36th International Gemmological Conference | August 2019

STUDY OF A RECUT HPHT SYNTHETIC DIAMOND: COLOUR VS SIZE VS SWUV TRANSMISSION

Presentation by J-P. Chalain

SSEF

LAYOUT

- Context & Challenges
- Recut of a HPHT synthetic diamond
- Colour vs Size
- SWUV transmission vs Size
- Normalized SWUV transmission vs Colour
- Conclusion

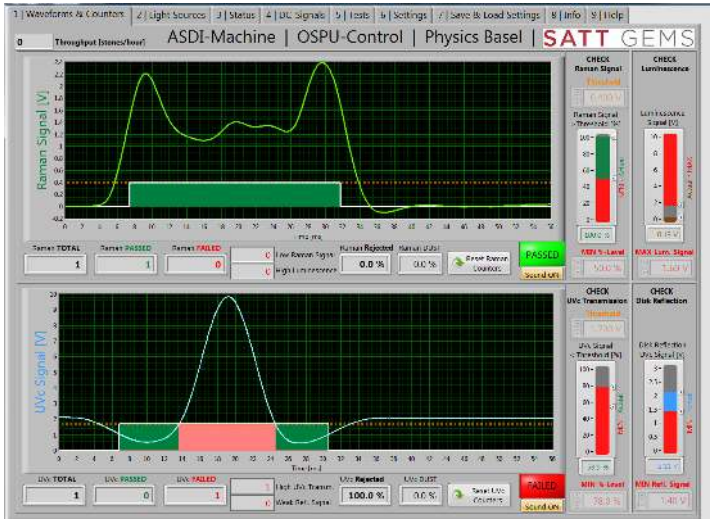
CONTEXT & CHALLENGES

ASDI

- 1st automated machine for separating natural D to J melees from possible synthetics
- Rejects all colourless diamonds transparent to SW (270 nm)
- So far, N-doped CVD synthetic diamonds are not in the “D - J colour range.”

DPA Project Assure

- 2019: ASDI passed 100% of the DPA-Project Assure Tests
- Testing samples: 1’000 diamonds, 200 simulants & 200 synthetics | Ø: 1 to 3.8 mm
- Speed rate measured > 6’500 stones/h
- all results available on: https://diamondproducers.com/assure/



Automated Spectral Diamond Inspection - ASDI

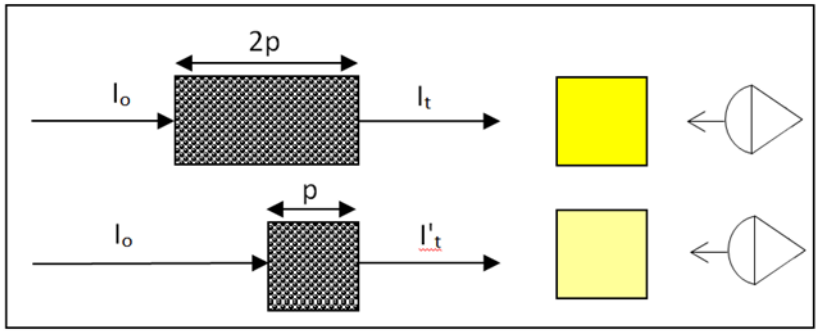
CONTEXT & CHALLENGES

$T\ (\%) = 100(I/I_0)$
$Abs = -\log_{10}(T/100) = \log_{10}(I_0/I)$

SSEF continues to challenge the ASDI

Two goals:

1. Make ourselves small synthetic diamonds (RB, Ø: 1.5 - 2.0 mm)
   - with a low [N]
   - would possibly enter inside the D-J colour range
   - will measure their SWUV transparency



D-J colour range???

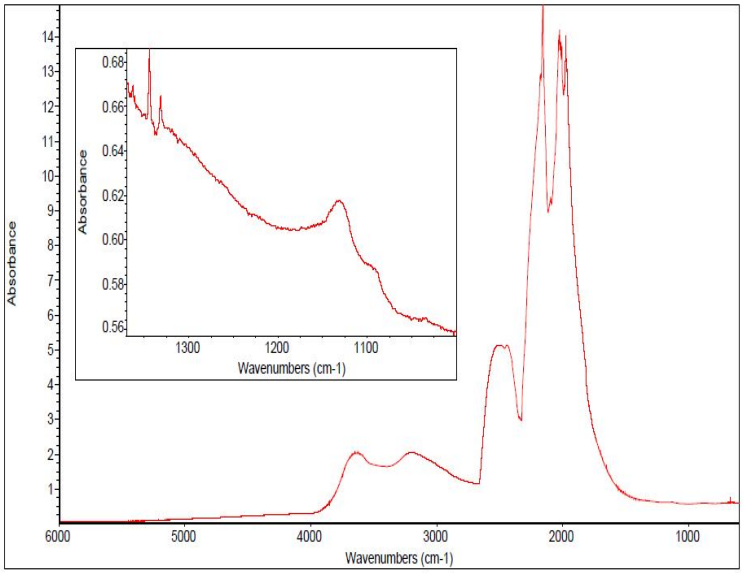
2. Predict the relation between colour grade and SWUV transparency
   - for natural and
   - synthetic diamonds

