



DCH Summary

Caltech
16 Dec 2010

Giuseppe FINOCCHIARO (LNF)

Michael RONEY (Victoria)

Presentations this week...

- Update on DCH background study with Bruno Riccardo CENCI (Maryland)
- Update on FullSim Studies
Dana LINDEMANN (McGill)
- Wide-angle Bhabha Backgrounds with FastSim
Darren SWERSKY (McGill)
- Update on LNF lab activities
Giuseppe FINOCCHIARO (LNF)
- Update on lab activities in Canada
Christopher HEARTY (UBC/IPP)
- DCH front-end status
Giulietto FELICI (LNF)

Outline

- Background simulation progress
- Cluster-counting R&D status
- Full-length prototype progress
- Electronics progress
- Aging studies status

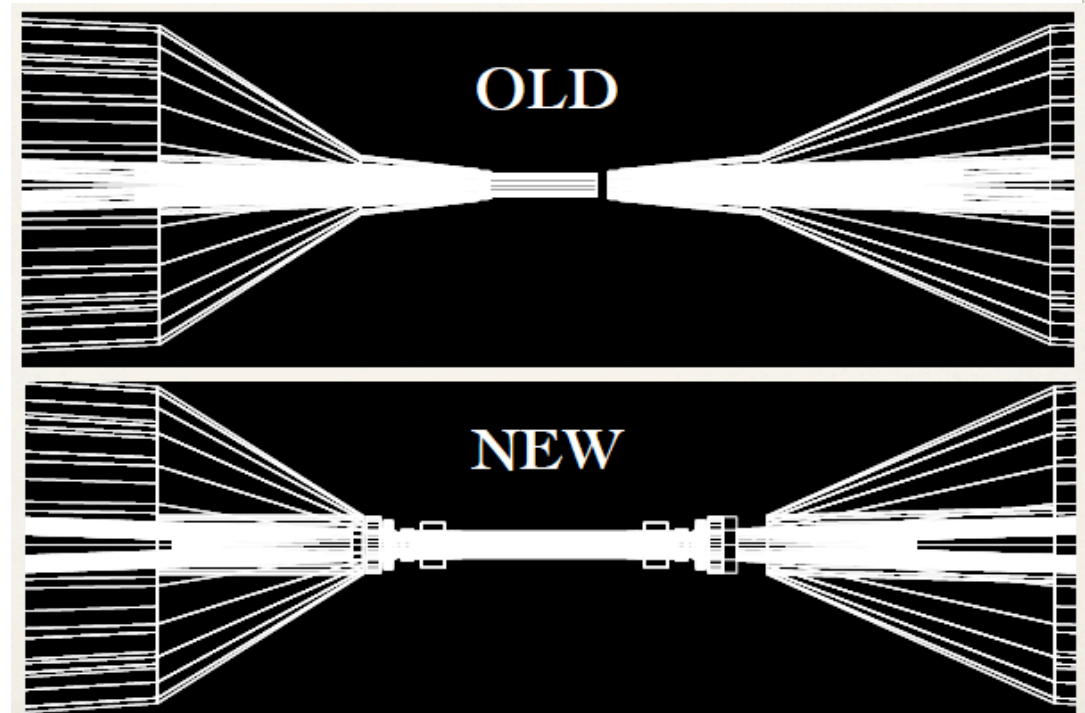
Background studies with Bruno

Riccardo CENCI (Maryland)

- Bruno Production with new IP geometry

Tungsten beaks
removed, real structure
for cooling and
pinwheeled L0, pipes,
flange and bellows

- 2-photon 'pairs' with
lower pT cut: 260us
- Rad.Bhabha: 2.4ms
study in progress

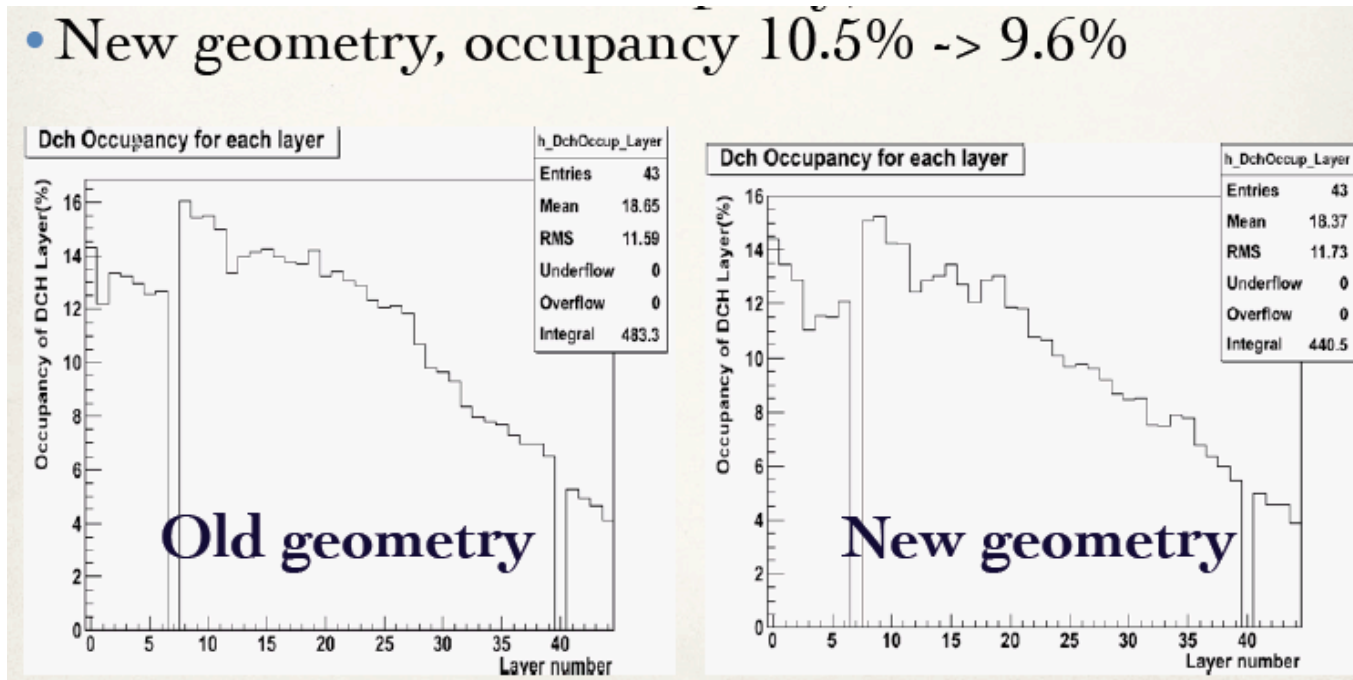


Background studies with Bruno

Riccardo CENCI (Maryland)

- 2-photon 'pairs': lower pT cut increases occupancy estimates from 1.5% -> 10.5% at layer 25

- New geometry, occupancy 10.5% -> 9.6%

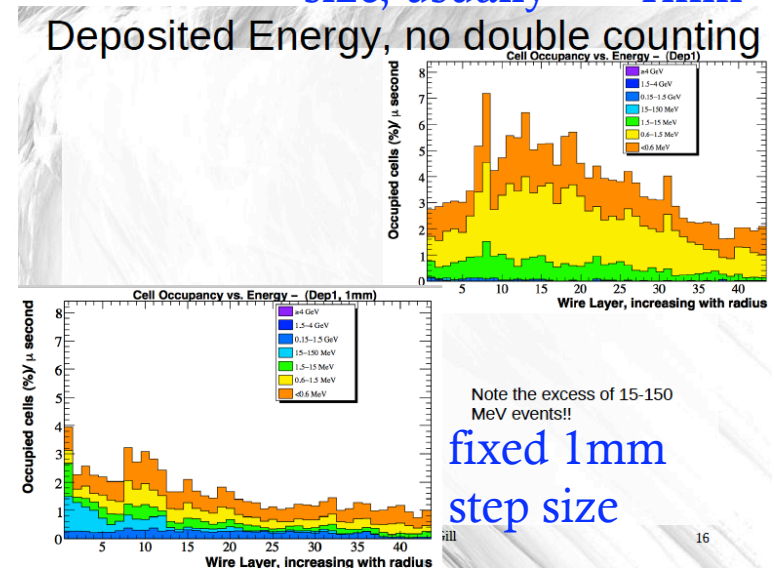


Update on FullSim Studies

Dana Lindeman (McGill)

