





MERIT Data Analysis

(latest update : 07Oct08)

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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 

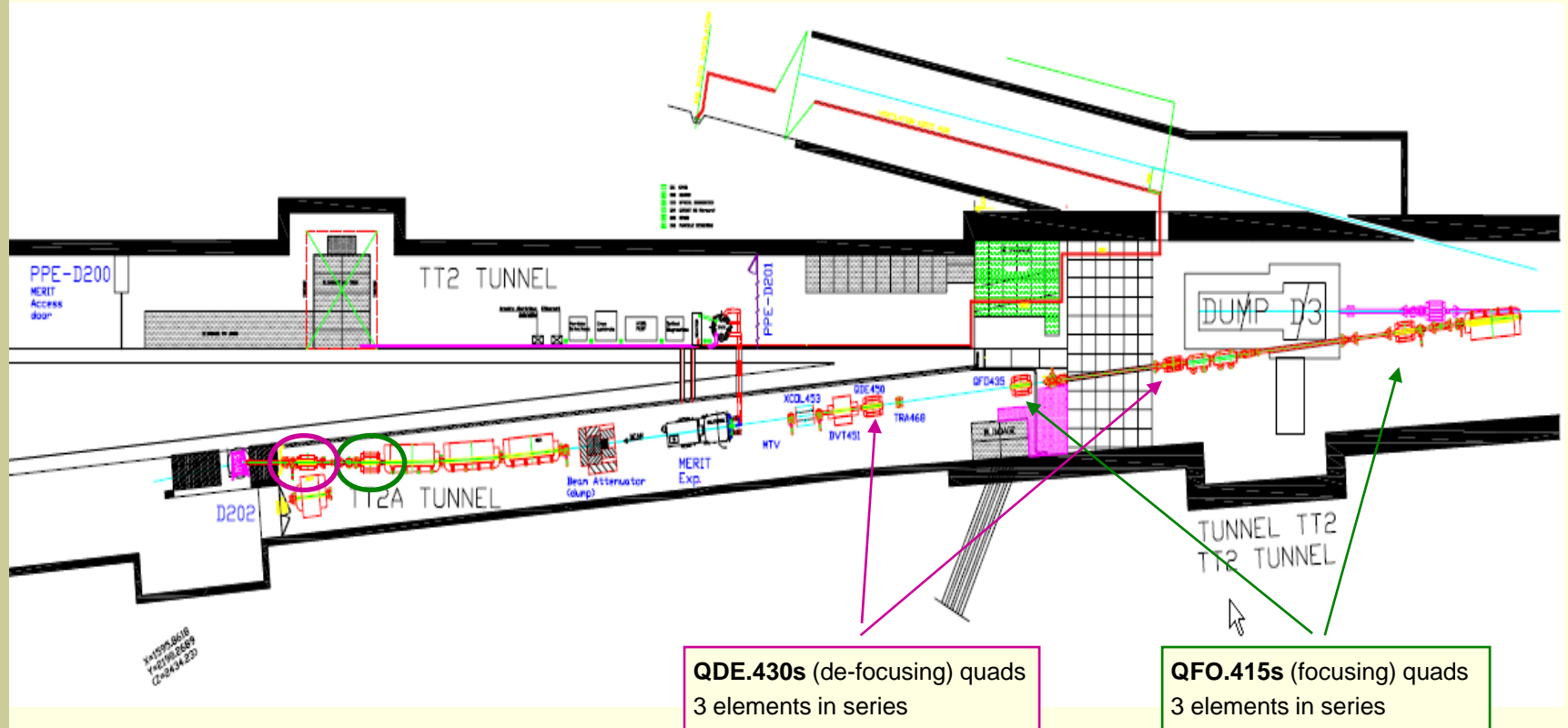
CERN/MERIT team: Adrian Fabich, J. Lettry, M. Palm,

I. Efthymiopoulos

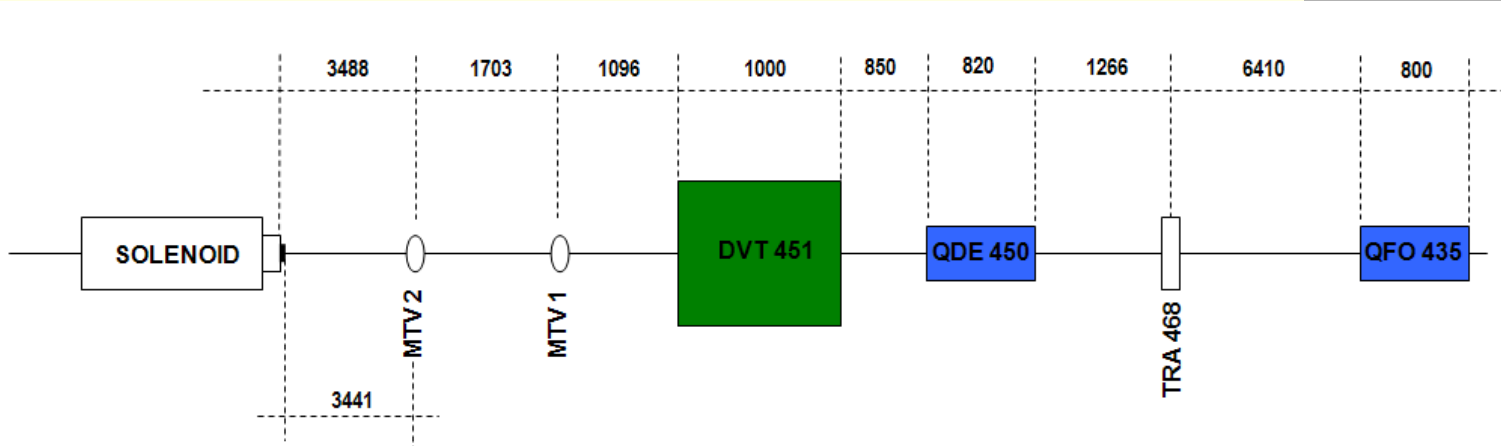
MERIT, VRVS Meeting
Ilias Efthymiopoulos

Beam spot size analysis

MERIT Elements – Layout



Survey data after the MERIT run – 18.12.2007



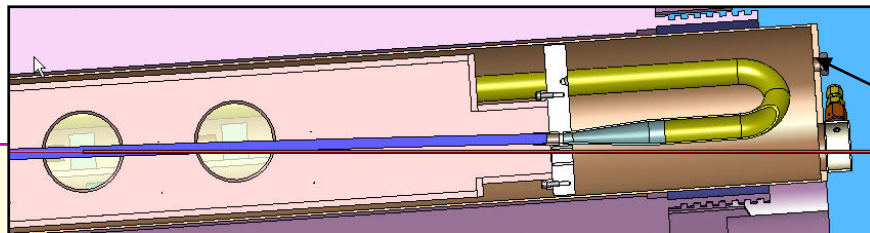
FTN start 304.69540

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

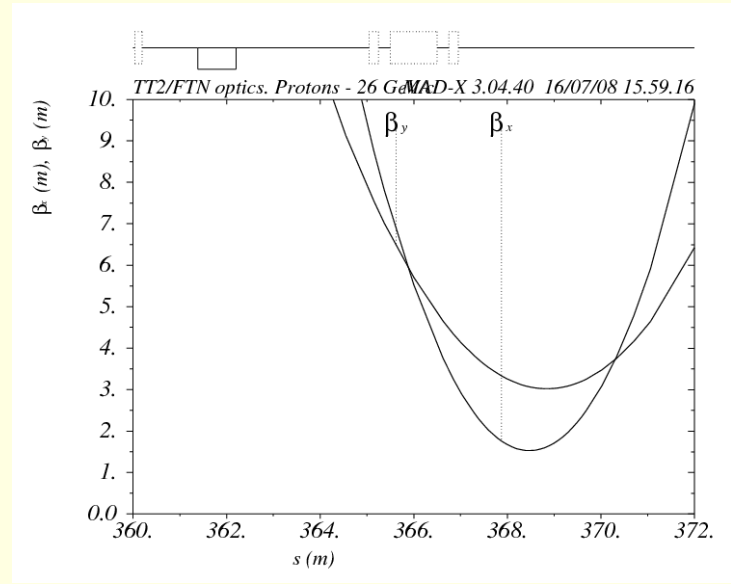
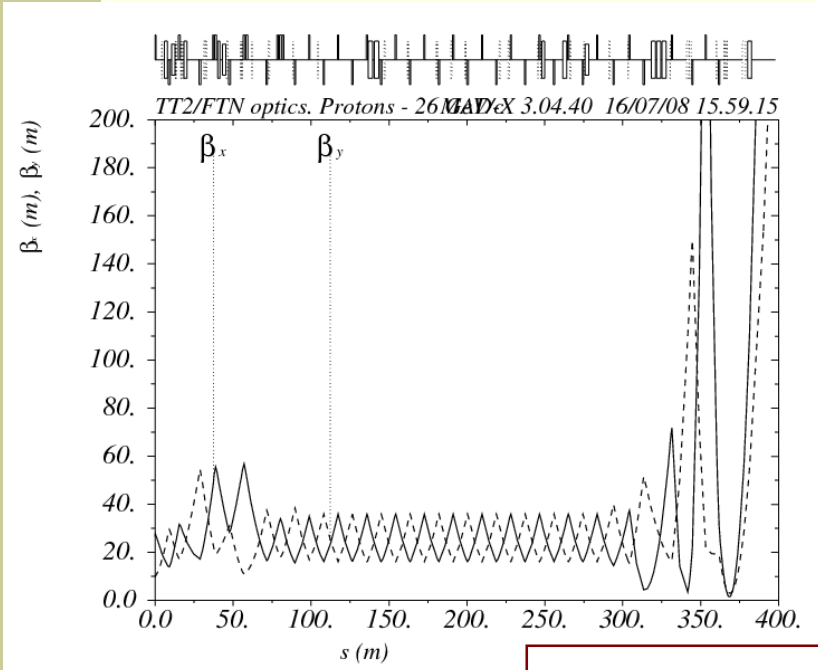
| Distance | TT2/FTN | Center |
|----------|----------|--------|
| 48.211 | 352.9064 | 48.611 |
| 49.011 | 353.7064 | |
| 55.421 | 360.1164 | 55.421 |
| 56.687 | 361.3824 | 57.097 |
| 57.507 | 362.2024 | |
| 58.357 | 363.0524 | 58.857 |
| 59.357 | 364.0524 | |



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

Upstream face: -72.3cm

- 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 |

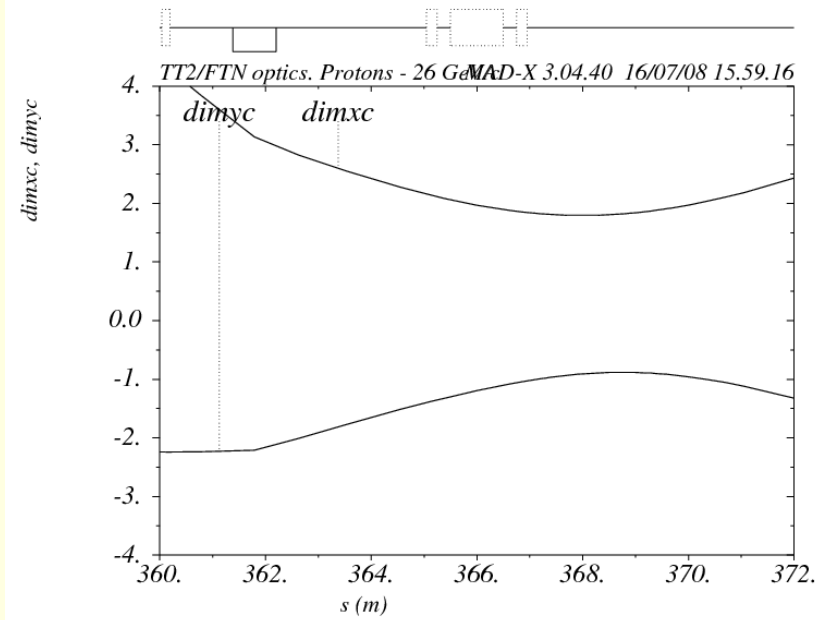
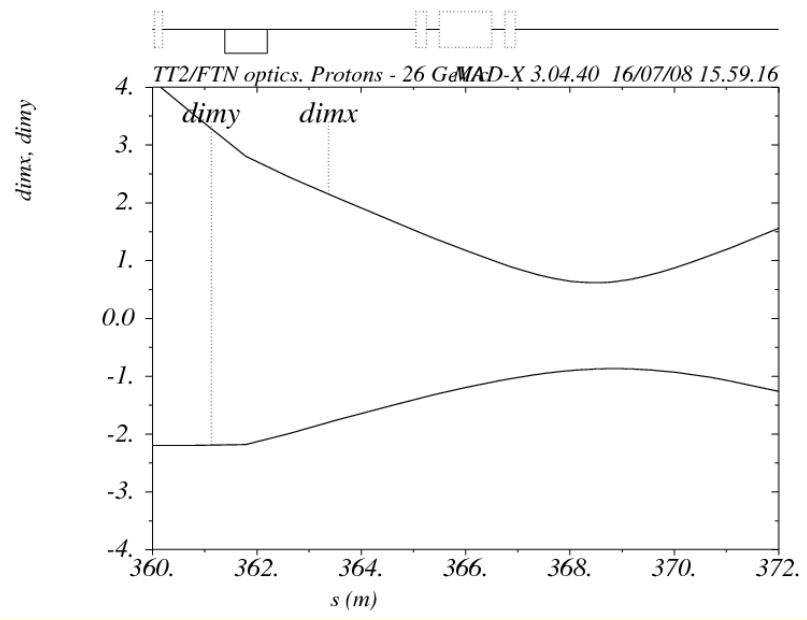
Beam envelope (1-sigma) - $\epsilon=0.25$ (mm.mrad), $D_p=0.1\%$