RECUT OF A HPHT SYNTHETIC DIAMOND

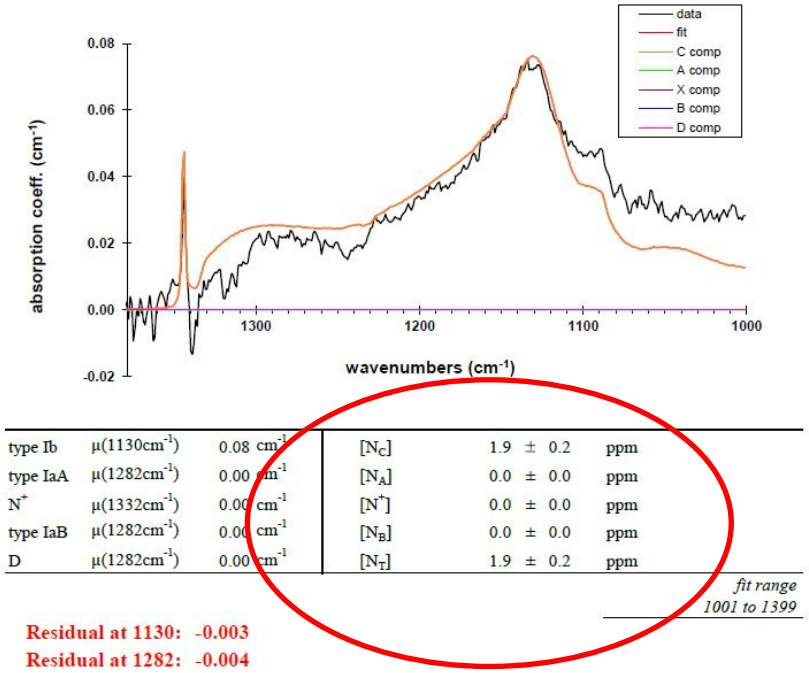
97768

Selection of a HPHT synthetic diamond:

- Round brilliant cut
- Ø = 5.2 mm
- Specifically low [N_C]: 1.9 ppm (C centres)



97768 | FTIR spectrum



97768 | Nitrogen concentration

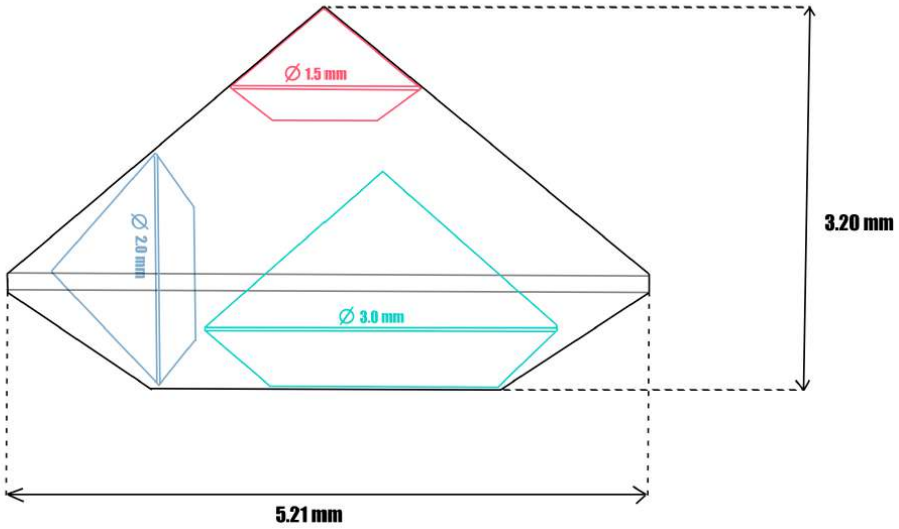
RECUT OF A HPHT SYNTHETIC DIAMOND

97768

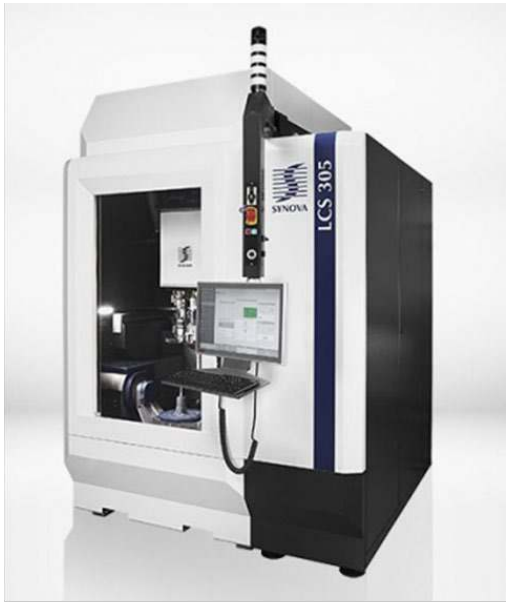
A new challenge:

Recut the selected synthetic into 3 stones of different diameters

- A recut project
- A very precise and extremely thin (25 µm) sawing process



97768 | Recut sketch

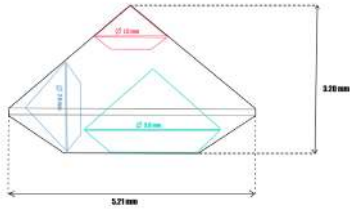


SYNOVA LCS 305

Ultra-Precise Laser Machining Center

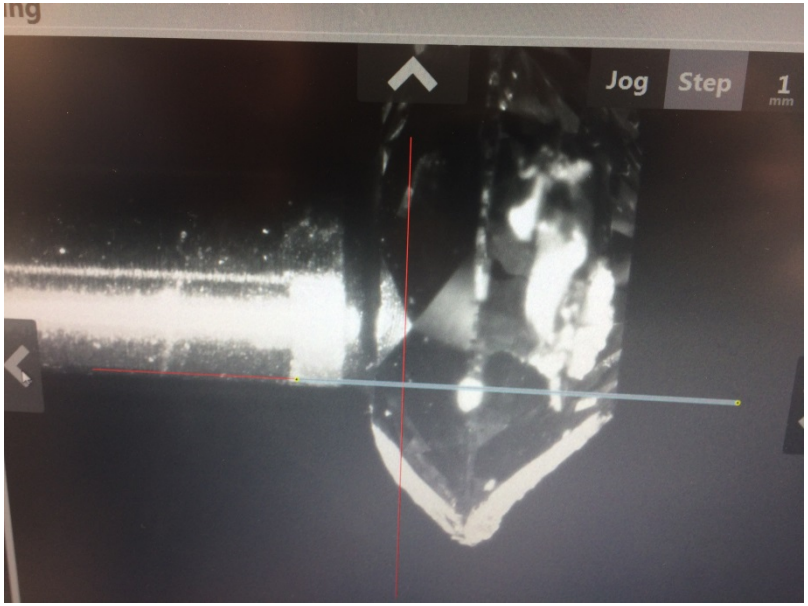
5-axis Laser system for 3-D applications

