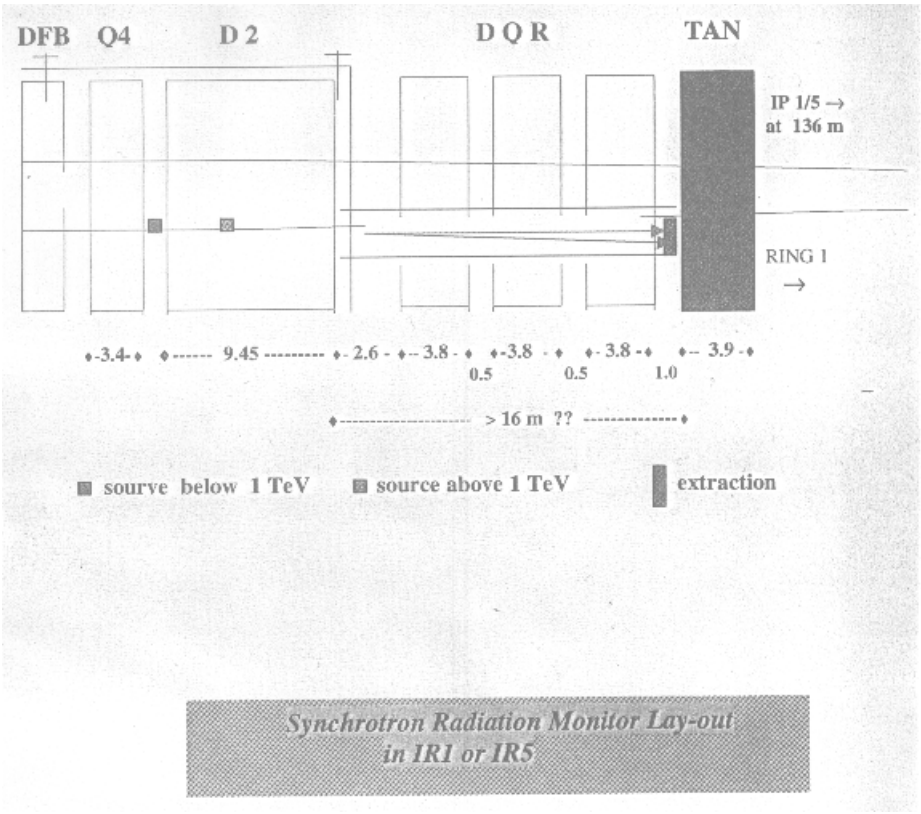
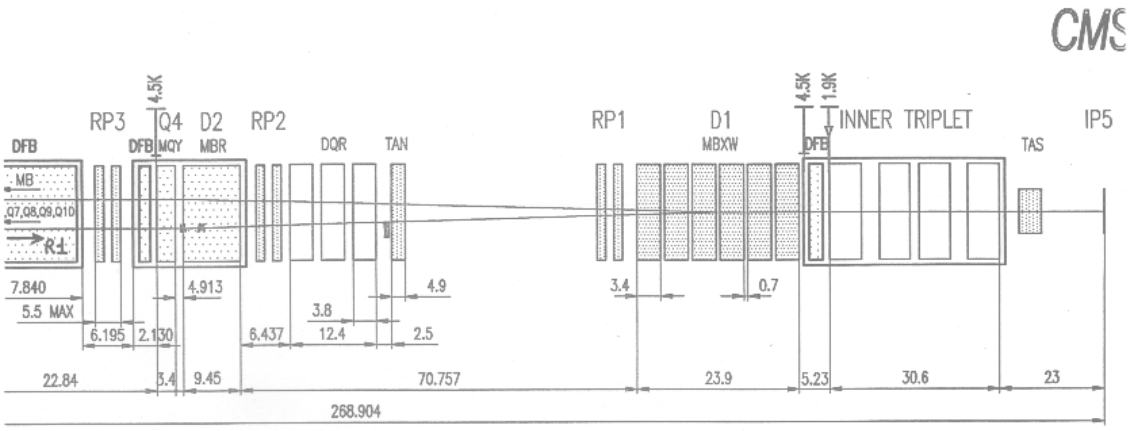
Synchrotron Light Monitor Considerations