- How to define "occupancy" in the absence of detector response simulation.
- Study how GEANT handles energy deposition for low energy tracks and variable step size.
- Variable step size could underestimate occupancy, but small step size is costly
- Validated that both have same number of tracks and average dE/dx in GEANT
- But occupancy is dependent on GEANT's step size choice

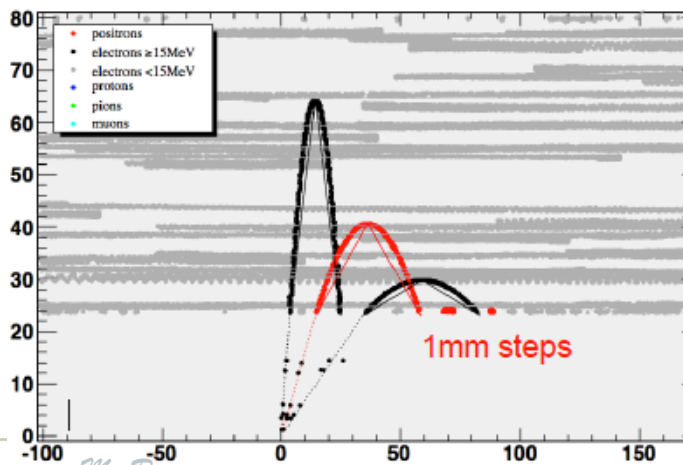
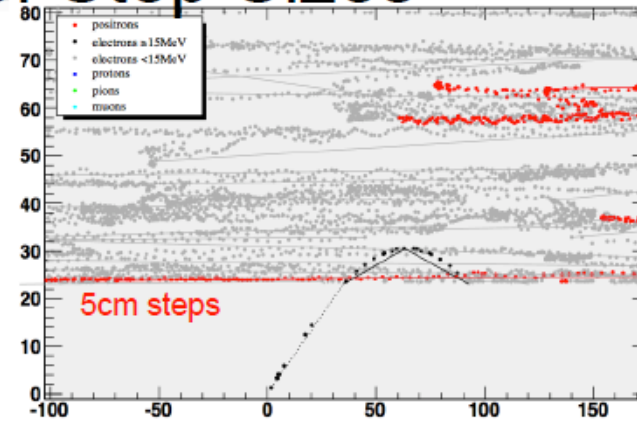
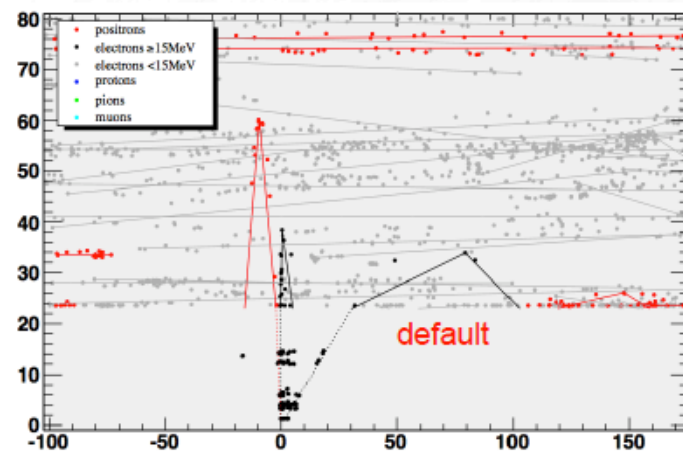
GEANT default step size, usually $\gg 1\text{mm}$



Update on FullSim Studies

Dana Lindeman (McGill)

Visualization of Step Sizes



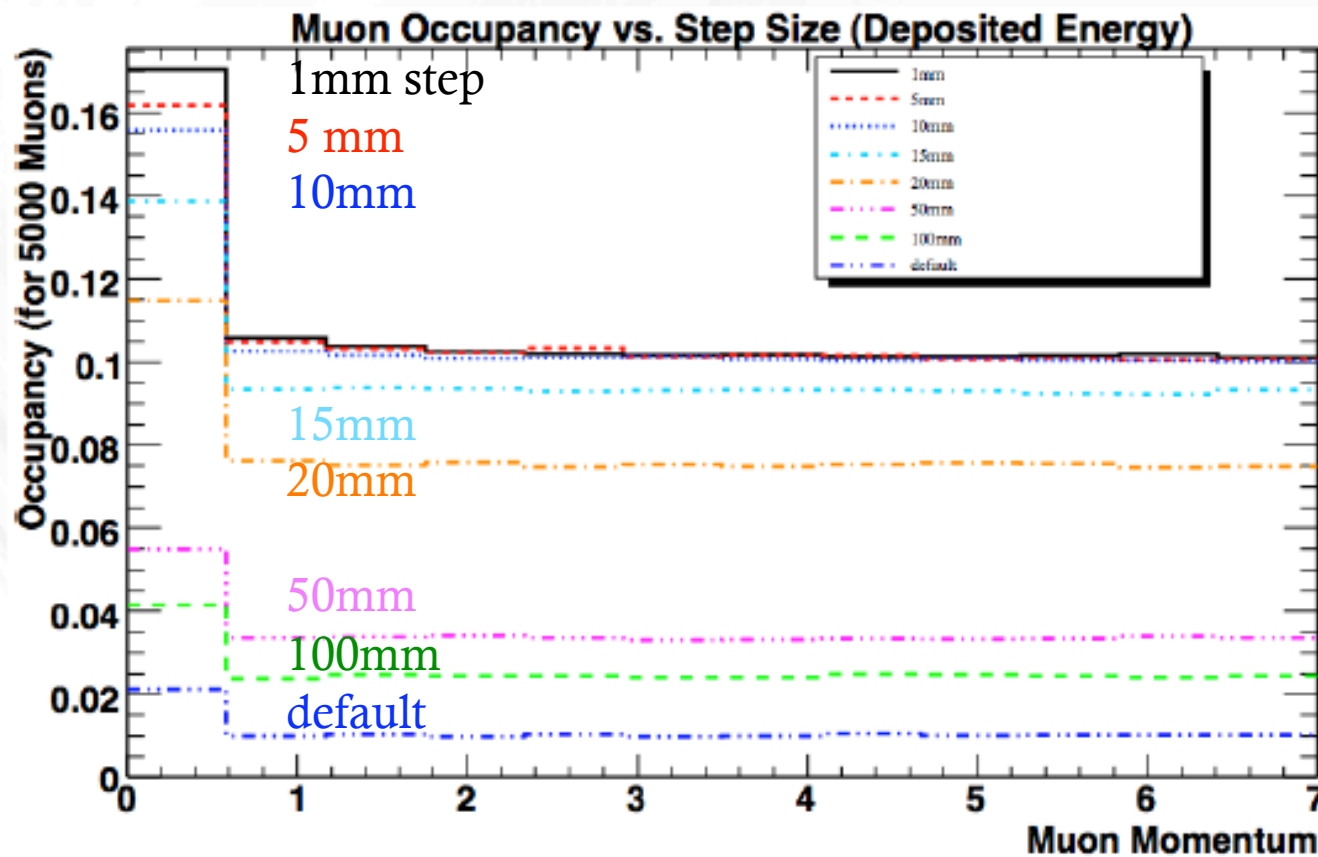
2000 events with tracks
 $1.5\text{MeV} < E < 150\text{MeV}$,
hits with $\text{depE} > 0$ only

1mm step size clearly more reliable

Update on FullSim Studies

Dana Lindeman (McGill)

