Secondary Particle Flux Detectors for the MERIT Experiment

Outline

- What we want to measure
- Experiment layout
- Error sources
- Detector possibilities

Ilias Efthymiopoulos,
Adrian Fabich,
Maurice Haguenauer

VRVS - Meeting
April 5, 2006

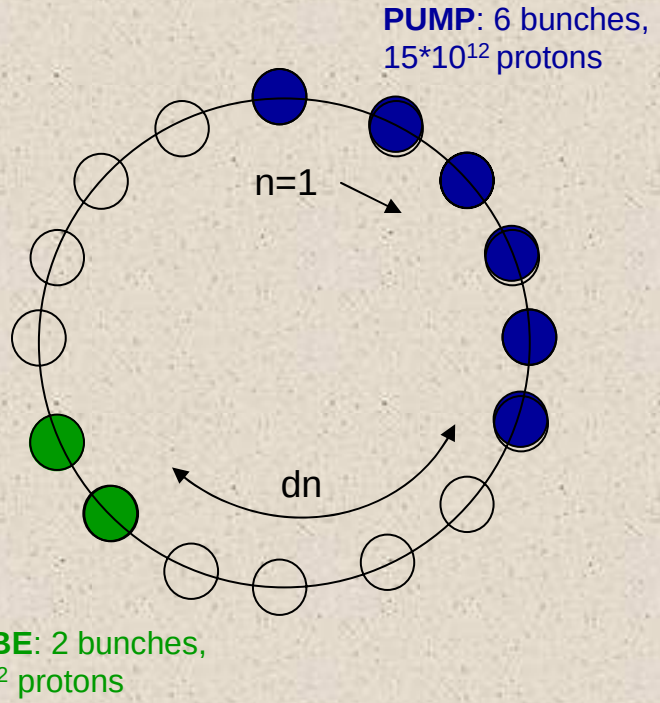
What we want to measure

Questions to answer :

