Contamination testing for ALADIN

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Thanks to:

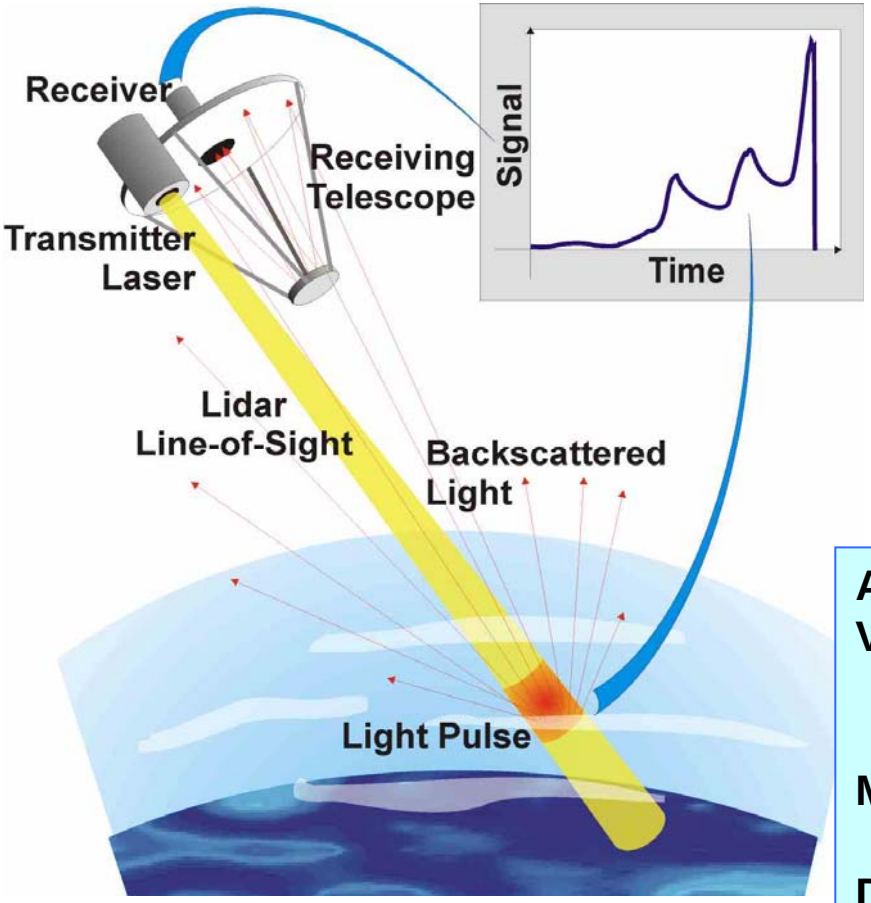
Elmar Reinhold, Denny Wernham, Martin Endemann, Errico Armandillo

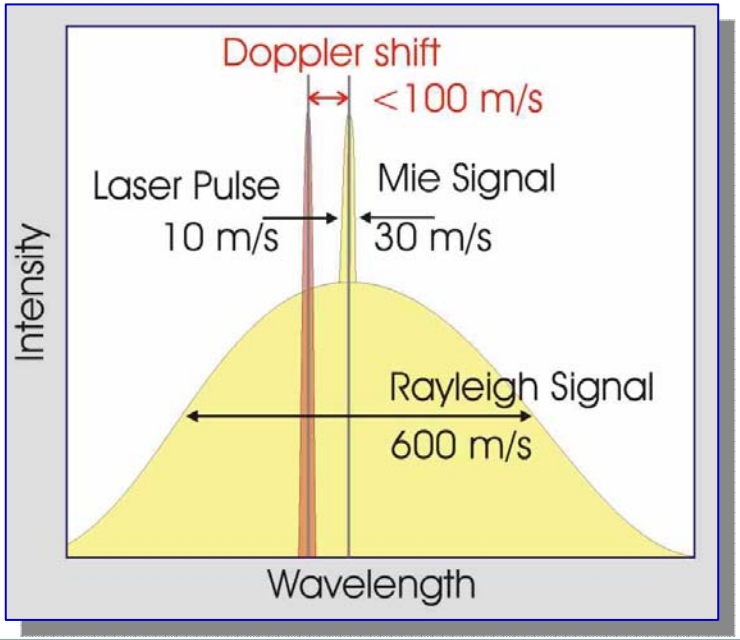
Wolfgang Riede, Helmut Schröder

Presentation overview

1. ALADIN background
2. Laser contamination issues
3. ESA contamination experiments
    1. Setup and method
    2. Growth behaviour
    3. Fluence dependency

