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PS/DI/NOTE 91-06
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TRAVEL REPORT

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Places : SLAC; Vancouver (Particle and Fields 91 Conference of the APS; K-Factory Workshop of TRIUMF)

Date: 7-9 August (SLAC); 18-22 August 1991 (Vancouver)

1. SLAC

1.1 SLC (S. Ecklund, J. Seeman, N. Phinney at PF91)

- **Schedule** : Pilot run for SLD detector since March 91 lasted until 15.8. About 1/3 of time MD. Real SLD run will be between 1.12.91 to June 92. Running-in with polarized e^- will start in November 91. DOE review of SLC in summer 92.

- **Performance**: Recently quite regularly 8 Z°/h (fig. 1) with good emittance $\varepsilon = 3\pi$ µrad m (6 π µrad m in 1990) (fig. 2). $N^{\pm}$ (typical) = 3.10^{10}. Availability 60%. Downtime due to hardware faults was 25%.

  Rep. rate: 60 Hz (120 Hz too expensive for test run). $\sigma^* = 2.5$ µm. Total Z_0 delivered in this run 600 ; 300 on tape. For the SLD run to come they aim at 50 Z^0/h with 120 Hz rep. rate and 35 to 40% availability.

- **Wire scanners**: Indispensable. Continuous, non-destructive beam monitoring (position, emittance using sets of 4, energy spread) now possible. They are installed in all 17 critical places. (cf. SLAC PUB 5556).

- **Problems**: Damping ring (DR) suffers from long, coupled-bunch instability; Passive cavity at 109 f_0 foreseen as remedy. Transverse damping in DR times longer than expected, hence emittance too large out of DR. Reason?

- **Position production**: Capture section operates with 40 MV/m. Accelerating phase used. Decelerating phase given shorter bunch length but not used because then e^+ energy too low and danger of wakefields by secondary e^-. Proposal of R. Miller et al. to install special decelerating section (SLAC PUB 5215), not top priority.

  Now yield (e^+/e^-) = 1.25 at DR to L; 1.7 at L to DR. Try to increase it by future installation of quads and bends of larger aperture in L to DR line.

- **Solenoids on positron capture sections**: Built at SLAC (first solenoids were built by industry and thrown away). Connections and pitches chosen to minimise B_t. Magnetic measurements at SLAC including B_t.

- **Conversion target** (A. Kulikov): Consists of 75% W, 25% Re in Ag cylinder, 6 λ_{rad}, doing quasi-circular transverse movement to avoid impinging of primary beam (σ = 0.6 mm) on same spot. Model of flux converter seen (cf. SLAC PUB 5473 and 5472).

- **Klystron modulators** (Tony Donaldson. Head of engineering and maintenance group in the power conversion department headed by A. Saab).

Department has responsibility for all power supplies, kickers, high voltage systems, the klystrons modulators and the klystron rf low-level drive.

Shift crew: 3 shifts/d; 3 technicians/shift (2 for power supplies, 1 for modulators); total number of shift workers 23.

Fault statistics: surprising fact is that they have not yet a fault database. From experience one can say:

- 1-2 big faults (downtime $\geq$ 4 h)/y, e.g. fault of rectifier transformer
- 1 major fault (downtime $\leq$ 2 h)/d, e.g. failure of tri-axial cable, thyratron problem
- 3 minor faults (downtime $\leq$ 15 min)/d, e.g. failure of relay, thyratron driving circuit, current breaker.

Thyratrons: lifetime 20-24 kh; suppliers ITT, EEV. "Ranging" of thyratrons ($\equiv$ adjustment of reservoir voltage and check of pulse): all 2000 h (500 h interval after installation).

