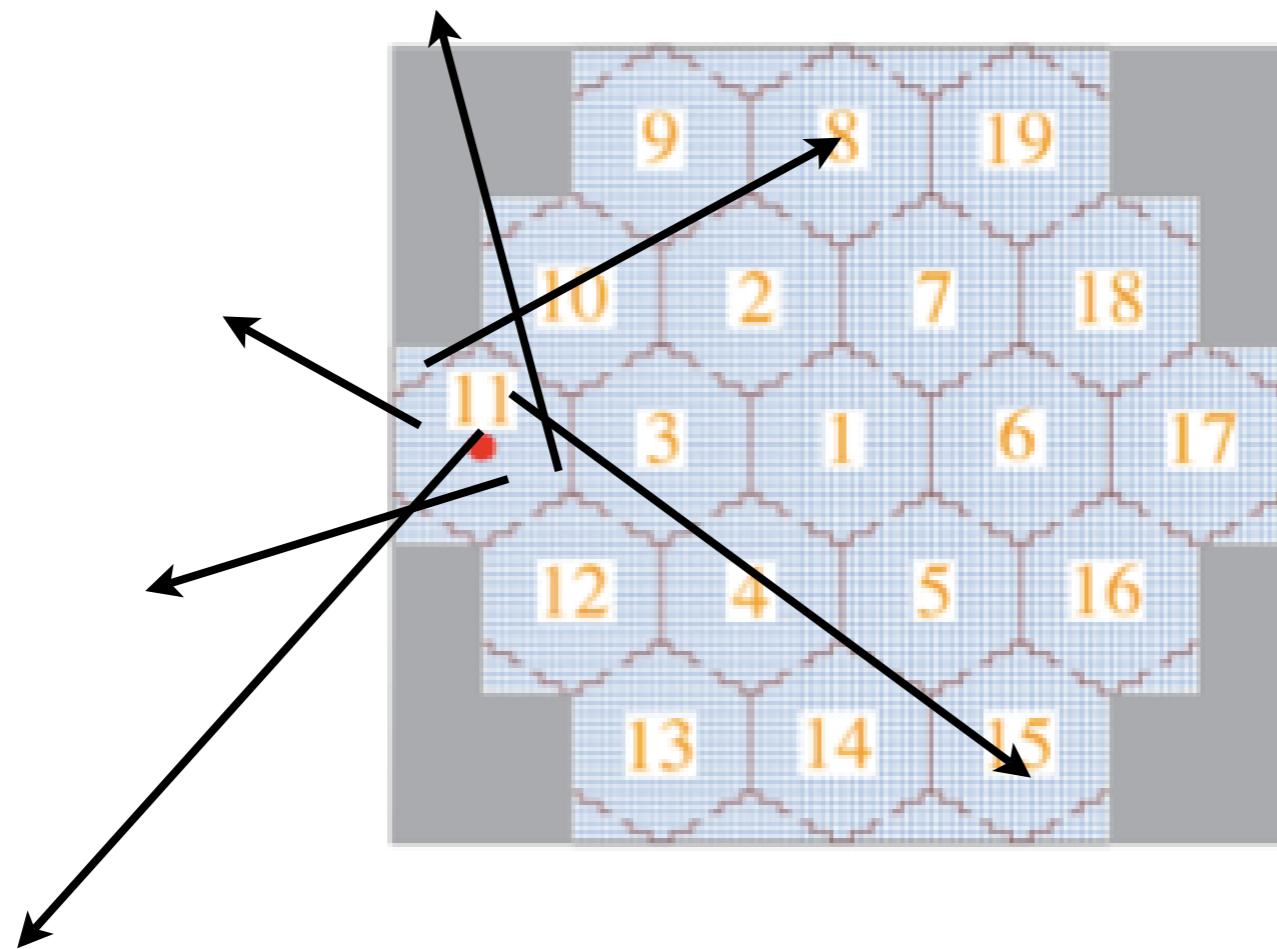
- Build modules at Fermilab
  - shops, space and support;
  - fully scalable truncated pyramid modules, both crystal and fiber
- Beam test at Fermilab
  - up to 100 GeV is good enough
  - crystal+fiber slice test

Back-up slides:

neutron and BGO measurements

neutron differential measurement:

Fire pion beam into tower 11, read out channels 10-3-12,  
2-1-4, 5-6-7 and 16-17-18 into GHz digital storage scope.



