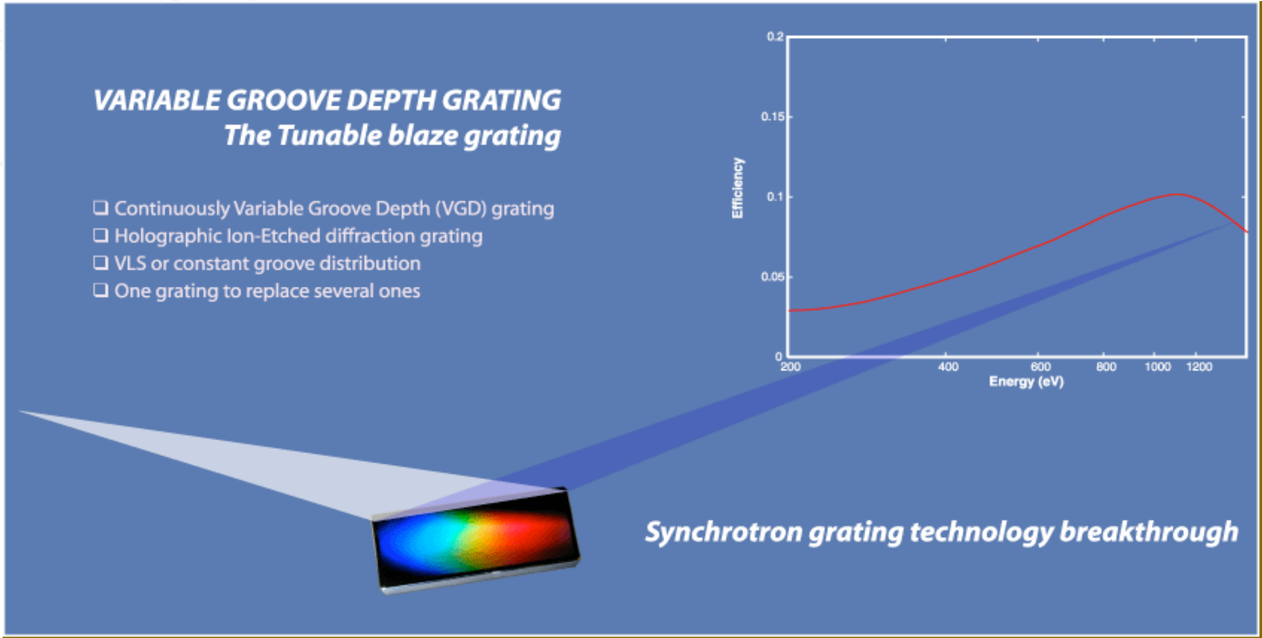
HORIBA JOBIN YVON

New Tunable Blaze Diffraction Gratings For EUV Applications



Bruno TOUZET 9 October 2008

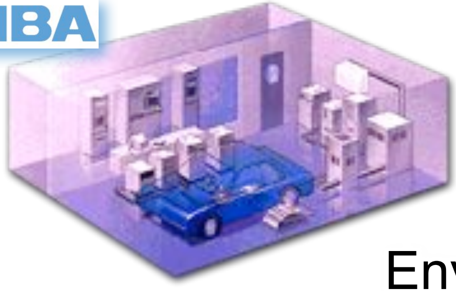
Jobin Yvon overview

- Founded in 1819
- JobinYvon = $ 100M
  - 600 employees, 5 production sites
  - Longjumeau, Lille, and Chilly-Mazarin, France; and Edison, NJ USA (2)
- Parent company:
  Horiba Instruments
  - $ 1000M company
  - 4700 employees

HORIBA : high technology instrumentation

Engine Exhaust System

HORIBA



Hematology Diagnostics

HORIBA ABX

Environmental Analyzers

HORIBA

Semiconductor Systems

Mass Flow Controllers

HORIBA STEC

Scientific Instruments

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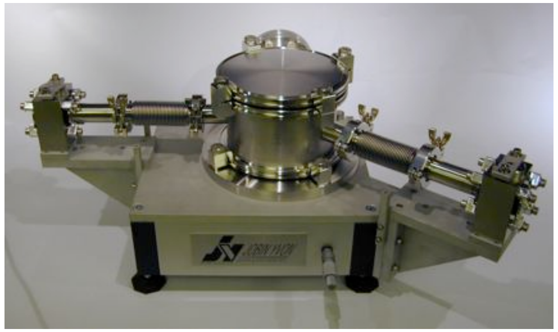
The gratings: the heart of Jobin Yvon

