Visible Emission Management Alternative Method 082 Certification Course Using

The Digital Opacity Compliance System Second Generation (DOCS II):

SIPRAC

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CTDEEP Office

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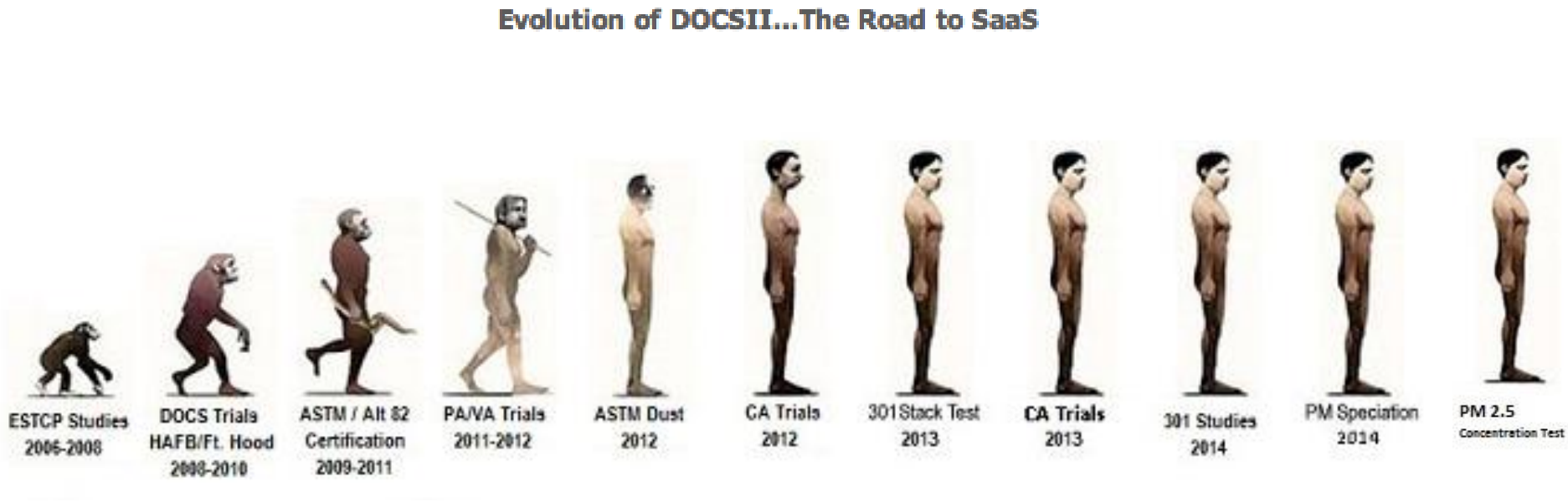
Evolution of DOCS II (2006-2016)



DOCS

DOCS II

DOCS II Web

DOCS II SaaS

DOCS III SaaS

Evolution of DOCS II

- 2000 to 2005 – Several research projects contracted by DOD & Universities
  - EPA Technology Transfer Network, Emission Technology Center Publishes PRE-008 - Determination of Visible Emissions Opacity from Stationary Sources Using Computer-based Photographic Analysis Systems

- 2005 to 2009 – Research continued by DOD
  - 2007 - ASTM Workgroup formed due to EPA consensus standard direction
  - 2009 - ASTM D7520-09 approved and published

- 2012 February – EPA Office of Air Quality Planning and Standards published US EPA Alternate Method 082 (ALT 082) in the Federal Register as a **Broadly Applicable Standard**, citing ALT 082 certified Digital Camera Opacity Techniques (DCOTs) can be used "in lieu" of Method 9, for all subparts of 40 CFR 60, 61 and 63
  - Federal Permit changes not required
  - Match ASTM D7520
  - Stationary, Mobile, Fugitive

