Target Proposal

- Considerations:
  - For low z target, much less power is deposited in the target for the same pion yield.
    - N. Mokhov (MARS) At 16 GeV, flux yield for C / Hg = 1 / 1.5; power deposited in target = 1 / 5. Net gain x 3.3 for C.
  - Graphite target enables simpler system design, compatible with high magnetic field, no toxic waste, replaceable option (several months is a viable target lifetime)
  - Existing designs (NuMI) for similar beam energy deposition density as a 1 MW Neutrino Source - but with different time structure
  - Initial operation using a solid low z target maintains later upgrade option if needed for highest beam power. Easier to understand R&D questions, modest cost to determine parameters for graphite target design

Target Proposal

- Proposal:
  - Begin with a graphite target
  - Consider 1.5 MW initial operation, but design target support facility with view toward 4 MW long term
  - Timely pursuit of R&D to understand graphite target design optimization for 1.5 MW. Relatively low cost with a focused goal; modeling with existing codes & beam test capability at an existing facility (Los Alamos)
- More conventional & simpler initial approach can be very important in progress toward a real facility

Target Proposal
Feb. 15, 2000
S. Childress

NuMI Graphite Target

- NuMI Beam:
  - 400 KW (4×10^{13} 120 GeV protons / 1.9 sec)
  - 1 mm beam size (σ) at target, 10μsec spill
  - max. deposition density ~ 0.11 GeV/cc/p
- Design criteria include:
  - Maximal neutrino yield
  - Reliability for > ten million pulses (1 year, with peak deposition about 5 dpa / year)
  - Module replacement capability
- Target design by IHEP, Protvino
  - (V. Garkusha Group)
- Reported in:
  - Advanced Conceptual Design Report, NuMI-B-454, can be found at http://www-numi.fnal.gov.8875/numi/beam/beam.html
- Successful beam test:
  - AP0 beam, 1×10^{13} per pulse, 0.25 mm sigma beam to reach > 1 dpa.

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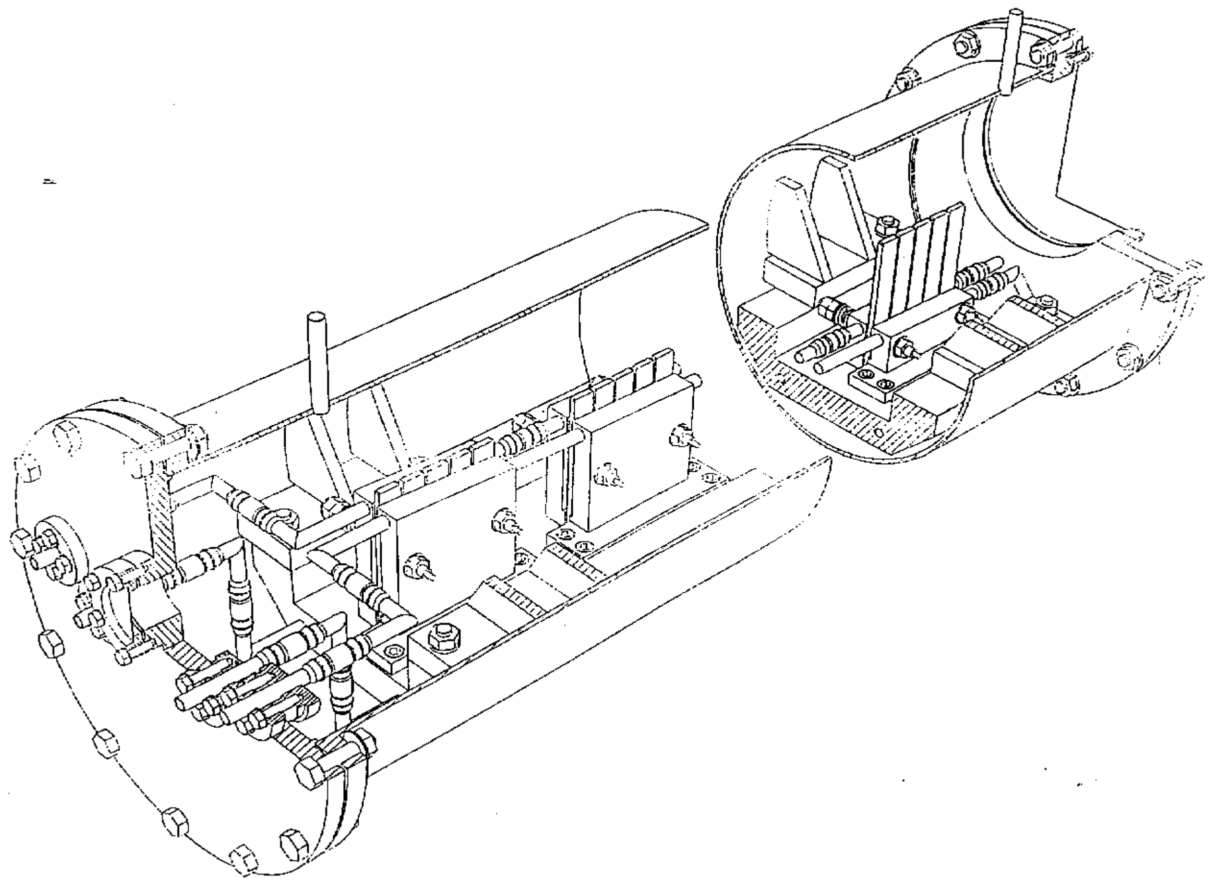
NuMI Target

