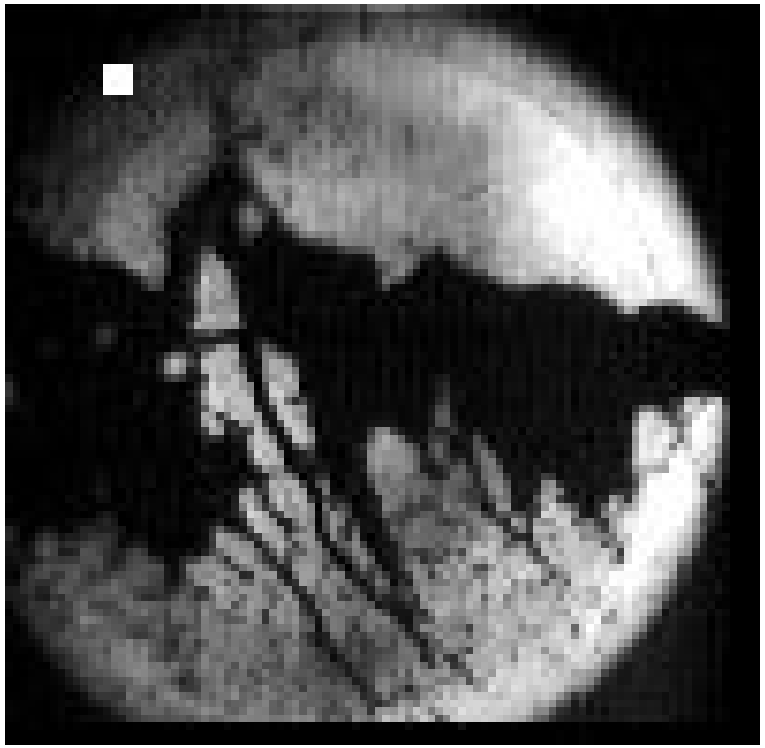
The Proposed TT2A Target Experiment

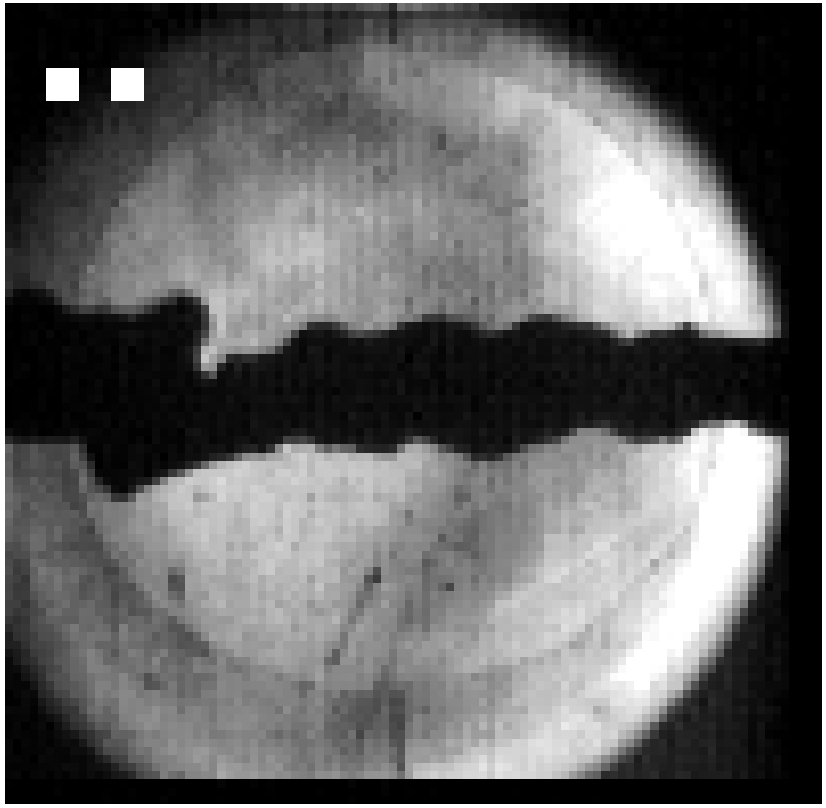


A.Fabich

CERN AB/ATB

Contents

- Physics goal
  - Liquid target concept
- Experiment in TT2A
  - layout
  - Safety
- Time schedule