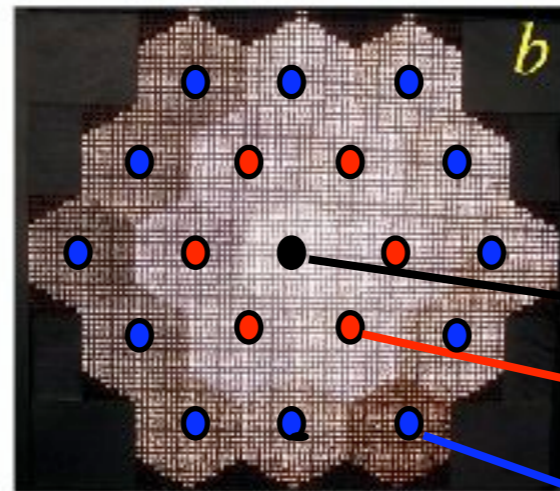
Most MeV neutrons escape the DREAM mass; mean free path  
~ 30 cm ~ size of DREAM at 8 MeV

neutron integral measurement: sum all Scintillation and Cerenkov channels, and read out in time

DAQ was 1 GHz 4-chan digital storage scope

transfer to counting house in fast air-core cables

Neutrons:  
-hadronic particle ID  
-energy resolution  
(50-300 GeV pions)



*Scintillating fibers*

“Fast 1”

“Fast 2”

“Fast 3”

*Cerenkov fibers*

1● + 6● + 9● → “Fast 4”

*Complete volume interrogation of DREAM: see delayed neutrons event-by-event. Analysis of data in progress.*

Fast 1

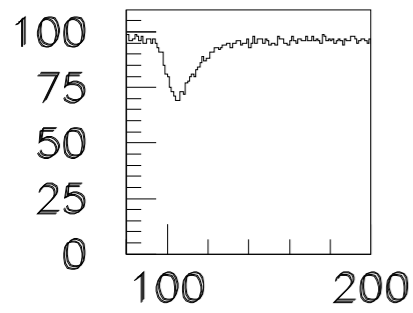
Fast-2

Fast-3

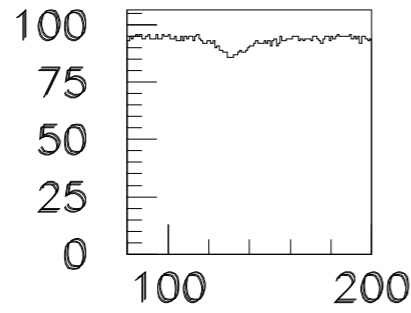
Fast-4

First 4 raw  
data events

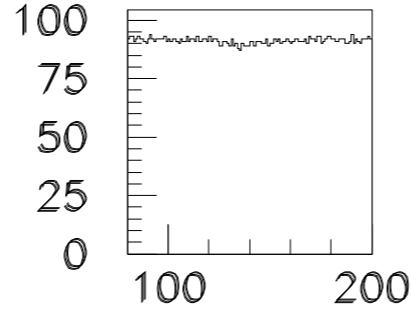
Run 1919 50 GeV e-



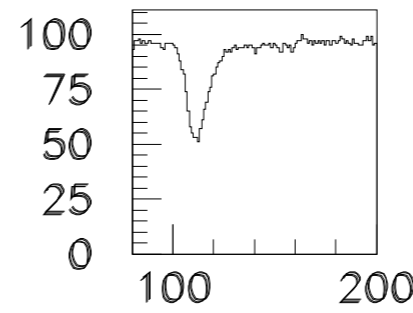
e- S0(t)



e- S1(t)

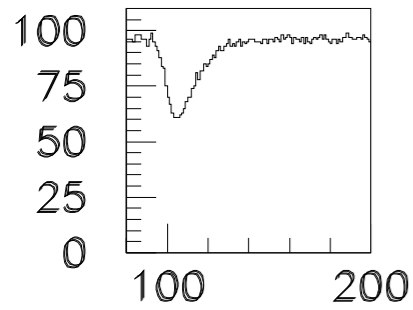


e- S2(t)