Muon Gun vs. Step Size – Dep. Occ



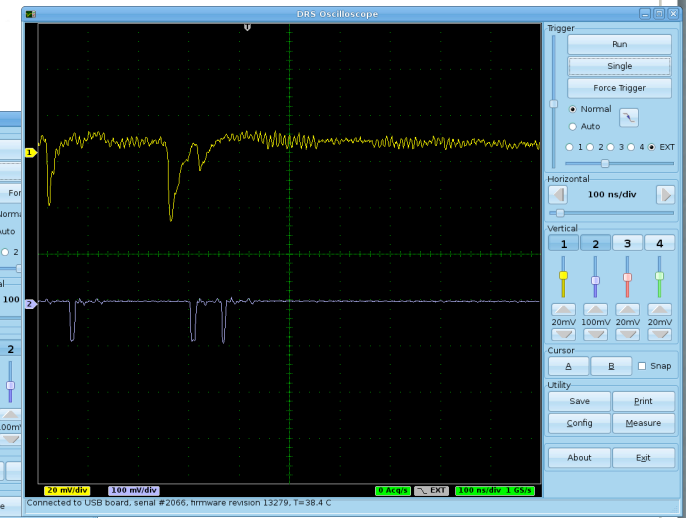
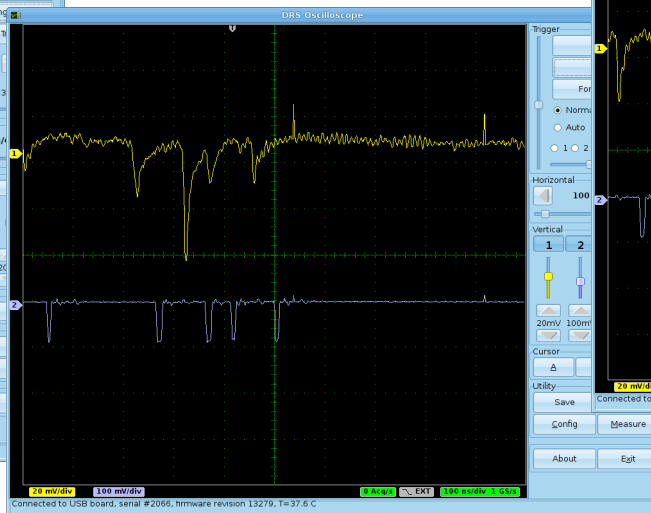
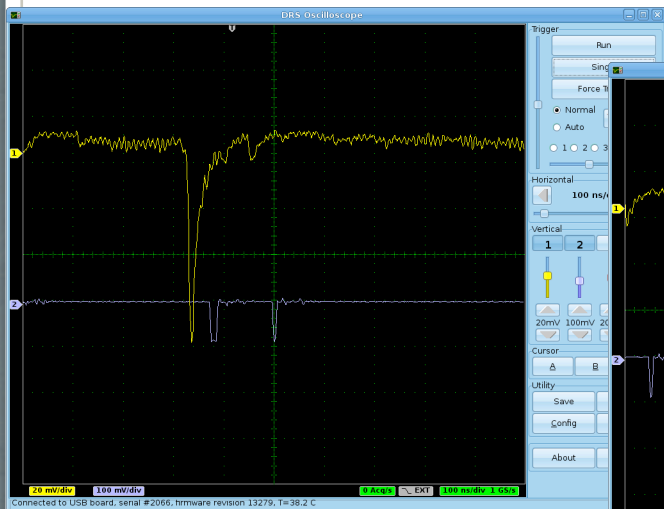
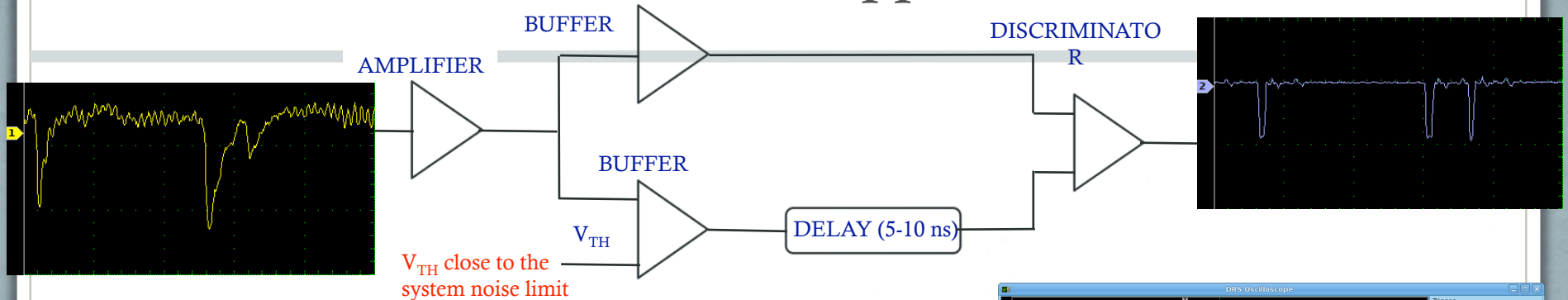
Background Studies

- Understanding backgrounds still the critical path item for finalizing DCH design
- Evident that 1mm step size gives most reliable information about occupancy
- Regardless of higher cost (CPU and disk) – will move forward with 1mm steps to evaluate occupancy
- Documentation of work with FastSim using BHWIDE also available from Darren Swersky (McGill)

Cluster Counting R&D @LNF

Local derivative method

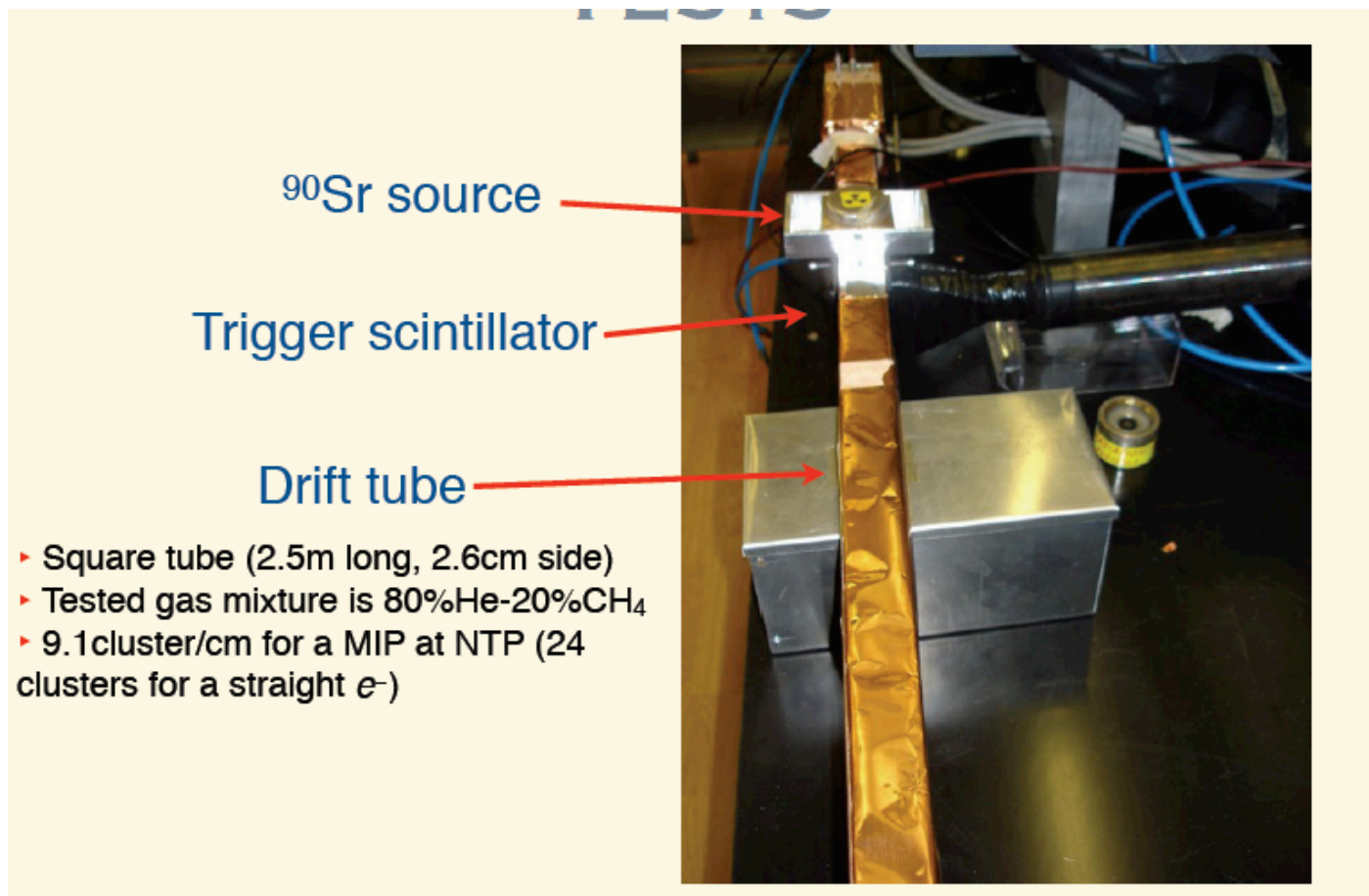
Giuseppe FINOCCHIARO



- First tests on 2.5m long, 24mm side square tube in He-CH₄ mixture
 - threshold and delay still to be optimized