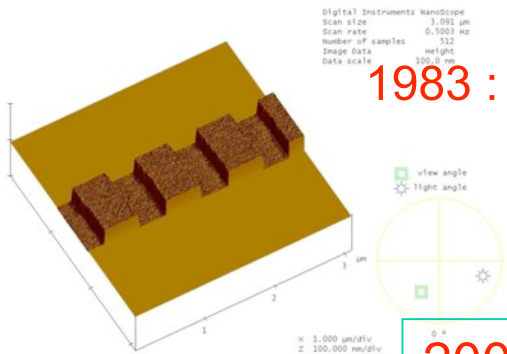
A serie of world renowned innovations

1968 : First **holographic** gratings

1969 : First patents for **aberration corrected** gratings



1975 : First **Toroidal** gratings
TGM Monochromators and
TGS Spectrographs



1983 : First **ion etched** gratings

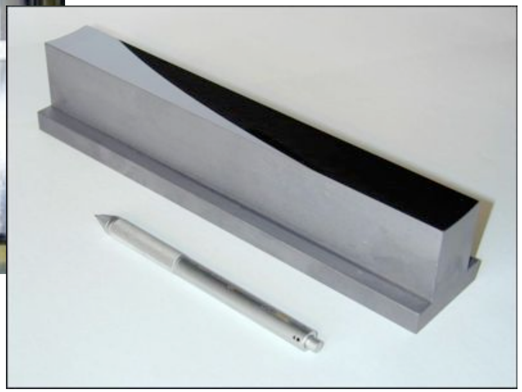
1995 : **VLS** (Variable Line Spacing) gratings

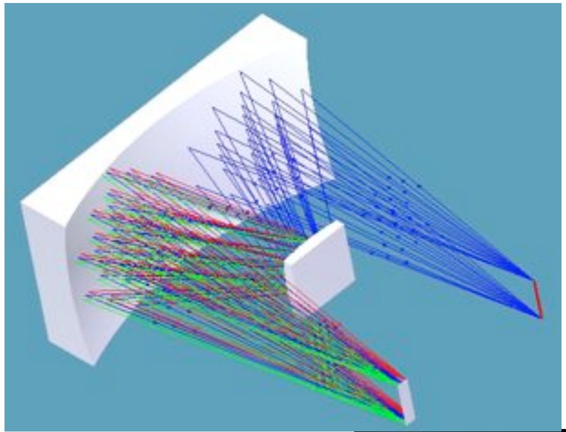
2005 : First **VGD** : **Variable Groove Depth** Gratings

For Astronomy, High Energy Lasers or VUV
Jobin Yvon gratings are at the forefront of the technology

An experienced research team and advanced techniques for manufacturing have earned the trust of world renown bodies such as NASA, CEA, CNES …


Megajoule Laser Gratings
Ion etched in Fused Silica


Toroidal mirror for synchrotron


Offner spectrograph


Rosetta mission (ESA) flying to Mars with Jobin Yvon gratings

Jobin Yvon gratings :

It is also volume OEM production

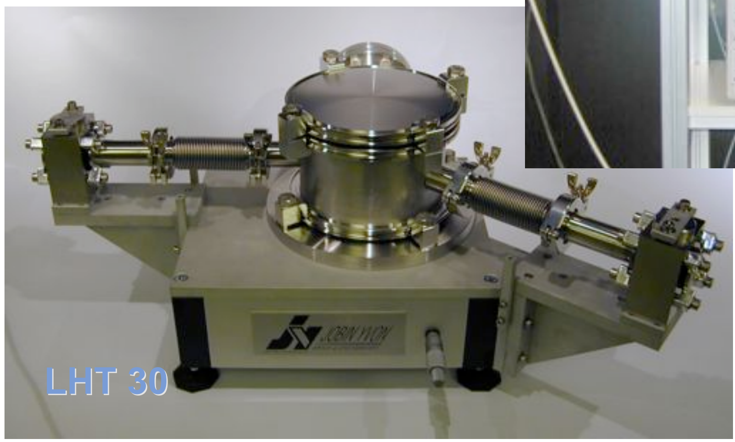
50 000 gratings are produced per year
and also OEM instruments

