TRIUMF Experiment E614
Beam Note #1

Previous Experience of Beam Line Studies
(Review)

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1.M13 beam line for E185 experiments ($P_\mu \xi \delta/\rho$ and δ)

Table1.Comparison of surface muon beam tunes on M13 (2mm carbon target)

From Chris Oram, Aug.05,1994

	NIM	MAY(<1984)	NOV(<1984)
P, Mev/c	29.5	29.46	29,48
B1(NMR), Gauss	--	--	865.88
B2(NMR), Gauss	--	956.38	942.75
B1, Amps	40.3	39.5	39.2
B2, Amps	44.2	43.9	43.2
Q1, Amps	209	206	202
Q2, Amps	57.3	56.5	56.0
Q3, Amps	130.8	127.3	131.5
Q4,Amps	106.8	99.6	106.9
Q5, Amps	130.8	132.7	131.8
Q6, Amps	52.3	51.0	51.3
Q7, Amps	62.1	58.6	57.2
SX1, Amps	Not installed	Not installed	OFF
SX2, Amps	Not installed	Not installed	OFF
Vertical Steer on Q7(pot)	--	280	OFF
F1HSL(mm), width	10	10	10
F1HSL(mm), pos.	0	0	0
F2HSL(mm), width	10	10	10
F2HSL(mm), pos.	0	0	–3
$\Delta p/p$, %	1.2*	1.03**	1.21**
Min. $\Delta p/p$, %, obtainable	--	0.5(FWHM)***	--
Beam spot:	π beam	μ beam	μ beam
Horizontal: FWHM, (cm)	1.0	1.1	1.4
FWTM, (cm)	2.6	2.2	2.6
Vertical: FWHM, (cm)	<1.6	0.8	1.1
FWTM, (cm)	n/a	1.6	2.2
Q6 Steering	--	1.5mm/%	0.3mm/%

Remarks:

Values of F0VJ and F0HSL are not known.
F3 focus: 103cm from Q7 face.
∗Measured using surface barrier detector and $(He^3)^{++}$ from π.
∗∗Measured using surface μ^+ edge.
∗∗∗Measured using 50Mev/c e^+.

1.2. Muon beam intensity, emittance and admixtures.

"At a typical proton beam current of 100μA, the beam line was tuned to deliver about 15,000 μ^+ per sec in a 1% momentum interval, focused in 0.3-msr cone on a ≅1-cm-radius spot at the muon-stopping target" [Ref.1, p.1971].

It corresponds to the beam divergence of ≅10mr and the beam emittance of ≅100mm·mr.

Admixture of π^+ was ≅0.15% [Ref.1, Fig.6].

The e^+/μ^+ ratio depends on steering the proton beam to the edge of production target. Primary proton beam position about 0.5–1mm lower the edge provides a minimum value of $e^+/\mu^+ \cong 1$ [2].

Some M13 beam parameters are shown in Figs.1, 1a.

One can see long tails of horizontal muon beam profile in Fig.1a at p=91MeV/c. The long tails are observed at surface beam also (see Fig.4, #3). Muons from the long tail can have $P_\mu<1$ and decrease therefore $P_\mu\xi$ value. Let me note here that M15 muon beam has not the long tails (see Fig.3.3.2). Big distance between quads for M15 line provides, probably, leaving of a particle with a large initial angle from the line. On the contrary, M13 is very dense line, and it promotes of a keeping of all particles inside the channel.

2. M13 beam line improvement (1984)[3]:

Table 2. Comparison of the measured currents in beam line elements between the initial (1980) tune and our recent work at 128Mev/c [Ref.3, p.119]

Element	Initial tune, A	% Difference	New tune, A	Comments
Q1	909	–27	713	New longer element
Q2	251	+3	259	Quad moved about 1cm
Q3	573	–2	563	
Q4	468	–5	446	New coils
Q5	573	–1	569	
Q6	237	0	237	
Q7	289	+15	341	Final focus moved
B1	175.1	–1.3	172.9	
B2	193.6	–1.4	190.9	

3. Apparatus for M13 beam line studies

Some apparatuses for measurement of beam emittance and particle separation are shown in Fig.1b.

3.1. Apparatus with two thin scintillators is shown as #1. Two thin scintillators (μ_1 and μ_2) with diameter of 46mm and thickness of 0.25mm serve as dE/dx counter. TRIUMF delay PC serves as 2D detector for X & Y profile measurement. Two thick scintillators (e_1 and e_2) register positron. The apparatus has been used for M13 and M15 beam studies. Results are presented below. Let me call some disadvantages of the apparatus:

- **Diameter 46mm of the μ-detectors is too small to measure muon profile tails. Counter with diameter $\cong$75mm is needed for the measurement. Increasing of the diameter of scintillator means a further worsening of e/μ/π separation. Proposed in [5] muon counter with diameter of 75mm can be useful for the beam studies.**
- **Amplitude distributions of pulses from pions and muons crossing with used μ_1 and μ_2 detectors. Therefore π/μ separation quality is not so good.**
- **Part of pions and muons stops in μ_1 or μ_2 scintillator, and decaying positron is register by e_1 and e_2 counters as a beam positron. Distance between μ_2 and e_1 (Fig.1b) must be about 300mm to eliminate the effect. The decaying positron will hit the delay chamber also and distort an initial muon space distribution. This effect can not be removed using the TRIUMF delay PC. We can not increase gap between the PC and μ_1 because muon scattering by the PC requests a further increasing of the muon scintillator size.**
- **TRIUMF delay PC scatters muons and pions because it has lot of materials (thick anode and especially cathode wires). Two our standard PC2 with standard gas (CF_4/ISO), and with standard front end (time + amplitude outputs) are the good substitution. Using of existing PCs with 0.75mm pitch and 1.5mm gap between cathodes requests a measurement of crosstalk value between wires and, besides, does not remove the problem of muon counter diameter increasing to the 75mm.**

Results of the M13 beam studies with the apparatus #1 are shown in Figs. 2-5.

3.2. Apparatus #2 with Si-diod was used for M13 beam study near F3 plane and results are shown in Fig.6. Let me mark a full separation of μ and π amplitude distributions (#2 and #3). μ/e separation is not so good (#1). Positron efficiency of the Si-diod is less than 100% (#1). Disadvantage of the apparatus is too small diameter of the used Si-diod (8mm only). Using of a 2D Si-counter with active area of $75\times75mm^2$ can provide very precise measurement of all beam parameters. Unfortunately it requests some expense for the detector itself and for a front end (several k$). Furthermore, it is open question about a possibility to provide both the time and the amplitude signals from the counter strips.

3.3. Suggested apparatus for more quality studies of M13 beam is shown as #3. PC2 measures an energy loss dE/dx of a particle. 3” scintillator with thickness of 1.5mm (for a surface muon beam study) provides a zero time t_0 for all particles and measures a total energy E_{total} for μ and π, and dE/dx for positron. Values of deposit energy in the PC2 [6] (4mm of DME gas) and in the scintillator (estimation) are shown in Table3.

Table 3. Deposit energies of "surface" beam in PC2 and scintillator

particle deposit energy,(keV)	positron	muon	pion
PC2	0.6-2	5-10	10-30
1.5mm scintillator	350	4000+(0-350) from $\mu \rightarrow e$ decay	3000+(0-4000) from $\pi \rightarrow \mu$ decay

Both the PC2 and the scintillator provide good μ/e separation. π/μ separation is not so good for PC2 and bad for the scintillator. A good π/μ separation provides only Si-diod (see above). Some advantages of the apparatus:

- **100% efficiency of positron registration.**
- **Complete μ/e separation because a positron signal will be much more (about 80e) than the PC2 noise and much more than a PMT noise because the scintillator is glued on photo-cathode directly. It is important for measurement of long time cloud muon tail.**
- **Positron/muon decaying backwards from the scintillator will hit the PC2 as before. This particle can be separated by time, amplitude and space analysis of the PC2 signals.**
- **Low cross talk value between wires because 2mm pitch.**

Best way is to manufacture 2 small PC2 with 32 wires per plane. One TDC module (96 channels) and one ADC module (64 channels) can serve the apparatus.