Cluster Counting R&D @ LNF

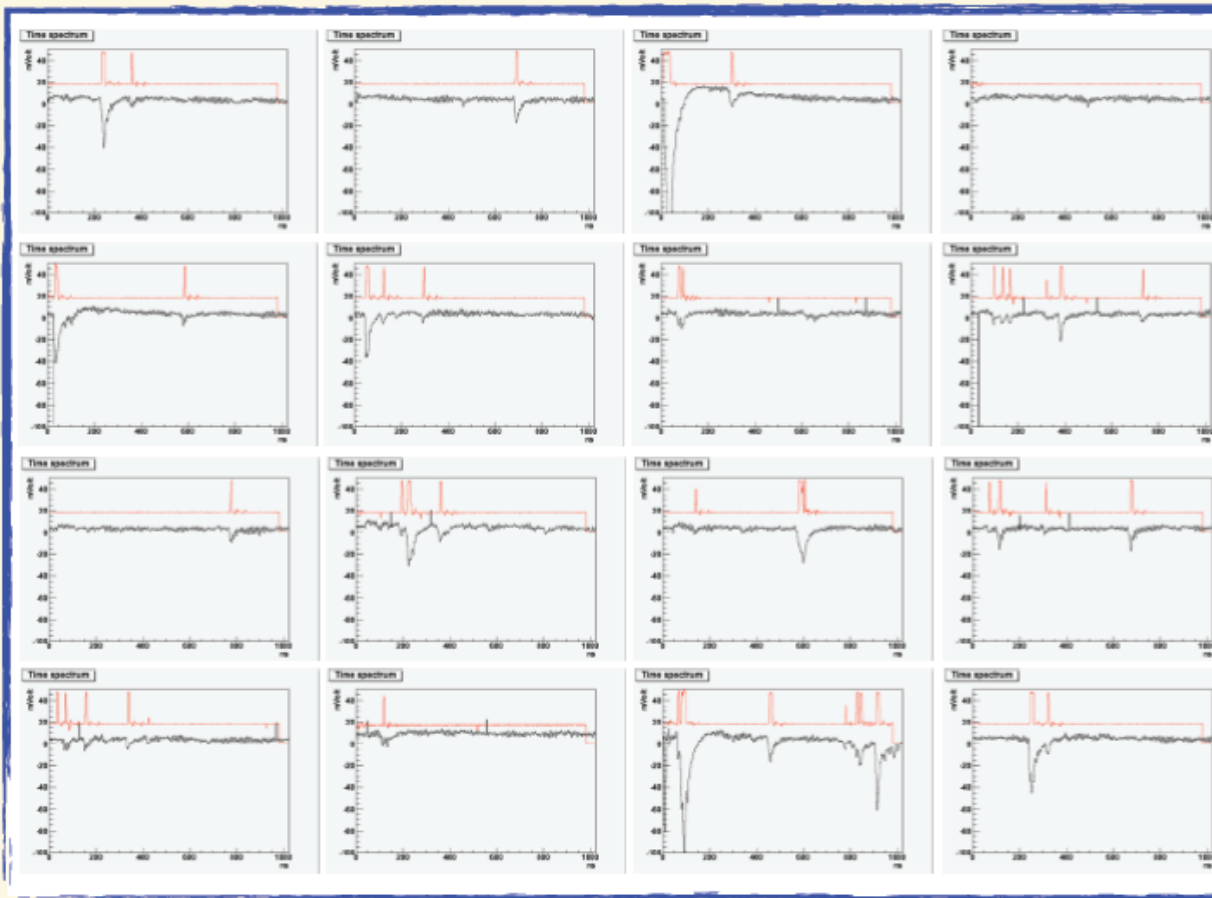
Giuseppe FINOCCHIARO



Cluster Counting R&D @ LNF

Giuseppe FINOCCHIARO

A COLLECTION OF SIGNALS



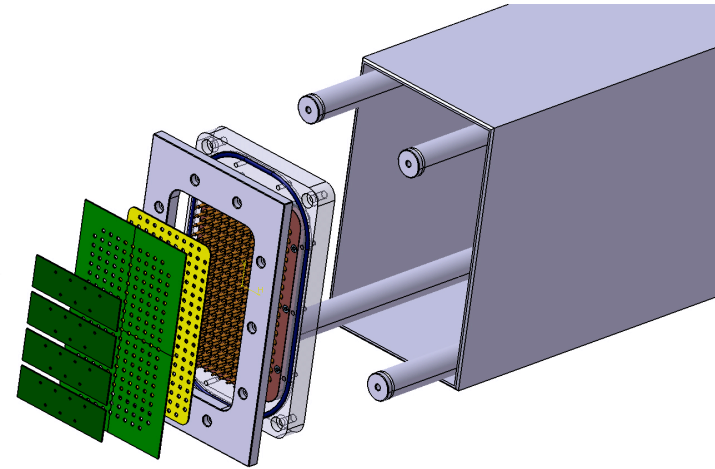
Very preliminary results shown indicate features of the methods

- ➔ No fake peaks
- ➔ Inefficiency for cluster spacing $\leq t_{\text{DELAY}}$
- Margins to optimize threshold and time delay
- **Not straight tracks:**
- ➔ Use cosmic ray tracks instead of β source
- ✓ Plan to study cluster counting efficiency as a function of impact parameter, gas mixture, distance from preamplifier

Full-length Prototype

Giuseppe FINOCCHIARO (LNF)

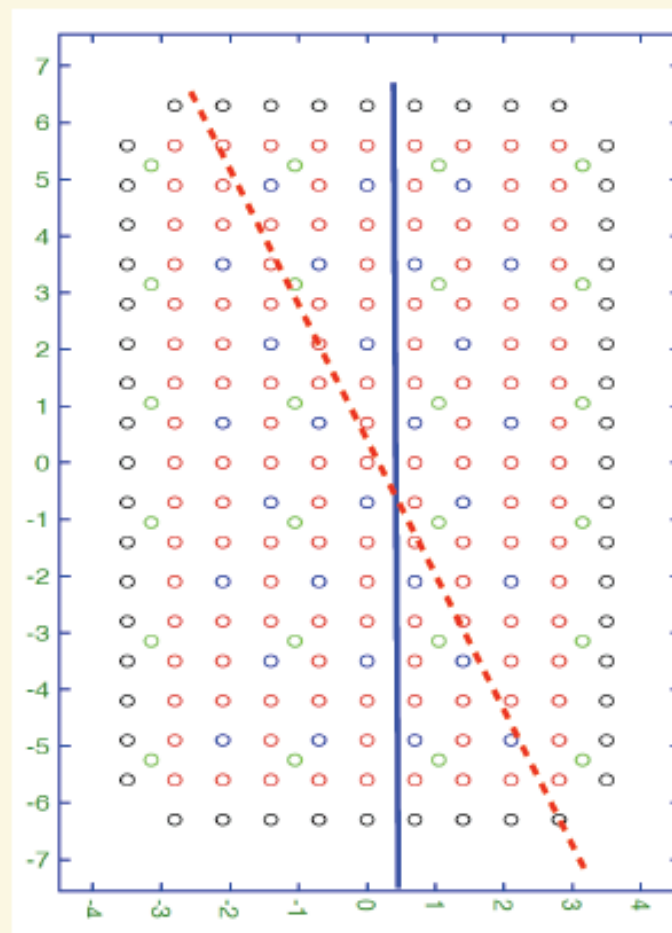
- 2.7m long, square-cell prototype to study DC response from single clusters in a realistic environment, and serve as a test bench for the final FEE
 - Mechanical design well advanced
 - End plates to be machined within 2010
 - Stringing and assembly early 2011
 - Cell layout study in collaboration with UBC/TRIUMF
 - 28 square 14mm-side cells, arranged in 8 layers (4-3-4-3-4-3-4-3)
 - Design of FEE in progress



Full-length Prototype

Giuseppe FINOCCHIARO (LNF)

- **BLUE CIRCLES: 28 SENSE WIRES ARRANGED IN 8 LAYERS (3-4-3-4-3-4-3-4)**
- **RED CIRCLES: FIELD WIRES**
- **BLACK CIRCLES: EXTERNAL LAYER OF GUARD WIRES TO MAKE CELL RESPONSE HOMOGENEOUS**
- ✓ **OPTIMIZATION OF WIRE POSITIONS AND HV DISCUSSED IN CHRIS' TALK**
- **GREEN CIRCLES: BLIND THREADED HOLES FOR SUPPORT OF FEE BOARDS**