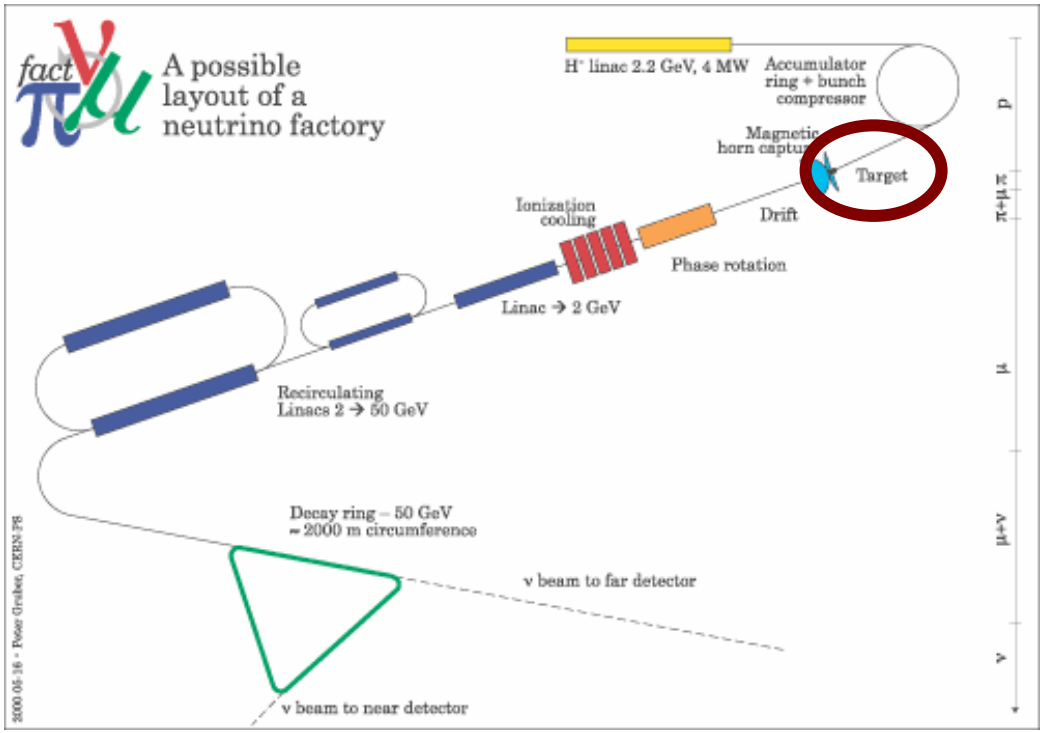


http://proj-hiptarget.web.cern.ch/

Producing particles of n-th generation

e.g. pions, muons, neutrinos or radioactive isotopes

- Super-beam
- Eurisol
- Neutrino factory



With a 4 MW proton beam on a target

- conversion tool
- provide unstable secondary particles

Liquid Targets with free surface

- withstand the power of multi-MW proton machines
- melting, vaporization, beam-induced pressure/shocks, radiation damage

Solid targets: not viable above a beam power of 1 MW
Contained liquid targets (e.g. SNS): pitting, failure of beam windows

- jet — avoid beam window
- Mercury — increased meson yield for high-Z materials, liquid at ambient temperature
- v~20 m/s — live with target rupture and replace target at 50 Hz
- D= 1-2 cm — Optimized for re-absorption of mesons
- B=20 Tesla — collection of secondary mesons with B=0 Tesla study case of magnetic horn

??? What is the impact on the jet target by

- 4 MW proton beam
- 20 T solenoidal field

Proposal

- LOI (Nov03) and proposal (May04) submitted to INTC (RB)
  - perform a proof-of-principle test
    - NOMINAL LIQUID TARGET
  - for a 4 MW proton beam
  - in solenoid for secondary particle capture
  - single pulse experiment
    - simulates 50 Hz operation
  - minimized integrated number of protons

Participating Institutes
- BNL
- CERN
- KEK
- MIT
- ORNL
- Princeton Univ.
- RAL

INTC (spring) and research board (July):

"… recommended for approval, but …
… further information on the support for the proposed test from the relevant scientific community, on the safety issues, and on the resources requested from CERN."

Collaboration responded and waits for RB 2nd December.