RECUT OF A HPHT SYNTHETIC DIAMOND



SYNOVA | Water Jet Guided Laser Technology

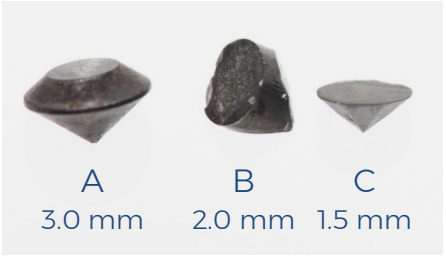
Sawing optical positionning & results



The 5.2 mm stone sawn at half height of pavillion

Julien **Le Clec'ch**,
process engineer, SYNOVA

97768 | Cut-off pieces



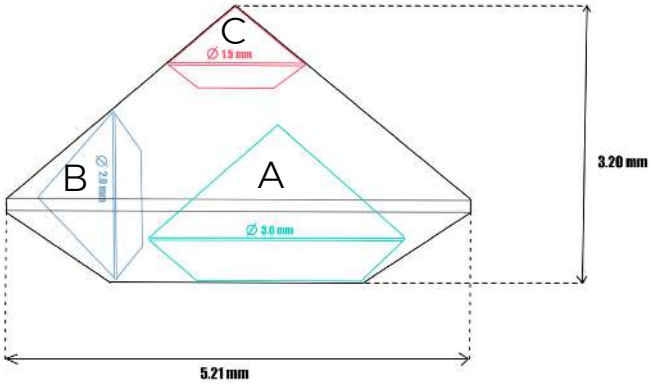
A 3.0 mm | B 2.0 mm | C 1.5 mm

97768 A | 97768 B | 97768 C

RECUT OF A HPHT SYNTHETIC DIAMOND

Mr. Bischoff, Geneva

Polishing was finalized on a traditional scaife



A & B: after facetting & polishing

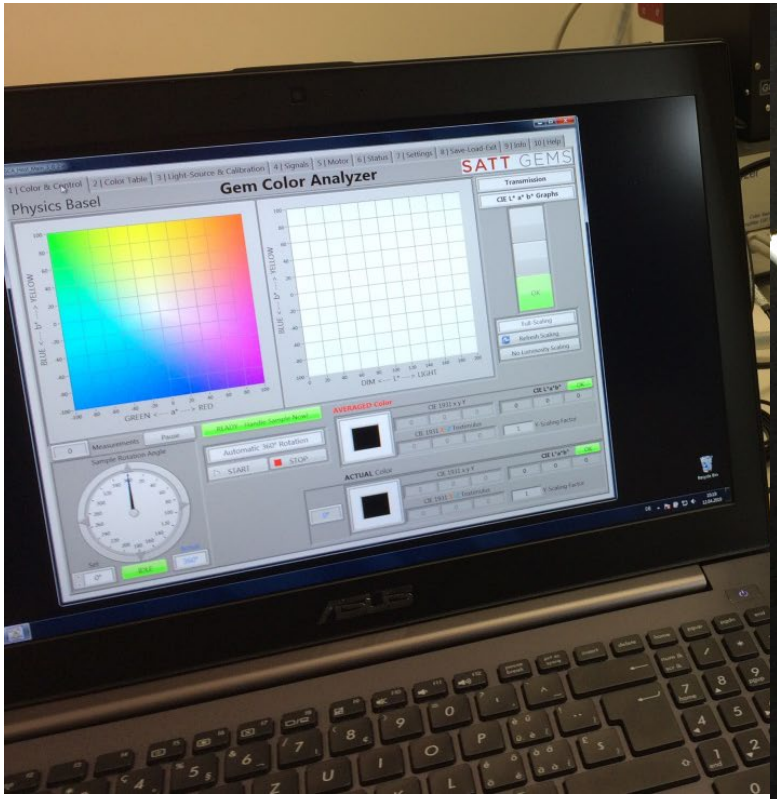
C: boiled in acid, unpolished
(no crown, need to be recut)

COLOUR vs SIZE

Colour measurement on SSEF “ASDI - CGM”

Colorimeter daily used at SSEF for three years now

University of Basel



SSEF Gem Color Analyzer
For RB, Ø: 1.0 mm to 6.6 mm

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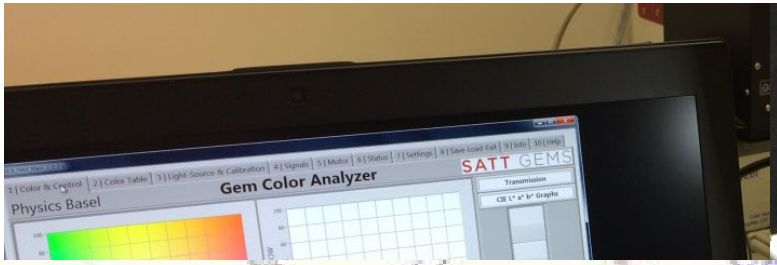

