

# Scientific Applications of Forensic Science for Detection of Criminals & Different Diseases using Optical Biosensor

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**Abstract:** *The Sequencing of DNA is always different from one human being to another. There will be many proofs available at the spot where Crime has occurred. At the spot, many evidences may be available like Hair, Blood, Semen, Finger Prints etc, From the Crime Spot Suspects DNA Profile will be Collected. If this matches with the Evidence DNA Profile, then the Crime Investigation becomes very easier by Using Forensic Analysis. For this, Proper analysis has to be done. Here we are analyzing Quality Factor of DNA Profile of the evident by using Opti FDTD. The analysis is done by using Simulation Process graphically.*

**Keywords—** DNA, Finger Prints Profile, Crime Forensic.

## 1. INTRODUCTION

Physical Evidence is one of the major factor for the Investigation of a Crime. Ethical values are very much important in the field of Forensics. Usually there will be more Pressure from the Police Department for Forensic Department. They want the Results very fast. Due to this sometimes, Forensics may also produce incompatible Results. The Suspect should never know the types of tests that will be conducted on him. For a Suspect, Visionless Skill Tests has to be conducted and therefore he cannot become Ready for the Investigation Process.

DNA (Deoxy ribonucleic acid) is a protein which is present in all Human beings & animals. It varies from Person to Person. It will never be identical even with twins. DNA frequencies vary from one Region to another Region. This means DNA frequencies changes from Continent to Continent. DNA testing even plays a major role in Paternity Testing.

Also DNA samples of the Persons who has done Crime frequently will be stored in the Forensic Labs and the data will be stored. By this method identifying Criminals becomes easier. There are so many types of the Detection of Crime like Lie detection, Data Mining, Finger Printing technique.

Nails have a very unique Identity compared to other parts of the Body which could be used for Forensic Testing. It can be preserved for more days & it will not get decayed. If Finger & toe nails are used for Forensic Analysis then it is called as Forensic Onychology. Whenever Terror attacks occur, the Preservatives under the Nails are collected from the Suspects & then it will be sent to Forensic Lab for further Investigation. The growth rate of Finger nails is 0.1mm per day & 3mm per month but the growth rate of toe nails is

0.03mm per day & it is 1mm per month.

Many people may become addicted to Alcohol and their Families may not know of their addiction to alcohol which may spoil their Families. The most highly detected chemicals in Alcohol is Ethyl glucuronide (EtG) phosphatidyl ethanol (PEth) have high Sensitivity & Specificity. If EtG is tested positive in the Urine Samples that is between 40 & 200 gram is the result then it indicates that the Person has Consumed alcohol. This could be tested even with Breathing. The samples released during Breathing could be tested to find whether the Person has Drunk or not.

## 2. EXISTING METHODOLOGY

### DNA Finger Printing

It is a technique used to form a link between Culprit & the Evidence. In this case, the Specimen which is collected in the Criminal Spot will be compared with the other Specimens collected at the Crime Spot. This test is used to do paternity test.

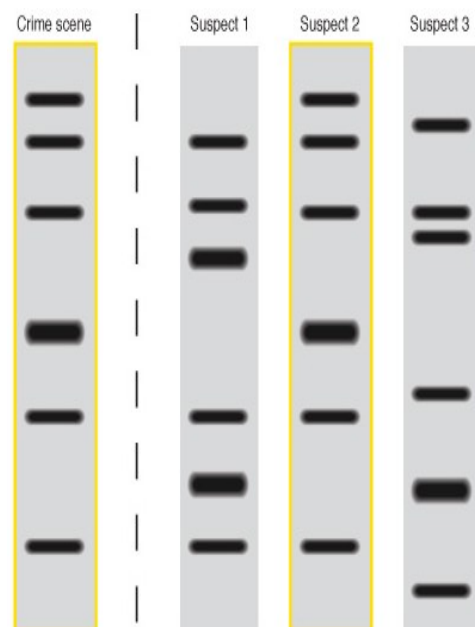


Fig 1: DNA Finger Printing technique

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Hydration dynamics is a method of soaking nails in Water.By soaking nails in water,we get different refractive Indices of nails.This can also be used as a type of test in the case of Forensic Analysis.This technique could be achieved by using Raman spectroscopy Method.