Experimental Site

	PSB/ISOLDE	GHMFL	BNL/AGS	PS/TT2A	NuFact
p+/pulse	3 10^{13}	----	0.4 10^{13}	2.5 10^{13}	3 10^{13}
B [T]	---	20	---	15	20
Hg target	Static	15 m/s jet	2 m/s jet	20 m/s jet	20 m/s jet
status	**DONE**	**DONE**	**DONE**	**PROPOSED**	**DESIGN**

BNL AGS capabilities

0.4 10^{13} per bunch

0.6 to 0.8 10^{13} foreseen (with bunch merging)

No multi-bunch single turn extraction (g-2 rebuild)

Exp. area: E951

CERN PS capabilities

0.5 10^{13} per bunch normal operation

0.7 10^{13} multi-bunches foreseen (for CNGS)

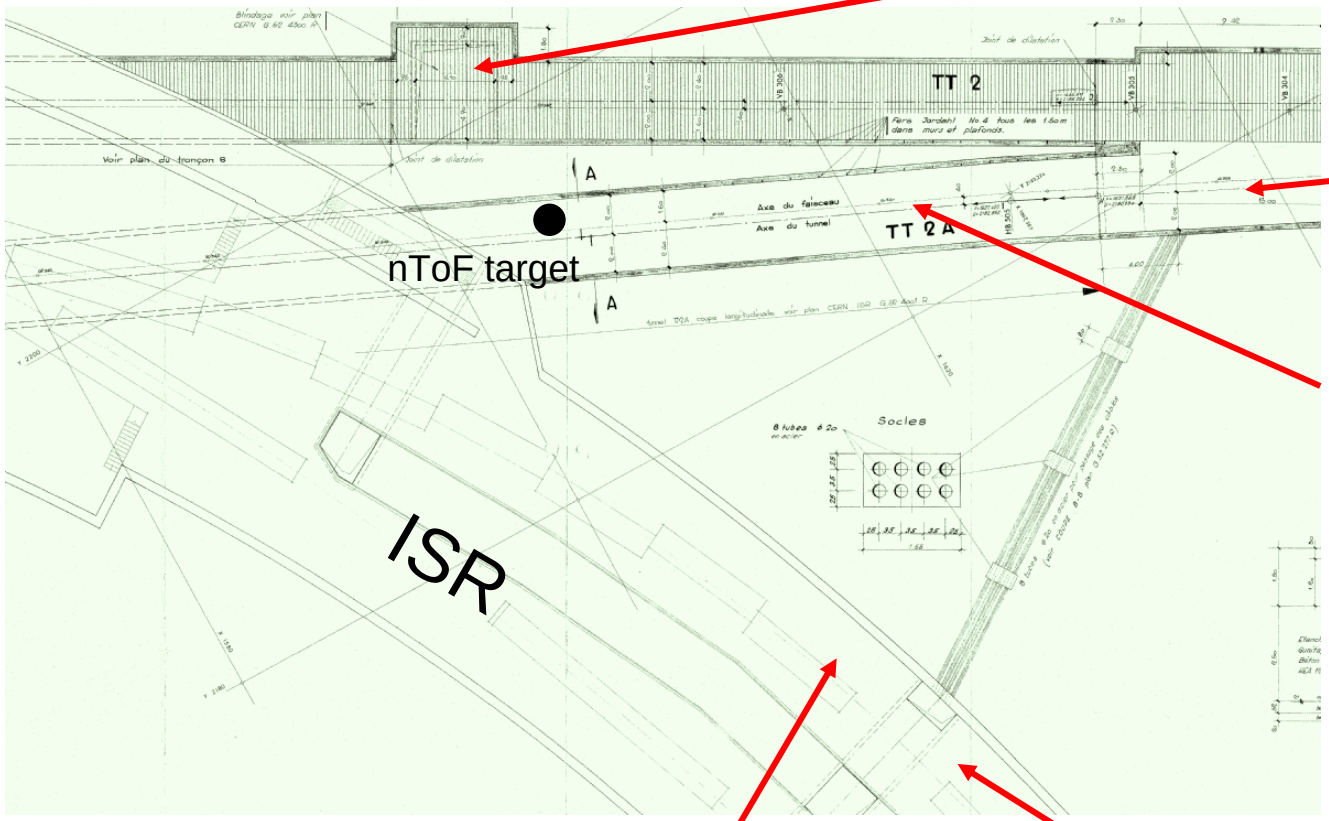
Multi-bunch single turn extraction available

4 bunch flexible fill of PS from booster available (Pump-Probe capability)

Exp. area: TT2A

- provides needed space for in beam and peripheral installation
- smallest impact on other beam users