3.4. TEC muon counter (#4 in Fig.1b) can be used for the beam studies. The counter can be used near F3 plane only because a transversal size of the TEC must be less than 30-40mm in order to provide a suitable space resolution. Longitudinal electron diffusion in the TEC with a low pressure gas restricts the transversal size. In addition, ADC outputs are needed from the TEC to provide a π/μ separation. In addition, the TEC does not register positrons.

4. Beam emittance measurement

Direct measurement of muon beam emittance can be done with the TEC counter because a large muon scattering in different apparatuses destroys the beam sufficiently.

Two dimensional beam profile can be measured by the apparatus #1, 2 or 3 at 3-4 positions along Z-axis of the beam line. Discussion and results of the measurement for M15 beam are shown on p.p. 13-17 and in Figs. 3.3.2, 3.3.4.

5. Reference:

1. **A. Jodidio, B. Balke, J. Carr, G. Gidal, K.A. Shinsky, H.M. Steiner, D.P. Stoker, M. Strovink, R.D. Tripp, B. Gobbi, C.J. Oram, Physical Review D34 (1986)1967**
2. **C.J. Oram, J.B. Warren, G. Marshall, J. Doornbos, D. Ottewell, Preprint TRIUMF TRI–80–1, May 1980**
3. **TRIUMF Annual Report 1985, pp.118–119**
4. **B. Balke, G. Gidal, A. Jodidio, K.A. Shinsky, H.M. Steiner, P.D. Stoker, M. Strovink, R.D. Tripp, J. Carr, B. Gobbi, C.J. Oram, Physical Review D37(1988)587**
5. **M.A. Quraan, J.A. Macdonald, J.M. Poutissou, Muon Trigger Scintillator, TN-26, January 20, 1999**
6. **D.H. Wright, TN-21, 10 April 1998, Fig.10**

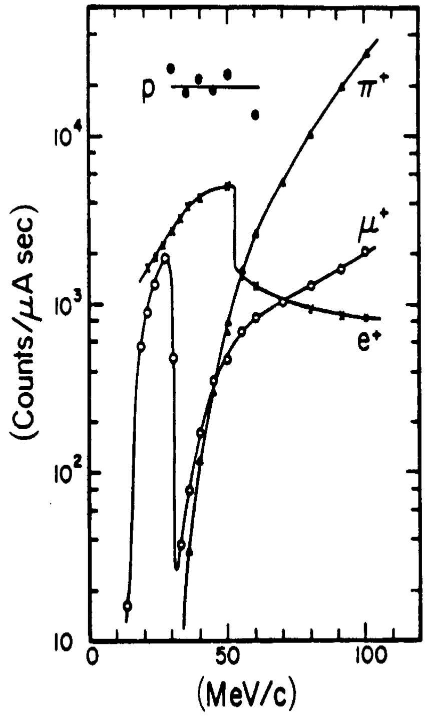

FIG. 5. Positive particle fluxes vs beamline momentum settings in the M13 beamline at TRIUMF (taken from Ref. 26). The data were collected with all slits and jaws in the beamline fully open.

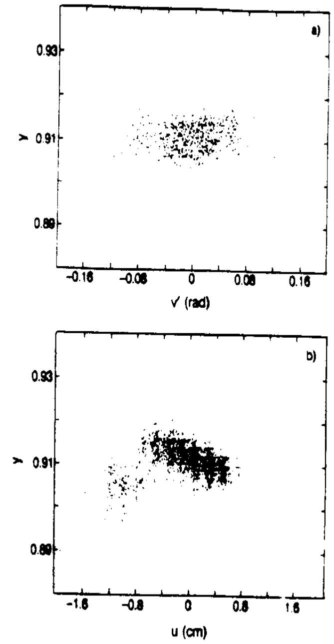

FIG. 8. Beam positron momentum correlations at $F3$. Correlations of the momentum delivered by the beam line with coordinates at the final focus $F3$, in a Cartesian system with w along the beam axis, u horizontal, v vertical, $u'=du/dw$, and $v'=dv/dw$. (a) Momentum y of beam positrons vs the vertical slope v' at $F3$. Cuts were made at $v'=\pm 0.05$ rad. (b) Positron momentum vs the horizontal coordinate u at $F3$. (b) and Fig. 9 indicate the presence of unexpected material in the target area near $S1$. Cuts were made at $u=\pm 0.7$ cm.

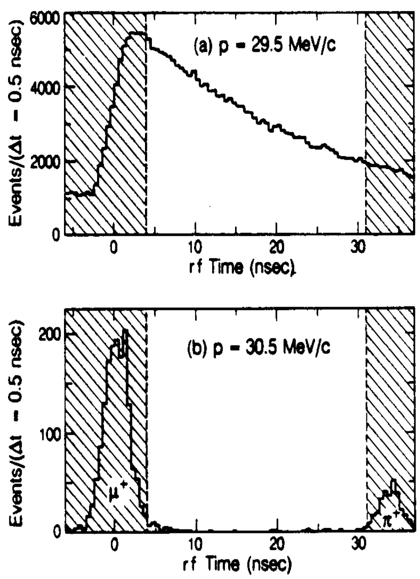

FIG. 6. Beam particle arrival times at the stopping target with respect to the cyclotron rf cycle at (a) 29.5 MeV/c and (b) 30.5 MeV/c. The shaded regions, containing almost all of the cloud μ^+ and prompt π^+ contaminations, were rejected.

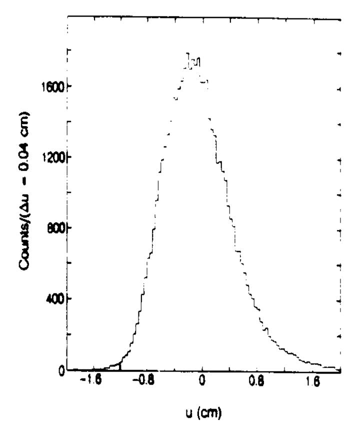

FIG. 9. Decay positron spot. See also the caption for Fig. 8. The distribution of decay positrons in intervals $\Delta u = 0.004$ cm vs the horizontal coordinate u at $F3$. The deficiency in counts for $u < -0.8$ cm indicates that muons at low u were stopped before reaching the target by extra material near $S1$.

Fig.1. Some M13 beam parameters from Ref.[1,4].