The optical properties varies from one person to that of the other by various constituents present in the nails like keratin, lipids, water, & to find elements like calcium(Ca), potassium(K), sodium, magnesium(Mg).The Nails will be usually soaked for around 4min,in this duration itself each of the suspect's nails shows different properties.

The Understanding of a DNA profile of a Person's sample is very accurate and can be used as a very good witness in the Law of Court. By following the highest matching probability of the matching of DNA profile the Culprit can be easily followed up.

Forensic pathology is one method to find the Suspect as well as Crime. Forensic pathologists may performs Post-Mortem is the process to know the reason of death.Forensic pathologists learn human residues & may find additional proofs so as to help solve a crime or reason of death, such as any passionate material in the Criminal's tissue. Bullets and other types of weapons leave particular kinds of wounds, and a forensic pathologist can make a verdict call on this.

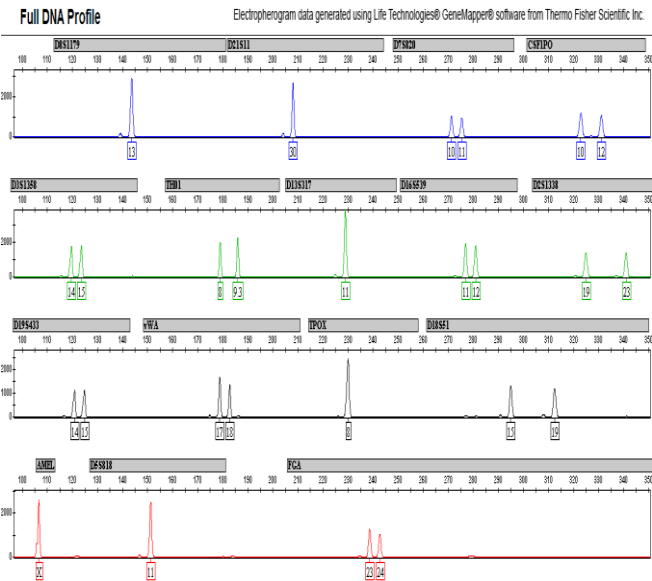


Fig 2: Chart of Electropherogram

The Chart shown above is known to be as an Electropherogram.This graph displays the Genetic material present at each loci.Actually speaking,Each Person will possess one or two peaks at each locus.The evidence samples will be collected, this will then be verified with the suspect's sample & then it will be verified like whether it matches with the evidence sample or not.

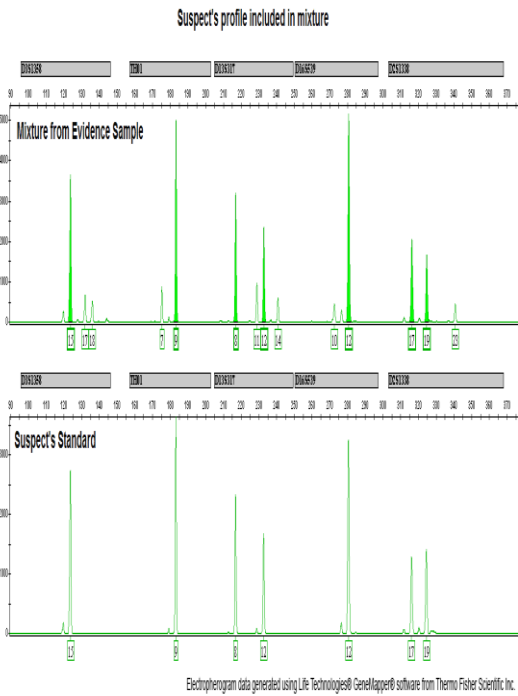


Fig 3:Chart with the Blood Groups of the Family

Let us see the Chart with the type of Blood group of a Child based on the blood Groups of Father & Mother

Table 1: Determination of Child's Blood Group based on Parents Blood Groups

3. PROPOSED METODOLOGY

Paternity Test is one of the most important that has been used nowadays to determine Parents for the Missed Children,Determining the Parents at the Court of

		Father's Blood Group			
Mother's Blood Group	A	A ;O	A;AB ;O	A;B;AB	A;O
	B	A;B;AB;O	B;O	A;B;AB	B;O
	AB	A;B;AB	A;B;AB	A;B;AB	A;B
	O	A;O	B;O	A;B	O

Evidence,finding Parenthood etc.This testing can be done by taking Blood samples from both the Parents.

