EP

For the elastic scattering $e^- + H \longrightarrow e^- + p$, we have the formula :

$$E = M_p \frac{cos\theta_e + \dfrac{sin\theta_e}{tg\theta_p} - 1}{1 - cos\theta_e}$$

M_p is the proton mass; θ_e, θ_p are the scattering angles of the electron and the proton. In the following, E_1 and E_2 are the beam energies calculated with one arm (trigger UP for example) and the other arm (trigger DOWN). α is the angle between the incident electron and the theoretical direction of the beam.

$$\begin{aligned} E_1(\theta_e - \alpha, \theta_p + \alpha) = E(\theta_e, \theta_p) \; & + \; \alpha \left(\frac{\partial E(\theta_e, \theta_p)}{\partial \theta_p} - \frac{\partial E(\theta_e, \theta_p)}{\partial \theta_e} \right) \\ & + \; \frac{\alpha^2}{2} \left(\frac{\partial^2 E(\theta_e, \theta_p)}{\partial \theta_p^2} + \frac{\partial^2 E(\theta_e, \theta_p)}{\partial \theta_e^2} - 2 \frac{\partial^2 E(\theta_e, \theta_p)}{\partial \theta_p \, \partial \theta_e} \right) \quad (1) \\ & + \; O(\theta_e^3, \theta_p^3) \end{aligned}$$

$$\begin{aligned} E_2(\theta_e + \alpha, \theta_p - \alpha) = E(\theta_e, \theta_p) \; & - \; \alpha \left(\frac{\partial E(\theta_e, \theta_p)}{\partial \theta_p} - \frac{\partial E(\theta_e, \theta_p)}{\partial \theta_e} \right) \\ & + \; \frac{\alpha^2}{2} \left(\frac{\partial^2 E(\theta_e, \theta_p)}{\partial \theta_p^2} + \frac{\partial^2 E(\theta_e, \theta_p)}{\partial \theta_e^2} - 2 \frac{\partial^2 E(\theta_e, \theta_p)}{\partial \theta_p \, \partial \theta_e} \right) \quad (2) \\ & + \; O(\theta_e^3, \theta_p^3) \end{aligned}$$

- $(1) + (2) \Longrightarrow E \simeq \dfrac{E_1 + E_2}{2} - \dfrac{\alpha^2}{2} \left(\dfrac{\partial^2 E}{\partial \theta_p^2} + \dfrac{\partial^2 E}{\partial \theta_e^2} - 2 \dfrac{\partial^2 E}{\partial \theta_p \, \partial \theta_e} \right)$

- $(1) - (2) \Longrightarrow \alpha \simeq \dfrac{E_1 - E_2}{2 \left(\dfrac{\partial E}{\partial \theta_p} - \dfrac{\partial E}{\partial \theta_e} \right)}$

With :

$$\frac{\partial E}{\partial \theta_e} = \frac{M_p}{tg\theta_p (cos\theta_e - 1)}$$

$$\frac{\partial E}{\partial \theta_p} = \frac{M_p \, sin\theta_e}{sin^2\theta_p \, (cos\theta_e - 1)}$$

$$\frac{\partial^2 E}{\partial \theta_e^2} = \frac{M_p \, sin\theta_e}{tg\theta_p (1 - cos\theta_e)^2}$$

$$\frac{\partial^2 E}{\partial \theta_p^2} = \frac{2 \, M_p \, sin\theta_e cos\theta_p}{sin^3\theta_p (1 - cos\theta_e)}$$

$$\frac{\partial^2 E}{\partial \theta_e \partial \theta_p} = \frac{M_p}{sin^2\theta_p \, (1 - cos\theta_e)}$$

k GeV/c	P_p GeV/c	k' GeV/c	θ_e ^{o}	$O^1(\theta_e, \theta_p)$ GeV/rad	$O^2(\theta_e, \theta_p)$ GeV/rad^2
0.5	0.336	0.442	41.3	-1.14	-0.22
1.0	0.519	0.866	31.2	-0.74	0.64
2.0	0.722	1.754	20.9	1.45	7.24
3.0	0.836	2.682	15.7	5.49	24.59
4.0	0.909	3.632	12.5	11.38	57.81
5.0	0.960	4.596	10.4	19.10	112.01
6.0	0.998	5.568	8.9	28.68	192.30

With :

