IU ATLAS SOFTWARE WORK AND PLANS

Fred Luehring

DOE SITE VISIT 07/12/00

1. Introduction & Personnel
2. Beampipe Design
3. Material Studies
4. Testbeam and dE/dx Work
5. GEANT3 Maintenance
6. GEANT4 Work
7. Software Coordination

PEOPLE

1. John Callahan
   - TRT Production Data Base (MS Access)
2. Rob Gardner
   - GRID (see next talk)
3. Fred Luehring
   - Architecture Review Committee Member
   - Inner Detector Simulation Coordinator
   - TRT “Material Cop”
   - TRT Software Coordinator
   - GEANT3 Monte Carlo
   - GEANT4 Monte Carlo / Detector Description
   - Also BridgeVIEW, PC System Management
4. Andrea Manara
   - Testbeam dE/dx Measurement Analysis
   - Testbeam Monte Carlo
   - Advanced dE/dx Technique Using Pulse Width

BEAM PIPE DESIGN

The design of the ATLAS beam pipe is being finalized and we ran studies to determine the effect of various pipe designs on the TRT charged particle rates. The results of the study were a major factor in deciding which proposed beam pipe design to select. The designs studied were:

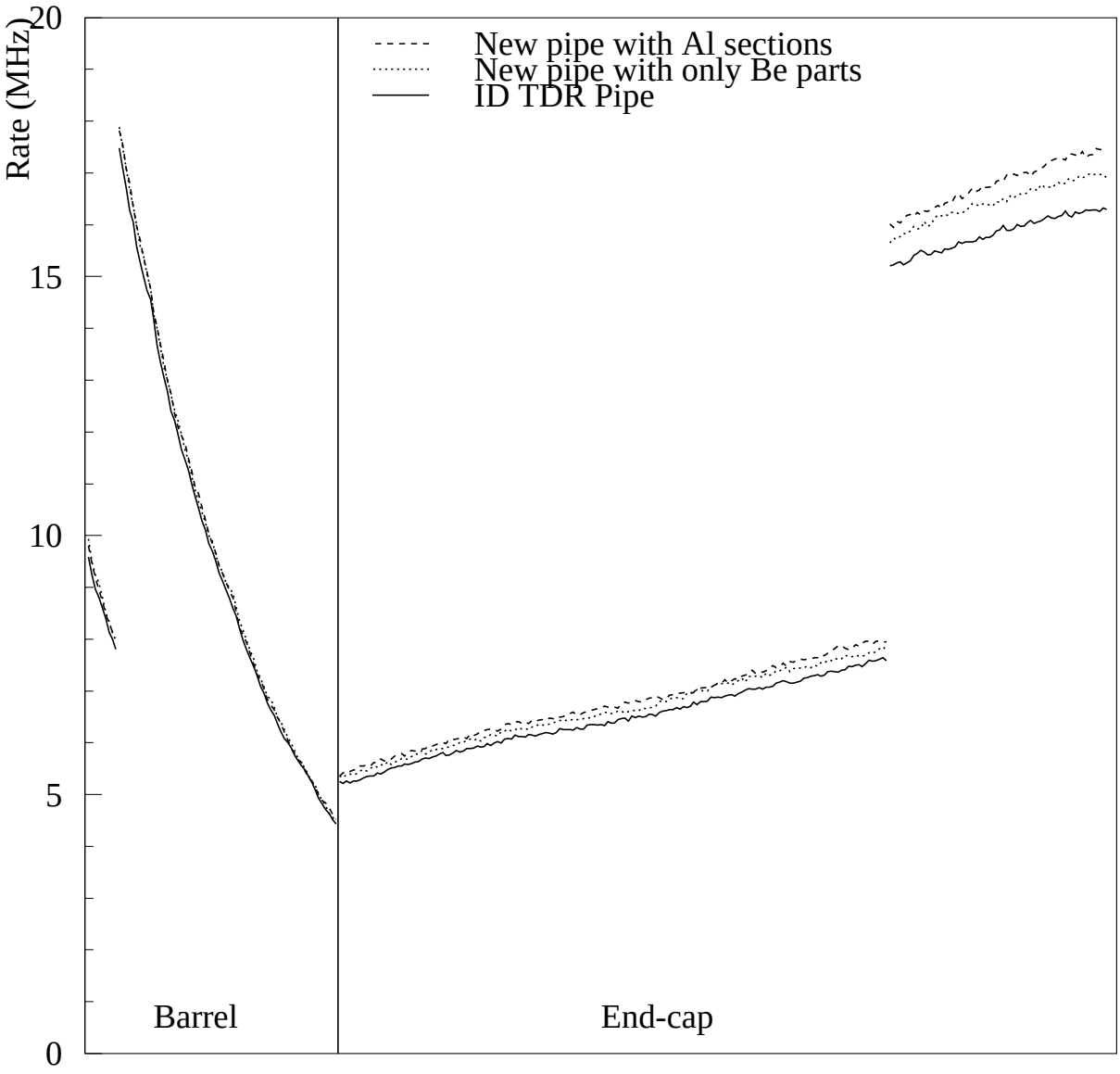
1. **Thin walled Be pipe used in original ATLAS studies (best case - used for comparison).**
2. **Current design with aluminium NEG pumps.**
3. **Current design with beryllium NEG pumps.**
4. **A stainless steel NEG pump design which was discarded based on this study and is not shown.**