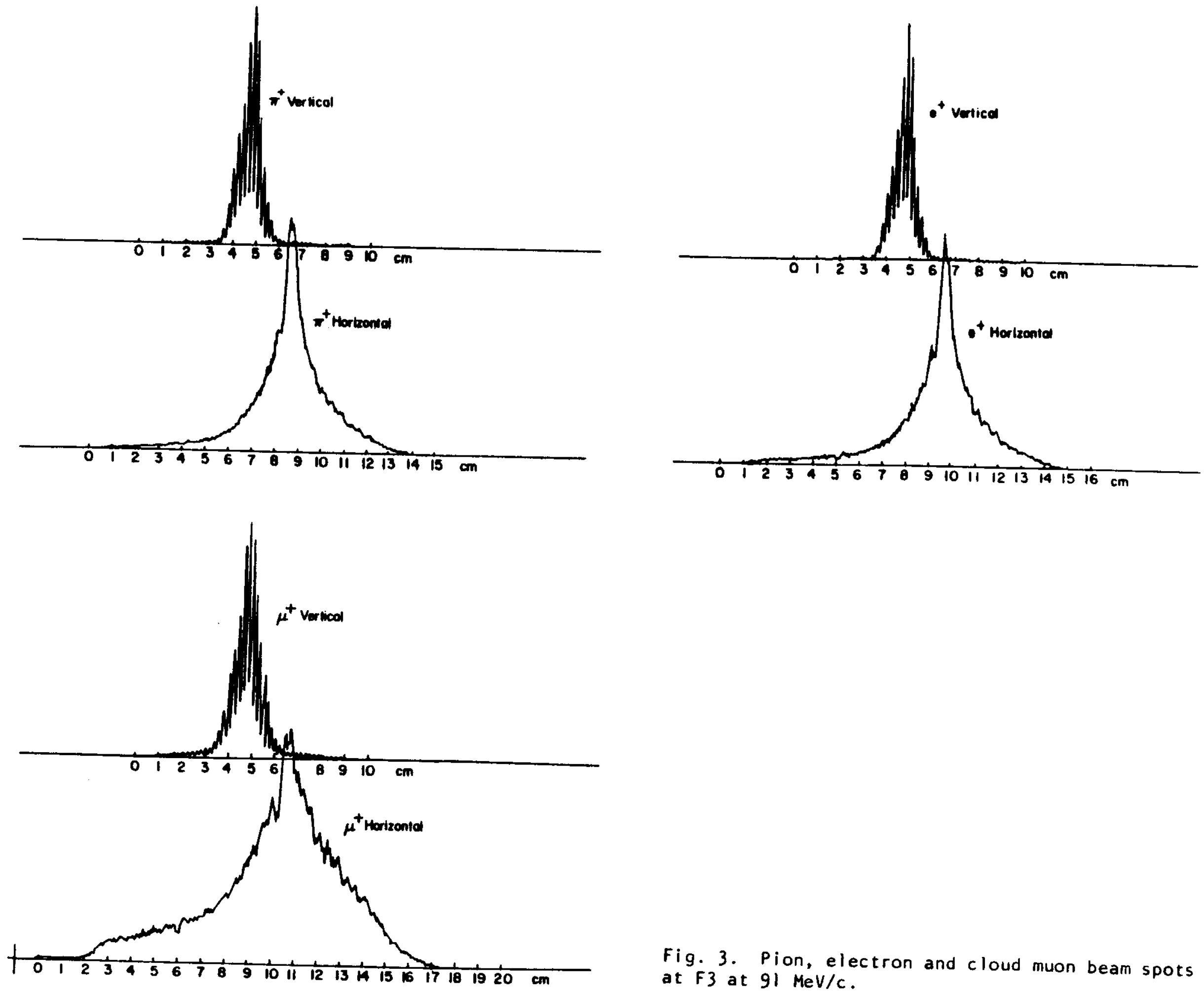

Fig. 3. Pion, electron and cloud muon beam spots at F3 at 91 MeV/c.

Fig.1a. Pion, positron and cloud muon beam spots at F3 at 91MeV/c [2]. All slits and jaws are open.

