LAST
LINE DRIVE

June 7, 2001

KEY ISSUES

In Technical Reviews of Linear Collider Designs

- Disclaimer
- ICFA "Technical Comparison"
- Global issues
- Reminder of technical system concepts (see illustrations at end)
- Global issues particularized

ICFA Technical Comparison

- Commissioned in March it will make detailed comparisons of NLC/JLC, JLC-C, TESLA and CLIC regarding technical parameters. Greg Loew, SLAC, will again be Chair

- Involved will be experts of the interested laboratories and from the community at large.

- Will provide input for the eventual selection of the technology with which to proceed.

Global Issues

- **LUMINOSITY** ($\hat{L}$, x 10^4)

- **ENERGY** (x 5 – 10)

- **Ease / flexibility of use for physics** (see '95)

- **RELIABILITY** ($\bar{L}$, $\hat{E}$)

Reminder of Technical Systems Involved

- **e^- source(s)**
- **e^+ source(s)**
- **Preaccelerators** → *INJECTOR*
- **Damping Rings**
- **Compressor(s)**
- **Main linacs**
- **Beam delivery system**
- **Final focus**

(see illustrations at end)

Assumptions

√ Cannot avoid making assumptions (judgements)
- they give needed weights to the technical issues
- they depend on your frame of reference
- *you must decide for yourself what frame to stand in.*

√ Standpoint taken here: 1. "Our job is to crack EWSB" ⇒ must be able to cover LHC territory as needed

⇓

E_{CM}	-	L
0.5- 1 or 1.5 TeV		$\sim 10^{34}$

Comment: This will be challenge enough. Meeting it will teach us things we cannot now imagine AND which we will need to know before taking the next step – *whatever that may be*.

2. Our job is to look for inherent differences, (concerns and advantages both), arising from the basic choices of *frequency and NC or SC*. Collaboration will take care of apparent weaknesses in current engineering choices within each technology.

(give examples)

LUMINOSITY

- Need ~ $10^4 \cdot L_{SLC}$
  - makes this very hot issue
  - remember "10^{32}" *be wise – not discouraged.* We do have the SLC as guide but still a long way to go *(more later)*

work on this

- $L \propto \overbrace{\left(\frac{H_D}{E_{CM}}\right) \cdot \left(\frac{N}{s_z}\right)}^{\text{no flex}} \cdot \left(\frac{P}{s_y}\right)$ (s_y asap AND aligned)

N source

s_z damping rings and compressor(s)

P specific *L* w. r. t. mains power – linac tech choice

s_y damping rings, (compressor), main linac, beam delivery system and final focus, site(ground motion)

Questions to ask:

1.For each of these items does the inherent LC technology choice (frequency and NC or SC) make successful delivery of the needed parameter relatively easy or relatively difficult? *(examples)*

- Tot up the “difficults” and ask whether success depends on improvements to existing methods or development of new technology.
- Are there alternatives?
- Compare the lists inhering in the various LC technology choices.
- Weigh the differences.

2. What have the test facilities shown regarding the key parameters? How close have we come to their achievement? Do we understand the shortfalls well enough?

3. What are the schemes for operating at the Z, W, t, etc. and what will the luminosities be? Will there be particular technical difficulties associated with the lower energy operation?

ENERGY

- Need ~ 5 – 15 x E_{SLC}

- Site and technology issue
  - both SC and NC versions expect that higher gradients will be available when needed
  - either version could extend energy by extending the length of the main linacs
  - changing energy impacts the main linacs, the beam delivery system and the final focus apparatus.

Questions to ask:

1. For each technology choice, what has been the recent history of gradient increases in the technology? How much operating time has been accumulated at the higher gradients?

2. If there is to be a political site selection, be sure to get expansion length as part of the selection criteria (see later under Reliability). If a specific site is being offered, can it support a significant increase in linac length?

3. Will beam delivery and final focus need changing with higher energy? Complete rebuild? Mod.?

4. What will be the impact of rising energy on beamstrahlung and related backgrounds?

5. What will be the luminosity as a function of energy?

RELIABILITY

- All subsystems contribute to the ultimate reliability.

- One of a kind subsystems are the most vulnerable e.g. damping rings, beam delivery...... .

- The main linacs and preaccelerators can be made partly redundant by having extra, normally unpowered units on line. (remember, we're assuming that there will be good engineering and that these things will be done adequately throughout including redundant one of a kind compressors, water pumps, etc.)

- Assuming that classical reliability analysis has been carried out properly and reasonable conservative engineering practices have been followed, questions remain.

Questions to ask:

1. A machine protection system will be essential to prevent destruction of machine components in the event of failures - either self destruction or destruction by mis-steered beam. Is reliable performance of these functions made easier or more difficult by the LC technology choice under examination? *(examples)*

2. Has the choice of a particular LC technology forced the use of components operating at the extremes of known practice or components requiring the use of an as yet untried or even undeveloped technology? If so how can this be mitigated?