Without dispersion term

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

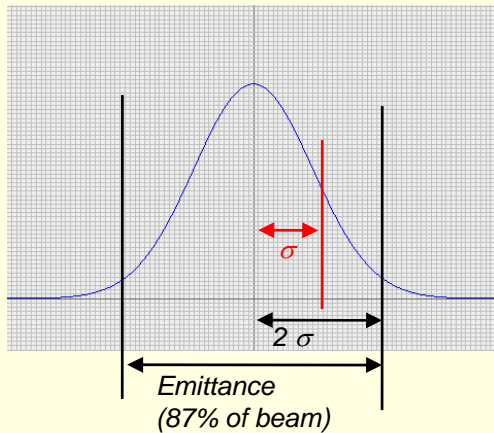
With dispersion term

- $\sigma(x) = 2.2\text{mm}$, $\sigma(y) = 1.1\text{ mm}$
- 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 4st.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,

File View Option Help

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

fws 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

fws MDPS Oct 26 18:32:41 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 - 1.76

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

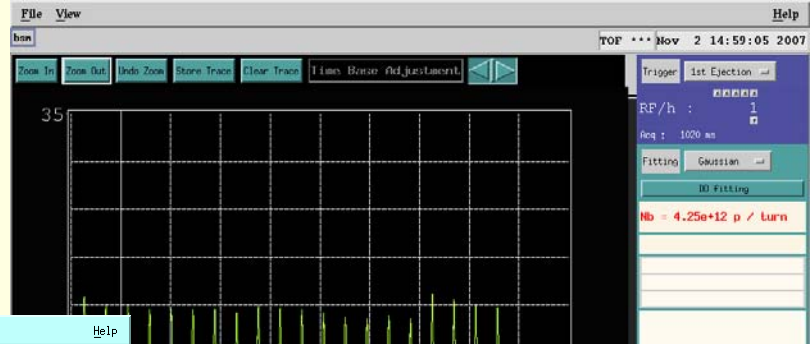
Dispersion (m.) 2.30

Scint. Transmission 100%

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

Beam Emittance measurement – 24 GeV/c

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



File Plot Views Option

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

TOF Nov 2 14:54:42 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 - 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 [mm] | 4s meas [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 |

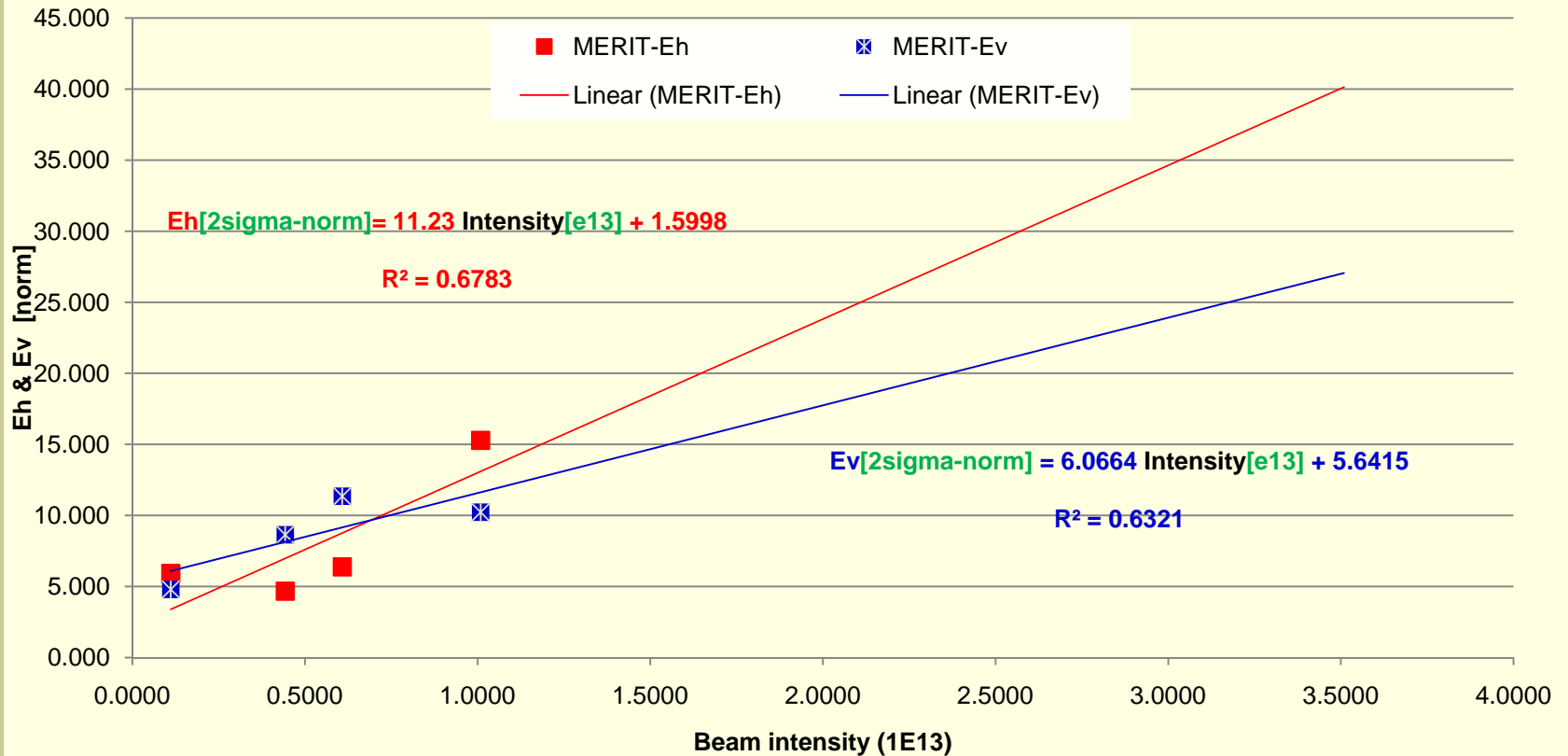
- Using the formulas of slide #6

| 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

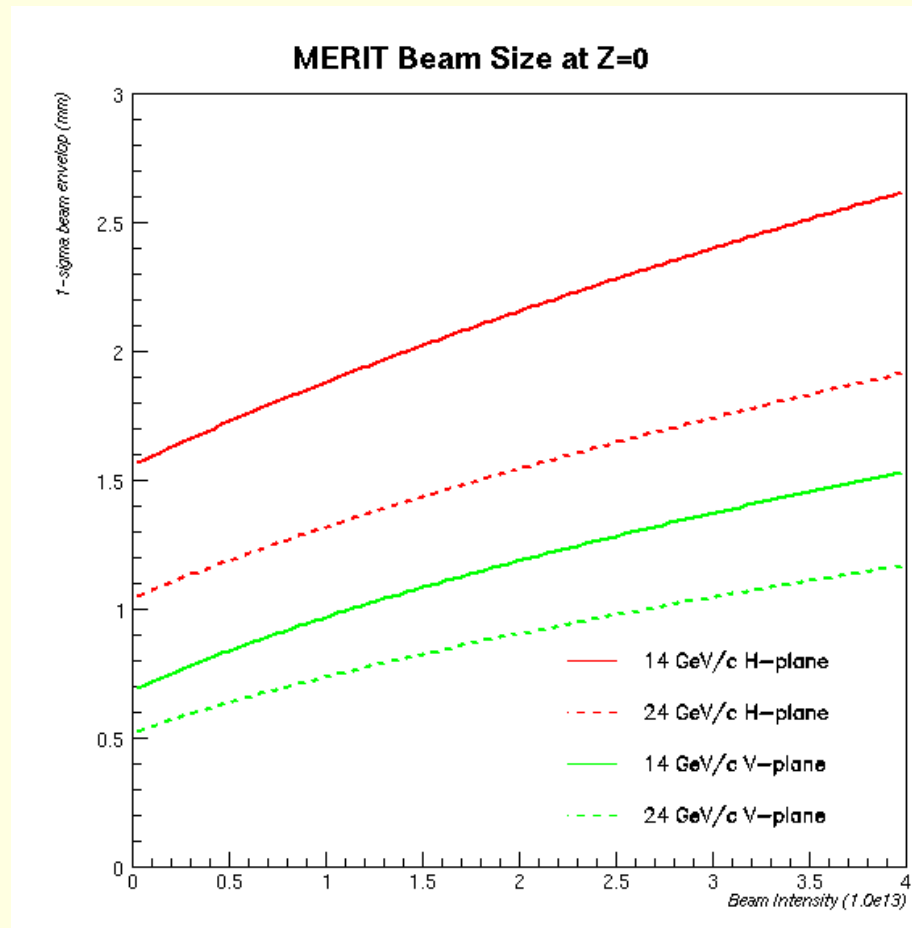
Emittance extrapolation

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)

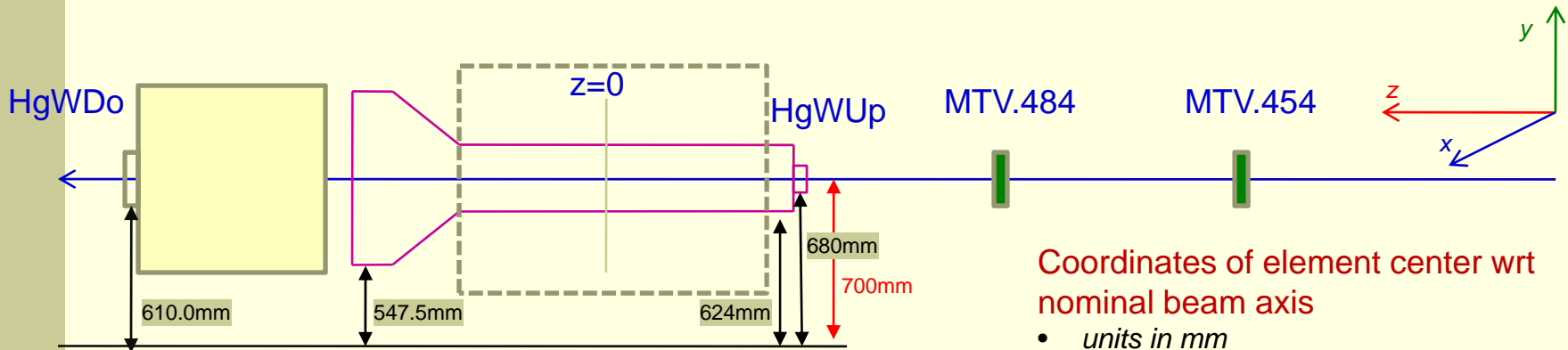
- Using $\delta p/p(2s) = 1.66(1.1)e-3$ for 14(24) GeV/c

| 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

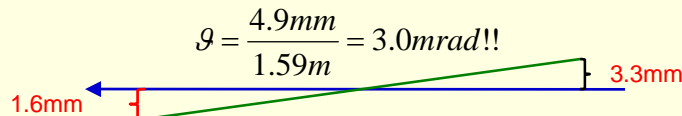
Solenoid tilt – (h-plane)