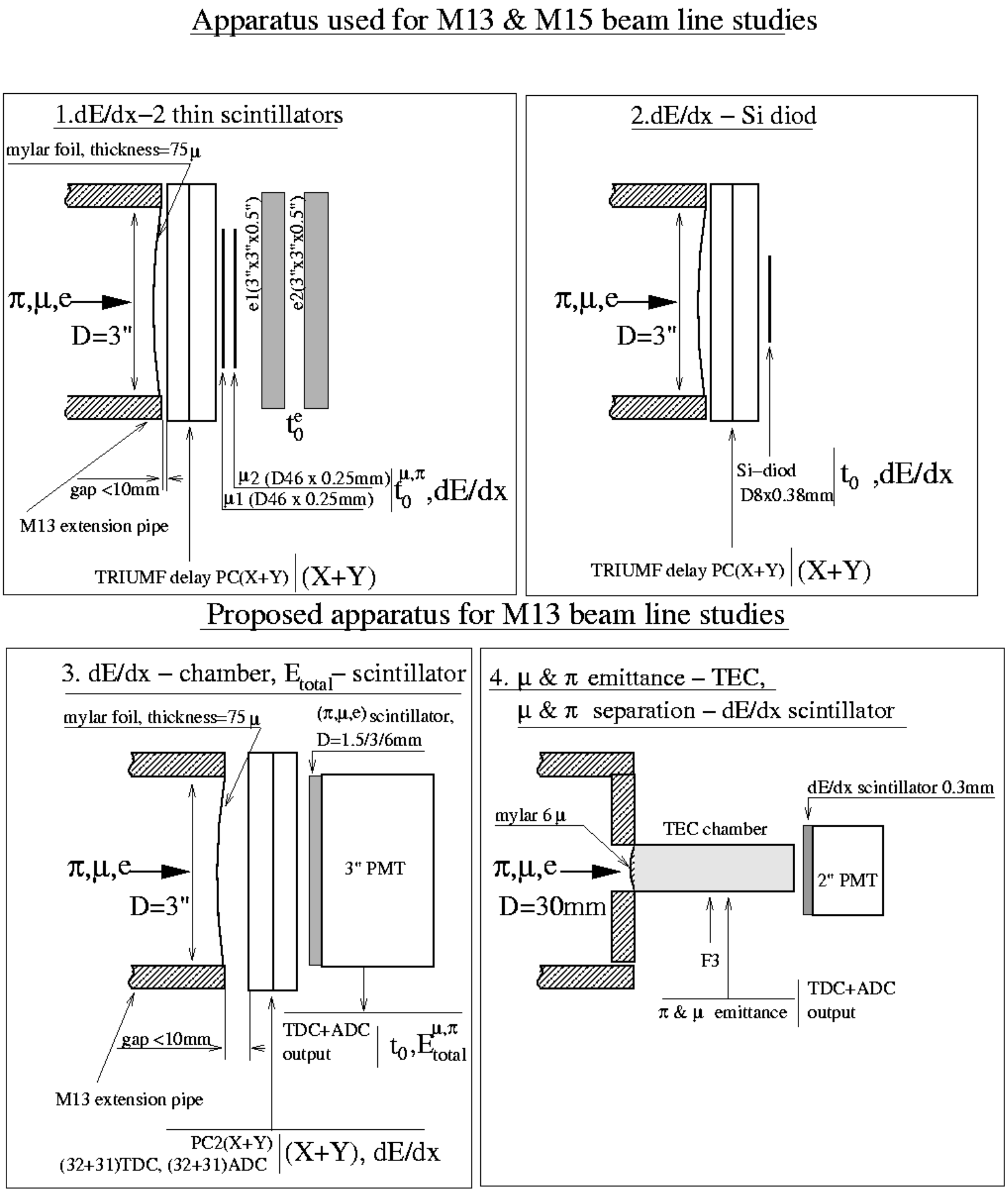

Fig.1b. Apparatus for M13 beam line studies

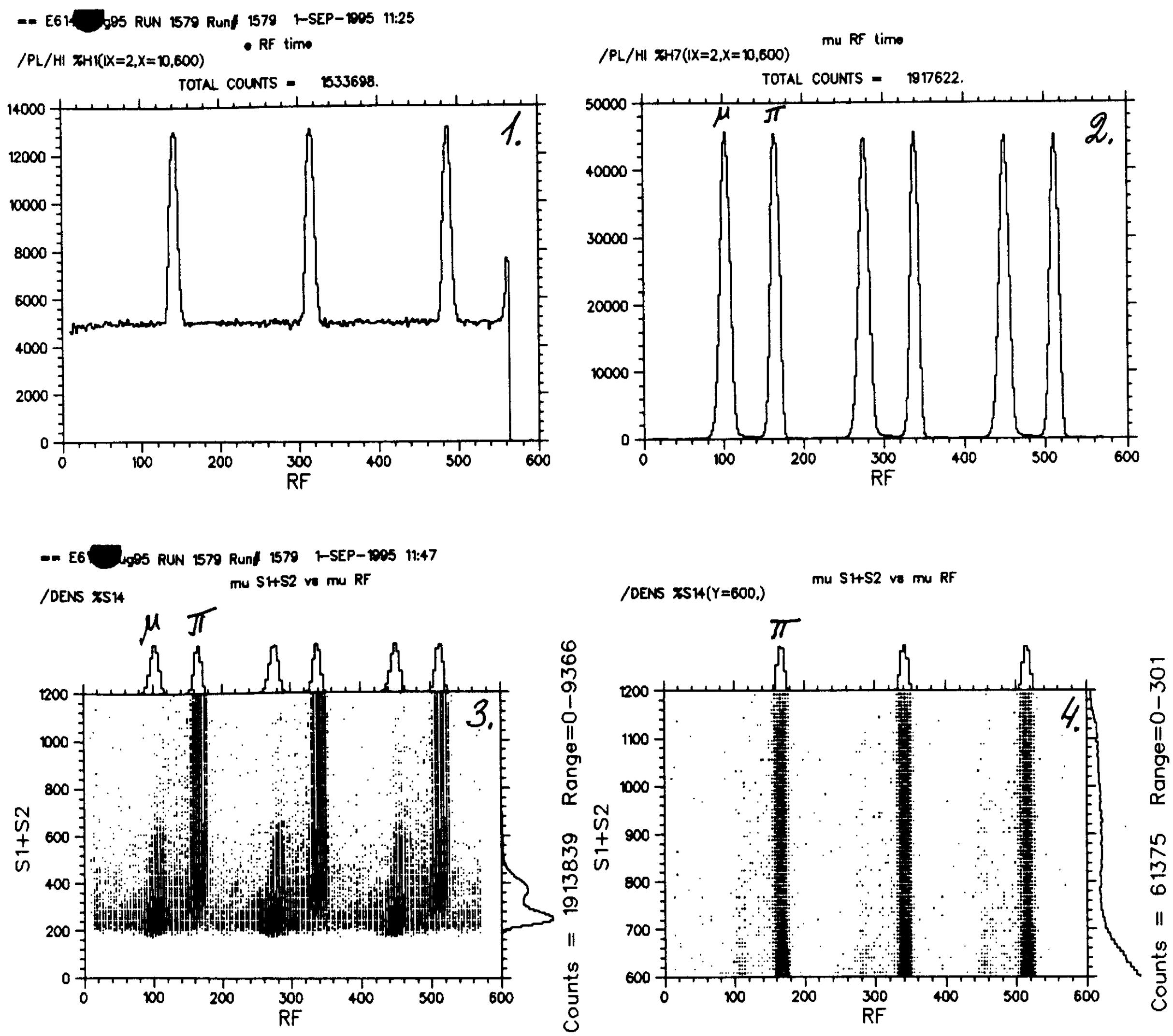

Fig.2. M13 beam at p=36MeV/c with two scintillators:

1. Positron flux $(e_1 \cdot e_2 \cdot \overline{\mu_1 \cdot \mu_2})$; 2. Muon & pion flux $(\overline{e_1 \cdot e_2} \cdot \mu_1 \cdot \mu_2)$;
3. Particle amplitude ($\mu_1 + \mu_2$) vs RF time.
4. Big particle amplitude ($\mu_1 + \mu_2$) vs RF time.

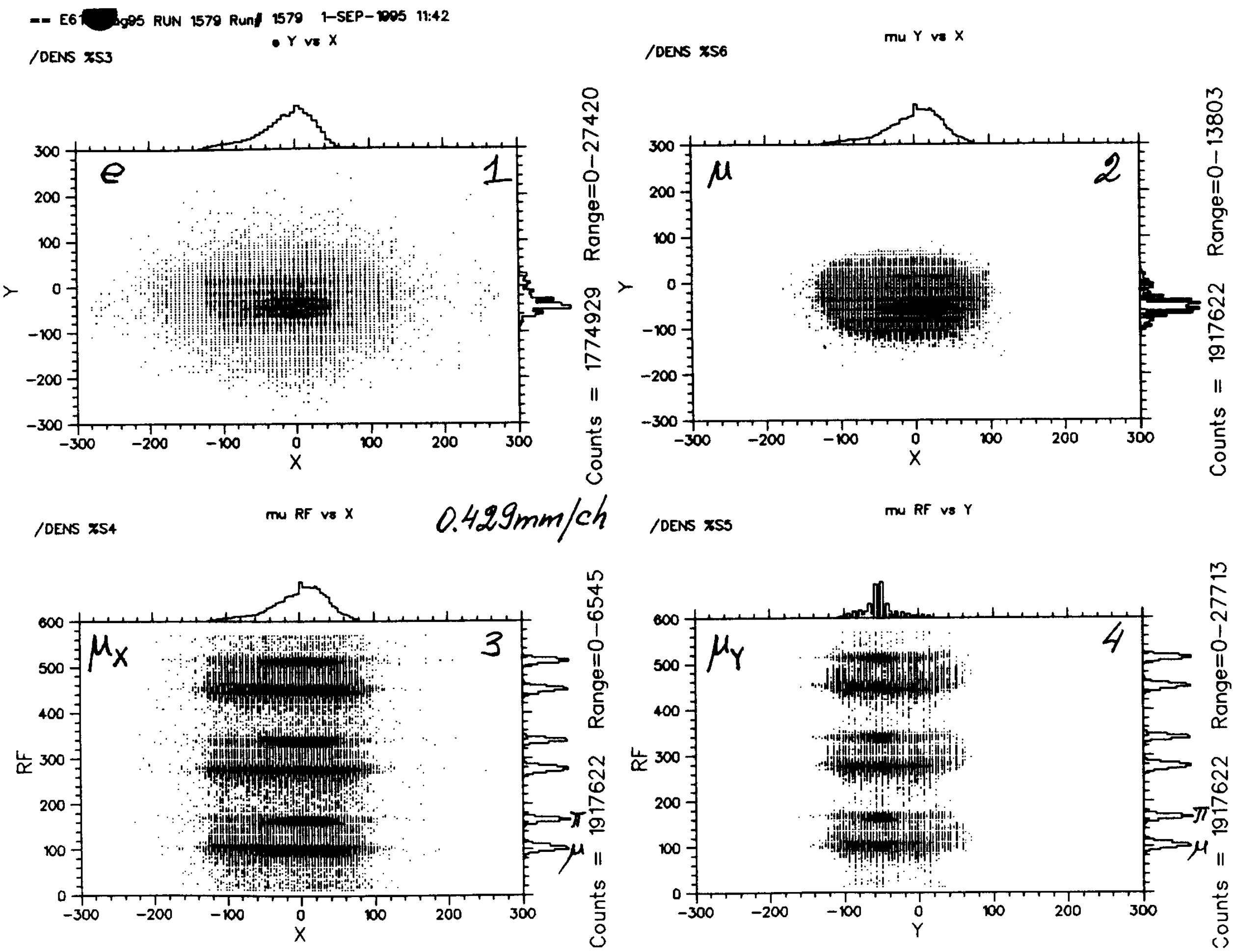

Fig.3. M13 beam at 36MeV/c with two thin scintillators:

1. Positron beam profile ($e_1 \cdot e_2 \cdot \overline{\mu_1 \cdot \mu_2}$); 2. (muon+pion) beam profile ($\overline{e_1 \cdot e_2} \cdot \mu_1 \cdot \mu_2$);