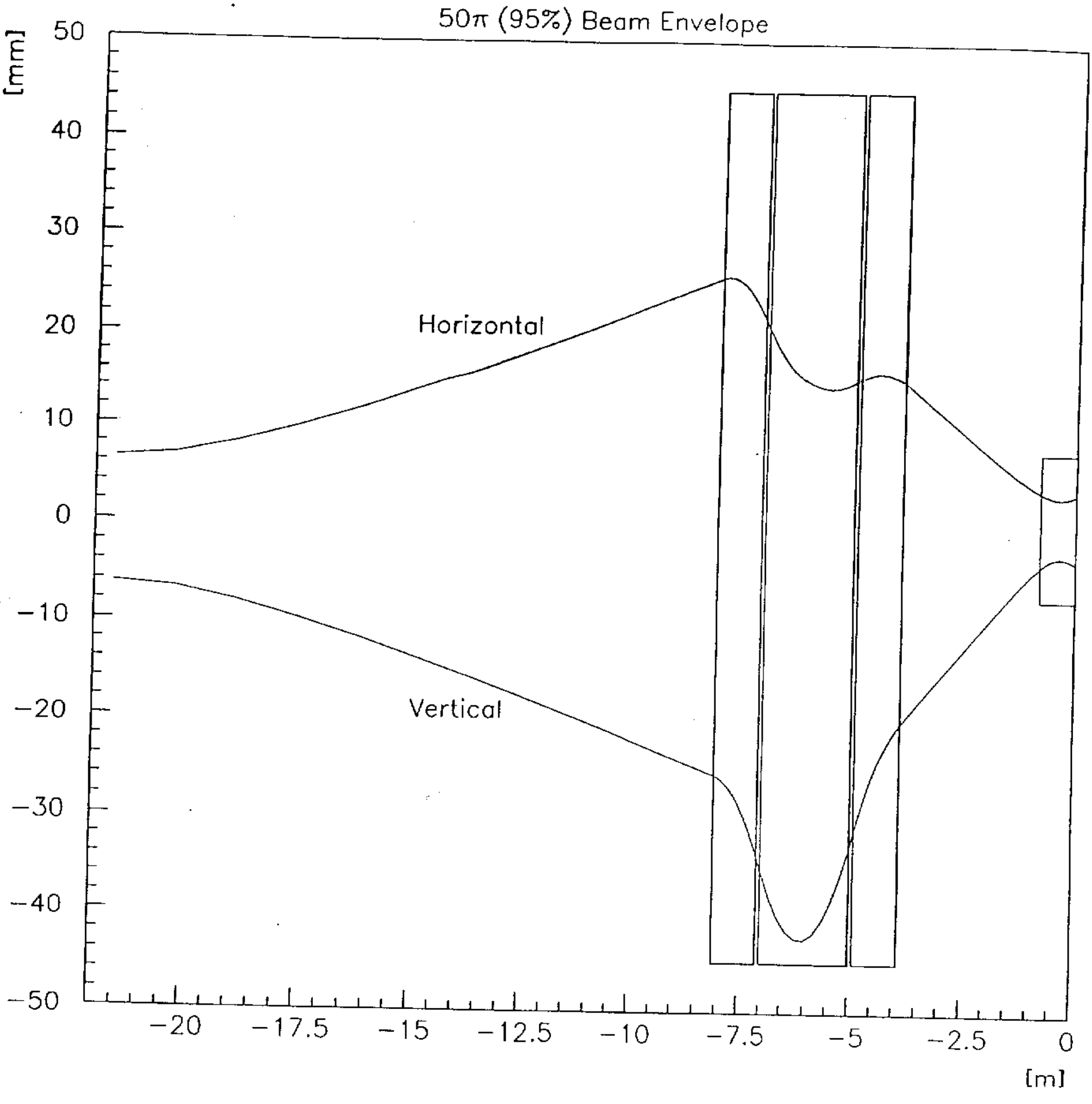


- Graphite 3.2 mm width, 0.96 meter length
- Fin design with slots to form 'teeth'
  - each tooth 12.5 mm long, with 2 mm gap