| 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 |

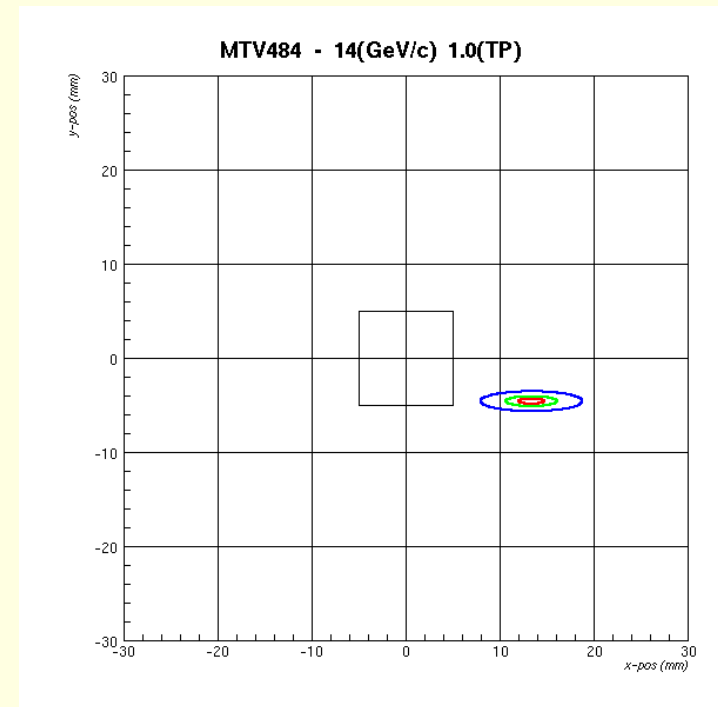
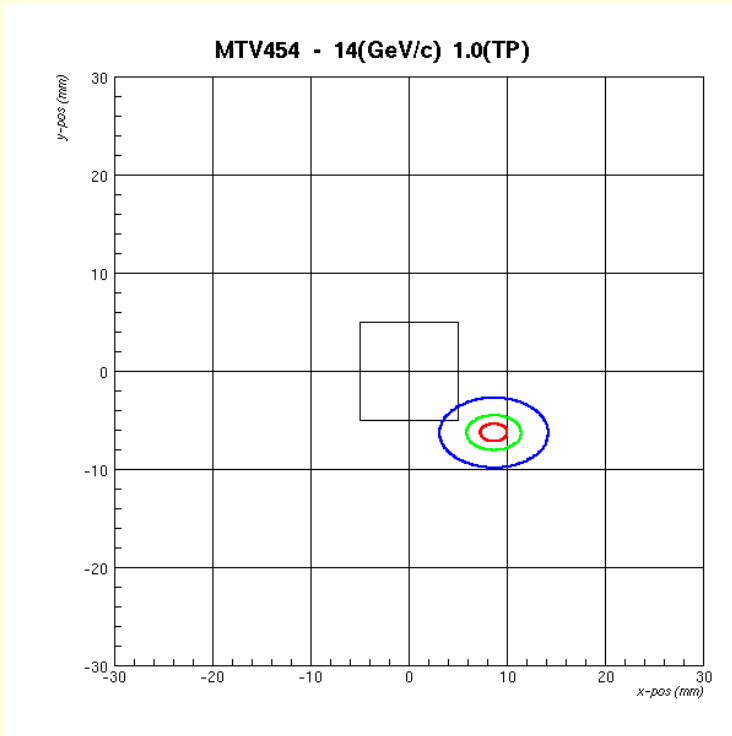
Coordinates of element center wrt nominal beam axis

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

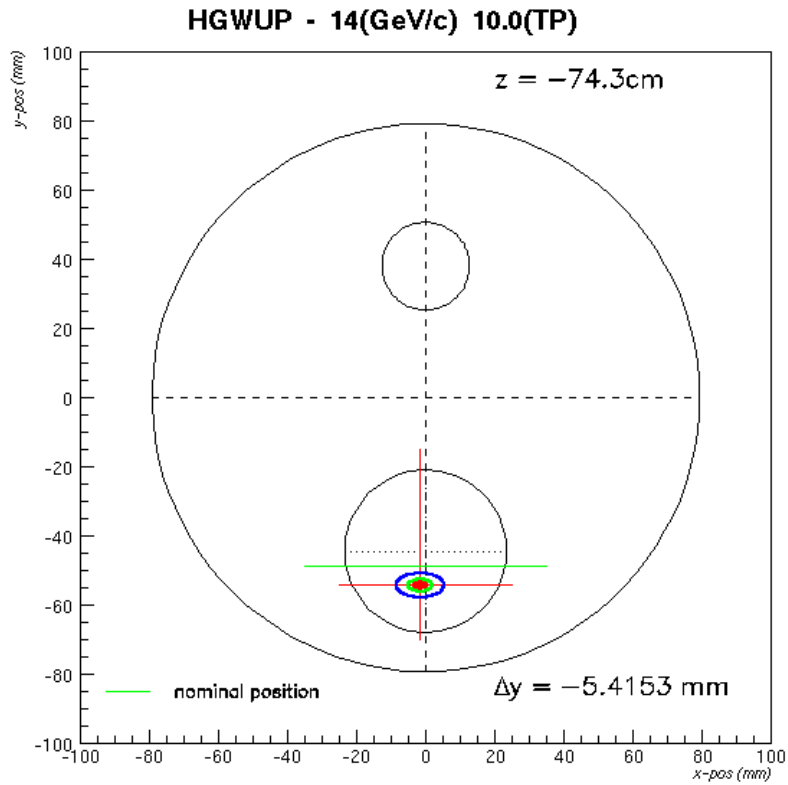
| Element | {x, y, z} |
|---------|-------------------------|
| MTV.454 | {+8.7,+6.3, -5893.95} |
| MTV484 | {+13.4, +4.6, -4230.95} |
| HgWUp | {-1.5,-10.0,-742.95} |
| HgWDo | {+57.0, -26.0, +2950.2} |
| Hgz=0 | {-1.0,??,0.0} |



Nominal beam position in various elements



Beam at Hg container



Impact point calculation from the MTV data

Projected beam impact point

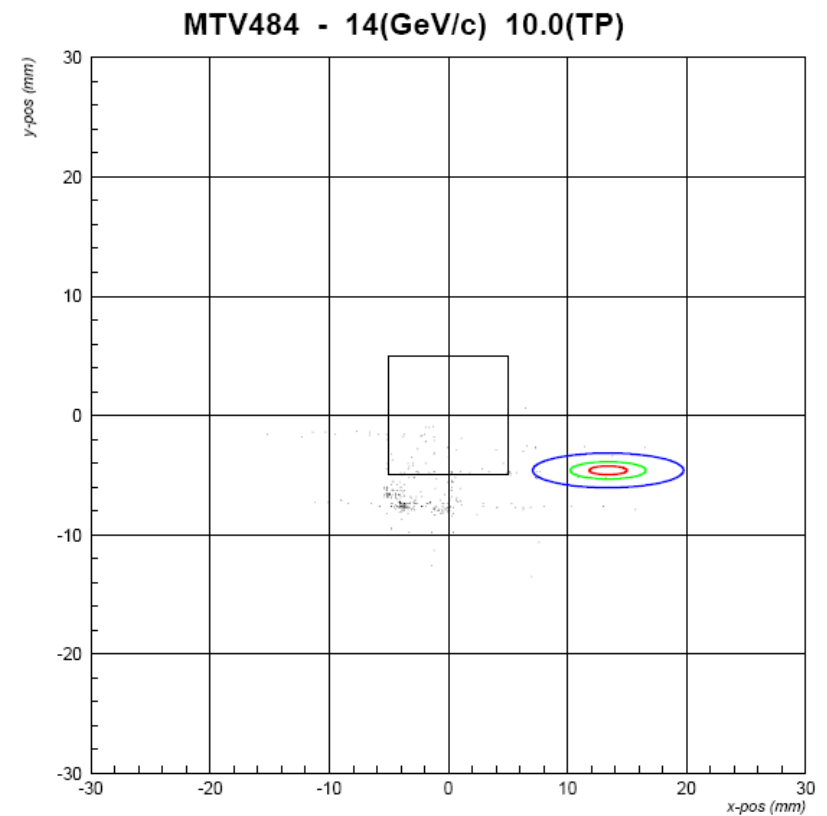
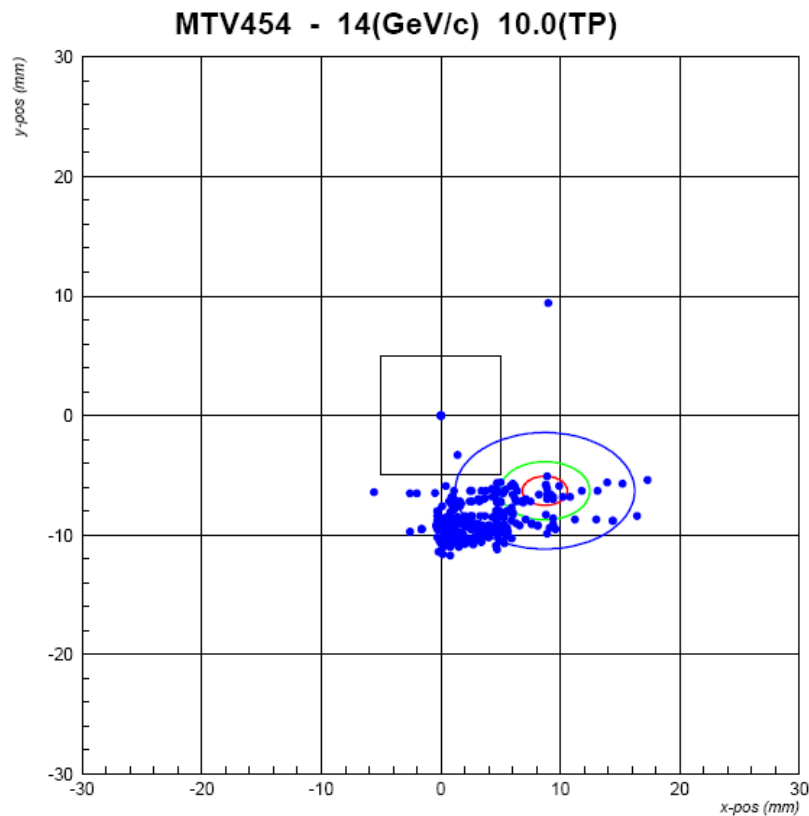
- Using the alignment information from the previous slides the beam impact point at the target can be calculated
 - For the H-plane there is no ambiguity
 - For the V-plane we must assume some tilt angle – or just the nominal?

- 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

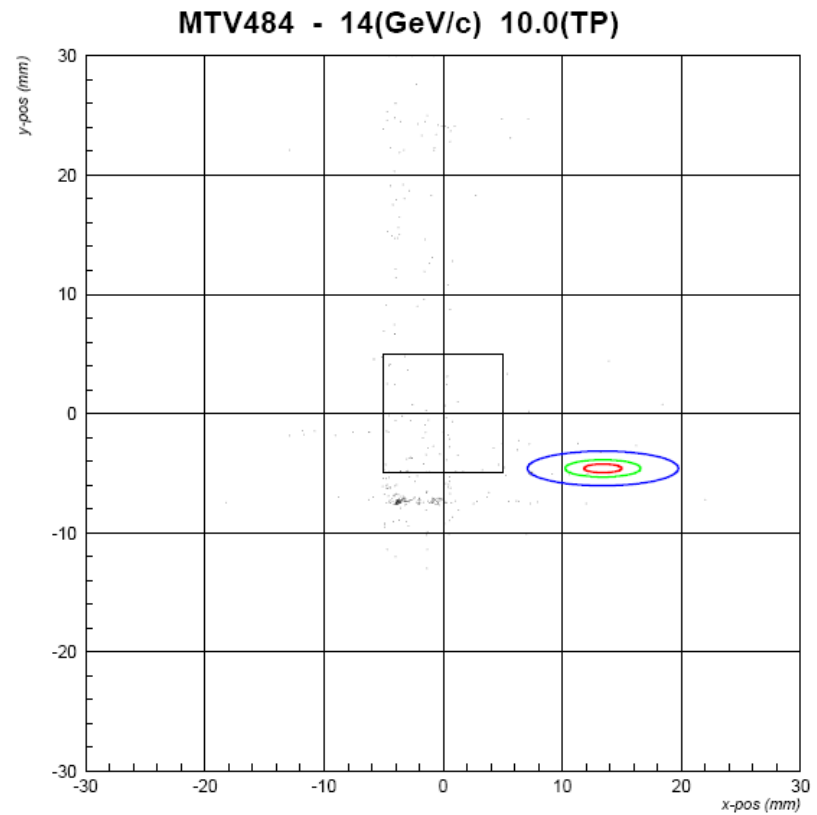
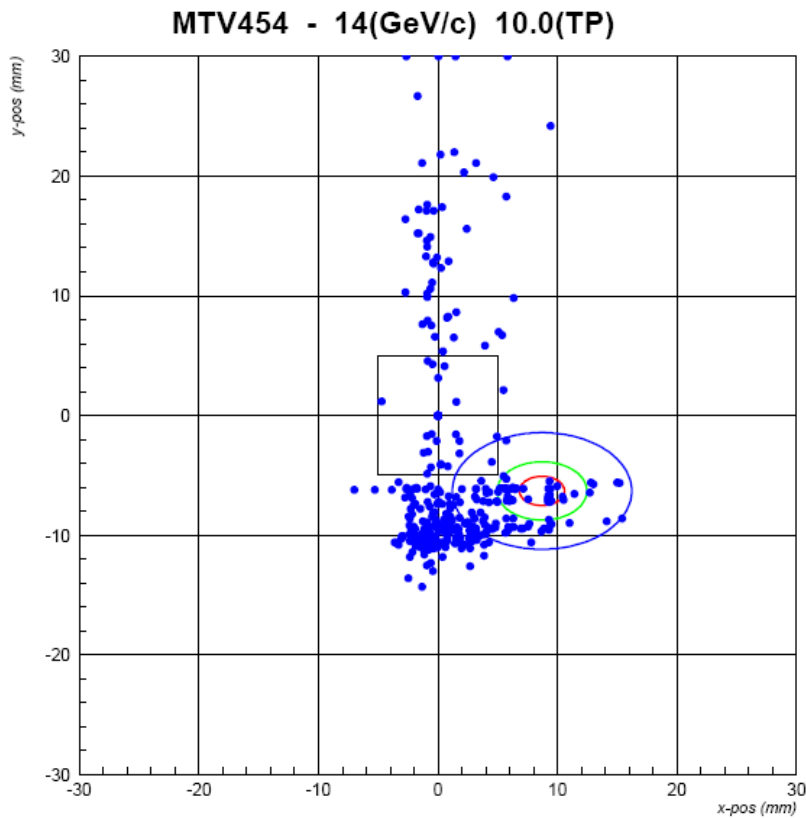
Online flag information from the logbook