Synchrotron Radiation Monitor Lay-out in IR1 or IR5



Synchrotron Radiation Monitors

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- *Proposal is to use the following light sources:*

  from 450 GeV up to 1 TeV: D2 stray field (upstream)

  from 1 TeV onwards: D2 dipole field (≅ 3m inside D2)

- *and to* **extract** *the light* **25 m downstream D2 (upstream TAN)**, *where the beam is deflected and where there is* **no cryostat.**

- **IR1/5 more favourable than IR2/8** *as beam optics makes beam dimensions larger (√2) which reduces the relative influence of* **parasitic effects:**

ε_n =3.75 μrad

	Injection optics v5		Collision optics v5
E (TeV)	.45	7	7
Source	Stray-field	dipolar field	dipolar field
$\beta_{H,V}$ (m)	224 , 110	215, 107	1588, 467
$\sigma_{H,V}$ (mm)	1.322, 0.926	0.328, 0.232 *most critical*	0.893, 0.484
Extraction upstream TAN (mirror location):			
$\beta_{H,V}$ (m)	125, 87	125, 87	1650, 1500
$\sigma_{H,V}$ (mm)	0.988, 0.824	0.251, 0.209	0.911, 0.868

[1] C. Fischer, LHC Luminosity Workshop,15 April 1999.

Bump Separation Scheme

- *Bump shape not frozen yet; but* **angle and separation** *are specified and with present* **bump configuration** *the region of interest for the S.R. monitor can be investigated.*

- **two nominal bumps** *as proposed* **in IP1/5** *considered.*

- *The* **radial plane** *is more important as* **D2** *acts in this plane.*

- **BUMP #1:**

  H angle (± 150 μrad): kept in collision
  V separation (± 2.5 mm): suppressed in collision

- **BUMP #2:**

  H separation (± 2.5 mm): suppressed in collision
  V angle (± 150 μrad): kept in collision

Polarity can be inverted ?

C. Fischer, LHC Luminosity Workshop,15 April 1999.

BUMP #1

- *Its impact on the beam trajectory for the two polarities.*

- **Three light sources considered** *namely*:

  a): *located at the bump extremum upstream D2 (second dipole bumper); it gives the direction of the* **background light** *generated upstream our sources* **(dipoles & Q4).**

  b): *gives the direction of the light generated by the* **fringe field of D2** *(up to 1 TeV).*

  c): *for the light emitted* **3 m inside D2** *(beyond 1 TeV).*

- **Extraction mirror** *at* **20 m** *from* **D2 exit** *end with* **TAN** *starting* **1.3 m downstream)**

H angle > 0:

at the mirror, • **b)** *is separated from* **a)** *by* **11.3 mm**
• **c)** *is separated from* **a)** *by* **20.5 mm**

• **beam axis** *at* **18 mm** *from* **non tilted machine axis**
⇒ **to maintain a clearance of :**

$$12\,\sigma_H + 1\text{ mm} + 4\text{ mm} = 16 - 17\text{ mm}$$

↑ tolerance ↑ closed orbit

the top of the mirror must stay within +1 mm
⇒ **at the axis of shower c)**

⇒ shower is cut at its maximum
⇒ signal reduction
⇒ relatively higher diffraction effects

Solution is to push the mirror further

C. Fischer, LHC Luminosity Workshop,15 April 1999.

H angle < 0:

at the mirror,

- **b)** ***is separated from*** **a)** ***by*** **11.3 mm**
- **c) (operational source)** ***is separated from*** **a) (background)** ***by*** **only 2 mm ⇒ bad conditions**
- **beam axis** *at* **34 mm** *from* **non tilted machine axis ⇒ to maintain a clearance of :**

$$12\,\sigma_H + 1\text{ mm} + 4\text{ mm} = 16 \text{ to } 17\text{ mm}$$

↑ tolerance ↑ closed orbit

the top of the mirror must stay within +17 mm ⇒ again at the axis of shower c)