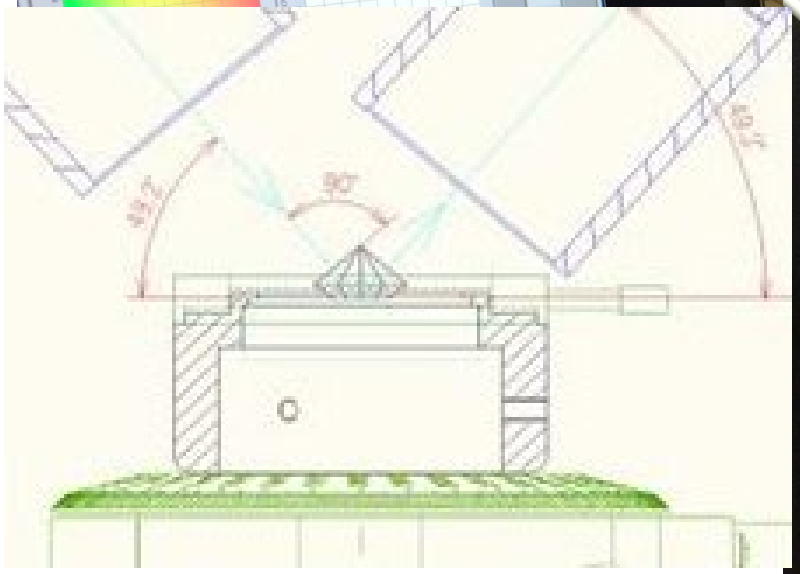

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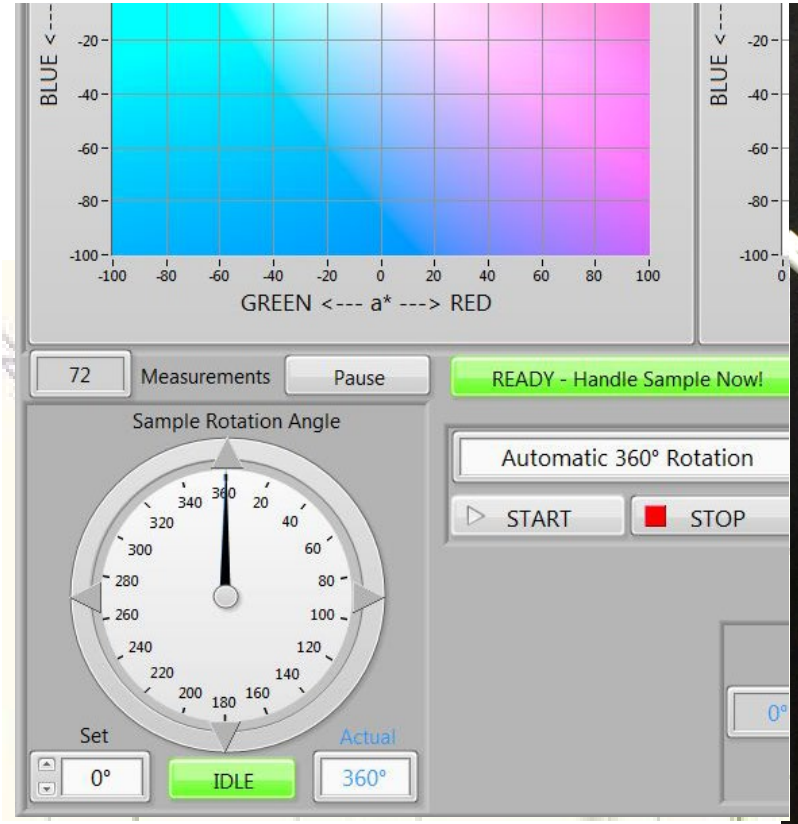

SSEF Gem Color Analyzer
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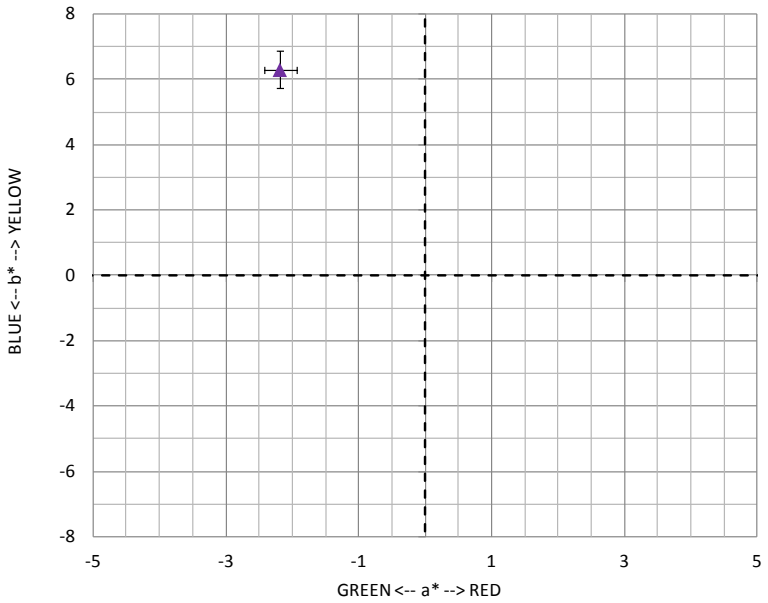
COLOUR vs SIZE