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

Recorded beam position in the two flags

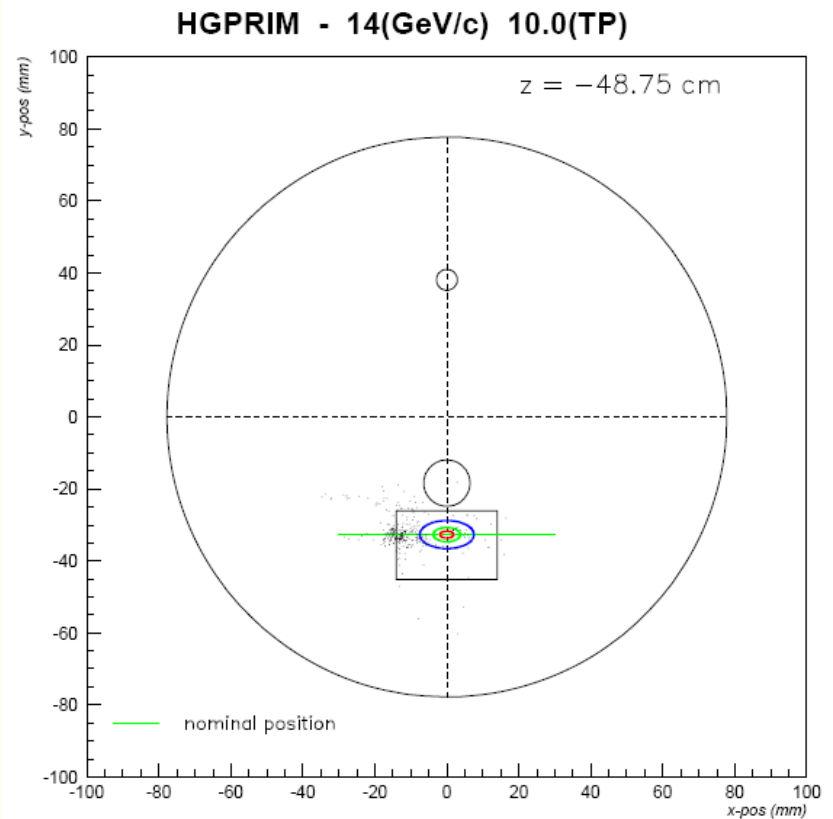
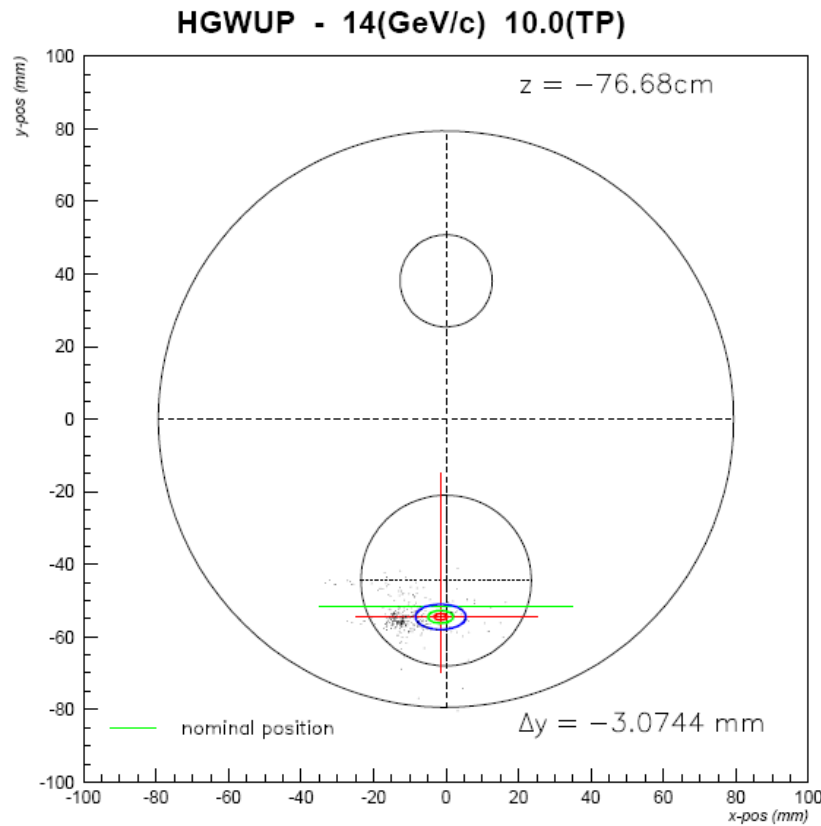
Flag position from Goran



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

Projected beam position in the target

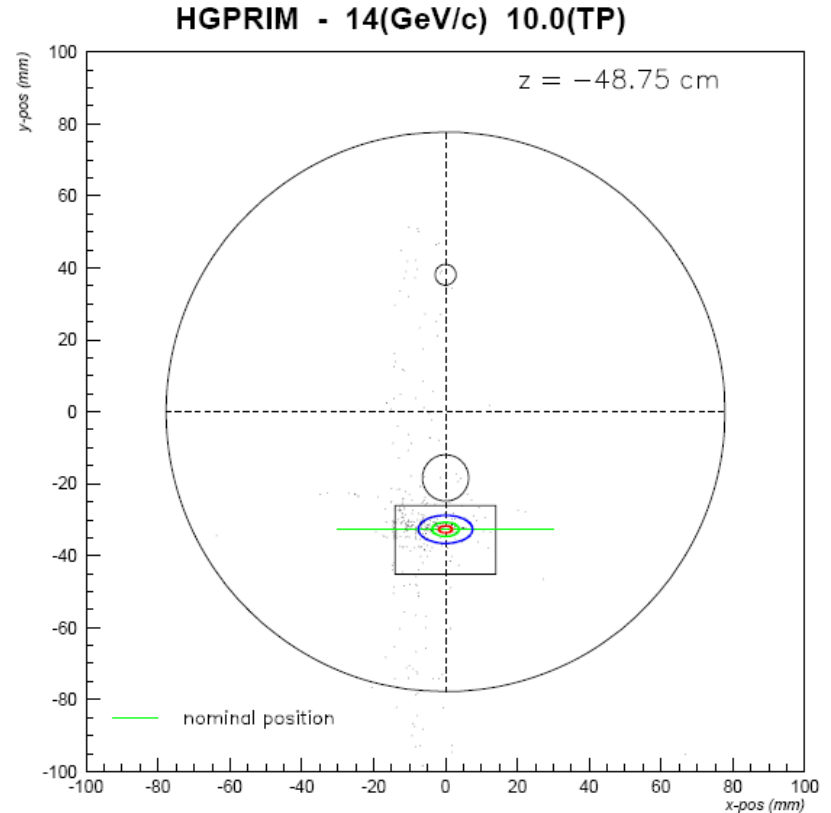
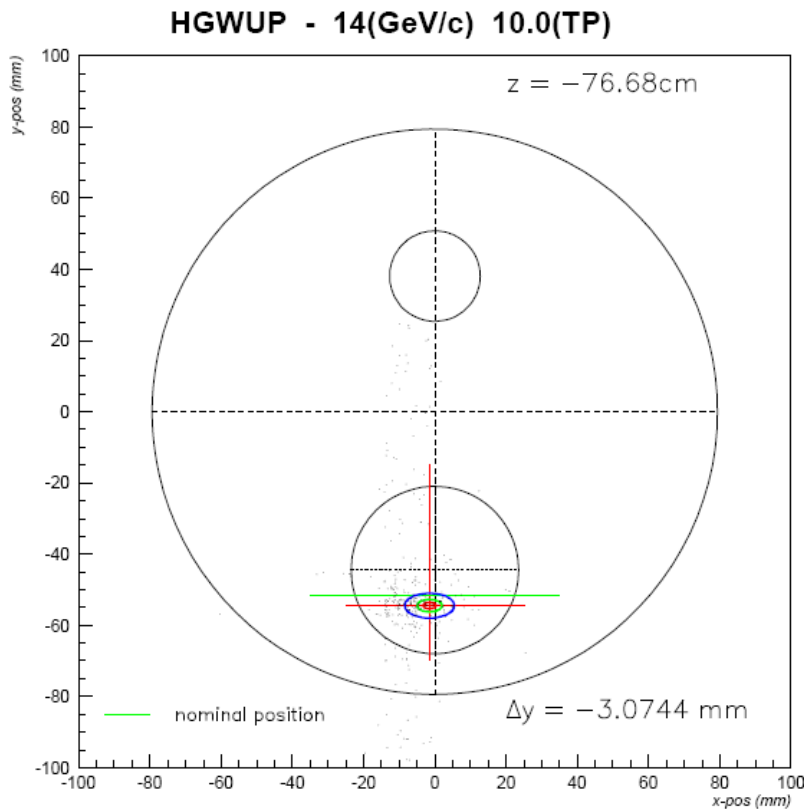
Online flag data from the logbook