Table 2:RI values of different Blood Groups

Blood group	RI
A	1.3768
O	1.3796
B	1.3788

According to the Survey carried out, there is an increased risk of Gastric Cancer for the people with the Blood Groups A & B. These Blood groups A, AB & B are called as Non-O blood Groups.

These Blood groups have 9% risk of dying of Medical disease & 15% risk of dying due to Cardiovascular Disease. According to the Survey There are eight different blood types which are known to be as the best Blood groups are O+, O-, A+, A-, B+, B-, AB+ and AB-.

Nearly 40% Cases fail because of the DNA mismatch for most of the Victims & also the Victims will be unco-operative in most of the cases. There are mainly 3 types of DNA tests. They are:

1. Y-DNA tests for Paternal tests
2. mt-DNA tests for Maternal tests
3. Autosomal DNA tests (at-DNA) for finding matches on Ancestral lines

Each of the DNA testing has its own significance depending on the Application. The third type of test i.e Autosomal DNA tests is more suitable for finding the Relationship with reference to Geographical Regions. Y-DNA & mt-DNA is more suitable for Family-Tree applications.

The R.I gains of HT-29 cells (Y-DNA) are  $1.367 \pm 0.004$  at 442 nm &  $1.382 \pm 0.004$  at 325 nm for chromosomes &  $1.356 \pm 0.009$  at 442 nm,  $1.369 \pm 0.008$  at 325 nm for the cytoplasm.

The RI value of mt-DNA is 0.909. It is situated in Mitochondria. This is especially inherited from Mother. In some conditions, human babies take mtDNA from both Parents i.e from Fathers & Mothers resulting in mtDNA Heteroplasmy. Recently mutation in mtDNA is used to diagnose prostate cancer in patients with negative prostate biopsy. Heteroplasmy means the presence of more than one Mitochondria within a cell. It should be noted that the sequential organization of organelles in animals is present only in Mitochondria & not in any other parts of the human body. Usually mt-DNA remains same throughout the generations.

Human beings have 22 Pairs of autosomal DNA's. At-DNA comes from both the Parents.

From these DNA tests the following Conclusion could be obtained in forming the Reports:

1. Recognition of the DNA base pair.
2. Comparing with preceding Results.
3. Clarifying with the previous stored results & the Present outcomes.

Signature Analysis is also called as Graphology. Based on the Signature analysis, we can detect Crime as well as criminal. From Individual's signature we can analyse so many characters of a person. Here are some characteristics of handwriting that apply only to signatures, and those are the ones that we will be examining here. They are:

1. Dimension of signature
2. Dimension of the 1st alphabet of the signature
3. Inclination of the signature
4. Employment of 1st name, last name, or beginning letters
5. Emphasizing of the signature
6. Spotting of the signature
7. Usage of turned around curves in the signature

## Autosomal Recessive Inheritance

It is a disorder passed through families. In this case, the Gene will be present in non-Sex chromosomes in a body. Without their knowledge, many people can be the carriers of this disease. Example for this type of disease are: Albinism, Cystic Fibrosis.