US EPA ALT 082 Broadly Applicable Standard

Evolution of DOCS II Continued

- 2012 October – ASTM D7520-13 Update Approved by ASTM
  - Allows use of any Digital Image Device: High Definition Digital Recorders (Digital Video), (Cell Phones), all Sony CCD based Cameras (98% of Digital Cameras)
  - Allows certification of optical and digital zoom
- 2012 to Present – Fugitive Dust Applicability
  - Original research performed June 05'- June 11'
  - Full NIST Long Path Trans. certification completed January 2012
  - ASTM Research Report submitted to committee July 2012
  - Applicable to fugitives per 40 CFR 60 Subpart ooo October 2012
- 2013 – 301 Testing began to eliminate 7' ASTM stack exit limit
  - EPA desired "comparison with current compliance method"
  - Results ALT 082 is the same as Method 9 observers on stack exits greater than 7'.
- 2015- EPA opinion "Any Creditable Evidence" rule of Clean Air Act, makes applicable to all sources types "a picture says a thousand words".
- 2015- FerroAlloy NESAP defines DCOT as BACT, and mandates for Process Fugitive Emis.
- 2016 – ASTM D7520-16 Approved no limits on Applicability. Stationary, Mobile, Fugitive
- 2017 – FerroAlloy NESHAP final reconsideration ruling DCOT is BACT for Opacity.

DOCS II is the only ASTM D7520-16 & ALT 082 certified DCOT

DOCS II Global Acceptance

World Bank Requires,<20% Opacity Guarantee for Payment

ASTM D7520-16, used for World Bank Opacity Measurement

Leading Organizations in Conservation, Compliance, Sustainability, Training
Regulatory Policy and Enforcement, Local and International, all Agree

Digital Image Based Monitoring is the Way to GO

Digital Image Based Analysis, The "Best" Solution

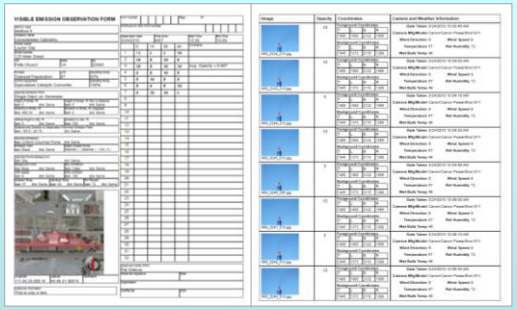
DOCS II Procedure

Capture

Transfer images automatically or manually

Send for Analysis

Receive Validated Digital **Report**



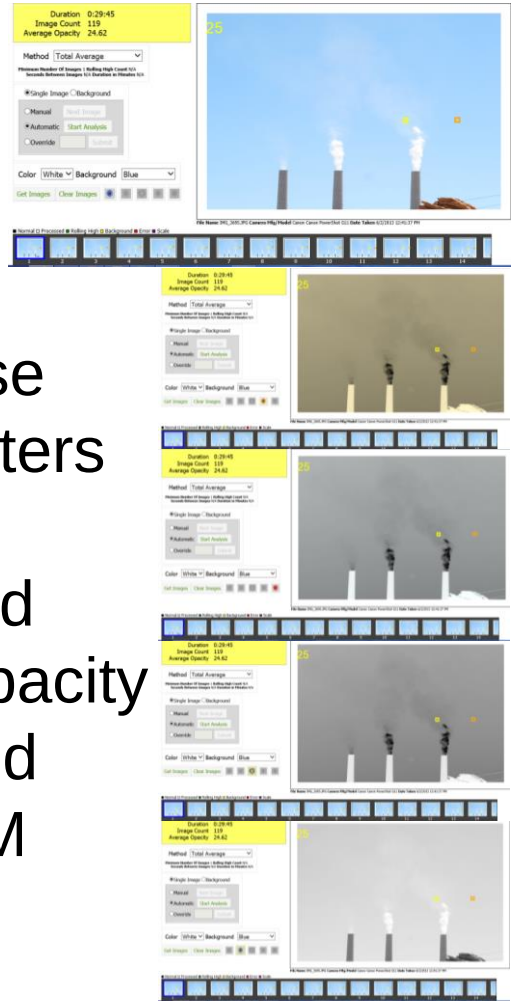
DOCS II Compared to Humans

- Less variation than Method 9 against NIST traceable transmissometer
  - Average deviation count for students at CARB certification is 23
  - Typical deviation count for DOCS II on same certification run is 15
  - Over 95% of DOCS II readings were zero or 1 deviation count
- Average deviation under ideal conditions (high contrast)
  - DOCS II $\pm$5%
  - Method 9 $\pm$10%
- Average deviation under difficult conditions (low contrast)
  - DOCS II $\pm$10%
  - Method 9 $\pm$15%
- Flexible applicability
  - Clouds, Rain, Snow, Trees, & Buildings
  - Day or Night
  - Close & Far (Limited only by camera zoom)