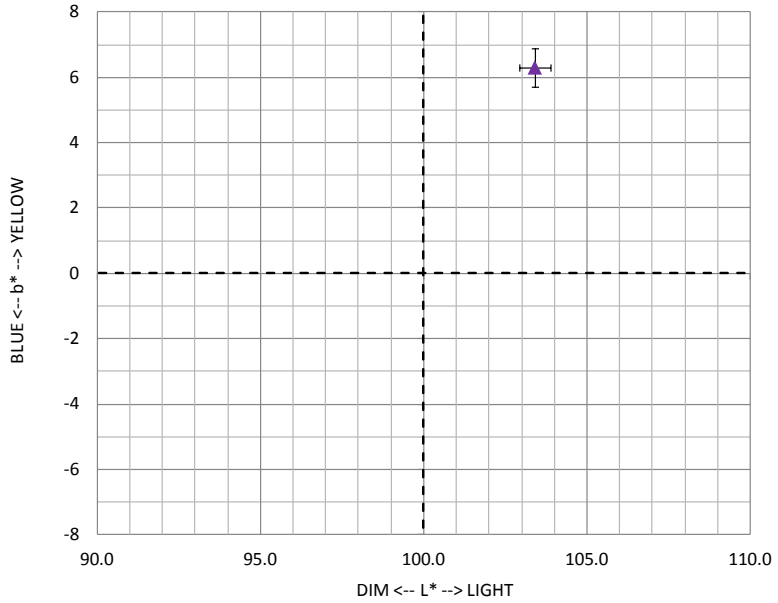
97768 | Colour measurement on SSEF “ASDI - CGM”

Date, Time	22.11.2018 08:44:46							
Host Application	Revision 3.0.2 | March 2018							
Number of Measurements	72							
Sample Name	**Transmission Measurement Mode:** Automatic 360° Rotation							
	AVERAGED Color Measurement Data (CIE, D6500)							
97768	**L***	L* STD	**a***	a* STD	**b***	b* STD	**OK**	Y-Scaling Factor	1.0000
	103.4152	0.4780	**-2.1697**	0.2366	**6.2871**	0.5729		

GCA Transmission AVERAGED Color (a*, b*)



GCA Transmission AVERAGED Color (L*, b*)

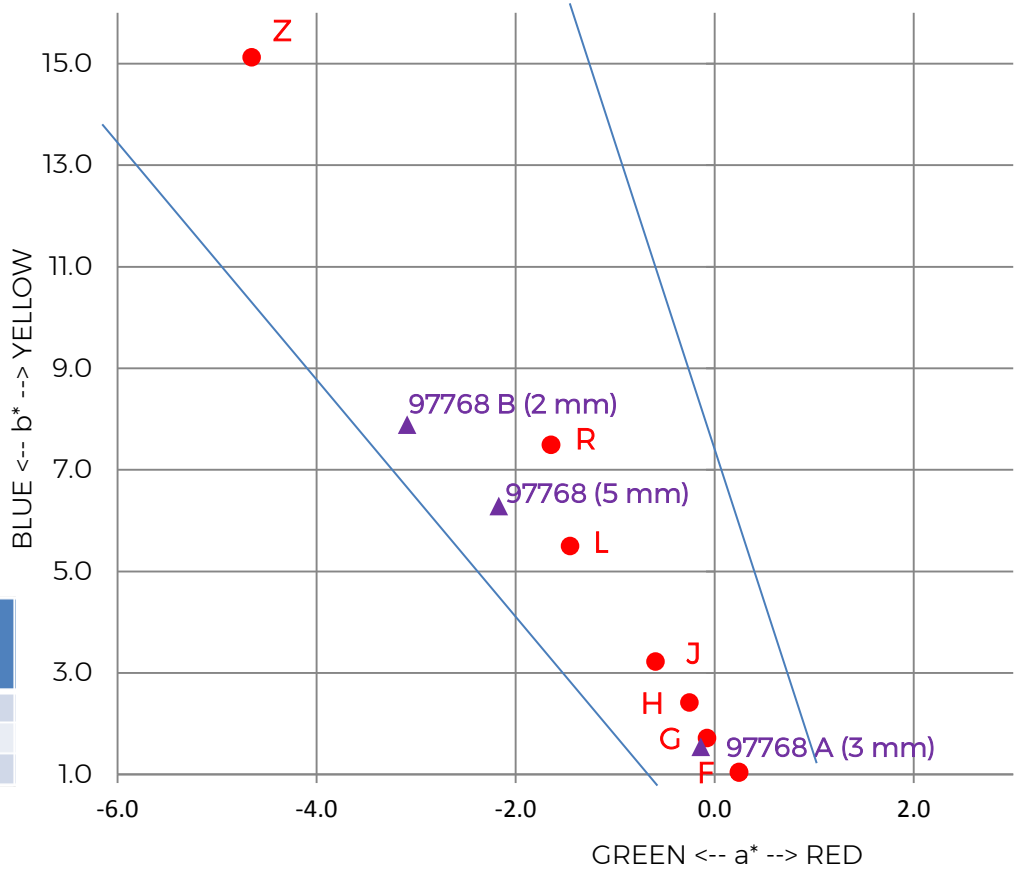


COLOUR vs SIZE

97768, 97768 A & 97768 B | compared to SSEF master-stones

97768 C not plotted, Luminance out of range (L*=76.0195)

Ref.	Ø (mm)	CIE (L*a*b*)	Colour Grade
97768	5.2	(103.4152, -2.1697, 6.2871)	M-R
97768 A	3.0	(101.4331, -0.1404, 1.5446)	G
97768 B	2.0	(98.6827, -3.0896, 7.8891)	S-Z



COLOUR vs SIZE

An apparent contradiction: "The colour of the 3 mm recut stone is much lighter than that the 2 mm recut stone."