Simulation Parameters of Various Beam Pipes

Name	Material	Wall (mm)	OD (mm)	Z Location (mm)
Original	Be	1.0	50.0	|Z| < 3650
Al NEG Pump	Be Be Al Al	0.8 0.8 1.1 1.1	59.6 67.6 60.2 68.2	|Z| < 2750 |Z| < 2750 2750 < |Z| < 3650 2750 < |Z| < 3650
Be NEG Pump	Be Be	0.8 0.8	61.2 67.6	|Z| < 3650 |Z| < 3650

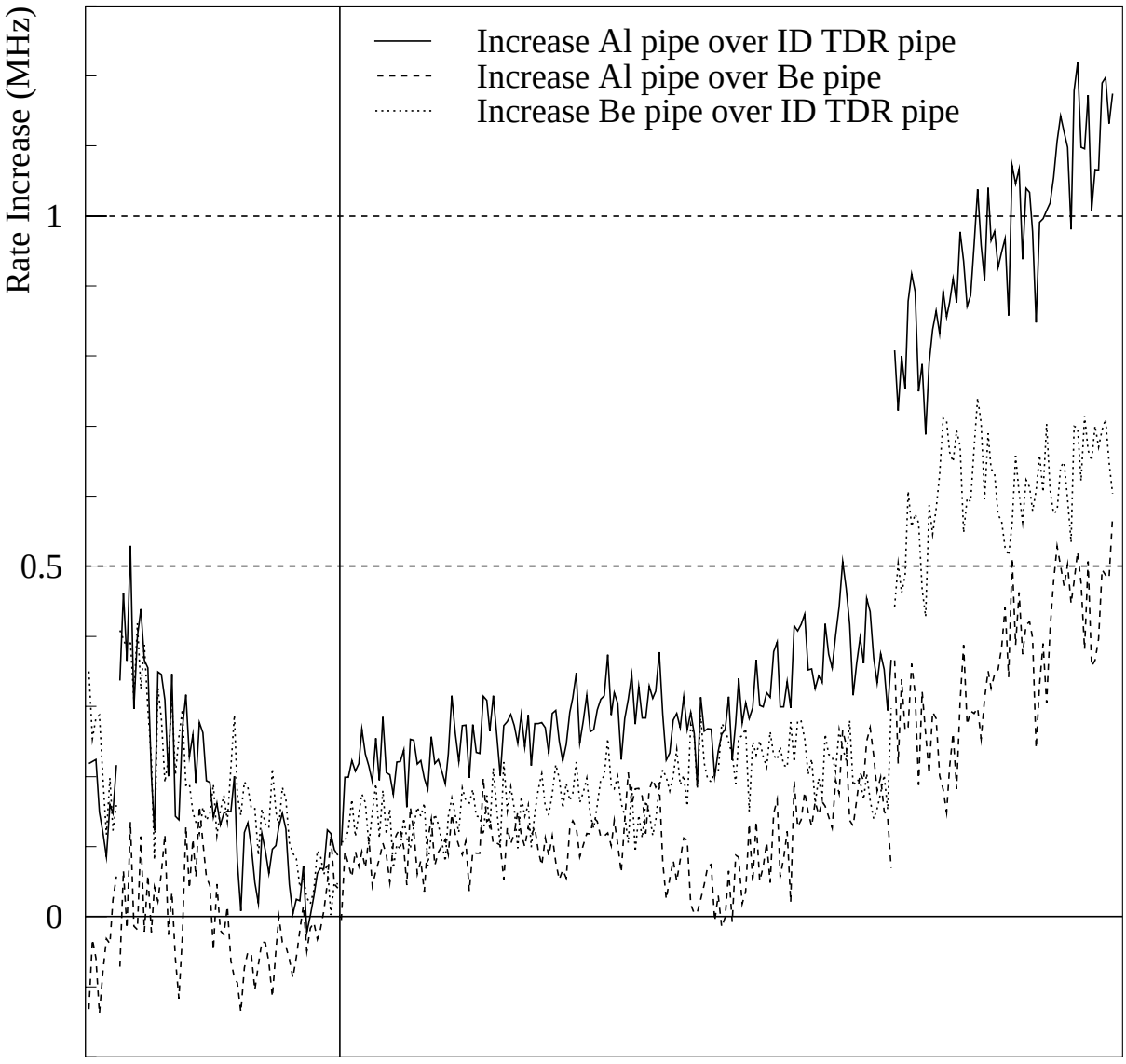
BEAM PIPE RESULTS

The rates of TRT hits by charged particles with E > 100 keV for the three beam pipe scenarios are:



BEAM PIPE RESULTS

The rate increase for each new beam pipe design:



R in Barrel, z in End-cap

The increase is probably OK for the Be designs but the Al pumps reduce the type C wheel performance.