3. X profile of (muon+pion) beam ($\overline{e_1 \cdot e_2} \cdot \mu_1 \cdot \mu_2$) vs RF time;

4. Y profile of (muon+pion) beam ($\overline{e_1 \cdot e_2} \cdot \mu_1 \cdot \mu_2$) vs RF time.

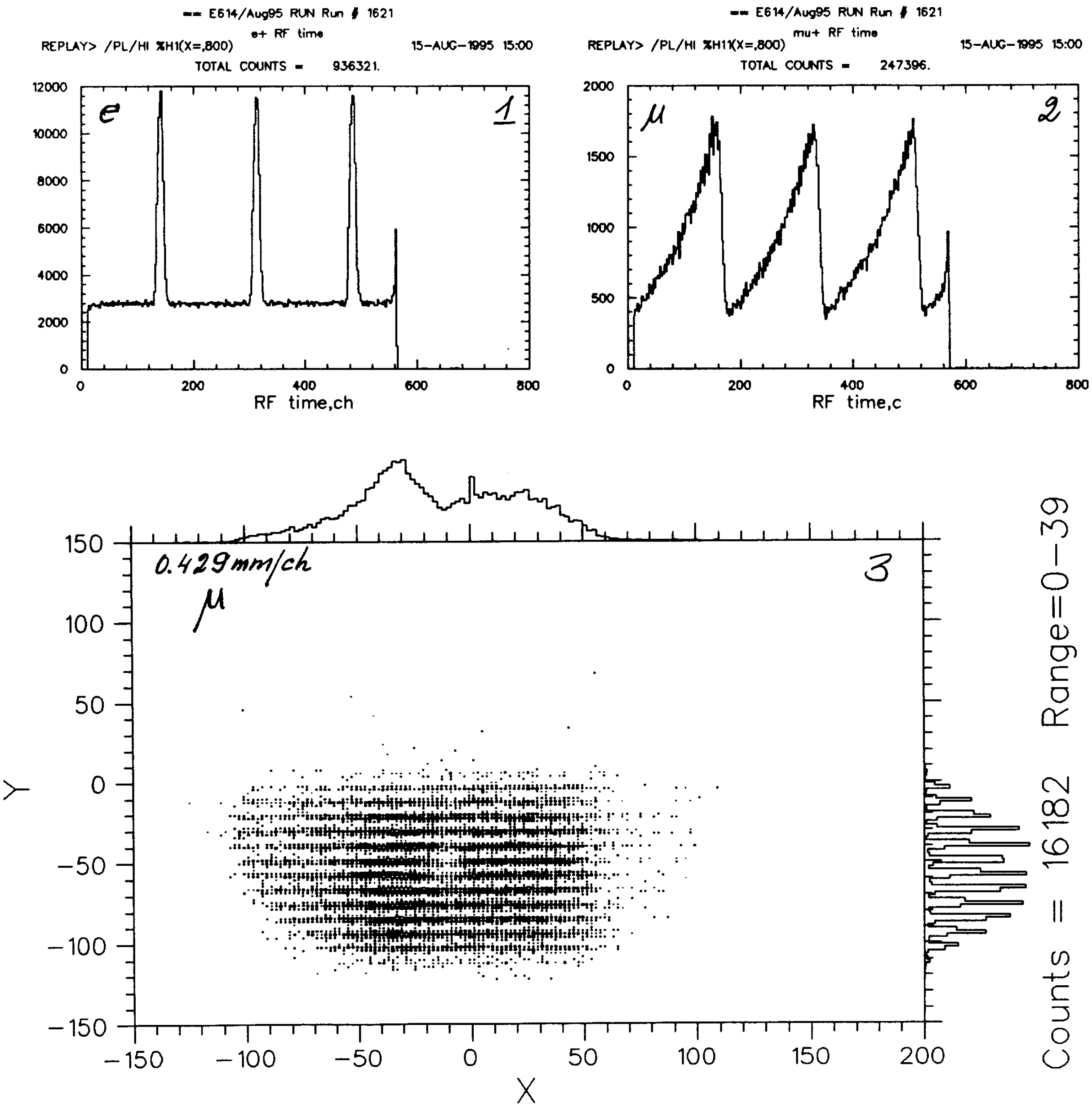

Fig.4. M13 beam at p=28MeV/c with two thin scintillators:
1. Positron flux ($e_1 \cdot e_2 \cdot \overline{\mu_1 \cdot \mu_2}$); 2. Muon flux ($\overline{e_1 \cdot e_2} \cdot \mu_1 \cdot \mu_2$);
3. Muon beam profile ($\overline{e_1 \cdot e_2} \cdot \mu_1 \cdot \mu_2$). Minimun of X–profile around X=–10 was caused by a dead zone of the delay PC.

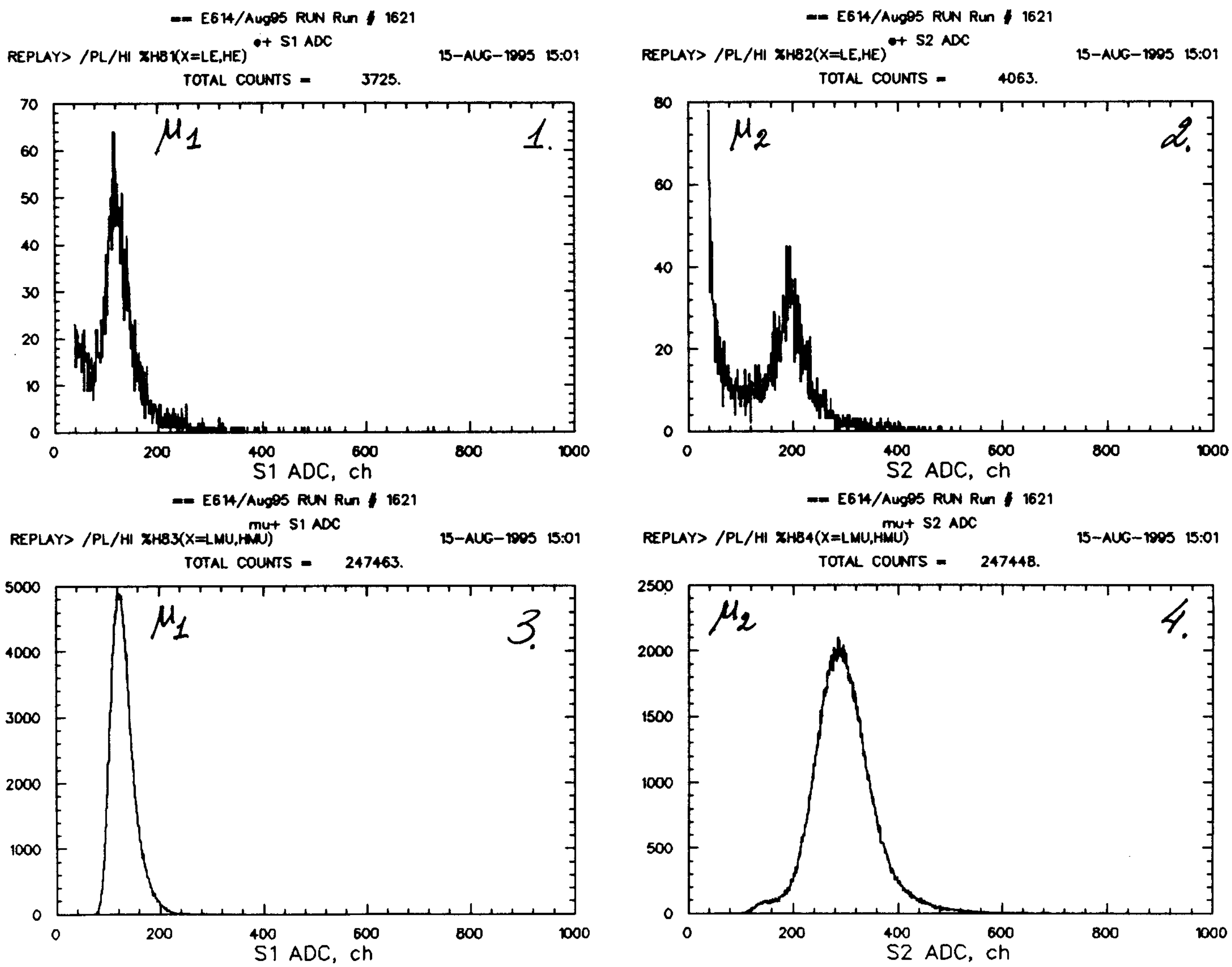

Fig.5. M13 beam at p=28MeV/c with two thin scintillators:

1. μ_1 amplitude with ($e_1 \cdot e_2 \cdot \mu_1 \cdot \mu_2$); 2. μ_2 amplitude with ($e_1 \cdot e_2 \cdot \mu_1 \cdot \mu_2$);
3. Raw μ_1 amplitude; 4. Raw μ_2 amplitude.

