DYE LASER LIGHT FOR HIGH-RESOLUTION CLASSICAL PHOTOGRAPHY

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1. INTRODUCTION

The test run with the bubble chamber HOLEBC in October 1981 offered the opportunity of checking the usefulness of de-speckled dye laser light for illumination purposes in high-resolution classical dark field photography of small bubble chambers. More detailed information about the photographic arrangement of HOLEBC is presented by H. Leutz in these proceedings. First results from experiments to destroy the coherence of dye laser light were reported at the second EHS workshop in Vézelay, in March 1980 [1]. Further work on this subject will be briefly presented here.

2. LASER

The dye laser used for these illumination tests was a home-made laboratory model, based on a 25 kV two-stage Marx driver and a simple (no water cooling) 60 J coaxial flash lamp (Candela Corp.) incorporating a 5 mm diameter dye cuvette of 150 mm length. The FWHM of the light pulse is 150 ns.

3. CAVITY

The 80 cm long resonating cavity was built in a plane-plane mirror configuration for broad-band output. The reflectivity of the output mirror was set at 60% in order to obtain maximum spectral width of the laser light.

4. DYE

Coumarin-522 was used in an ethanolic solution of 2×10^{-4} mol/ℓ concentration. The dye has a moderate output efficiency of about 0.3, compared with Rhodamin 6 G which is often taken as an output standard. 53 J electrical discharge energy yielded an output energy of 33 mJ.

5. REPETITION RATE

The repetition rate was 6 pulses/min at lower output energies (< 5 mJ) and 2 pulses/min at higher energies. The reduction in rate is due mainly to the absence of water cooling, since in the case of the simple lamps the discharge heat stored in the quartz envelope of the discharge lamp has to be removed by the circulating dye solution. With modern quadrax flash lamps repetition rates of up to 5 Hz are possible.

6. DE-SPECKLING ELEMENTS

50 m of PCS quartz monofibre QSF 1500 C with a 1.5 mm diameter core served a twofold purpose: to allow a great distance between laser and bubble chamber and to de-speckle the dye laser light. This arrangement was very effective: only a 60 cm long quartz rod was still needed to remove entirely the granularity of the laser light. The promising results will stimulate further development of this interesting subject.

7. SET-UP

Figure 1 outlines the set-up. A thin quartz plate is used to reflect 7% of the light beam onto a joulemeter. Appropriate neutral density filters are used to protect the joulemeter from damage and also to vary the light energy according to the photographic system under consideration.

The two principal arrangements of classical photography are sketched in Fig. 2. Bright field photography is shown in Fig. 2a, while Fig. 2b shows the dark field arrangement of HOLEBC, the average scattering angle being 6°. The energies needed to illuminate these two arrangements are quite impressive: in bright field photography 0.05 mJ of pulse energy at the input end of the fibre (its losses were not measured) were sufficient to obtain an optical density $D_{opt} \sim 1.0$, while dark field photography in HOLEBC needed 25-30 mJ for acceptable density of the bubble images on the film.

8. POSSIBLE APPLICATIONS

The dye laser provides very high spectral energy density (expressed in mJ/nm), enabling

- spectral decoupling of each of several photographic channels, serving different purposes at different times during the expansion cycle of a bubble chamber;
- fast light pulses, 120-150 ns FWHM (even linear flash lamp-pumped medium to high energy dye lasers hardly go beyond 2 μs pulse width, while excimer laser-pumped dye lasers have only 10-15 ns pulse width);
- efficient focusing into quartz fibres and thus energy transport over large distances, owing to the small divergence of the laser beam.

REFERENCE

1) Second EHS Workshop, Vézelay, March 1980, CERN/EP/EHS/PH 80-2 (1980).