Simple, Fast, Reliable, Repeatable

How DOCS II Works

- An image or images of the emission source are captured by a certified Camera Operator using a certified camera
- The images are uploaded to the “Cloud” where they are acquired by a Certified Analyst who identifies the Regions of Interest (marked according to explicit rules and training)
- DOCS II then applies algorithms to the Regions of Interest and calculates the opacity of each image and the average, based on the selected rule, e.g. 6 min. avg., 3 min. avg.
- DOCS II generates a draft VEE report
- Source owner accepts and/or rejects the draft VEE report
- DOCS II generates final VEE report and archive record



Use Filters to find Opacity and PM

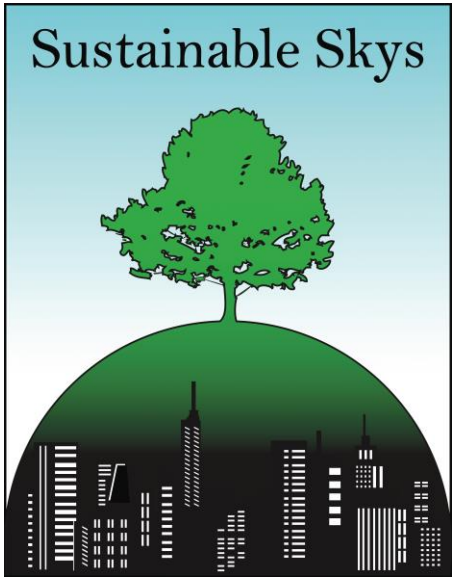
Simple, Fast, Reliable, Repeatable

Products Available

Regulatory Compliance, Community, Conservation

- Digital Opacity Compliance System second generation (DOCS II) – Digital Camera Opacity Technique, Software as a Service
- Spot the Smoke – Public Application
- Multi Point Visible Emission Survey Method 22
- Virtual Watch: Stacks, Flares, Vents, Continuous Near Real time Opacity Monitoring and PM Concentration Estimates

GAS and Oil MACT ooooa:
If you use a combustion control device, you must also maintain a continuous pilot flame at all times of operation and conduct monthly visible emissions tests. You must conduct the visible emissions test for 15 minutes using EPA Method 22. Devices must be operated with no visible emissions, except for periods not to exceed 1 minute during any 15-minute period.[§ 60.5415a(b)(2)].



Community Air Protection Program: Technical Summits - February 2018

The California Air Resources Board (CARB) invites you to participate in technical summits on the implementation of the Community Air Protection Program (Program).