- **Controls system:** R. Humphrey (Head); S. Clark (Head of software group). Works well and has sophisticated software. Ex. : When a klystron station fails, all other klystrons are automatically phased to keep total energy gain constant and optics is changed automatically to provide same beam at end of linac.
- **Guns** (J. Clendenin, D. Yeremian):
  - Thermo-ionic gun: good performance, ε_n = 15π μrad measured before first S-band section;
    ε_n = 20-30 π μrad/m at 1 GeV (4 wire scanner meas.)
    ε_n (calc.) = 10π μrad/m (calculated with E-GUN for gun + PARMELA after gun)
  - Polarized e^- gun: vigorous programme. GaAs cathode cesiated after bake-out. Present dye laser 715 nm, P(rated) = 75 kW but 5 kW only for reliable operation. Tunable Ti-Saphhire laser in preparation P = 200 kW (5 kW needed), Δt(FWHH) = 2 ns. Expected degree of polarisation: 30% with former laser, 45% with latter one; with strained lattice cathodes 80%.
- **Staff running SLC:**
  - MD : 20 competent MD shift leaders + 10 deputies (recent post-docs) + 30 "helpers" (mainly from R. Ruth's department).
  - Operations crew: 1 Engineering operator (8 in total, B.S. degree level)
    3 Operators (25 in total!, technicians)

    All run 1 shift/d for 10 d

    1 "Programme deputy" ($\equiv$ our supervisor) is on call all the time for one week (10 in total). He runs the daily 8.00 o'clock meeting.

1.2 PEP II B-Factory (A. Hutton at SLAC and J. Dorfan at PF91)

Collaboration SLAC/LBL/LLNL (the latter mainly for engineering expertise). Machine cost : 170 M $ (1990); more expensive than Cornell machine partly due to higher union labour cost (CA 55 $/h, NY 30 $/h) though 85% of conventional facilities from PEP I used.

$$\hat{L}_0 = 3 \times 10^{33}\ \mathrm{cm}^{-2}\,\mathrm{s}^{-1}\ (e^-\ \text{ring 9 GeV},\ e^+\ \text{ring 3 GeV}).$$

Study leader: Dorfan in Research Division (headed now by D. Leith; C. Prescott resigned and is proposing a fixed target experiment with 50 GeV polarised e^-). Machine study : Hutton (Zisman is counterpart in LBL); Detector study : D. Hitlin (Caltech). Full-time staff on PEP II at the moment : ≈ 30 people from the three labs. It seems that PEP II is now second priority for SLAC after SLC.

Hardware R&D started : RF Cu-cavity by LLNL and Chalk River; Cu-vacuum chamber by LLNL. Closed-down PEP I will be dismantled over 100 m to make space for a PEP II model.

1.3 **Linear Colliders** (E. Patterson, R. Ruth, G.H. Low, G. Caryotakis, R. Miller, P.B. Wilson, Juwen Wang and J. Irwin at PF91).

G. Caryotakis replaces M. Allen as Head of department "klystrons and microwave" since Jan. 91. The latter became Head of the (newly created?) division for Health, Safety and Environment to prepare SLAC for the visit of the DOE Tiger Team on 7 October 91.

- **X-band Next Linear Collider** (NLC) : Reference design by end 92; conceptual design by end 96. Basic unit still klystron, delay-line rf pulse compressor and two sections.

- **A NLC Test Accelerator** (NLC TA) is planned (fig. 3). This true model of NLC will consist of 3 X-band klystrons (50 MW) and 6 X-band sections (1.8 m long, no slot in iris, but HOM couplers) with delay-line rf compressors (4x). Output energy 700 MeV. Later on: double number of klystrons.

  Injector 200 MeV. S-band linac providing 1 to 20 bunches $\sigma_s = 0.1$ mm. $N_b = 1$ to 2×10^{10}. Thermo-ionic gun (later on rf gun?) with 714 MHz subharmonic bunchers.

  Time plan for NLCTA : Proposal by May 92, Prototype of klystron and rf compressor, structure design by en 92. Structure constructed by mid- 93. Funding starts when Final Focus Test Facility (FFTF) is finished.

- **X-band klystrons** (cf. SLAC PUB 5508):
  Achieved 72 MW for 100 ns and 38 MW for 800 ns.
  Desired 100 MW for 0.8 ms. Problems : breakdown in output cavity.
  Relativistic klystron discontinued: experiments at LLNL showed that it is too complex and costly. R&D in cluster klystrons and sheet-beam klystrons continue at low level.