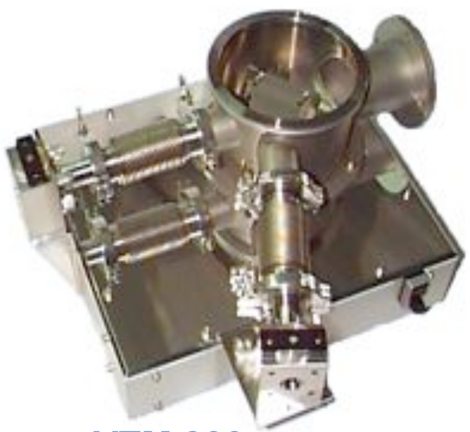
CP 140

Spectrograph CC 250

constant quality
reliable deliveries

A line of VUV monchromators





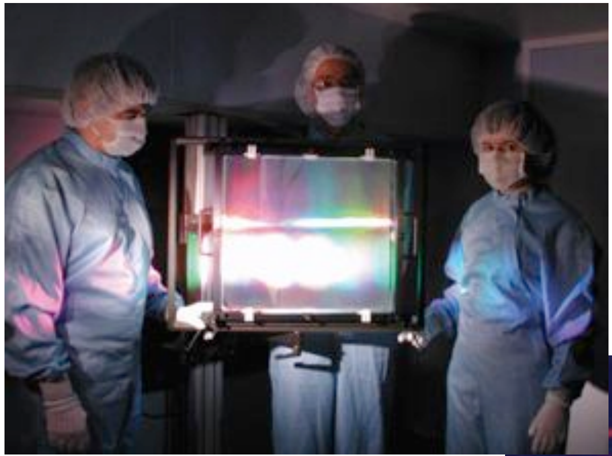
VTM 300

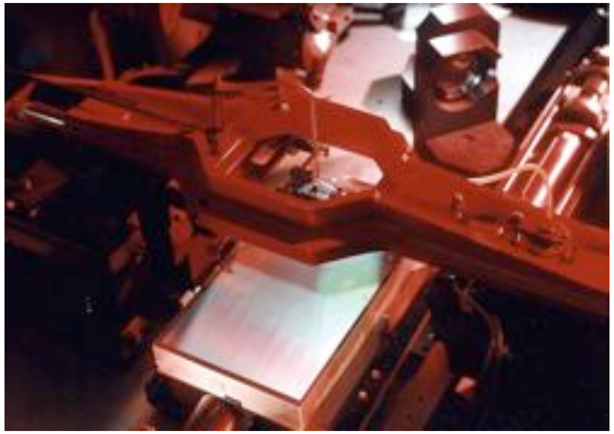
Facilities: clean rooms

World largest commercial holographic facility

Master grating manufacturing

Ruling engines
Holographic recording
Ion etching

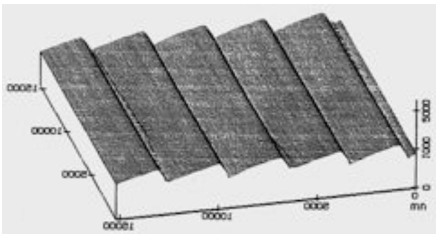


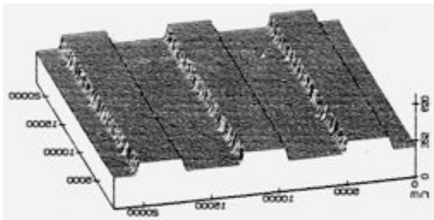



Optical Metrology

Characterization:

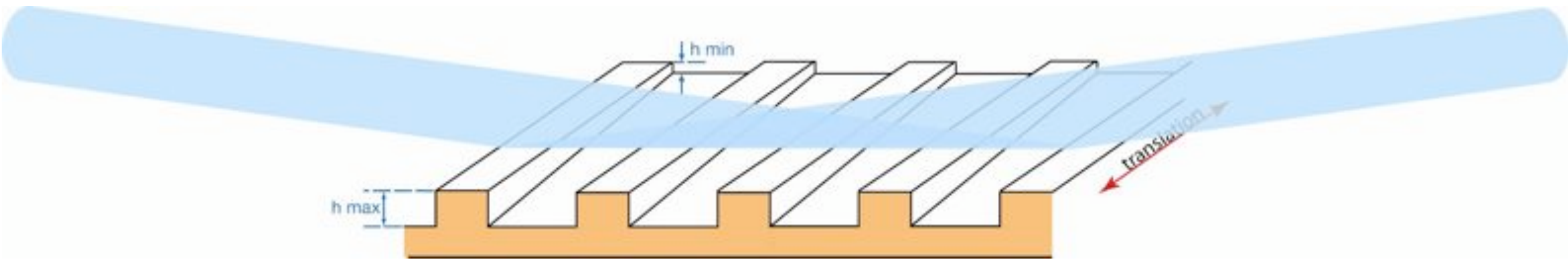
- Roughness
- Groove profile
- Wavefront
- Efficiency
- And more……





VGD Variable Groove Depth grating

VGD Grating Principle

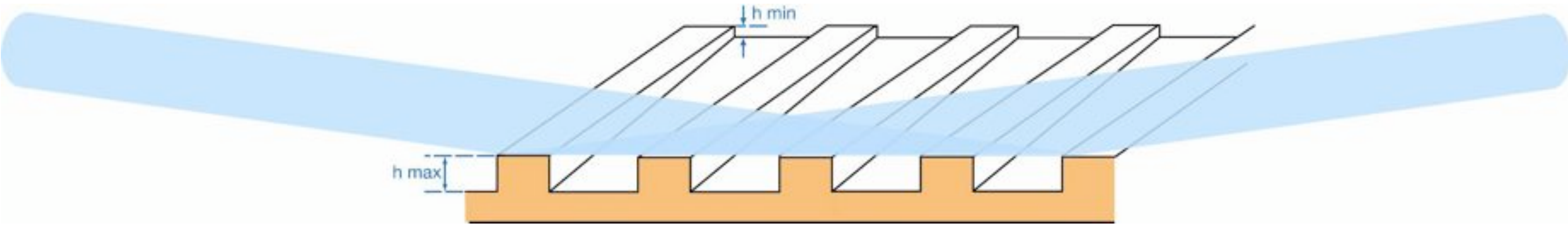


The groove depth is continuously varying from one edge of the ruled area to the other edge.