Products Available

Regulatory Compliance, Community Conservation

Software As a Service

Observation Analysis

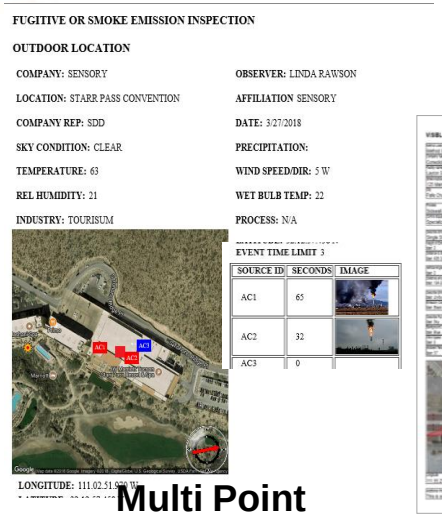
Observation Analysis

MPG/JPG VEE Process

MPG/JPG VEE Manage

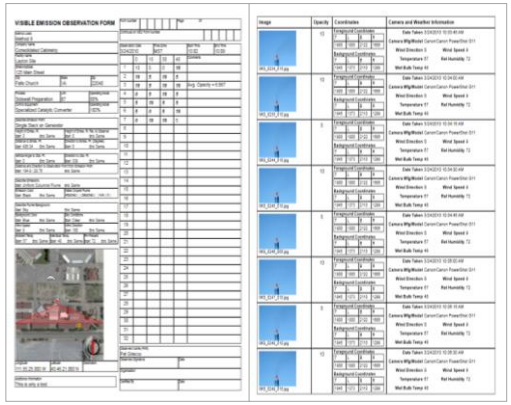
Obs. Event Trans for Analysis

Onsite Observation Switch Archive Storage



Multi Point Method 22 Surveys

Electronic Complaints

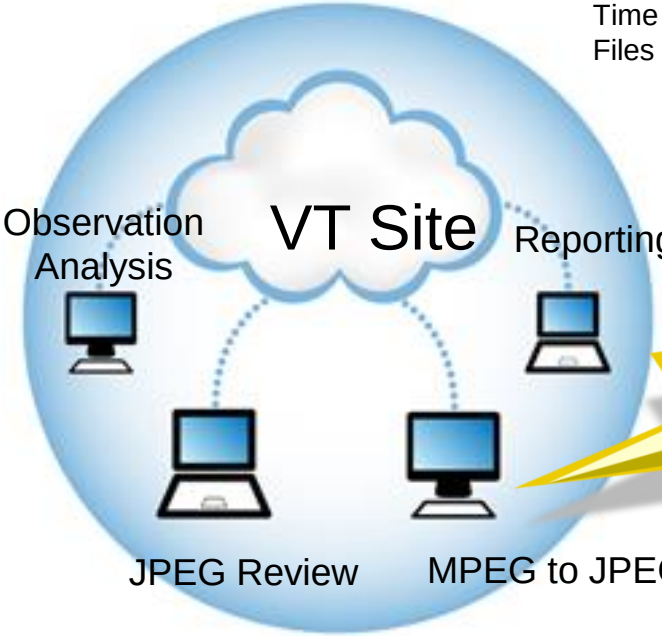


Electronic VEE Reports

Flare Monitoring System with Opacity Event Reporting

Convert to JPEG every 15 seconds
During marked event times
and display for observation cut down

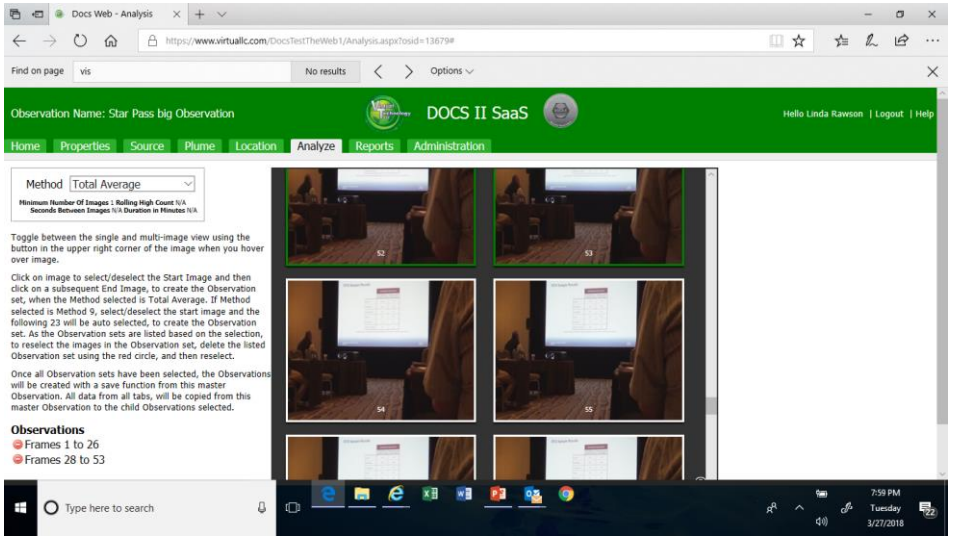
Time Marked
Files to Cloud



Flare Site

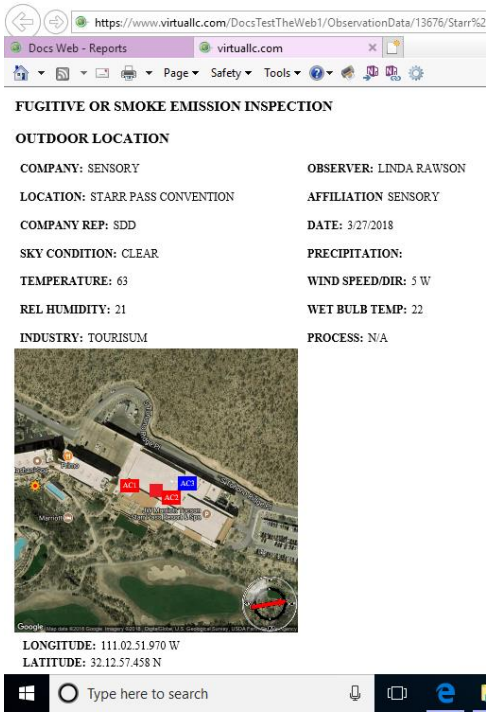
Local Mounted
Intrinsic all weather
Internet Protocol Cam