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

Projected beam position in the target

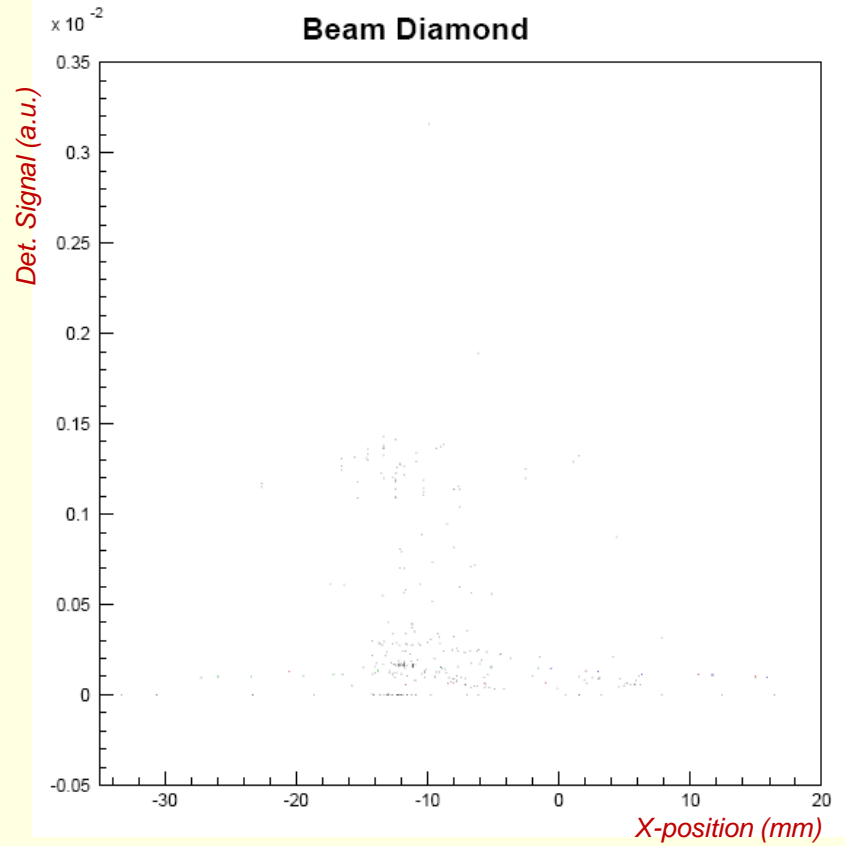
Using the data from Goran



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

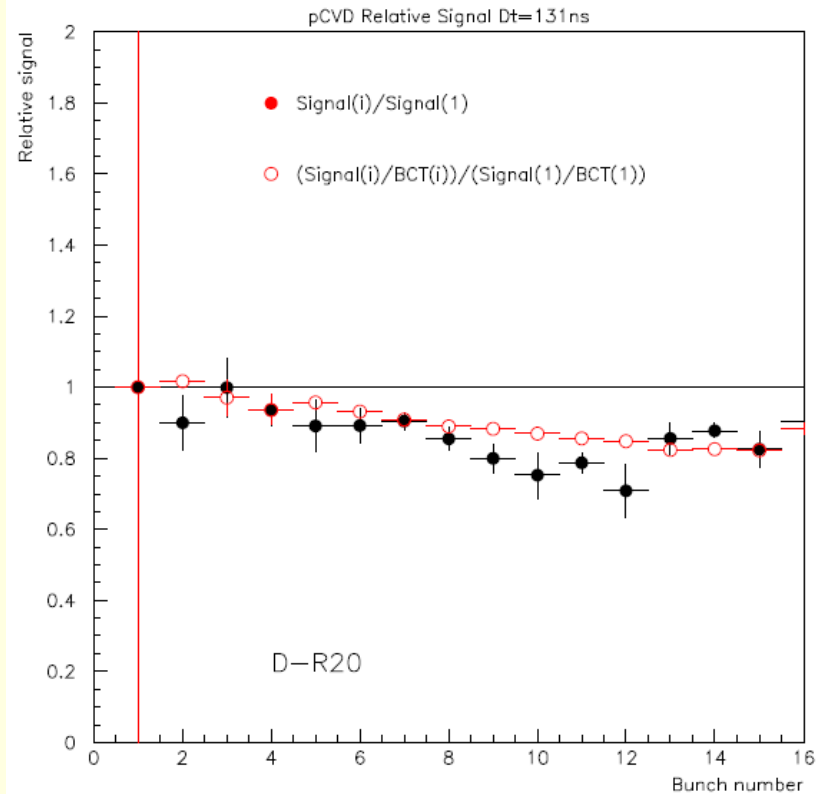
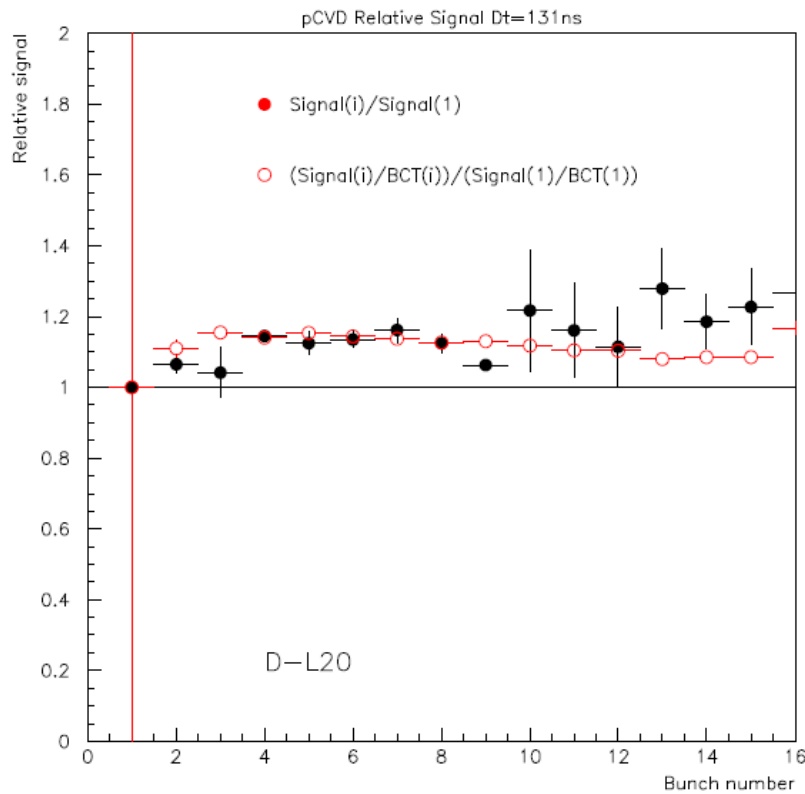
Pump – probe analysis using the diamond detectors

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

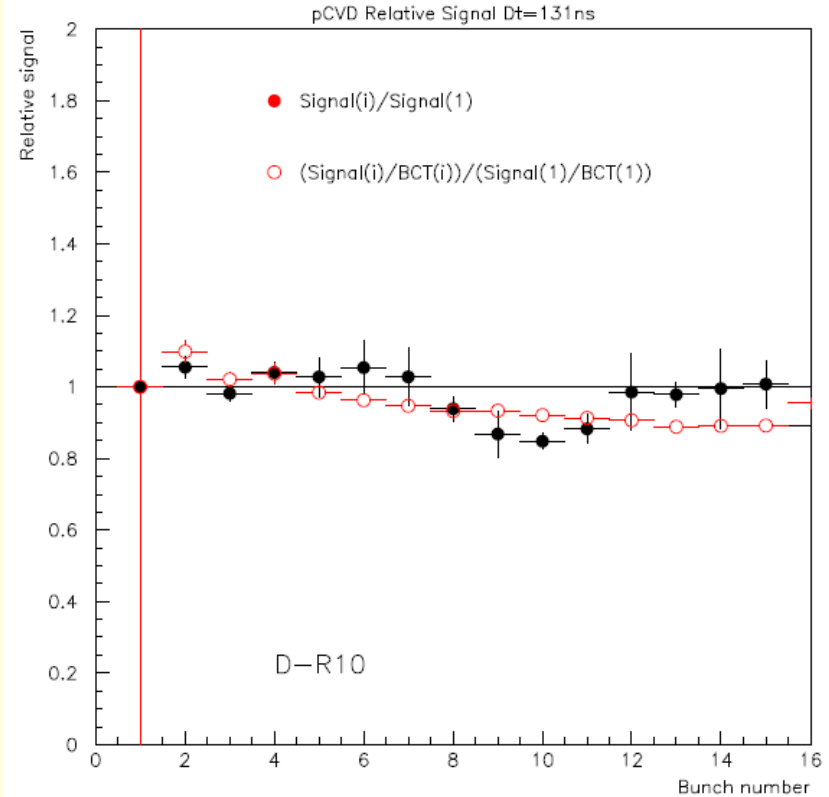
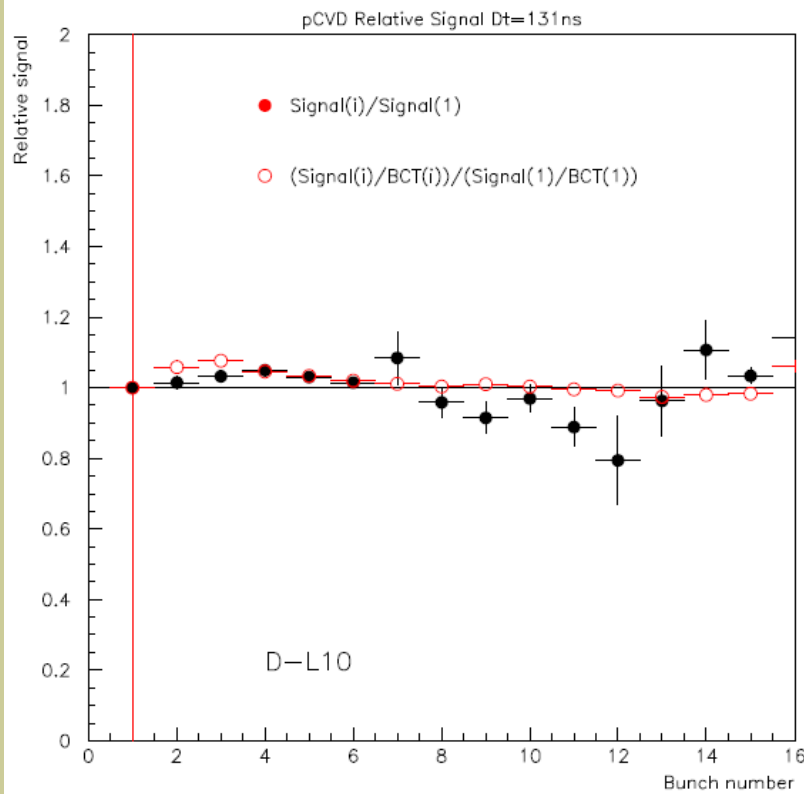
Data from all good runs with $Dt(\text{bunch})=131\text{ns}$



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

Diamond response vs bunch number

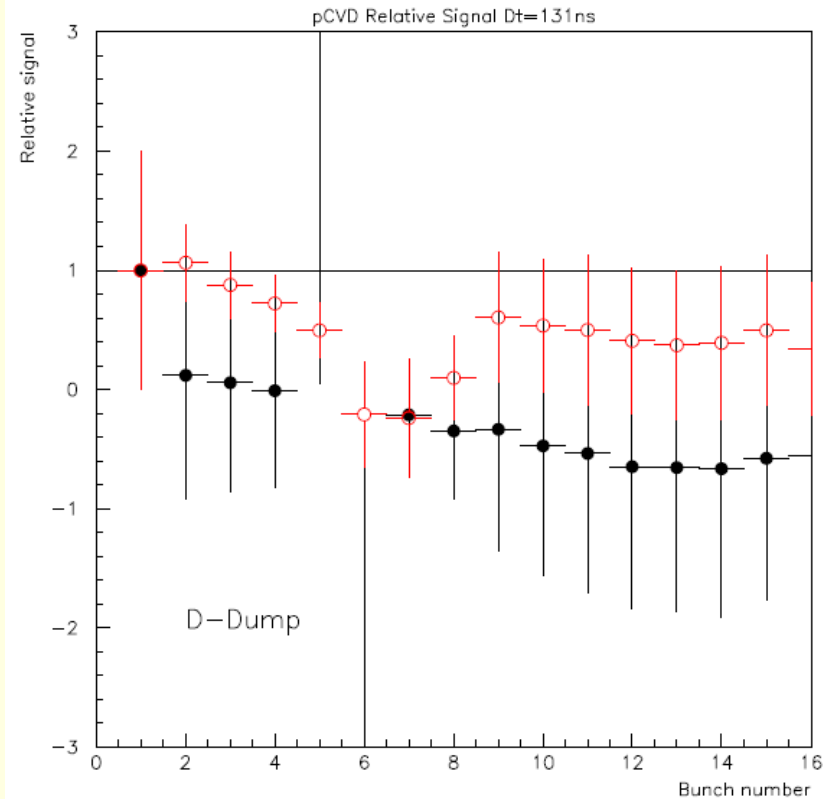
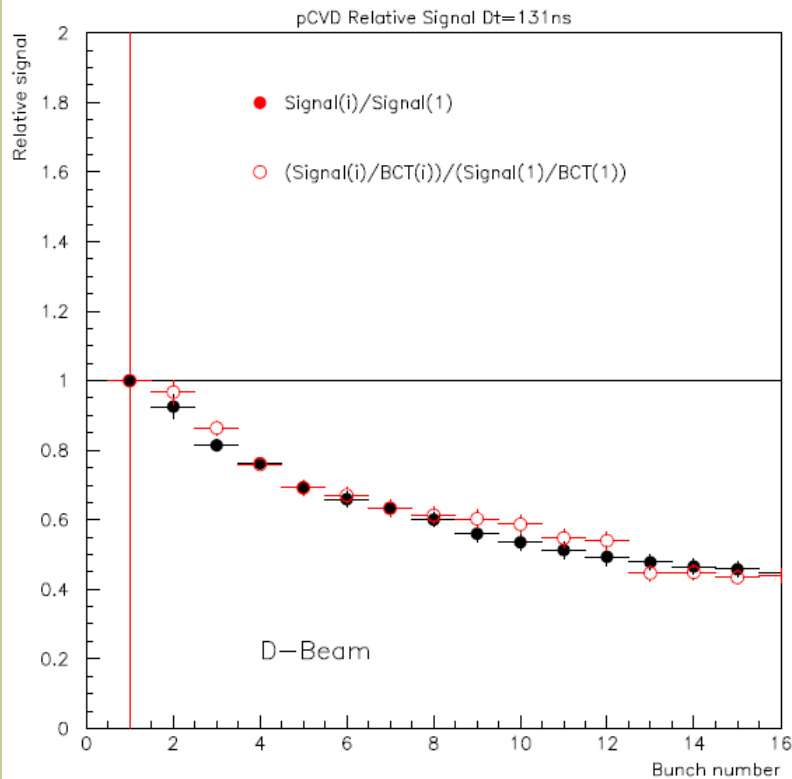
Data from all good runs with $Dt(\text{bunch})=131\text{ns}$