VGD gratings have been developed with SOLEIL synchrotron team

VGD Variable Groove Depth grating

VGD Grating Principle

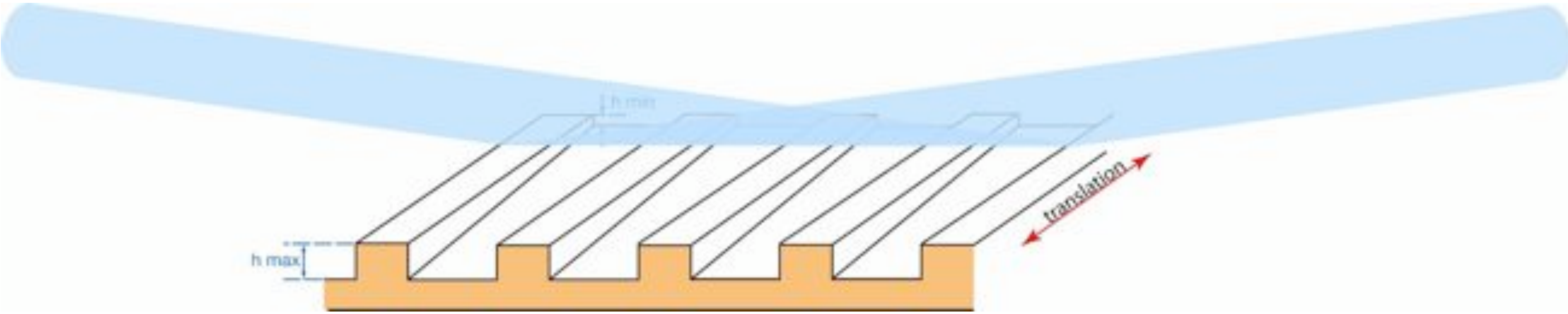


In this case the modulation depth is maximum

So efficiency 1st order is optimised for low energy range

VGD Variable Groove Depth grating

VGD Grating Principle



In that case the modulation depth is minimum

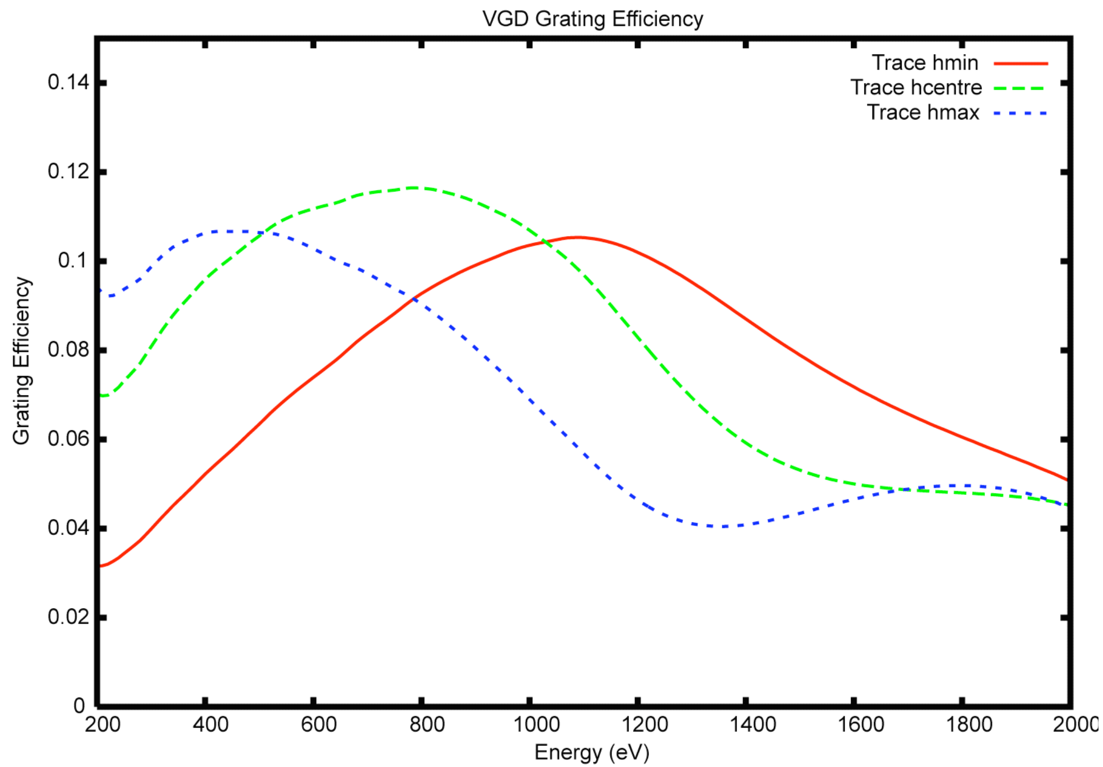
So efficiency 1st order is optimised for high energy range

