





# MERIT Data Analysis

(latest update : 07Oct08)

## Contents

1. Estimate of beam spot size using emittance measurements and optics 
2. Alignment information and beam direction 
3. Impact point calculation from the MTV data 
4. Pump/probe analysis 

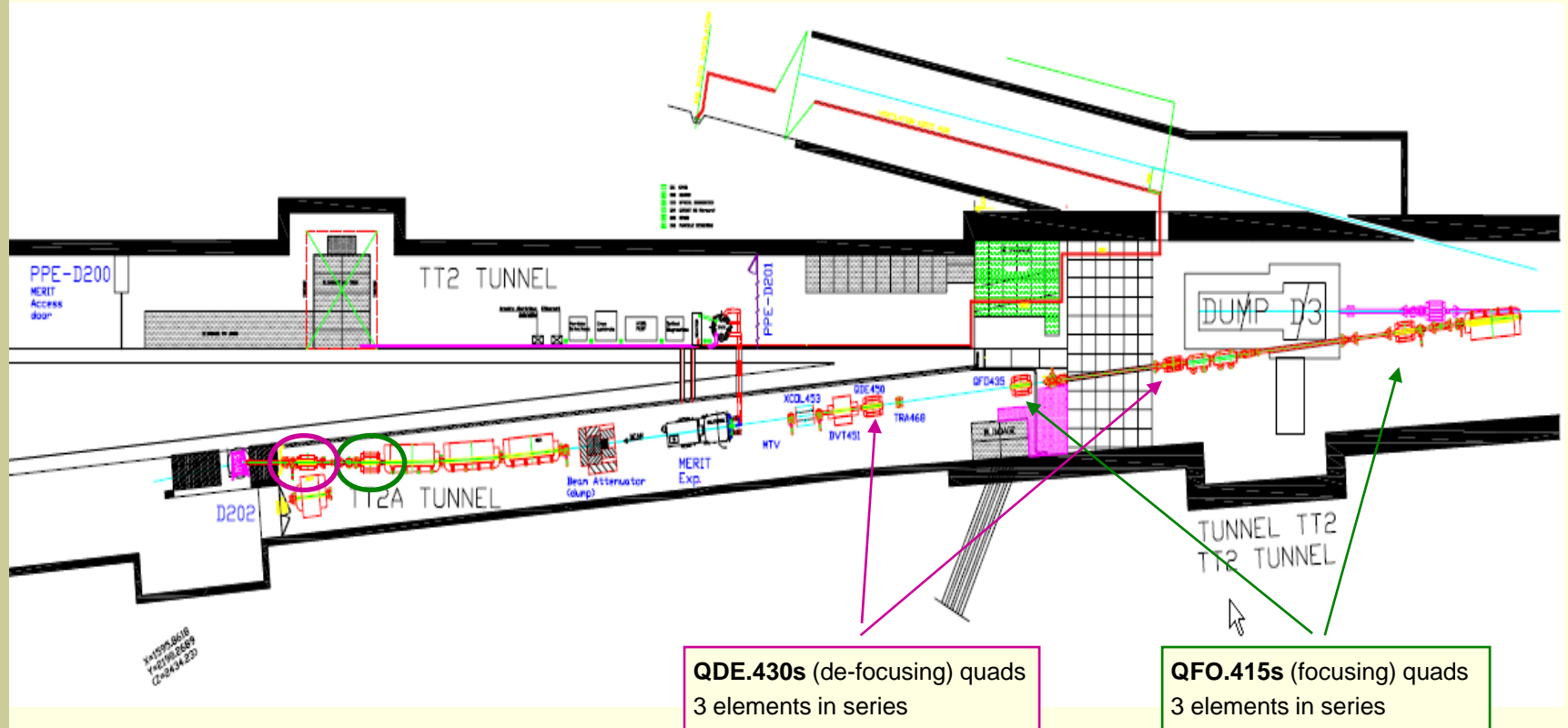
**CERN/MERIT team:** Adrian Fabich, J. Lettry, M. Palm,

I. Efthymiopoulos

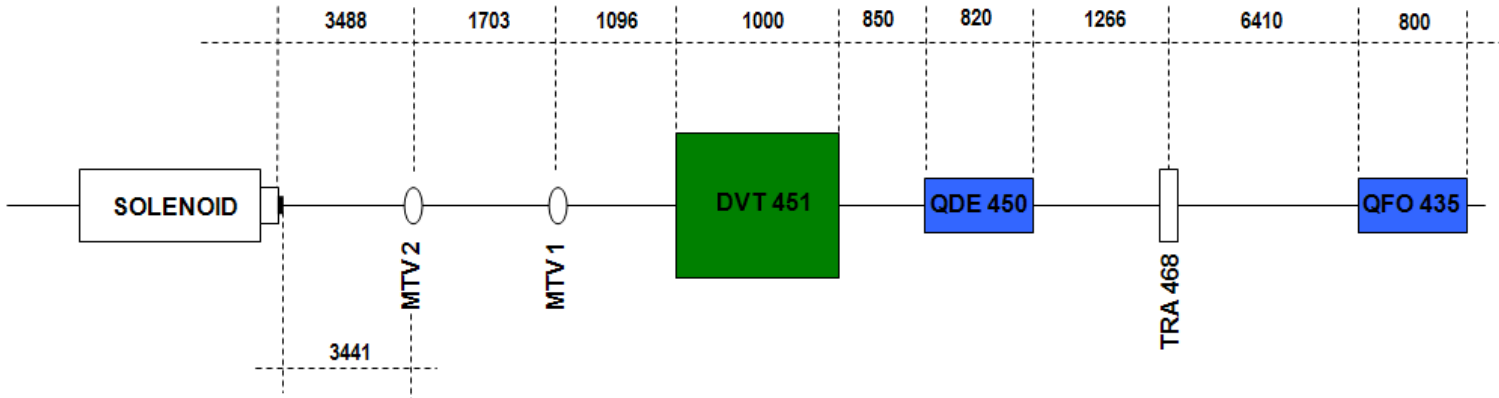
MERIT, VRVS Meeting  
Ilias Efthymiopoulos

# Beam spot size analysis

# MERIT Elements – Layout



# Survey data after the MERIT run – 18.12.2007



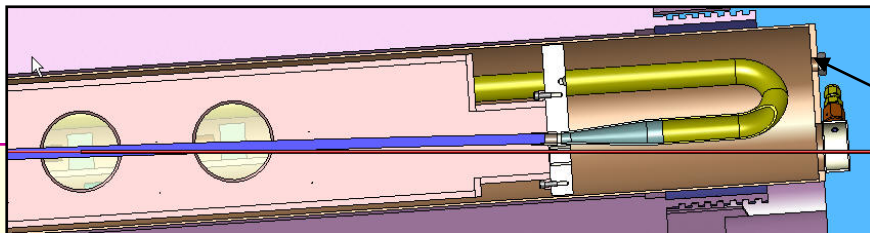
FTN start 304.69540

Data from GEODE database, registered on 15 June 2007

Element	Position	x	y	z	Distance	Rel. Distance	Center	TT2/FTN
FTNQFO.435	E	1636.84951	2179.54532	2434.22735	48.21100		48.61100	353.30640
	S	1636.11207	2179.85546	2434.22734	49.01100	0.80000		
FTNTRA.468	E/S	1634.82593	2180.39636	2434.22734	50.40625	1.39525		
FTNQDE.450	E	1629.01792	2182.83899	2434.22733	56.70700	6.30075	57.11700	361.81240
	S	1682.26050	2183.15688	2434.22733	57.52700	0.82000		
FTNDVT.451	E	1627.44810	2183.49920	2434.22732	58.41000	0.88300	58.91000	363.60540
	S	1626.52630	2183.88687	2434.22732	59.41000	1.00000		
FTNXCO.453	E	1625.49113	2184.32222	2434.22732	60.53300	1.12300	61.03300	365.72840
	S	1624.56933	2184.70990	2434.22732	61.53300	1.00000		

Measurements - 18.12.2007

Distance	TT2/FTN	Center
48.211	352.9064	48.611
49.011	353.7064	
55.421	360.1164	55.421
56.687	361.3824	57.097
57.507	362.2024	
58.357	363.0524	58.857
59.357	364.0524	

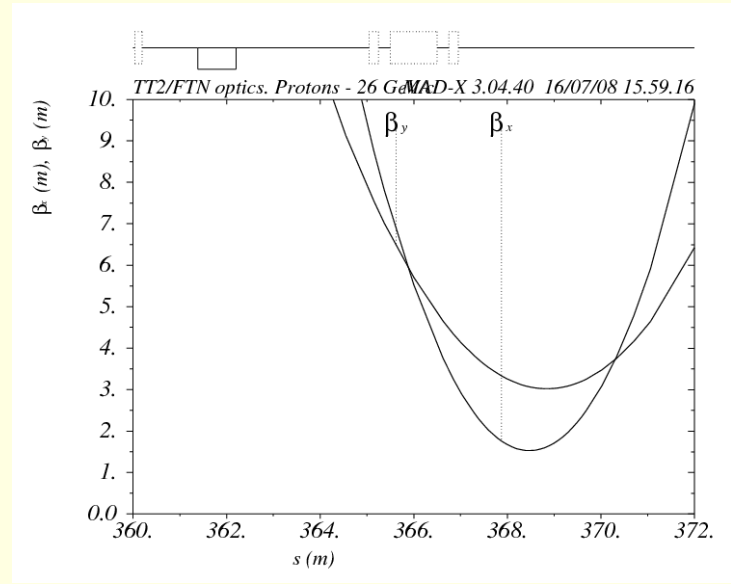
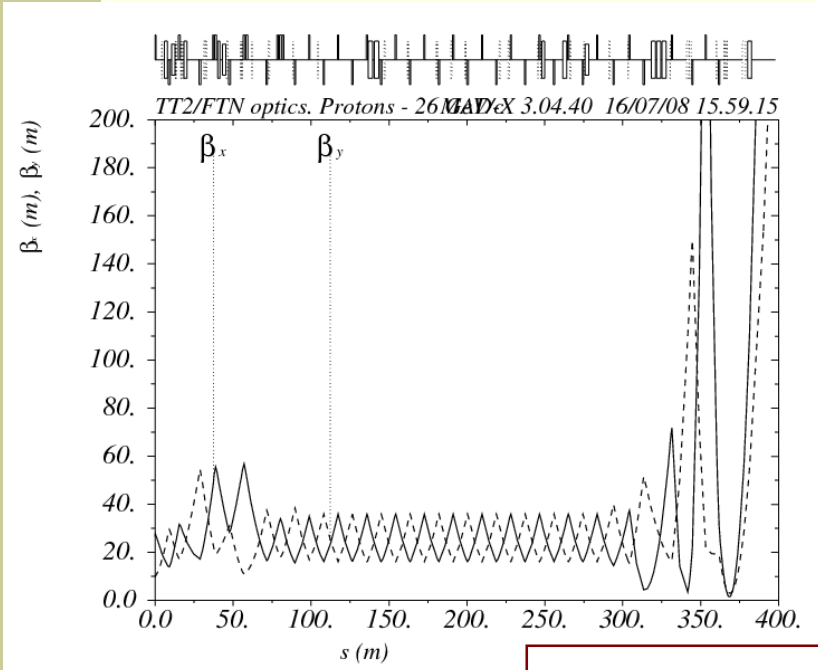


MTV1	60.453	365.1484
MTV2	62.156	366.8514
HGTAU	65.644	370.3394
HGTAR	66.367	371.0624

Upstream face: -72.3cm

# Beam optics

- Fit parameters: QFO, QDO strengths and locations (within limits)



Element	S_line [m]	Beta_x [m]	Alfa_x [ ]	Delta_x [m]	Beta_y [m]	Alfa_y [ ]	Delta_y [m]
MTV.454	365.1484	8.7535	2.1732	1.5415	7.5513	1.2242	-0.0419
MTV.484	366.8514	3.2477	1.0598	1.6209	4.3414	0.6607	0.0294
HG-WUP	370.3394	3.8082	-1.2205	1.7834	3.7581	-0.4934	0.1756
HG-TARG	371.0624	5.9148	-1.6932	1.8171	4.6446	-0.7327	0.2058
HG-WDO	373.6914	19.3362	-3.4119	1.9397	10.7838	-1.6025	0.3160

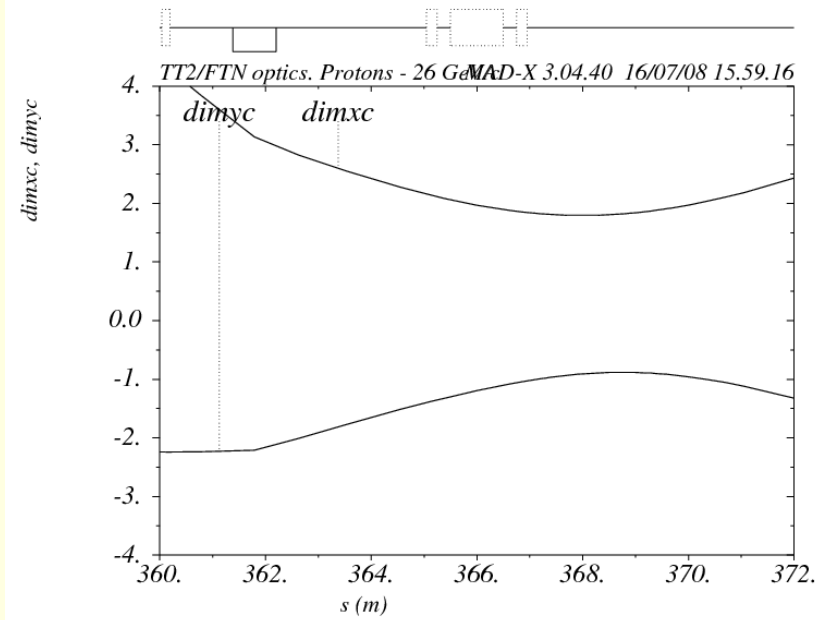
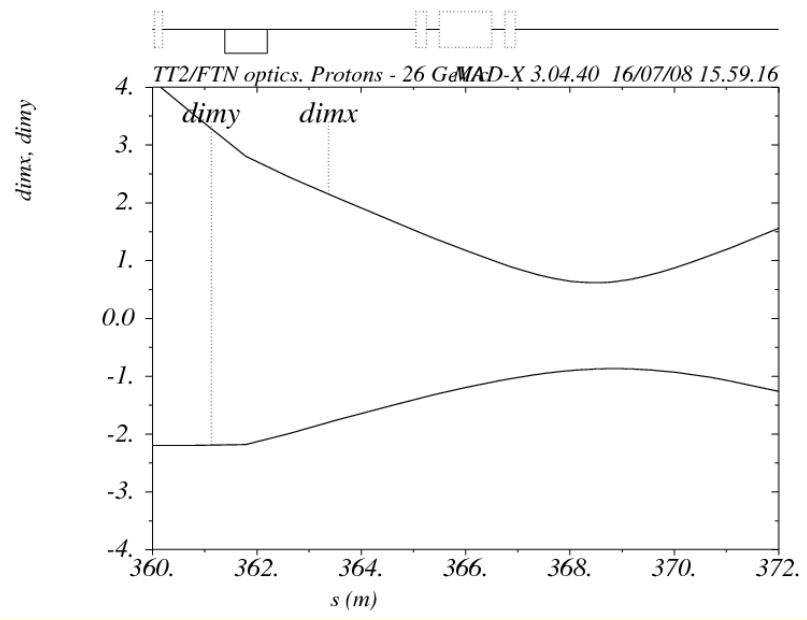
# Beam envelope (1-sigma) - $\epsilon=0.25$ (mm.mrad), $D_p=0.1\%$