By increasing the distance of the light extraction from 20m to ≥ 25 m from D2, situation is much better:

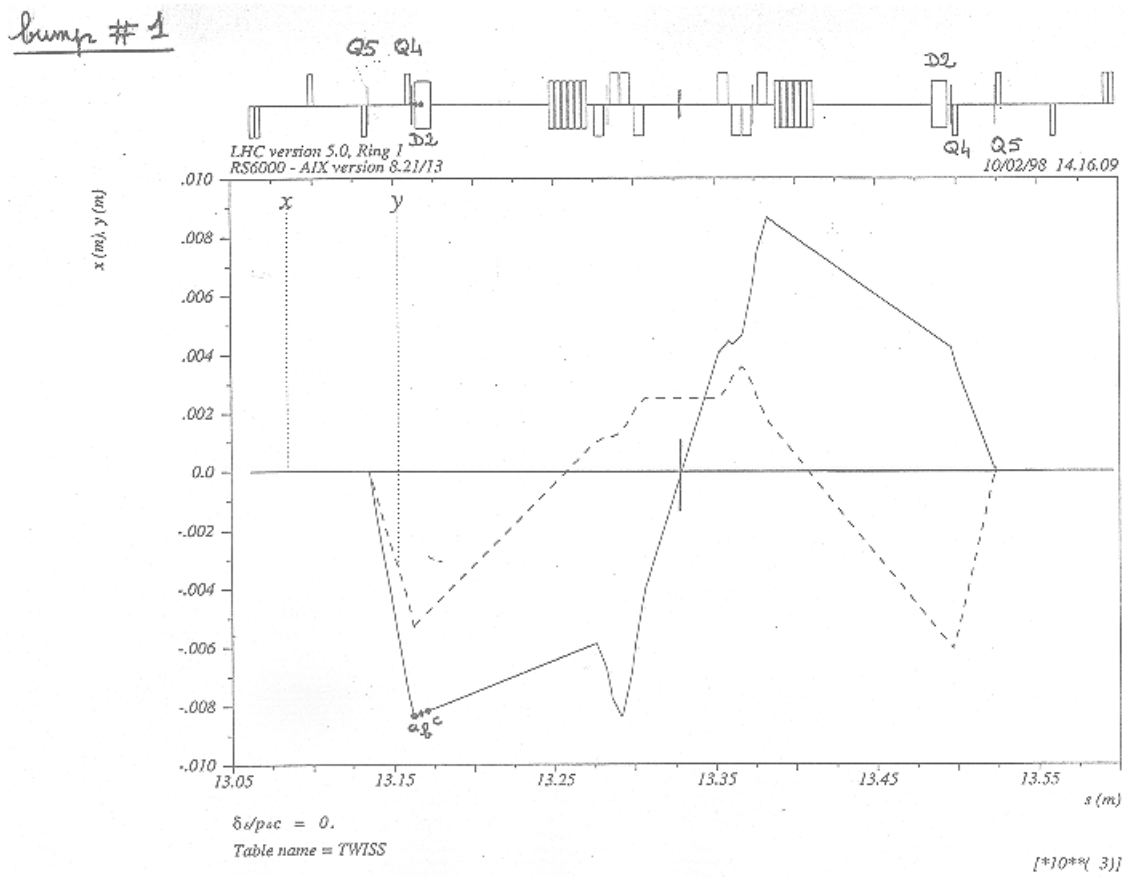
- H angle < 0: is not convenient due to previous point