MATERIAL & RADIATION LENGTH WORK

An example section from a spread sheet is used to track the TRT material and radiation length.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**8-Jul-00 3:26**	**Who**	**Material**	**Mass (g)**	**# Mod 1**	**# Mod 2**	**# Mod 3**	**Mass Mod 1**	**Mass Mod 2**	**Mass Mod 3**	**Total Mass**	**X0 (g/cm2)**	**X0 %**	**Totals**
2														**Barrel Flange Region**
3	Shell beyond active length of straw	Craig/Harold	XN-050A	NA	2.69	3.37	4.22	86.09	107.93	134.92	328.93	44.06	0.03%	
4												**Shell**		**0.03%**
5	End Plug	Alan	Ultem	0.045	329	520	793	473.76	748.80	1141.92	2364.48	42.47	0.21%	
6	End Twister	Alan	Ultem	0.050	329	520	793	526.40	832.00	1268.80	2627.20	42.47	0.23%	
7	Sealing Epoxy	Bryan/Dave	Treat as Mylar	NA	24.00	36.83	57.37	768.00	1178.54	1835.96	3782.50	39.89	0.35%	
8												**Straw End (Mech)**		**0.78%**
9	Xe-CF4-CO2 beyond active length	Craig	Xe-CF4-C02	NA	0.38	0.59	0.91	12.13	18.77	29.06	59.96	9.95	0.02%	
10												**Gas (Within End Assly)**		**0.02%**
11	HV Plate (1.8 mm thick part)	Chiho	G10	NA	48.54	74.39	116.00	1553.37	2380.40	3712.00	7645.77	32.98	0.85%	
12	HV Plate (0.2 mm thick part)	Chiho	G10	NA	4.86	7.44	12.45	155.36	238.08	398.40	791.84	32.98	0.09%	
13	HV Plate Ground Plane/Traces	Chiho/Rick	Cu	NA	2.57	3.97	6.15	82.19	127.20	196.95	406.34	12.81	0.12%	
14	Kapton HV Distribution Sheet	Chiho	Treat as Mylar	NA	4.98	7.61	11.89	159.39	243.52	380.57	783.48	40.61	0.07%	
15	Kapton HV Distr Sht Ground/Traces	Fred	Cu	NA	2.57	3.97	6.15	82.19	127.20	196.95	406.34	12.81	0.12%	
16	HV Plate Solder	Fred	Pb/Sn	NA	0.33	0.52	0.79	10.46	16.53	25.21	52.21	7.23	0.03%	
17	HV Plate Glue	Fred	Treat as Mylar	NA	0.15	0.23	0.36	4.86	7.45	11.61	23.92	39.89	0.00%	
18	Cap Sleeve	Ken	Ultem	0.057	42	65	100	76.61	118.56	182.40	377.57	42.47	0.03%	
19	Cap Socket - upper	Chiho	Brass	0.014	42	65	100	19.08	29.54	45.44	94.06	12.33	0.03%	
20	Cap Sockets - lower (2 Sockets)	Chiho	Brass	0.028	42	65	100	38.17	59.07	90.88	188.12	12.33	0.06%	
21	Cap Double Pin	Ken	Brass	0.040	42	65	100	53.76	83.20	128.00	264.96	12.33	0.08%	
22	Cap Top Wire	Chiho	Cu	0.020	42	65	100	26.88	41.60	64.00	132.48	12.81	0.04%	
23	Capacitors	Chiho	BaTiO2	0.119	42	65	100	159.94	247.52	380.80	788.26	10.64	0.27%	
24	Resistors	Chiho	Ceramic (SiO2	0.005	42	65	100	6.72	10.40	16.00	33.12	27.06	0.00%	
25	Fuse Box	Jack	G10	NA	8.09	11.07	17.04	258.88	354.24	545.28	1158.40	44.06	0.10%	
26	Fuses	Valeri Sosn.	Use Cu	0.030	22	34	50	21.12	32.64	48.00	101.76	12.81	0.03%	
27	Fuse Box Capacitors	Chiho	BaTiO2	0.120	7	6	5	26.88	23.04	19.20	69.12	10.64	0.02%	
28	Fuse Box Resistors	Jack	Ceramic (SiO2	0.005	14	12	10	2.24	1.92	1.60	5.76	27.06	0.00%	
29	Spring Clip in Fuse Box	Jack	Brass	0.015	26	38	56	12.48	18.24	26.88	57.60	12.33	0.02%	
30	Fuse Box Kapton Circuit	Jack	Kapton	NA	0.28	0.37	0.55	8.96	11.84	17.60	38.40	40.61	0.00%	
31	Mounting Pins	Craig	Steel (use Fe)	0.494	2	2	2	31.65	31.65	31.65	94.94	13.85	0.03%	
32												**HV (Fuse both ends)**		**1.99%**