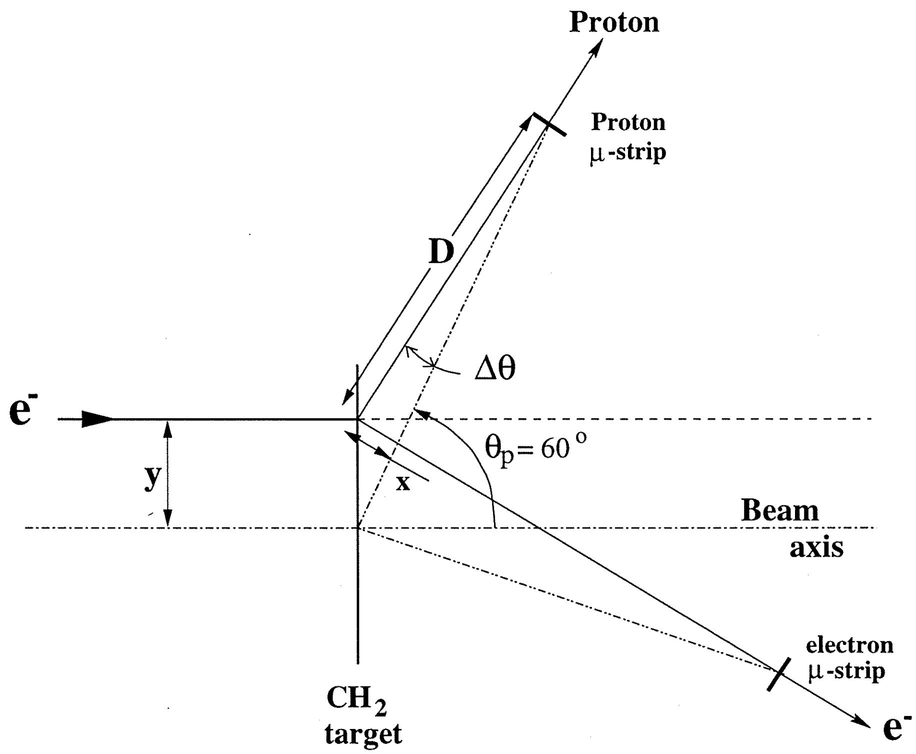
$\theta_p = 60\ ^o$

$$O(\theta_e, \theta_p) = \frac{\partial E}{\partial \theta_p} - \frac{\partial E}{\partial \theta_e}$$

$$O(\theta_e^2, \theta_p^2) = \frac{1}{2}\left(\frac{\partial^2 E}{\partial \theta_p^2} + \frac{\partial^2 E}{\partial \theta_e^2} - 2\,\frac{\partial^2 E}{\partial \theta_p\, \partial \theta_e}\right)$$

k	$\alpha = 0.5\, mrad$		$\alpha = 1.0\, mrad$		$\alpha = 1.5\, mrad$		$\alpha = 2.0\, mrad$	
GeV/c	$E1 - E2$ MeV/c	$2^{nd} Order$ keV/c	$E1 - E2$ MeV/c	$2^{nd} Order$ keV/c	$E1 - E2$ MeV/c	$2^{nd} Order$ keV/c	$E1 - E2$ MeV/c	$2^{nd} Order$ keV/c
0.5	-1.14	0.1	-2.28	0.2	-3.42	0.5	-4.57	0.9
1.0	-0.74	-0.2	-1.48	-0.6	-2.21	-1.4	-2.95	-2.6
2.0	1.45	-1.8	2.91	-7.2	4.36	-16.3	5.82	-28.9
3.0	5.49	-6.1	10.98	-24.6	16.47	-55.3	21.97	-98.3
4.0	11.38	-14.5	22.75	-57.8	34.13	-130.1	45.50	-231.2
5.0	19.10	-28.0	38.21	-112.0	57.31	-252.0	76.42	-448.0
6.0	28.68	-48.1	57.36	-192.3	86.04	-432.7	114.72	-769.2

Drawing in "the reaction plane" :