Aladin: Doppler Wind Lidar



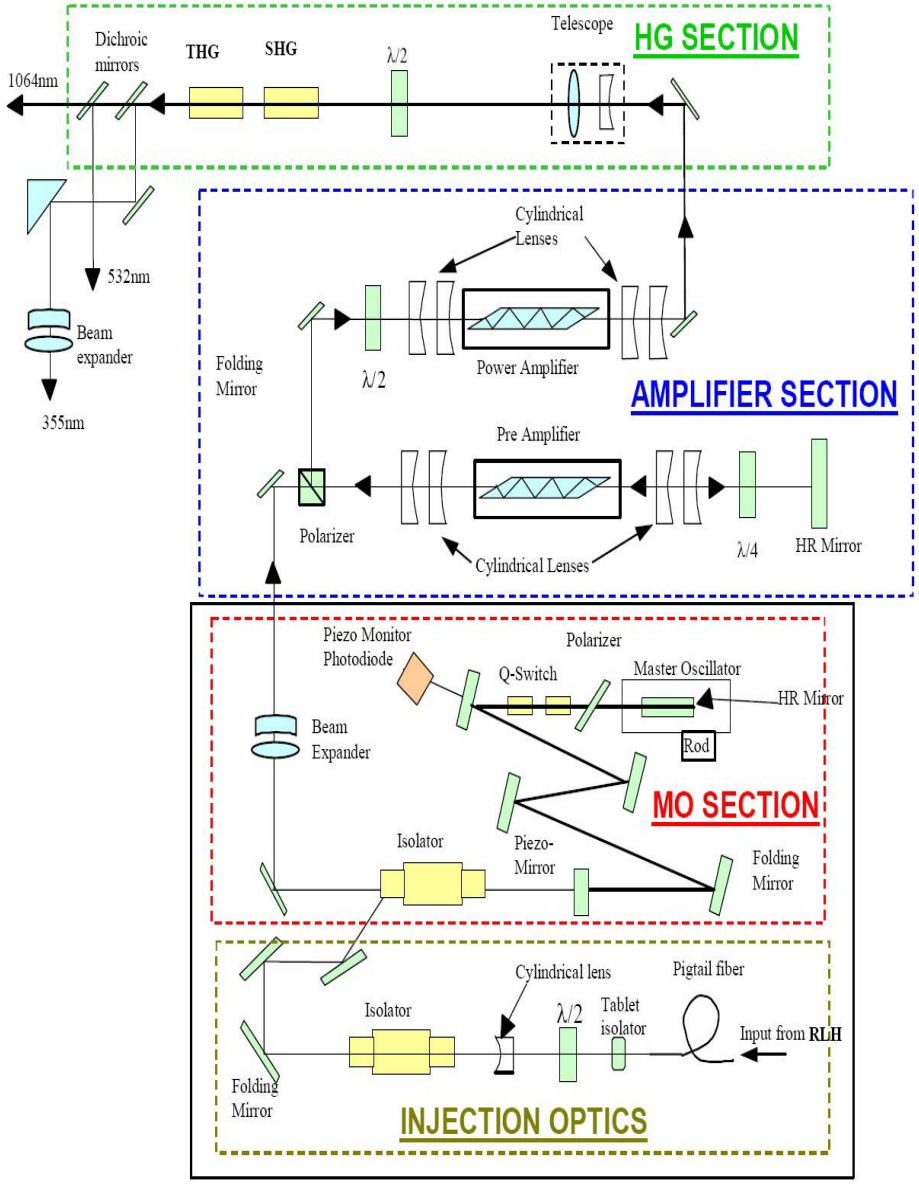


ADM-Aeolus specifications

Vertical resolution:	**0.5 km up to 2 km**
(total up to 25 layers)	**1 km up to 16 km**
	2 km up to 30 km
Measurement accuracy:	**1 m/s up to 2 km**
	2 m/s up to 16 km
Dynamic range:	**-150 to +150 m/s**

ALADIN

- The ALADIN laser is a frequency tripled MOPA Nd:YAG laser
- Compact design: 50cm·60cm·30cm box
- 510mJ and 28ns duration at 1064nm, 120mJ and 15ns duration at 355nm.
- 100Hz operation in 12s bursts every 28s
- 39 month mission duratio



Contamination

We separate between

Particulate contamination. From instrument production and AIT.

Molecular contamination. From AIT, storage and outgassing in vacuum

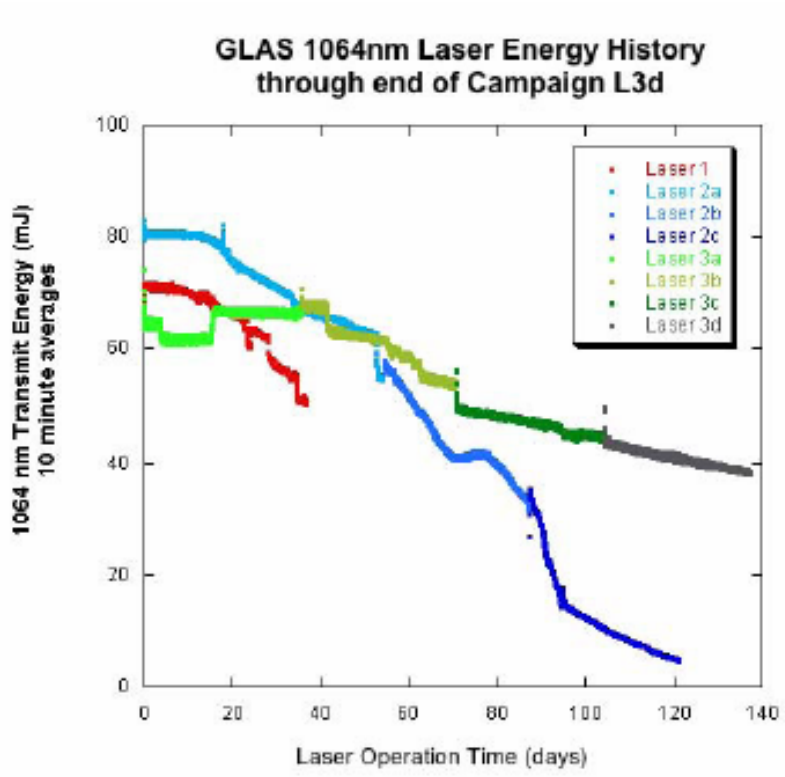
Molecular contamination may

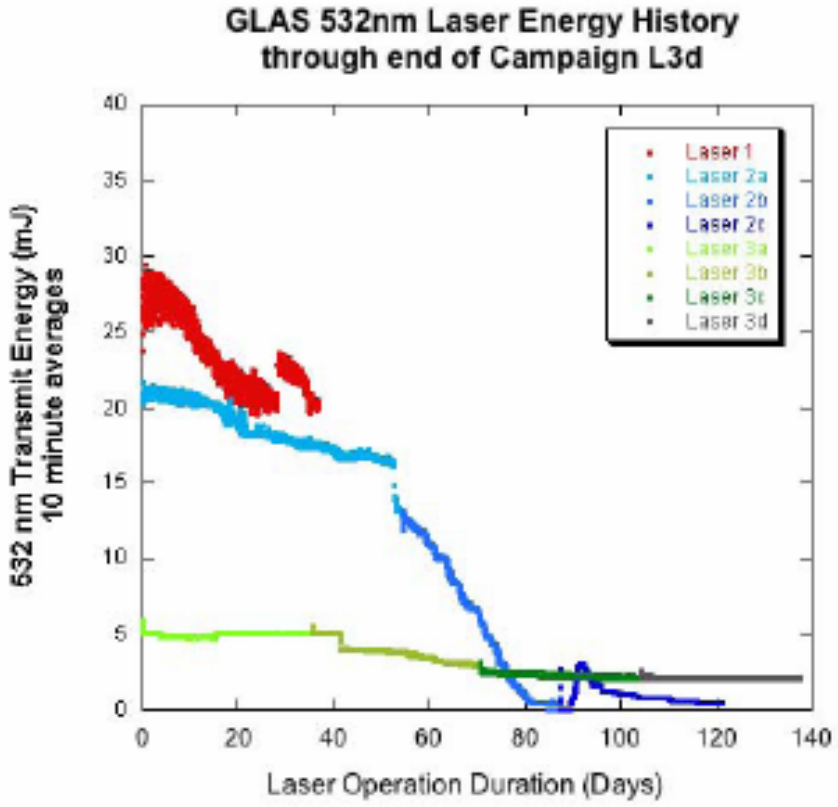
- Absorb a significant portion of the beam
- Lower the damage threshold of underlying optics
- Affect the beam quality of the laser