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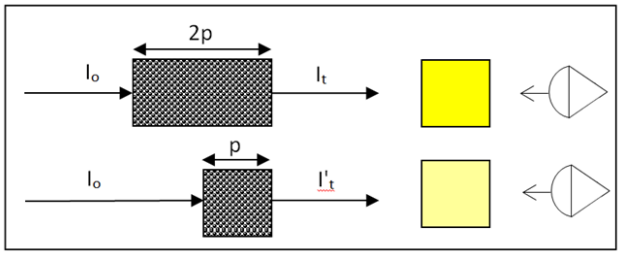
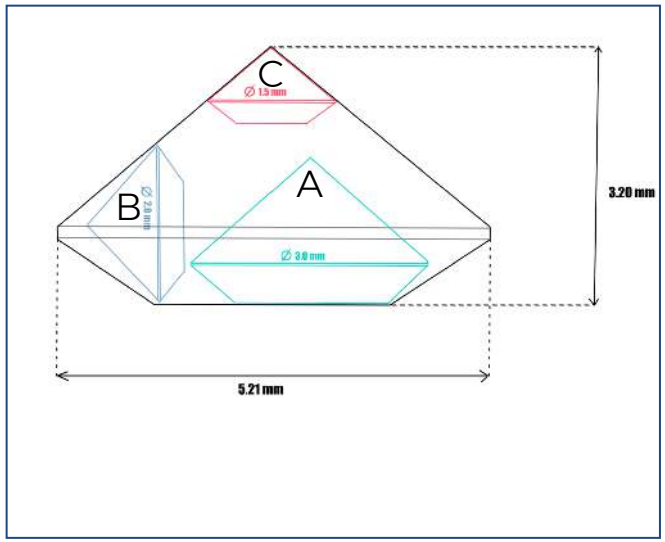


Theoritically, the thinner the lighter.

So the 3 mm stone is lighter than 2 mm?



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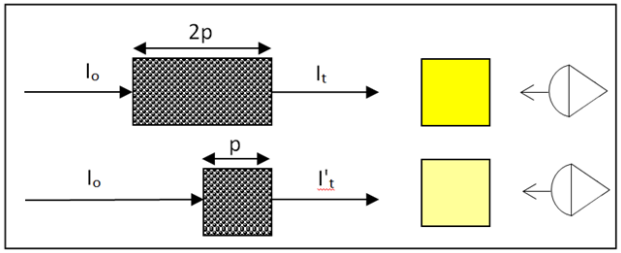

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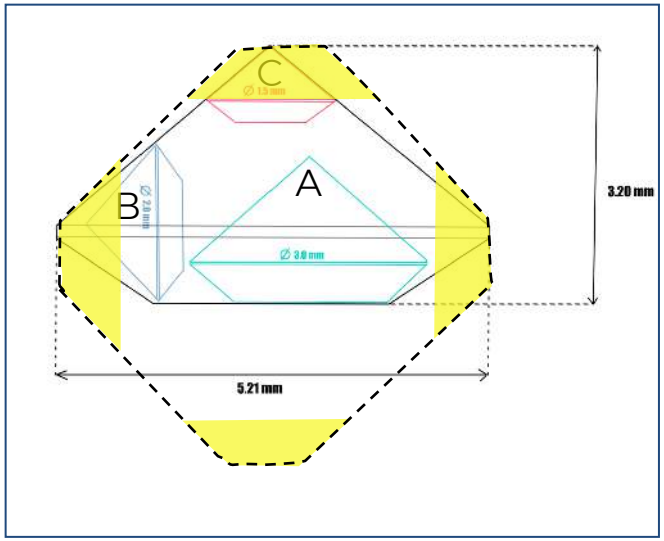


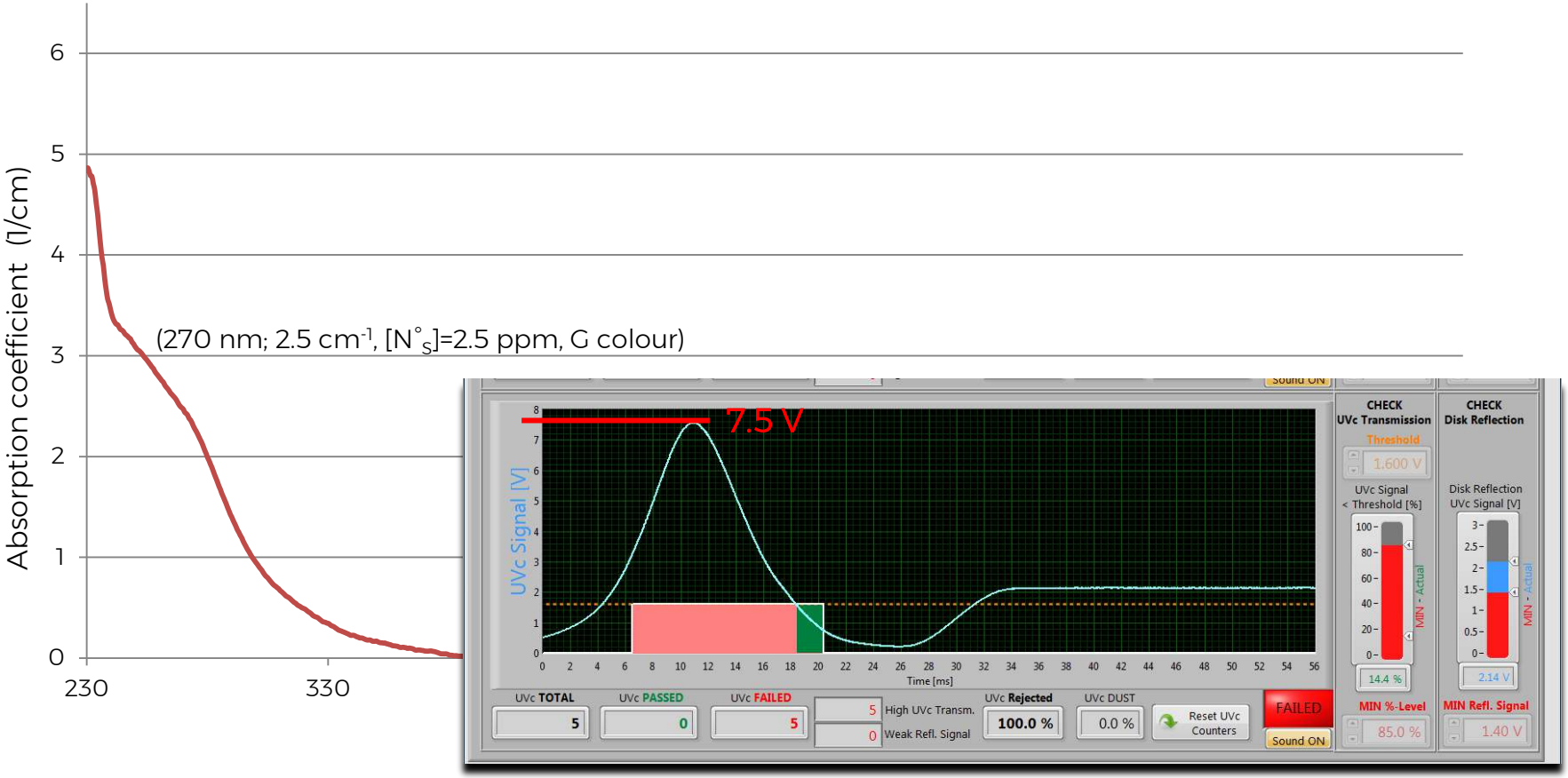
So the 3 mm stone is lighter than 2 mm?