## Without dispersion term

- $\sigma(x) = 1.2\text{mm}$  ,  $\sigma(y) = 1.1\text{ mm}$
- 238 J/gr @ 30TP

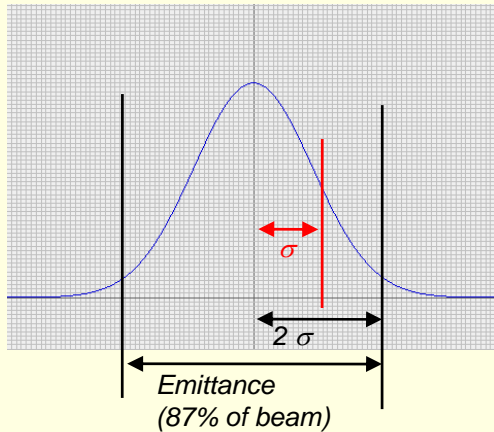
## With dispersion term

- $\sigma(x) = 2.2\text{mm}$  ,  $\sigma(y) = 1.1\text{ mm}$
- 130 J/gr @ 30TP



# Reminder – Beam Emittance

- For **proton machines**, the emittance is measured by measuring the beam profile in a position of known beam parameters (optics)
  - The convention is to use **TWO sigma** value



Geometrical emittance:

$$\mathcal{E}_{\text{protons}} = \frac{(2\sigma)^2}{\beta}$$

Normalized emittance:

$$\mathcal{E}^* = (\beta\gamma) \mathcal{E}, \quad \beta\gamma = \frac{P_0}{M_0}$$

P [GeV/c]	( $\beta\gamma$ )
14.0	14.92
24.0	25.58

Including dispersion

$$\sigma = \sqrt{\mathcal{E} \cdot \beta + \left( |D_p| \frac{\delta p}{p} \right)^2}$$

What is measured in the machine

$$\mathcal{E}_{2\sigma} = f(w_{4\sigma}, \frac{\delta p}{p}_{2\sigma}) = \frac{\left( \frac{w_{4\sigma}}{2} \right)^2 - \left( |D_p| \frac{\delta p}{p}_{2\sigma} \right)^2}{\beta}$$

# Beam Emittance measurement – 14 GeV/c

- Friday 26.10@15:55
- Beam intensity:**
- h16, 1E13

File View Option Help

opdisp MDPS 26 Oct 26 16:00:46 2007

Beam State	INJ User	PS User	Particule	Harmonique	Destination
SPARE		MDPS	PROTON	H8H16	TT2_D3

	Acquisition	Losses	Eff (%)	BLMS	Plot
1 ring 1 acc	282.35			16	17
2 ring 2 acc	264.77			41	5
3 ring 3 acc	279.42			42	97
4 ring 4 acc	278.45			43	75
5 Sum PSB acc	1104.99			44	81
6 BTP.TRA	1050.00	55	95.0	5	45
7 Injected	1062.71	42	96.2	5	46
8 Bef.Trans	1011.40	51	95.2	7	16
9 aft.Trans	1011.40	0	100.0	0	26

File Plot Views Option Help

MDPS Oct 26 16:48:31 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start Measurement

Requested Parameters

Device V75 (0 scans)

Occurrence - Any

Expected Ip - 5e11

Velocity - 20 m/s

Single Sweep

C Timing - 760

PM Voltage 1 V75 - 480

PM Voltage 2 V75 - 480

Scint. Trans. V75 - 100%

Results for V75

At C Pulse : 760

e (2s) (mm.mrad) 0.68

e (2s) (normalised) 10.28

4s measured (mm) 5.65

Centre of Mass (mm) 3.31

Measurement Parameters

At C Pulse : 760

B Pulse (1G Train) 6667

p (GeV/c) 13.99

Ip (E10) 986.97

Device : V75

PM Voltage (V) 3129

b (m) 11.6

Dispersion (m.) --

Scint. Transmission 100%

WARNING The graphs displayed may not correspond to the requested settings.

File Plot Views Option Help

MDPS Oct 26 16:42:20 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start Measurement

Requested Parameters

Device H64 (0 scans)

Occurrence - Any

Expected Ip - 5e11

Velocity - 20 m/s

Single Sweep

C Timing - 760

PM Voltage 1 H64 - 450

PM Voltage 2 H64 - 450

Scint. Trans. H64 - 100%

Results for H64

At C Pulse : 760

e (2s) (mm.mrad) 1.02

e (2s) (normalised) 15.33

4s measured (mm) 10.62

Centre of Mass (mm) -3.26

Measurement Parameters

At C Pulse : 760

B Pulse (1G Train) 6667

p (GeV/c) 13.99

Ip (E10) 1008.96

Device : H64

PM Voltage (V) 3129

b (m) 12.6

Dispersion (m.) 2.30

Scint. Transmission 100%

WARNING The graphs displayed may not correspond to the requested settings.



# Beam Emittance measurement – 14 GeV/c

- Friday 26.10@17:37
- Beam intensity:**
- 2.5E11/bunch
- 2 extracted bunches,

File View Option Help

opdisp MDPS 26 Oct 26 18:06:46 2007

Beam State	INJ User	PS User	Particule	Harmonique	Destination
SPARE		MDPS	PROTON	H8H16	TT2_D3

	Acquisition	Losses	Eff (%)
1 ring 1 acc	-0.00		
2 ring 2 acc	-0.01		
3 ring 3 acc	119.00		
4 ring 4 acc	-0.00		
5 Sum PSB acc	118.98		
6 BTP.TRA	126.25	-7	106.1
7 Injected	114.53	4	96.3
8 Bef. Trans	111.48	3	97.3
9 Aft. Trans	111.11	0	99.7
10 Bef. Eject	111.23	3	97.1
11 Aft. Eject	54.33	57	48.8
12 TRA126	55.23	56	49.7

BLM's Plot	
	INT
16	12
41	0
42	17
43	8
44	17
45	6
fl6	1

File Plot Views Option Help

MDPS Oct 26 18:12:31 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start Measurement

Requested Parameters

Device V75 (0 scans)

Occurrence - Any

Expected Ip - 5e11

Velocity - 20 m/s

Single Sweep

C Timing - 760

PM Voltage 1 V75 - 620

PM Voltage 2 V75 - 620

Scint. Trans. V75 - 100%

Results for V75

At C Pulse : 760

e (2s) (mm.mrad) 0.32

e (2s)(normalised) 4.80

4s measured (mm) 3.86

Centre of Mass (mm) 3.37

Measurement Parameters

At C Pulse : 760

B Pulse (1G Train) 6667

p (GeV/c) 13.99

Ip (E10) 112.58

Device : V75

PM Voltage (V) 3129

b (m) 11.6

Dispersion (m.) - -

Scint. Transmission 100%

Wire V75 ( Fri Oct 26 18:12:22 2007 ) MDPS

WARNING The graphs displayed may not correspond to the requested settings.

File Plot Views Option Help

MDPS Oct 26 18:15:53 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start Measurement

Requested Parameters

Device H64 (0 scans)

Occurrence - Any

Expected Ip - 5e11

Velocity - 20 m/s

Single Sweep

C Timing - 760

dp/p for C760 - 1.66

PM Voltage 1 H64 - 600

PM Voltage 2 H64 - 600

Scint. Trans. H64 - 100%

Results for H64

At C Pulse : 760

e (2s) (mm.mrad) 0.40

e (2s)(normalised) 5.94

4s measured (mm) 8.85

Centre of Mass (mm) -3.98

Measurement Parameters

At C Pulse : 760

B Pulse (1G Train) 6667

p (GeV/c) 13.99

Ip (E10) 110.62

Device : H64

PM Voltage (V) 3129

b (m) 12.6

Dispersion (m.) 2.30

Scint. Transmission 100%

Wire H64 ( Fri Oct 26 18:15:43 2007 ) MDPS

WARNING The graphs displayed may not correspond to the requested settings.

# Beam Emittance measurement – 14 GeV/c

- Friday 26.10@18:24
- Beam intensity:**
- 1.3E12/bunch
- 2 extracted bunches,

opdisp MDPS 26 Oct 26 18:26:56 2007

Beam State	INJ User	PS User	Particule	Harmonique	Destination
SPARE		MDPS	PROTON	H8H16	TT2_D3

	Acquisition	Losses	Eff (%)
1 ring 1 acc	-0.01		
2 ring 2 acc	-0.06		
3 ring 3 acc	488.50		
4 ring 4 acc	0.01		
5 Sum PSB acc	488.44		
6 BTP.TRA	457.50	31	93.7
7 Injected	456.84	32	93.5
8 Bef.Trans	451.96	5	98.9
9 Aft.Trans	449.51	2	99.5
10 Bef.Eject	447.07	10	97.9

BLMs	INT
16	140
41	29
42	255
43	255
44	255
45	255
f16	4

File Plot Views Option Help

MDPS Oct 26 18:36:03 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters

**Requested Parameters**

Device V75 (0 scans)

Occurrence - Any

Expected Ip - 5e11

Velocity - 20 m/s

Single Sweep

C Timing - 760

PM Voltage 1 V75 - 580

PM Voltage 2 V75 - 580

Scint. Trans. V75 - 100%

Results for V75

At C Pulse : 760

e (2s) (mm.mrad) 1.02

e (2s)(normalised) 15.34

4s measured (mm) 6.90

Centre of Mass (mm) 3.35

Measurement Parameters

At C Pulse : 760

B Pulse (1G Train) 6667

p (GeV/c) 13.99

Ip (E10) 442.18

Device : V75

PM Voltage (V) 3129

b (m) 11.6

Dispersion (m.) --

Scint. Transmission 100%

WARNING The graphs displayed may not correspond to the requested settings.

File Plot Views Option Help

MDPS Oct 26 18:32:41 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters

**Requested Parameters**

Device H64 (0 scans)

Occurrence - Any

Expected Ip - 5e11

Velocity - 20 m/s

Single Sweep

C Timing - 760

dp/p for C760 - 1.76

PM Voltage 1 H64 - 540

PM Voltage 2 H64 - 540

Scint. Trans. H64 - 100%

Results for H64

At C Pulse : 760

e (2s) (mm.mrad) 1.73

e (2s)(normalised) 25.82

4s measured (mm) 12.36

Centre of Mass (mm) -3.75

Measurement Parameters

At C Pulse : 760

B Pulse (1G Train) 6667

p (GeV/c) 13.99

Ip (E10) 439.74

Device : H64

PM Voltage (V) 3129

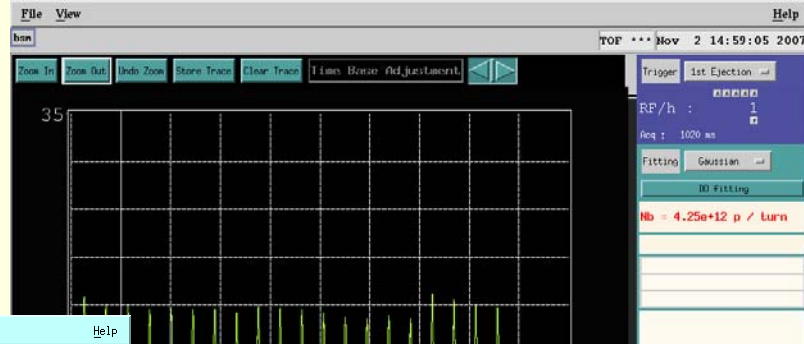
b (m) 12.6

Dispersion (m.) 2.30

Scint. Transmission 100%

WARNING The graphs displayed may not correspond to the requested settings.

- Friday 02.11 @14:55PM
- Beam intensity:**
- 2.5E11/bunch
- 16 bunches



File Plot Views Option

fwS TOF Nov 2 14

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start

**Requested Parameters**

Device V75 (0 scans)

Occurrence - Any

Expected Ip - 5e12

Velocity - 10 m/s

Single Sweep

C Timing - 1010

PM Voltage 1 V75 - 480

PM Voltage 2 V75 - 480

Scint. Trans. V75 - 100%

Results for V75

At C Pulse : 1010

e (2s) (mm.mrad) 0.33

e (2s)(normalised) 8.66

4s measured (mm) 3.96

Centre of Mass (mm) 2.87

Measurement Parameters

At C Pulse : 1010

B Pulse (1G Train) 11424

p (GeV/c) 23.97

Ip (E10) 442.18

Device : V75

PM Voltage (V) 3129

b (m) 11.6

Dispersion (m.) --

Scint. Transmission 100%

Wire V75 ( Fri Nov 2 14:57:56 2007 ) TOF

WARNING The graphs displayed may not correspond to the requested settings.

File Plot Views Option

fwS TOF Nov 2 14:54

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start Measurement

**Requested Parameters**

Device H64 (0 scans)

Occurrence - Any

Expected Ip - 5e12

Velocity - 10 m/s

Single Sweep

C Timing - 1010

dp/p for C1010 - 1.10

PM Voltage 1 H64 - 480

PM Voltage 2 H64 - 480

Scint. Trans. H64 - 100%

Results for H64

At C Pulse : 1010

e (2s) (mm.mrad) 0.18

e (2s)(normalised) 4.68

4s measured (mm) 5.90

Centre of Mass (mm) -2.89

Measurement Parameters

At C Pulse : 1010

B Pulse (1G Train) 11423

p (GeV/c) 23.97

Ip (E10) 442.18

Device : H64

PM Voltage (V) 3129

b (m) 12.6

Dispersion (m.) 2.30

Scint. Transmission 100%

Wire H64 ( Fri Nov 2 14:54:34 2007 ) TOF

WARNING The graphs displayed may not correspond to the requested settings.

# Beam Emittance measurement – 24 GeV/c

Friday 02.11 @ 16:02PM

## Beam intensity:

- 16 bunches,
- 6E12 protons

File View Option Help

opdisp TOF 28 Nov 2 16:03:28 2007

Beam State	INJ User	PS User	Particule	Harmonique	Destination
SPARE		TOF	PROTON	H8	TT2_D3

	Aquisition	Losses	Eff (%)
1 ring 1 acc	159.15		
2 ring 2 acc	166.48		
3 ring 3 acc	161.79		
4 ring 4 acc	161.60		
5 Sum PSB acc	649.02		
6 BTP. TRA	630.00	19	97.1
7 Injected	632.74	16	97.5
8 Bef. Trans	613.19	20	96.9
9 Aft. Trans	608.31	5	99.2
10 Bef. Eject	608.31	24	96.1
11 Aft. Eiect	0.15	608	0.0

BLM's Plot	
INT	
16	6
41	4
42	29
43	24
44	34
45	16
f16	46

File Plot Views Option Help

fws TOF Nov 2 16:03:01 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start Measurement

### Requested Parameters

Device V75 (0 scans)
Occurrence - Any
Expected Ip - 5e12
Velocity - 10 m/s
Single Sweep
C Timing - 1010
PM Voltage 1 V75 - 480
PM Voltage 2 V75 - 480
Scint. Trans. V75 - 100%

Results for V75

At C Pulse :	1010
e (2s) (mm.mrad)	0.44
e (2s) (normalised)	11.35
4s measured (mm)	4.54
Centre of Mass (mm)	2.94

Measurement Parameters

At C Pulse :	1010
B Pulse (1G Train)	11424
p (GeV/c)	23.97
Ip (E10)	615.64

Device : V75

PM Voltage (V)	3129
b (m)	11.6
Dispersion (m.)	--
Scint. Transmission	100%

WARNING The graphs displayed may not correspond to the requested settings.

File Plot Views Option Help

fws TOF Nov 2 16:07:30 2007

(VERSION May 14 2007 16:46:17) Measurement mode: Photomultiplier Plot.

