LEP INJECTOR LINAC (LIL)

Mechanical Engineering and Drafting Effort Estimate

B.Szeless

A. EXPLANATION

1. The enclosed list of assemblies, subassemblies and machine-components is what ever we understood from different sketches, descriptions and discussions with people involved in the pro=ject.

2. Certain groups of elements have been considered existing where no or nearly no more manpower is needed. These are from list B:
   1. Front end, point 1
   2. Some items from Inter-sections, point 3
   3. Several wave guide elements, point 5.2
   4. LIPS, point 5.3.

   On the other hand all the tooling development has been included for the other items.

3. The sketches fig.1 to 3 are illustrations corresponding to the list of assemblies. This rough and incomplete version will be replaced by a more complete, better defined and more detailed one.

4. Under engineering and drawing effort is understood: elaboration of complete dossiers of production drawings with appropriate assembly and installation drawings, materials, production and assembly specifications if needed.

5. Not included in this estimate are manpower for tests, lab. work, puchase and order follow-up activities.

6. The numbers of drawings are estimated by comparison with similar items used in proton accelerators.

7. The effort, expressed in man-days, has been calculated from the number of drawings, therefore it presents an ideal case which may be realistic for some subassemblies, but certainly not for the whole project. The reason will be mainly missing or too late specifications.
   The total needed effort would be:
   Engineering effort: 6 man-years
   Drafting effort: 20 man-years

8. The number of drawings and manpower effort are estimated for fully frozen specifications. Any modification in already frozen specifications results in increased engineering effort followed by drawing production.

9. The number of drawings might drastically increase, if for the 4+12 sections too many individual options are considered neces=sary.

10. Manpower need for engineering effort means graduate engineers in mechanical field, drafting effort means technicians and draftsmen (about 50% of each).

11. Experience shows that for a smooth development of the project work at least the same number of engineers of other fields and physicists are needed.

B. LIST OF ASSEMBLIES AND SUBASSEMBLIES

1. FRONT END

1.1. Electron gun with modulator

1.2. Buncher
standing wave cavity; length 2.2m; cells and single coupler different to 2.1

1.3. Interspace
pick up, prebuncher and one or two vacuum valves, moveable diaphragm, surrounded by solenoids and steering magnets.

2. ACCELERATING SECTION

2.1. RF structure

2.1.1. Accelerating waveguide structure
cells made of OFHC copper, forged, diamond machined, measured, tuned, assembled, soft soldered, tuning checked;
total length:4.5m (=135 cells),
heavy on tooling and measuring equipment,

2.1.2. Tooling
Measurement jig
Soldering jigs and clamps
Assembly tooling
Tuning tooling
Transport jigs

2.1.3. Input coupler
Assembly jig

2.1.4. Output coupler and resistive load
watercooled rf load on downstream end of structure

2.1.5. Cooling on structure
watercooling system for temperature stabilisation
Soldering tool

2.2. Vacuum envelope

2.2.1. Tank
stainless steel tube ϕ150/154

2.2.2. Structure centring support
(welded-in solution)

2.2.3. Assembly jig for 2.2.2

2.2.4. Tank support to girder
might require several types due to solenoids or FODO quads in different positions.

2.3. Alignment and support

2.3.1. Girder
Welded steel or aluminium structure, machined

2.3.2. Jacks
three mechanical jacks to move complete unit

2.3.3. Waveguide supports
for 2.1.3 and 4

2.3.4. Magnet supports

2.3.5. Alignment elements for tank, magnets, etc

2.4. Magnets around structure

2.4.1. Solenoids
one or two types in pancake construction.

2.4.2. Quadrupole
one type

2.4.3. Stray field correction coils (wires)

2.4.4. Steering magnets (or coils only)

3. INTER-SECTIONS

3.1. Assemblies (16 different)

3.1.1. Installation drawings, sub-assemblies

3.1.2. Alignment jigs

3.1.3. Supports

3.2. Elements

3.2.1. Triplet

3.2.2. Quadrupole singlet
could be central quadrupole of triplet or as 2.4.2.

3.2.3. Collimator
fixed or motorised, cooled,

3.2.4. Current transformer
torus with ceramic gap

3.2.5. Charge measuring transformer
could be same as 3.2.4

3.2.6. Profile measuring device
Wire or grid moving, stroke 60mm,

3.2.7. Position measuring device
like 3.2.6 or moving jaws or pick-up type

3.2.8. Phase measuring device
small cavity, temperature stabilized,

3.3. Special items

3.3.1. RF deflector
short bit of structure

3.3.2. Short solenoid

3.3.3. (Correction dipoles)