Because the distribution of the yellow colour (C centres) inside the grown crystal is inhomogeneous.
Its core is colourless and its rim is yellow

The larger stone (A) cut at the centre of the crystal, is colourless (G colour grade)
The smaller stone (B) cut at one summet of the crystal, is yellow (S-Z)

SWUV TRANSMISSION vs SIZE

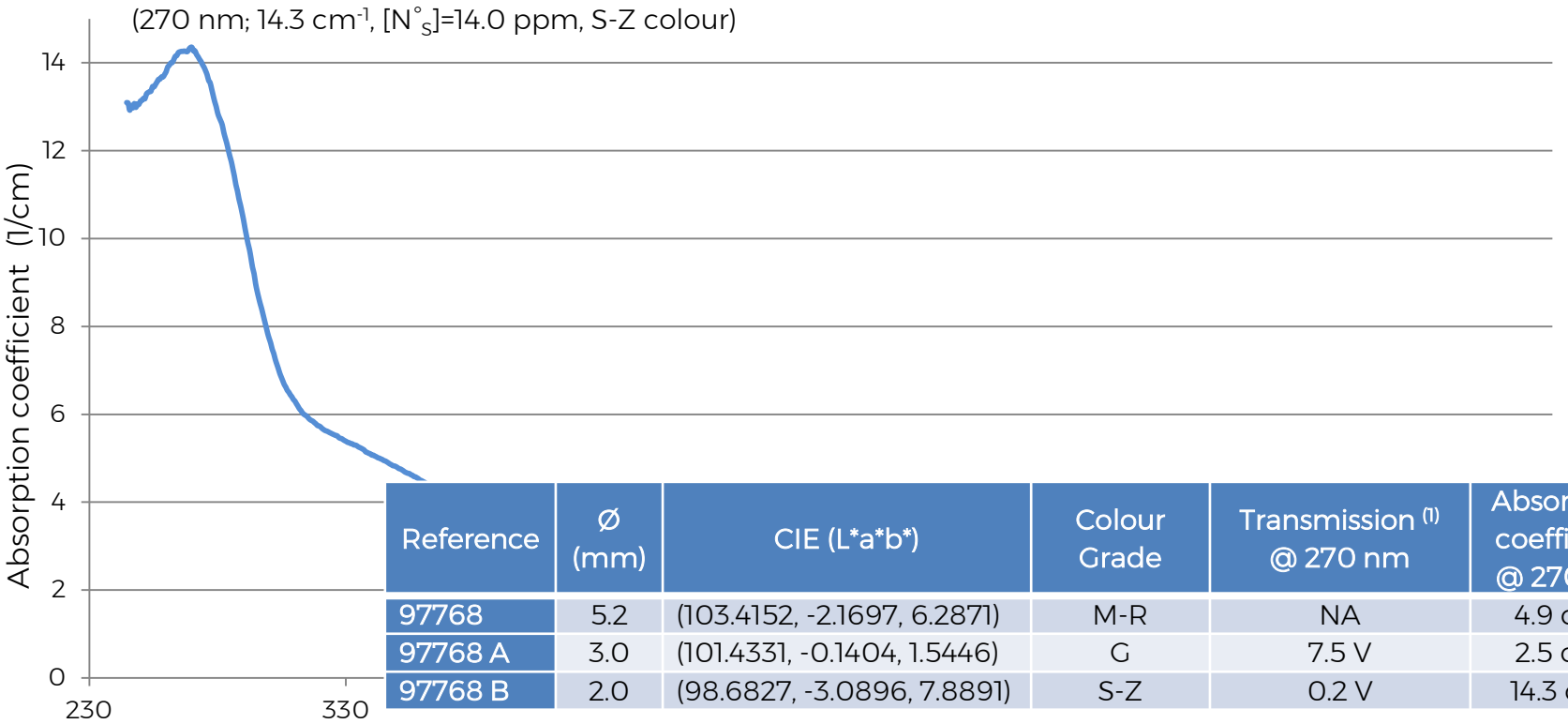
97768 A (G colour) | SWUV transmission (ASDI) & Absorption coefficient