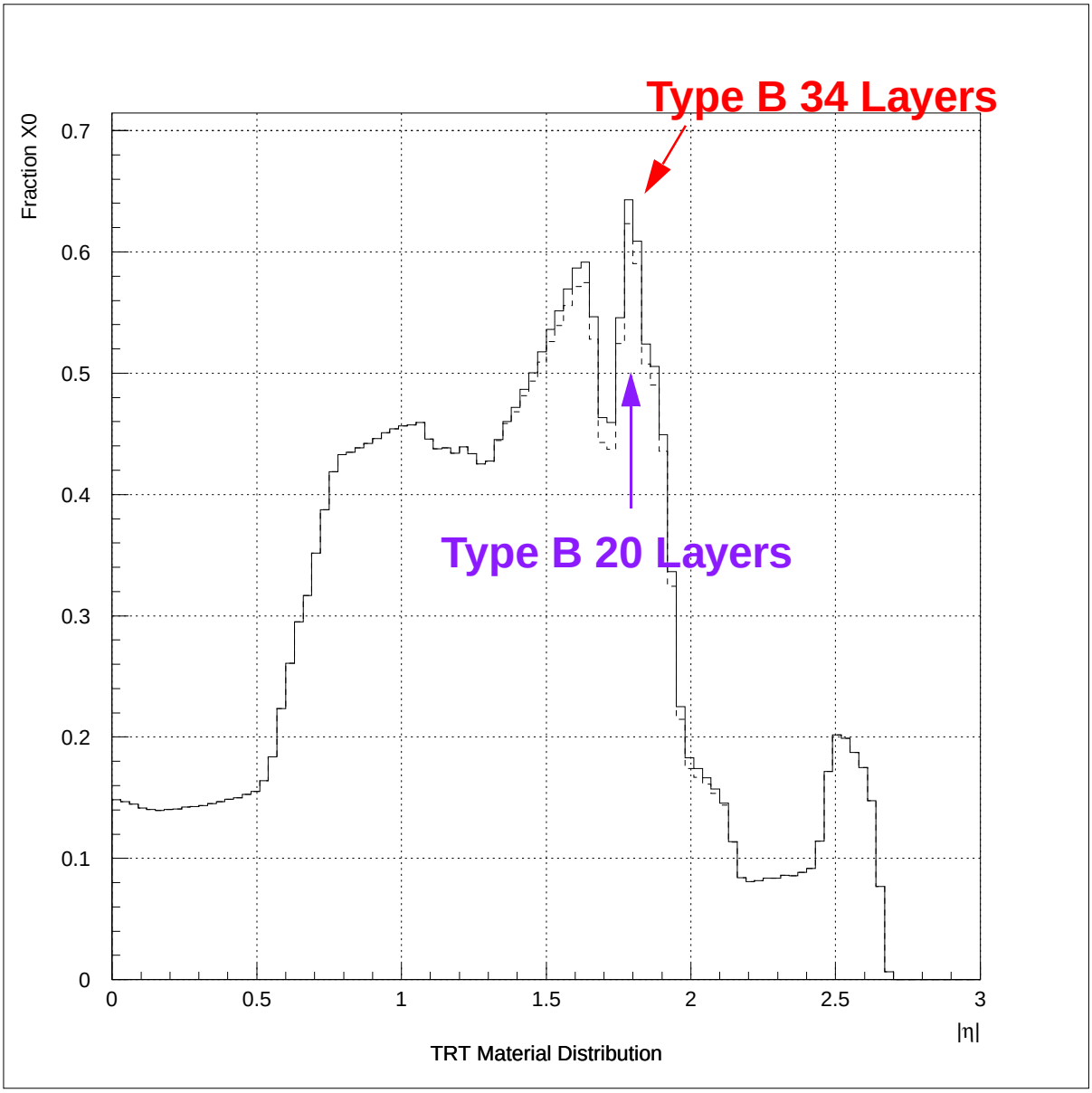
The material information is routinely compiled for use in the ATLAS inner tracker simulation and material budget audits.

The current radiation length of the barrel has risen to ~10.0% X0 (not including cables) while the original budget was 7.5% X0.

Currently a huge amount of recent information about the outer edge of the TRT end-cap wheels & their attached cables is being put into the worksheets.

MATERIAL DISTRIBUTION

The PRELIMMINARY material plot:



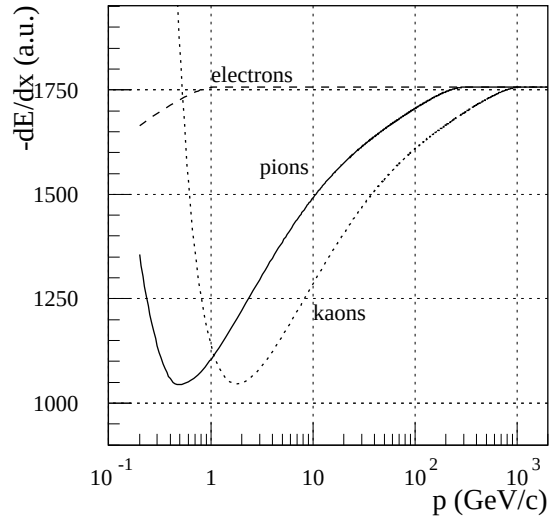
We are near to having a plot of the current situation.

TEST BEAM dE/dx Particle ID Work

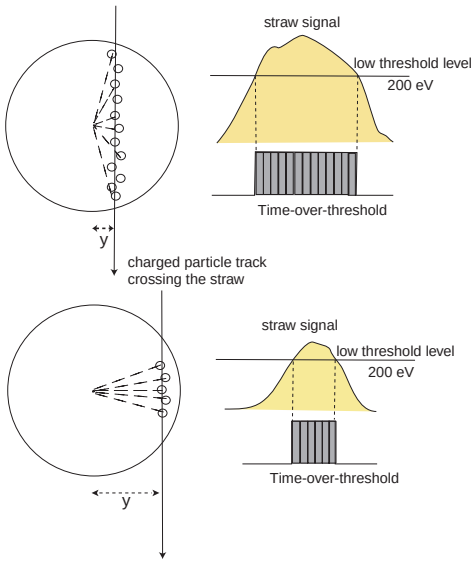
A significant improvement in the ATLAS TRT particle identification capability at low energy is possible by using the width of the discriminator output to measure track energy deposition in the TRT straw gas volume (time-over-threshold technique).

Table 1: Time-over-threshold and energy loss.

Bethe-Bloch Curves for TRT Gas Mixture



Time-over-Threshold and y-Dependence



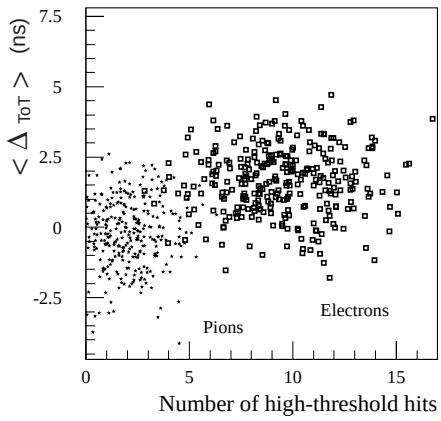
Technique development, test-beam data analysis and Monte Carlo simulation was done at IU by A. Manara with help from H. Ogren and F. L.