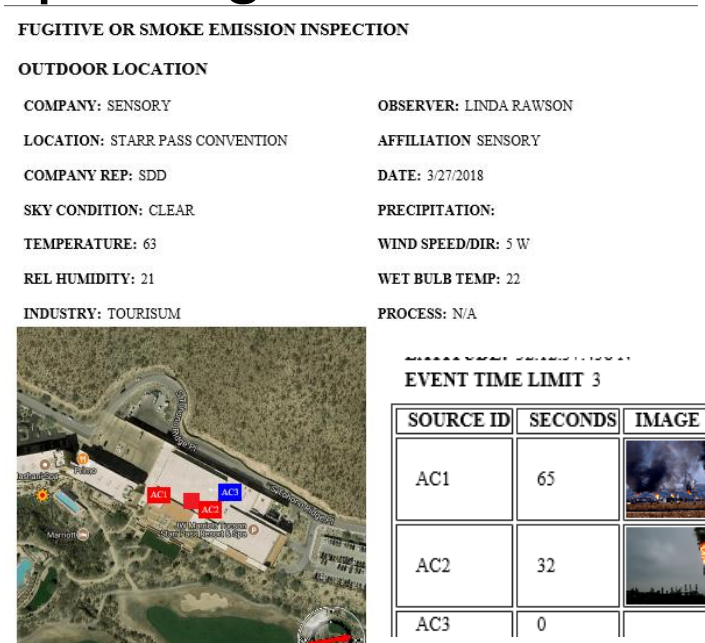
Local copy of MPG4 “video files” mirrored high capacity drives, Archived monthly Time marked by “Control Operators log” for events.



Remote copy of MPEG “video files”
Control Operators log, time marked for events.
Cuts MPEG into JPG at 15 second increments
Extracts JPG sets (Observations)
Runs screening on Observations
Marks observations JPG w opacity.
Generates Monthly and Semi Annual report.

Gas & Oil OOOOa Fugitive Emission Survey Opacity Event Reporting





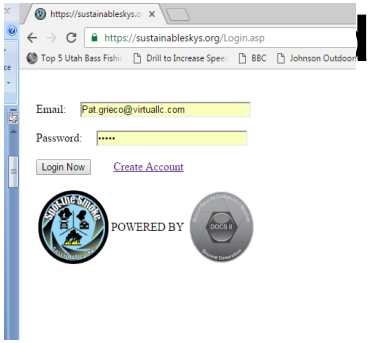
- User drags the emission points from facility onto map.
- Emission Points all start Blue
- User touches each Emission point as they see emissions
- Emission points toggle color Green on Red off
- Clock displays survey time and remaining time
- End of Survey sum totals all on/off events by source and compares to limit
- Generates Survey report listing emission units, visible emission time
- User prompted to record picture of exceeding emission units.