3. Among the one of a kind systems the failure of which would stop operation, how many active components are involved in each of the LC technology choices? What is known about the reliability of these types of active components?

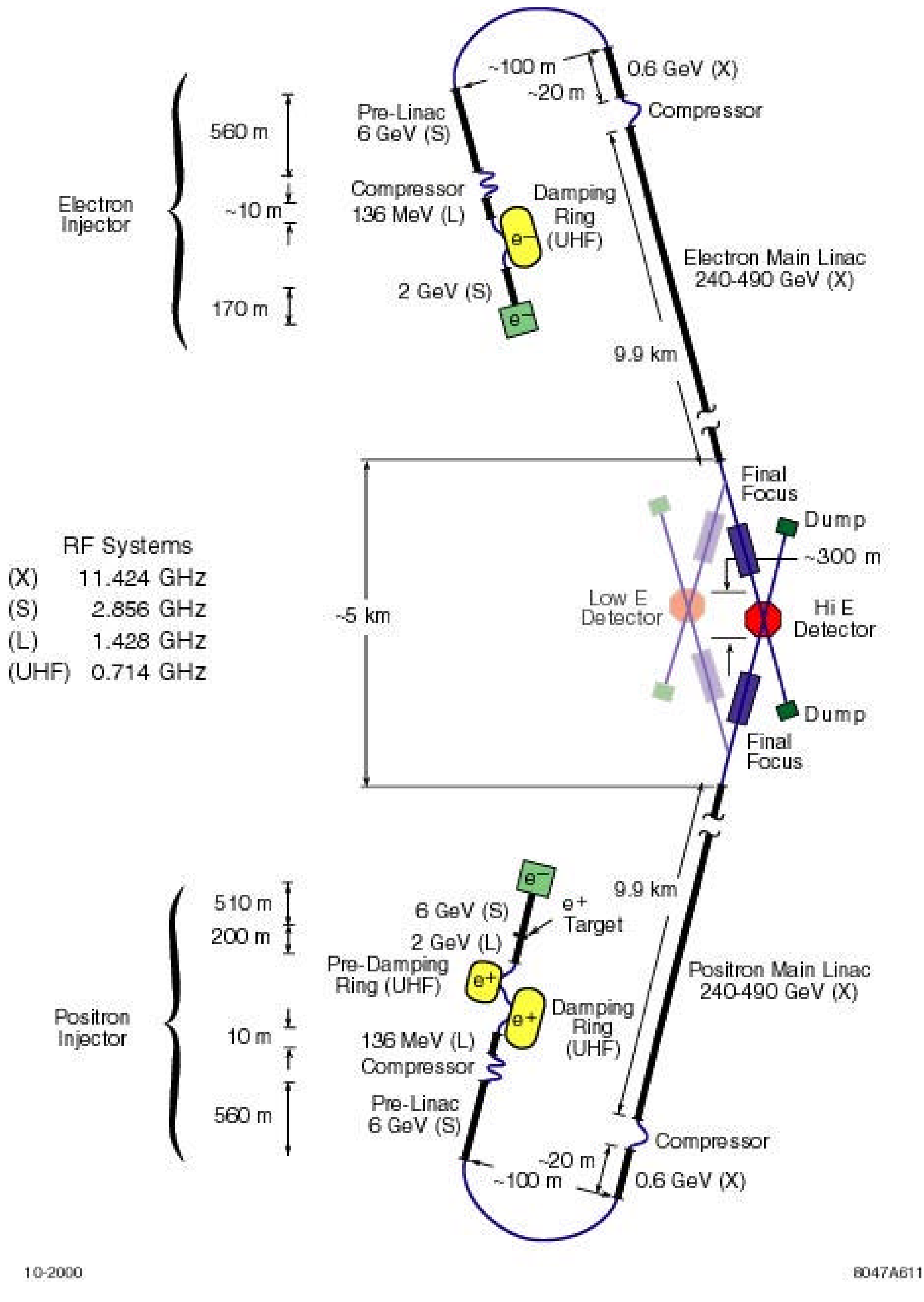
4.Means for mitigating inevitable ground motions will be essential. Do the various LC technology choice make this task relatively easy or relatively difficult in the face of expected ground motions?

- Tot up the "difficults" and ask whether success depends on improvements to existing methods or development of new technology.
- Are there alternatives?
- Compare the lists inhering in the various LC technology choices.
- Weigh the differences.

SUMMARY

- Input assumptions are crucial in determining the outcome of any overall comparison for the purpose of choosing which way to go. Agreeing on those assumptions must be an early order of business for us individually and collectively.

- Under the assumptions made here, LUMINOSITY and the closely linked RELIABILITY issues dominate as the KEY ISSUES.