Prepare Meas. Parameters Start Measurement

### Requested Parameters

Device H64 (0 scans)
Occurrence - Any
Expected Ip - 5e12
Velocity - 10 m/s
Single Sweep
C Timing - 1010
dp/p for C1010 - 1.10
PM Voltage 1 H64 - 460
PM Voltage 2 H64 - 460
Scint. Trans. H64 - 100%

Results for H64

At C Pulse :	1010
e (2s) (mm.mrad)	0.25
e (2s) (normalised)	6.45
4s measured (mm)	6.18
Centre of Mass (mm)	-2.88

Measurement Parameters

At C Pulse :	1010
B Pulse (1G Train)	11423
p (GeV/c)	23.97
Ip (E10)	618.08

Device : H64

PM Voltage (V)	3129
b (m)	12.6
Dispersion (m.)	2.30
Scint. Transmission	100%

WARNING The graphs displayed may not correspond to the requested settings.

# Beam Emittance measurement

- Summary of measured data

Measured emittances during MERIT operation - (MERIT logbook)

Date	Pbeam [GeV/c]	Beam Type	Intensity				Horizontal	Vertical	dp/p [2sigma, 0.1%]
			Bef.Eject	TRA126	TRA283	TRA386	4s meas	4s meas	
				[e10]			[mm]	[mm]	
26-Oct	13.99	h16	1008.96	695.71	996.75	1037.25	10.62	5.64	1.7
26-Oct	13.99	2x2.5e11, DT=1.7us	111.23	55.23	53.2	54.4	8.85	3.86	1.66
26-Oct	13.99	2x1.3e12, DT=1.7us	447.07	168.98	222.75	281.25	12.36	6.9	1.76
2-Nov	23.97	16x2.5e11	442.8			425	5.9	3.96	1.1
2-Nov	23.97	16bunches	608.31	6.26	560.25	632.25	6.18	4.54	1.1

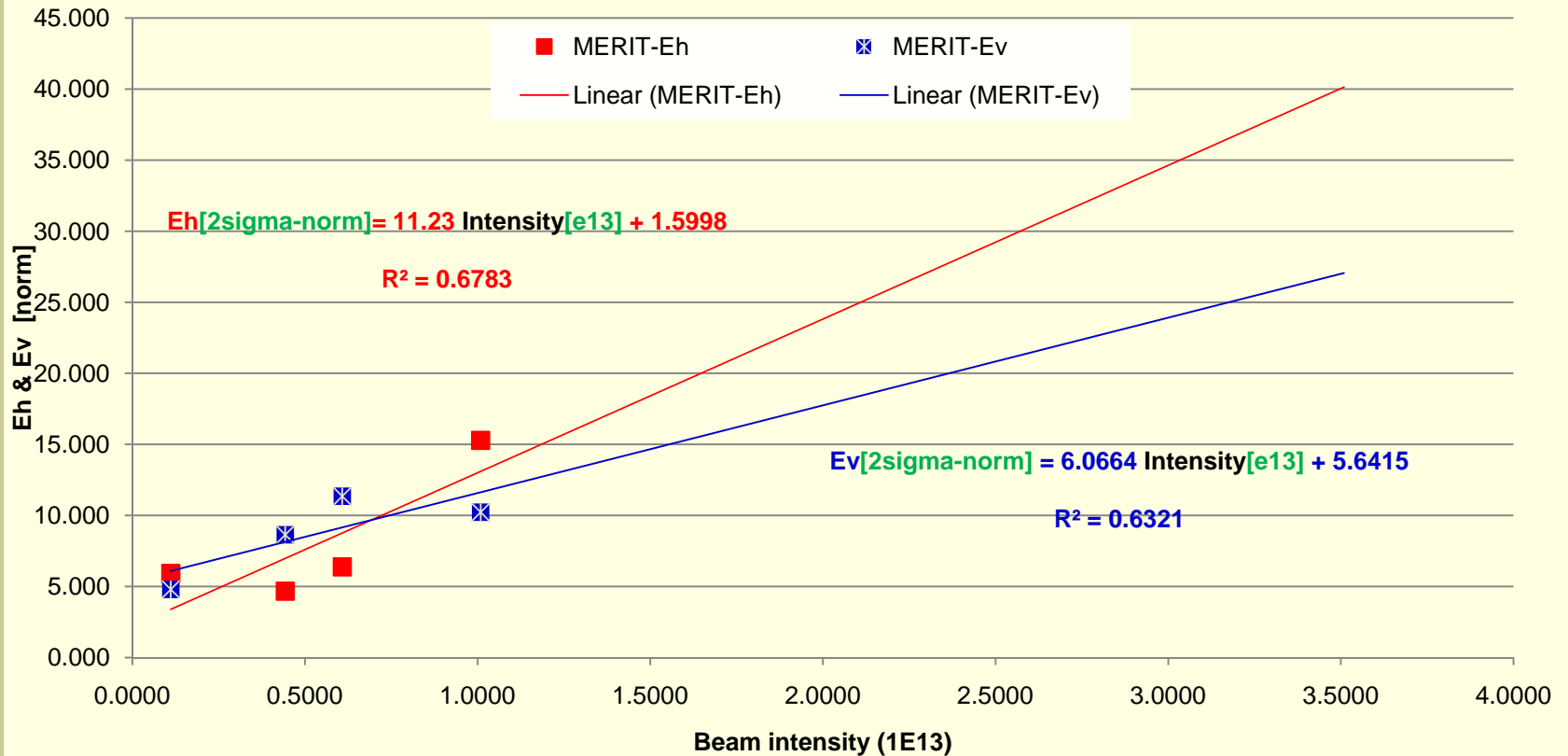
- Using the formulas of slide #6

Intensity [e13]	Pbeam [GeV/c]	Eh(2s) [mm.mrad]	Eh(2s) [norm]	Ev(2s) [mm.mrad]	Ev(2s) [norm]
1.0090	13.99	1.0244	15.279	0.6856	10.225
0.1112	13.99	0.3971	5.923	0.3211	4.789
0.4428	23.97	0.1827	4.668	0.3380	8.636
0.6080	23.97	0.2498	6.383	0.4442	11.352
0.4471	13.99	1.7306	25.812	1.0261	15.304

- in good agreement with the online calculations

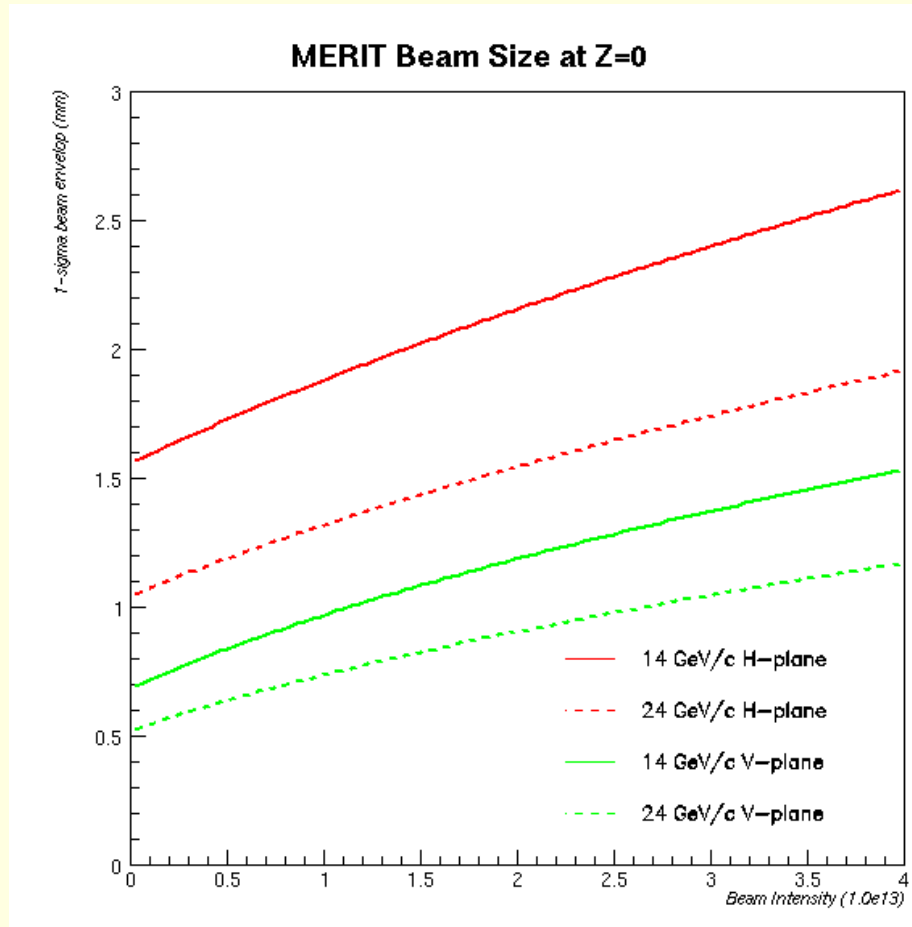
# Emittance extrapolation

## Transverse emittance (2s) in TT2



# Estimated beam spot at the target (z=0)

- Using  $\delta p/p(2s) = 1.66(1.1)e-3$  for 14(24) GeV/c



# Estimated beam spot at the target (z=0)

- Using  $\delta p/p(2s) = 1.66(1.1)e-3$  for 14(24) GeV/c

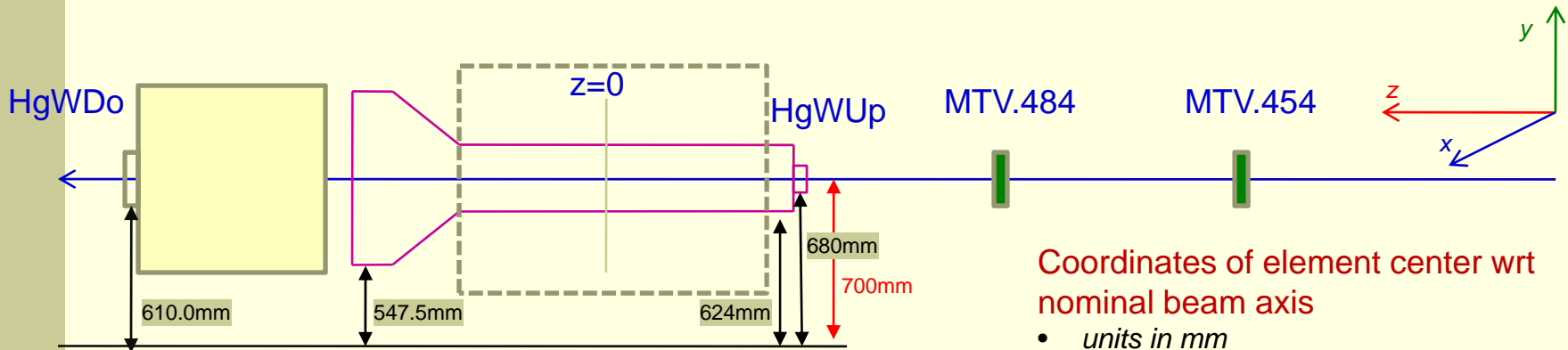
Pbeam	Intensity	BetaGamma	Emittance-h(1s)	Dp*dp/p(1s)	Size-h(1s)	Emittance-v(1s)	Dp*dp/p(1s)	Size-v(1s)
[GeV/c]	[Tp]	[]	[mm.mrad]	[mm]	[mm]	[mm.mrad]	[mm]	[mm]
14	1.0	14.925	0.0456	1.508193	1.5951	0.1047	0.1708	0.7178
14	5.0	14.925	0.1208	1.508193	1.7290	0.1453	0.1708	0.8391
14	10.0	14.925	0.2149	1.508193	1.8830	0.1961	0.1708	0.9695
14	15.0	14.925	0.3090	1.508193	2.0253	0.2469	0.1708	1.0844
14	20.0	14.925	0.4030	1.508193	2.1583	0.2977	0.1708	1.1883
14	25.0	14.925	0.4971	1.508193	2.2836	0.3485	0.1708	1.2837
14	30.0	14.925	0.5911	1.508193	2.4023	0.3993	0.1708	1.3726
24	1.0	25.586	0.0266	0.999405	1.0753	0.0610	0.1132	0.5444
24	5.0	25.586	0.0705	0.999405	1.1899	0.0848	0.1132	0.6376
24	10.0	25.586	0.1254	0.999405	1.3192	0.1144	0.1132	0.7377
24	15.0	25.586	0.1802	0.999405	1.4369	0.1440	0.1132	0.8257
24	20.0	25.586	0.2351	0.999405	1.5457	0.1737	0.1132	0.9052
24	25.0	25.586	0.2899	0.999405	1.6474	0.2033	0.1132	0.9783
24	30.0	25.586	0.3448	0.999405	1.7431	0.2329	0.1132	1.0463



# Alignment Information and Beam Direction

# MERIT beam element survey

- Done by CERN geometers (TS/SU) after the run, 18.12.2007



Reference line on floor

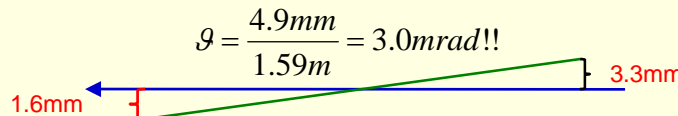
Solenoid tilt – (h-plane)

Position	Distance	Radius	total	Difference
HgWUp	680	23.495	703.495	-3.495
SecUp	624	79.375	703.375	-3.375
SecDo	547.5	150.876	698.376	+1.624
HgWDo	610.0	57.15	667.15	+32.85

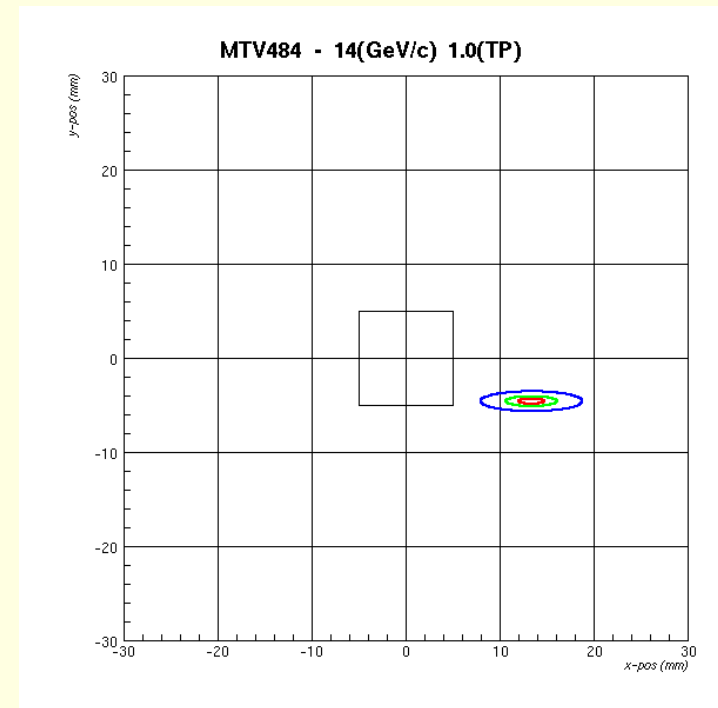
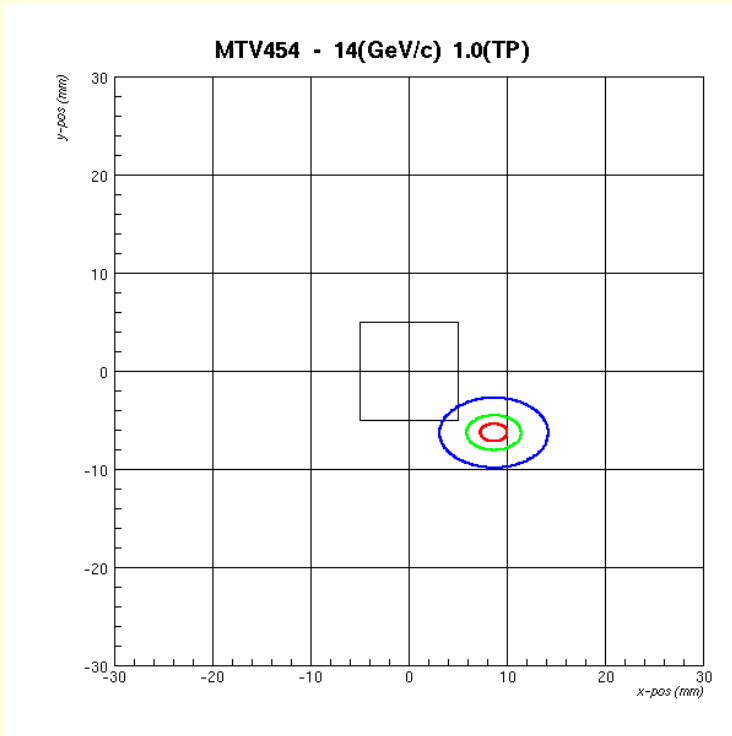
Coordinates of element center wrt nominal beam axis