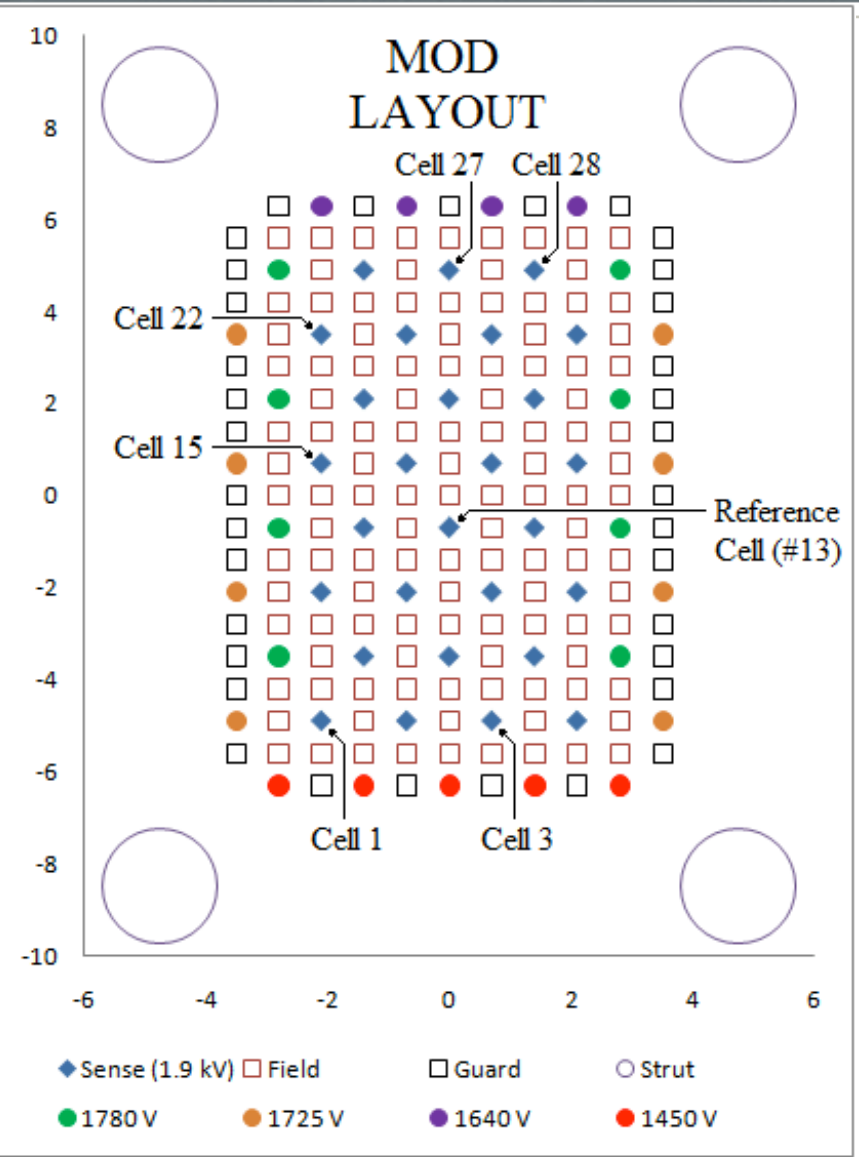
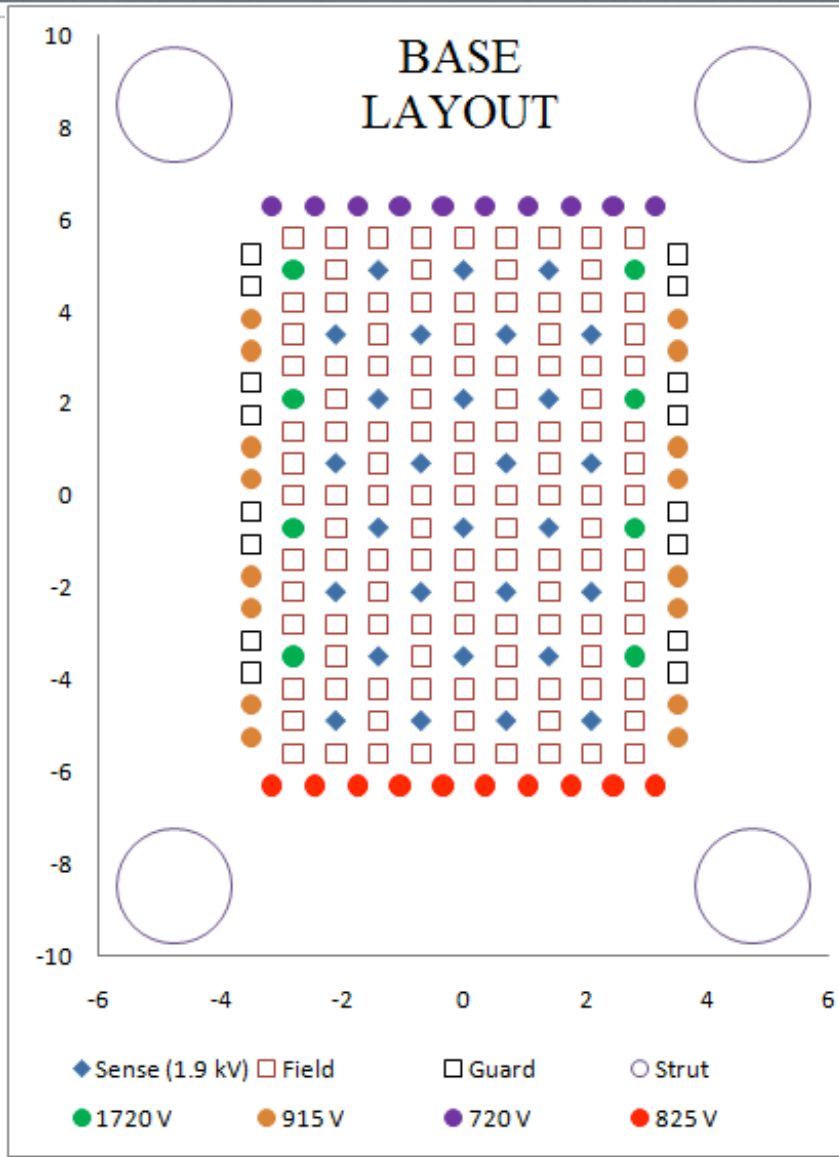


Full-length Prototype

Garfield Studies

Chris Hearty (UBC/IPP)

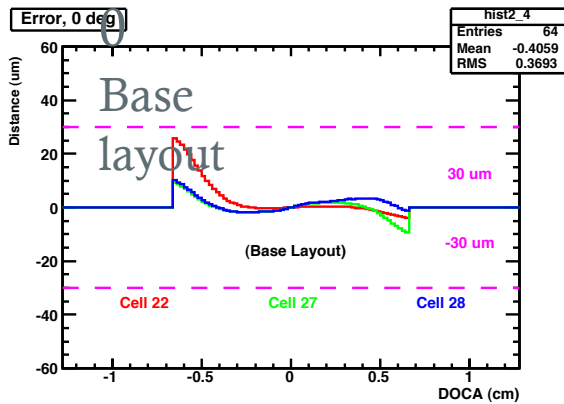
- Philip Lu has been doing Garfield studies for large LNF prototype, starting from model created by Giuseppe.
 - 14 mm square cells; 25 μm sense wires, 80 μm field wires.
 - This study uses He:Ne 90:10 with 3000 ppm water, $B = 0$.
- Idea is to select guard wire locations and voltages to minimize reconstruction errors. Specifically, look at the error incurred by using the nominal time-to-distance relationship (cell 13) for all other cells.



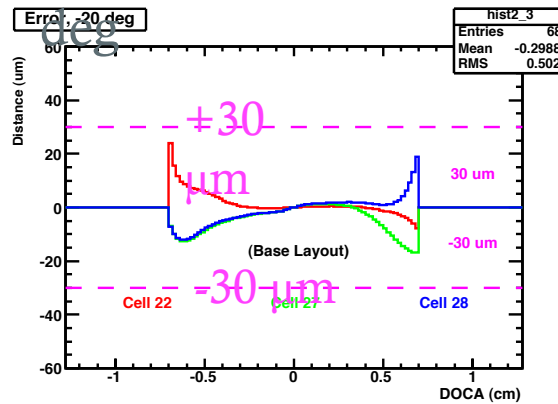
- In the modified layout, the guard wires follow the same pattern as the nominal layout, but with different voltages.

