Operation of a Free Hg Jet Delivery System for a High-Power Target Experiment

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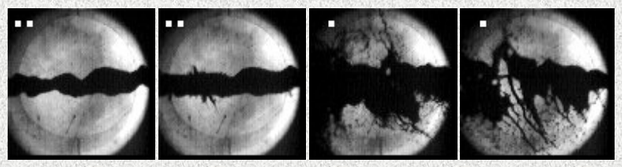
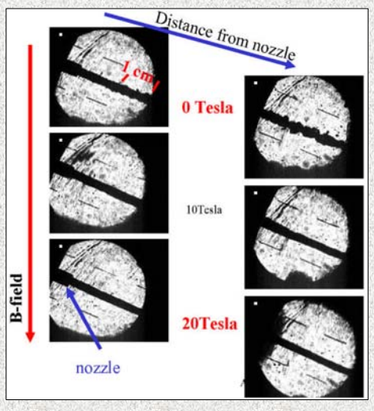
DESCRIPTION

The **MERIT Experiment** was performed at CERN in 2007 and served as a proof-of-principle test for a target system that converts a 4-MW proton beam into a high-intensity muon beam for either a Neutrino Factory or a Muon Collider facility. The target system was based on a free mercury jet that intercepts an intense proton beam inside a 15-T solenoidal magnet.

MERIT equipment and cross-section view through solenoid bore.



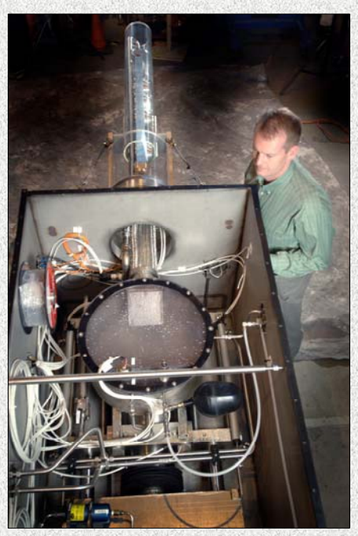
Past studies: A 1-cm-diameter, 2.5-m/s Hg jet at 0, 0.75, 10, and 18 ms after interaction with 3.8 x 10^{12} 24-GeV protons. The velocity of the filamentary dispersal was ~ 40 m/s.

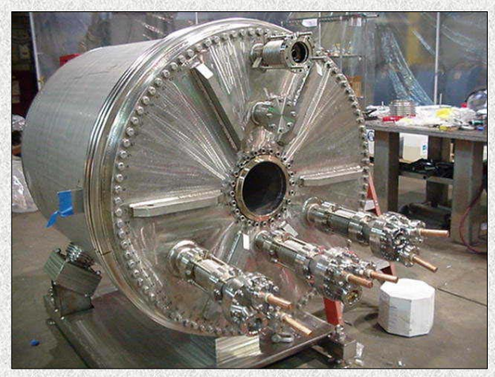


Past studies: The Rayleigh instability of a mercury jet (4-mm diameter and 12-m/s velocity) is suppressed by high magnetic fields.

EQUIPMENT

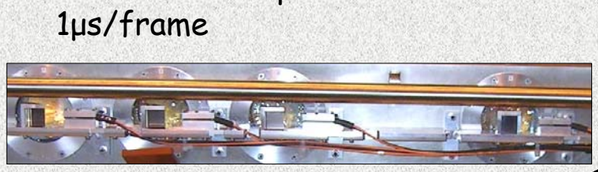
Hg Delivery System
- Hydraulically actuated syringe pump
- Center 25-cm-diameter Hg cylinder w/two side-mounted 15-cm-diameter drive cylinders
- Hydraulic power unit: 30kW, 50 liter/min pump, 260 bar
- Hg volume: up to 23 liter
- Up to 12 sec jet duration for 20 m/s jet





Solenoid
- 15-T, DC-pulsed magnet
- LN_2 cooled to 80K operating temperature
- 7200A/700V/5.5MW
- 3 nested copper coil construction
- Warm bore: 15-cm diameter, 1-m length

Optical Diagnostics
- Back-illuminated, laser shadow photography
- Passive optic components inside solenoid bore
- Radiation-resistant fiber bundles, 30K pixels/bundle
- Light source: 20W, 850-nm, Class 4 lasers
- Frame rates up to 1μs/frame

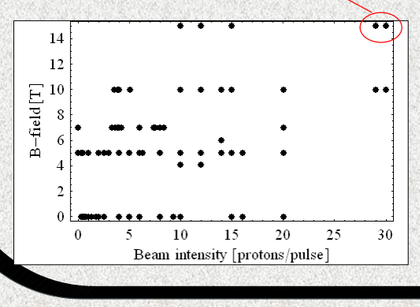


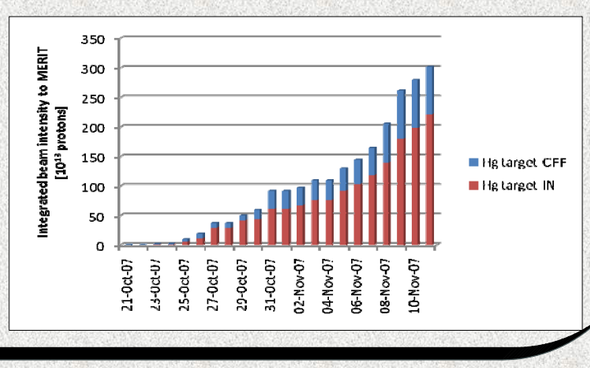
DATA COLLECTION

- Experiment conducted at CERN over 3 weeks Oct-Nov 2007
- 267 target jets produced
- Beam energies: 14 GeV & 24 GeV
- Field strengths: 0 T, 5 T, 10 T, 15 T
- Jet velocities: 15 m/s, 20 m/s
- Total of 220 x 10^{13} protons on target

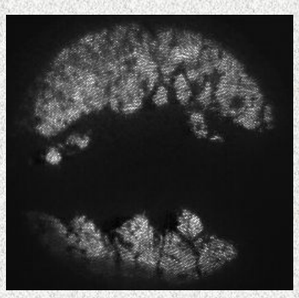
MERIT equipment installed at CERN

30 TP @ 24 GeV → 115 kJ
A CERN PS Record!



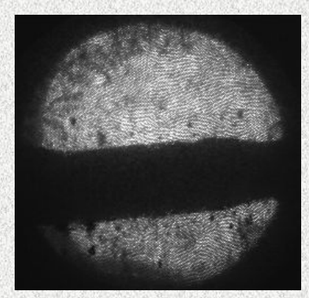


Pump-Probe Study: 14 GeV, 7T



4-T*p* Pump, SingleTurn Extraction
➔ 0 Delay

4-T*p* Probe extracted on subsequent turn
➔ 3.2 μs Delay



4-T*p* Probe extracted after 2nd full turn
➔ 5.8 μs Delay

Target supports 14 GeV, 4-T*p* beam at 172-kHz rep. rate without disruption