- units in mm
- z distances from z=0 at solenoid center

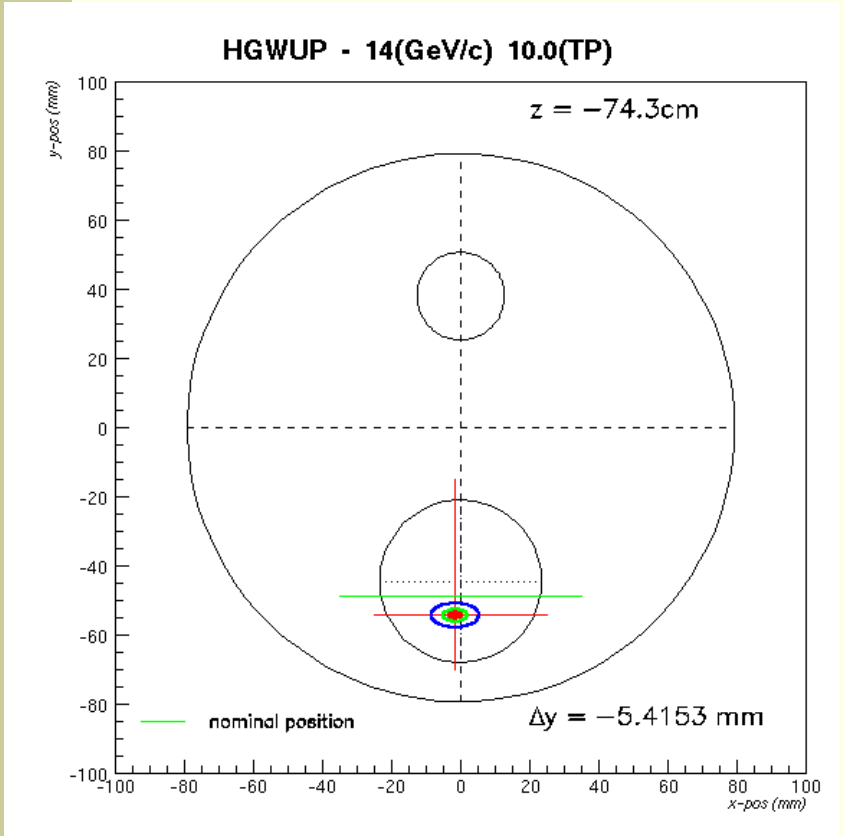
Element	{x, y, z}
MTV.454	{+8.7,+6.3, -5893.95}
MTV484	{+13.4, +4.6, -4230.95}
HgWUp	{-1.5,-10.0,-742.95}
HgWDo	{+57.0, -26.0, +2950.2}
Hgz=0	{-1.0,??,0.0}



# Nominal beam position in various elements



# Beam at Hg container



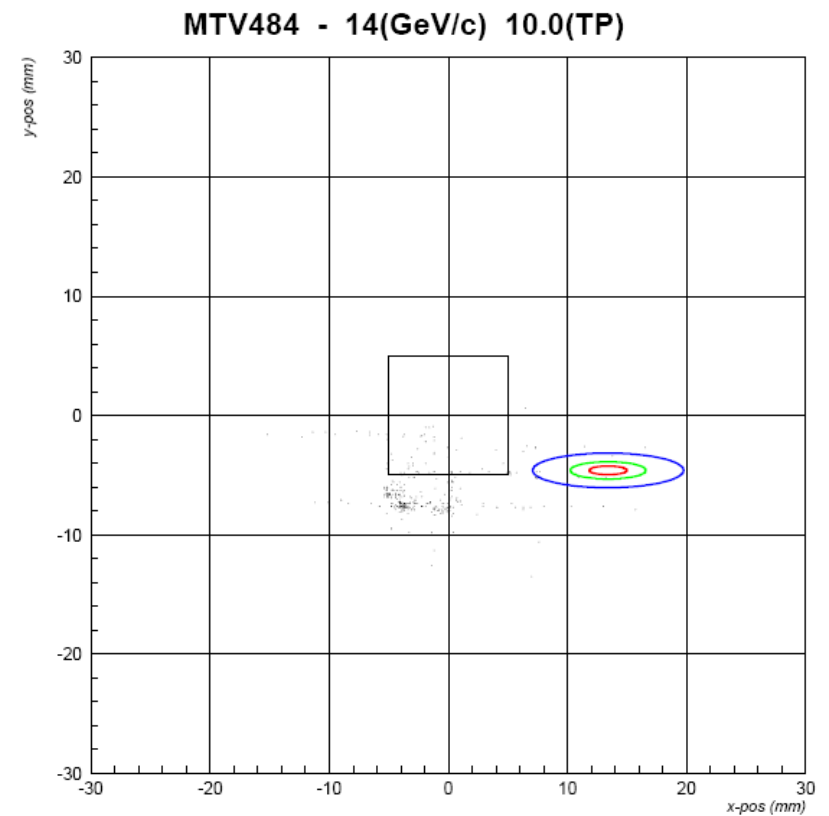
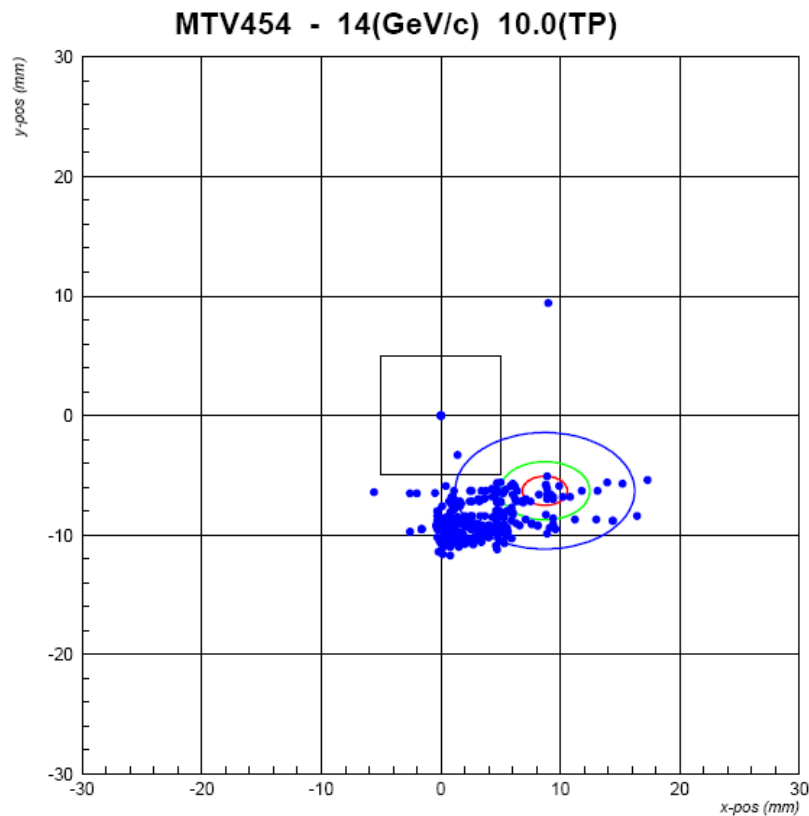
# Impact point calculation from the MTV data

# Projected beam impact point

- Using the alignment information from the previous slides the beam impact point at the target can be calculated
  - For the H-plane there is no ambiguity
  - For the V-plane we must assume some tilt angle – or just the nominal?
  
- Two sets of MTV data were used:
  - The online measurements as recorded in the log files
  
  - The data from Goran who analyzed the flag information

# Recorded beam position in the two flags

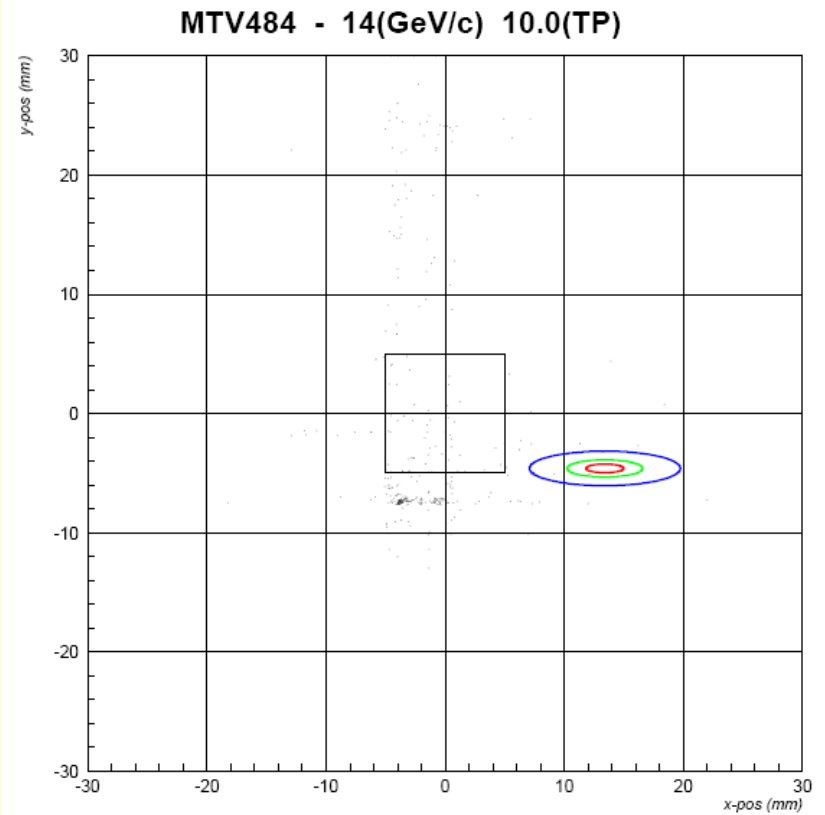
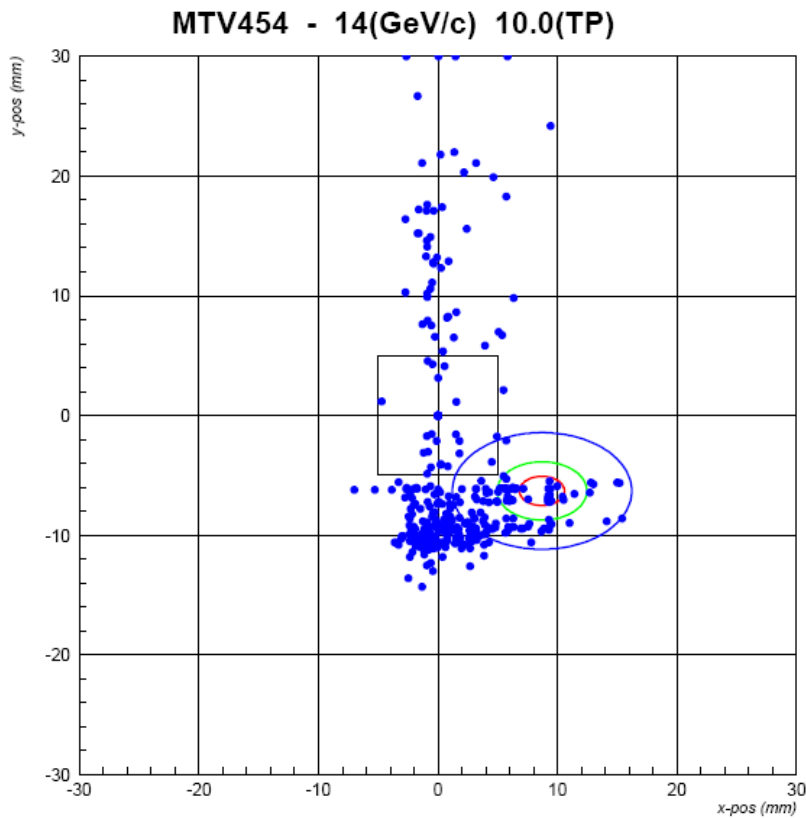
*Online flag information from the logbook*



The ellipses indicate the nominal beam position at the flags according to the geometeters

# Recorded beam position in the two flags

## Flag position from Goran

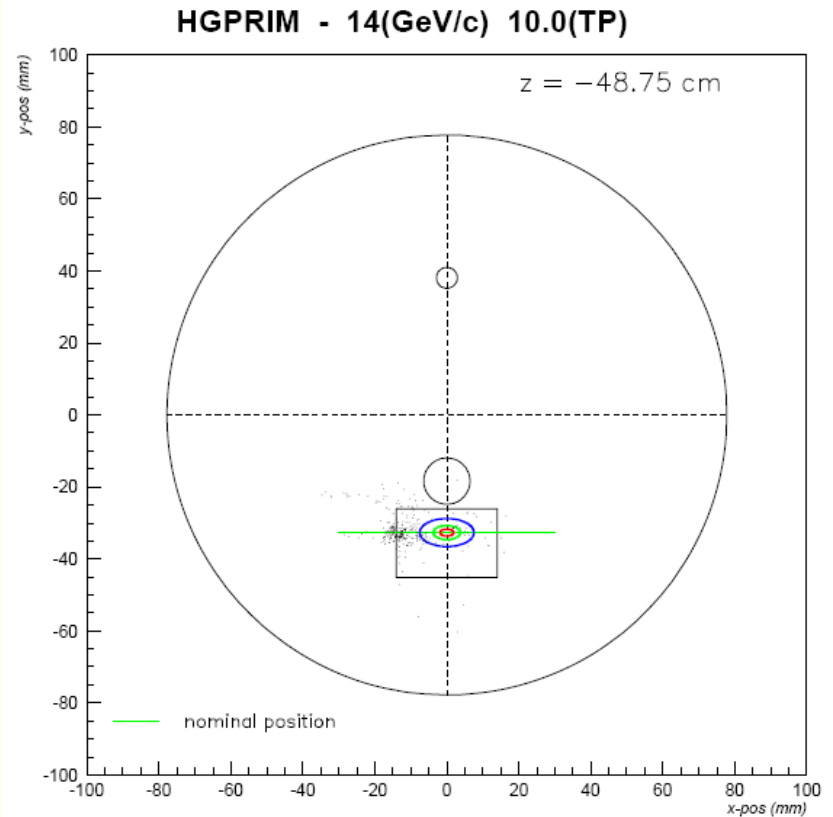
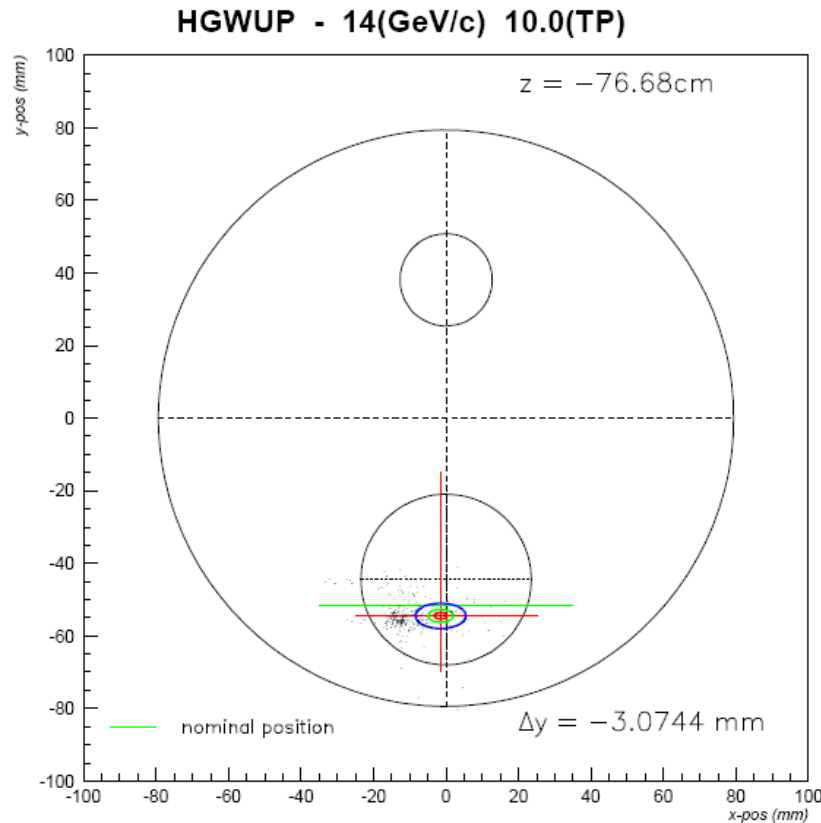