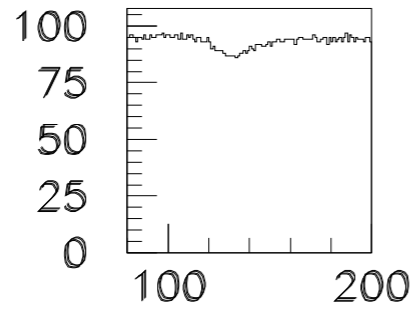


e- Ch(t)

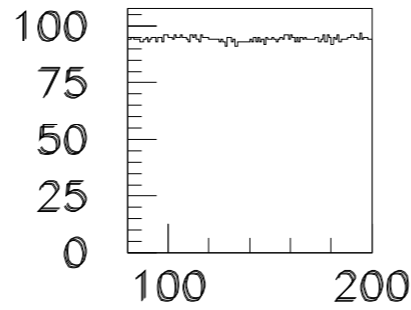
1



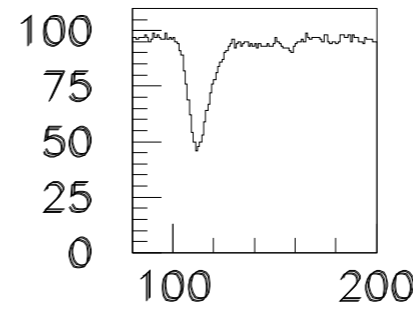
e- S0(t)



e- S1(t)

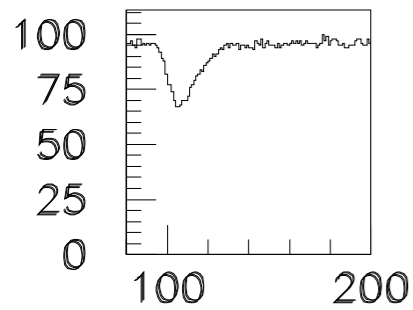


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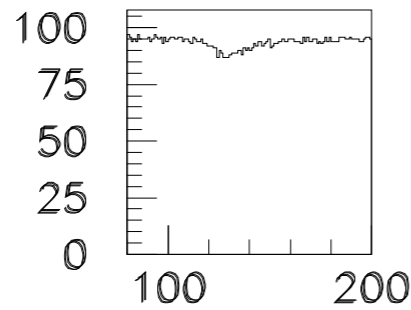


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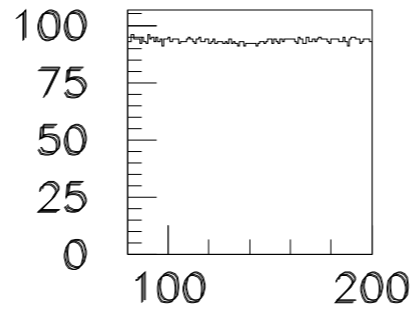
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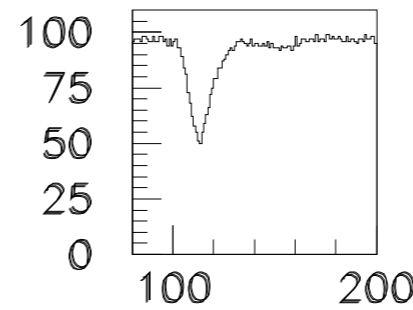
e- S0(t)



e- S1(t)

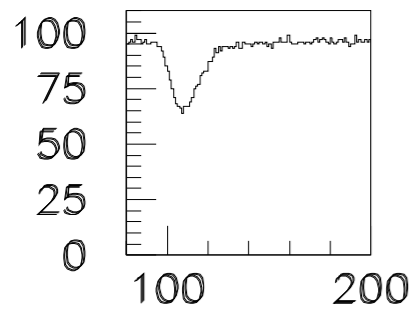


e- S2(t)

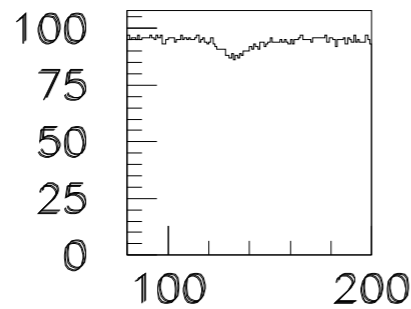


e- Ch(t)

