EHF - 87 - 45

HINTS

FOR A **SINGLE**-SYNCHROTRON EHF.

H. Schönauer

LEITMOTIV :

REDUCE THE NUMBER OF MACHINES IN ORDER TO

- **SIMPLIFY OPERATION**
- **REDUCE DOWN-TIME**

EVEN IF THERE IS NO REDUCTION OF CAPITAL COST !

THE SINGLE-RING H.F.

(+)

- SAVE 2 RINGS
  2 TRANSFERS
  1 TUNNEL
  40% CONTROLS

i.e.
- LESS TRANSFER LOSS (septa!)
- LESS BLOW-UP

- SIMPLER SETUP
- HIGHER RELIABILITY
- LESS OPERATION COST (MAN POWER)

(−)

- RF SYSTEM : LARGE VOLTAGE and POWER at FULL SWING
- POLARIZED BEAMS MORE DIFFICULT
- TRANSITION CROSSING

¿ CAPITAL COST ?

COMPARISON OF CAPITAL COST

SINGLE-RING vs. Booster + H. + Main Ring

1st Order Approximation:

- Magnet Cost $\propto$ Weight$^{\alpha}$

  Weight $\propto$ $g^2 L$ (round beam!.)

  Power Supply Cost $\propto$ STORED ENERGY

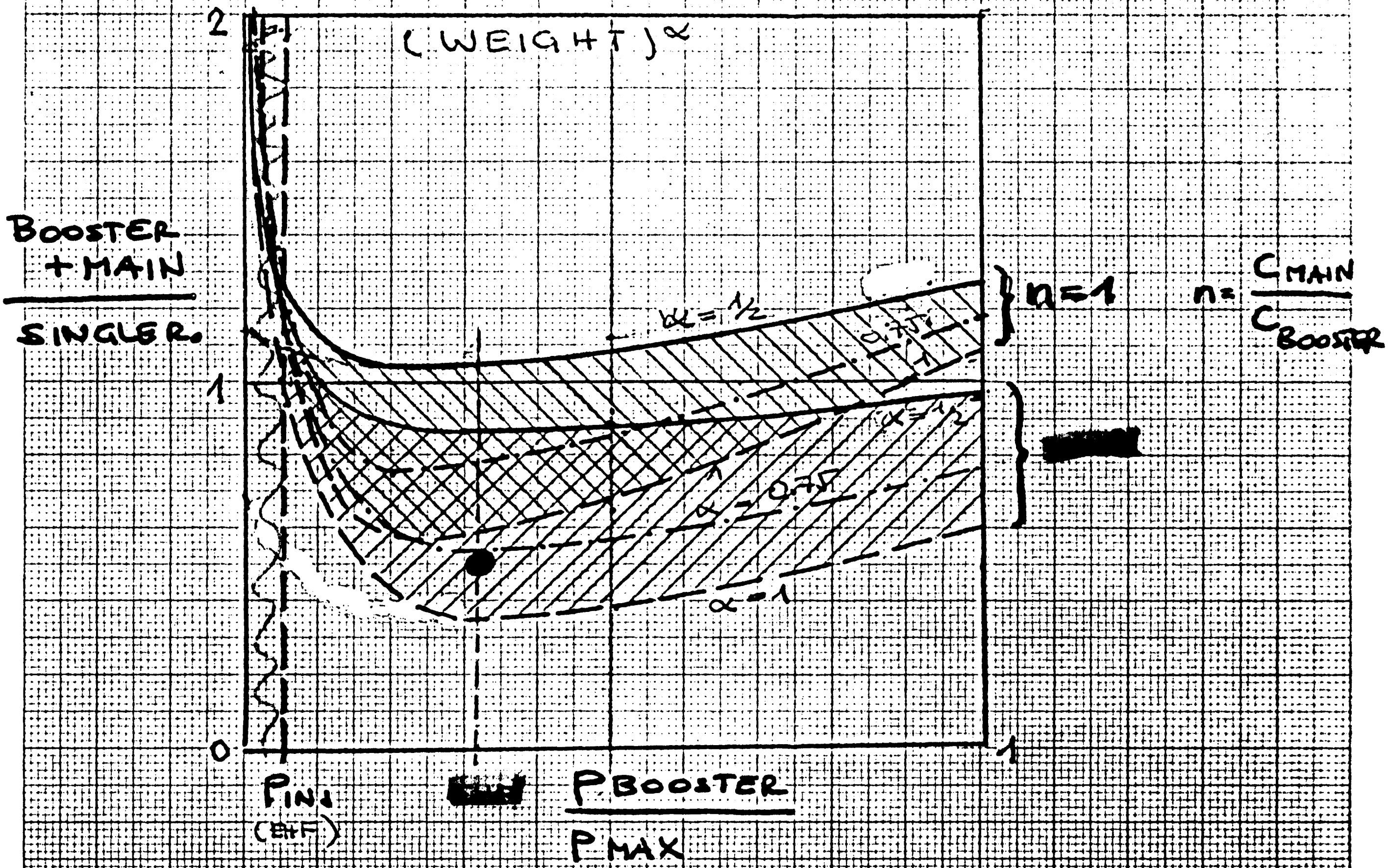
  STORED ENERGY $\propto$ $(B_{max}^2 - B_{min}^2)\, g^2 L$