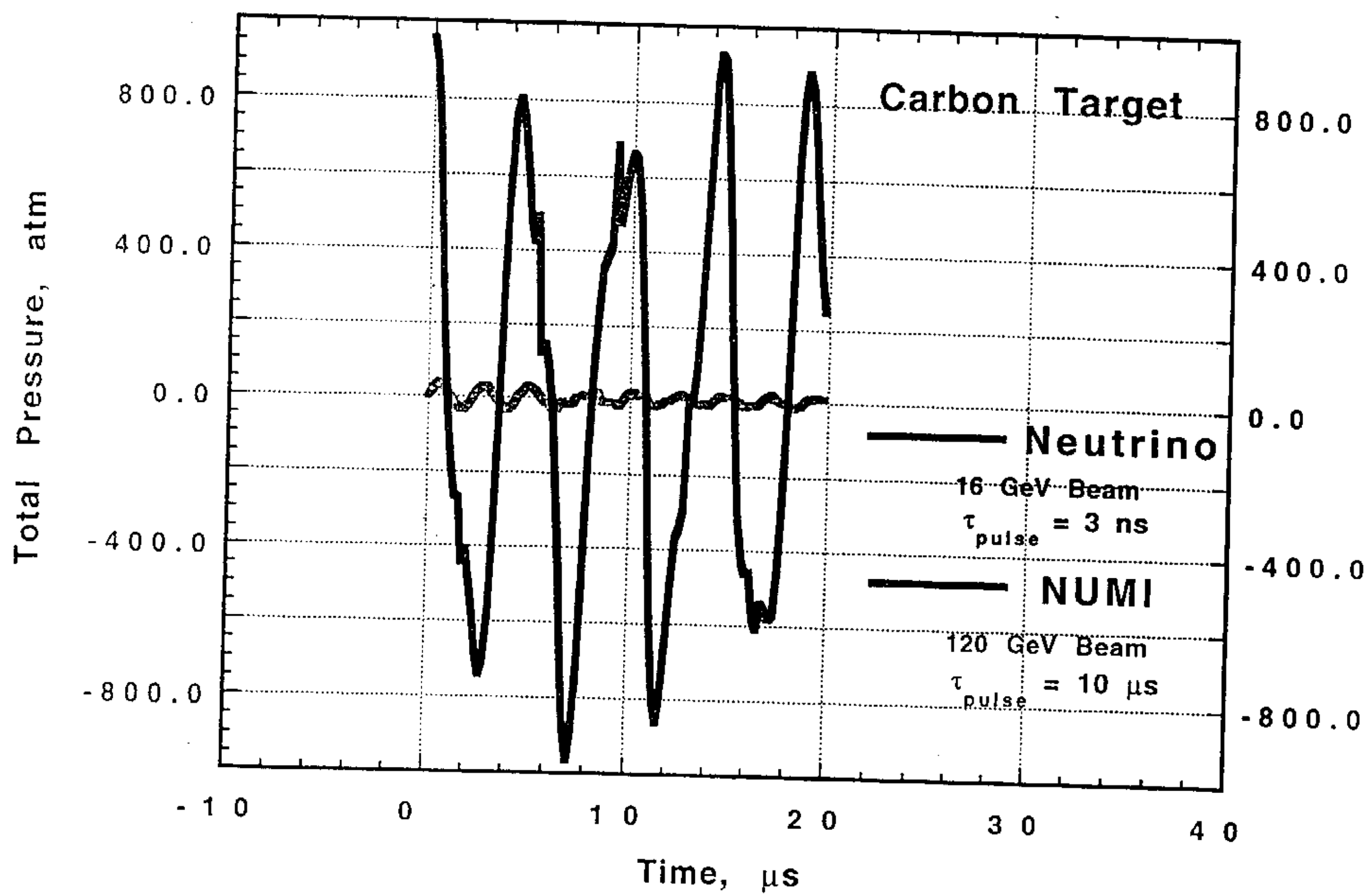
Key Efforts
Neutrino Source Target

- Incident primary beam optics
  - T. Kobilarcik (FNAL)
- Target energy deposition, yields
  - N. Mokhov (FNAL)
- Target heating effects
  - J. Haines (ORNL)
- Shock wave effect calculations
  - A. Hassanein (ANL)

- Parameters
  - Graphite target with 7.5 mm radius, 60 cm length
  - 16 GeV proton beam with σ (x,y) of 3 mm. RMS bunch length 3 nsec. 1.5 MW incident beam power. 15 Hz


50π (95%) Beam Envelope
[mm]
50
40
30
20
10
0
−10
−20
−30
−40
−50
Horizontal
Vertical
−20
−17.5
−15
−12.5
−10
−7.5
−5
−2.5
0
[m]