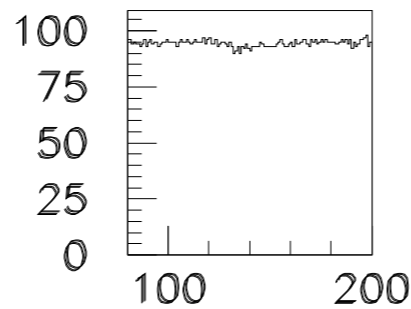
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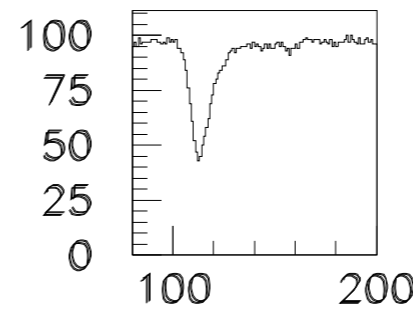
e- S0(t)



e- S1(t)



e- S2(t)



e- Ch(t)

4

clearly  
electrons

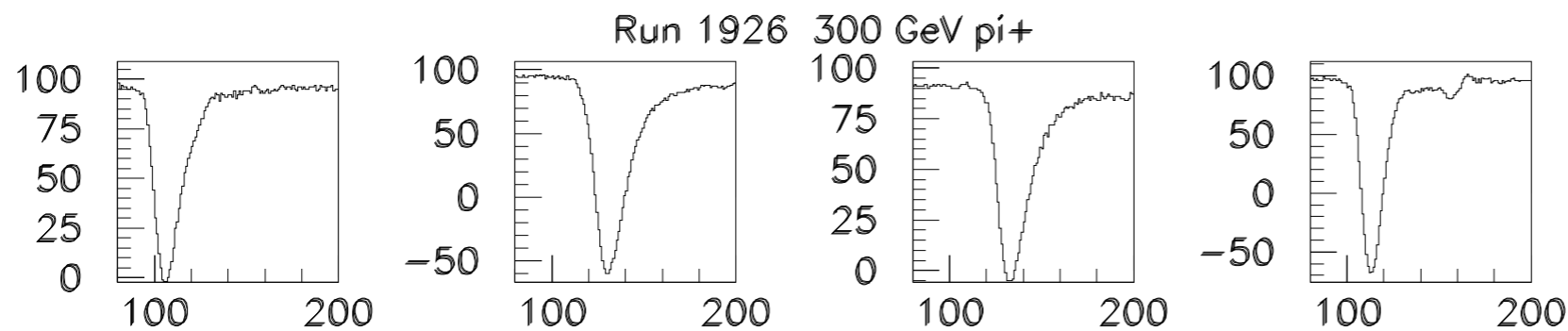
Fast 1