A. Manara

eπ SEPARATION

Table 2: Test-beam data. Performance of Time-over-Threshold method at 5GeV.

Time-over-Threshold vs. Pulse Height



Combined Technique Performance

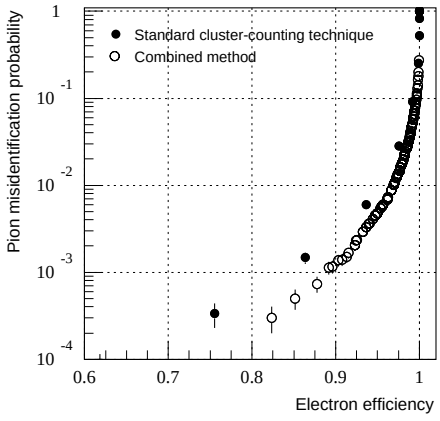
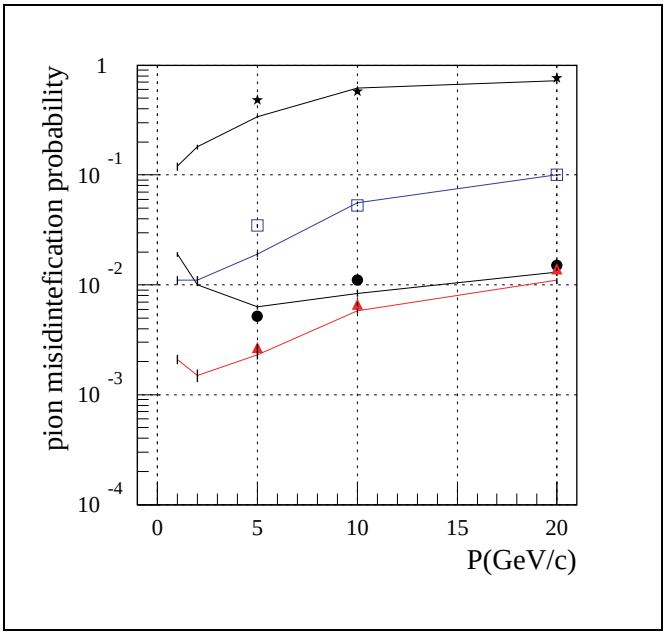


Table 3: Test-beam data and Monte Carlo



Points: Testbeam Data
Lines: Monte Carlo Prediction

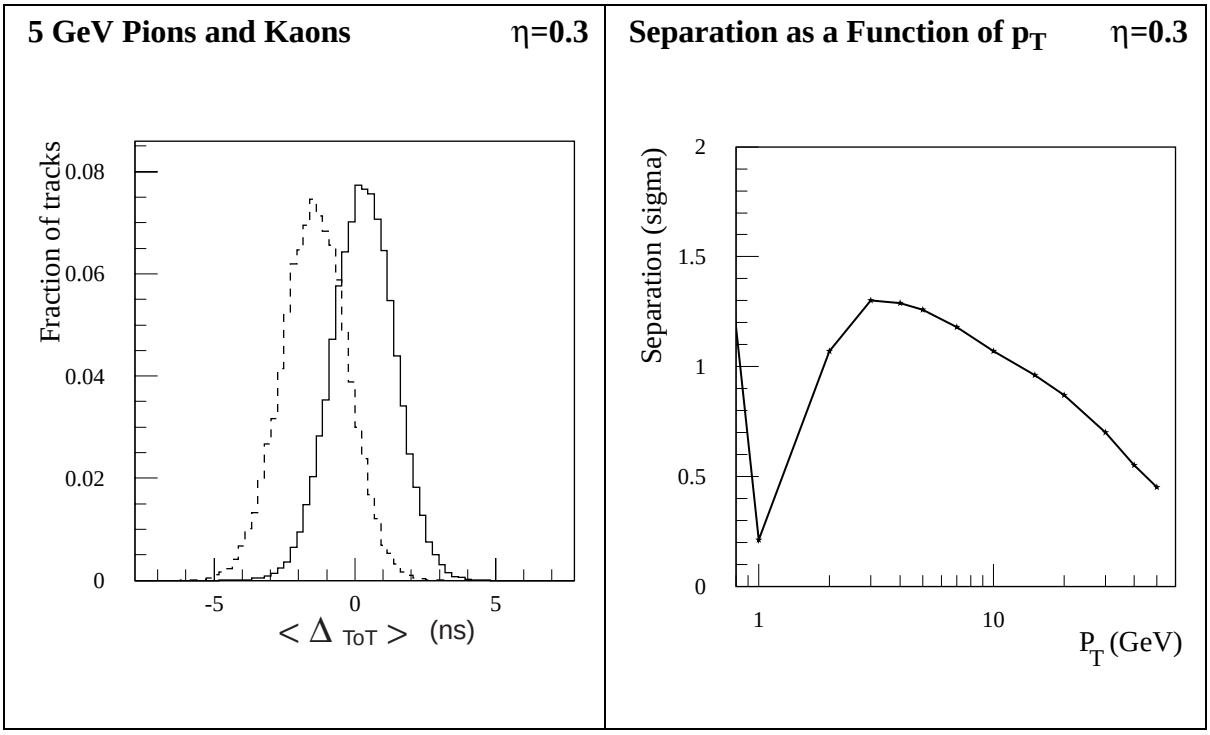
Signal Width (no HT hits) stars
Signal Width (all hits) squares
High Pulse Height (TR) Hits circles
Width / TR Combined triangles

Note: Width means Time-over-Threshold

A. Manara

K/π SEPARATION

Table 4: ATLAS Monte Carlo Simulation



The K/π separation achievable with the Time-over-Threshold (signal width) technique will be very helpful for B-physics studies in ATLAS.