- **X-band rf pulse compressor**: delay line principle*. Theoretical compression 6, achieved 4.4. Best output power 120 MW in 70 ns (Filltime of section 80 ns). Problems with overmoded waveguides. Binary pulse compression à la Farkas will not be used.

- **X-band structure**: 7-cavity structure at 11.4 GHz worked with $E_s = 400$ MV/m in resonant ring test facility powered by 30 MW X-band klystron. For multi-bunch operation, the section will have medium HOM damping (Q = 100 to 200) and smart pseudo-constant gradient iris grading to reduce long-range wakefield.

- **S-band approach**: was reviewed by SLAC with negative result: (i) Beam dynamics issues are as severe as X-band for $E_{CM} = 0.5$ TeV; (ii) no expansion potential.

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* A. Fiebig and C. Schieblich, "A Radiofrequency Pulse Compressor for Square Ouput Pulses", EPAC, Rome (1988) 1075.

A very detailed and thorough cost estimate has been made by G.A. Loew ("The cost of the SLAC linac, the SLC and possible extrapolations to future linear colliders, AAS Note 62, July 1991). Comparing the cost of a collider providing E_{CM} = 0.5 TeV using the different frequency bands he finds 4.1 G$ for S-band, 2.3 to 2.7 G$ for X-band and 3.5 G$ for the C-band. This excludes the cost of common items as injectors, damping rings, final focus and campus.

2. Particle and Fields 91 Conference, Vancouver

Talks on AGS, FNAL Main Injector and Tevatron (next collider run in 92 with 6 bunches; in 94, 36 bunches with electrostatic separators for helical separation orbits; in 96, 36 bunches and new injector $\hat{L} = 5 \times 10^{31}$). We should have better contacts with AGS and FNAL as they have many problems in common with the PS.

Talk on HERA (no ramping yet with beam), SSC Design, LHC, TRISTAN (high luminosity operation up to 94, in 95 conversion of main ring to synchrotron radiation source, in 96 start of construction of asymmetric B-Factory; tunnel will eventually house 3 machines). Further talks on LEP, SLC, NLC and TBA's.

Talk on SSC by R. Schwitters (5 cm aperture short dipole models: 7 kA easily reached, 6.6 kA design, but field quality not yet sufficient; first full size dipole ready end of September; quadrupoles still at 4 cm aperture, not enough mechanical stability; string test of half-cell comprising 5 dipoles and 1 quad planned for summer 92; Bush has signed for 533 M$, Congress authorized 483 M$ in FY 92, Texas will add 100 M$; total cost 8.2 G$; Congress undecided about Soviet offer to contribute to injectors.

Physics talks were dominated by LEP results. The UA2 results played an important rôle in the presentation of the pbar-p results, which I expected to be dominated by the Tevatron results.

3. K-Factory Workshop

TRIUMF would provide a proton current of 100 μA average at 30 GeV. Perpendicular biased ferrite tuned cavity operational. Progress on all prototypes for TRIUMF but not yet authorized by the Federal Government. Total cost 708 MC$ over 5 years, province of B.C. contributes 1/3 of cost.

ISIS (RAL) provides now a proton beam of 130 μA average at 800 MeV with the following efficiencies: 98% (injection), 90% (acceleration), 99.5% (extraction).

Work on a European Spallation Source was reported (G. Rees). RAL proposes a 1 GeV, 10 μA proton linac operating at 50 Hz plus a 1 GeV compressor ring to produce 1 μs long pulses. Total cost 1 GDM.

For the Moscow K-Factory Project a 45 GeV synchrotron is planned. Linac (600 MeV, 100 Hz, 500 μA) exists but construction of the rest of the facility would need 50 MRubbles/a. Difficult at present time. Soviet-Canadian Collaboration if TRIUMF obtains authorization?