The correction with the BCT data smoothens the observed dependence

Diamond response vs bunch number

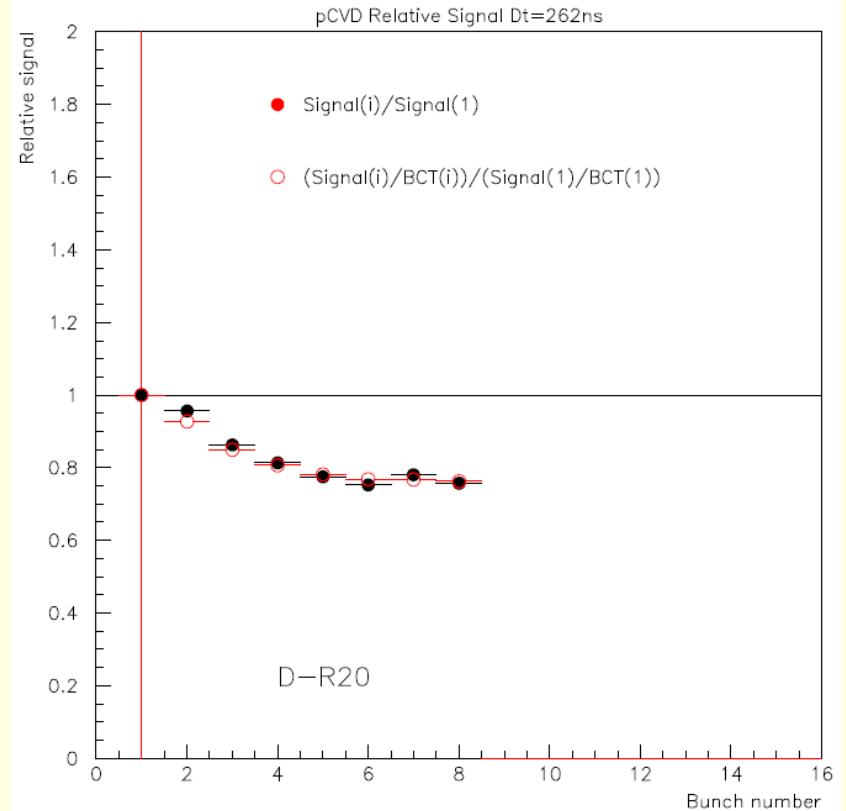
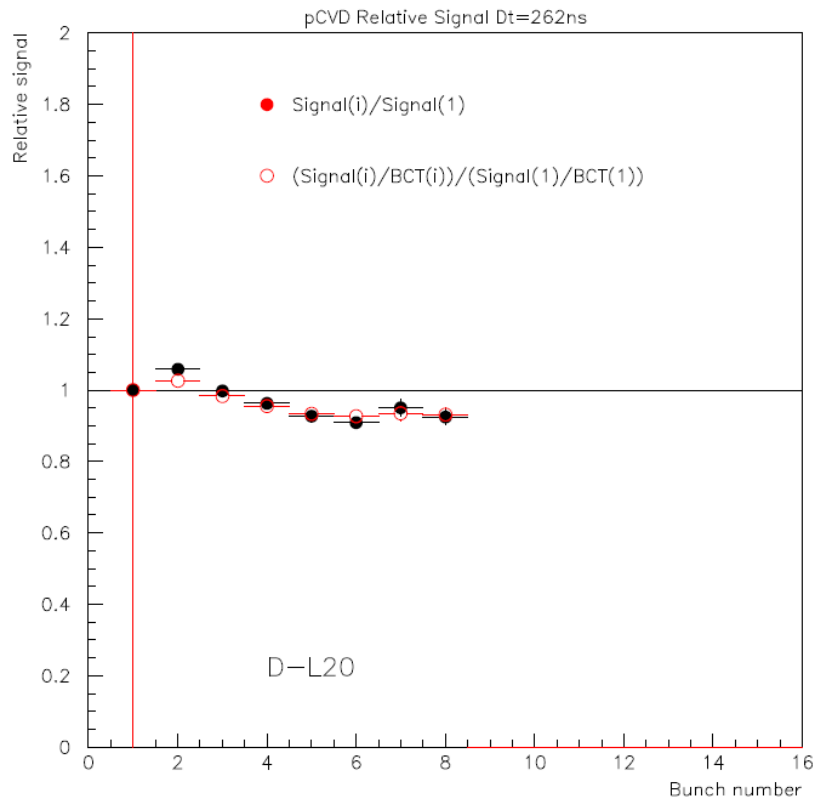
Data from all good runs with $Dt(\text{bunch})=131\text{ns}$



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

Diamond response vs bunch number

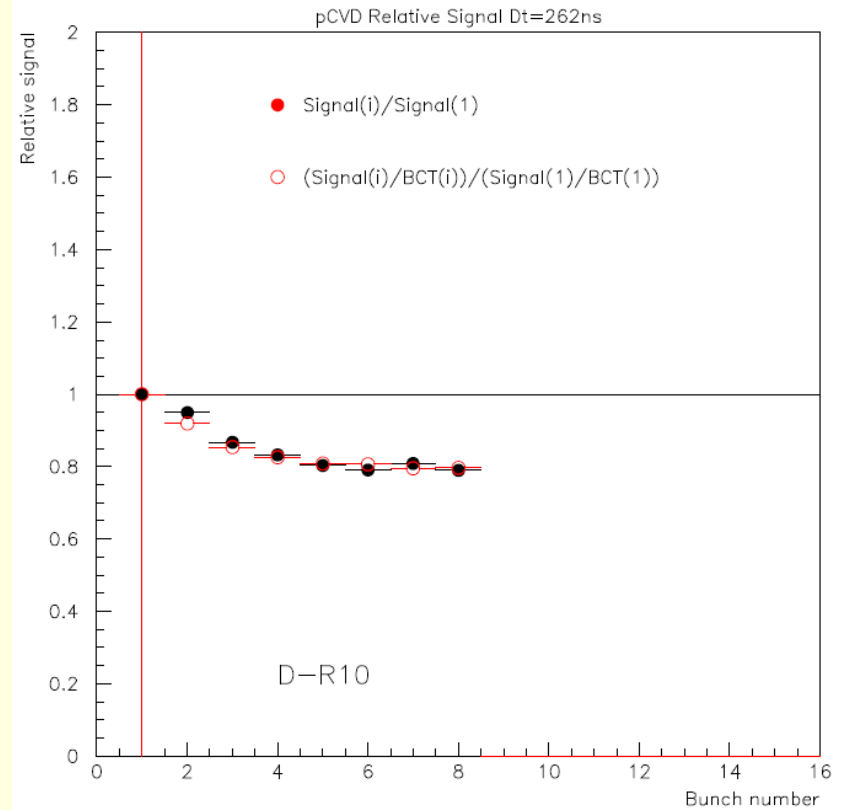
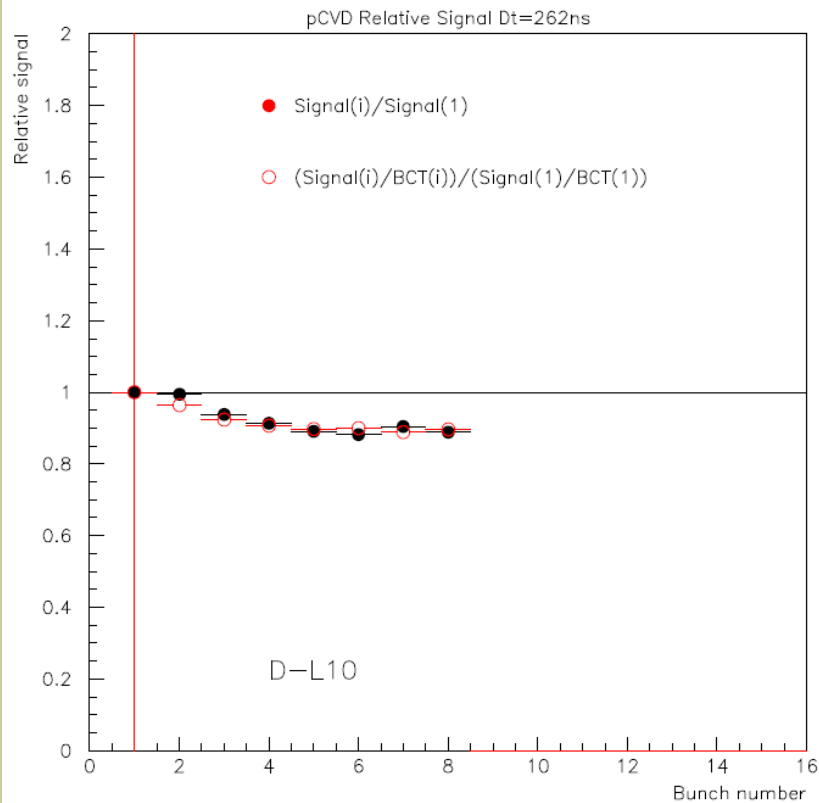
Data from all good runs with $Dt(\text{bunch})=262\text{ns}$



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

Diamond response vs bunch number

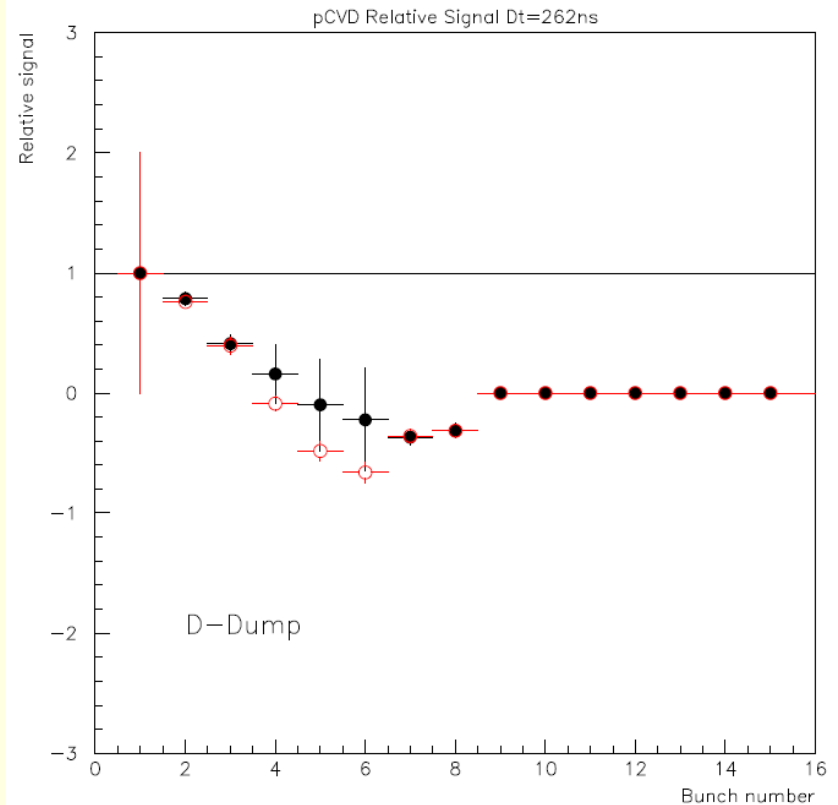
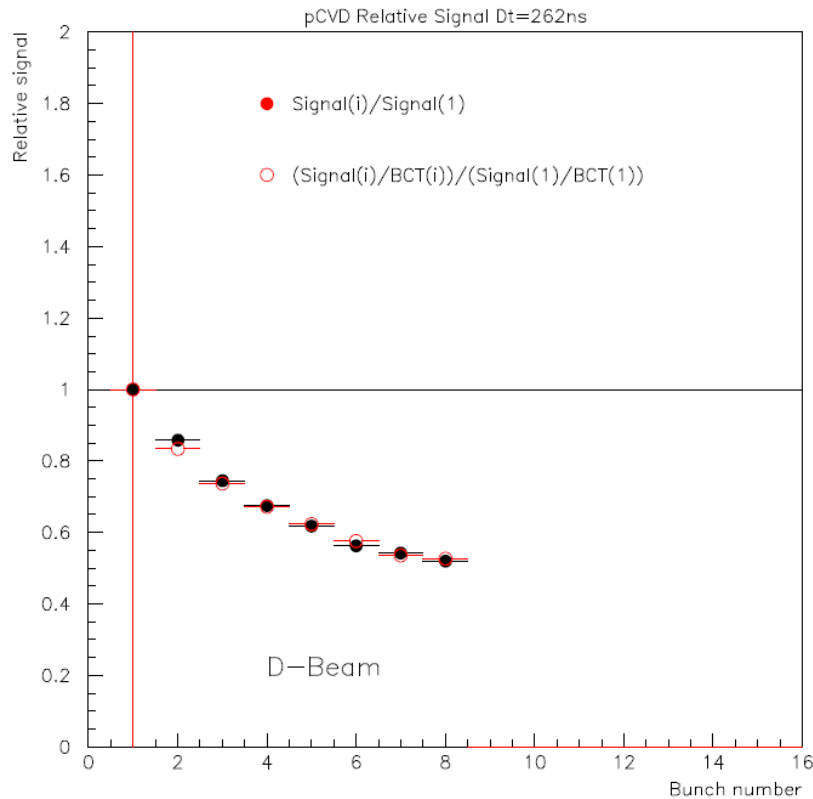
Data from all good runs with $Dt(\text{bunch})=262\text{ns}$



