Towards
an advanced hadron facility
at Los Alamos

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a presentation for the European Hadron Facility Workshop
Santa Margherita, Italy
5 October, 1987
Recent News From Los Alamos

1. Budget Not Increased
2. Superconducting rf Idea
   * menu of new designs
   * bunch rotator for kaons?
3. TRIUMF/Los Alamos Collaboration
   * rf and PSR Commissioning
4. 50 MHz rf System Test, PSR 1989

2 9/25/87
3 GHz Test Cavity

AT-MP Collaboration

Fused-Quartz Cylinder

3 GHz Niobium Cavity

High Tc Superconductor Sample

Electric Coupler

With the cavity submerged in liquid helium, Q is measured with and without the sample

- Special Funding for High Tc Work Available

Los Alamos
High Tc Superconductor Test

Eddy-Current FM Technique
For Superconductor Characterization
Oxide (High Tc) Superconductors

- Results to Date
  * Like Copper at 3.9°K and low H
  * Dominated by Residual Resistance
    - Temperature Independent Part
  * worse if significant surface H
  * need about $50 \times 10^6$ A/cm$^2$
    and higher $H_c$ to compete
    with Niobium
- Not Very Encouraging Information!
LEP Scruncher

- a niobium single cell 402.5 MHz module
- no proton buncher required
- improves LEP for Clamshell
- $700k if purchased from INTERATOM
- we should not fabricate it here without facilities
  * Can we share facilities with
    - NPB
    - and FEL?

Los Alamos
LEP Scruncher

Graph showing kinetic energy (MeV) vs. yield gain, MeV/meter, and resolution (MeV).

Los Alamos
Kaon Bunch Rotators?

- Think again about rf Frequency
  * 100-400 MHz?

- Short Bunches

- rf On During Extraction

- Also Useful for rf Separators
Menu of Modular AHF Designs

- Booster Only - - - - - - - 6 GeV*, 10 μAmp*
- Minimum Kaon Factory - - - - 45 GeV*, 10 μAmp*
- World Class Kaon Factory - - - 60 GeV, 25 μAmp
- LANSCE 800 MeV Upgrade - - - 0.8 GeV, 1200 μAmp
- Combined Kaon / Neutron Factory:
  1.6 GeV Superconducting H⁻ Linac
  & High Energy Compressor - - - 1.6 GeV, 600 μAmp

* = upgradeable

- Gives Confidence to AHF Steering Committee
- Flexibility for Science, Funding & Politics
- Design Independent r&d Plan

Los Alamos
AHF Design Workshop
Feb 22-March 2, 1988

- Accelerator Physics Working Meeting
- Uses LAMPF & LANSCE Experience
  AT-3, AT-6, MP-5, MP-14, P-LANSCE
- 4-6 International Visitors, Expenses Paid
- Anyone Welcome
- compare scenarios for Menu
- (Cost Estimates Later)
Combined Kaon / Neutron Factory is Cost Effective

Compare with

- 1/2 Julich SNQ
  1.5xDM 1389 million

- plus EHF
  1.5xDM 867 million

AHF Estimate
- $ 600 million
Further Thoughts

- Full-Size Booster Attractive!
  * Staging - In A Single Tunnel
  * Slow Extraction From Booster
  * Single Booster / Main Ring Power Supply
  * A good match to Siberian Snakes
- Technical Problem - High Synchrotron Frequency
  * Higher Energy Linac (1600 MeV ?)
  * Lower Frequency rf (25 MHz ?)
- Cost Similar to Small Booster
AHF Needs High Beam Availability!

- LAMPF Front End Reliability Improvements
  - New "volume type" H⁻ ion source
  - RFQ replaces Cockroft-Walton?
  - Replace 201.25 MHz tetrode rf
- Linac as Best Part of LAMPF
  - Side-coupled like 805. MHz
  - if superconducting, separate
    rf source for each 4-cell module
- Use Hardware & Diagnostics Experience from PSR
- Minimize Number of Rings
- High Beam Availability is Design Constraint
- Ring Acceptance = 4 x space charge emittance + momentum + closed orbit
- Acceptance Sufficient for 0.1% Injection Losses in Gaussian Beam Model
- PSR Slow Loss Caused Me to Look Again At Allowance for Beam Halo
- Painting with "Fixed Brush"
  20% of input beam is 2 sigma Gaussian
- Halo = 10 x Space Charge Emittance!
Painting Problem: Cures?