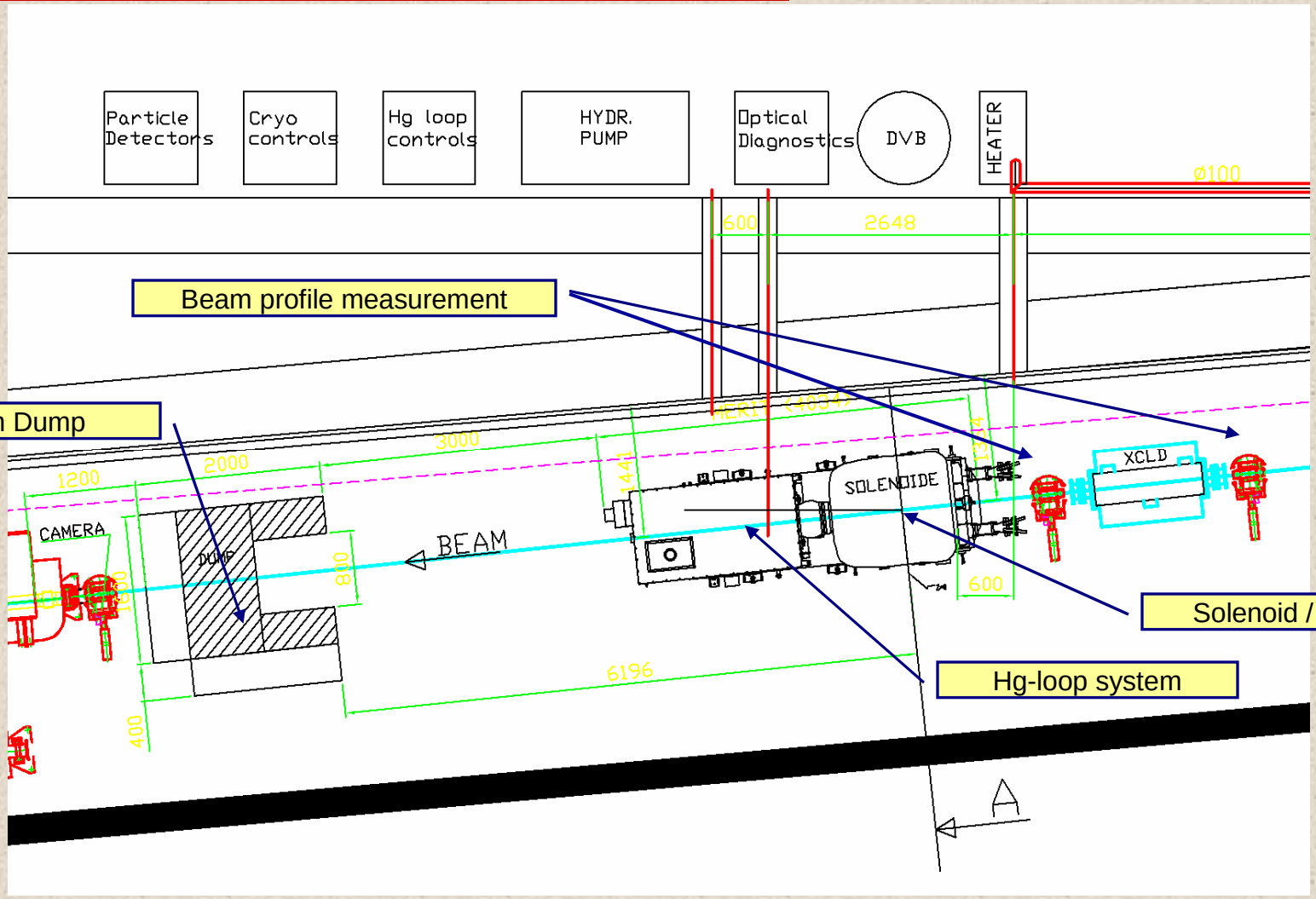
- Is there any particle yield reduction at high beam intensities?
  - Simulate high intensities with pump/probe method
- Is there any cavitation developed that reduces the effective target length?
  - We know that cavitation occurs but how it develops in a 15T magnetic field?
  - The times involved are “slow”, c~1.5km/sec not

Target parameters - reminder:

- 1-cm diameter Hg jet, v ≅ 20m/s
- Pump-probe method to simulate target excitation and 50 Hz operation as in ν-fact
- Proton beam:
  - 24 GeV/c from the PS (single turn)
    - 14 GeV/c (multiple turns, Δt>1 us)
  - Bunch length:
    - 50ns (base), spaced every 131ns



The Experimental Layout



MERIT - Particle Detection System

Strategy

- No need to measure sub-bunch structure, i.e. integrate answer for each bunch
- **Relative** measurement between bunches
  - i.e. compare 6 measurements (pump) to two measurements (probe)
- Aim to an overall precision of few %
  - **5%** should be possible, even 10% would be sufficient as answer

Detector requirements and constraints

- **Integrate** particle counting within **60 ns** (50ns pulse + margin)
- Readout within 60 ns or storage (memory)
- High particle fluxes : ~10^7 particles/cm^2/bunch
- Radiation
- Magnetic field

MERIT - Particle Detection System

Measurement precision:

Relative measurement between bunches → two sources of error

1. The knowledge of the beam
   - Beam intensity (bunch-to-bunch)
   - Beam direction ({x, y} at target, angle)
   - Beam longitudinal length (bunch shape, out of bunch particles)
2. The precision of our detectors
   - Number of particles to integrate, S/N
   - Stability over time
   - Acceptance vs target configuration

Input beam definition

Intensity measurement - Bunch-Current-Transformers (BCTs)