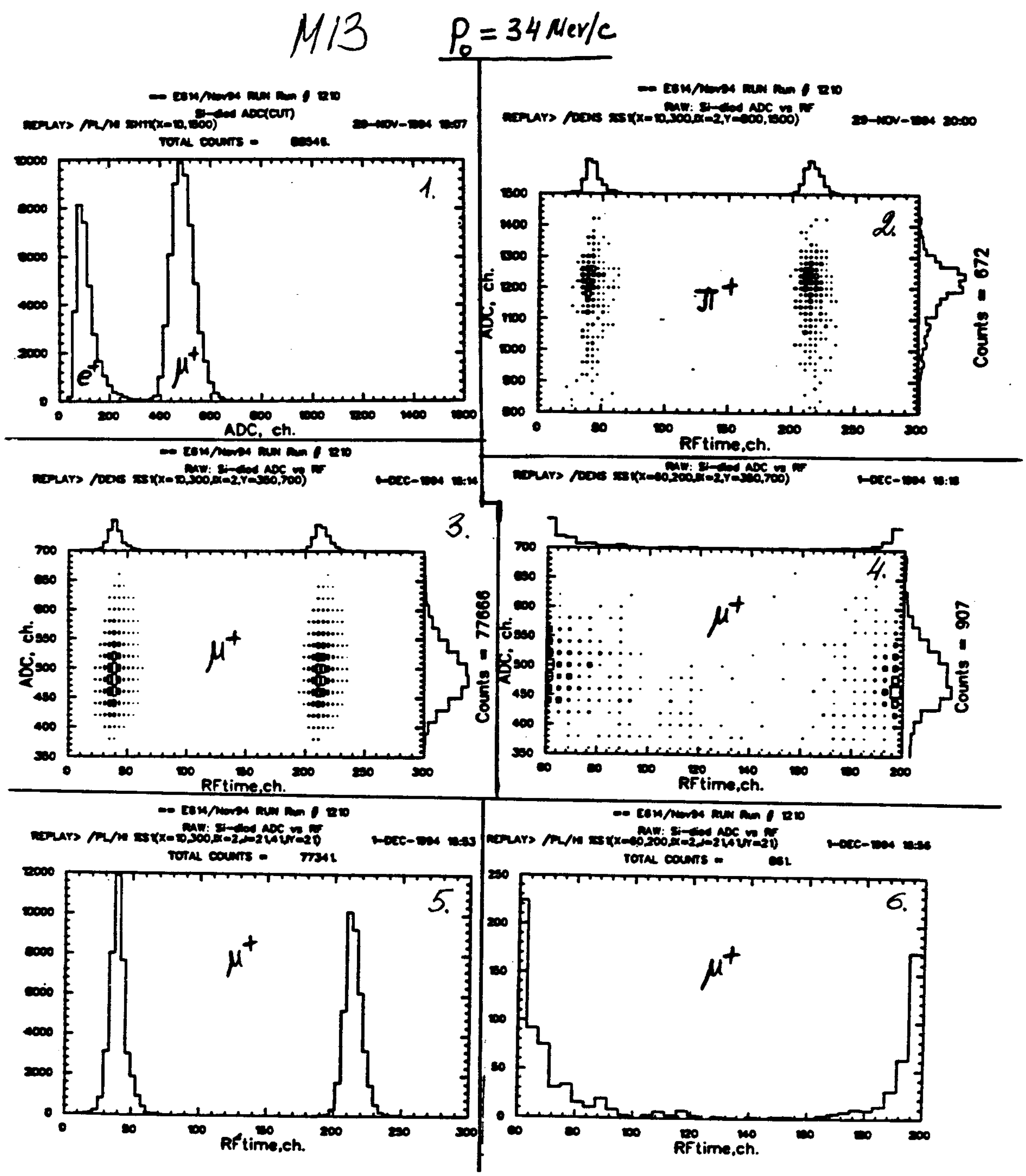

Fig6. M13 beam at p=34MeV/c with Si–diod:

1. Raw amplitude;
2. Scatter plot of pion amplitude vs RF time;
3. Scatter plot of muon amplitude vs RF time;
4. Scatter plot of muon amplitude between the cloud muon peaks vs RF time;
5. Muon amplitude vs RF time;

PRECISION MEASUREMENT OF MUON DECAY PARAMETERS

Review of the Experiment 614 TRIUMF

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Abstract

We propose to measure with high precision the differential muon $\mu^+ \to e^+\nu_e\tilde{\nu}_\mu$ decay rate $d^2N/dXd(cos\theta)$ in the range $0.4 < X \leq 1$ and $0.5 < |cos\theta| < 0.985$. The surface muons stop inside the thin planar aluminum stopping foil perpendicular to the muon beam direction. Positrons from μ decay going either upstream or downstream are recorded by one of the two planar drift chamber assemblies (PDCs) located symmetrically with respect to the stopped target each one consisting of 20 planes (10X + 10Y) perpendicular to the muon beam direction. The experiment will be done in axial magnetic field $B = 3T$.

Based on the analysis of total 10^9 recorded events of $\mu \to e$ decay the following constrains on the predominantly right-handed gauge boson W_2 mass and on the left-right mixing angle ζ will be obtained: $M(W_2) > 821GeV$ ($90\%C.L.$), $-0.0099 < \zeta < 0.0086$ ($90\%C.L.$).

M15 surface muon beam has been investigated. Prototypes of PDCs has been made and tested. Estimations of possible systematic errors for MTS spectrometer are given. Total statistical and systematic errors on Michel parameters are shown to be

$$\begin{aligned}
\sigma(P_\mu\xi) &= [\pm 10(stat) \pm 15(syst)] \cdot 10^{-5}, \\
\sigma(\rho) &= [\pm 5(stat) \pm 13(syst)] \cdot 10^{-5}, \\
\sigma(\delta) &= [\pm 18(stat) \pm 12(syst)] \cdot 10^{-5}.
\end{aligned}$$

The main sources of systematic errors are muon depolarization in fringe field, absolute positron energy calibration and radiative losses of positron in both stopped target and chambers assembly.

Draft, March 1994

3 Tests of the beam, PDCs prototype and muon depolarization in PC's gas.

3.1 Beam contamination.

The muon beam contamination and time structure were measured with plastic scintillators. The beam consists of "surface" muons, $2.5 \cdot 10^{-2}$ "cloud" muons per one "surface" muon (p.s.m.)(Fig.3.1.1) and 9.5 positrons (p.s.m.). The time structure of the cloud muon beam is presented on Fig.3.1.2. It is obvious from this figure that cloud muons polarization is approximately zero. The similar distribution for muons with $p = 29.4MeV/c$ is presented on Fig.3.1.3. As it follows from Fig.3.1.2, the fraction of other particles in the range of arrival times $(34 - 49)ns$ is less than $1.2 \cdot 10^{-5}$ (p.s.m.).

3.2 The momentum spread.

The momentum spread of the muon beam was measured by the time-of-flight method. The result is: $\Delta p/p = 1.4\%(FWHM)$, Fig.3.2.1.

3.3 Beam emittance.

The characteristics of the beam were measured with MWPCs. The final results are:

- beam emittance:
  $(133 \pm 13) mm \cdot mrad(X)$, $(136 \pm 14) mm \cdot mrad(Y)$ $(FWHM \times FWHM)$
- muon intensity is about 1400 muon/sec at $100\mu Amps$.

In our 1993 EEC progress report we presented the same estimations of beam emittance. Those estimates were done with the accuracy $(10 \div 20)\%$, which we considered and consider to be adequate for the preliminary estimates of the fringe field depolarization. Numerous questions and remarks forced us to repeat the measurements of beam emittance with better accuracy and take into account all possible errors. Our additional effords practically did not changed the previous estimates of the fringe field depolarization.

Our emittance measurements are based on the measurement of $2D$ distributions of the beam density in several transverse planes at different positions along beam axis. The commonly used method of simulteneous measurement with PDCs of both coordinate and angle of each beam particle gives very big systematic error for the surface muons in real conditions. Really, the multiple scattering angle of surface muons is about $15mrad$ for the $50\mu m$ mylar output window. Below we describe our approach.