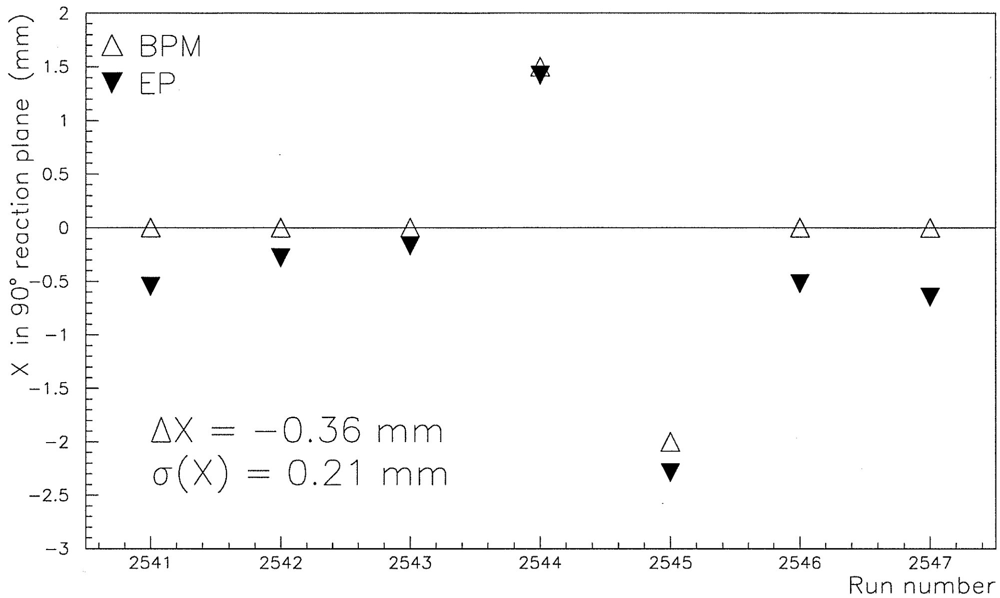
$$\sin \Delta\theta \simeq \Delta\theta = \frac{x}{D}$$

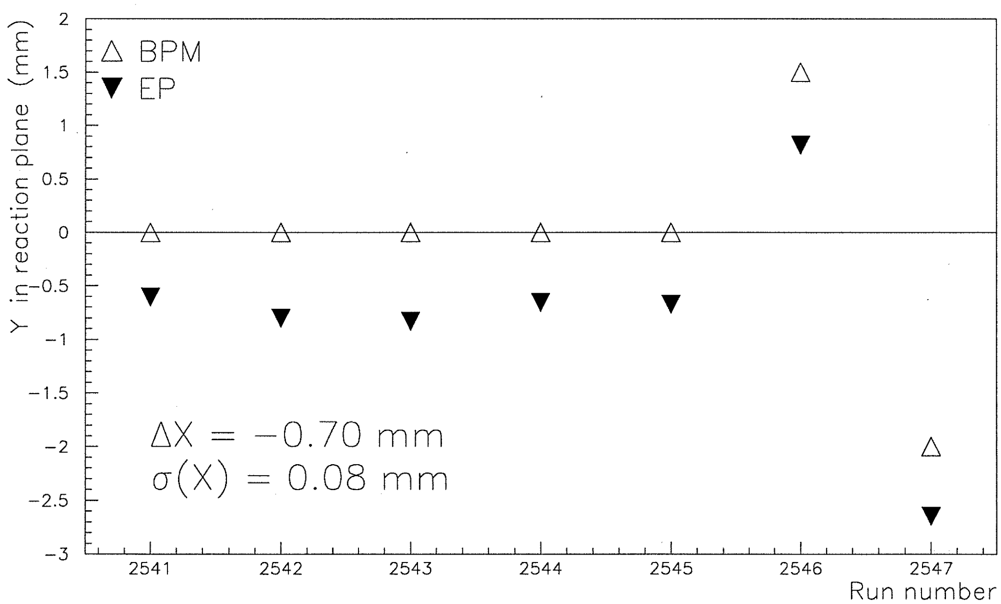
$$y = \frac{x}{\cos 60}$$

$$\boxed{y \simeq 2\,D\,\Delta\theta}$$

Determination of the vertex position :

comparison between EP and BPM values (may 1999).