Installations



LN2 supply

PS beam

Solenoid

Mercury circuit

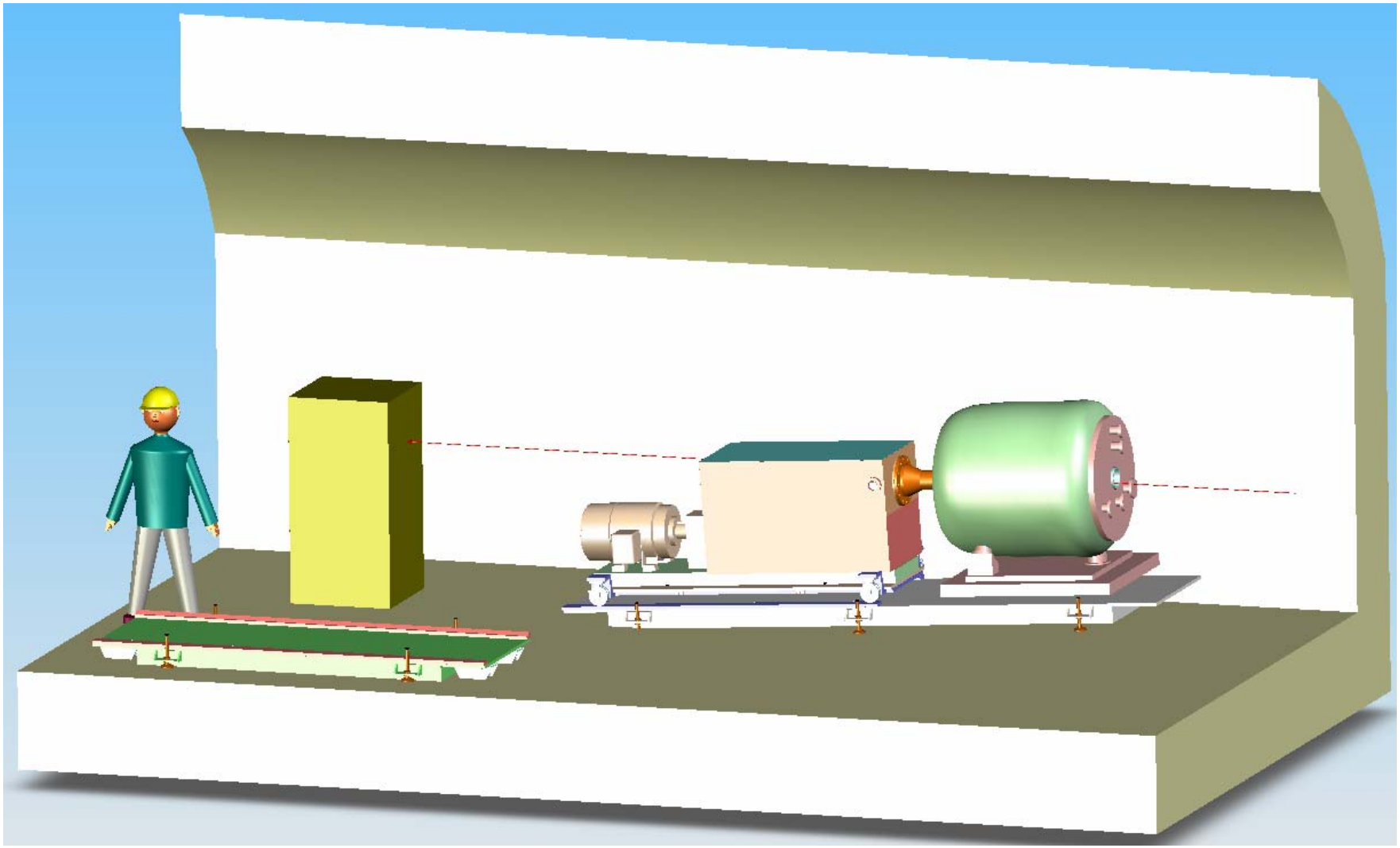
Diagnostics

SAFETY

Control room

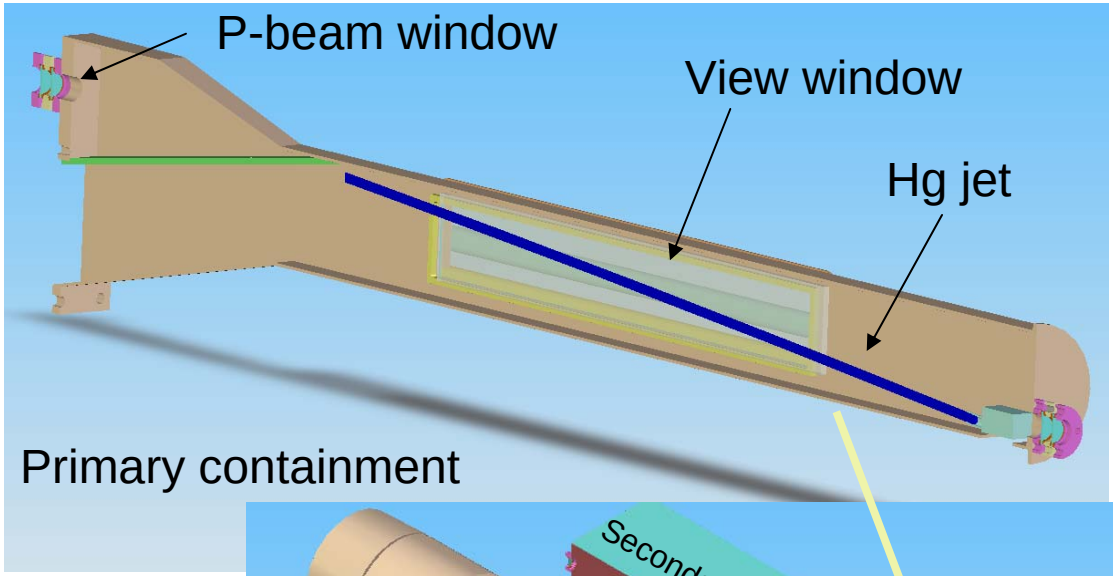