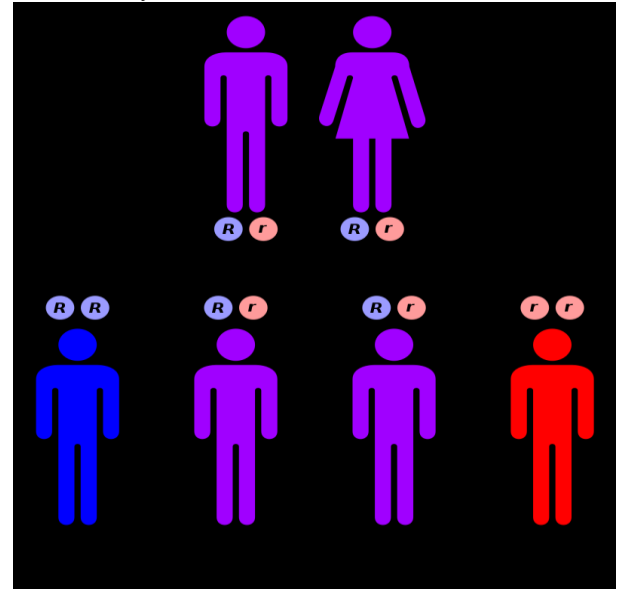


Fig 4: Picture Showing Effected Kid from parents

The reason for the Death of a person can be determined by a branch of forensic Science i.e called as Forensic pathology. This is carried out by using the process of post-Mortem.

Even we have different Refractive Indices for Hairs with Brown colour as follows:

Table 3: RI values of Hair of the People of Different Countries

Sl.No	Age	Sex	Ancestry	R.I
1	23	M	Japanese	1.5544
2	2	M	Dutch, English	1.5532
3	42	F	Finnish	1.5494
4	22	F	English	1.5516
5	20	M	Mexican	1.5505

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma			None	
Antigens in red blood cell				None

Fig 5: Table showing Antigens of different Blood Groups

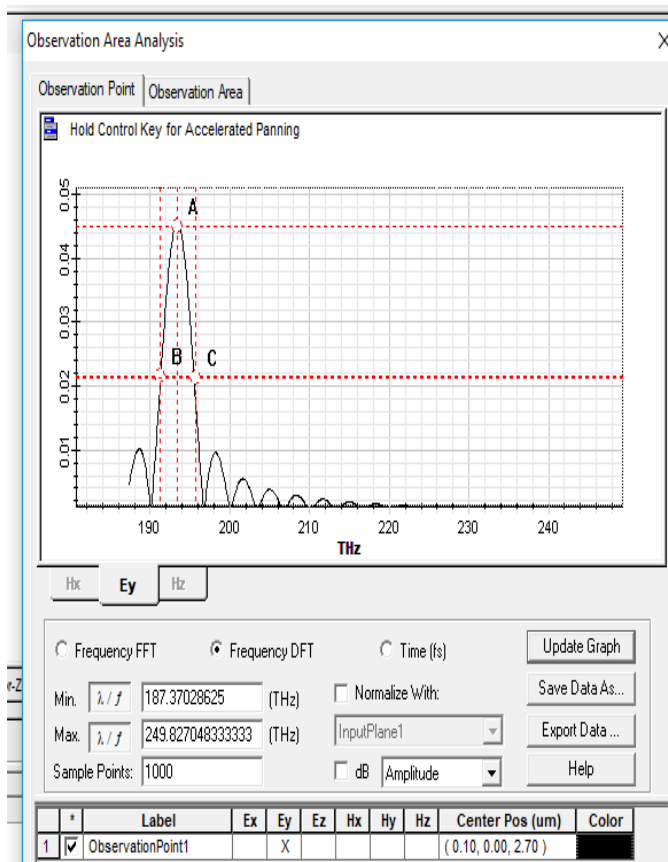
Let us see the Compatibility mode for the blood Transfusion for different Blood groups

**Table 4: Determination of Universal Donor & Receptors**

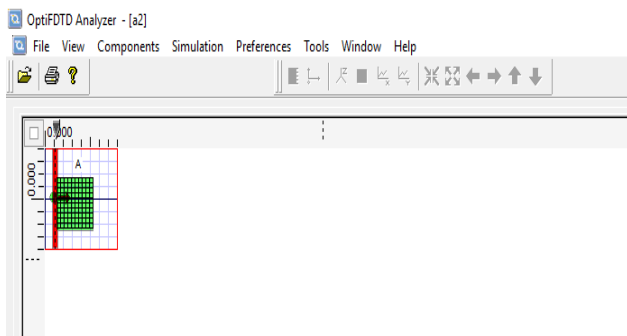
Recipient	Donor			
	O	A	B	AB
O	✓	✓	✓	✓
A	✗	✓	✗	✓
B	✗	✗	✓	✓
AB	✗	✗	✗	✓

From the above table we can say that 'O' Blood group is Universal Donor & 'AB' Blood group is an Universal Receptor.