A. Manara

GEANT3 MAINTENANCE

The existing GEANT3 model on the TRT detector must be maintained during the transition to GEANT4.

During the last year the main changes have been in the end-cap region where final engineering for the services has reduced the straw active length:

The Incredible Shrinking Straws

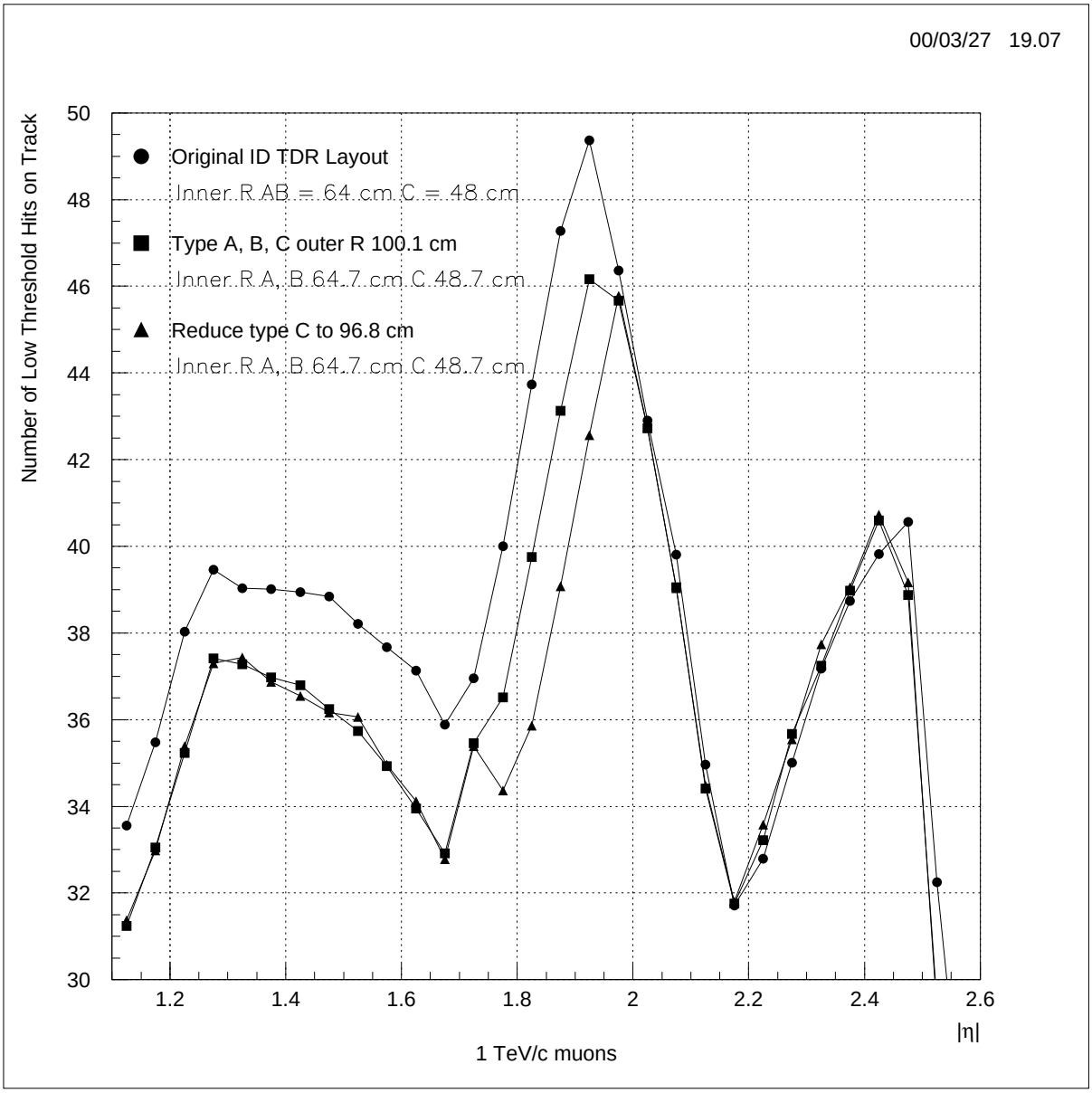
	A,B TDR	A,B NOW	C ID TDR	C NOW
Outer Radius	1030.0 mm	1001.0 mm	1030.0 mm	968.0 mm
Inner Radius	640.0 mm	646.6 mm	480.0 mm	486.7 mm
Active Length	390.0 mm	354.4 mm	550.0 mm	481.3 mm

The Z positions of the straw layers have also been rearranged to match the latest design of the support structures and services for the precision trackers.

The recent successful submission of the TRT electronics requires revision of the model of the electronic signal shape and discriminator.