Let the transverse distribution density of the beam in crossover (focus) in position z_{focus} be normal. For x plane it can be written in the form

$$p(x_0,\theta_{0x}) = \frac{1}{2\pi\sigma_{0x}\sigma_{0\theta_x}} exp(-\frac{x_0^2}{2\sigma_{0x}^2} - \frac{\theta_{0x}^2}{2\sigma_{0\theta_x}^2})$$

At the longitudinal distance $z - z_{x,focus}$ from the focus this distribution becomes for the beam in field-free space

$$p(x,\theta_x) = \frac{1}{2\pi\sigma_{0x}\sigma_{0\theta_x}} exp(-\frac{x_0^2(x)}{2\sigma_{0x}^2} - \frac{\theta_{0x}^2(\theta_x)}{2\sigma_{0\theta_x}^2})$$

where: $x = x_0 + (z - z_{x,focus}) \cdot tg\theta_{0x}, \;\; \theta_x = \theta_{0x}$. The transverse beam profile is given by the distribution density

$$p(x) = \int_{-\infty}^{\infty} p(x,\theta_x) d\theta_x$$

Under the assumption $\theta_x \ll 1$ one can readily obtain

$$p(x) = \frac{1}{\sqrt{2\pi}\sigma_x(z)} exp(-\frac{x^2}{2\sigma_x^2(z)})$$

$$\sigma_x(z) = \sigma_{0x}\sqrt{1 + (z\sigma_{0\theta_{0x}}/\sigma_{0x})^2}$$

The last equation describes the beam envelope along beam axis. Therefore, with this equation the measurements of transverse beam size $\sigma_x(z)$ at three different position z_1, z_2, z_3 allow to find σ_{0x}, $\sigma_{0\theta}$ in focus plane as well as the position of the focus $z_{x,focus}$. Beam emittance is defined as $\epsilon_x = \sigma_{0x} \times \sigma_{0\theta_{0x}}$ for x plane, and, similarly, $\epsilon_y = \sigma_{0y} \times \sigma_{0\theta_{0y}}$ for y plane.

The experimental setup for beam emittance measurements is shown on Fig.3.3.1.

Now we shall estimate possible systematic errors for our installation for the measurements of $2D$ distributions of the beam density.

- The multiple scattering angle for $50\mu m$ mylar output window of M15 beam line at momentum $p = 30MeV/c$ is $\theta_{0,\mu} = 15mrad$ for surface muons and $\theta_{0,e^+} = 4mrad$ for positrons. Therefore, an initial very narrow beam at the distance l will have nearly gaussian distribution with $\sigma = \theta_0 \cdot l$. For $l = 30mm$ the values of σ are: $\sigma_\mu^{out} = 0.45mm$, $\sigma_{e^+}^{out} = 0.12mm$.

- Similar calculations for the protecting kapton window of PCs assembly give: $\sigma_\mu^{pr} = 0.09mm$, $\sigma_{e^+}^{pr} = 0.02mm$.

- The values of σ for cathode planes are: $\sigma_\mu^c = 0.14mm$, $\sigma_{e^+}^c = 0.02mm$.

- The space resolution of PC itself is $\sigma^{PC} = 1mm$.

Hence, the measured beam size σ^{meas} is given by the equation

$$(\sigma^{meas})^2 = \sigma^{true} \oplus \sigma^{out} \oplus \sigma^{pr} \oplus \sigma^c \oplus \sigma^{PC}$$

Here σ^{true} is the true beam size.

For the conditions of our measurements

$$\sigma_\mu^{true} = \sqrt{(\sigma_\mu^{meas})^2 - (1.1mm)^2}$$

and

$$\sigma_{e^+}^{true} = \sqrt{(\sigma_{e^+}^{meas})^2 - (1mm)^2}$$

Somewhat different effect has a foil inside M15 beam line. Let's assume that the beam has crossover at the position of the foil with parameters σ_x and σ_{θ_x} and the foil multiple scattering angle is σ_θ^{sc}. Then the beam emittance in front of the foil is given by $\epsilon_0 = \sigma_x \cdot \sigma_{\theta_x}$. After the foil it becomes $\epsilon_1 = \sigma_x \cdot \sigma_{\theta_x} \cdot \sqrt{1 + (\sigma_\theta^{sc}/\sigma_{\theta_x})^2}$. If the foil is at the position where $\sigma_\theta^{sc} << \sigma_{\theta_x}$ then it practically does not effect the beam emittance, while if $\sigma_\theta^{sc} >> \sigma_{\theta_x}$ then $\epsilon_1 >> \epsilon_0$ and the emittance of the beam is fully determined by the foil. That is why any foil can be installed in M15 beam line only in positions where $\sigma_\theta^{sc} << \sigma_{\theta_x}, \sigma_{\theta_y}$. In particular, for $3\mu m$ polyester foil $\sigma_{\theta,\mu}^{sc} = 3.1mrad$, $\sigma_{\theta,e^+}^{sc} = 0.83mrad$.

Now we'll proceed with the analysis of the results of the beam size measurements.

Beam profiles for two different positions of slits $SL1$ and $SL2$ are presented on Fig.3.3.2,3.3.3. In both cases muon beam intensity was approximately the same. Muon beam spot size is smaller for the case of Pos.SL1=-2mm, Pos.SL2=-15mm. Nevertheless, we shall use the data from the Fig.3.3.2 taken with Pos.SL1=Pos.SL2=0mm to compare with our previous data from Feb'93 runs taken under the same conditions. Fig.3.3.4 shows the measured FWHM values of beam transverse sizes at four different positions along beam axis. Data at positions 380,1150 and 1770mm were taken in Feb'93 runs and were presented in our July'93 EEC Progress Report. Data at position 1104mm were obtained in Aug'93, also two $3\mu m$ polyester foils were removed from the M15 channel. The newly measured beam sizes are: $FWHM^{meas}_{\mu,x} = 9.7mm$, $FWHM^{meas}_{\mu,y} = 8.0mm$, $FWHM^{meas}_{e,x} = 9.3mm$, $FWHM^{meas}_{e,y} = 7.4mm$. Taking into account multiple scattering of muons and positrons, we obtain: $FWHM^{true}_{\mu,x} = 9.3mm$, $FWHM^{true}_{\mu,y} = 7.6mm$, $FWHM^{true}_{e,x} = 9.0mm$, $FWHM^{true}_{e,y} = 7.0mm$.

Positron beam size at $z = 1104mm$ after correction for multiple scattering is slightly smaller than the one measured in Feb'93 runs, while muon beam size practically the same. We estimate the errors in measured FWHM values to be about $\pm 10\%$. That is why we repeat here the estimate for muon beam emittance presented eirlier in our July'93 EEC Report:

$$\epsilon_x = (133 \pm 13)mm \cdot mrad\ (FWHM)$$

$$\epsilon_y = (136 \pm 14)mm \cdot mrad\ (FWHM)$$

We want to note here, that fringe field depolarization effect (Sec. 4.9) was estimated under the assumption of $160mm \cdot mrad$.

3.4 *PDC*s assembly prototype.

We made and tested 12 planar drift chambers with 10 sense wires in each plane.