Molecular contamination facts:

- Contamination accumulates over time
- Problem is more acute in inert environment
- Shorter wavelengths more critical

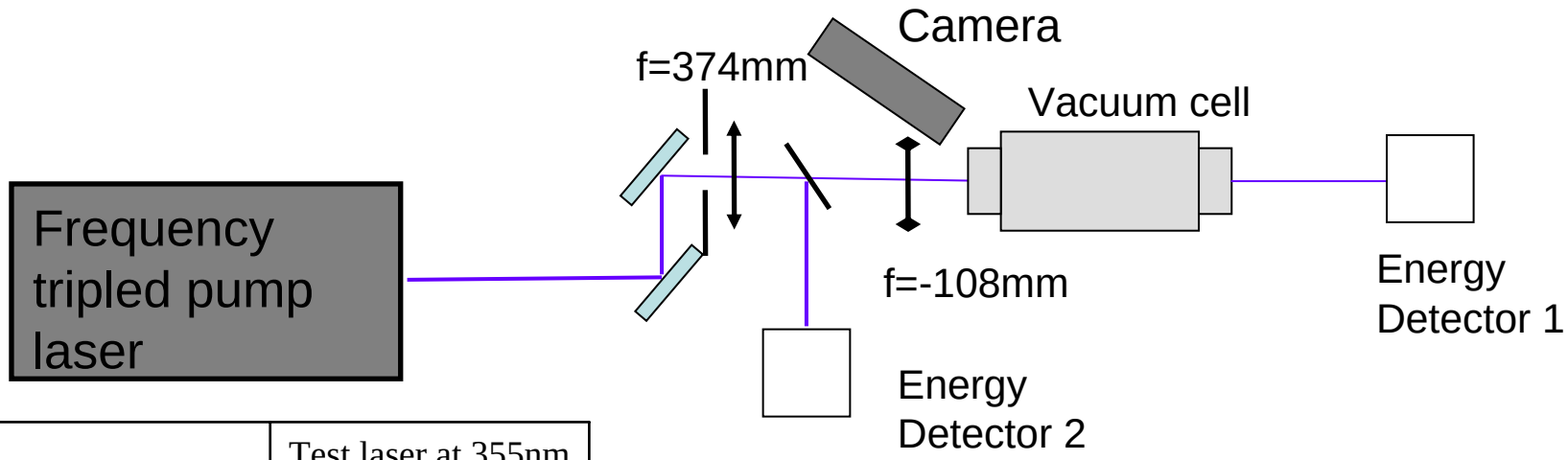
Operational risk: ICESat's GLAS



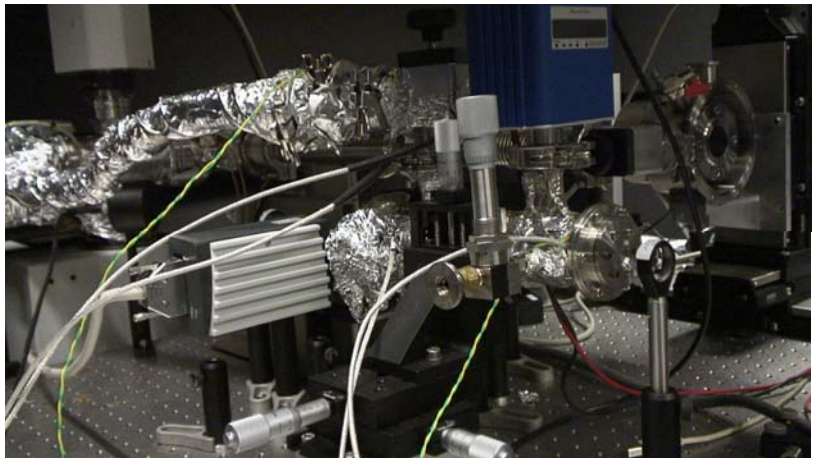


Afzal et al., Photonics West 2006, SPIE 6100

Contamination experiments at ESTEC



	Test laser at 355nm
Pulse repetition rate	50Hz
Pulse duration	5ns (specified)
Wavelengths	355nm
Pulse energy	50mJ at 355nm
Fluence	2(1)J/cm^{-2}
Pulse to pulse energy stability	Approximately 10%



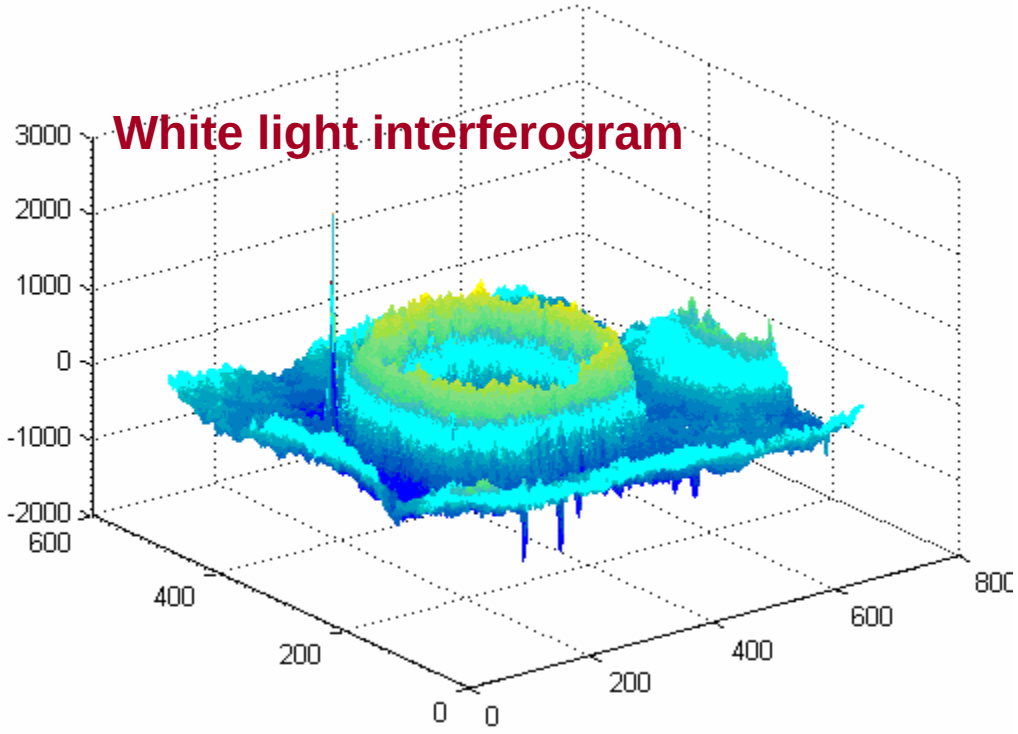
Outgassing of samples

Deposit Characterisation

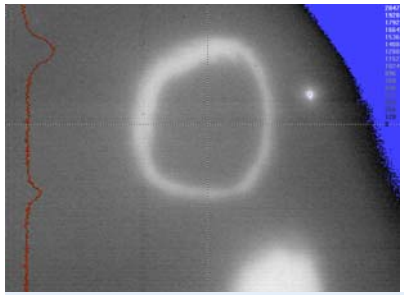
•Magnifying microscopy. The deposits are semi-transparent.
•White-light interferiometric microscopes reveal deposit thicknesses of 10s of nm after 24 hours of exposure