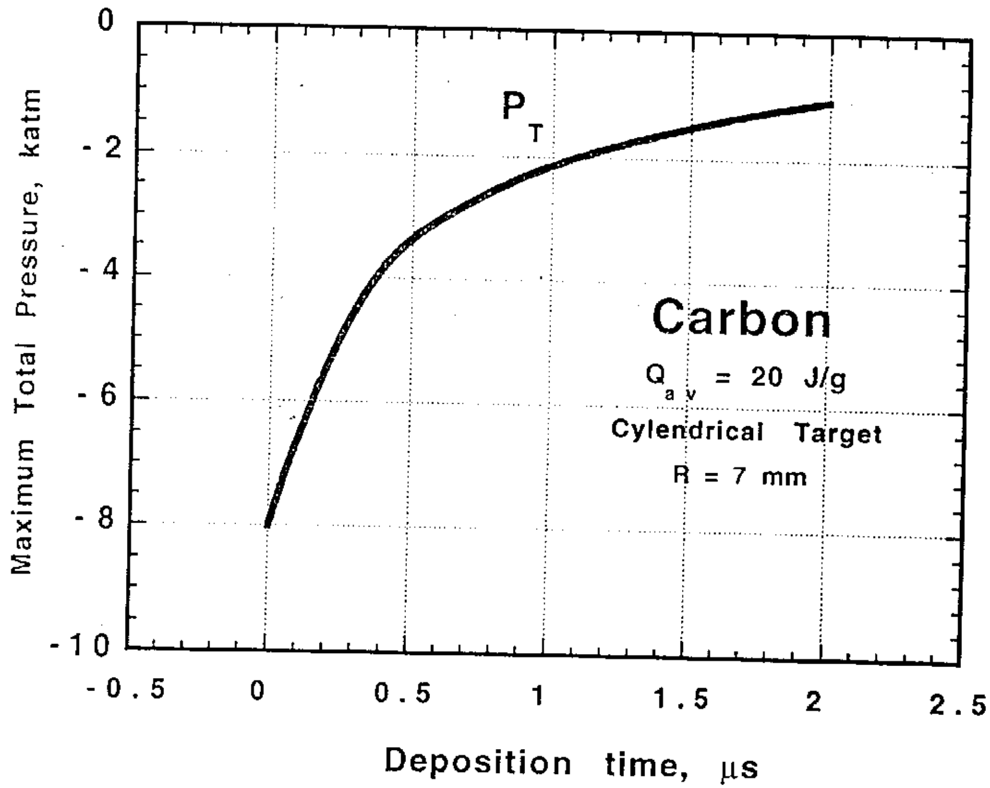
HEIGHTS Calculations of NUMI and Neutrino Target Total Pressure Oscillations Following Beam Deposition



Target Survivability

- The major issue for target survivability is due to the fast heating of the target and subsequent shock wave resulting in large pressure wave. Particular concern for large negative pressure reflective wave near axis. A. Hassanein
  - 3 nsec spill vs. 10μsec for NuMI
- Other relevant parameters which affect this:
  - Target shape - Cylinder aids to cumulative shock
  - Beam vs. Target size - Significant beam density near target edge is worse. (figure on next slide shows uniform beam across target; x 4 beam power. Shock wave increases by x 10)
  - Effect of target construction (graphite sheet or stranded fibers ~ golf club shaft)
- Radiation damage
  - Plan facility to replace target at ~ 5 dpa, or several months
  - Measure actual limits with test beam

HEIGHTS Calculations of Dependence of Total Pressure on Energy Deposition Time



4 MW
Uniform Beam Density

Target Survivability (cont)

- Cooling - 23 kW per MW of beam power
  - A significant advantage of carbon is that cooling requirement is much reduced
  - At 1 - 1.5 MW beam, radiative cooling appears feasible (J. Haines)
  - Water cooling complicates flux optimization & must also be aware of survival for cooling tubes. Careful engineering.
- Consider geometry options which aid cooling & minimize radiation dose
  - Example: Rotating band target - B. King (BNL)
- Graphite Target R&D Priorities
  - 1) Detailed understanding of shock effects vs. target shape, material configuration - Excellent model capabilities at ANL
  - 2) For viable designs based on 1), measurement of radiation degradation effects - High power short spill beam - Los Alamos
  - 3) Based on results of 1) & 2), optimize cooling approach & design

Target Facility Design & Requirements

- Presentations:
- Particle Production, Shielding, Capture
  - N. Mokhov (FNAL)
- Target Facility Design
  - P. Spampinato (ORNL)
- Target-Solenoid System Design
  - J. Miller (NHMFL)

- Target R&D Program for Multi MW Beams
  - K. McDonald (Princeton)