Power supply

Installation TT2A tunnel

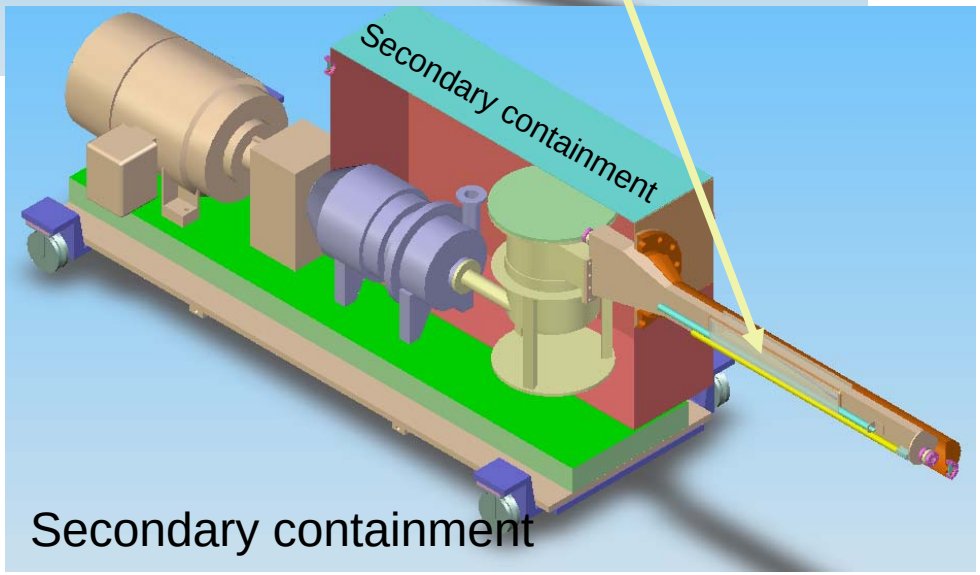


Mercury target

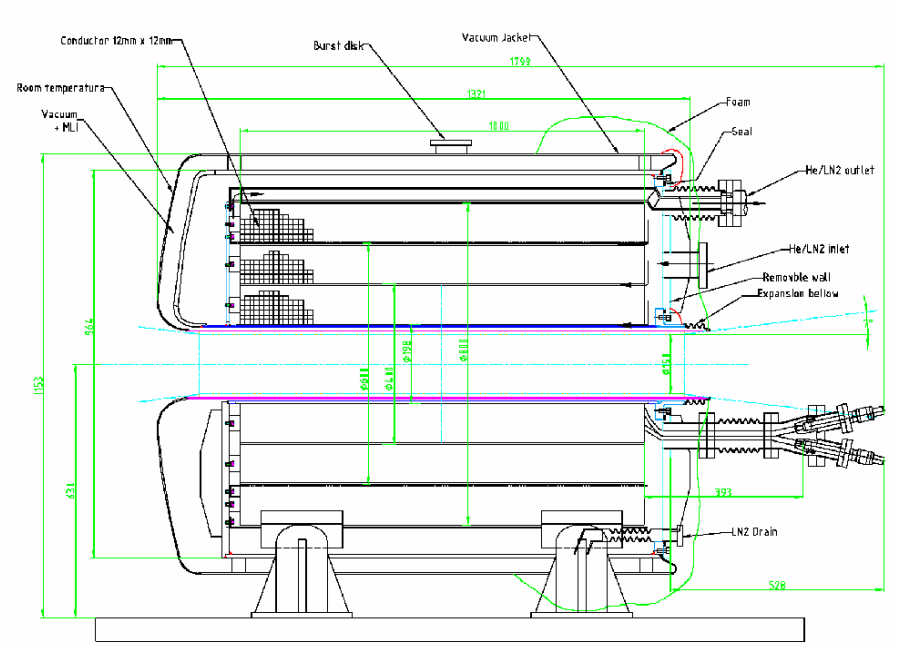
Jet target
- D=1 cm
- V=20 m/s



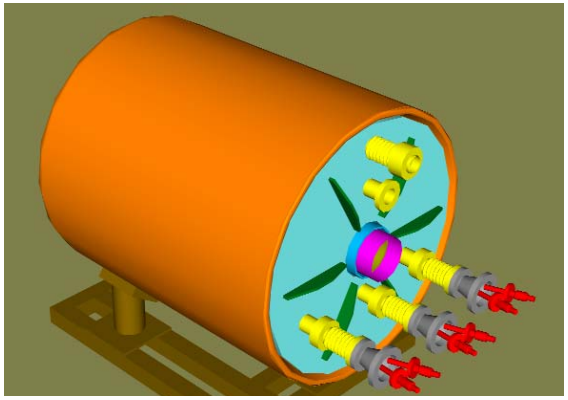
System contains
- Mercury loop
  - Double containment
  - Pump
  - Reservoir
  - 6-8 l mercury
- Motor
- optical diagnostics