Tracking error vs drift distance for cell 22, cell 27, and cell 28

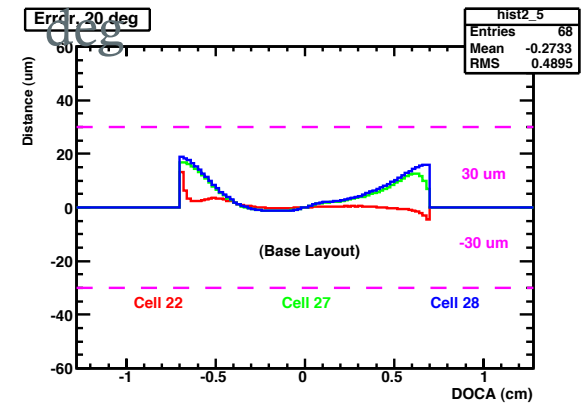
Entrance angle =



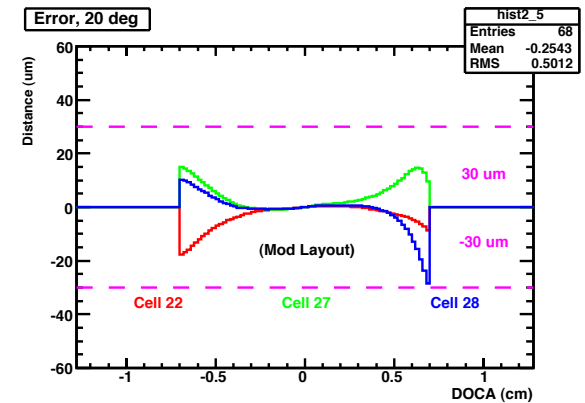
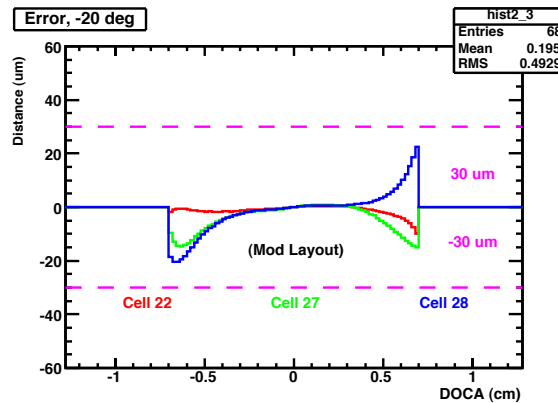
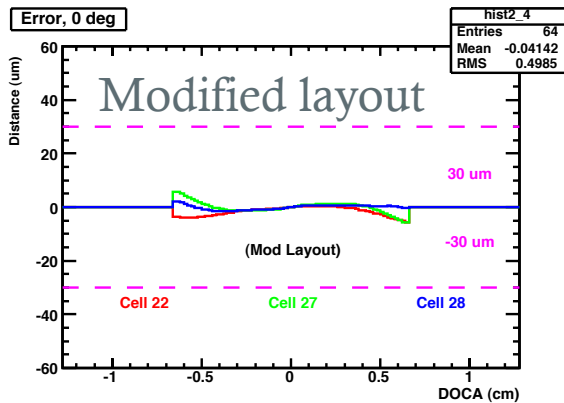
Entrance angle = -20



Entrance angle = +20



Modified layout



Full-length Prototype

Garfield Studies

Chris Hearty (UBC/IPP)

- Tracking errors $<30 \mu\text{m}$ for either layout. Negligible for standard tracking; maybe not so negligible for cluster counting.
- Next step is to look at gain variation. Overall, gain looks low compared to BaBar.

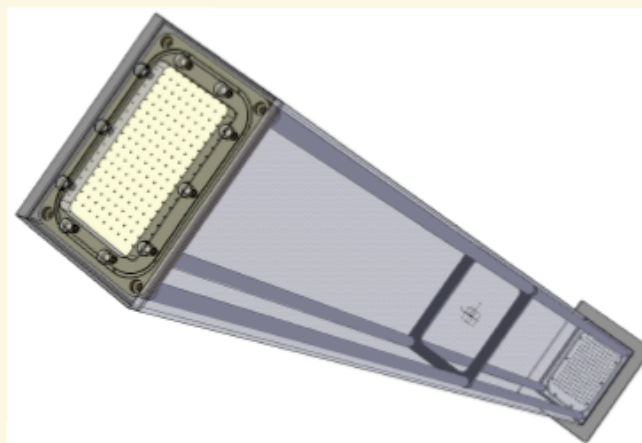
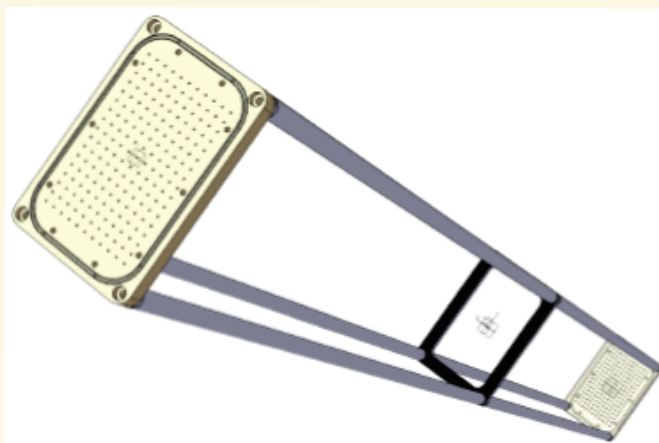
Full-length Prototype

Giuseppe FINOCCHIARO (LNF)