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

Diamond response vs bunch number

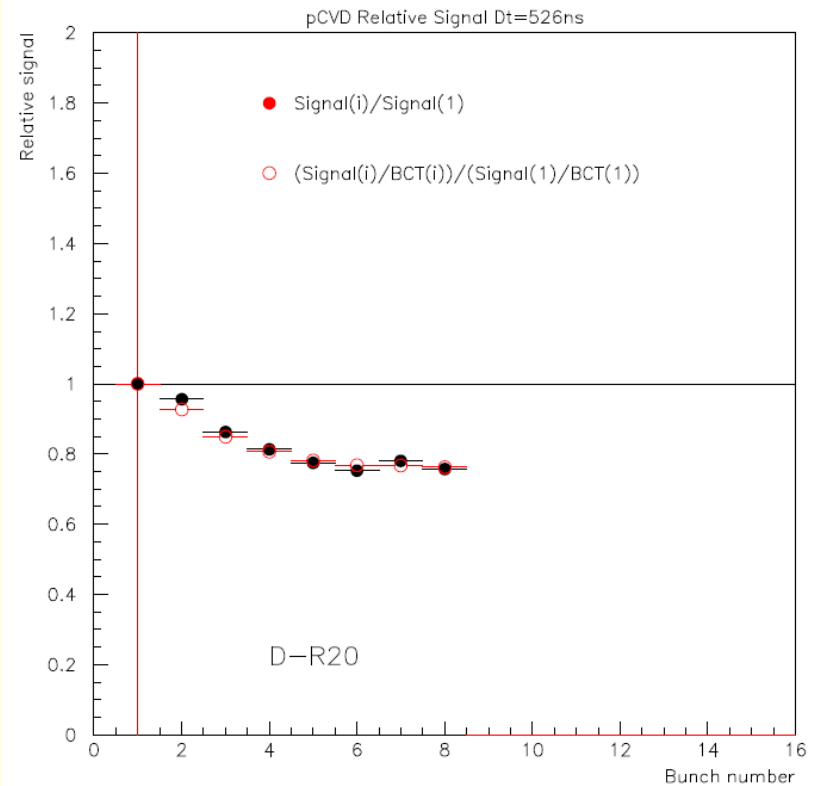
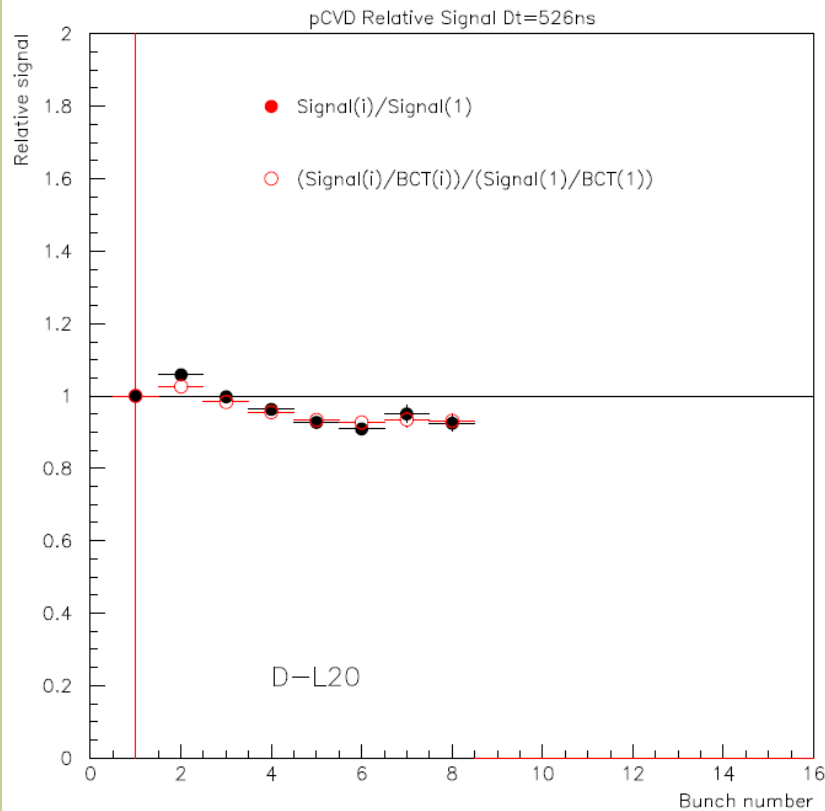
Data from all good runs with $Dt(\text{bunch})=262\text{ns}$



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

Diamond response vs bunch number

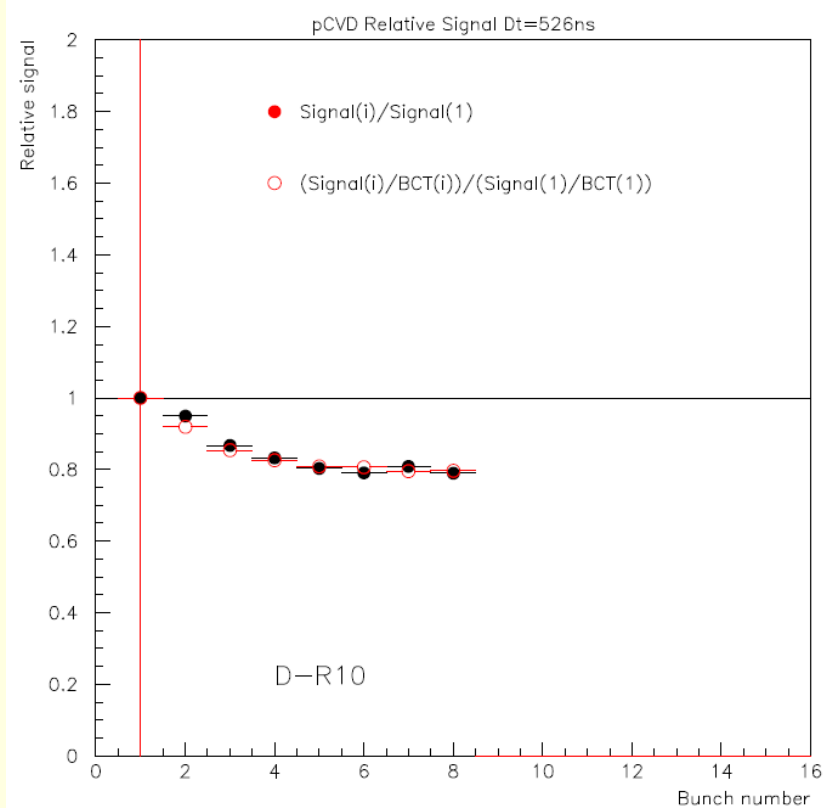
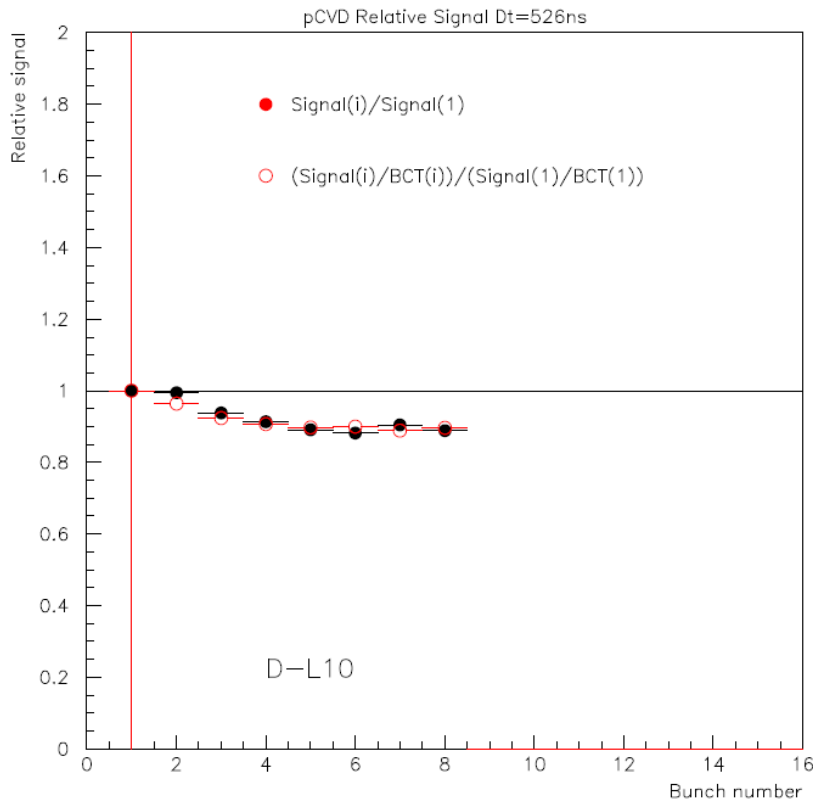
Data from all good runs with $Dt(\text{bunch})=526\text{ns}$



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

Diamond response vs bunch number

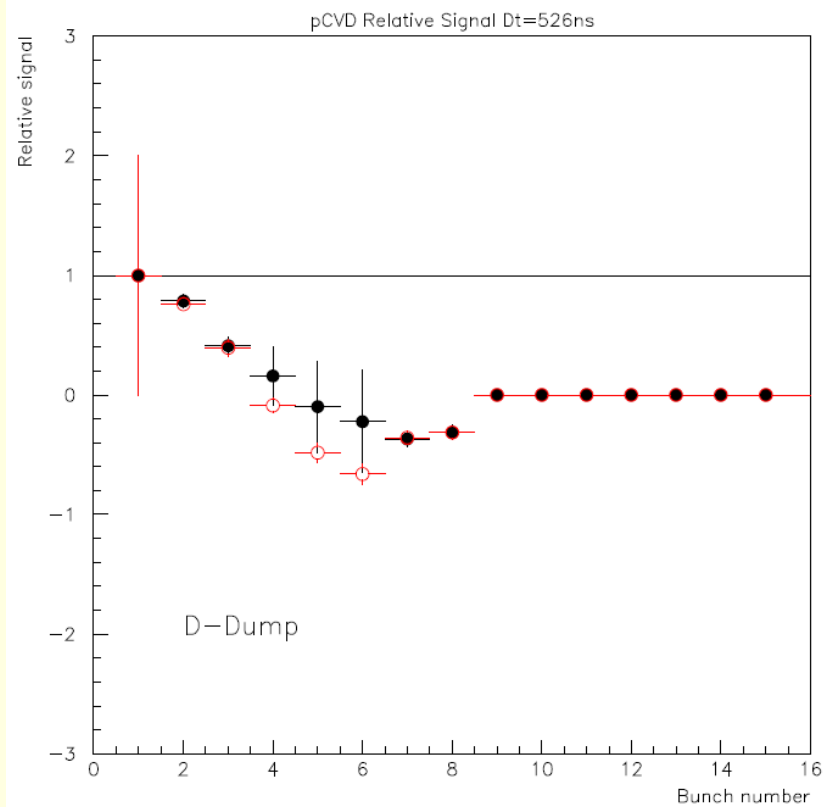
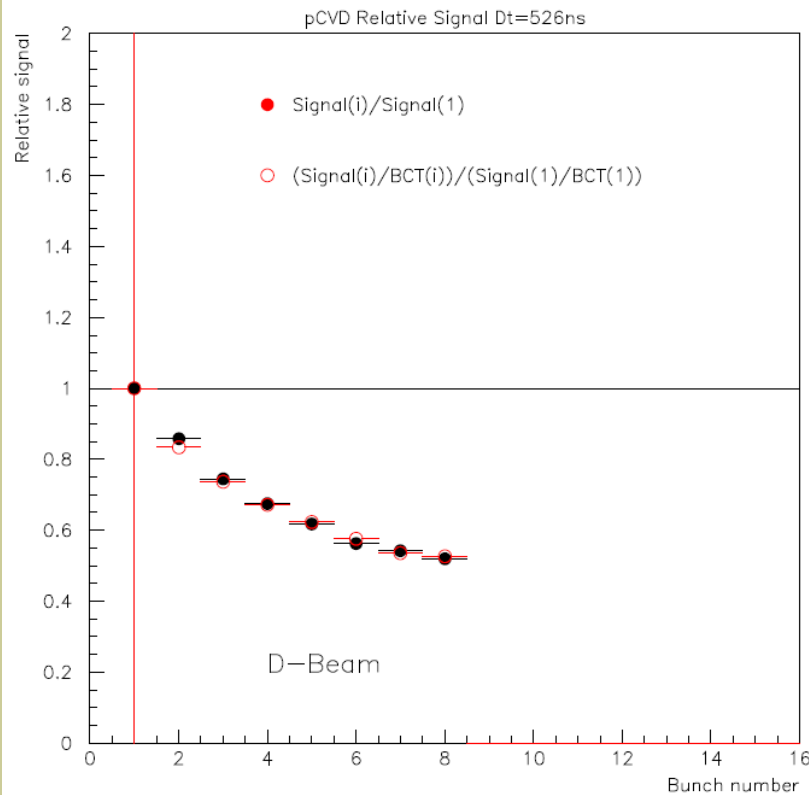
Data from all good runs with $Dt(\text{bunch})=526\text{ns}$