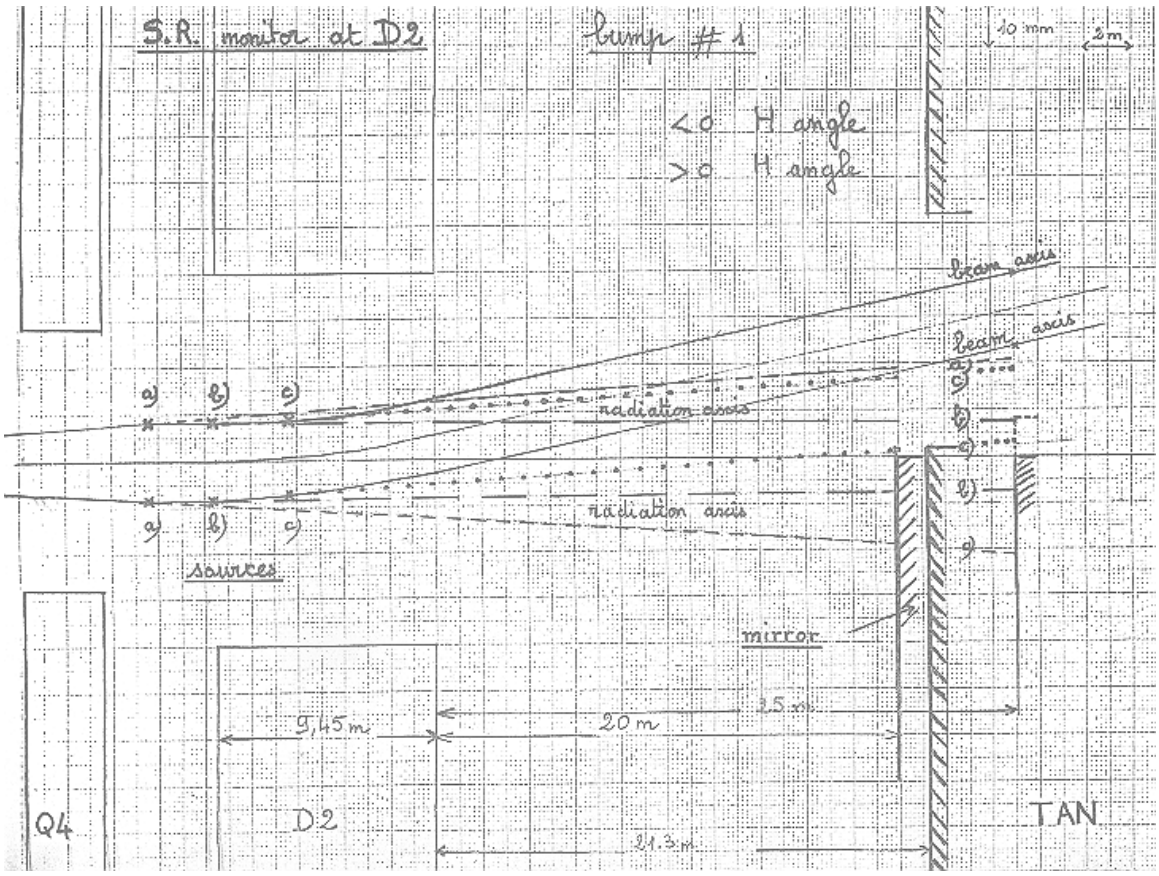
but

- **H angle > 0:** beam axis is then at 24 mm

mirror can be set up to + 7 mm while maintaining the clearance, i.e.

4 mm ($1\,\sigma_{ph}$) beyond c) shower axis


bump # 1
Q5 Q4
D2
D2
Q4 Q5
LHC version 5.0, Ring 1
RS6000 - AIX version 8.21/13
10/02/98 14.16.09
x (m), y (m)
x
y
.010
.008
.006
.004
.002
0.0
-.002
-.004
-.006
-.008
-.010
13.05
13.15
13.25
13.35
13.45
13.55
s (m)
δs/pac = 0.
Table name = TWISS
[*10**(3)]


S.R. monitor at D2
bump # 1
10 mm
2 m
< 0 H angle
> 0 H angle
beam axis
beam axis
a) b) c)
radiation axis
radiation axis
a) b) c)
sources
mirror
9,45 m
20 m
25 m
Q4
D2
24,3 m
TAN

BUMP #2

H separation > 0:

at the mirror,
- b) *is separated from* a) *by* 9.7 mm
- c) *is separated from* a) *by* 19.1 mm