TECHNICAL DESIGN

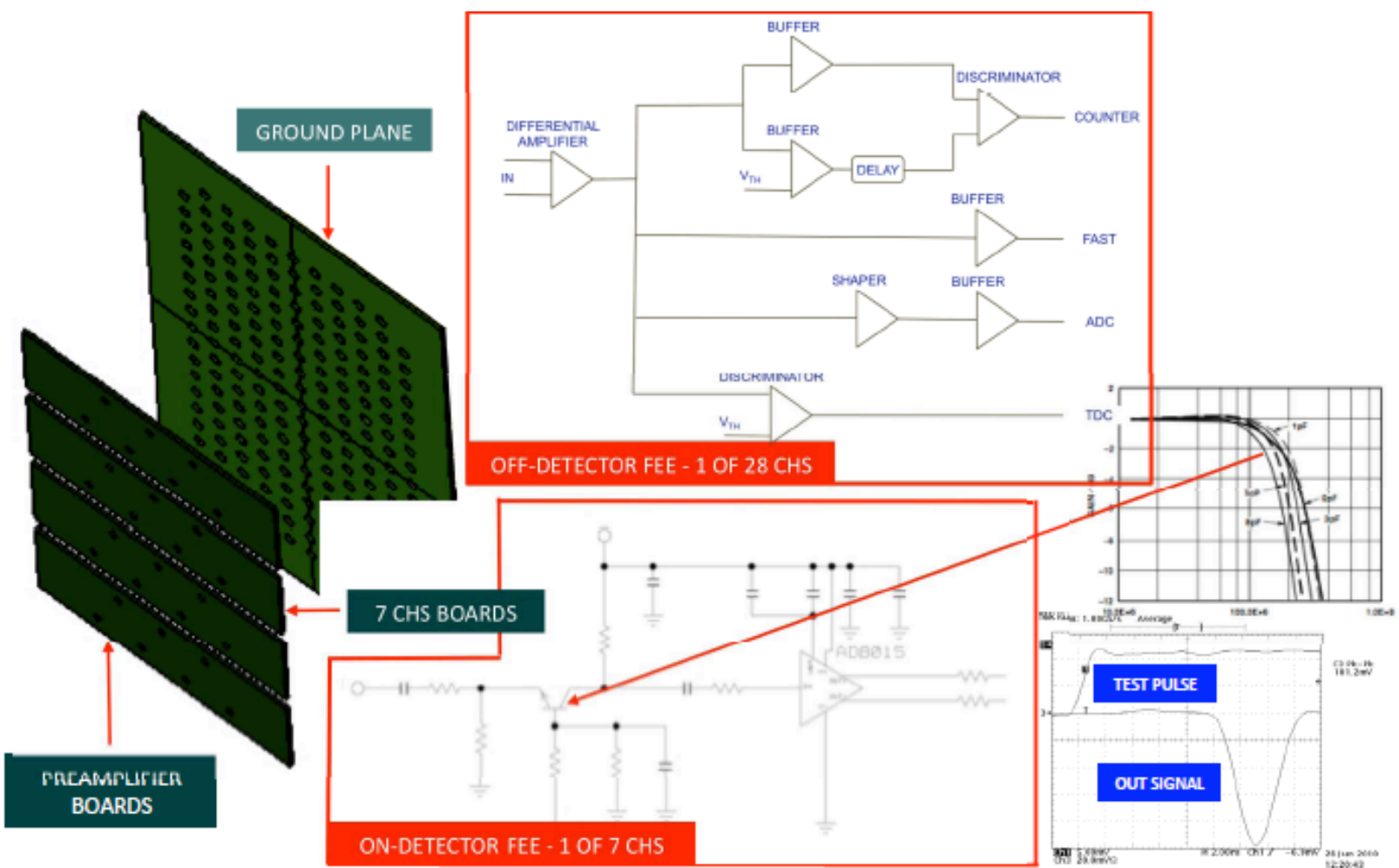
E. CAPITOLO
A. CECCHETTI
LNF

- ✓ **2.7M LONG, LIGHT STRUCTURE WITH ENDPLATE FRAMES SEPARATED BY 4 ALUMINUM ROD STRUTS**



- ✓ **AFTER STRINGING, STRUCTURE SLID INTO 3 MM THICK METAL CASE FOR GAS TIGHTNESS**
- **ALUMINIZED MYLAR WINDOWS TO MINIMIZE MATERIAL SEEN BY TRACKS AT VARIOUS LONGITUDINAL POSITIONS**

- 28 chs chamber prototype front-end design has been started. Front-end will be split in two sections. The first one (on-detector) will be based on a wide band transimpedance preamplifier, while the second one (off-detector electronics) will include local derivative circuit and outputs for ADC/TDC and as well.



Full-length Prototype

Giuseppe FINOCCHIARO (LNF)

WIRES



- Field/Guard wires: **80/120 μ m** bare Al-5056 (as in Proto1)
- Sense wires:
 - ✓ Gold-plated W-Rh (\varnothing **25 μ m**) used in Proto 1 (and in the KLOE DC)
 - ✓ Gold-plated Molybdenum has lower resistivity (less signal losses), possibly beneficial for cluster counting

Properties of tungsten wire alloyed with 3% Rhenium	
Purity of tungsten before rhenium addition	99.95% W
Melting point	3380 °C
Density	19.22 g/cm ³
Specific electrical resistance at 20 °C	0.092 Ohm x mm ² /m
Modulus of elasticity at 20 °C	430 kN/mm ²

Properties of bare Molybdenum wire	
Purity	99.9% Mo
Melting point	2620 °C
Density	10.14 g/cm ³
Specific electrical resistance at 20 °C	0.052 Ohm x mm ² /m
Modulus of elasticity at 20 °C	320 kN/mm ²

- ❖ **-200Kg LESS TENSION ON DCH ENDPLATES FOR 10,000 WIRES**
- ❖ **NEGLIGIBLE DECREASE OF OVERALL MATERIAL DENSITY**

- ➔ 400m spool (\varnothing **20 μ m**) purchased from Luma Metall
 - $T_{\text{break}}=(60\pm 6)\text{g}$ - [three tests]
 - $R_{\text{W-Rh}} = 180\Omega$; $R_{\text{Mo}}=170\Omega$ (corresponding to 110Ω for **25 μ m** \varnothing)
- ▶ consistent with factory specifications

Full-length Prototype

- Order 25 μ um Molybdenum wire in new year
- String ~80% of chamber with Molybdenum and rest with 25 μ um W-Rh as control for effects of resistivity

DCH Electronics R&D

Giulietto FELICI (LNF)

Specs

System

- Trigger rate (average): **150 kHz**
- Trigger (fixed) latency : $\approx 6 \mu\text{s}$
- Data OL BW : **16 OL @ 2 Gbits/sec**
- ECS OL BW : **16 OL @ 2 Gbits/sec**
- Trigger OL BW : **64 OL @ 1.2 Gbit/sec**
- Trigger spacing (min) > **36 ns** (sampling frequency = 56 MHz)
- Trigger burst : **4 events** (check other sub-detector ..)

Detector

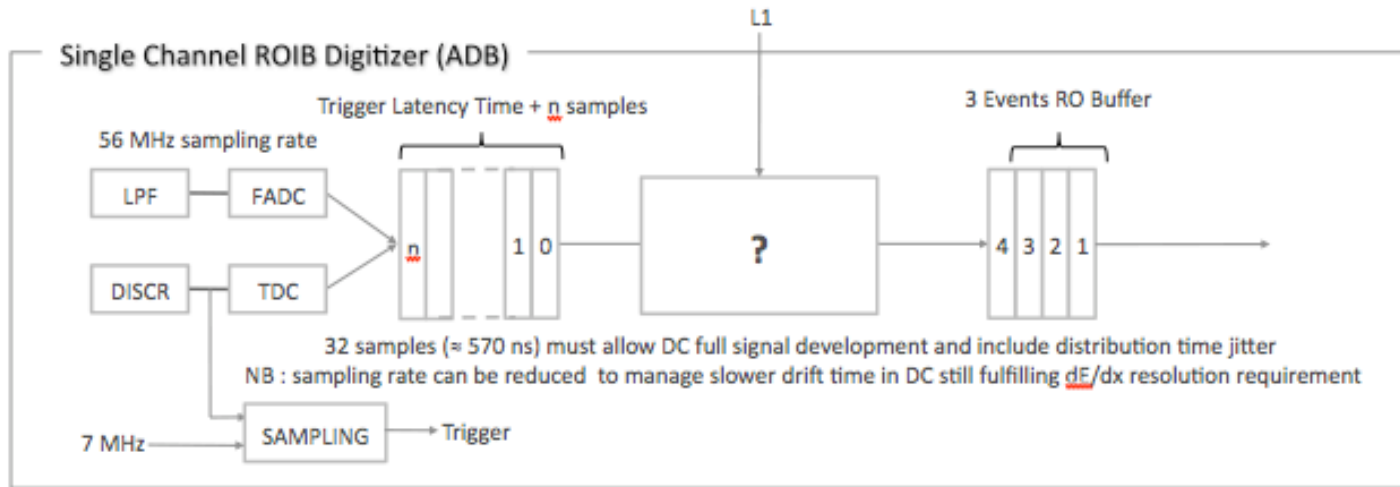
- Number of cells (guess): ≈ 9216
- Chamber occupancy : **15%** (Inner layers)
- Chamber gain : $5 \cdot 10^4 - 1 \cdot 10^5$
- Sense wire parasitic (C_D) $\approx 25 \text{ pF}$

DCH Electronics R&D

Giulietto FELICI (LNF)



ADB main blocks & data frame (remind)



Digitized Data Frame Example

A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	T	A	A	A	T	A	A	A	A	A	A	
D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	
#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	
3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	2	9	8	7	1	5	4	3	2	1	0

Position inside the frame → coarse time measurement (5 bits)
 Content → fine time measurement (6 bits)