VGD Variable Groove Depth grating

VGD Grating Principle

Efficiency of 3 tracks :

Right
Central
Left



First benefit : To enlarge drastically the energy range of a VUV grating

Energy range : 200 to 2000 eV with one single grating

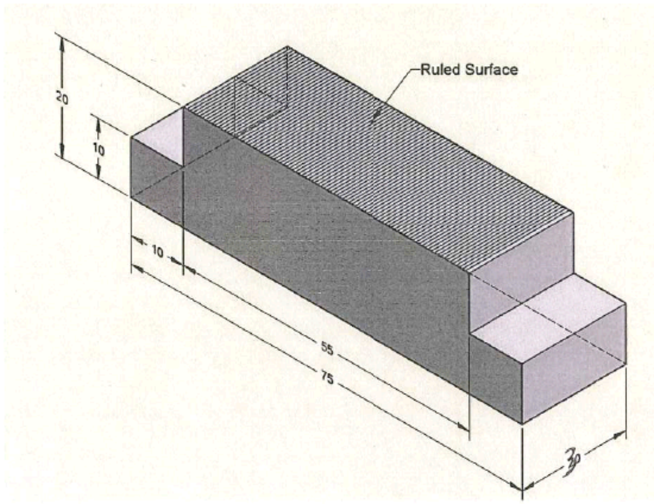
An example of VGD grating produced for Brookhaven National Lab, USA

The Request was :

300g/mm
Ruling Depth : continuously variable from 52 to 148 nm over 25 mm

Width/spacing ratio: 0.7

Spherical substrate : radius 10 meters



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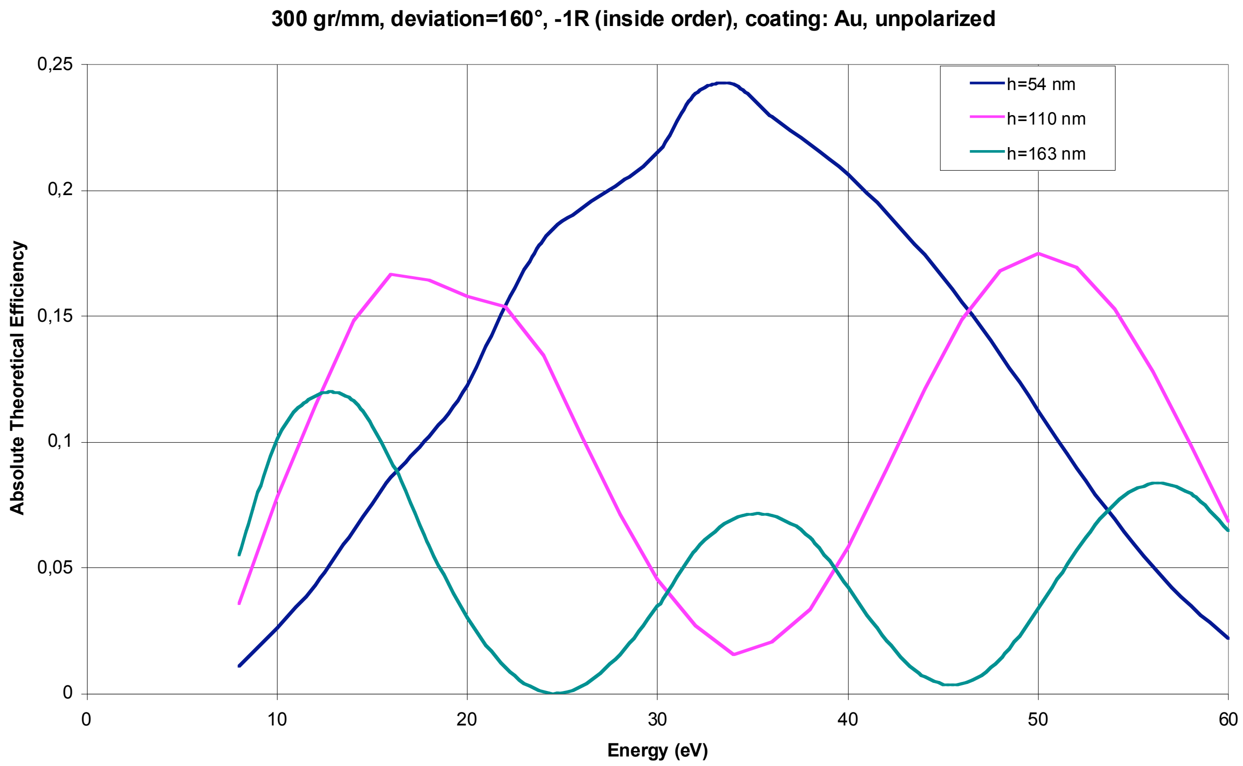
An example of VGD grating produced for Brookhaven National Lab, USA

