Laser Update

SBLM
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Laser Objectives for AWAKE through end of year

- Proton Beamline Commissioning
  - Activities:
    - Placement of MP5 (final turning mirror) on translation stage
    - Spatial overlap and alignment with proton beam on BTVs up and downstream of vapor source
    - Synchronization with proton beam
  - Required Capabilities:
    - Safety document complete for beam permit
    - RF locked laser applied at safe level uJ level pulses for BTV screens
    - Observation of virtual line for alignment correction due to thermal drifts in laser amplifier
    - BTVs with unsaturated laser image
    - Referencing of protons on final design trajectory with BTVs
    - Streak camera to observe temporal overlap of laser and OTR from protons

- Self Modulation Measurement
  - Activities:
    - Ionization of rubidium vapor to seed SMI
  - Required Capabilities:
    - Dynamic Delay to acquire high powered shots
    - Cameras fully implemented
    - Data acquisition fully implemented (Energy, 3 camera profiles, autocorrelator)
    - Low power beam interlocks implemented and enabled
    - Counter and shifter for LBDP 2 (laser beam dump immediately downstream of vapor source)

Laser Status for Proton Beamline Commissioning

- Beam permit documents:
  - Laser description document revised and sent for approval again.
  - Laser safety inspection of TSG40 will happen on Thursday to check corrective actions
- RF locked laser at appropriate levels:
  - Locked on fundamental (88 MHz): sufficient for SMI measurement
  - Will be improved by Menlo with BOMPD c. November, this is required for phase II
- Virtual beamline:
  - Setup but must be realigned once more (only virtual line) before beamline commissioning (after hours Thursday, for example)
- BTVs with unsaturated laser image:
  - Need neutral density OD 6 filter in BTVs (replacing OD1) to get unsaturated image, Stephane Burger ordered already
- Protons referenced on design trajectory:
  - A goal of first three days of proton beamline commissioning
- Streak Cameras:
  - BI / MPP discussion

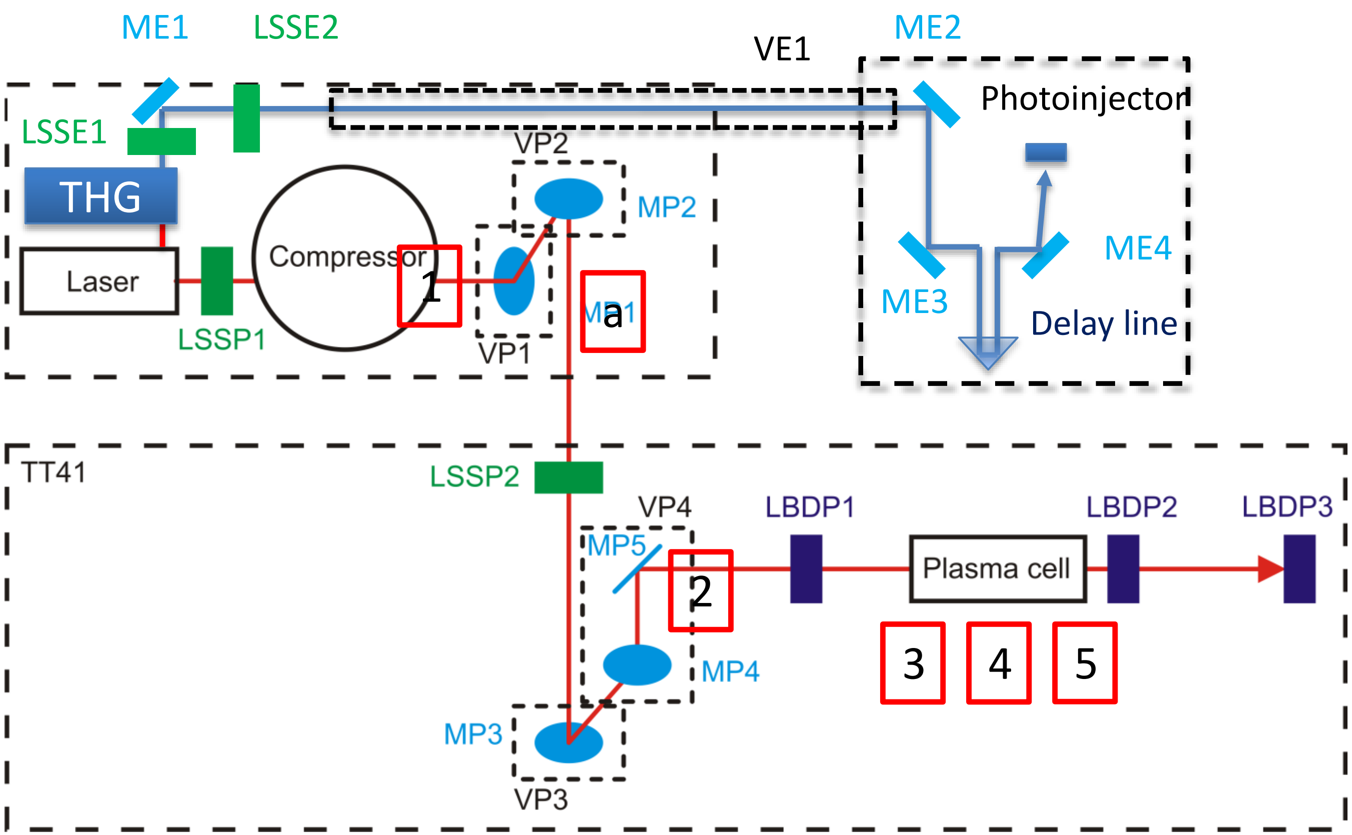
Laser Status for SMI (after vapor source commissioning)