The ellipses indicate the nominal beam position at the flags according to the geometeters



# Projected beam position in the target

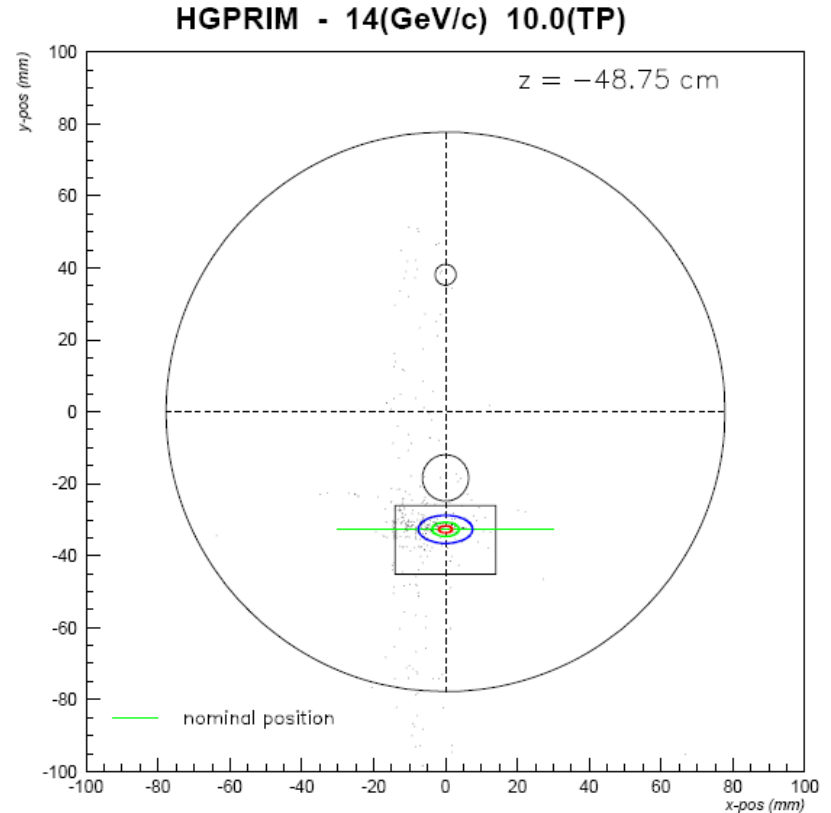
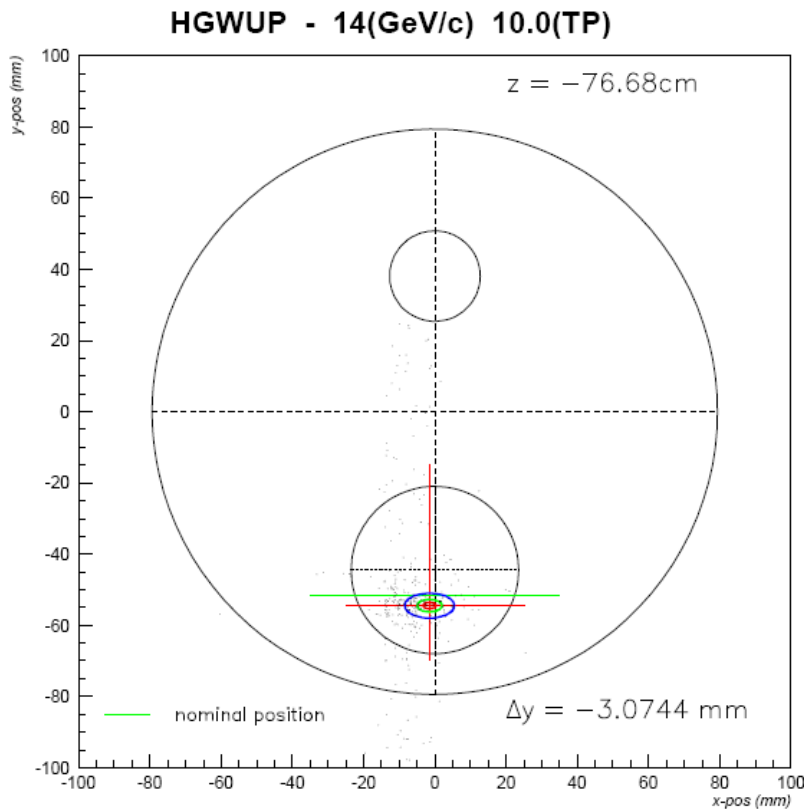
Online flag data from the logbook



The ellipses indicate the nominal beam position at the flags according to the geometers

# Projected beam position in the target

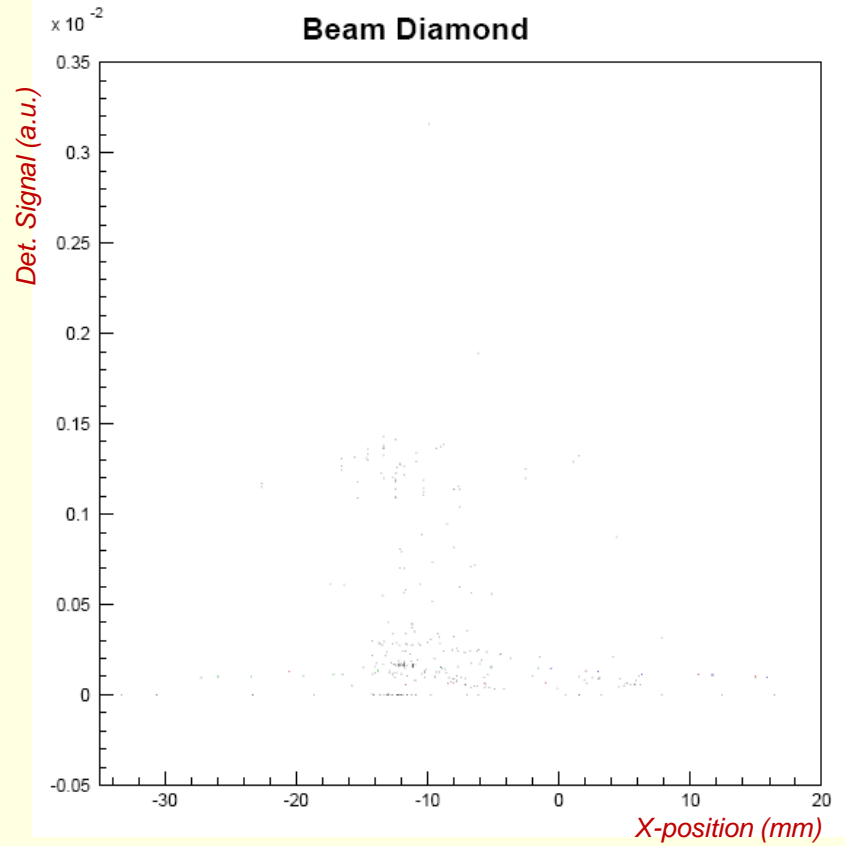
*Using the data from Goran*



The ellipses indicate the nominal beam position at the flags according to the geometers

# Information from the beam diamond

*pCVD detector installed at the upstream window, well aligned with the target*



According to this, the diamond position is around -12mm.

# Projected beam impact point

## Conclusions

- The recorder online (“eye”) and Goran’s analysis results for the flag info basically agree
  - Goran’s data show more spread,
    - remaining errors in the analysis that the eye is easier to correct
- The beam seems to be way off for flag-2 (MTV.484)
  - I don’t believe the alignment information from the geometers, but I don’t understand where the error comes
- Using the alignment information from the previous slides the beam impact point at the target can be estimated but it comes completely off that can’t be true
- The signal of the beam diamond (aligned within  $\pm 1.5\text{mm}$  to the target) peaks at  $\sim -12\text{mm}$  in the horizontal direction
  - Re-calibrating using that offset, the beam impact point at the upstream window is within  $< 2\text{mm}$  from the nominal
  - However we can’t say much on the **angle of the beam!!!**
- Vertically we seem to be ok

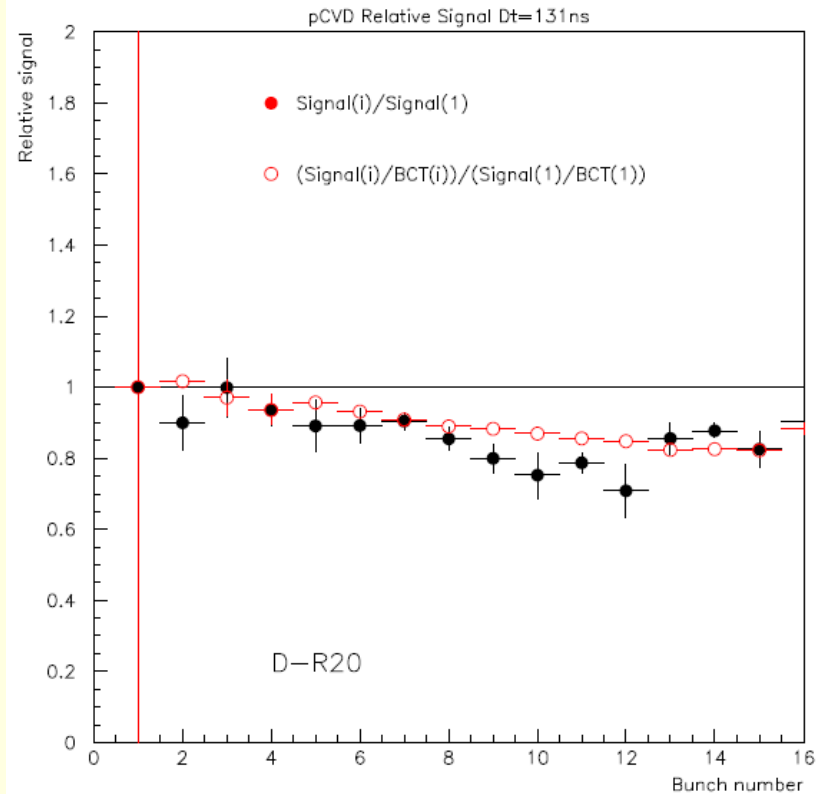
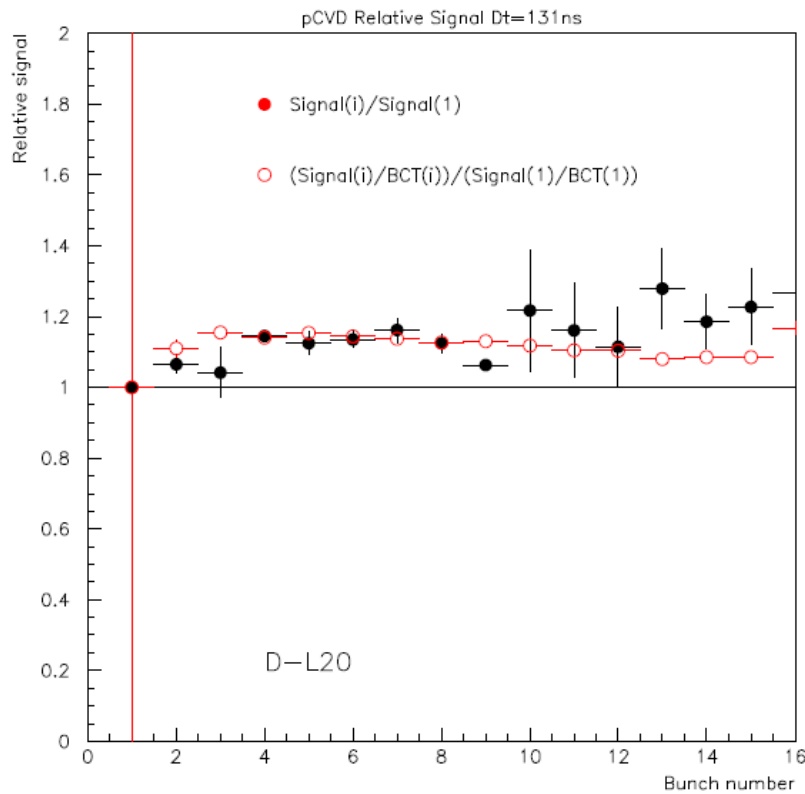
# Pump – probe analysis using the diamond detectors

# Pump – probe data analysis

- The data used are from the Macrus's files
  - Reminder: the detector response for each bunch is calculated as the integral of the recorded signal over a time window
    - typically set to the interbunch spacing
  - i.e. no additional correction or more sophisticated algorithm for the signal extraction
- Runs used
  - Use the information from Harold's run list to classify the runs
  - Use Adrian's data for BCT bunch information
  - Rung are flagged as "bad" and rejected from the analysis if
    - Information is missing (e.g. BCT) or
    - Wrong readings for some bunches
- The observed response dependence vs bunch number was corrected