Measured depth of modulation of 3 tracks and duty ratio

An example of VGD grating produced for Brookhaven National Lab, USA

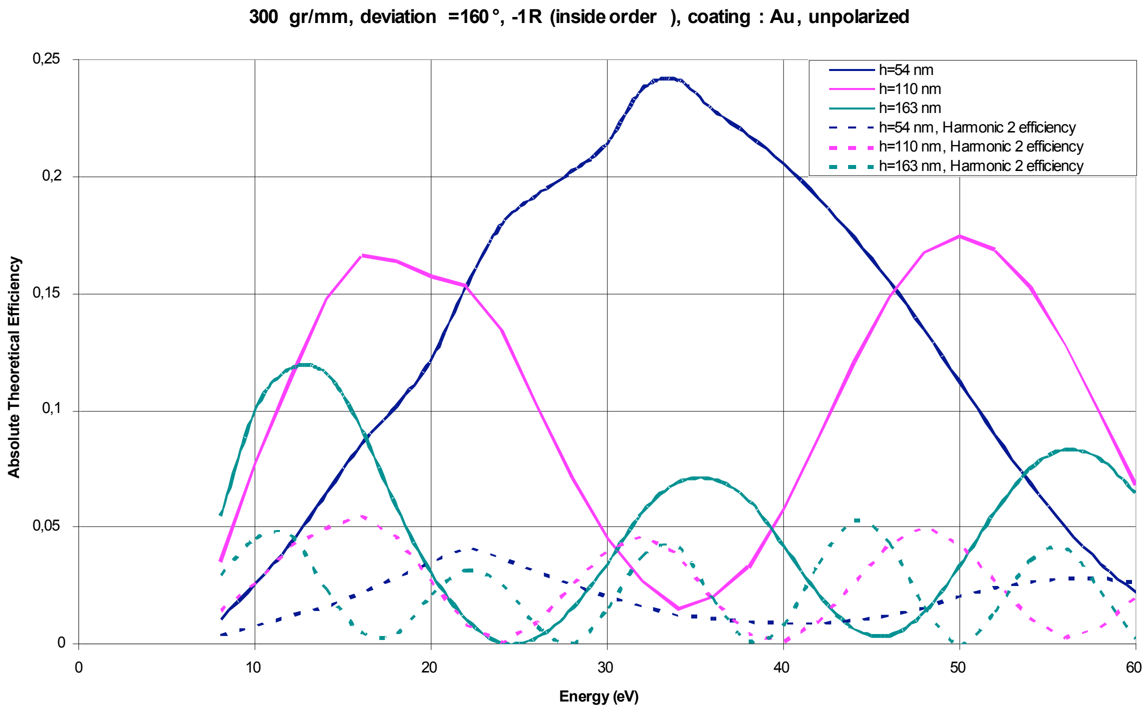
Efficiency curve along the 3 tracks



Energy range : 10 to 60 eV with one single grating

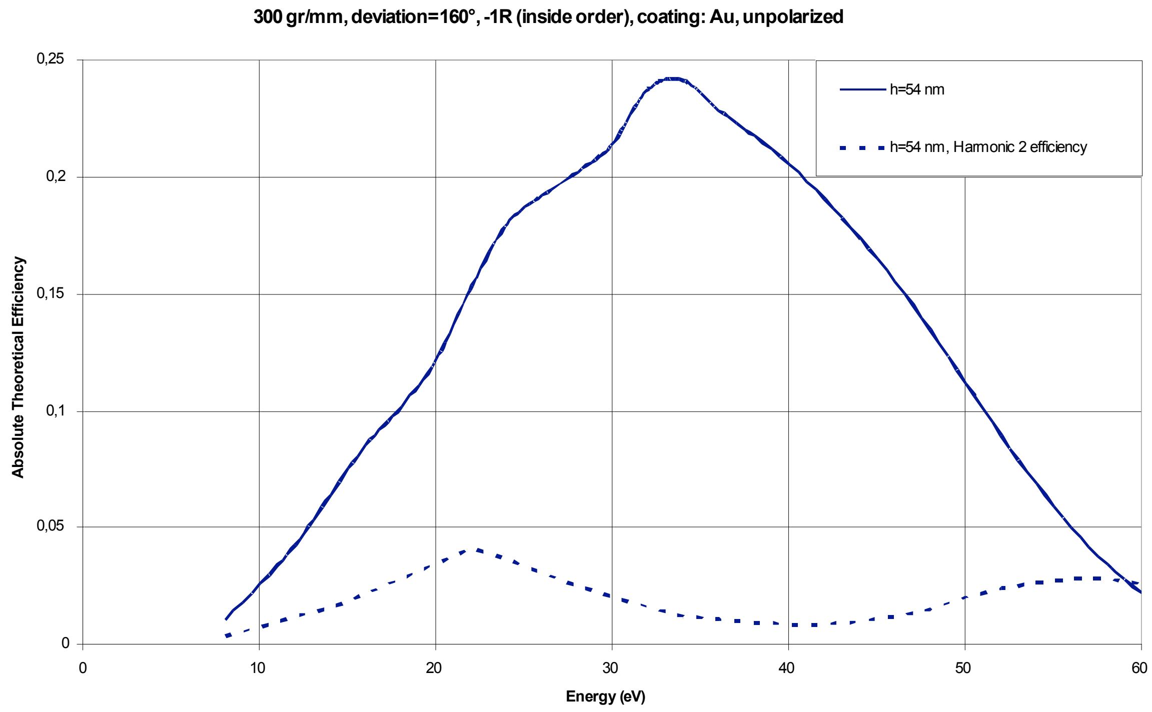
An example of VGD grating produced for Brookhaven National Lab, USA