~100 m
0.6 GeV (X)
~20 m
Compressor
Pre-Linac
6 GeV (S)
560 m
Compressor
136 MeV (L)
Damping
Ring
(UHF)
Electron
Injector
~10 m
e−
Electron Main Linac
240-490 GeV (X)
2 GeV (S)
170 m
e−
9.9 km
Final
Focus
Dump
RF Systems
(X) 11.424 GHz
(S) 2.856 GHz
(L) 1.428 GHz
(UHF) 0.714 GHz
~300 m
~5 km
Low E
Detector
Hi E
Detector
Dump
Final
Focus
9.9 km
e−
510 m
6 GeV (S)
e+
Target
200 m
2 GeV (L)
Pre-Damping
Ring (UHF)
e+
Positron Main Linac
240-490 GeV (X)
Positron
Injector
e+
Damping
Ring
(UHF)
10 m
136 MeV (L)
Compressor
Pre-Linac
6 GeV (S)
560 m
Compressor
~20 m
~100 m
0.6 GeV (X)
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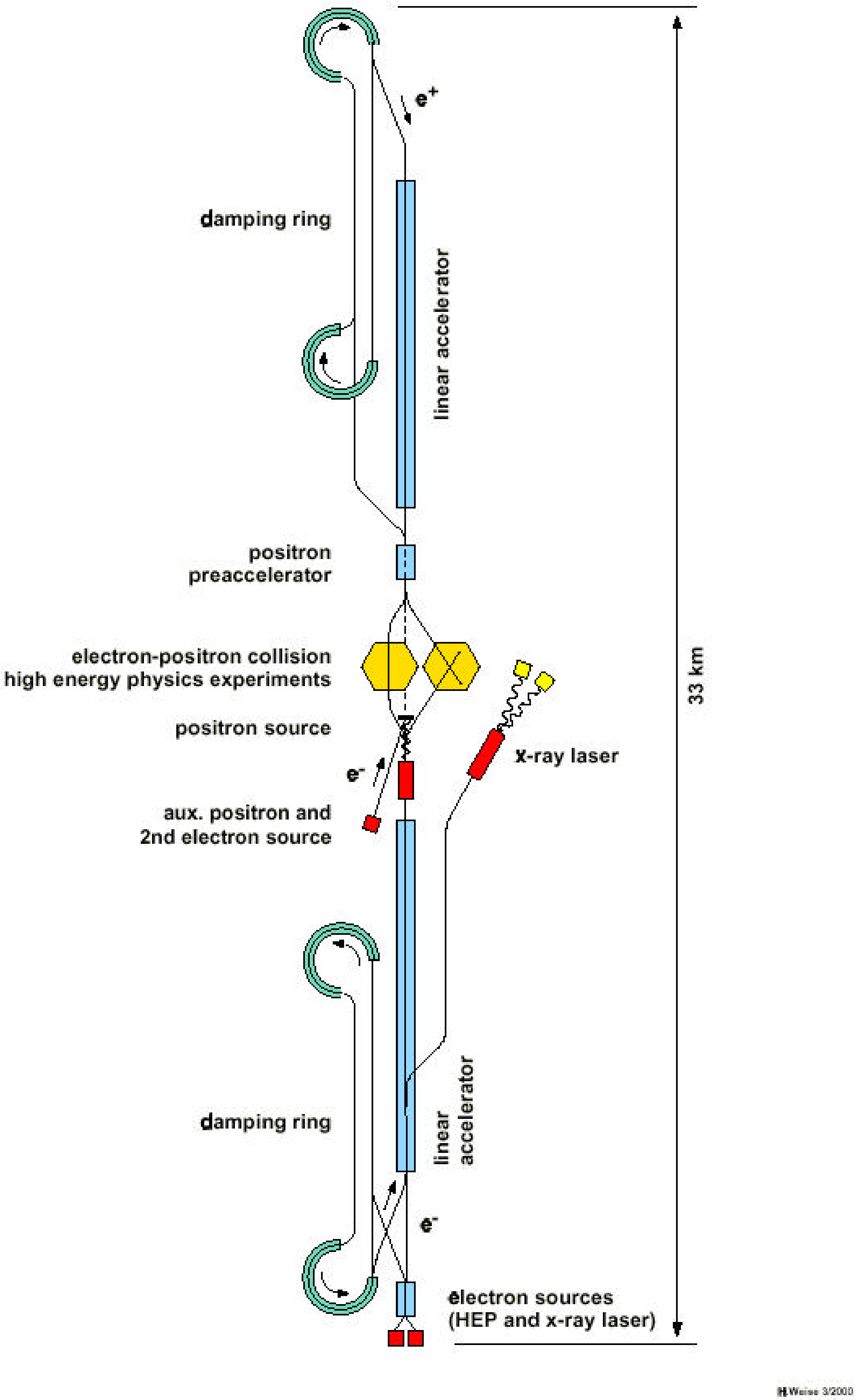