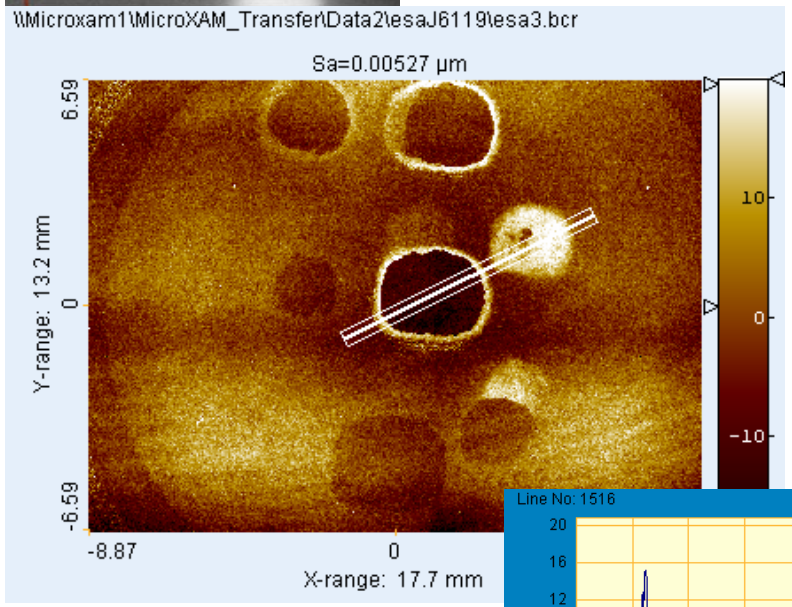
Microscope Image
(contrast enhanced)