DCH Electronics R&D

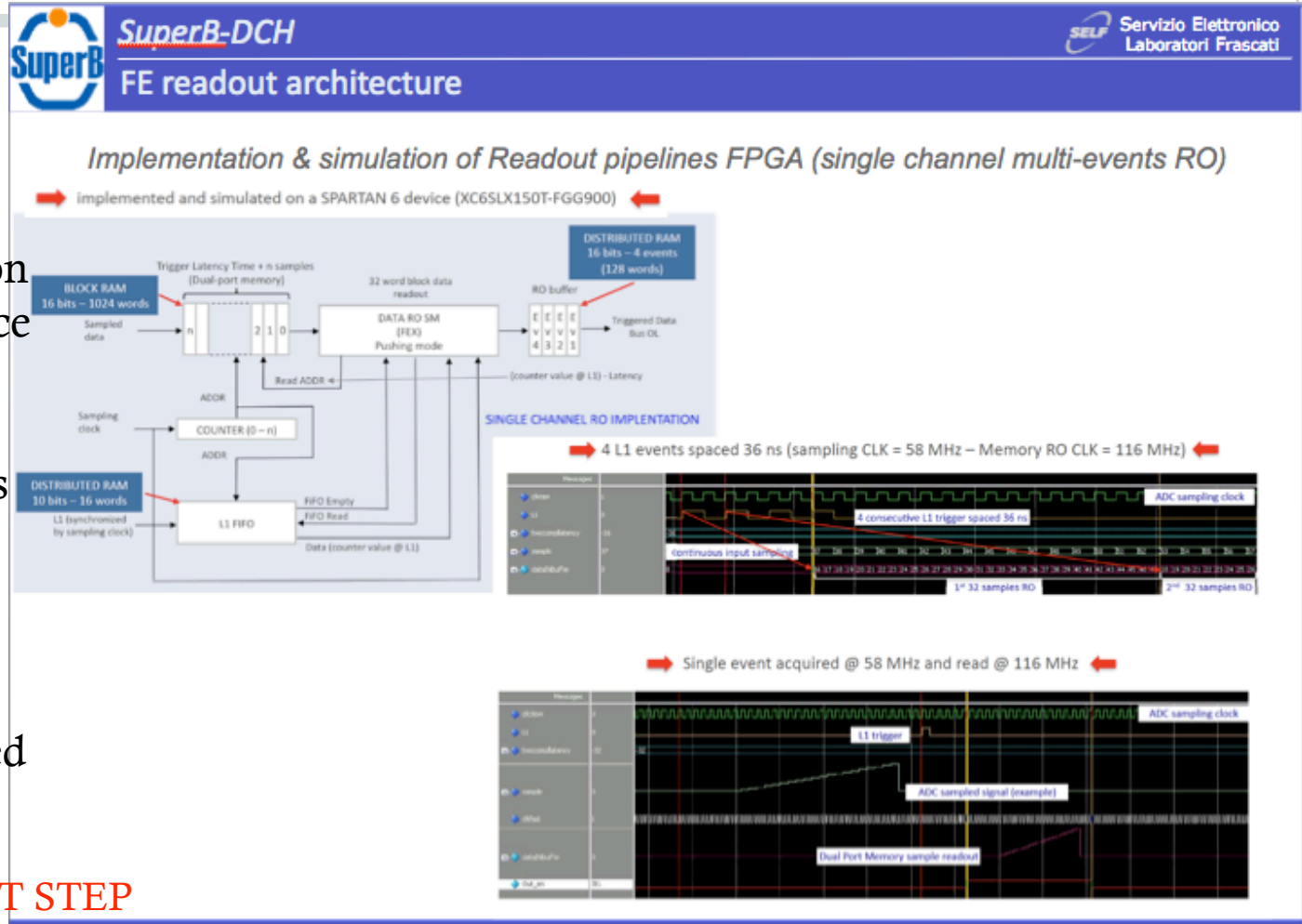
Giulietto FELICI (LNF)

started FE readout architecture simulation. A single readout channel has been implemented on a SPARTAN 6 device and fully simulated for consecutive triggers spaced 36 ns (up to 4 triggers).

Example of (a very simple) reconstructed waveform

SIMULATION NEXT STEP

FEX implementation for a single channel



Aging studies

Chris Hearty (UBC/IPP)

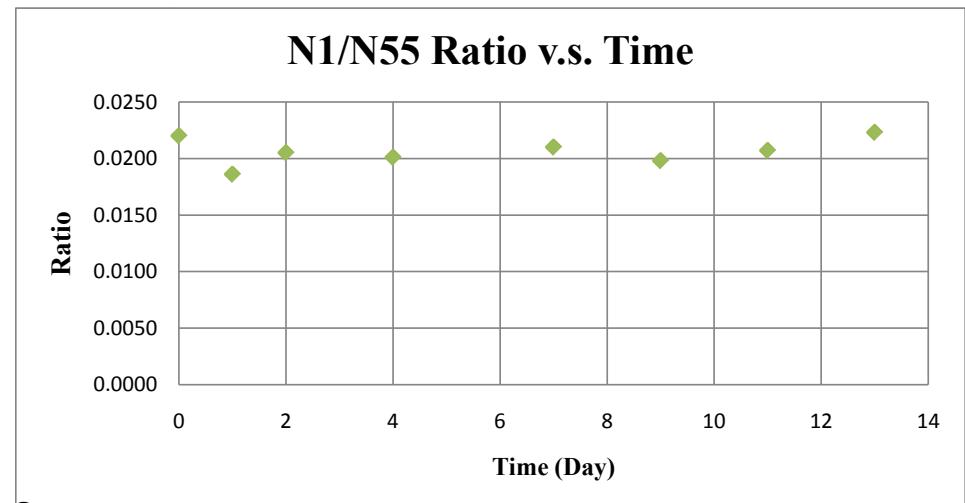
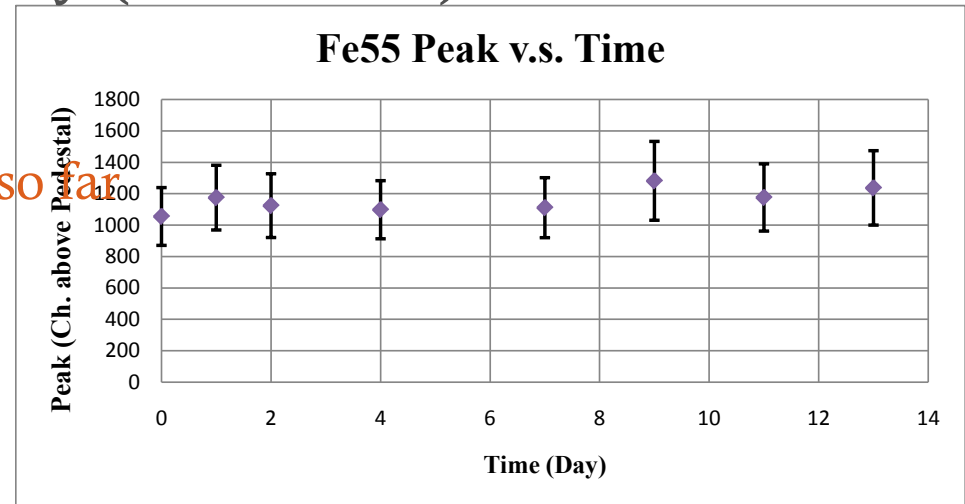
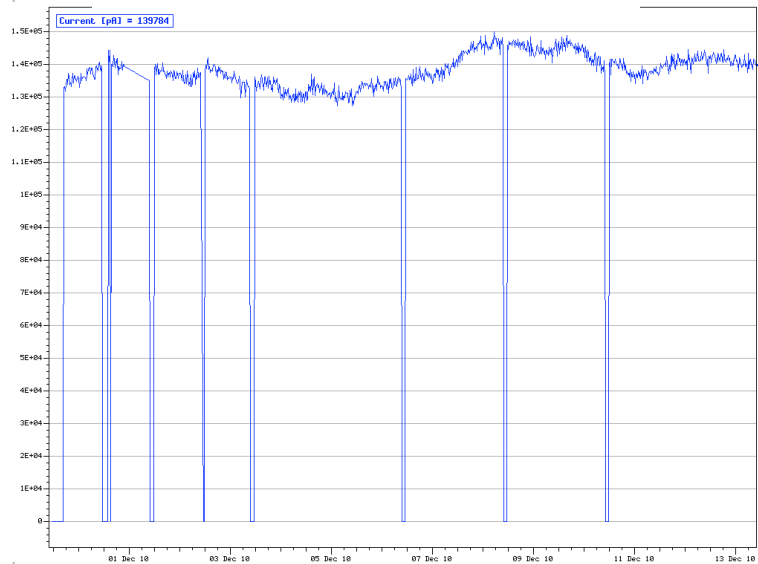
- Aging studies are underway. Currently testing BaBar set up:
 - 120 μm gold-coated aluminum field wires
 - 20 μm gold-coated tungsten sense wires
 - He:Isobutane 80:20 (but no water)
- Age chamber with a 100 mCi ^{55}Fe source; measure ^{55}Fe spectrum with a low-intensity source.
- Monitor current, ^{55}Fe peak location (gain), and ratio of small pulses to ^{55}Fe interactions.
 - Number of small pulses increase as Malter effect sets in.

Aging studies

Chris Hearty (UBC/IPP)

- error bars = width of distribution
- no density corrections so far

Sense wire current vs date



- No signs of aging so far

Aging studies

Chris Hearty (UBC/IPP)

NEXT STEPS:

- Use 120 μm bare aluminum. Try that next, probably with BaBar gas, no water.
- In the longer run, try SuperB gas, with and without water.
- Compare results to background calculations.

Summary

- Background occupancy estimation will proceed with 1mm steps in full sim. Need to validate new IP with rad. Bhabhas
- Cluster-counting derivative method electronics design provides promising baseline for prototype studies
- Full-length prototype to be strung early in 2011 with Mo. and some W-Rh wire progress
- Prototype results will be input to TDR
- FEE architecture simulation progressing
- Aging studies in progress