Fast-2

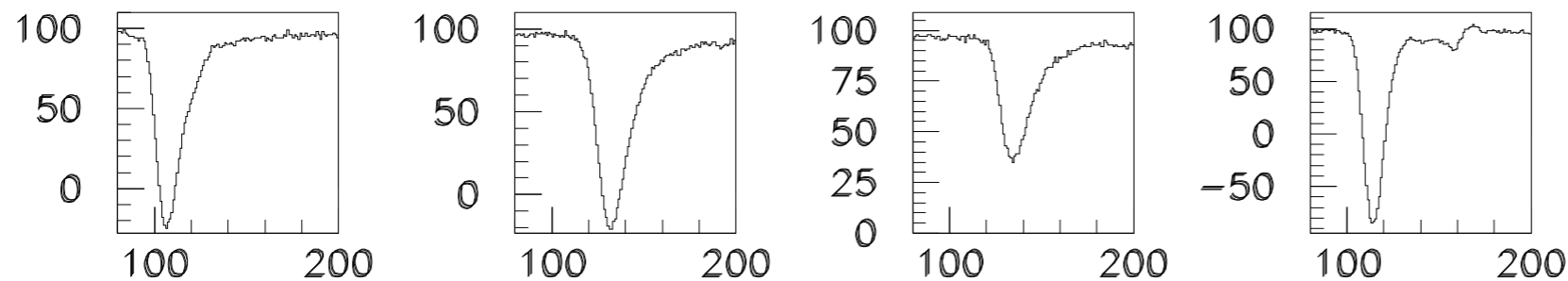
Fast-3

Fast-4

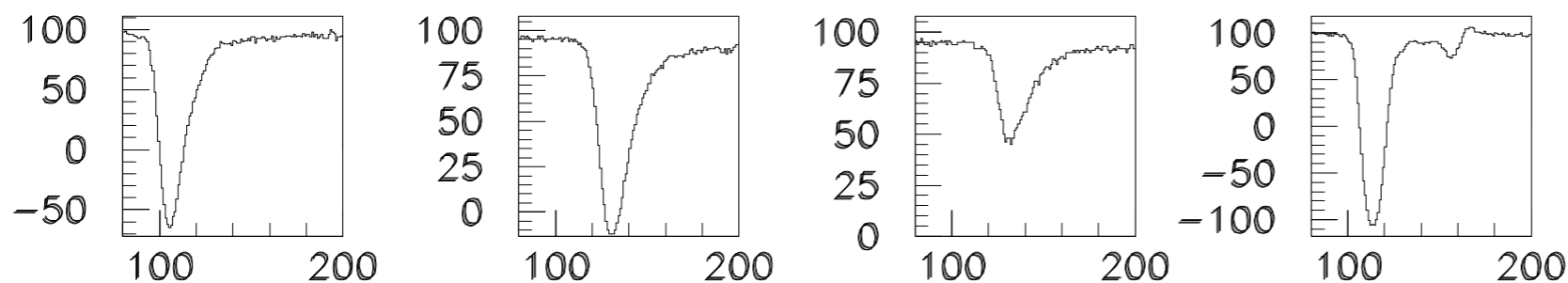
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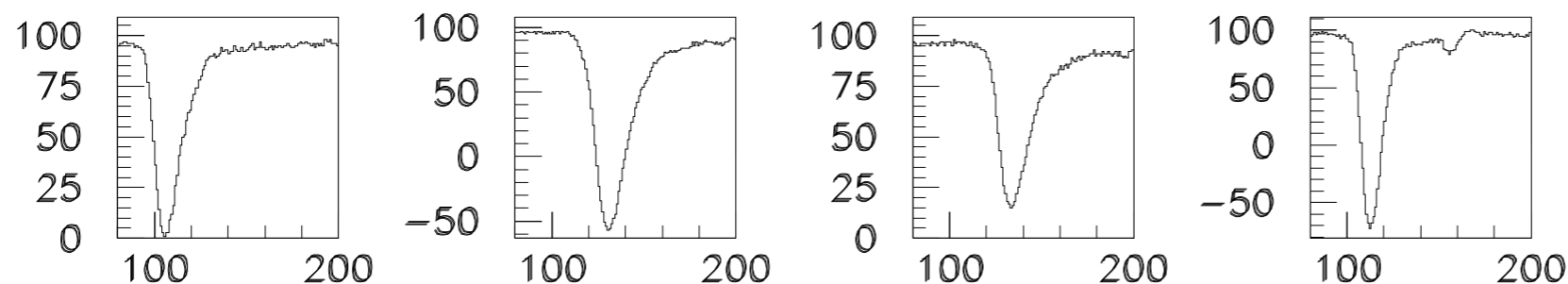
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2