Efficiency curve along the 3 tracks with second harmonics



Groove profile is laminar

An example of VGD grating produced for Brookhaven National Lab, USA



Harmonic contamination : high around 24 eV

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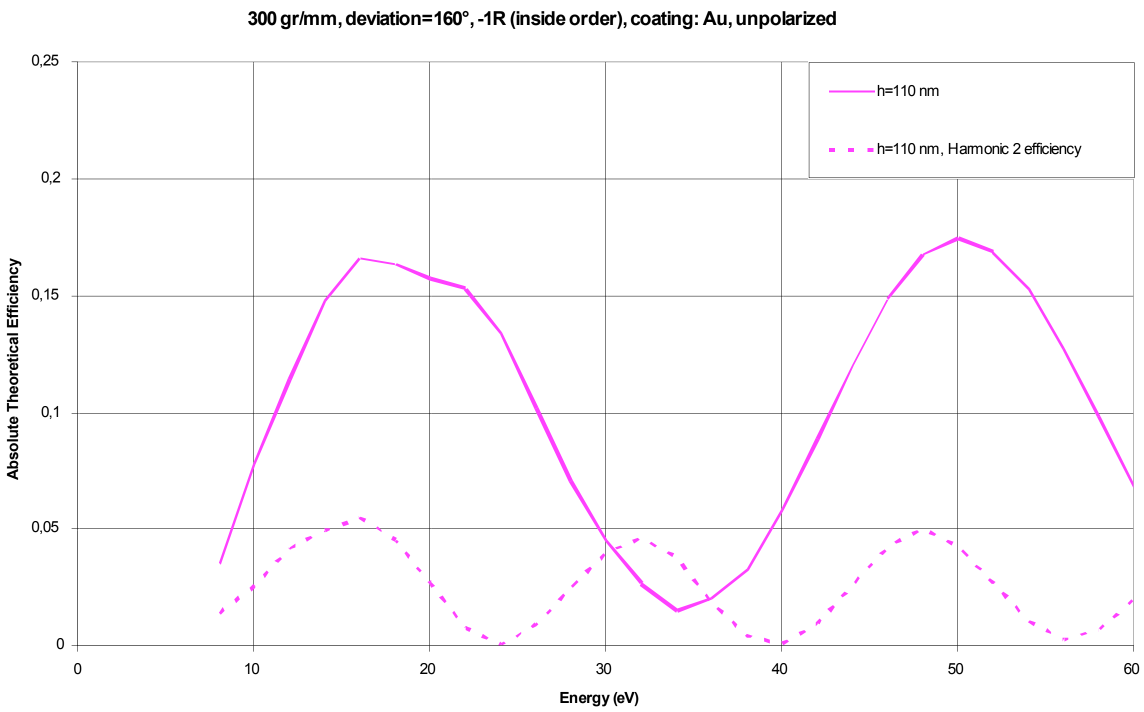
An example of VGD grating produced for Brookhaven National Lab, USA