1. Inside the PS ring just before extraction
   - possible to measure bunch per bunch ; 2-5% precision can be achieved

2. At TT2 transfer line, right after extraction
   - measure total intensity of the extracted beam

- Measurement error:
  - BCT precision, assuming same losses for pump and probe bunches in the TT2 line
    - Calibrate the two BCTs using a single turn extraction at 14 and 24 GeV/c
  - Kicker current setting would contribute for multiple turn extraction
    - Could be measured/corrected afterwards
    - Test of kicker repeatability – during 2006 MDs ???
    - Beam simulations:
      - particle losses in TT2 vs kicker setting
      - beam location at the MERIT target vs kicker setting

Input beam definition

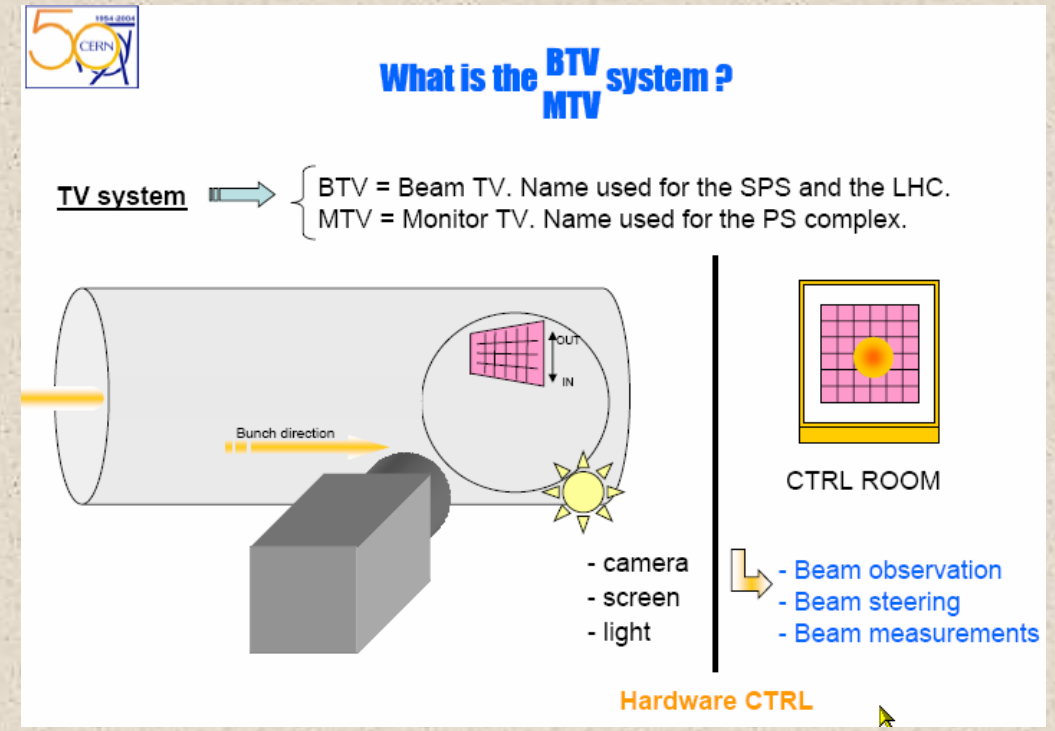
Beam spot and angle measurement

1. Use beam profile monitors installed upstream of the experiment
   - Baseline: MTV screens
     - <1mm precision
       - 3 m distance → 160micro-rad precision
     - Provide {x,y} location
     - Alignment: <0.3mm relative between target and MTVs (6 m)
   - Alternative option:
     - BPMs of LHC