# Diamond response vs bunch number

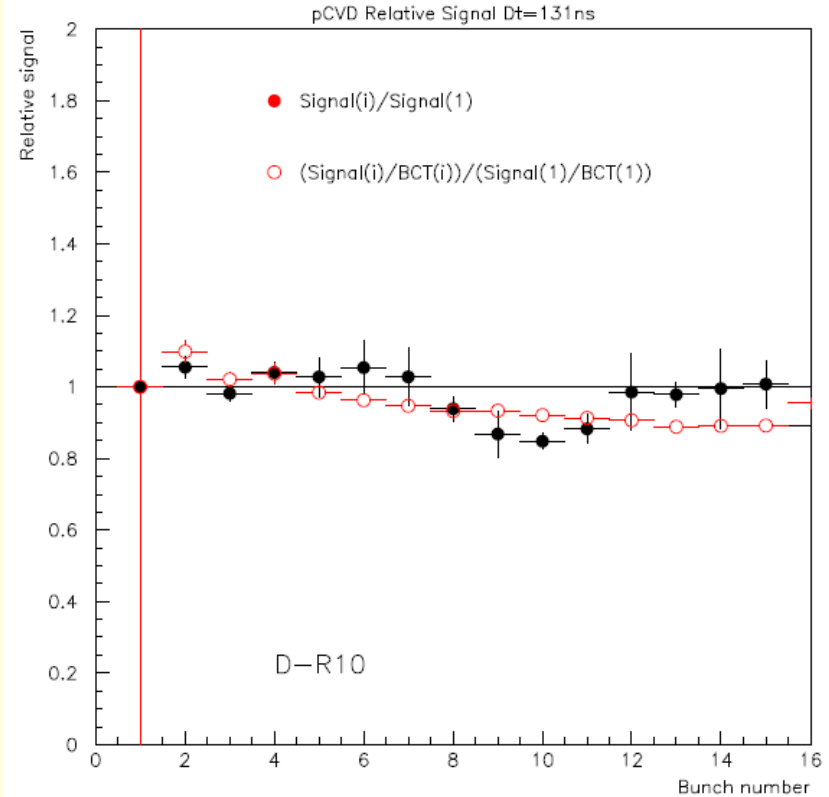
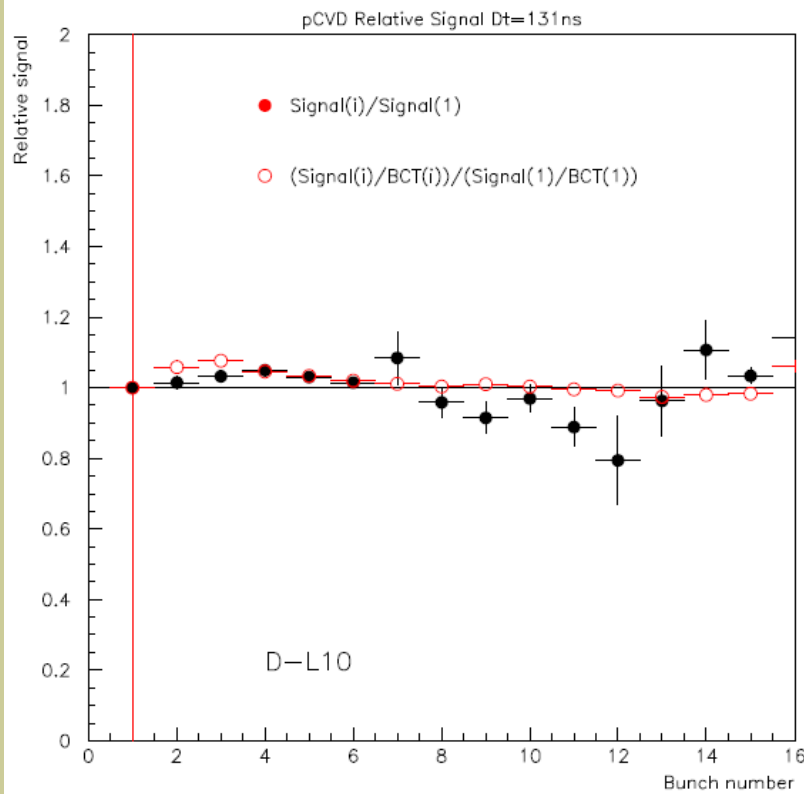
Data from all good runs with  $Dt(\text{bunch})=131\text{ns}$



What is plotted is the response per bunch divided by # of protons, normalized to the first bunch

# Diamond response vs bunch number

Data from all good runs with  $Dt(\text{bunch})=131\text{ns}$

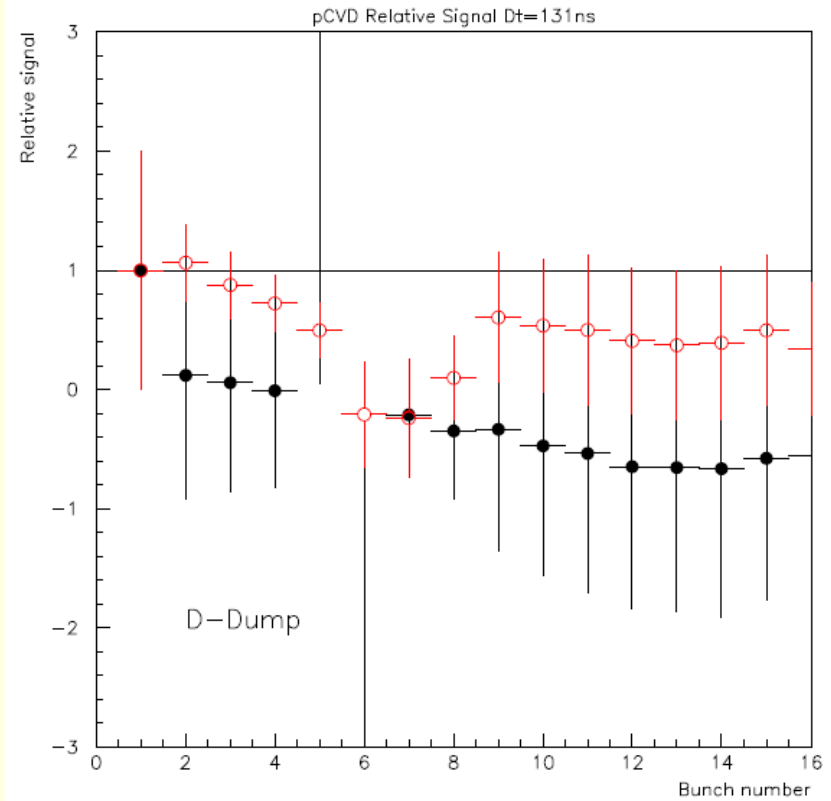
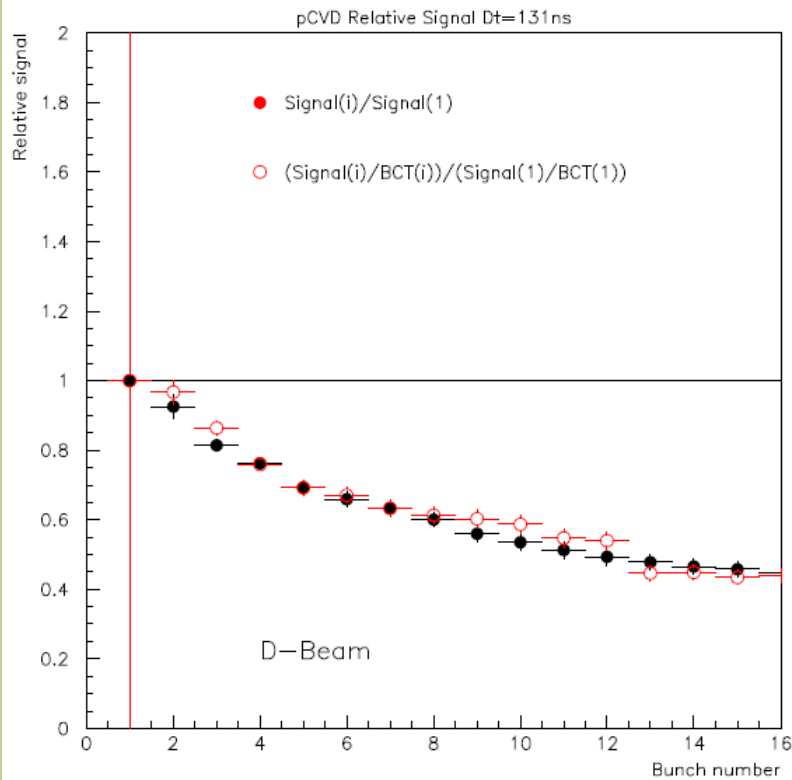


The correction with the BCT data smoothens the observed dependence



# Diamond response vs bunch number

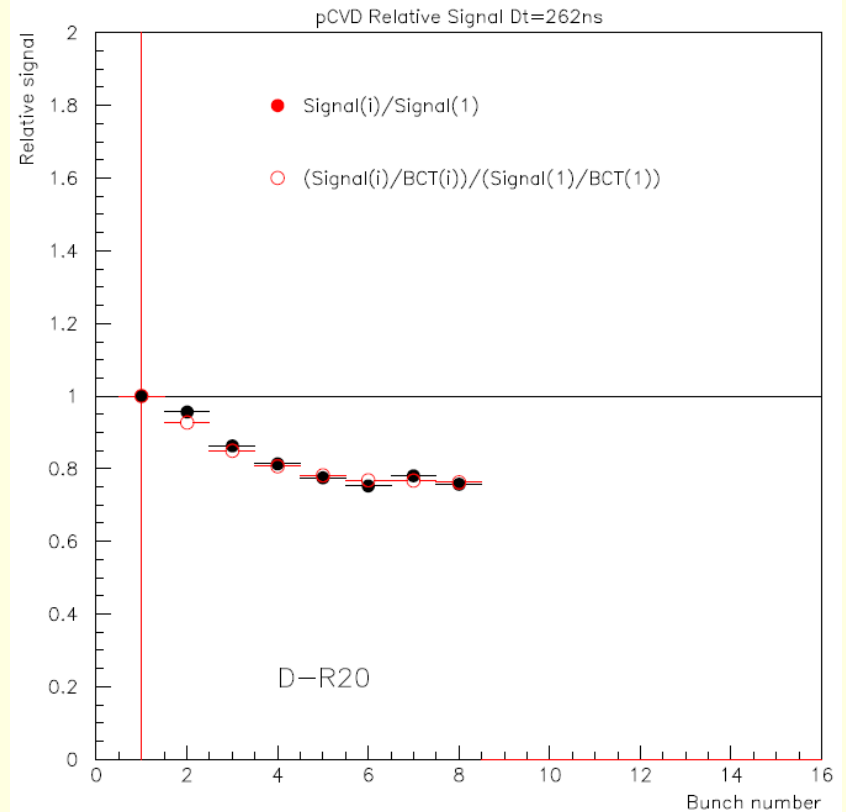
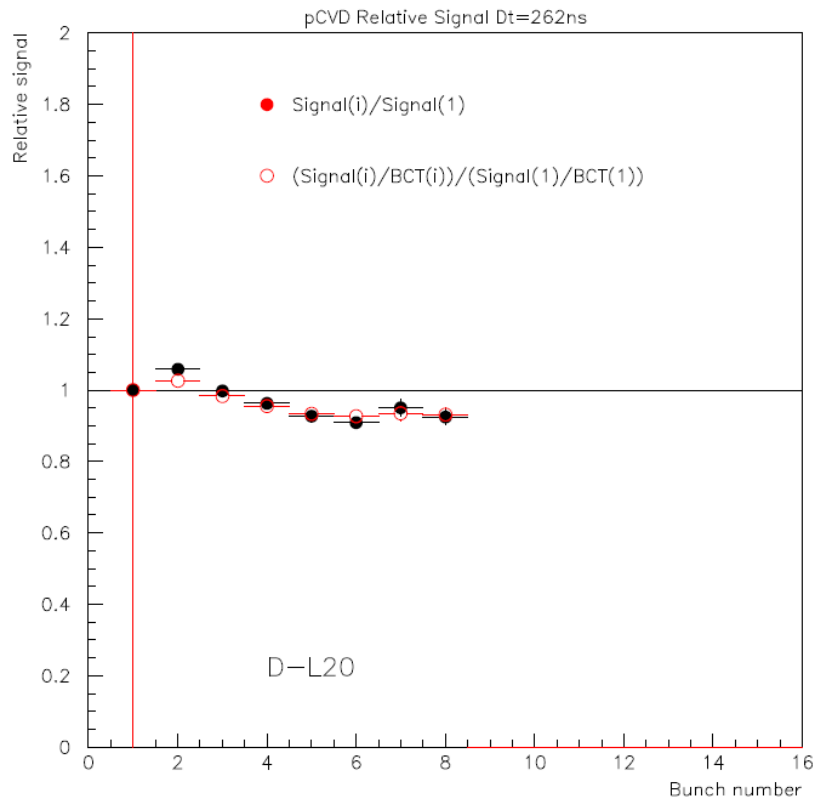
Data from all good runs with  $Dt(\text{bunch})=131\text{ns}$



The strongest effect is for the beam diamond; the dump detector is rather strange at all cases...

# Diamond response vs bunch number

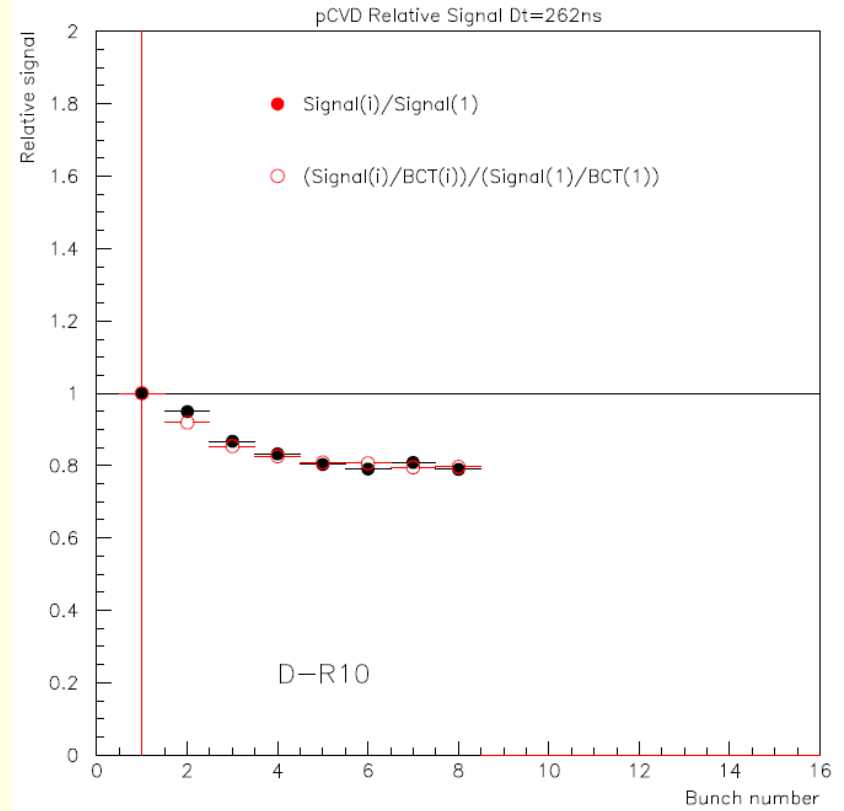
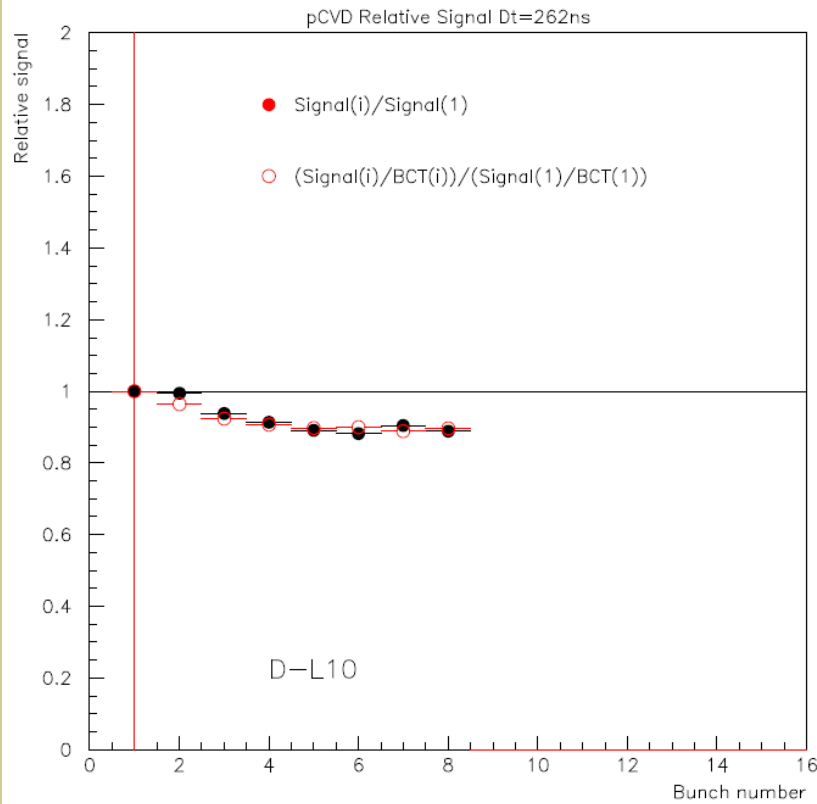
Data from all good runs with  $Dt(\text{bunch})=262\text{ns}$



Normally the effect should be reduced with longer interbunch spacing, however the signal is larger...