- Dynamic Delay logic is implemented and tested, need extraction warning from Heiko
- Low power mode interlocks installed minus screen status signals from BI and sending veto signals, PLCs need a bit of debugging/refinement
- Data acquisition:
  - Needs some work:
    - Cameras: Pierre
    - Pulse length Autocorrelator file reader (Veronika and I)
    - Energy measurement (waiting on Gentec heads, but FESA implemented)
- LBPD2:
  - Needs some work counting

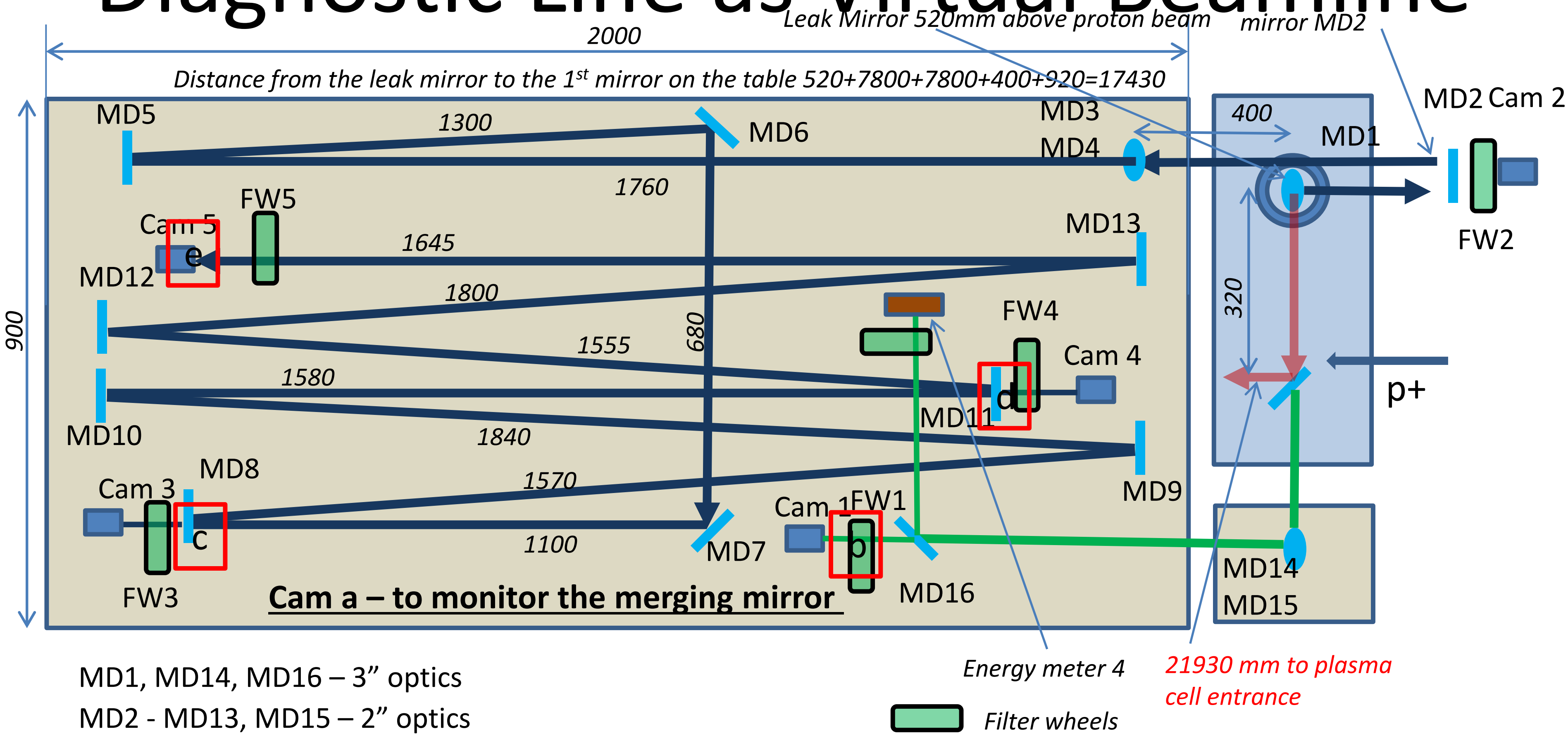
Cameras

- 6 Cameras in the line
  - Beam profiler in laser room (compressor)
  - 5 Basler CCD cameras on the transport line
- Camera Purpose:
  - Profiler acts as closest observation to gratings
  - CAM1: closest observation to optic of highest fluence.
    - Needs objective.
  - CAM2: Virtual delay line (wide aperture, can be used for coarse alignment if beam walks off CAM3-5)
    - Needs objective.
  - CAM3: Virtual Entrance of plasma cell.
    - No objective needed but sensor nearly fully covered by beam.