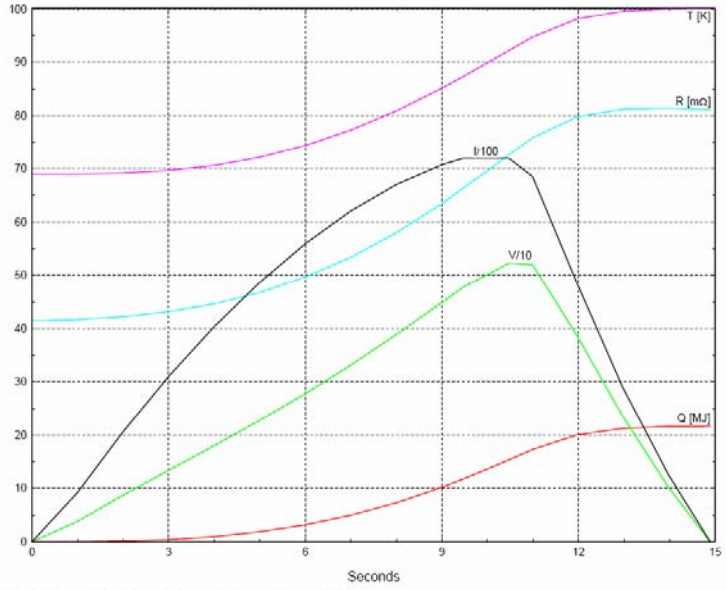
High Field Pulsed Solenoid



Peter Titus, MIT



Parameters of Pulse Coil Precooled to 69 K and Energized at 600 V to 7200 A



Bob Weggel's 10-14 analysis of the LN2 magnet operation

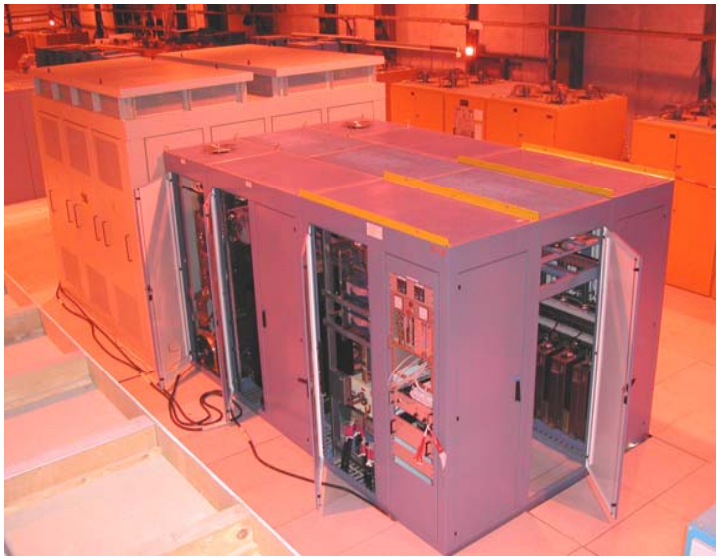
- collecting device for mesons
- 80 K Operation to optimize for costs
- 15 T with 4.5 MW Pulsed Power
- 15 cm warm bore (L=1m)
- 4.5 ton

Auxiliaries

Power supply

Evaluating solutions “available” at CERN

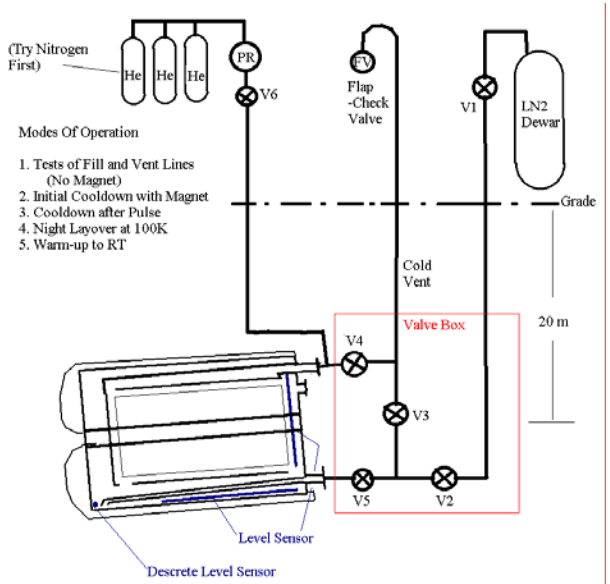
1. Type ALICE/LHCb



2. Recently “old” WA power supply found, which needs refurbishment - evaluation ongoing

Cryogenics

Using common standards

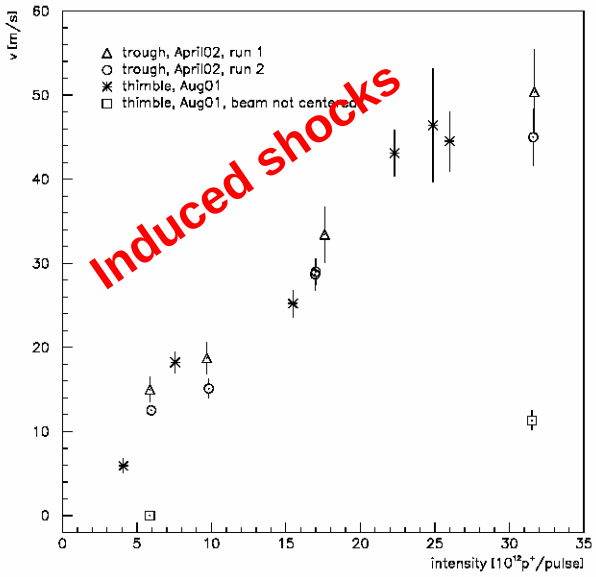


Currently designing general layout and flow scheme

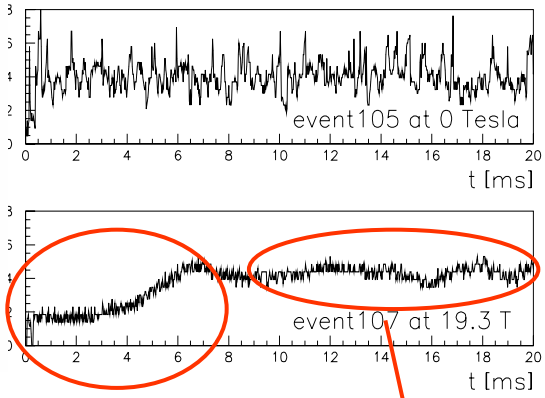
Upcoming: first iteration with SC on flow scheme and operation