- A Serious Problem
  * Losses Above 0.1% Level Intolerable
  * Extra Aperture Doubles Magnet & PS Cost
- Stripping Collimators in Switchyard
  * Significant loss of Linac Beam
- Paint Hollow Beams
  * May Lead to Instability
- Paint With Moving Brush, best solution
  * Complicated, Expensive, May Lead to Correlations
- Have We Underestimated Multiple Scattering?
- A Subject for This Workshop? 

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Design-Independent R & D Plan for AHF

- ferrite-tuned cavities & test in PSR
- ceramic vacuum chamber
- resonant magnet power supplies
- injection and extraction hardware
- beam dynamics
- superconducting cavities & separator
- high Tc superconductors
- experimental area design
International Collaboration on Kaon Factory Development?

AHF - TRIUMF - EHF?

- PSR Commissioning / Learning Experience
- shared r&d cost
  * TRIUMF - driver & controls for PSR test
  * EHF - a.c. hardware for booster cavity?
  * I Will Accept Any Reasonable Suggestion
- peer review
- improved visibility of -
  * scientific motivation
  * project design

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PSR Test in 1989

Install TRIUMF/AHF "Main Ring" Cavity in PSR
- Next Generation Perpendicular Bias Design
- Tuning Range Sufficient for TRIUMF Main Ring
- 200 kV, R/Q=35 Ohm, Single Gap
- Tests Cavity Hardware & Controls
- Injection "Painting" Scheme
- Beam Loading
- Coupled-Bunch Instability

TRIUMF to Bring Controls & Transistorized rf Driver

Does not improve PSR beam!
Magnet Power Supply Update

- Praeg System May Not Save Money
  * Needs 2nd Capacitor Bank
  * Switches Not Expensive
  * Increases Cost by x1.5
  * Not Made Up By rf Cost Savings
- Flattop Not As Expensive
  * Increases cost by x 1.15
- 2nd Harmonic Interesting, But Expensive?
- 3rd Harmonic Compatible With Flattop!
- New Study by G. Karady Underway

Los Alamos
Ceramic Vacuum Chamber

- Next Step After Rutherford Design
- Needed for Large Field, Rep Rate, or Beam Size
- Integral rf Shield & Blocking Capacitors
- Wall Thickness -- 2 mm Possible!
- Cost - Same as DESY II Design!
- Impedance Measurements Required
- Goal is 3 meter Curved Pipe & Flanges

* expected in Fall 1988

A World-Class Development

Los Alamos
Science of AHF

- Kaon Factory Workshop
  * Summer School 1988
    - G. Garvey
  * Would TRIUMF or EHF Like to Join Us?
- Materials Science
  * Science Summer School Not Needed Now
  * Tighter coupling of Users and Machine Builders needed!
    * Make connection via R. Macek
- Steady Progress Required!

Los Alamos
AHF Construction Start

- FY-1993 Not Precluded
  * difficult if superconducting
  * superconducting linac as upgrade?
- 5 year Los Alamos funding plan insufficient
  * need another source of funds!
  * 10-15% advance development cost pays off in earlier commissioning and higher beam availability!
- International Collaboration on Construction
  * may be forced by TRIUMF start?
Summary: AHF in FY-88

- World's Best Funded Kaon Factory r&d Program
- use LAMPF & LANSCE experience
- cost effective combined kaon & neutron factory
- high beam availability needed
- need improved painting scheme or larger aperture
- menu of modular accelerator designs
- design-independent r&d plan
- test of rf hardware in PSR in 1989
- international collaboration underway
- FY-1993 construction start not precluded