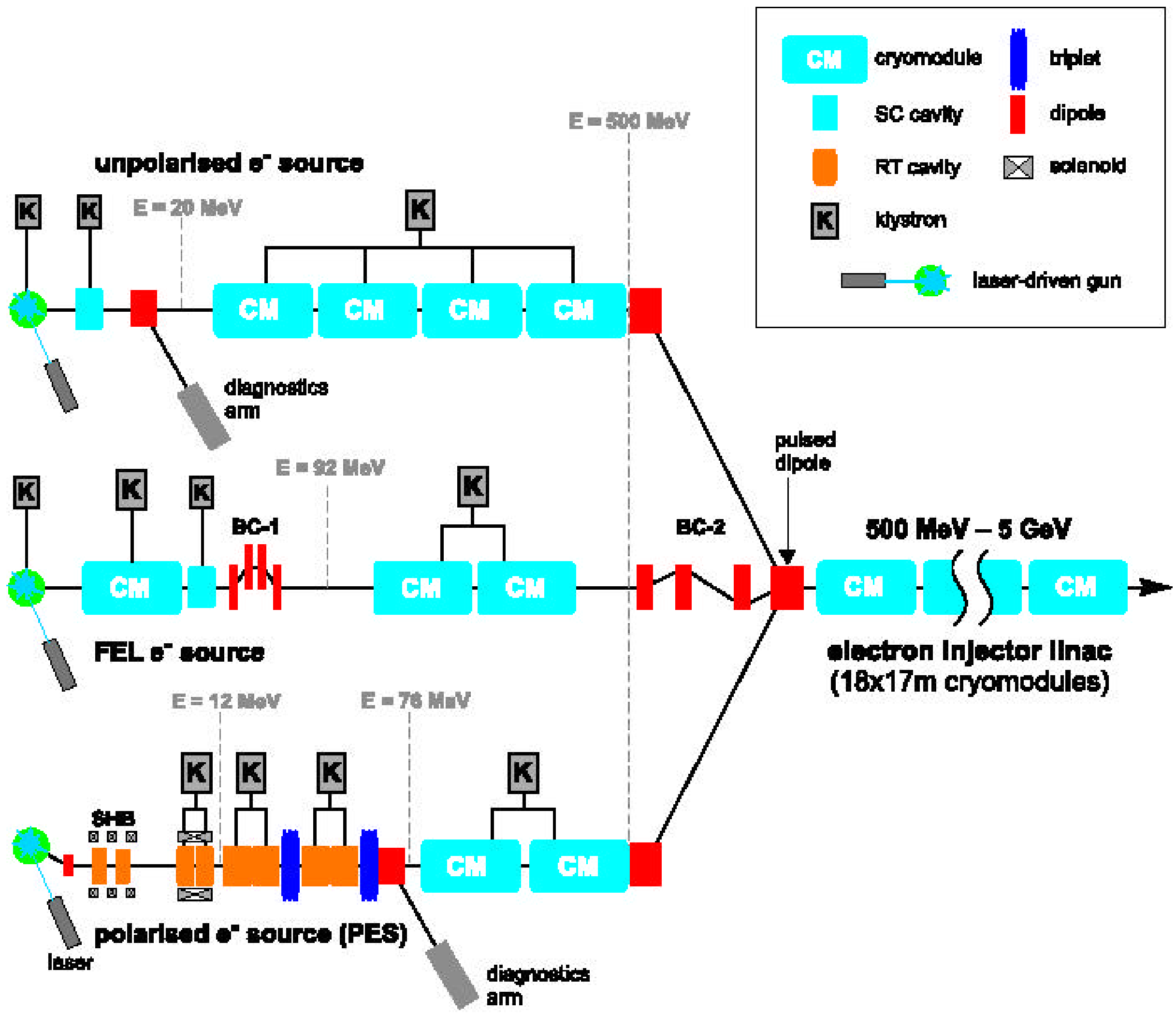


e+
damping ring
linear accelerator
positron
preaccelerator
electron-positron collision
high energy physics experiments
positron source
33 km
x-ray laser
e-
aux. positron and
2nd electron source
damping ring
linear
accelerator
e-
electron sources
(HEP and x-ray laser)
H.Weise 3/2000



CM cryomodule
triplet
SC cavity
dipole
RT cavity
solenoid
klystron
laser-driven gun
E = 500 MeV
unpolarised e⁻ source
E = 20 MeV
K
CM
diagnostics arm
E = 92 MeV
pulsed dipole
BC-1
BC-2
500 MeV – 5 GeV
FEL e⁻ source
electron injector linac (18x17m cryomodules)
E = 12 MeV
E = 76 MeV
SHB
polarised e⁻ source (PES)
laser
diagnostics arm