1.5 mm less than with bump #1

- **beam axis** *at* 22 mm *from* **non tilted machine axis**

⇒ **to maintain a clearance of :**

$12\,\sigma_H$ + 1 mm + 4 mm = 16 to 17 mm

↑ tolerance ↑ closed orbit

the top of the mirror must stay within +5 mm

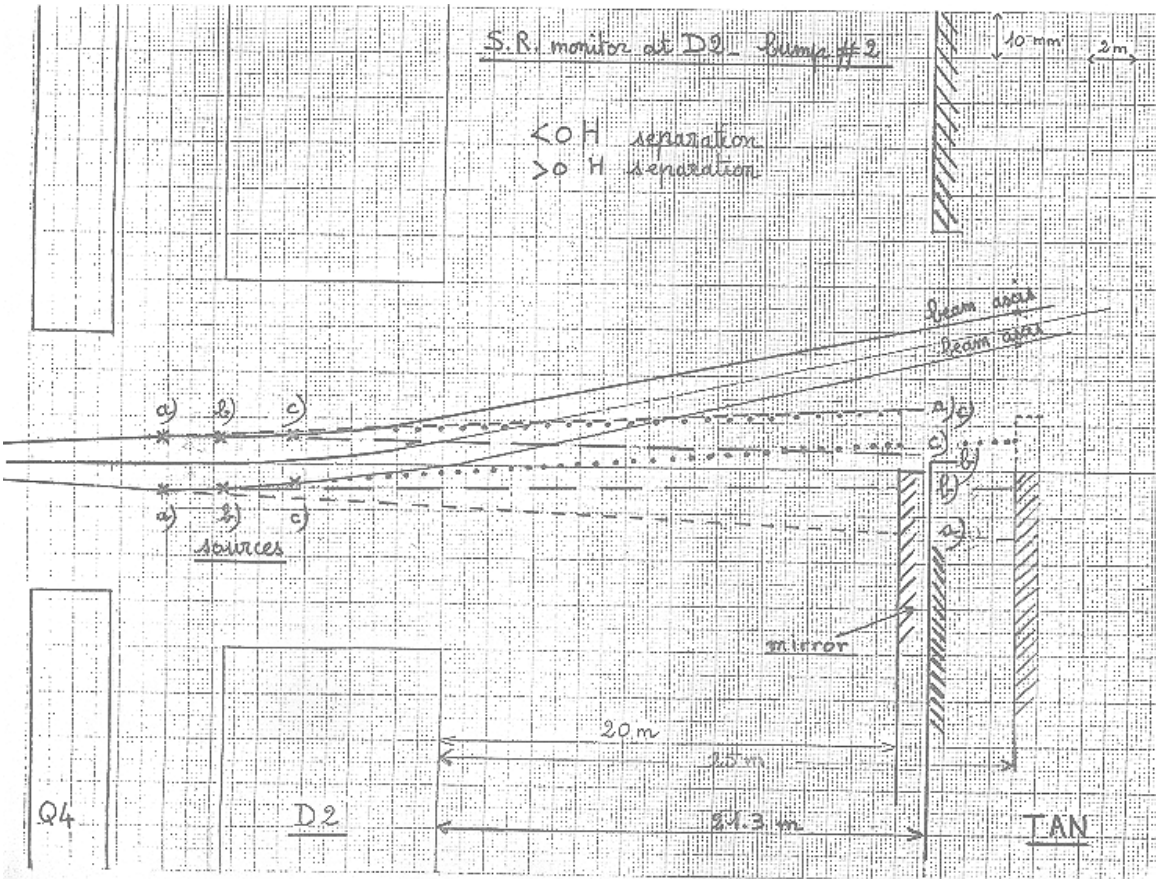
⇒ **again at the axis of shower c)**

H separation < 0: **(mandatory in one ring)**

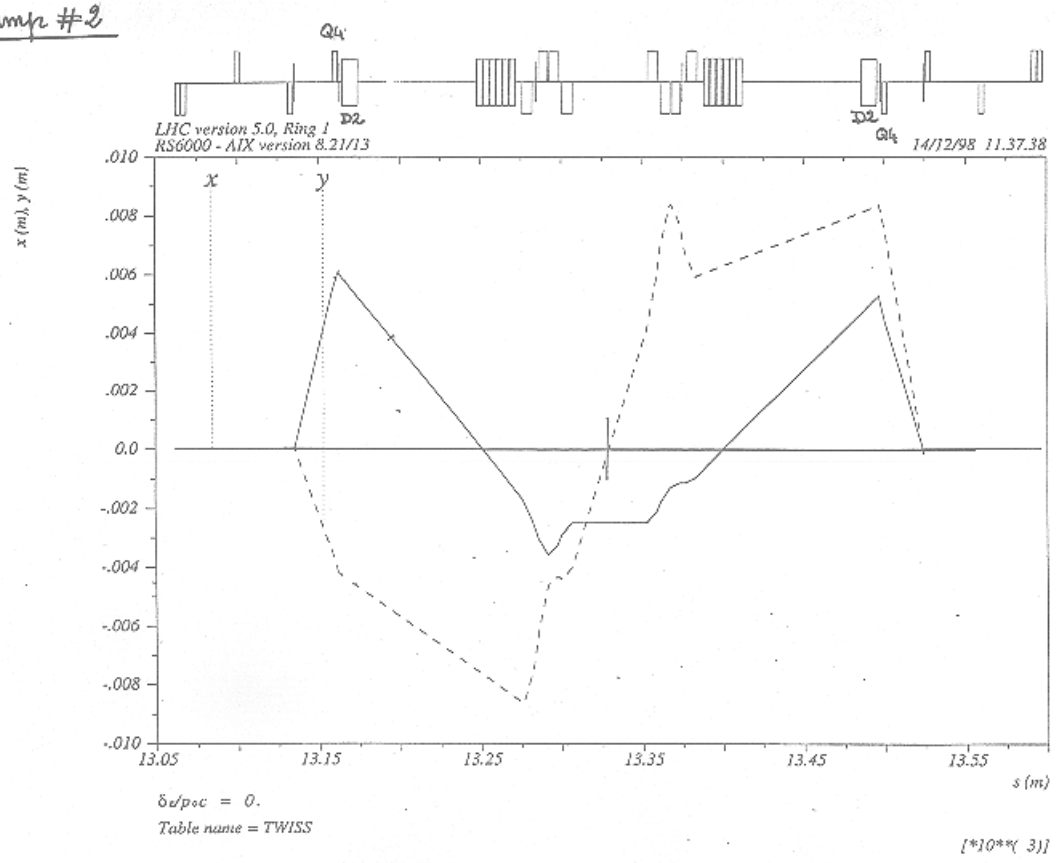
at the mirror,
- b) *is separated from* a) *by* 9.7 mm
- c) *coincides with* a)

- **again limitation at the axis of shower c)**

compared to **bump #1:**
- less clearance w.r.t. a)
- **anti-symmetrical** situation between the rings and one ring in a **bad shape**
- conditions **not stable**: H separation **removed** in collision


S.R. monitor at D2 - bump #2
10 mm
2m
<0 H separation
>0 H separation
beam axis
beam axis
a) b) c)
a) b) c)
sources
mirror
20 m
24.3 m
Q4
D2
TAN

bump #2


Q4
D2
D2
Q4
LHC version 5.0, Ring 1
RS6600 - AIX version 8.21/13
14/12/98 11.37.38
x (m), y (m)
x
y
.010
.008
.006
.004
.002
0.0
-.002
-.004
-.006
-.008
-.010
13.05
13.15
13.25
13.35
13.45
13.55
s (m)
δd/p0c = 0.
Table name = TWISS
[*10**(3)]

⇒ **BUMP #1**

with :

- **H angle > 0 in Ring 1 & < 0 in Ring 2 (symmetry w.r.t. IP)**
- **Mirror at ≥ 25 m from D2 exit end**

is the most convenient.

further advantage

- **conditions stable as H angle is maintained in collision**

C. Fischer, LHC Luminosity Workshop,15 April 1999.