# Diamond response vs bunch number

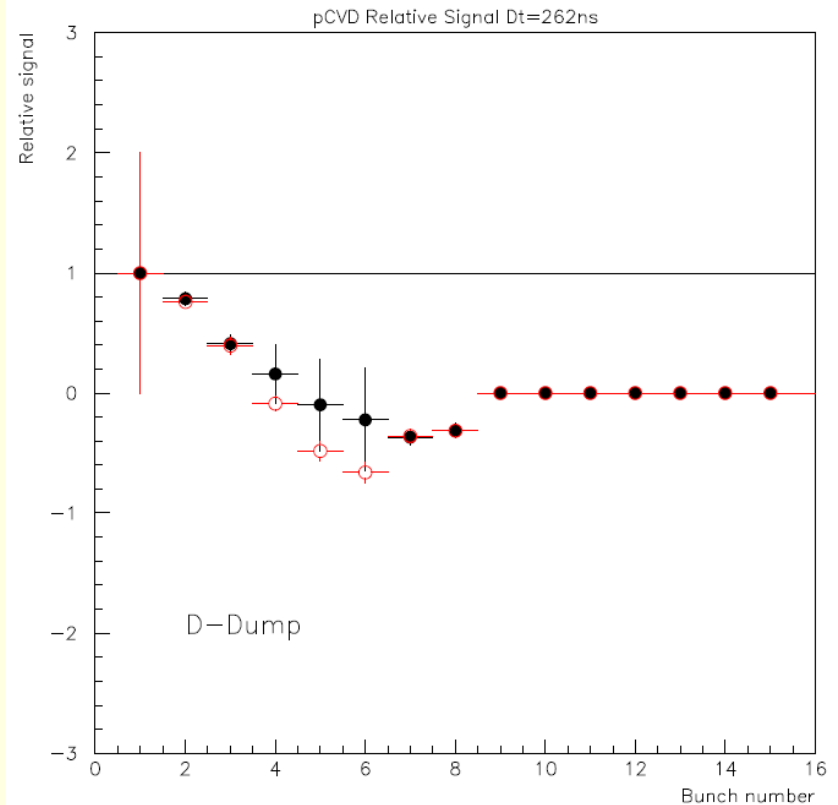
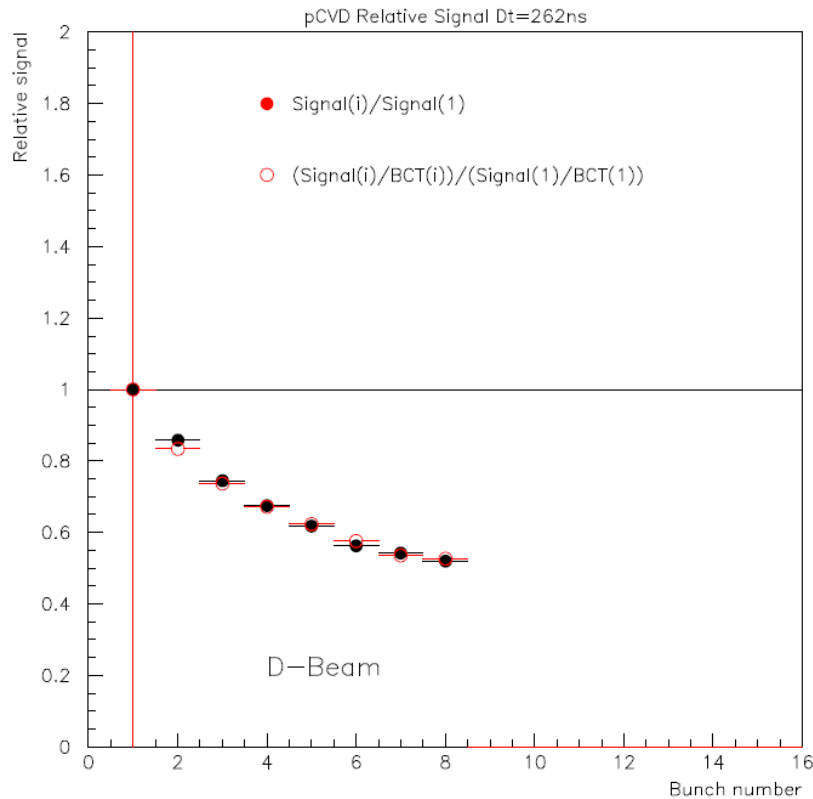
Data from all good runs with  $Dt(\text{bunch})=262\text{ns}$



Normally the effect should be reduced with longer interbunch spacing, however the signal is larger...

# Diamond response vs bunch number

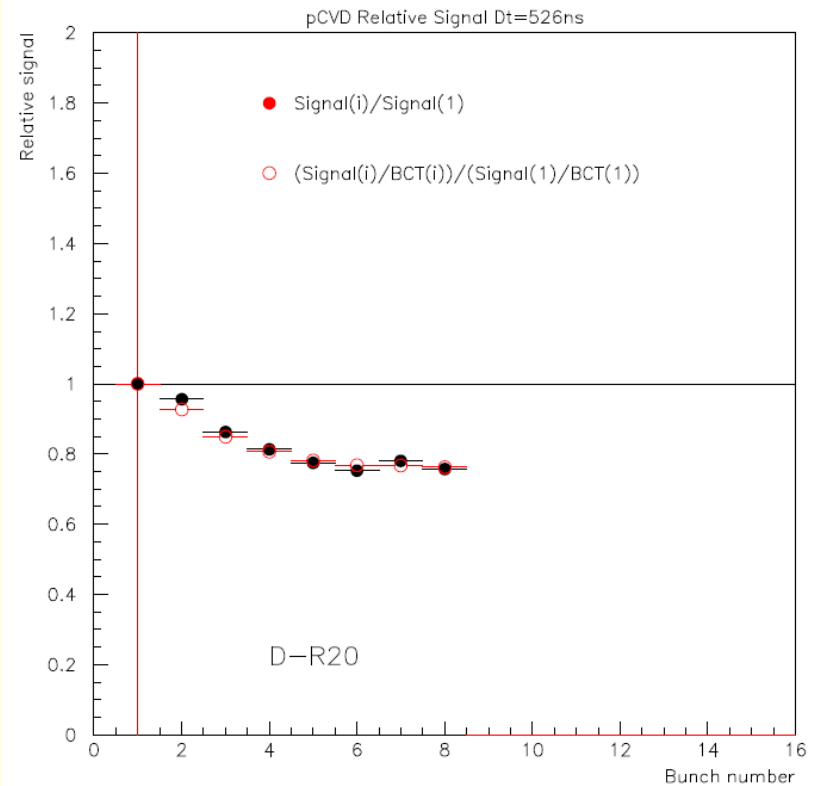
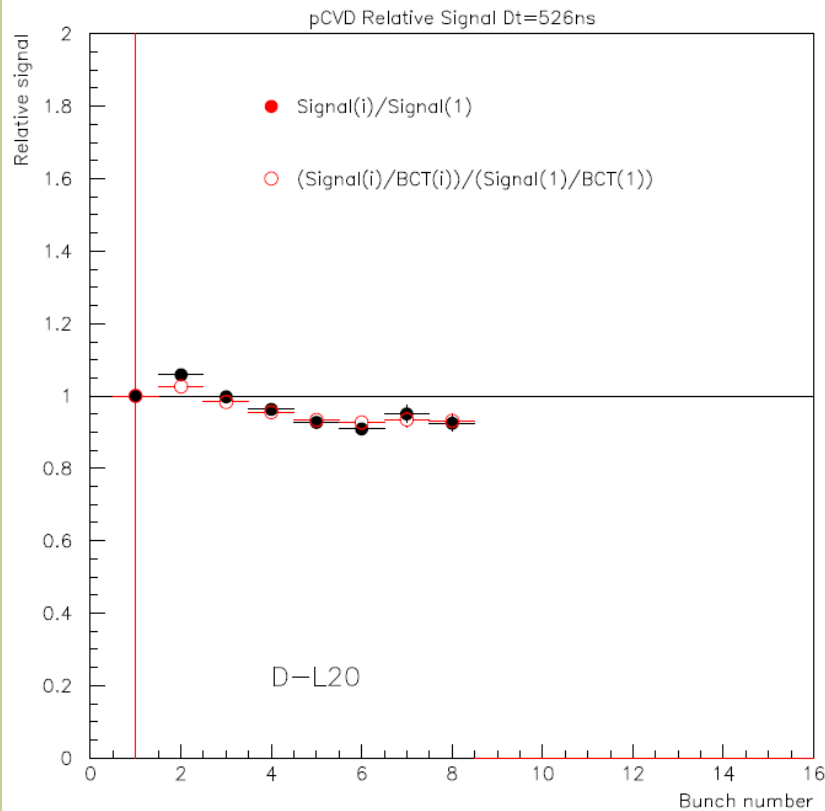
Data from all good runs with  $Dt(\text{bunch})=262\text{ns}$



Normally the effect should be reduced with longer interbunch spacing, however the signal is larger...

# Diamond response vs bunch number

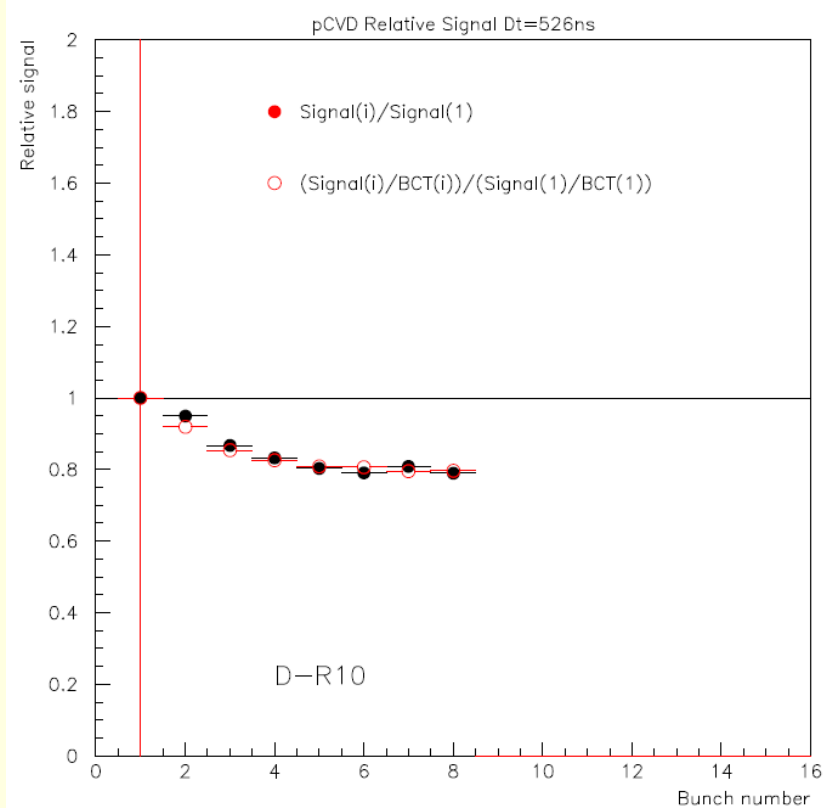
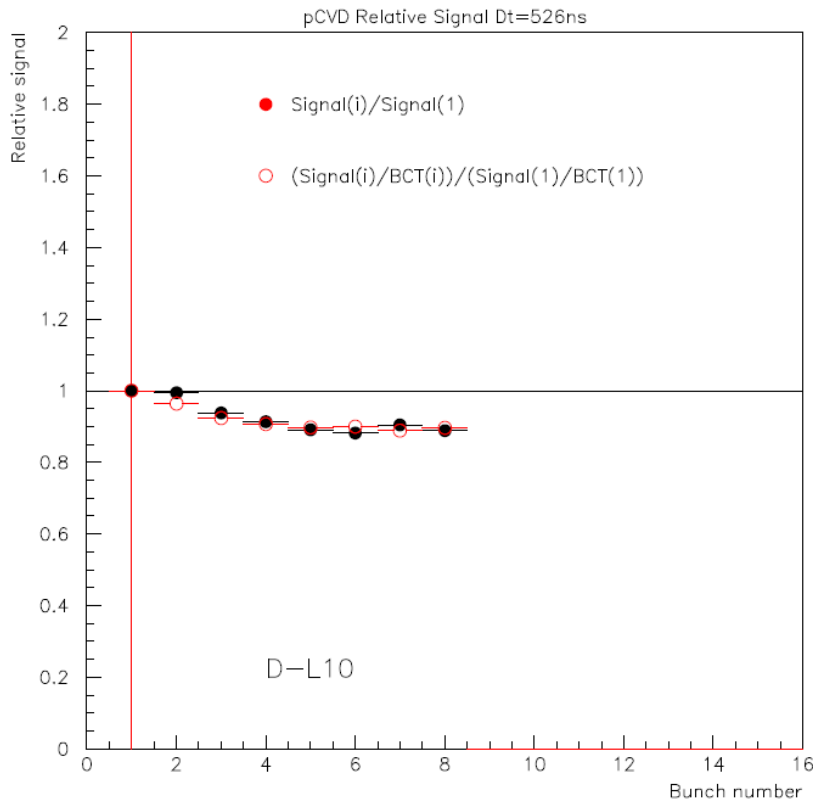
Data from all good runs with  $Dt(\text{bunch})=526\text{ns}$



Normally the effect should be reduced with longer interbunch spacing, however the signal is larger...