WHEEL OUTER RADIUS

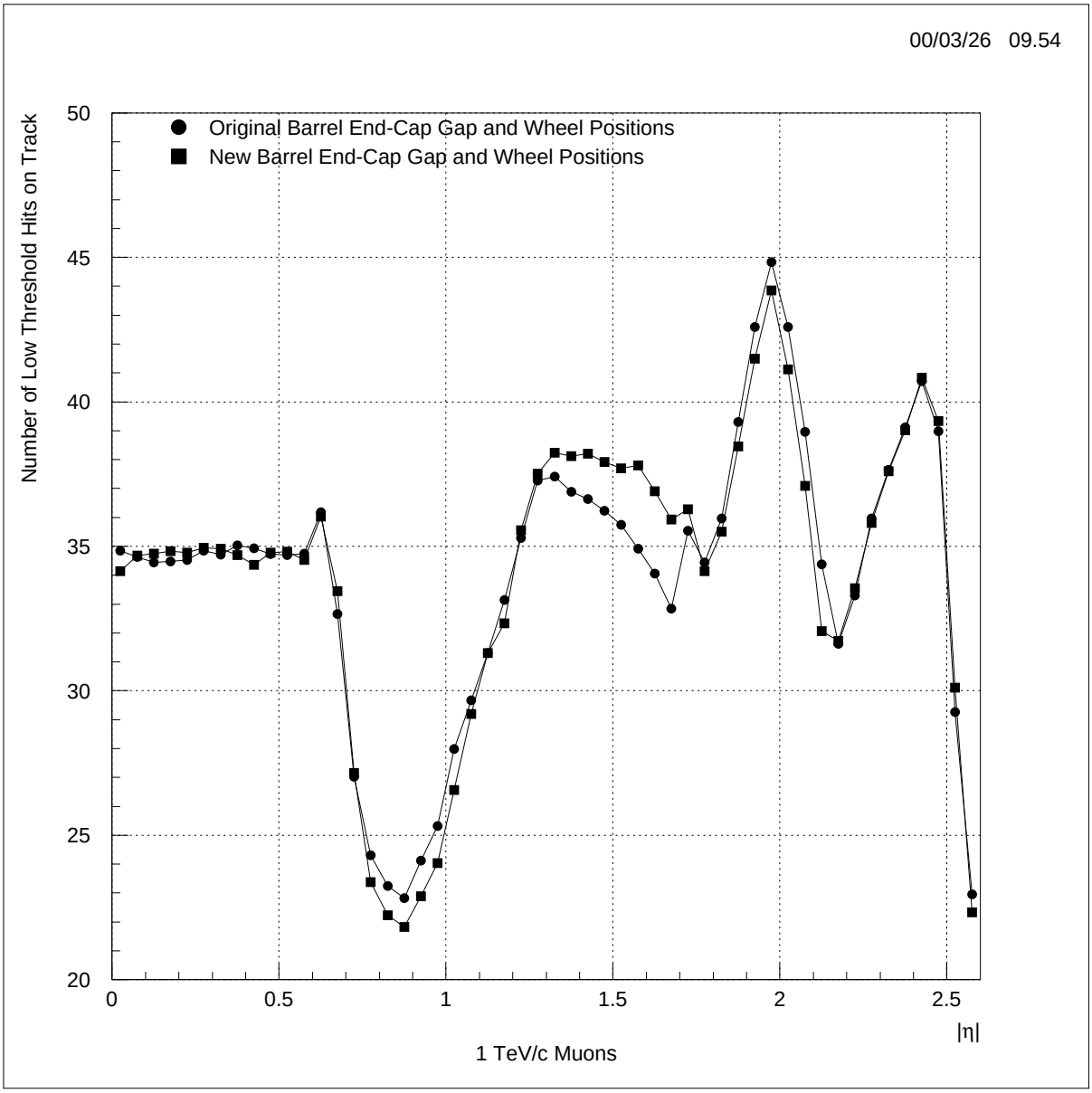
The number of possible hits on a stiff track falls as straw length is reduced:



This is tolerable because of the large number of hits.

GAP WIDTHS

The number of hits on a stiff track crossing the barrel end-cap gap falls as the gap is widened:



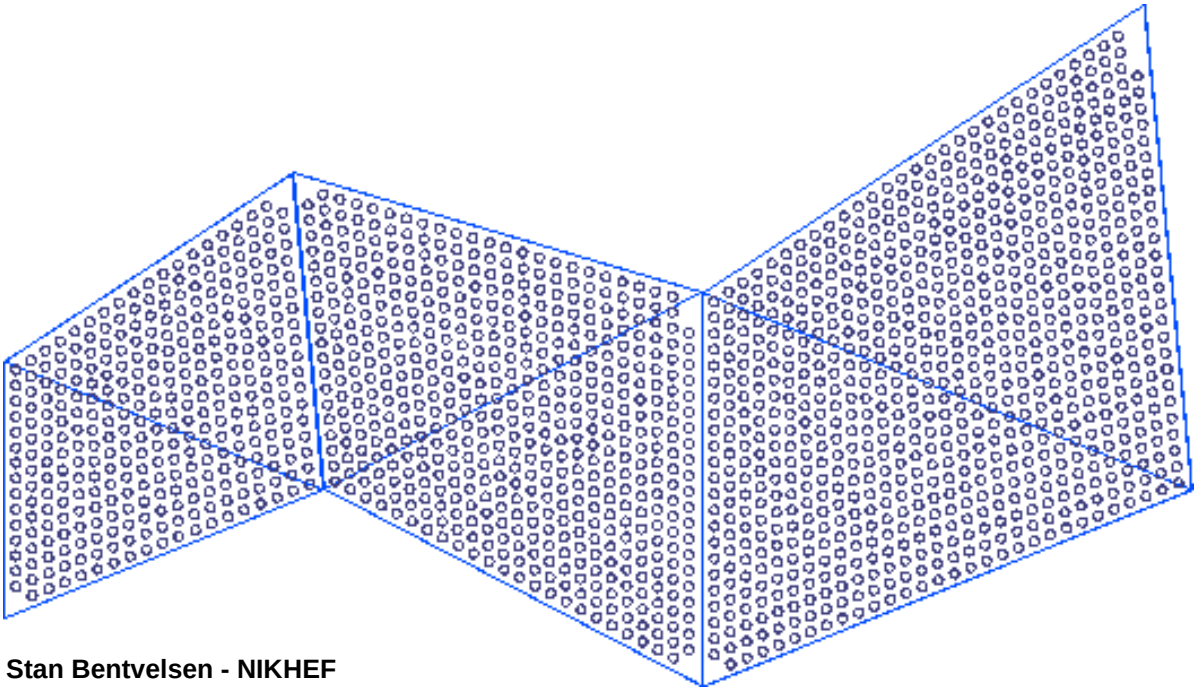
Recall that the TDR specification calls for 36+ hits...