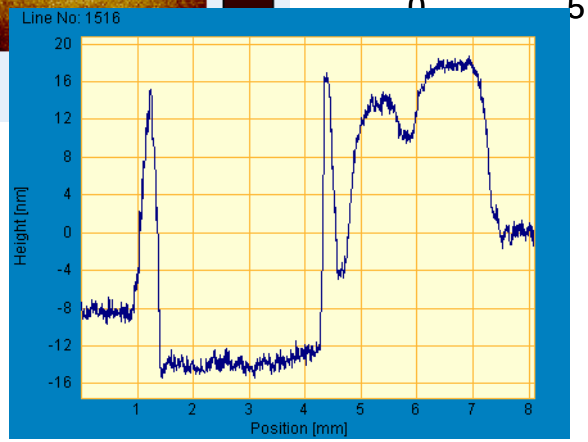
White light interferogram

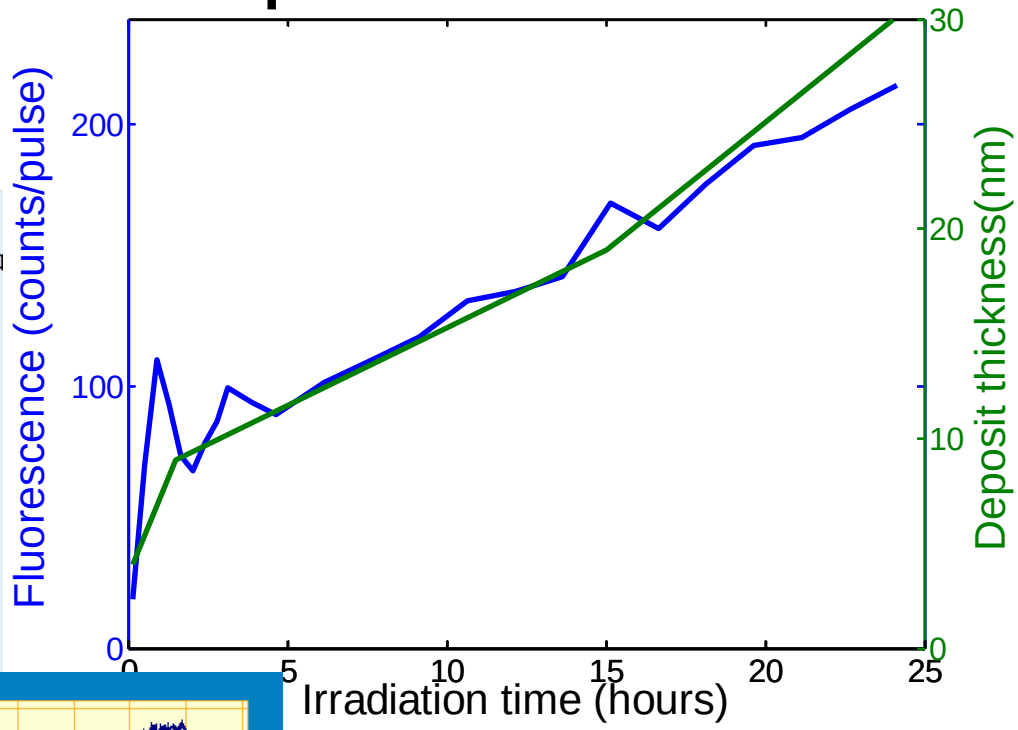


Time development

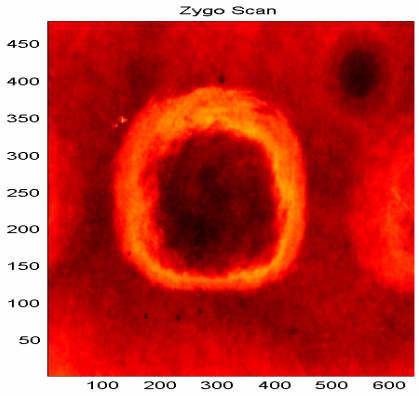


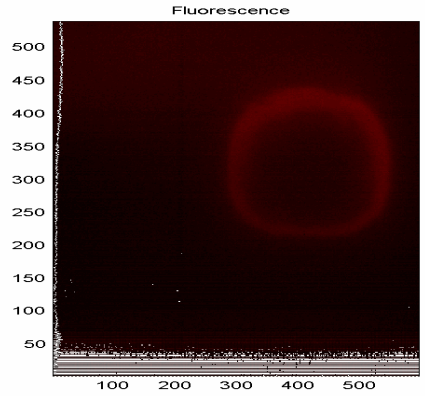


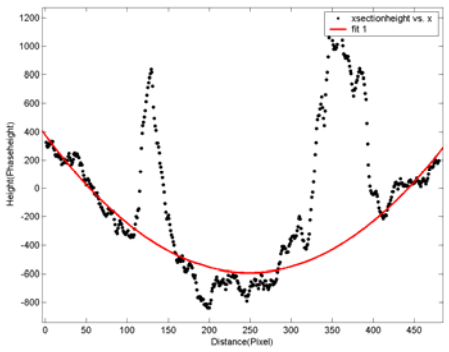


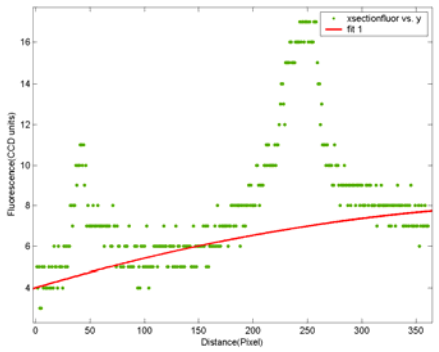


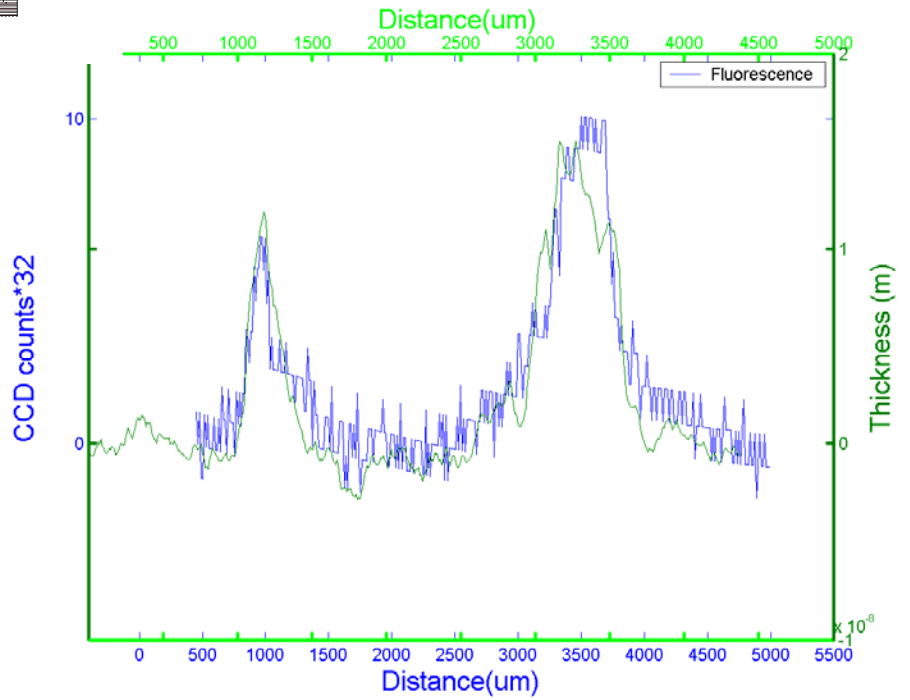
Deposit and Fluorescence