SLC Performance 9.8.91

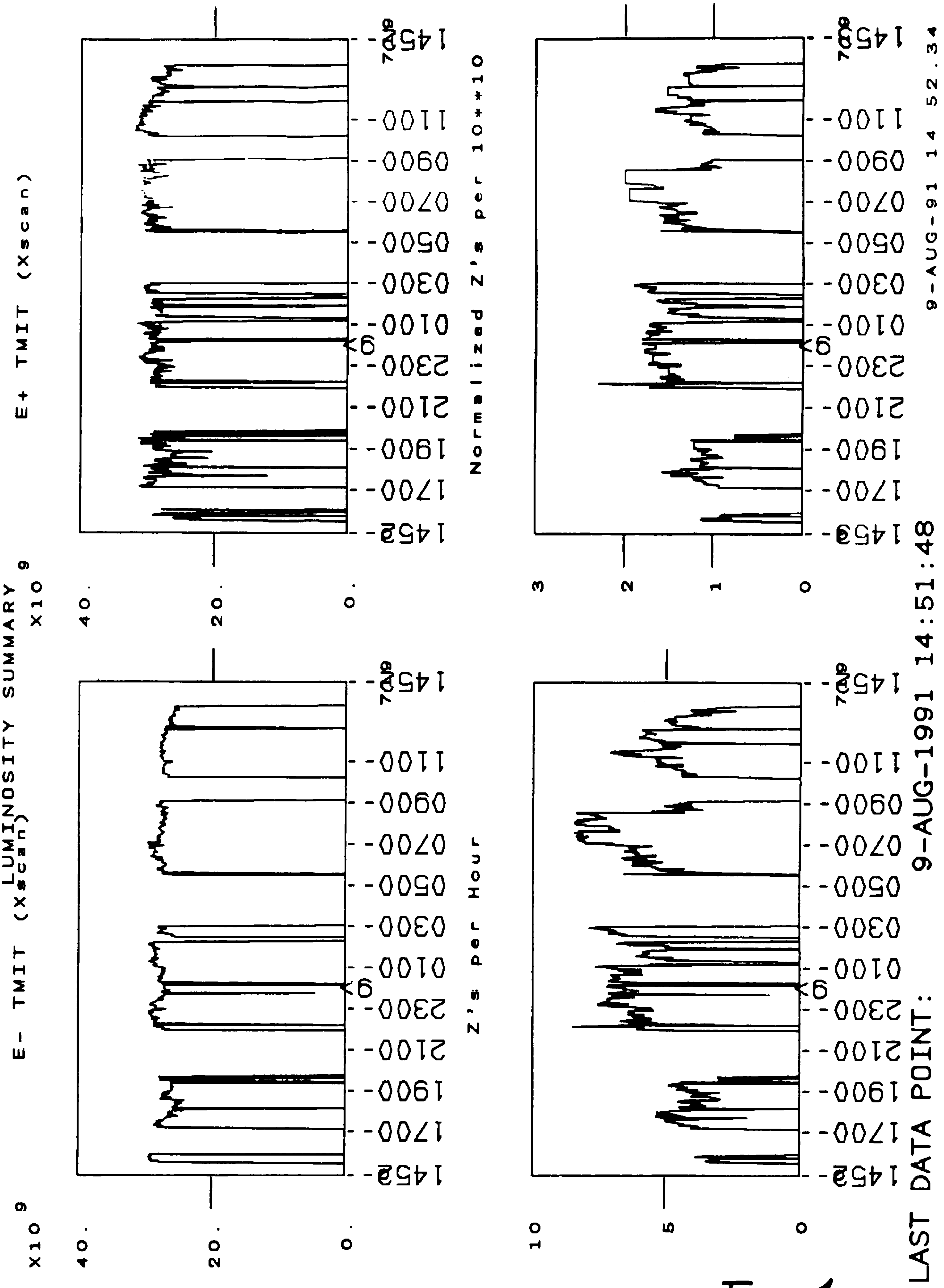

Fig. 1

SLC Performance 9.8.91

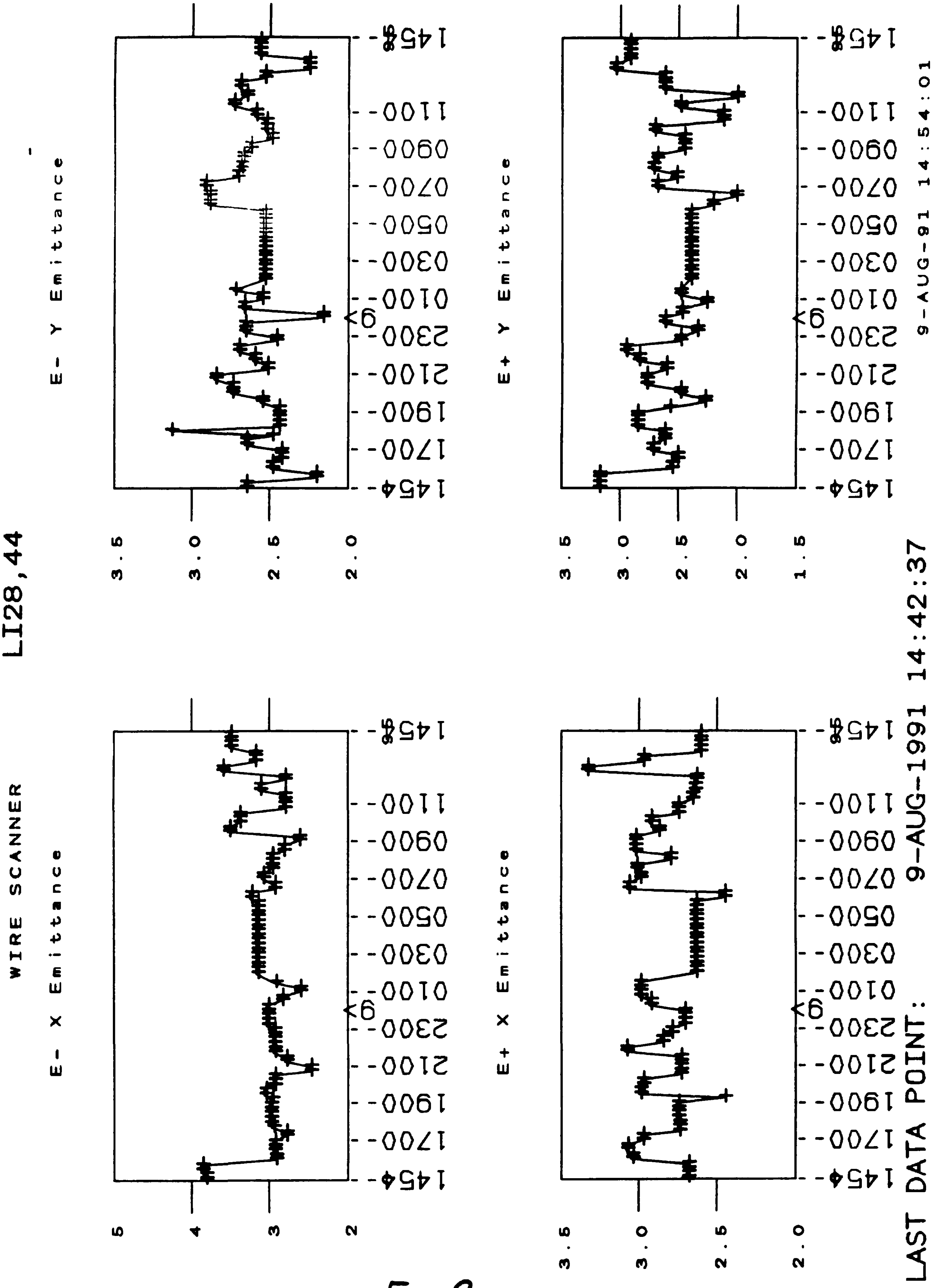

Fig. 2

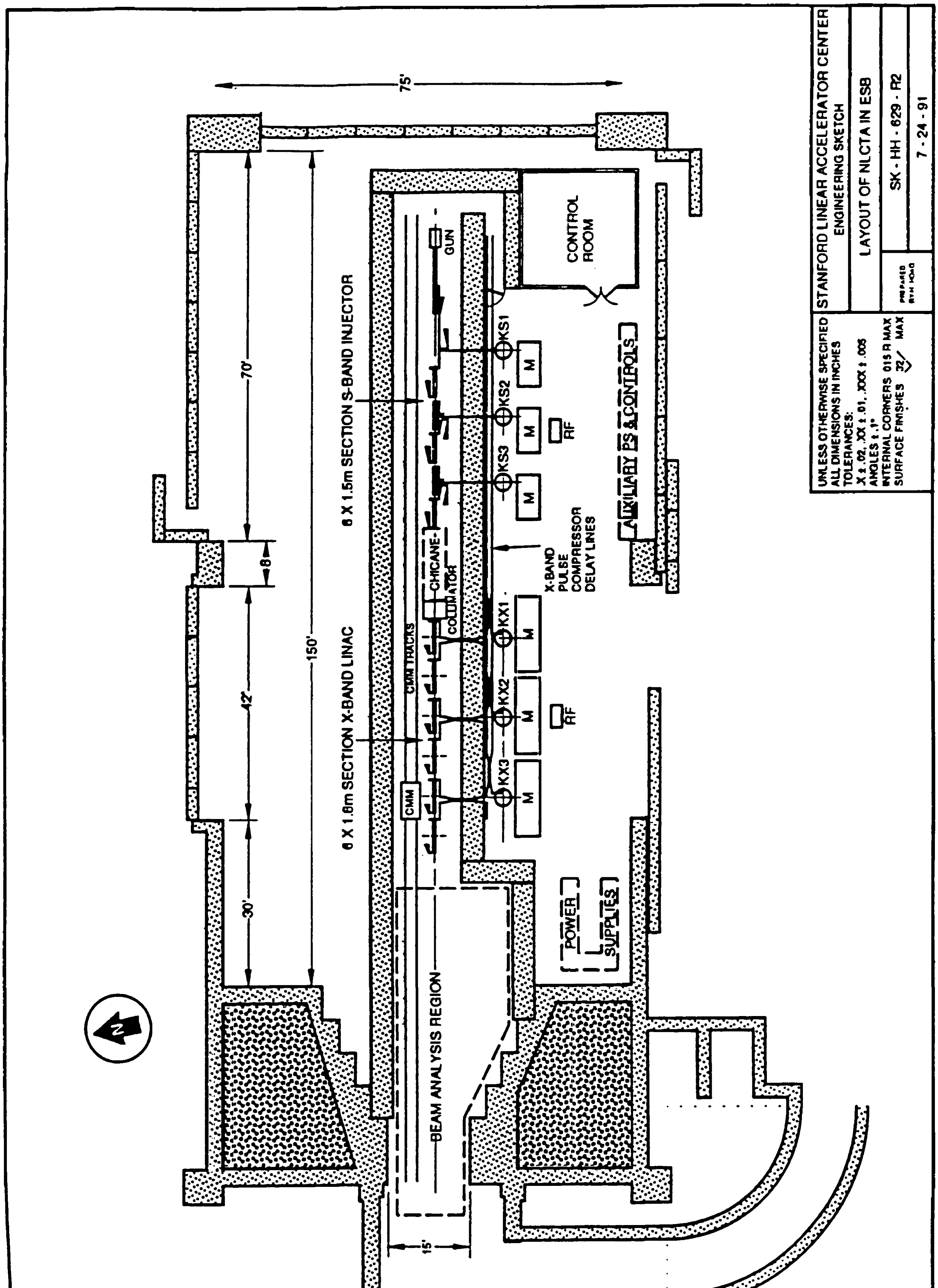
STANFORD LINEAR ACCELERATOR CENTER
ENGINEERING SKETCH
LAYOUT OF NLCTA IN ESB
SK - HH - 629 - R2
7 - 24 - 91
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES
TOLERANCES:
X ± .02, .XX ± .01, .XXX ± .005
ANGLES ± 1°
INTERNAL CORNERS .015 R MAX
SURFACE FINISHES 32 MAX
75'
70'
150'
42'
30'
8'
15'
6 X 1.5m SECTION S-BAND INJECTOR
6 X 1.8m SECTION X-BAND LINAC
CMM TRACKS
CMM
GUN
CHICANE-COLLIMATOR
CONTROL ROOM
KS1
KS2
KS3
KX1
KX2
KX3
M
RF
AUXILIARY PS & CONTROLS
X-BAND PULSE COMPRESSOR DELAY LINES
POWER SUPPLIES
BEAM ANALYSIS REGION
N

Fig. 3

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