### Results:

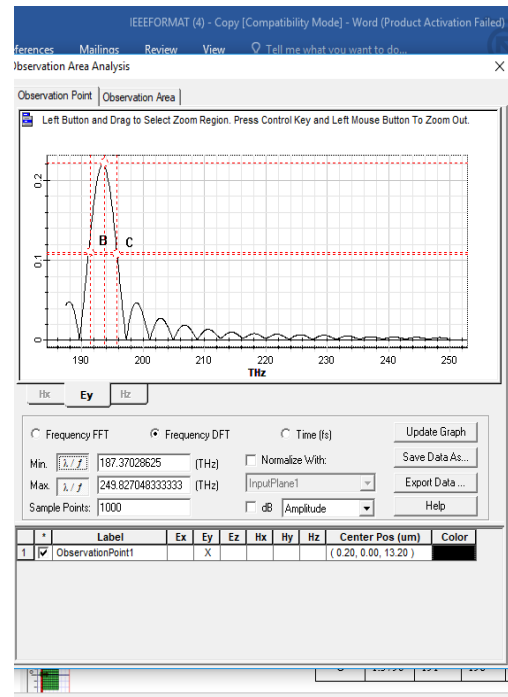


**Fig 6 : optical Designer Graph for Blood Group 'A'**



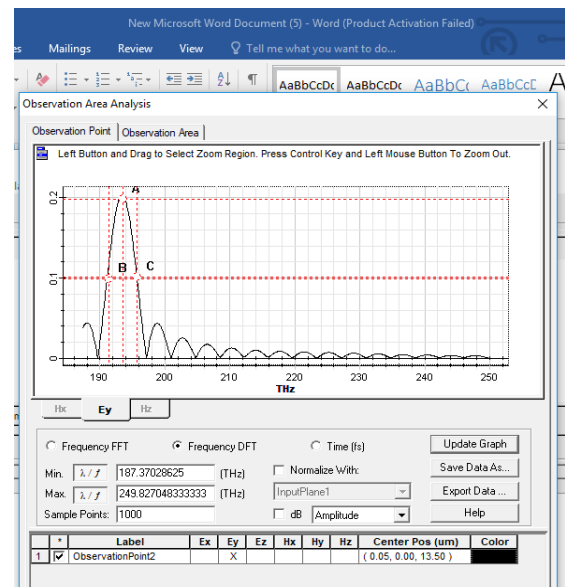
**Fig 7: Optical Analyzer Window for Blood Group 'A'**

Blood Group	R.I	F1 (In Thz)	F2	F0	QF (no Dimensions)
A	1.3768	191	195.6	193.6	41.8



**Fig 8: Graphical Characteristics of Blood Group 'O'**

Blood Group	R.I	F1 (In Thz)	F2	F0	QF (no Dimensions)
O	1.3796	191	195.6	193.6	42.1



**Fig 9: Graphical Characteristics of Blood Group 'B'**

lo o d G r o u p	I	1 (In Th z)	2	0	(no Dim ensi ons)
B	1. 37 88	1 9 1. 3	1 9 5. 6	1 9 3. 5	92.1

Thus we have got the Graphical characteristics of the Blood Groups A, B & O with Quality factors.

### Nails

Even with human nails, we can do the Investigation with respect to Forensics, because nails have the Refractive Index value ranging from  $1.70 \pm 0.03$ , in the frequency range of 0.2 to 1 THz. Even with the nails Sample, we can investigate whether Person has Disease like Diabetes Mellitus or not. For this even data acquisition is done of different Samples.

Thus Nails are also one of the main Source for Investigation of Crime as well as Determination of different Diseases.