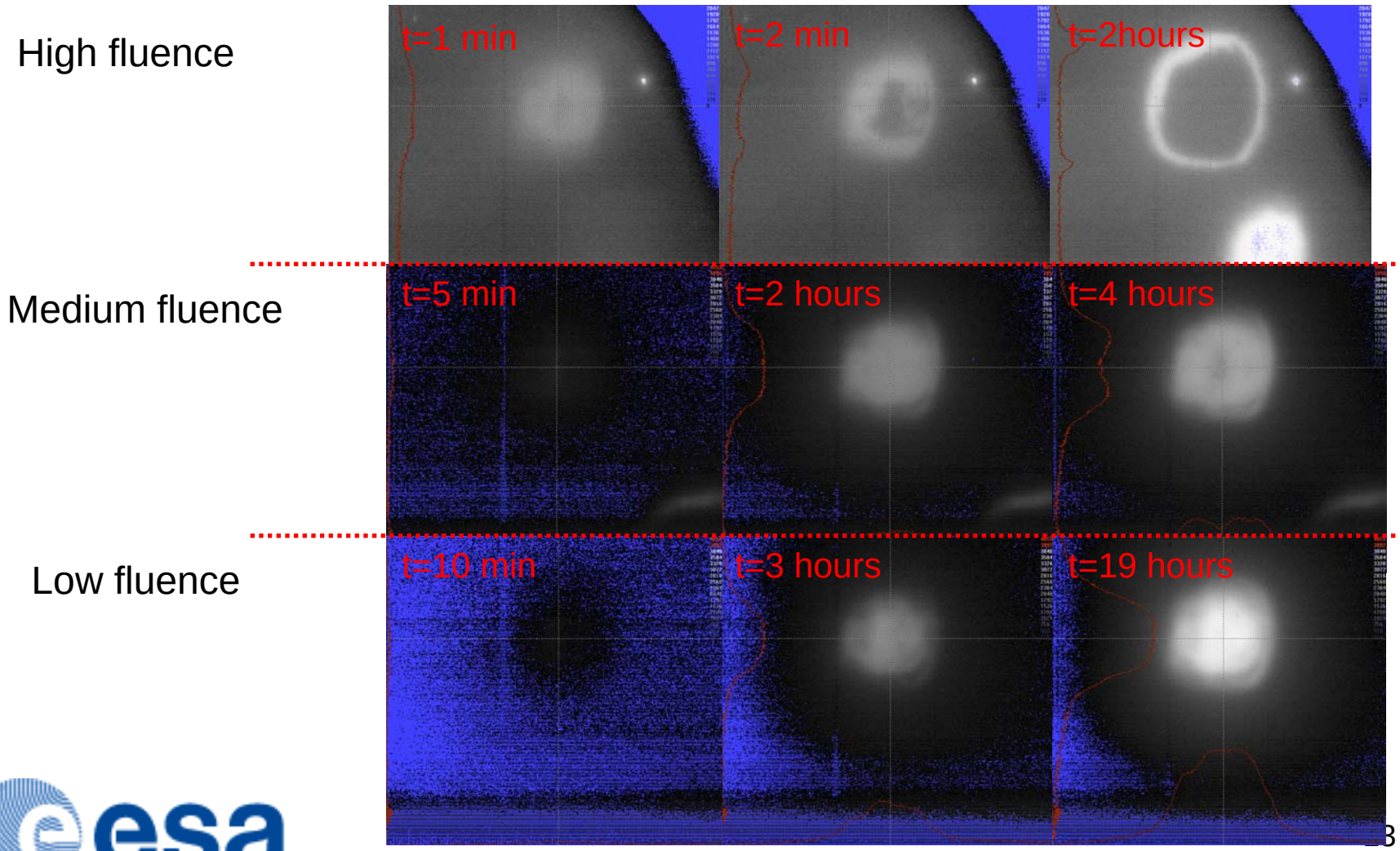




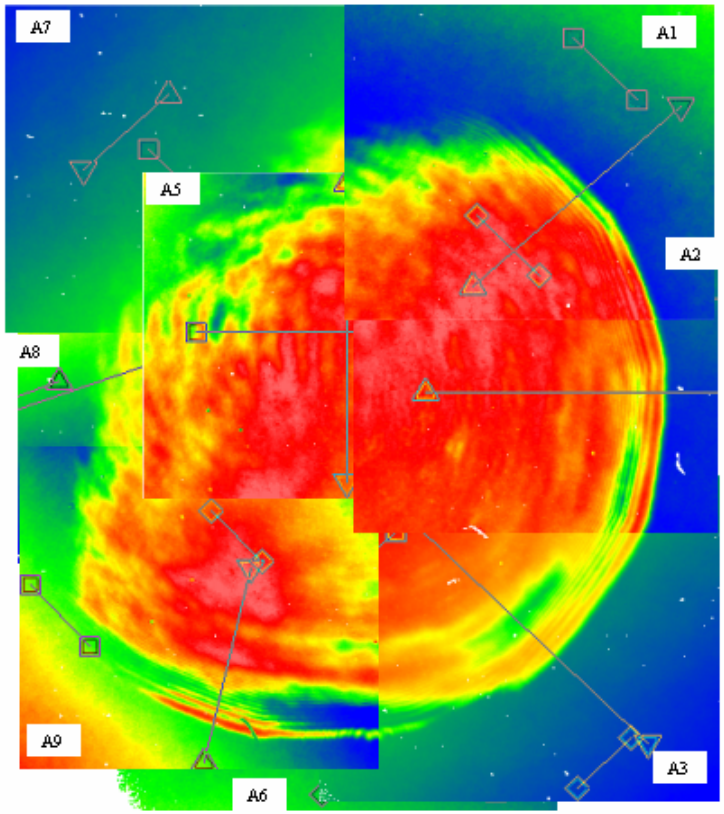


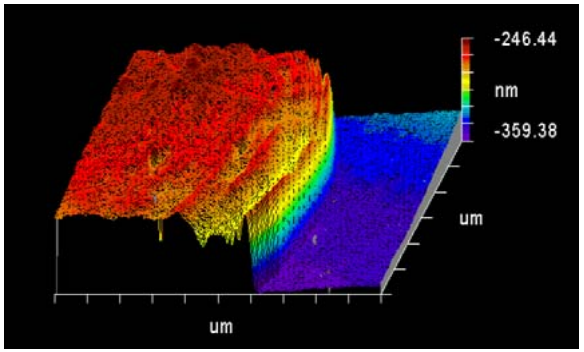
Deposit development with fluence

1.5 g of Screwlocking Agent

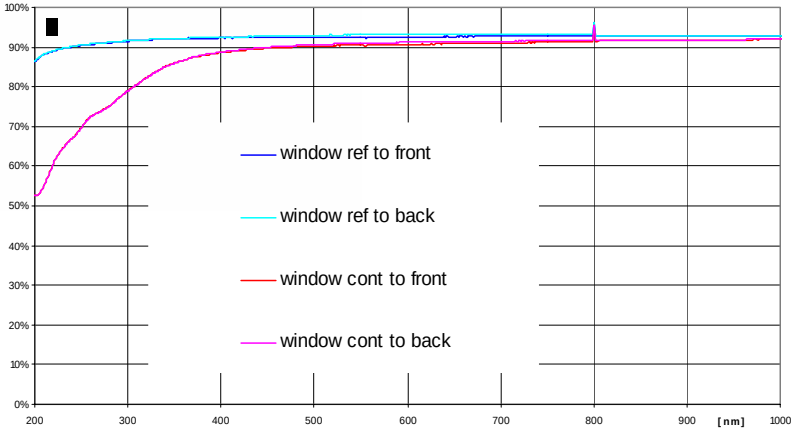


Very low fluence regime

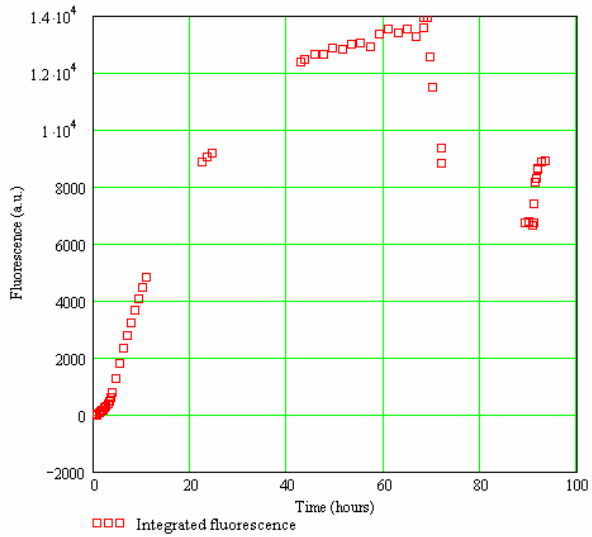




- Still pancake after 72 hours,
- Deposit thickness of 70nm
- Absorption of 6% at 355nm