4. CONVERTER REGION

4.1. Elements

4.1.1. Electron gun off-axis

4.1.2. Alpha magnet to deflect low energy beam on to accelerator axis

4.1.3. Prebuncher

4.1.4. 2 MeV buncher

4.1.5. Solenoids
might be several types, araldited coils in steel housing,

4.1.6. Converter
target moving in and out and lens in vacuum,
about 0.1sec for 5mm stroke,

4.1.6. 90Ômagnet for spectrometer line, pulsed

4.1.7. Detector
might be same as 3.2.6

4.1.8. Beam stopper

4.1.9. Other measuring equipment and triplet
taken from chapter 3.

4.2. Assembly

4.2.1. Support structure

4.2.2. Alignment fixtures

5. WAVEGUIDE AND RF POWER DISTRIBUTION

5.1. Installation drawings

5.2. RF elements

5.2.1. WG elements, power divider, etc
all watercooled and under vacuum

5.2.2. Resistive loads
like under 2.1.4

5.2.3. WG under SF6 (directly after klystron window)

5.2.4. Coax reference line

5.3. LIPS

5.4. Klystron
support, cooling, transformer tank

6. MODULATOR

installation of different power supplies, pulse forming network, delay lines, RF-tight racks

7. WATER & ELECTRICITY

7.1. Water

7.1.1. Cooling circuit for structure and loads

7.1.2. Cooling circuit WG

7.1.3. Cooling circuit magnets

7.2. Electricity

7.2.1. Cable trays

7.2.2. Rack installations

8. INSTALLATION

8.1. Transport and lifting gear

8.2. Alignment furniture, survey pillars

C. TABLE OF MANPOWER EFFORT AND DRAWING QUANTITIES

No of assy	quantity of drawings		drwg eff	eng eff
	assy & sub	prod dwgs	in days	
1.	10	40	120	25
2.1	40	250	465	150
2.2	15	80	155	55
2.3	30	150	300	110
2.4	20	100	200	50
3.1	70	150	435	175
3.2	40	210	410	100
3.3	10	60	115	25
4.	90	450	900	225
5.	50	160	380	100
6.	20	80	175	40
7.	30	70	190	75
8.	30	120	260	75
sum	455	1920	4105	1205