TRT GEANT4 WORK

The work of converting the TRT code to GEANT4 will concentrate in two areas for the rest of the year:

1. **Work on an XML (eXtensible Mark-up Language) description of the TRT geometry.**

   ATLAS uses the XML language to store the parameters describing the ATLAS geometry and material. The image below was produced by an ATLAS program that reads XML geometry statements. The XML file used is the first attempt at a description of the TRT barrel modules.



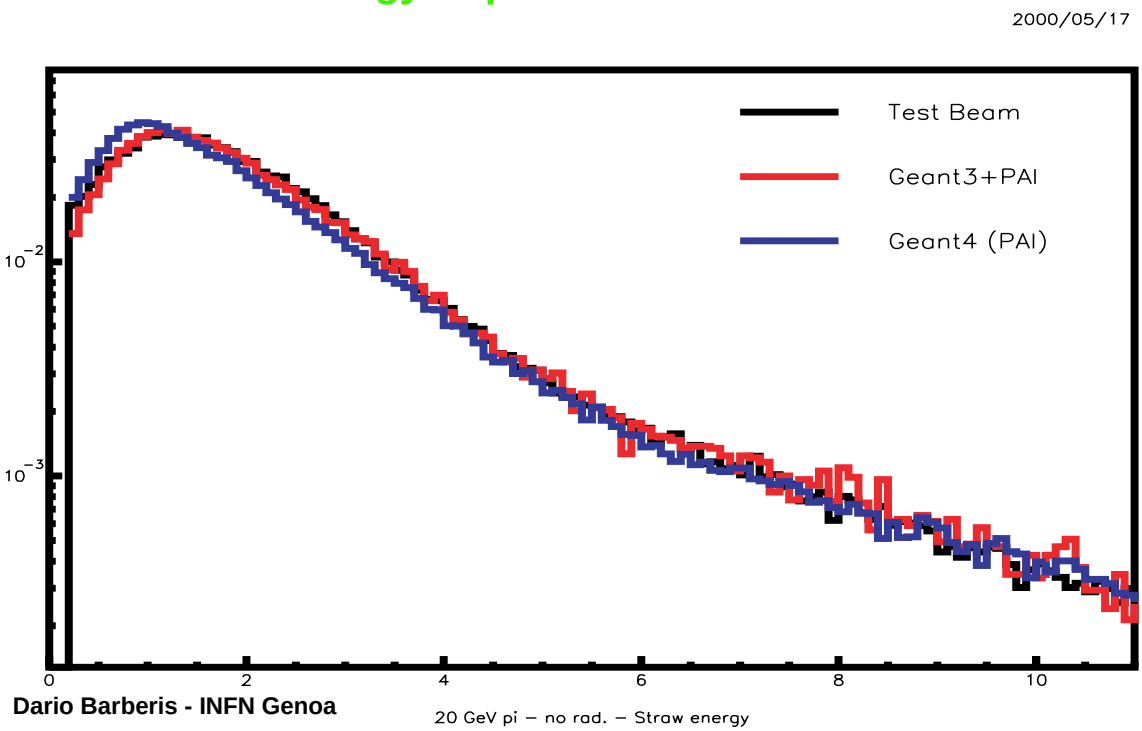
Stan Bentvelsen - NIKHEF

   It is planned that the XML file will be the sole source of geometry information for all parts of the ATLAS software. Much work remains to use the XML information to produce a workable GEANT4 geometry model of the TRT.

GEANT4 WORK (CONT.)

2. **Work on extending the TRT GEANT4 testbeam simulation to have a proper digitization routine which will let us compare the Monte Carlo to data.**

   The TRT testbeam geometry has been entered in GEANT4 and used to validate the GEANT4 ionization model. After much work by the Genoa group and the GEANT4 development team, GEANT4 is getting reasonable energy depositions from the PAI model.



   IU working with Hampton University, will now put in the effect of the clusters and energy resolution to produce a reasonable energy vs. time distribution for each straw. We will also put in the model of the electronics shaping, the discriminator, and the TDC.

SW COORDINATION

We are responsible for:

1. **Tracking the amount of material in all parts of the TRT.**
2. **GEANT3 software maintenance.**
3. **GEANT4 code development for both geometrical and material description of the TRT.**
4. **GEANT4 code to model the TRT electronics and read-out.**
5. **Coordinating the entire inner tracker GEANT simulation effort.**
6. **Coordinating the TRT test beam software effort (both analysis and Monte Carlo).**
7. **Assisting in the current review of the new ATLAS offline analysis framework by being a member of the Architecture Review Committee (ARC) a high level review of the progress in implementing the recommendations of the recent Architecture Task Force (ATF) report.**