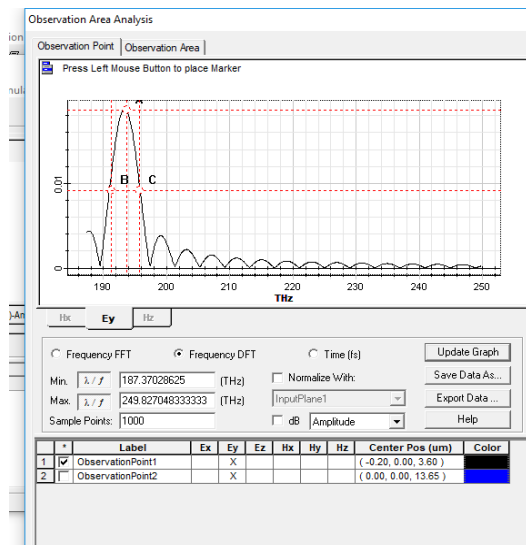


Fig 10: Graphical Characteristics of Nail with Maxm.RI

Nail R.I	F1	F0	F2	QF
1.73	191.01	193.46	195.92	39.4

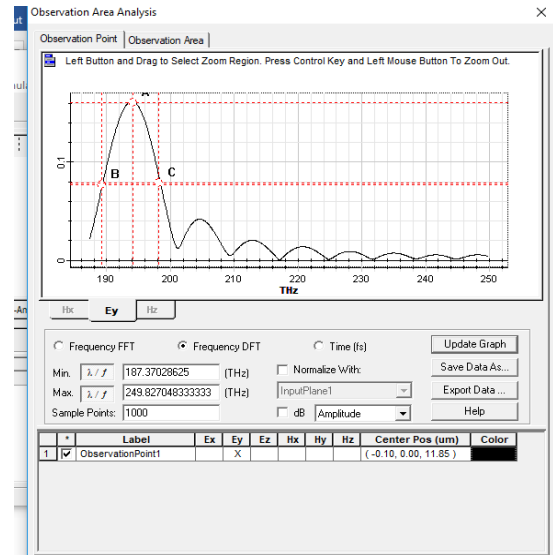


Fig 11: Graphical Characteristics of Nail with Minm.RI

Nail R.I	F1	F0	F2	QF
1.67	18 9.3	193.9	198.1	22

Hair R.I	Count ry	Age sex	F1	F0	F2	QF
1.554 4	Japan	23, Male	188. 3	193.5 5	200.4	15.9

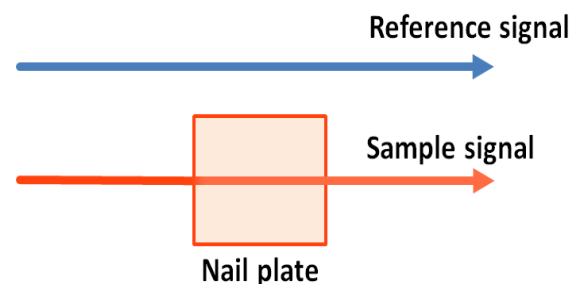


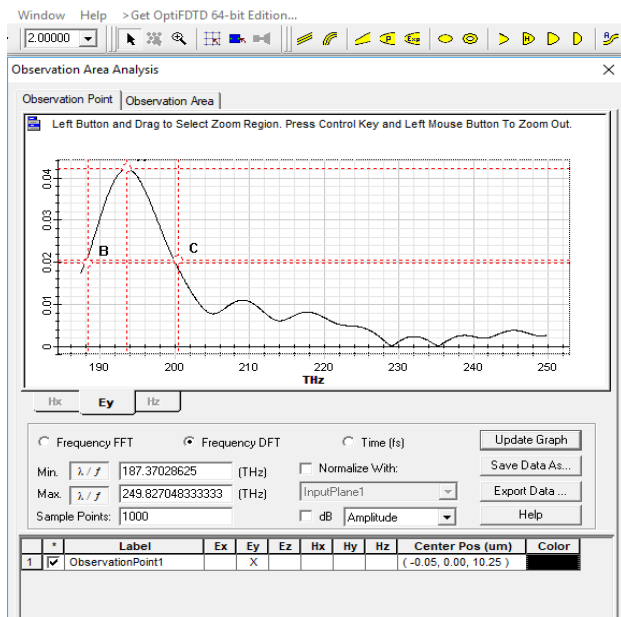
Fig 12: Pictorial Representation of determination Nail RI

The above fig shows how we can record the Values of the Nail by using different Samples.