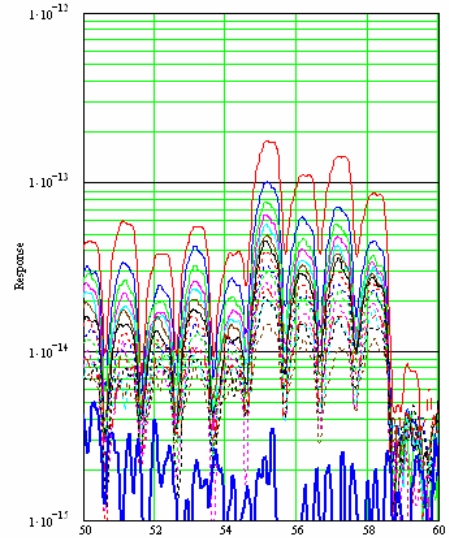


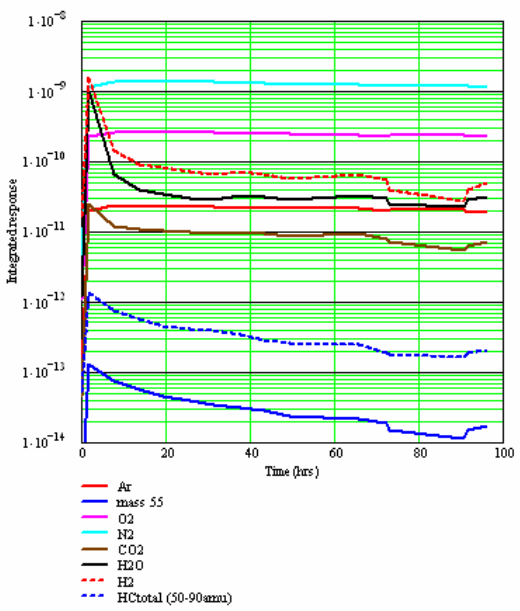
Deposit growth with time



Fluorescence growth drops with time, this may indicate

- Smaller amount of outgassed materials reduces growth rate,
- Fluorescence is loosely coupled to deposit thickness
- Deposit is affected by oxygen