  - CAM4: Virtual center of plasma cell.
    - No objective needed (beam is small)
  - Cam 5: Virtual exit of plasma cell
    - No objective needed, sensor nearly covered by beam.

Functional scheme of main laser lines



Diagnostic Line as Virtual Beamline

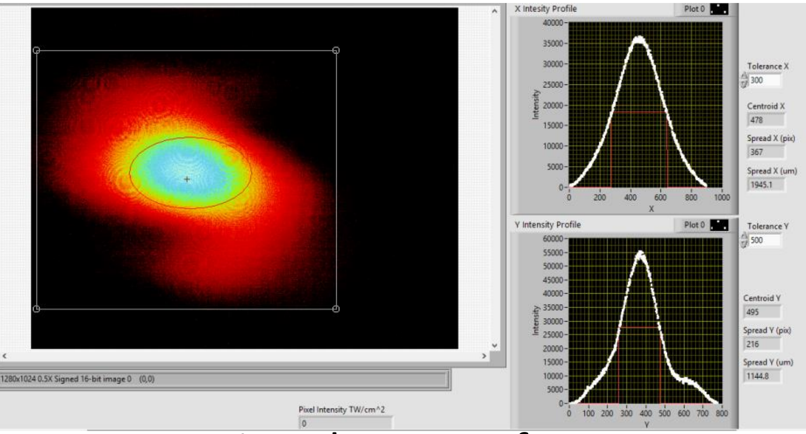


a. TSG40 Beam Profiler: Closest virtual position to final grating in compressor
b. CAM1 / Additional Camera: virtual optic of highest fluence
c. CAM3 virtual beginning of vapor source
d. CAM4 virtual center of vapor source
e. CAM5 virtual exit of vapor source

Setup and Analysis Explanation

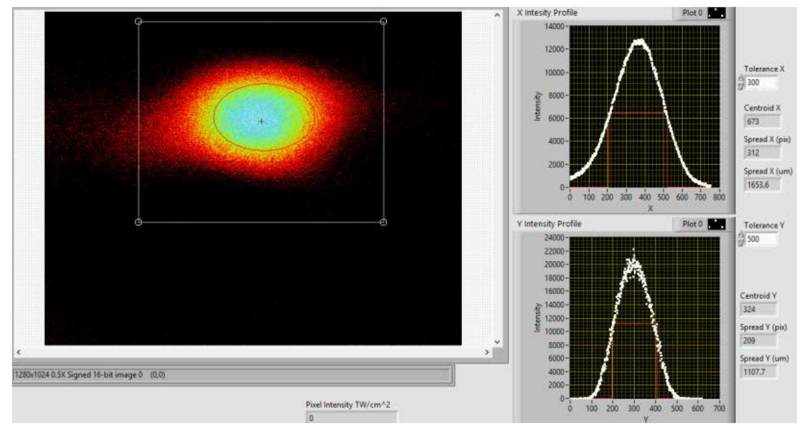
- <u>Setup:</u>
  - Laser run with LBDP1 in
  - Laser run at 30mJ to attempt to see laser profile with gain
  - No objectives on CAMs 3, 4, 5
- <u>Analysis:</u>
  - Camera array summed. Individual values normalized with Energy of 100 mJ to get fluence, then divided by 120 fs to get intensity at each pixel
  - Checked peak intensity and intensities at r = 1mm