## 5. RESULTS & DISCUSSIONS

The Individualisation of Hair is the most important Property. The morphological Properties of the hair changes according to the Geographical Regions, Area etc. There will be Chemical differences present in hair. It has different Refractive Indices based on region.



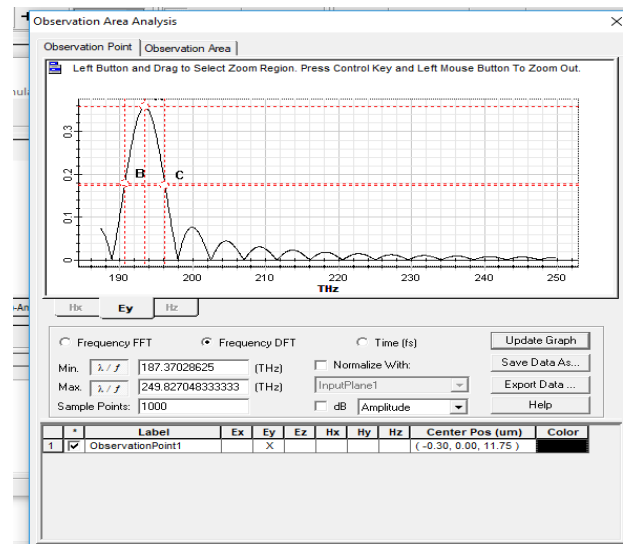


**Fig 13: Graphical Characteristics of Hair with RI**

Hair R.I	Country	Age sex	F1	F0	F2	QF
1.5505	Mexican	20, Male	188.6	193.3	198.1	20.4

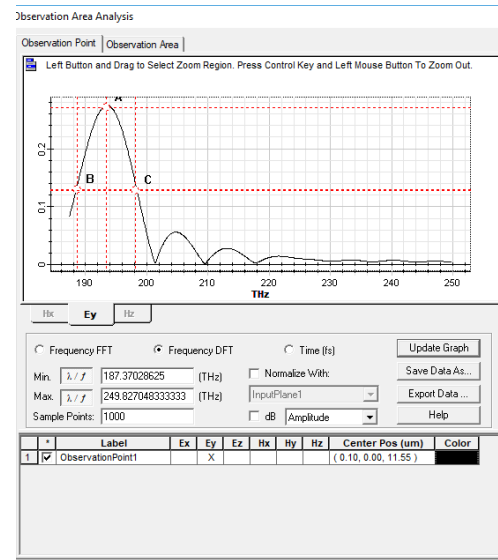
**Value of 1.5544**

Hair R.I	Country	Age sex	F1	F0	F2	QF
1.5532	Dutch, English	2, Male	190.88	193.47	195.91	38.56



**Fig 14: Graphical Characteristics of Hair with RI Value of 1.5532**

The refractive Indices taken are from the Cuticle part of the Hair & not from the Cortex Part of the Hair.



**Fig 15: Graphical Characteristics of Hair with RI Value of 1.5505**

## 6. DISCUSSIONS

Thus by Using the concept of Refractive Indices ,we can determine Quality factors of Nails, Hair ,Blood Serum, Different Blood types like A,B,AB & O.

Even by using Blood samples placed on an Optical Sensor we can determine many diseases like Malaria, Tuberculosis,Cholera,Diabetes etc.

Like this even the Sensitivity Factor can also be determined.Here Opti FDTD Simulation Software is used where Photons i.e Light is Passed through the Samples which may be Blood,Tears,Saliva etc which is placed on the Biosensors & the values are determined.

First Design is done & later Carried out by Using Analysis.This can be designed using Waveguides also.Here 32-Bit Simulation

is carried out. The Response obtained is of Time-Domain nature.

The design can be carried out using Linear waveguide, Ring resonators & other types of Structures also. The Outputs we can obtain both in 2-D & 3-D forms. But here we are using only 2-D Layouts. Even Spectrum analysis can also be done using Opti-FDTD.

Even Cancerous Cells could be determined in the body if we know their RI Values

## 7. CONCLUSIONS & FUTURE WORKS

Thus we can determine many Parameters using above Proposed technology & in future it can be implemented in Hardware form to detect Criminals & diseases.

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