Diagnostics

- **Optical System**
  - Direct observation of jet behavior



Magneto-fluid-dynamics

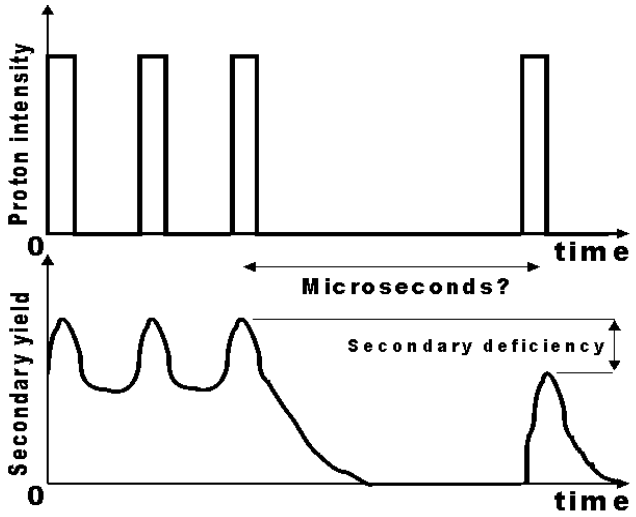


Tip shaping

Jet smoothing

@ 19.3 Tesla

- **Particle detector**
  - Interaction efficiency



  - Does cavitation reduce the secondary particle yield?

- Primary Proton
  - Beam intensity
  - Beam position
- Magnetic field

Varied parameters

- parameters to vary:
  - Magnetic field (0-15 T)
  - Pulse intensity (1-25 10^{12} p.o.t./extraction)
  - Pulse length (0.5-2 μs)
  - ~~Spot size~~
  - Beam position (±5 mm)

- Total number of protons on target (no tuning):

  < 3 10^{15} (~100 pulses)

- Needs ~2 weeks of beam time
  - Does not include time for beam tuning

Safety

- Radiation
- Mechanical safety
- Mercury
- LN2 cooling
- High magnetic field
- …
- “Waste” management

Procedure established:

- Define requirements/specs
- Prepare layout/design
- Safety review

SAFETY CONTACT PERSON FOR ALL MATTERS: Herve Buret Tel.: 160013 (replacement since Oct.2004, former Bruno PICHLER tel: 16 0889 or 73362	
	Responsible
DSO of AB	Paolo CENNINI
General Safety	Bruno PICHLER
Radiation	Thomas OTTO
Gas and Chemicals	Jonathan GULLEY
Electricity	Fritz SZONCSO
Emergency stops	
Magnetic Field	
Laser	
Fire	Fabio CORSANEGO (material also J.Gulley)
Material	
Mechanical safety	Alberto DESIRELLI
-- --- --- --- ---	also Maurizio BONA
Cryogenics	Gunnar LINDELL

---------- Memos available ----------

Safety

Mercury loop
- Construction at ORNL
- 6 to 8 Liter mercury
- Experience
  - at ORNL and CERN
- Double containment
- ISO 2919 “sealed sources”

Radiation
- ALARA
- Minimum number of integrated protons
- Activation of area and mercury

Chemicals
- Minimum amount of mercury
- Continuous vapor monitoring
  - Inside secondary containment
- Define procedures/operation

Safety

Mechanical safety

- According to CODAP2000/ASME
- Double containment
- Pressure vessel

- **Beam attenuator**
  - to protect nToF target
- controls, **interlocks**, timing

Cryogenics

- Standards used
- ODH study

- Waste management
- decommissioning

Decommissioning

- removal of all equipment
  - Approx. 2 weeks to restore beam line
- "Waste" management
  - Activated mercury — returned to ORNL
  - Solenoid — shipped to Japan
    considered for further use
  - Power supply — goes with solenoid
  - Mercury loop — reused in Japan/US?
  - …

Time schedule

- **2003**
  - Autumn LOI
- **2004**
  - Spring proposal to INTC
  - Summer detailed study at CERN (ongoing)
  - Summer solenoid construction launched
- **2005**
  - January solenoid delivered to MIT
  - Spring purchase of power supply

Summary

- proof-of-principle test
  - jet target in a magnetic field exposed to a proton beam
  - Synergies of a target for a neutrino factory with super-beam, Eurisol, ….
- TT2A is a highly suitable location
  - to perform this single pulse experiment
  - limited number of pulses and integrated number of protons
  - Major technical and safety issues have been discussed and positively concluded
- Upcoming:
  - Input by RPC
  - approval of research board?