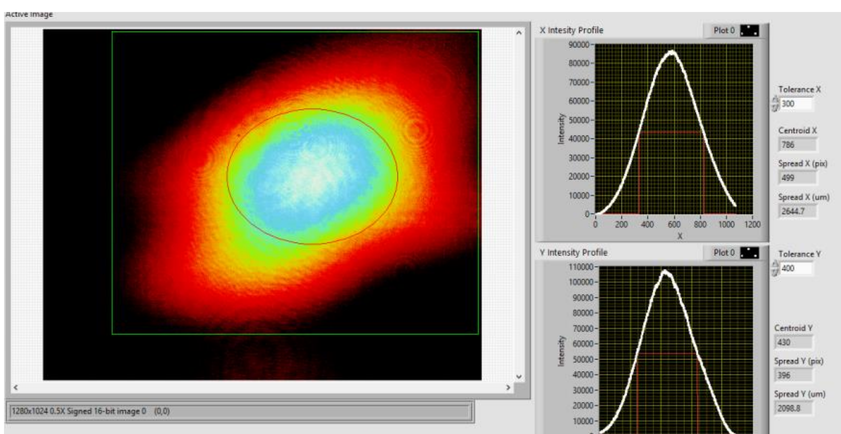
Virtual Line Cameras



CAM3: Virtual entrance of vapor source
FWHM: X: 2.1 mm Y: 1.2 mm
Peak Intensity: 20 TW/cm^2
1mm X: 3 TW/cm^2
1mm Y: 15 TW/cm^2

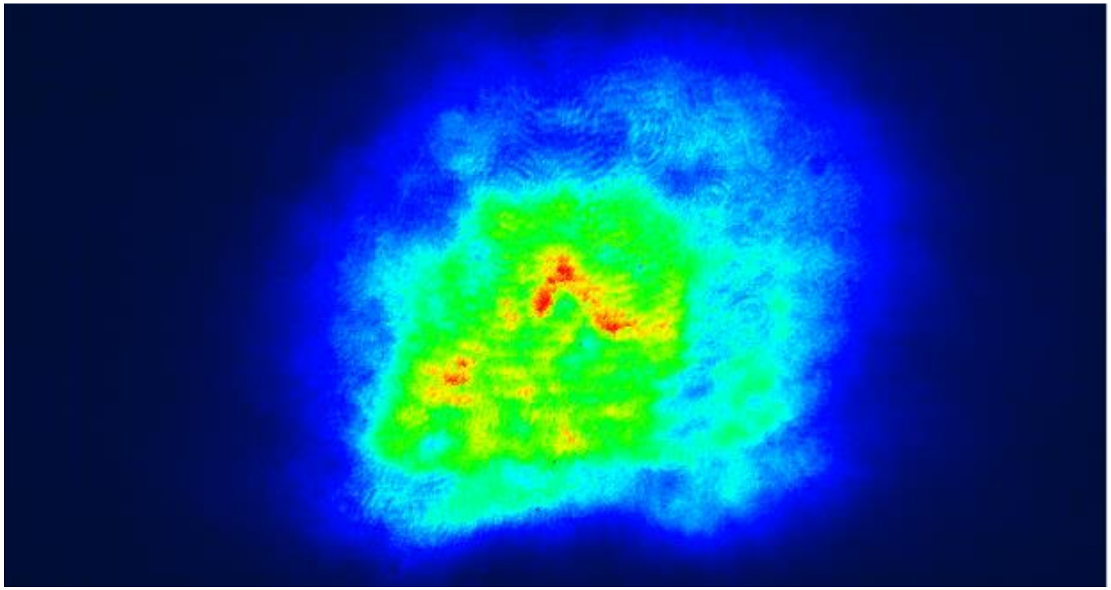
CAM4: Virtual center of vapor source
FWHM: X: 1.6mm Y: 1.1mm
Peak Intensity: 40 TW/cm^2
1mm X: 10 TW/cm^2
1mm Y: 4 TW/cm^2





CAM5: Virtual exit of vapor source
FWHM: X: 2.8 mm Y: 2.3 mm
Peak Intensity: 10 TW/cm^2
1mm X: 7 TW/cm^2
1mm Y: 6 TW/cm^2

TSG40



Effective diameter of beam: 27mm

Average fluence at 450mJ: 60 mJ/cm^2

@ 100mJ: 13 mJ/cm^2

Damage thresh for gratings: 100 mJ /cm^2

This plane is downstream of the gratings so at this plane the beam is a bit smaller than at the actual gratings, 2m upstream of the imaging point