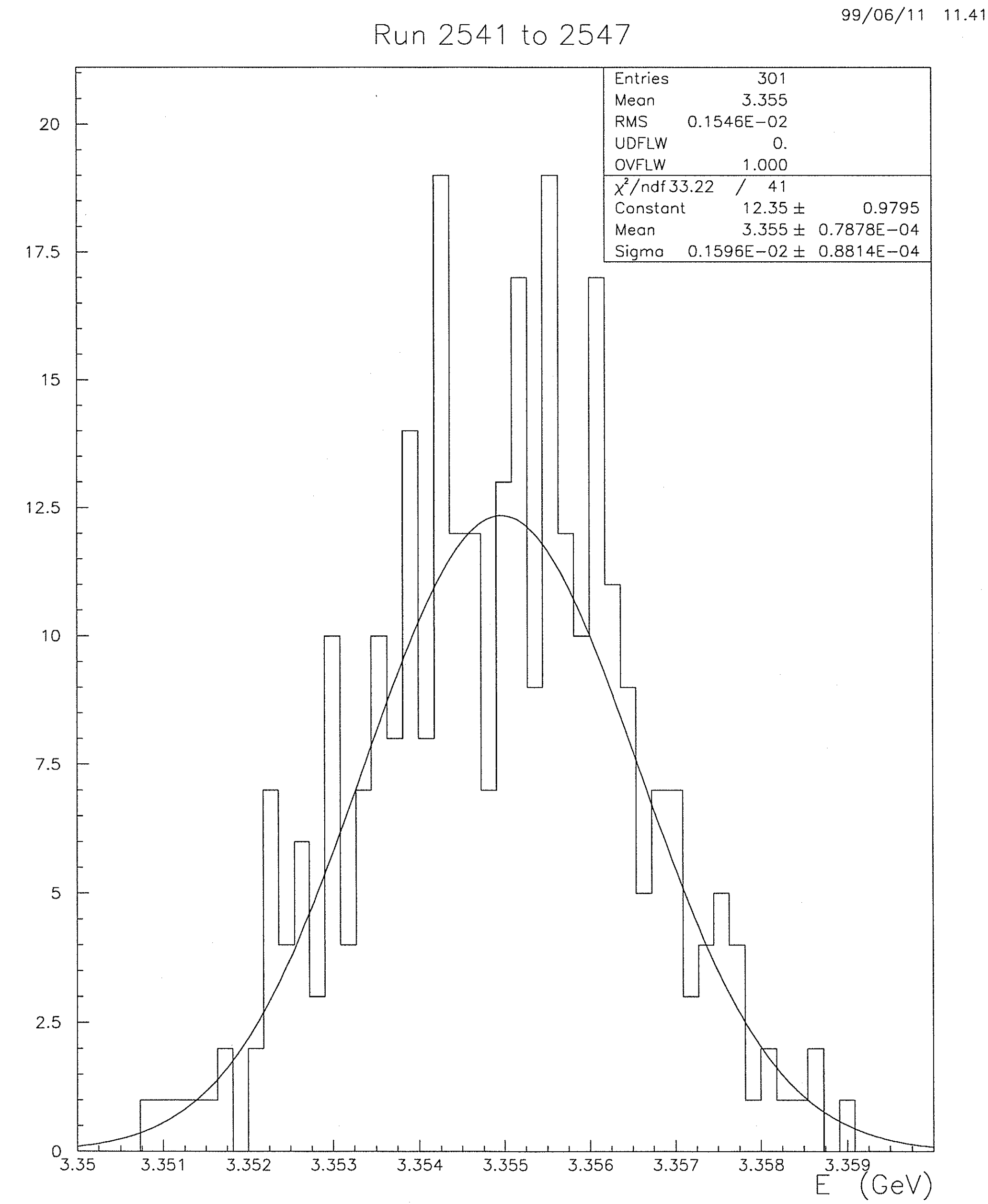


Interesting points :

- absolute calibration of BPM values (but firstly, should be better to make an EP calibration with "super-harps" data coming from ARC),
- auto-calibration of μ-strips, if we have to replace one!

EP	**3354.98 ± 0.54 ± 0.7 MeV**
ARC	**3355.10** ± 0.7 MeV
Accelerator	**3362.00 MeV**

Relatif gap between EP-ARC : 3.5 10^{-5}



Following data was taken may 27^{th}, 1999.

Run	Time $(h:mn)$	I (μA)	Triggers	Rate $(cps/\mu A/mn)$	Efficiency (%)
2541	0:37	5.9	47	0.22	33
2542	0:27	5.8	43	0.27	42
2543	0:42	11.8	102	0.22	31
2544	0:28	6.75	31	0.16	25
2545	0:30	6.65	24	0.12	18
2546	0:31	6.5	32	0.16	24
2547	0:36	7.	22	0.09	13
Total	3:51		301		

Rq : efficiency is evaluated from rates calculated with the proton elastic form factors.

The first 3 runs were taken when beam was centered on the EP target (CH_2) of 13 μm thickness :

$\Longrightarrow$ Rates = 0.23 coups/μA/mn (100 hits in 36 mn at 12 μA)

Run 2541 is the only one for which the beam didn't pass through the polarimeter magnetic chicane. The halo "attenuated" by the chicane should explain the increasing efficiency from 33 to 42% for run 2542!

For the last other runs, beam was not centered.

We may conclude that an explanation for the efficiency decreasing in terms of halo should be retained.