  $\alpha = 1$ .... simple minded approach

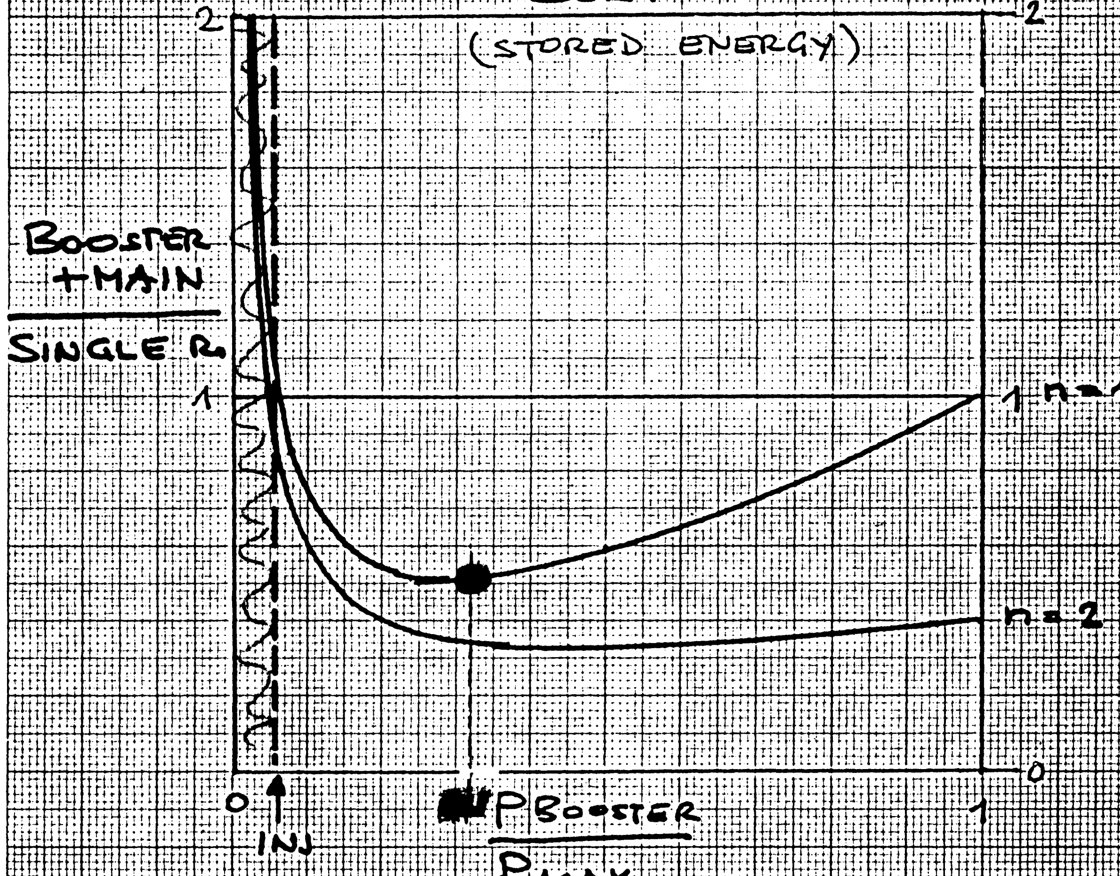
  J. Crawford: Cost $\propto (g^2)^{\frac{1}{2}} L \rightarrow \alpha \sim \frac{1}{2}$

  $\alpha < 1$, but not explicitly given: Craddock & Wienands

- RF Cost $\propto$ Beam Power
  (in fast cycling high-intensity machines)



RESONANT POWER SUPPLY (f_{rep} = const) COST



AS 2.10.87

From the curves, infer that

$$\left(\text{Magnet + PS Cost}\right)_{\substack{\text{Booster} \\ \text{+ Main}}} \simeq \frac{1}{2}\left(\text{Mag + PS Cost}\right)_{\text{SINGLE R.}}$$