# Diamond response vs bunch number

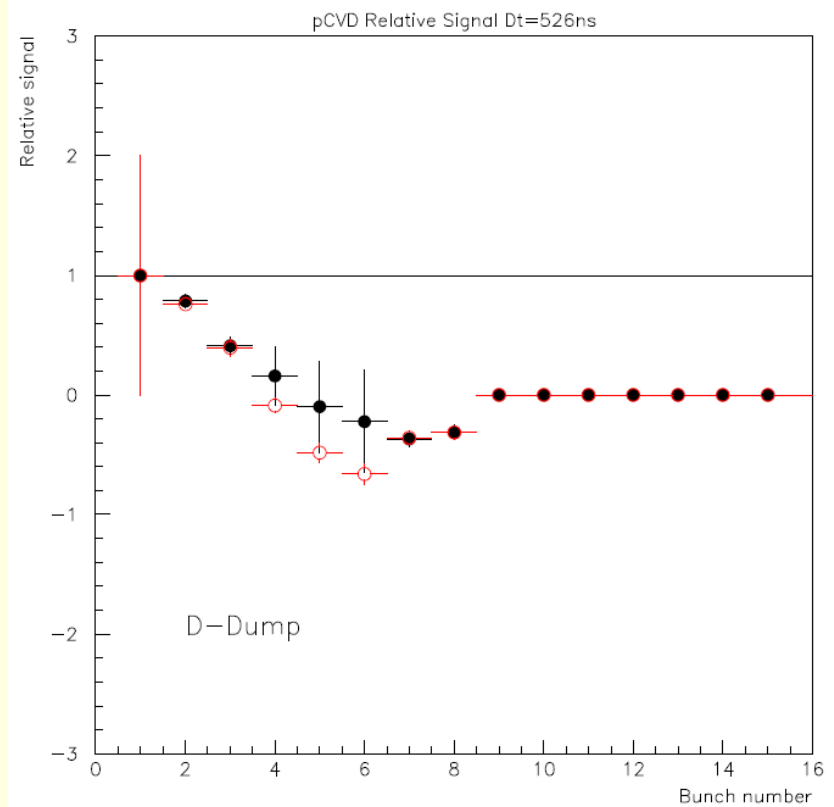
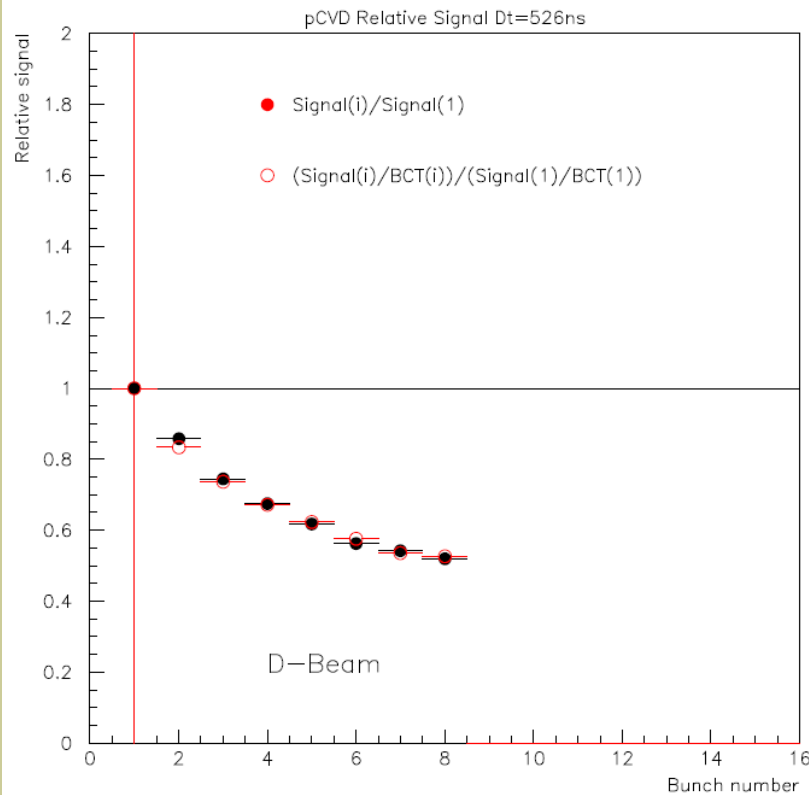
Data from all good runs with  $Dt(\text{bunch})=526\text{ns}$



Normally the effect should be reduced with longer interbunch spacing, however the signal is larger...

# Diamond response vs bunch number

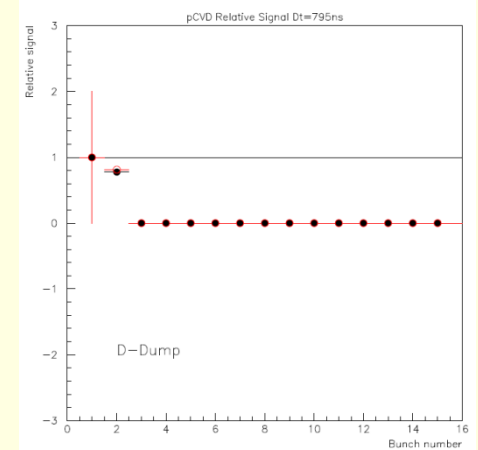
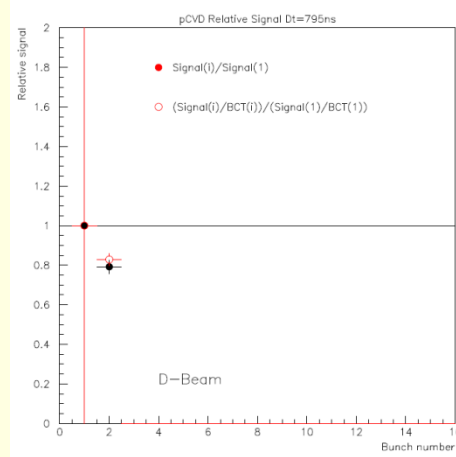
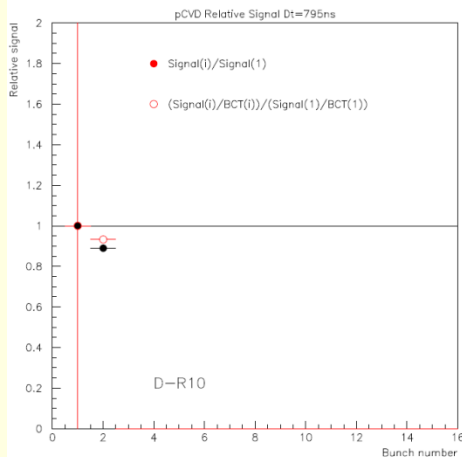
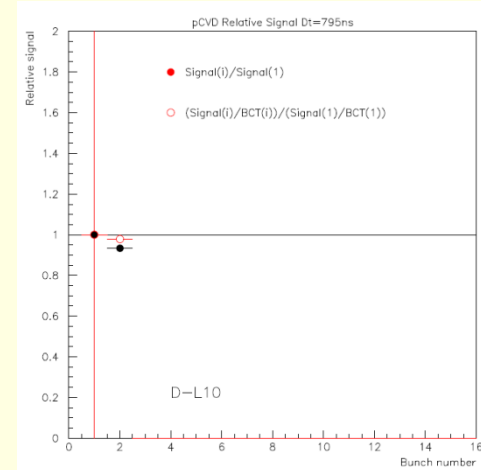
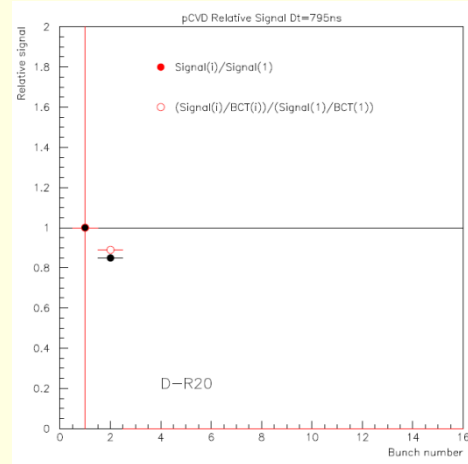
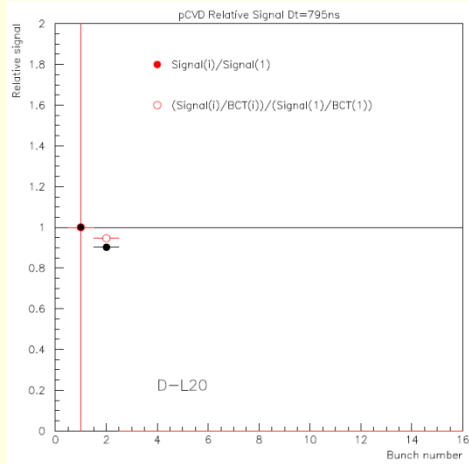
Data from all good runs with  $Dt(\text{bunch})=526\text{ns}$



Normally the effect should be reduced with longer interbunch spacing, however the signal is larger...

# Diamond response vs bunch number

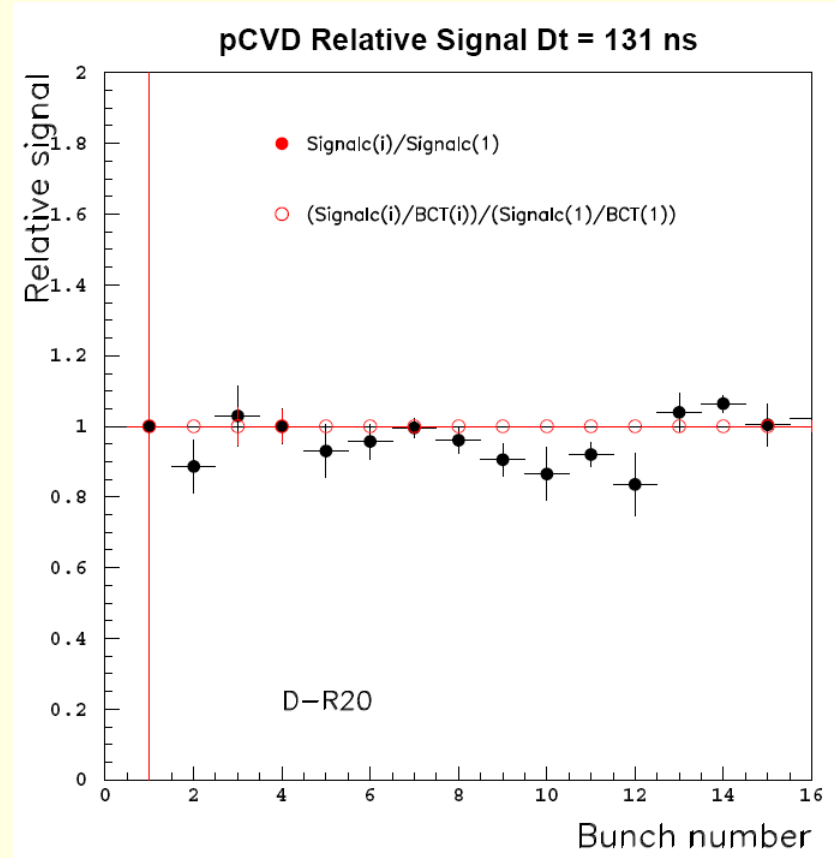
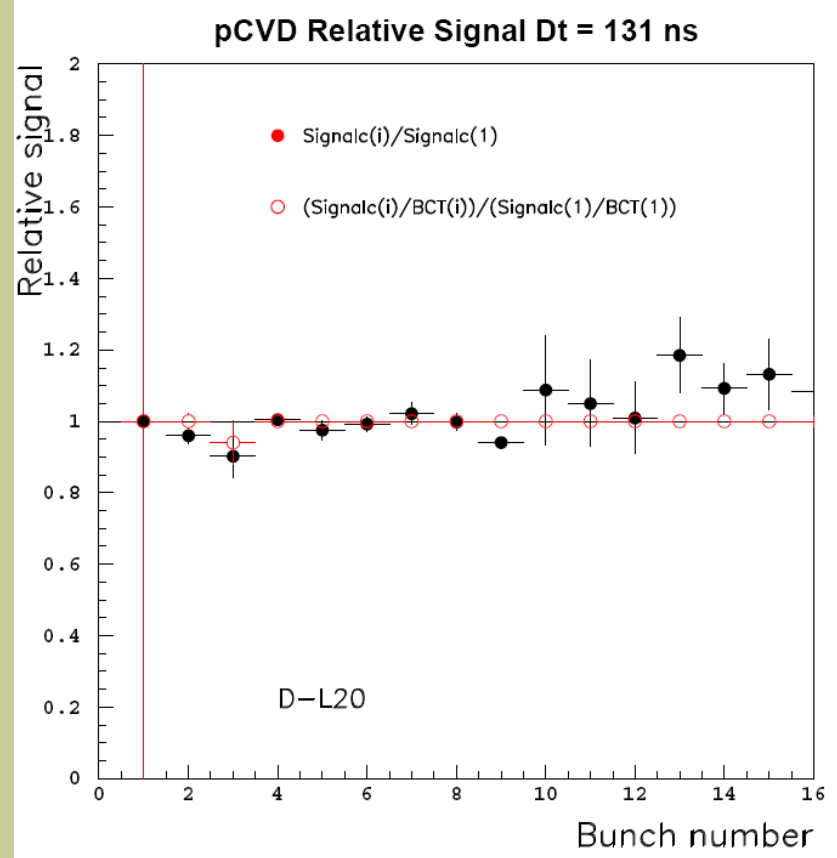
Data from all good runs with  $Dt(\text{bunch})=795\text{ns}$





# Diamond response vs bunch number

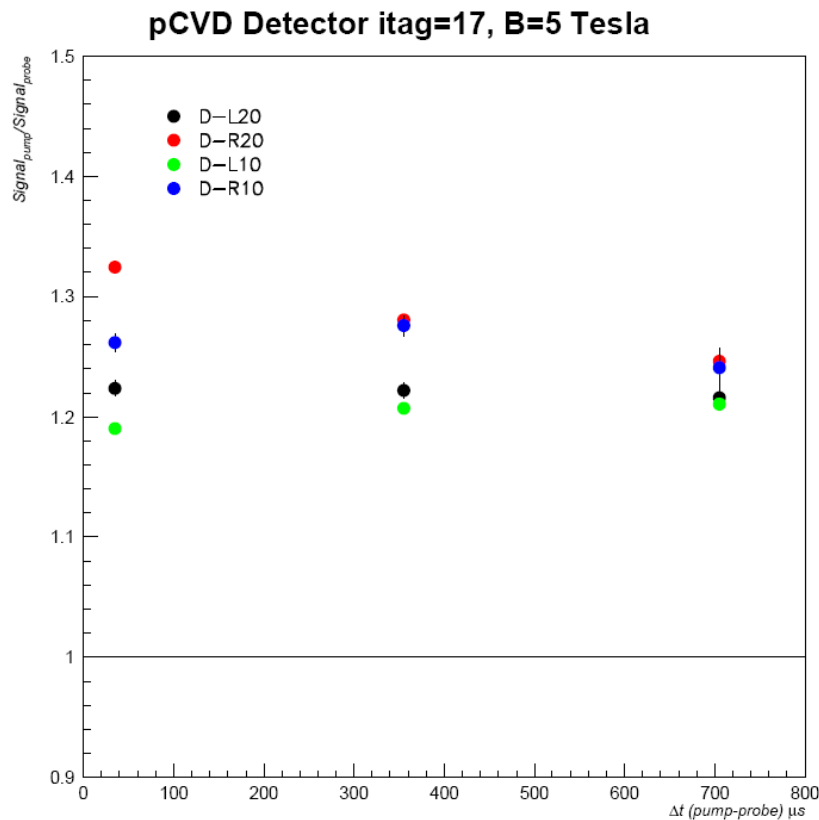
Data from all good runs with  $Dt(\text{bunch})=131\text{ns}$  – after correction



Similar plots for the other cases, not included here...

# Pump – probe analysis result

Data from pump-probe runs – various  $\Delta t(\text{bunch})$



- What is plotted is:

$$R(\text{det}) = \frac{\sum_{i=1, N_{\text{pump}}} A(dt_{\text{bunch}}, \text{det})_i \cdot \frac{S_i}{BCT_i}}{\sum_{i=1, N_{\text{probe}}} B(dt_{\text{bunch}}, \text{det})_i \cdot \frac{S_i}{BCT_i}} \cdot \frac{N_{\text{pump}}}{N_{\text{probe}}}$$

- where A, B are the correction coefficients evaluated as before for each bunch
- In the present analysis A and B are the same coefficients, i.e. treat 1<sup>st</sup> bunch of probe as 1<sup>st</sup> bunch of pump – **what would be the alternative???**

- If cavitation is formed in the target, then the ratio should increase with the pump-probe distance (lower denominator)
- Is the difference L-R significant?

# Pump – probe analysis

## Comments – next steps

- Some runs are rejected because no BCT information is available  
→ Adrian is checking that
  
- Additional correction vs beam position to apply
  
- Separate analysis vs beam(pump) intensity
  - what info from the beam impact can we get from the cameras?
  
- Do ratios (e.g. L/R) to improve errors?
  
- Is 5% “cavitation” something the MFH models predict?