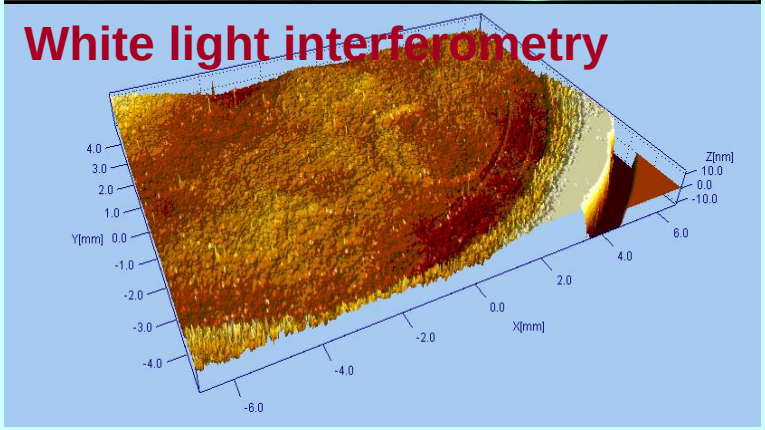
Trace gas contamination

Screw-locking material

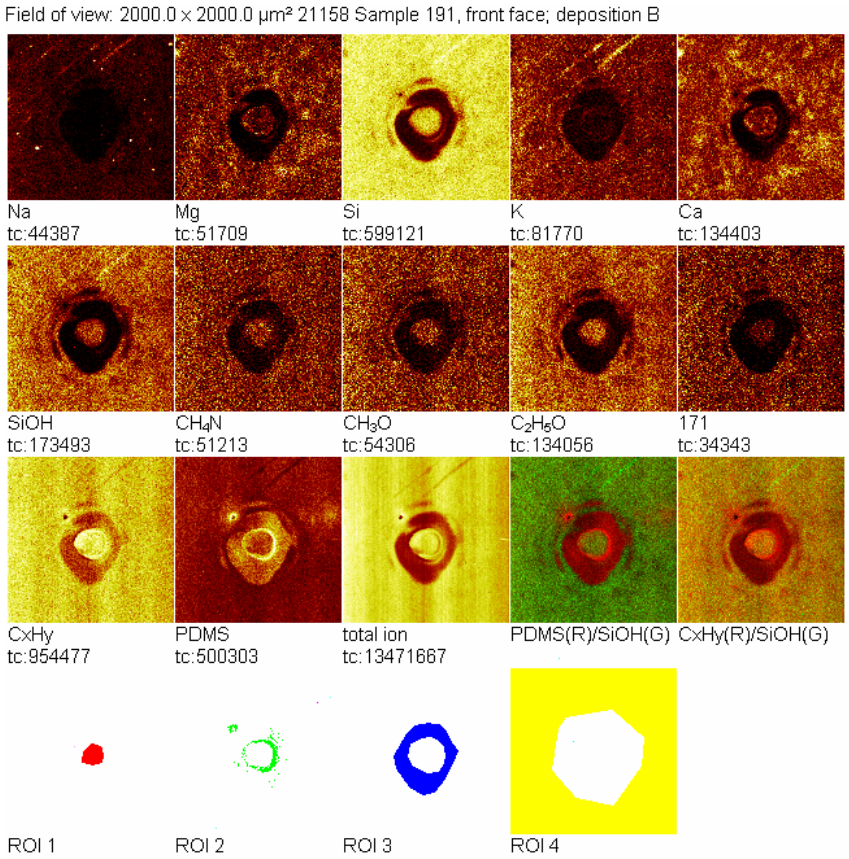
Test setup

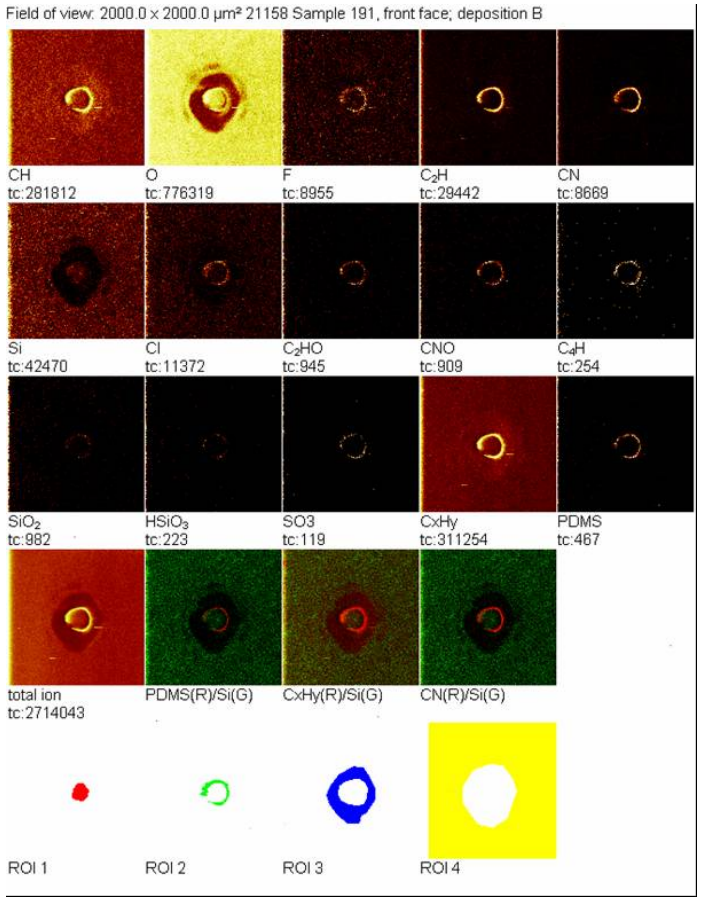
- **Pressure: $3(1)\cdot10^{-5}$mbar**
- **Fluence: 2J/cm²**
- **Temperature: 40 ºC**
- **Shot #: 10 million**

Result: 3nm deposit



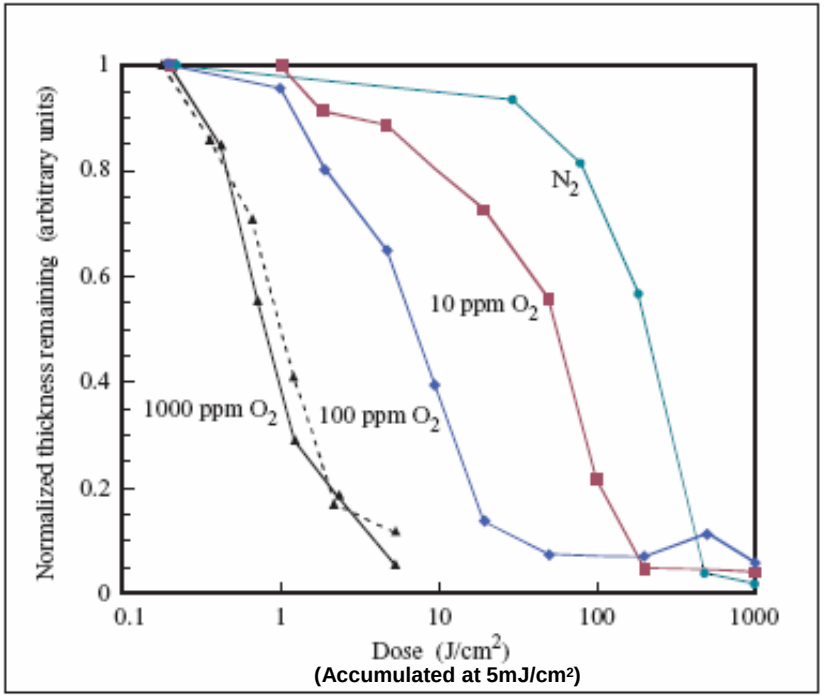
Deposit composition
ToF results





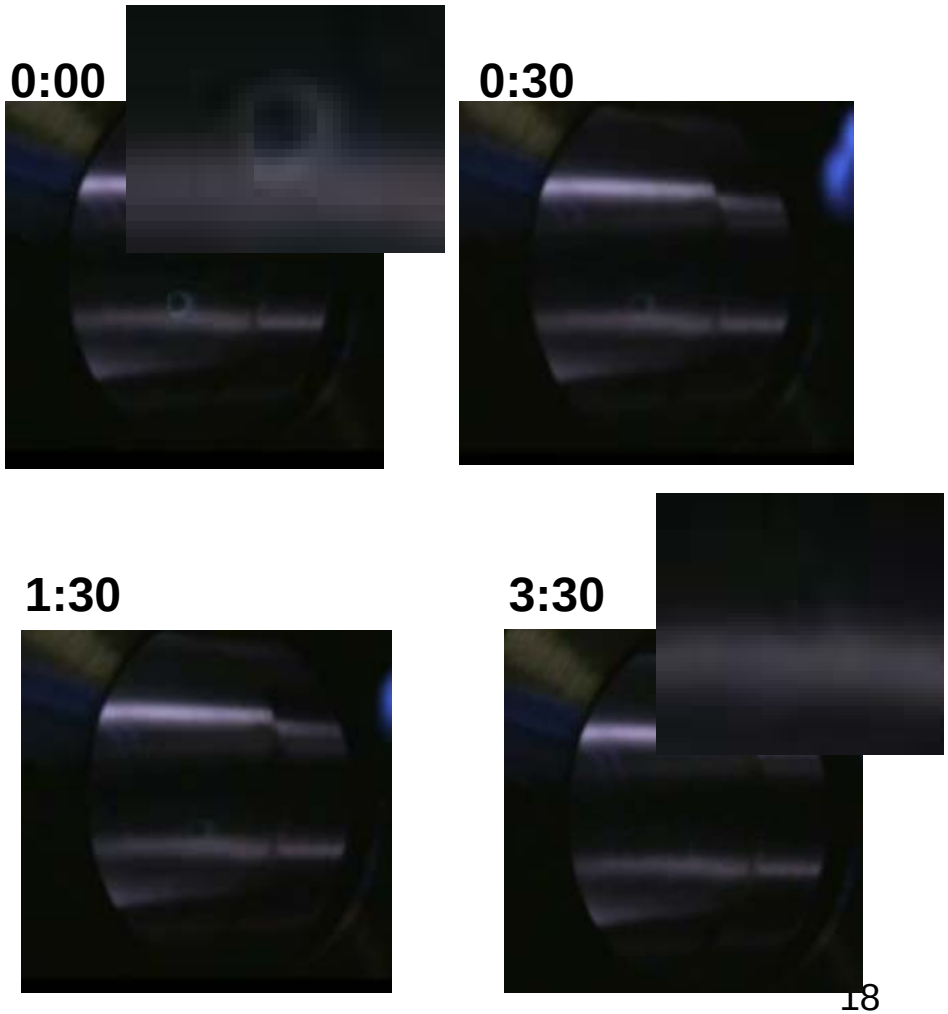
Contamination cleaning with oxygen

157nm



A. K. Bates et.al, IBM J. RES. & DEV., vol. 45, no. 5, 605 (2001)

355nm



Future steps

- Introduction of oxygen into laser
- Investigate the level of contamination acceptable to laser
- Reduce contamination levels