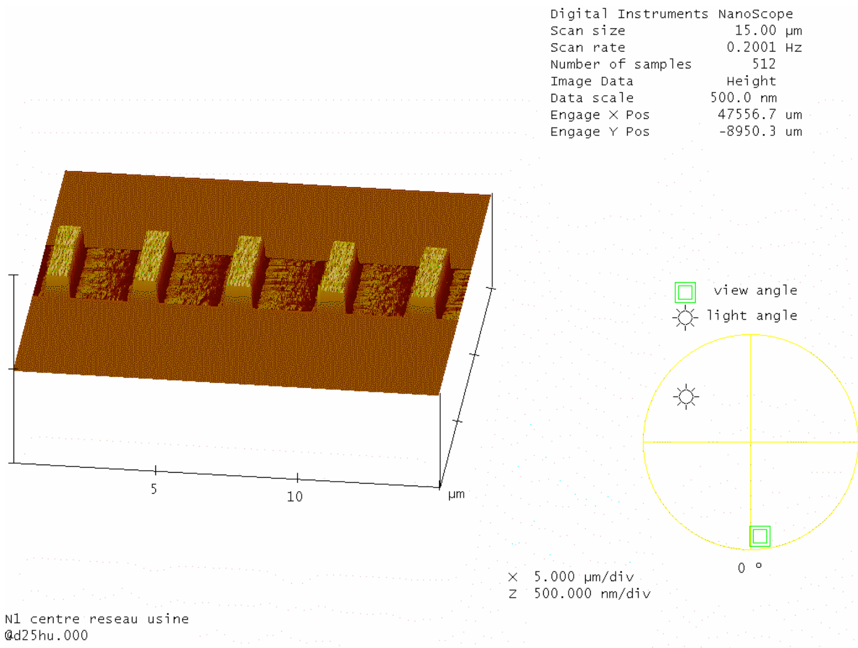
Harmonic contamination : low around 24 eV

Second benefit of VGD gratings : Minimise harmonic contamination over a wide spectral range

An example of VGD grating produced for Brookhaven National Lab, USA

The VGD grating presents all the advantages of holographic recorded and ion etched gratings :

Low stray light
Aberration correction
VLS correction
Silicon or fused silica substrate
Plane, spherical or aspherical substrate



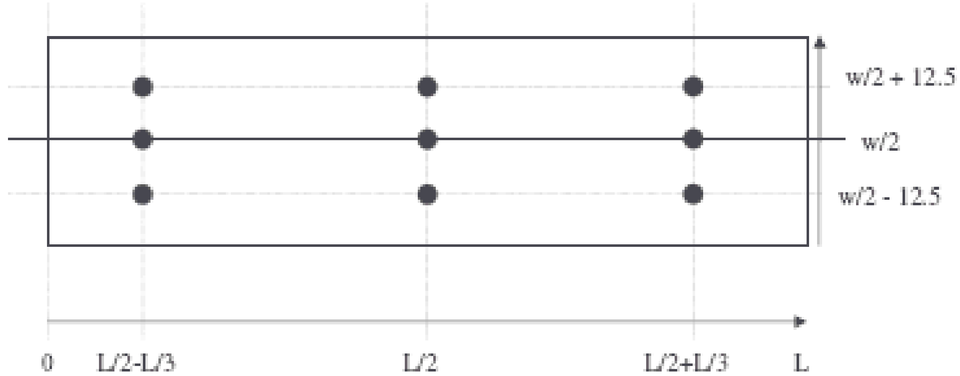
AFM image of the groove profile

How to specify your VGD Grating ?

Variation of groove depth in nm/mm :

H (nm/mm) = 0.076 + 0.037 h average

Standard VGD gratings have a width of 40mm with a ruled area width of 35mm



We can calculate h min and h max :

h min = h average – H x 12.5
h max = h average + H x 12.5

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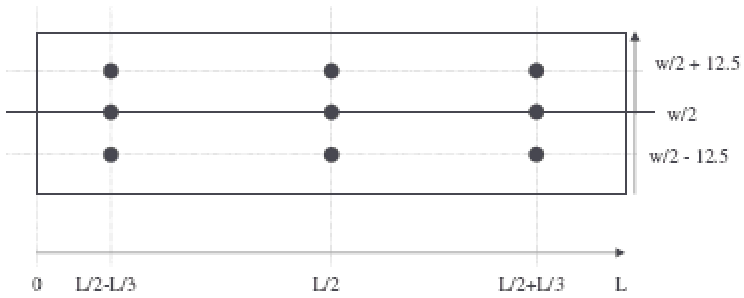
Example of VGD Gratings

blank size (mm)	useful arera (mm)	grooves density (l/mm)	Nominal depth variation over 25 mm		
			h min (nm)	h centre (nm)	h max (nm)
40x100x30	35x90	1800	4.5	10	15.5
40x100x30	35x90	600	18	35	52
40x100x30	35x90	300	42.5	80	117.5



Typically a ratio 3 between h min and h max

Conclusions

With narrow synchrotron beam
VGD gratings bring 2 major benefits :

- Larger spectral range

- Better harmonic rejection

VGD gratings keep all properties of

Ion etched Holographic VUV gratings
VLS, Aberration corrected
Plano,spherical or aspherical substrates

Thank you