Longitudinal bunch shape

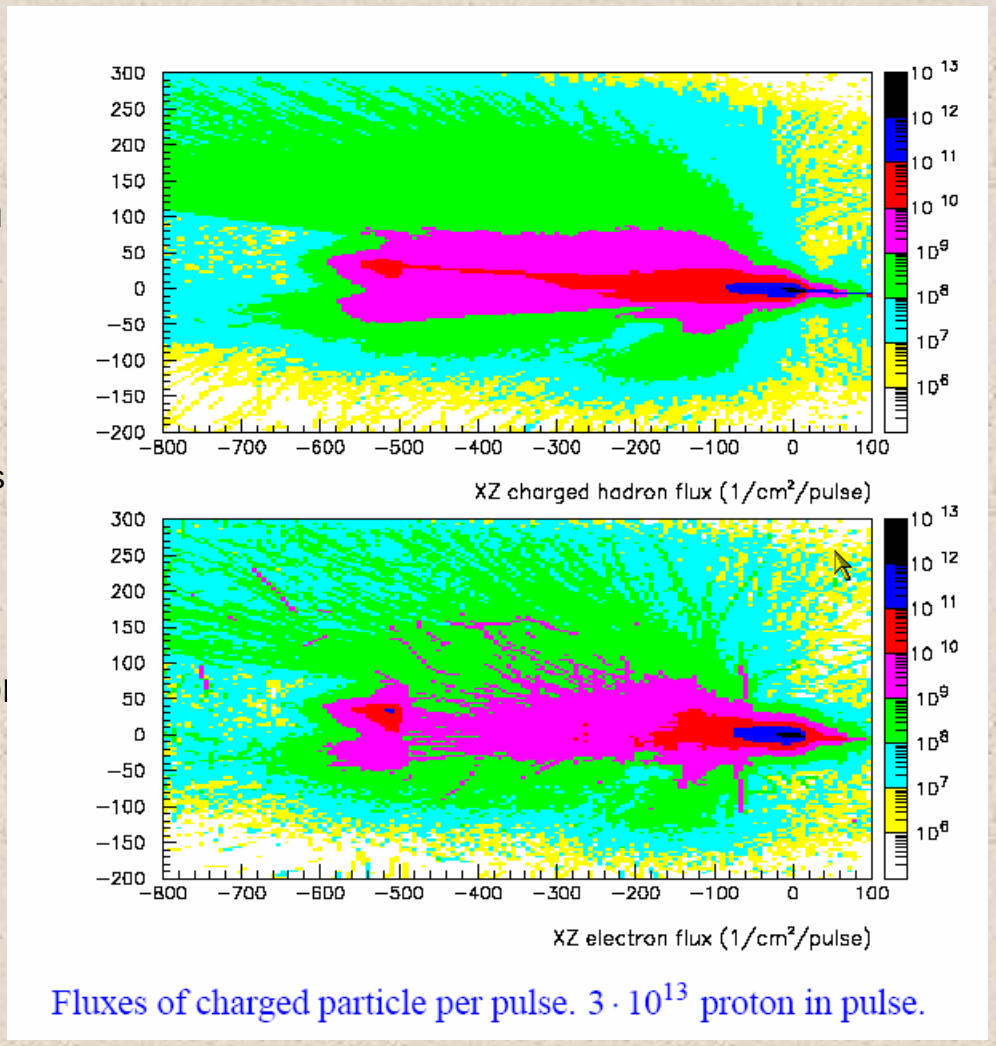
- Measured online inside the PS ring
- Gives also the number of particles out of bunch (<% effect)