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

Diamond response vs bunch number

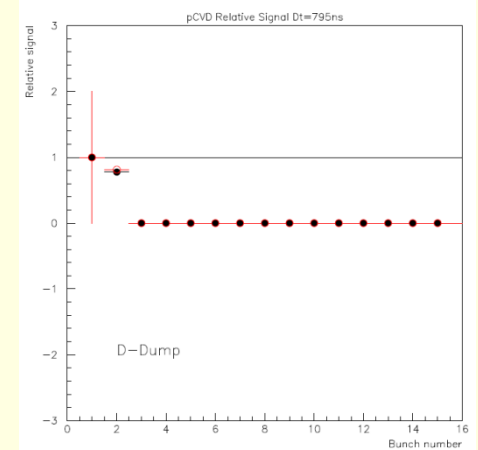
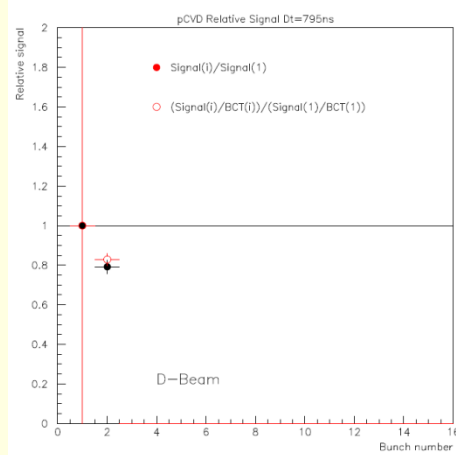
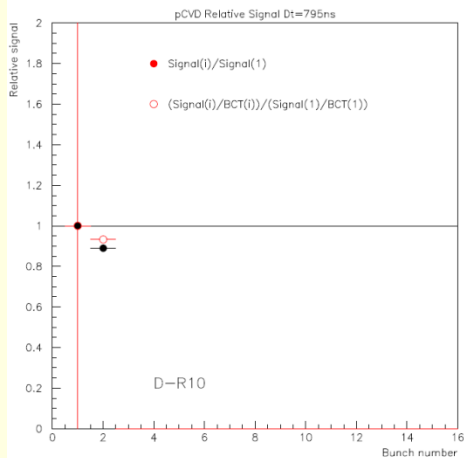
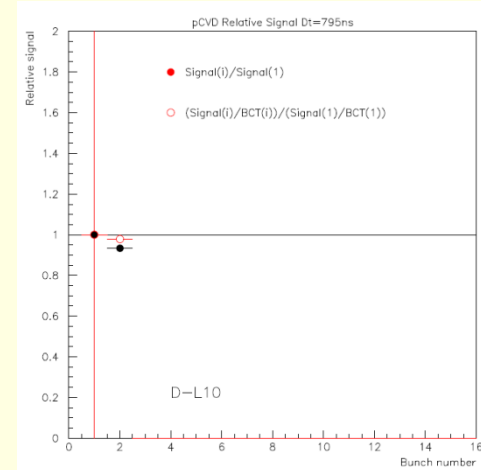
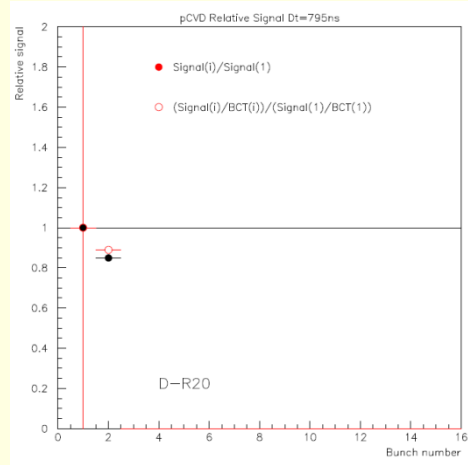
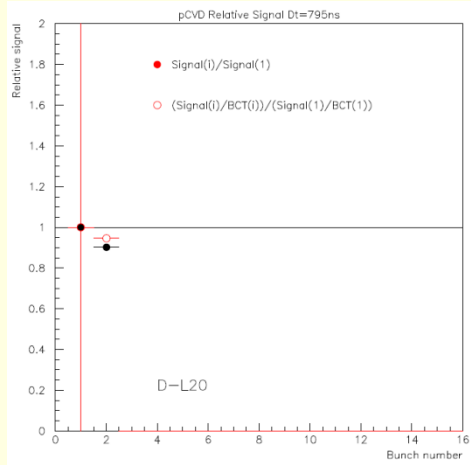
Data from all good runs with $Dt(\text{bunch})=526\text{ns}$



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

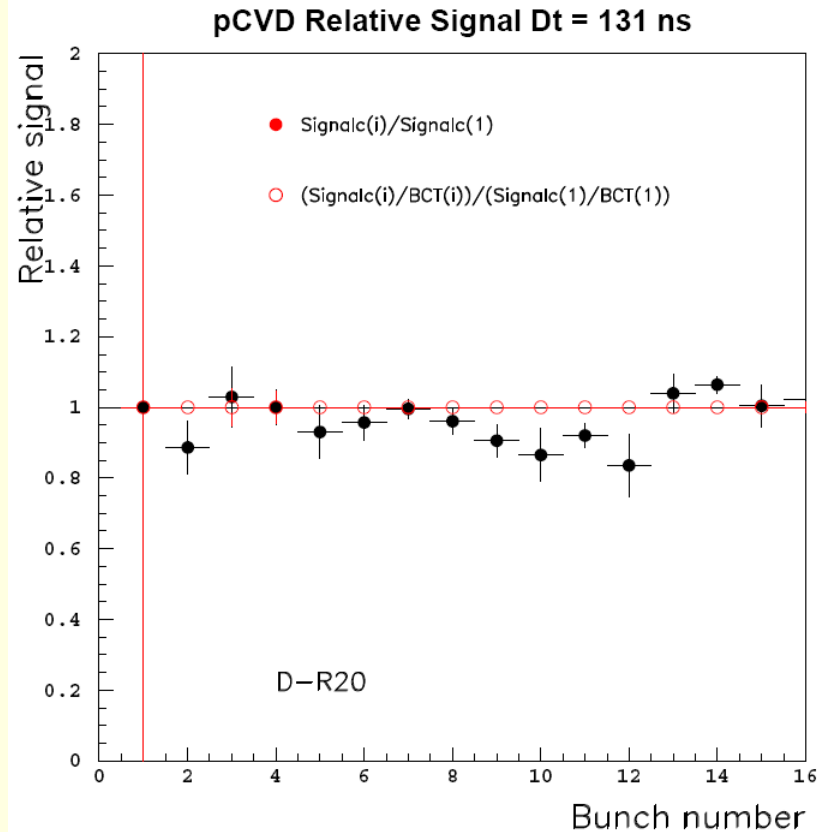
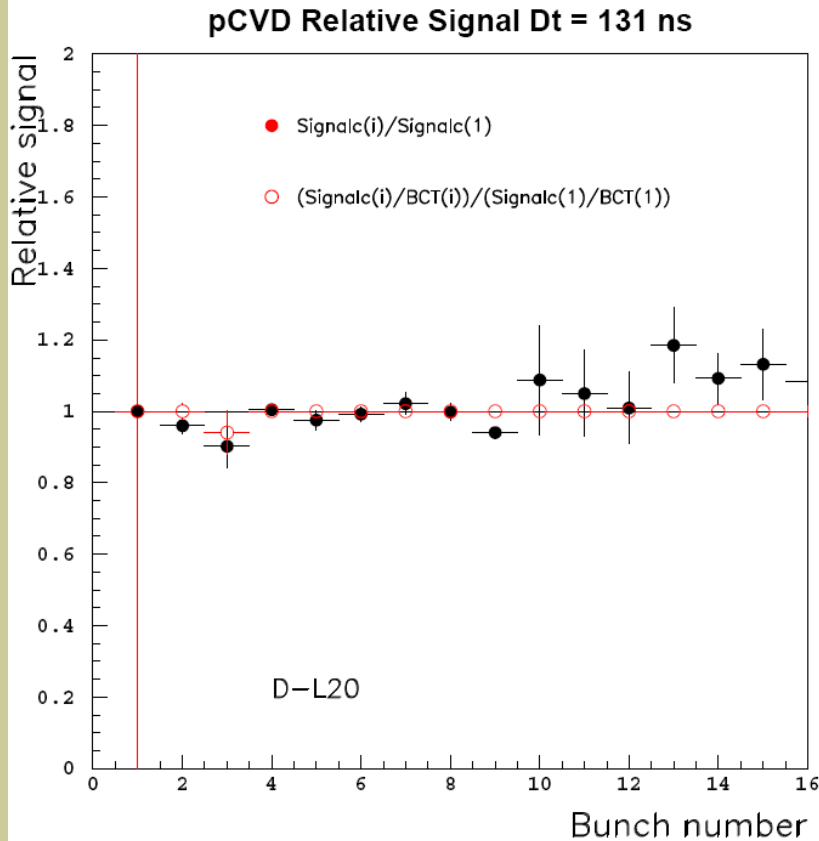
Diamond response vs bunch number

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



Diamond response vs bunch number

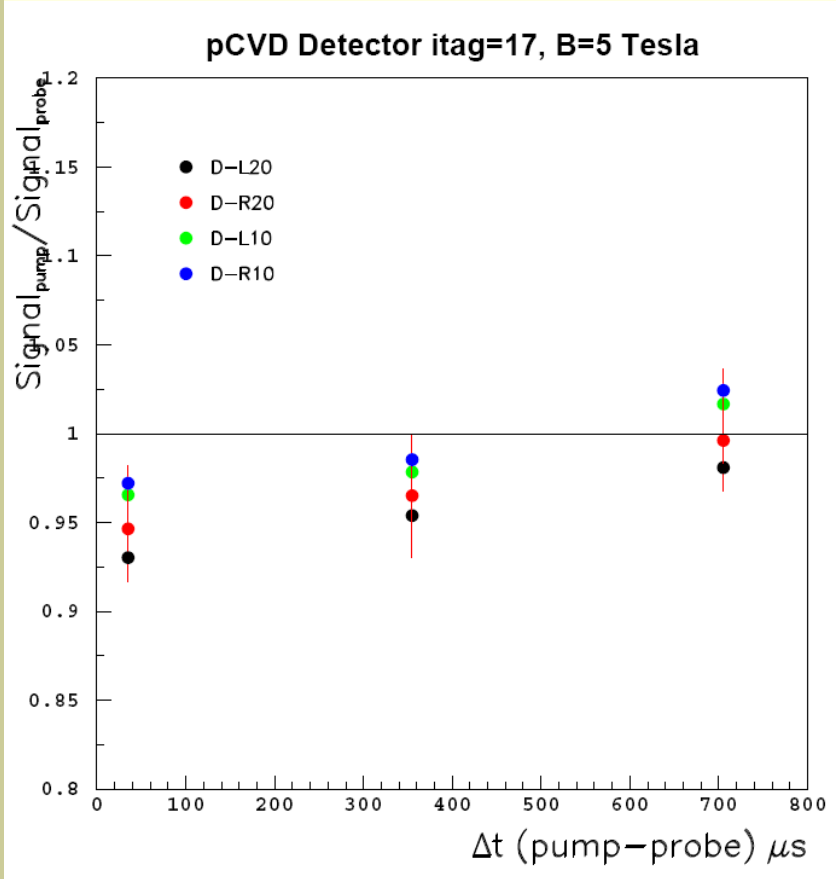
Data from all good runs with $Dt(\text{bunch})=131\text{ns}$ – after correction



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:

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

where A, B are the correction coefficients evaluated as before for each bunch

- If cavitation is formed in the target, then the ratio should increase with the pump-probe distance (lower denominator) as it does!
- However 5% “cavitation” is it reasonable?

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?