97768 A (3.0 mm) REFERRED FOR ITS SWUV TRANSPARENCY (7.5 V)

SWUV TRANSMISSION vs SIZE

97768 B (S-Z, out of ASDI spec) SWUV absorption coefficient



Reference	Ø (mm)	CIE (L*a*b*)	Colour Grade	Transmission (1) @ 270 nm	Absorption coefficient @ 270 nm
97768	5.2	(103.4152, -2.1697, 6.2871)	M-R	NA	4.9 cm^{-1}
97768 A	3.0	(101.4331, -0.1404, 1.5446)	G	7.5 V	2.5 cm^{-1}
97768 B	2.0	(98.6827, -3.0896, 7.8891)	S-Z	0.2 V	14.3 cm^{-1}

(1) Voltage measured by the ASDI device
NA: Not Applicable due to the size out of specifications

CONCLUSION

OPTICAL PROPERTIES

- Inhomogeneous distribution of colour in a HPHT synthetic diamond of low [N]
- Relationship between colour & SWUV transmission for synthetics and naturals

SWUV transmission remains an efficient method
for fast screening of D-J melee diamonds

For more data, we will soon recut two additional
HPHT synthetic diamonds with low [N]

THANK YOU

CO_AUTHOURS

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Michael Steinacher[3]

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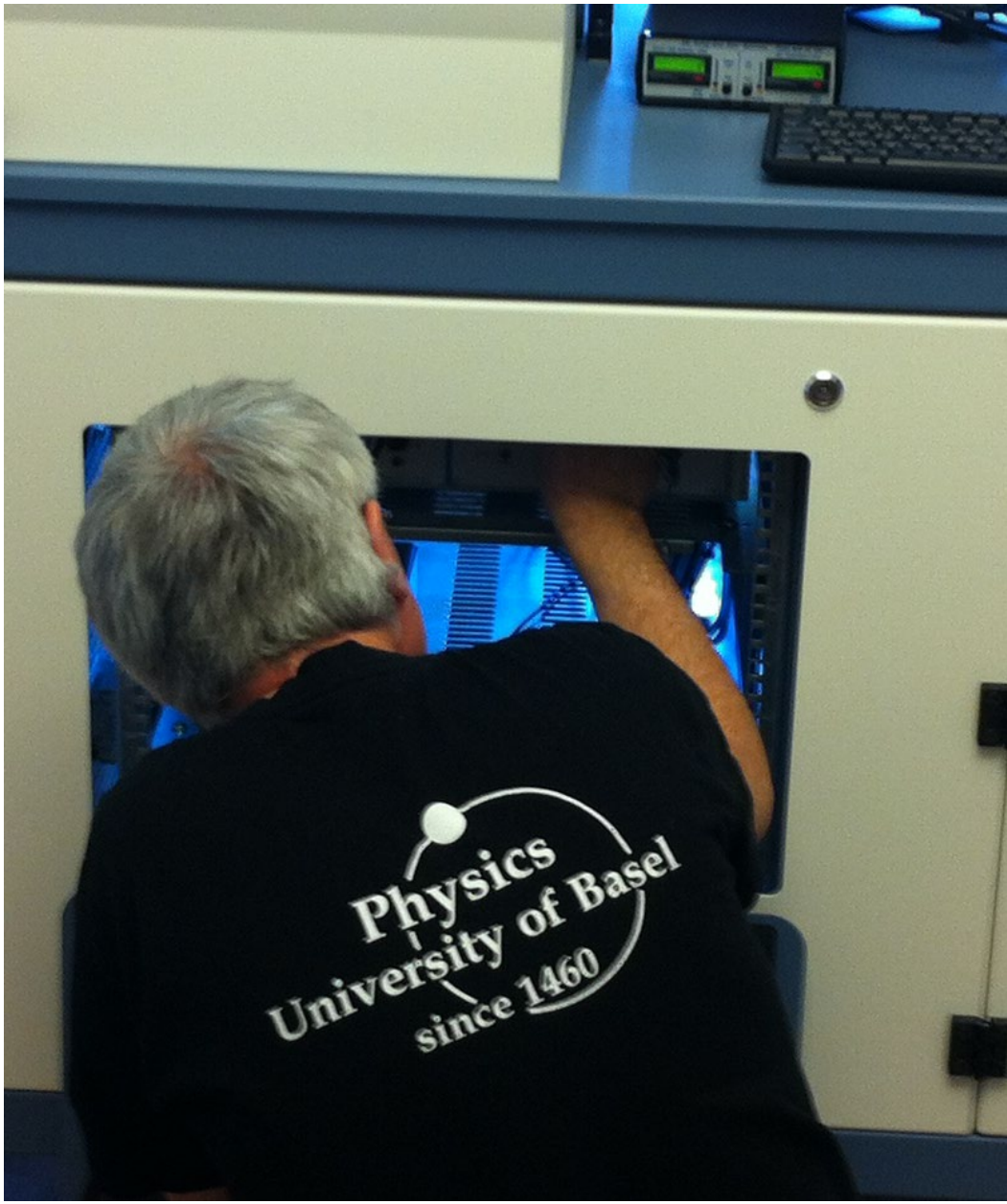
(3) Department of Physics, University of Basel, Basel, Switzerland

SPECIAL THANKS TO

Stephan Bischoff, STEN Sarl, Geneva
Pierre Lefèvre, Luc Pan & Vito Lanzafame, SSEF



Michael Steinacher fine tuning the ASDI machine