All measurement data can be fetched from the PS control system logs



Particle fluxes

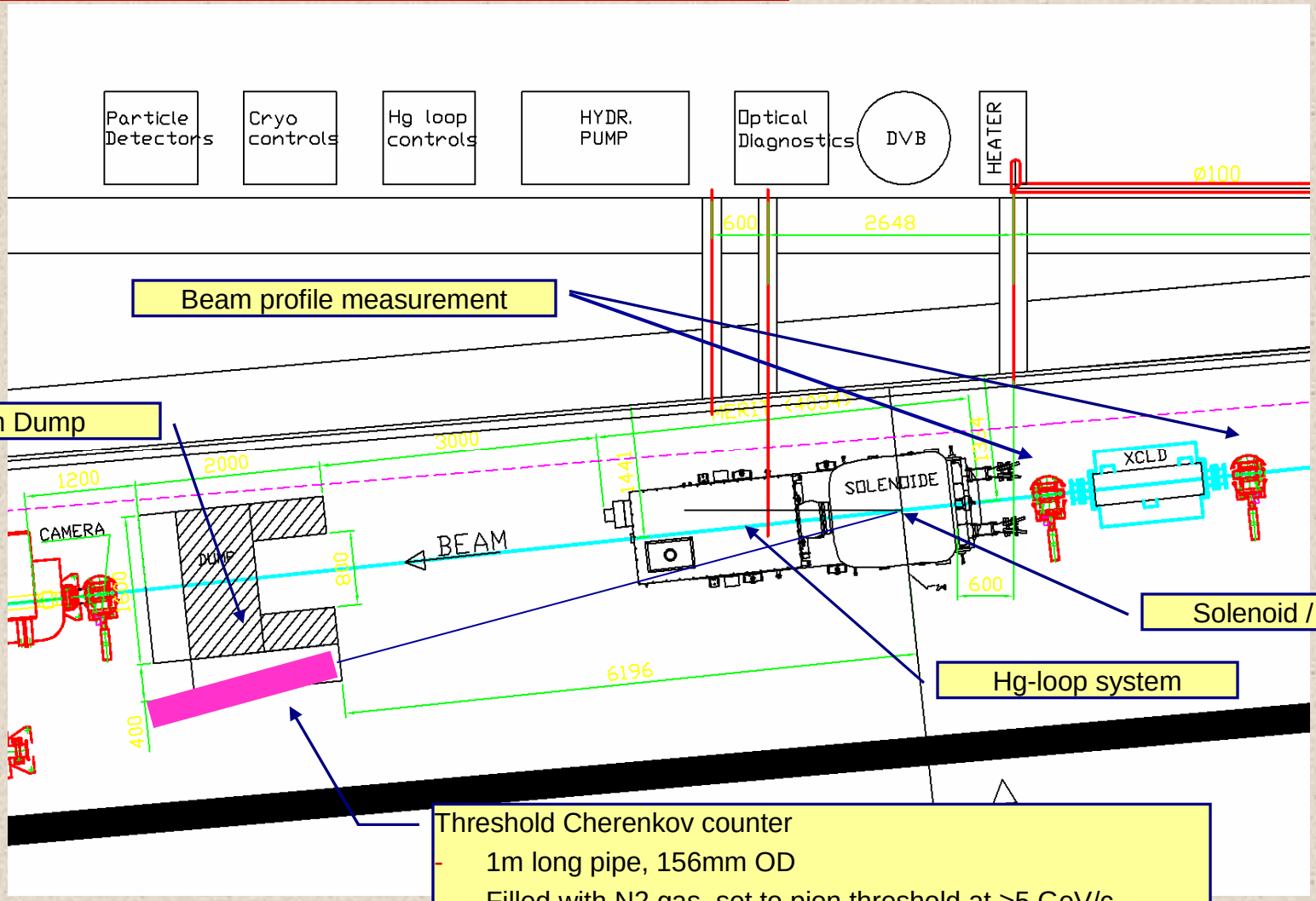
- MARS simulation results
- Detector locations:
  - at large angle around Z=0 cm
  - at large angle downstream
    - Cherenkov signal of fast protons
    - Small detectors
      - scintillators or silicon diodes
  - Behind the dump in straight line
    - Muon detector (scintillato
- Particle fluxes:
  - ~10^7 particles/cm^2/10^{12}pot
  - 3×3 cm^2 detector
  - ➔ 10^8 particles /bunch



Fluxes of charged particle per pulse. $3 \cdot 10^{13}$ proton in pulse.

S.Striganov – 18.10.2005

The Experimental Layout



Threshold Cherenkov counter

- 1m long pipe, 156mm OD
- Filled with N2 gas, set to pion threshold at >5 GeV/c
- Pb sheets in front to reduce electron rate