Chamber parameters:

Sense wire diameter	$12\mu m$ (W)Au
Field wire diameter	$25\mu m$ (W)Au
High voltage planes	$6\mu m$ (mylar)Al
Wire distances	$2mm$
Gap width	$2mm$
Drift gas	DME

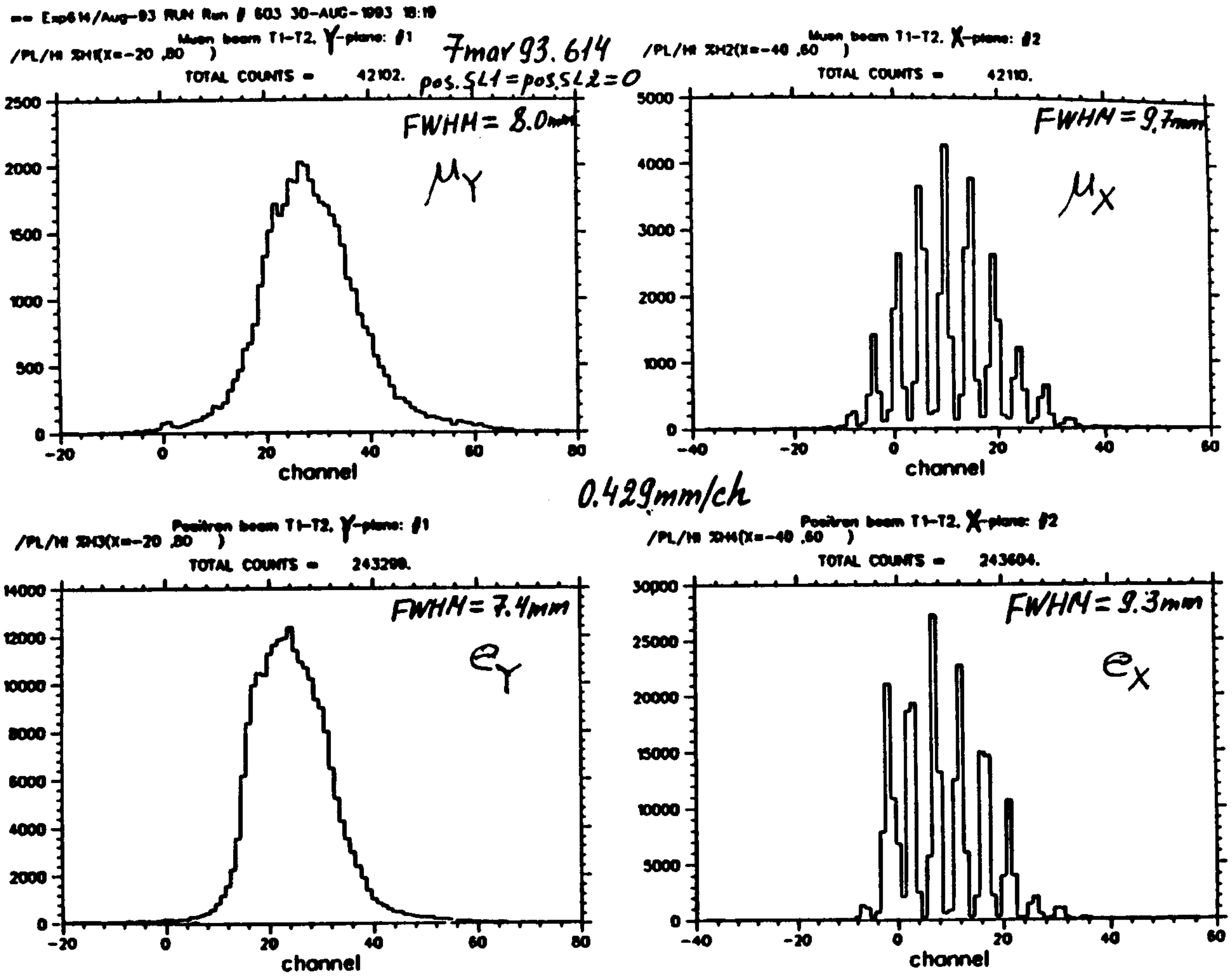

Figure 3.3.2: Measured beam profiles at the distance $1104mm$ from Q17 centre. Data were taken with slits 1,2 in the positions: $Pos.SL1 = Pos.SL2 = 0mm$.

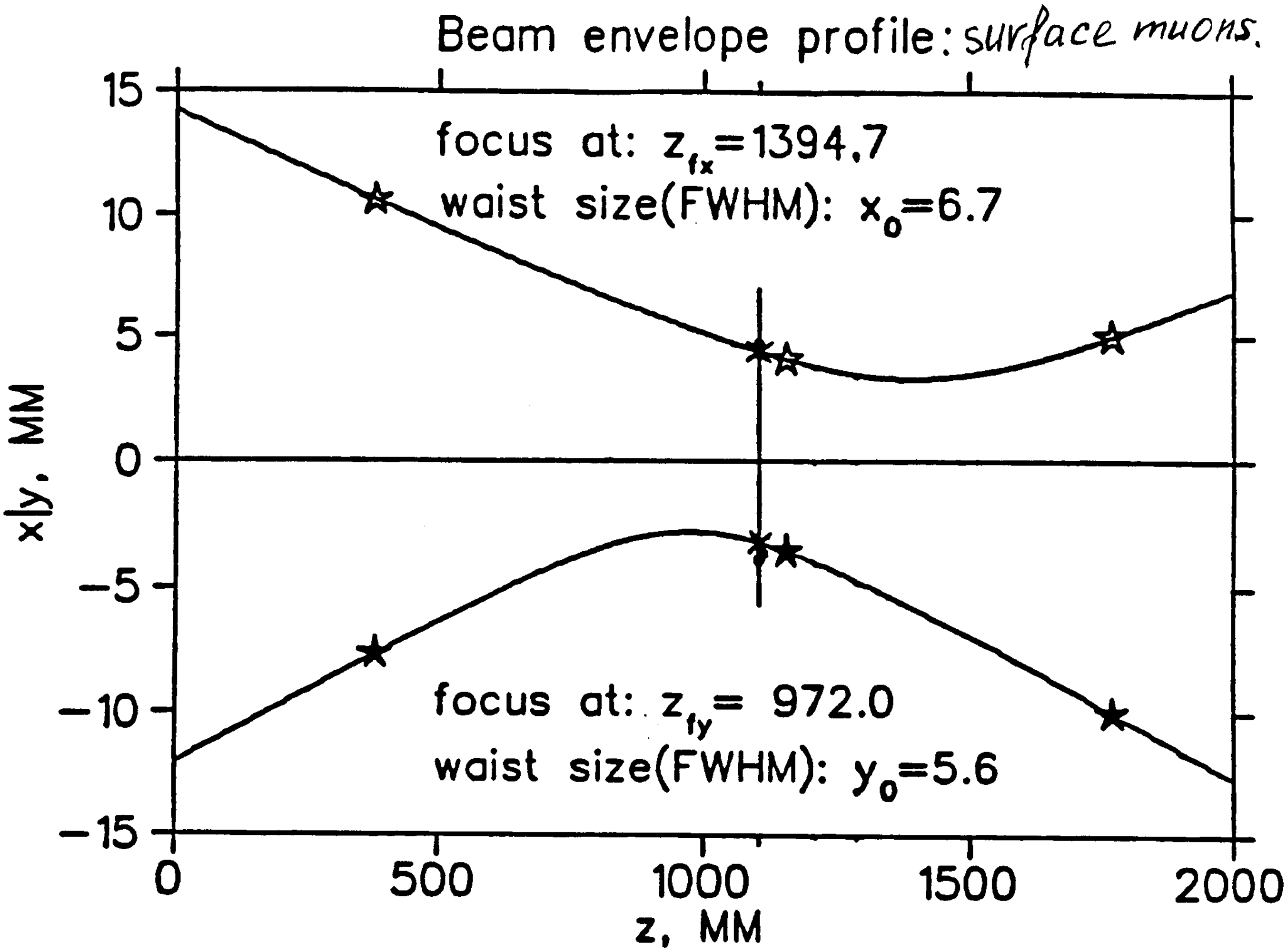

Figure 3.3.4: Beam profiles FWHM as a function of longitudinal coordinate. They were measured at the distances 380*cm*, 1150*cm* and 1770*cm* from Q17 center. Solid curves are fitted envelopes of the positron beam for X and Y plane. These data were taken during Feb'93 runs. Data for the distance 1104*mm* (Fig.3.3.2) were measured during Aug'93 runs. Points on the plot represent the measured FWHM values for muons and crosses — for positrons.