D. SKETCHES

1. Layout with inter-sections and converter region
2. Structure
3. RF power distribution

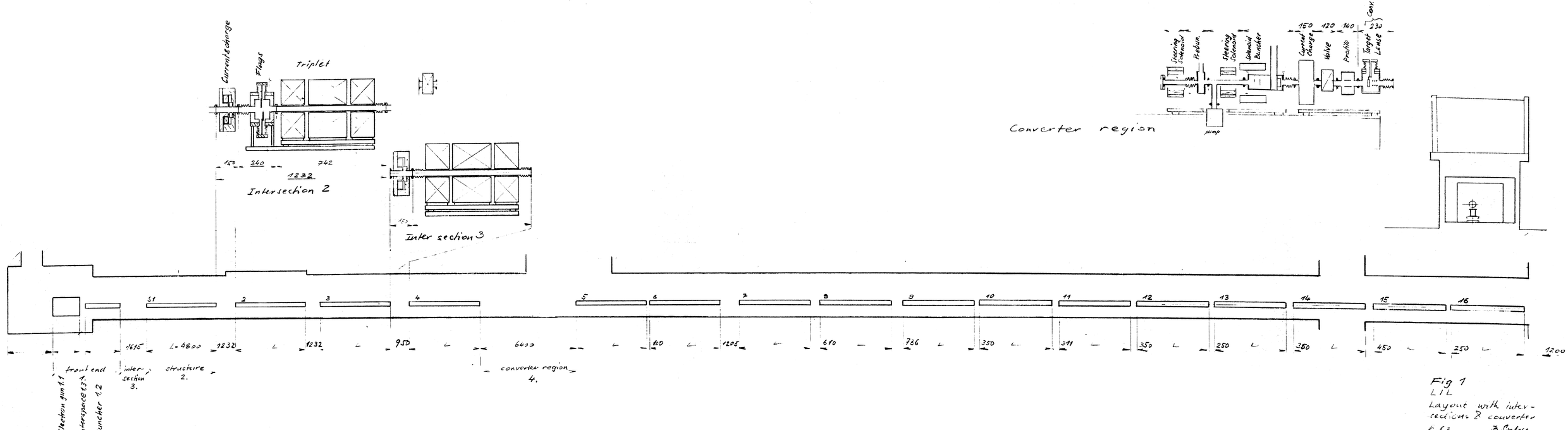

Fig 1
LIL
Layout with intersections & converter
B. Sharkov

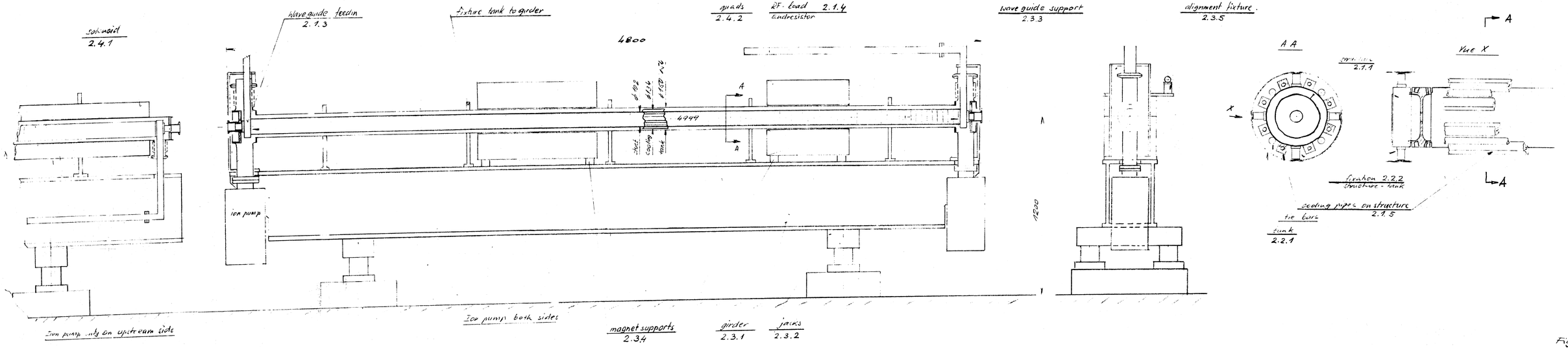

Fig. 2
LIL type structure

6.82

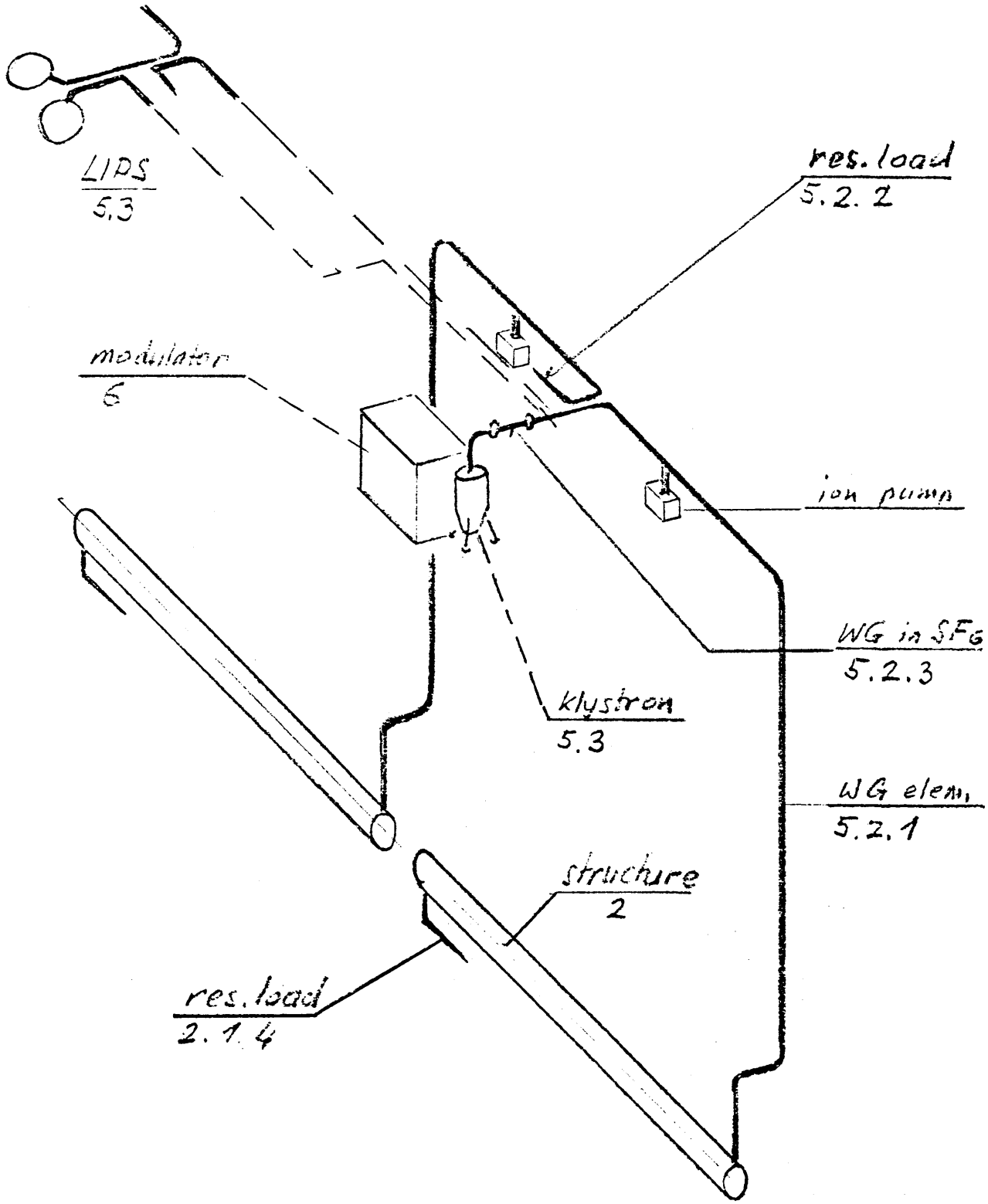

Fig. 3
LIL
RF power distribution
6.82 B. Jecker