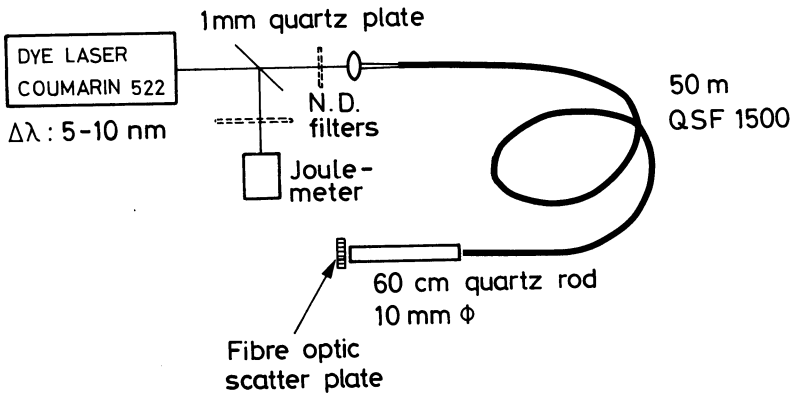
1mm quartz plate
DYE LASER
COUMARIN 522
Δλ : 5-10 nm
N.D.
filters
Joule-
meter
50 m
QSF 1500
60 cm quartz rod
10 mm Φ
Fibre optic
scatter plate

Fig. 1

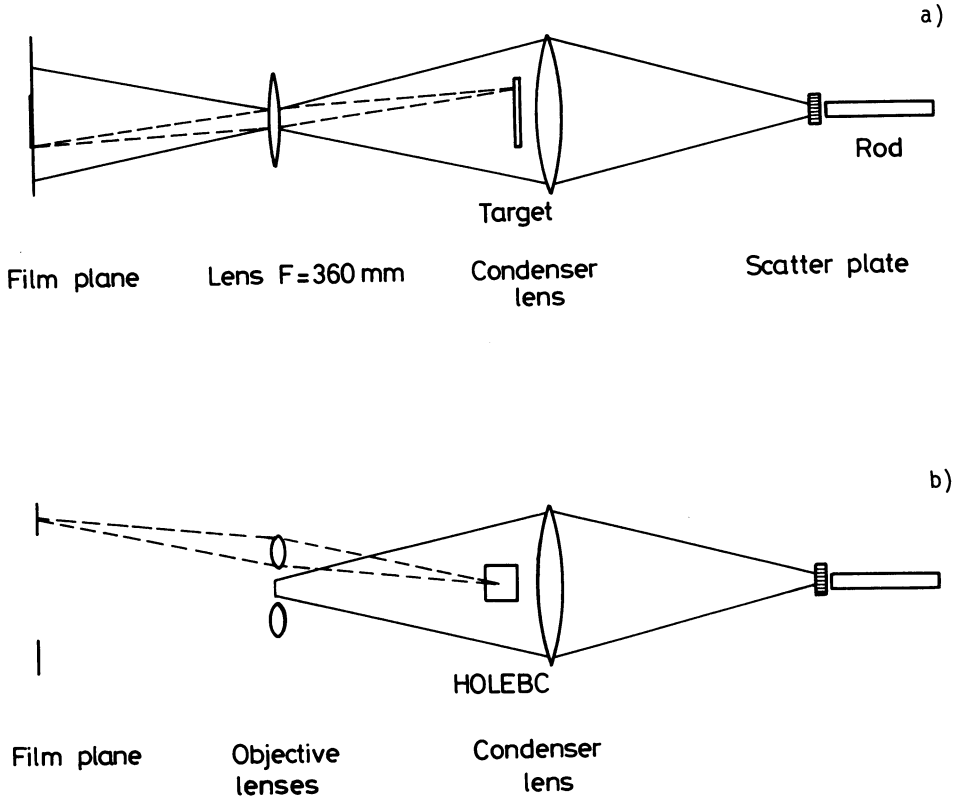
a)
Rod
Target
Film plane
Lens F=360 mm
Condenser
lens
Scatter plate
b)
HOLEBC
Film plane
Objective
lenses
Condenser
lens

Fig. 2