$32 + 51 = 84$ MDM

i.e. $\left(\text{Mag + PS Cost}\right)_{\substack{\text{SINGLE} \\ \text{RING}}} \approx 168$ MDM

(implies same $f_{rep} = 12.5$ Hz)

NOW COMPARE :

SINGLE RING =

	MDM
MAIN RING	147
− MAIN RING MAG + PS	− 51
+ SINGLE RING MAG + PS	168
+ BOOSTER RF	21
Total :	285

EHF

	MDM
BOOSTER	90
HOLDING R.	32
MAIN R.	147
BUILDINGS BOOSTER + H.	15
Total	284

LINAC 1.2 GeV

	MDM
H^--Source, RFQ-Section, Chopper	7
ALVAREZ-Section (400 MHz):	
RF-System	20
Linac-Structure (fully equipped)	25
Sidecoupled Section:	
RF-System	35
Linac-Structure (fully equipped)	35
Installation	7
Transferline to the Booster	7
	—
	136

[redacted]

	MDM
[redacted]	[redacted]
Vacuum System	10
RF-System	21
Injection System	2
Extraction System	3
Collimators and Dumps	1
Beamline to Holding Ring	1
Beam Instrumentation	5
Controls	8
Stands	3
Installation	4
	–
	[redacted]

[redacted] GeV (480m)

	MDM
Magnet System	12
Vacuum System	2.5
RF-System	2
Injection System	1.5
Extraction System	3
Collimators and Dumps	1
Stands	2
Beam Instrumentation	3
Controls	2
Beamline to Main Ring	1
Installation Labour	2
	[redacted]

[redacted]-30 GeV (960 m)

	MDM
[redacted]	[redacted]
Vacuum System	15
RF-System	44
Injection System	2
Extraction System	4
Stands	5
Collimators, Dumps	1
Beam Instrumentation	5
Controls	10
Beamline to external Dump	2
Beamline to Stretcher	1
Installation Labour	7
	[redacted]

[redacted]

	MDM
Linac building	19
[redacted]Ring.	[redacted]
Equipment Building Main Ring+Stretcher	10
Laboratory, Central Control and Operation Building	15
[redacted].	[redacted]
Ring Tunnel(960 m) for Main R.+Stretcher	12
[redacted]	[redacted]
Access Shafts Main Ring	3
Transfer Tunnels	3
	[illegible]

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4. FEATURES OF A SINGLE RING ACCELERATING 50 – 100 μA TO 30 GEV

(i) One ring cycling at a rep rate of [redacted]ith asymmetric magnet cycle : Rise time = 3 * Fall time . 100 μA = 3.1 10^{13} p/p

(ii) H^0 injection form a linac of ≅ [redacted] "Painting" of RF buckets with linac micro-bunches.

(iii) Transition is crossed. But γt has to be low, ≤ 5.5 , cf. (iv).

(iv) Double RF system [redacted], [redacted] peak each – The 50 MHz system has to provide the full frequency swing whereas the 200 MHz system, active above transition, needs only 1 – 2 % swing. It also helps to avoid the RF phase jump at γt. otherwise Vrf(50 MHz) > Vrf(200 MHz). OR 2 50 MHz systems, 4.2 MV peak (together)

(v) A [redacted]attice. This is another way to avoid depolarising resonances. Only one is crossed if the # of periods is chosen ≥ 70. As a consequence, combined – function magnets are a must.

(vi) Magnet Apertures and Vacuum Pipe :
Vertical aperture is kept small by assuming small beam emittances together with less halo margin thean in other designs. The vacuum pipe is an unsolved problem in all present proposals: Eddy current effects are very strong for all but ceramic chambers which are delicate and waste aperture.

(vii) Beam parameters :
[redacted]m, ε_L = 0.04 eVs. [redacted]referrable for easier γt – jump but may cost somewhat higher voltage at 200 MHz.

In the Appendix the individual features (i) – (vi) are discussed in more detail.

How to deal with these problems?

- RF SYSTEM : 4,2 MV

50 – 60 % ... full swing $\frac{\Delta f}{f}$ = 11 %
50 – 40 % ... reduced swing $\frac{\Delta f}{f}$ = 4.5 %
2nd set switched on at transition

- Polarization:

1) Hyper. periodicity ≥ 70 → Comb. Functions
2) SC Snake cf. P. Blüm
at lower energies: Solenoid?

- Transition:

Possible with γ_{tr}-jump
$\dot{\gamma}_t$ = – 2.8 10^3 s^{-1}
during 0.32 ms → $\Delta\gamma$ = – 0.9