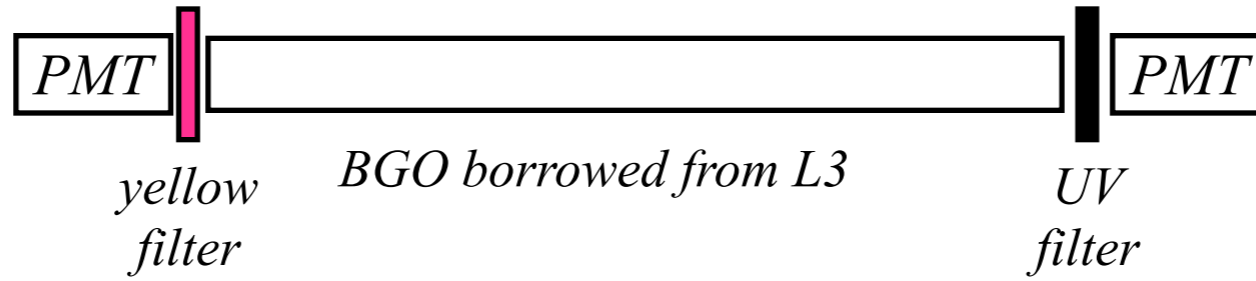
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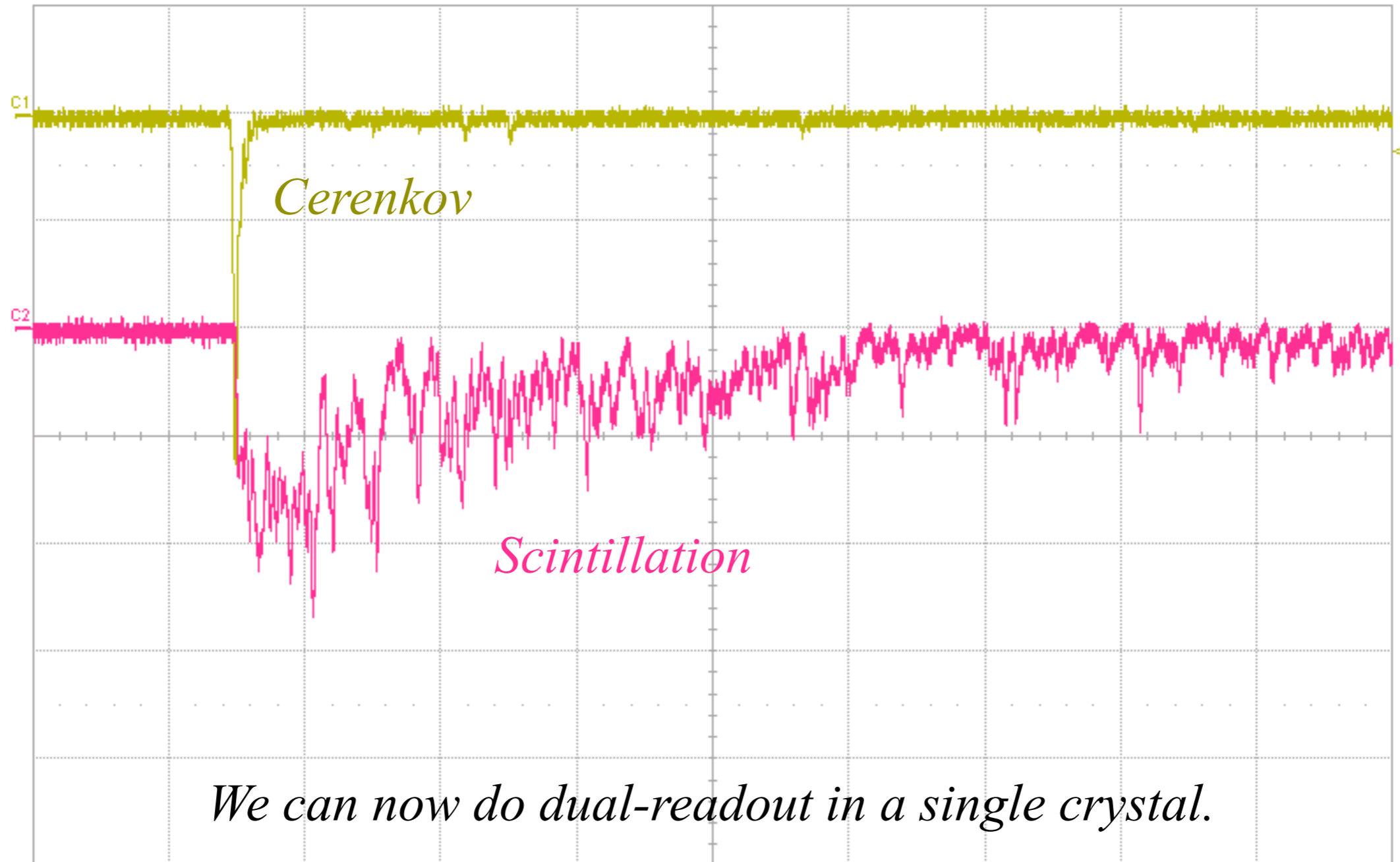
4

clearly  
pions

*“Scintillation”*



*“Cerenkov”*



*We can now do dual-readout in a single crystal.*

C1	DC50	C2	DC50
50.0 mV/div		50.0 mV/div	
148.0 mV ofst		49.0 mV ofst	

Timebase	-350 ns	Trigger
	100 ns/div	Stop
10.0 kS	10 GS/s	Logic

Data from A. Cardini