Coalition For Clean Air Citizen Science

California Assembly Bill 617 Community Air Protection Program Now Law and

Navigate to SustainableSkys.Org

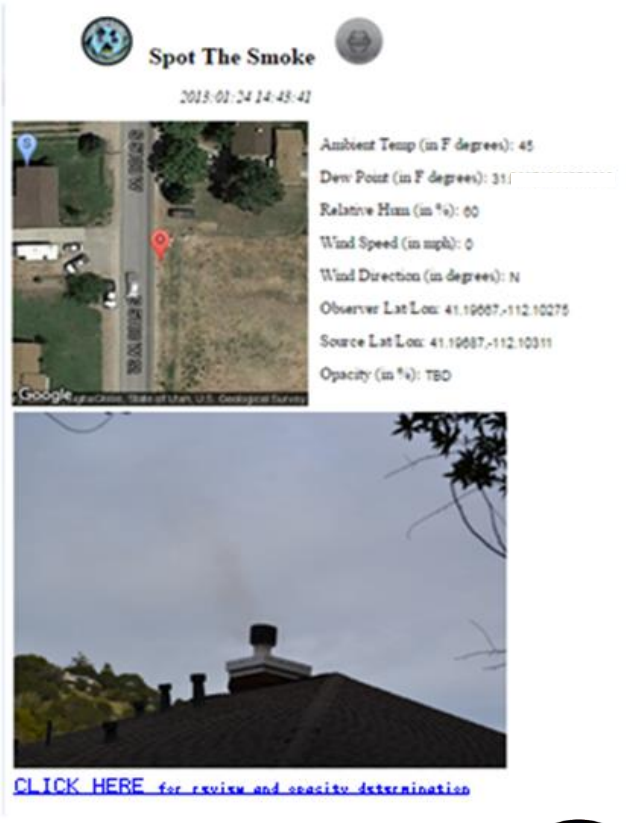
Log In or Create an Account



Submit to create a Draft Report

Submit Draft for Opacity Analysis

Receive Final Report



Take or Attach an Exiting Picture

Touch the Screen to Indicate Where you are looking

2-5 Billion Dollars

To Build Community Air Monitoring Infrastructure

Spot the Smoke
CA AB 617 Community Air Protection Program

- Spot the Smoke Released in March 2014 (7 Step)
  - Buggy and did not operate well on iPhone (Safari) platform
  - Revision 2, in June 2015 still has browser compatibility (5 Step)
    - works plug and play 70% of the time.
  - Revision 4, Released January 2017, (3 Step)
- Stationary Sources
  - Requiring Permits, require other compliance monitoring
  - Category people pay to expedite
- Mobile Sources
  - Smaller mobile sources, cars, trucks
  - Requiring frequent licensing
  - Larger mobile sources, planes, trains, ships
  - Reduced licensing frequency
- Fugitive Area Sources
  - Larger sources farms and agriculture
  - Fugitive emissions, largest category of undocumented air pollution
  - Includes Wood Smoke also category people pay to expedite
- Natural Area Sources (spikes during event)
  - Great Dust Storm and Forest Fire Pictures
  - Not predictable

Gas Turbine Stack Opacity and PM Sources

Common Sources of Liquid Fuel GT Opacity:

- Acid mist: H_2SO_4, etc..
  - < 5 ppm H_2SO_4 for 20% opacity
- SO_3 (Blue plume)
  - ~ 10 ppm SO_3
- NO_2 (Yellow plume)
  - ~15 ppm NO_2
- Solid PMs
  - Carbon soot
  - Ash
- Other vapors
- UHCs reactions with NO_x & SO_x(?)
  - Greatly increase NO_2
  - Maybe SO_3
- Mitigations:
  - Stack temperature (SOx, H2SO4)
  - Fuel composition
  - Oxidation catalyst
  - Carbon soot catalyst
  - ESP, Electrostatic Precipitator
  - FGD, Flue Gas Desulfurization
- Measurement:
  - Digital Opacity Meter, EPA 082
  - Human, EPA 9

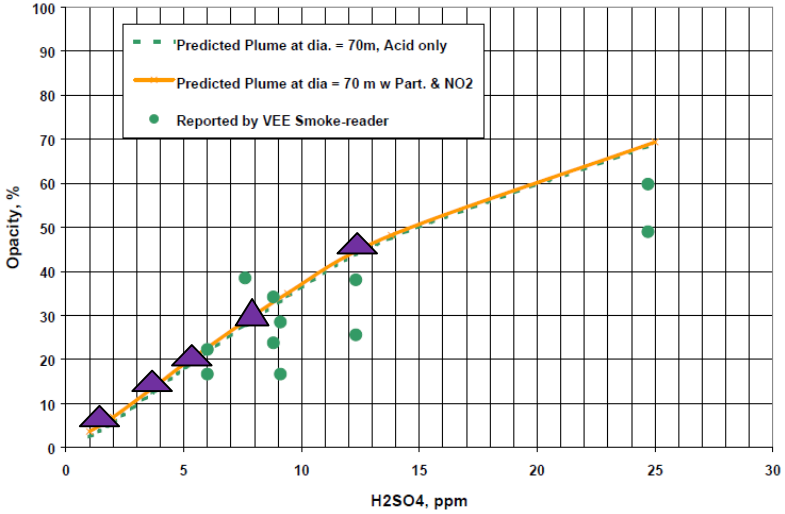
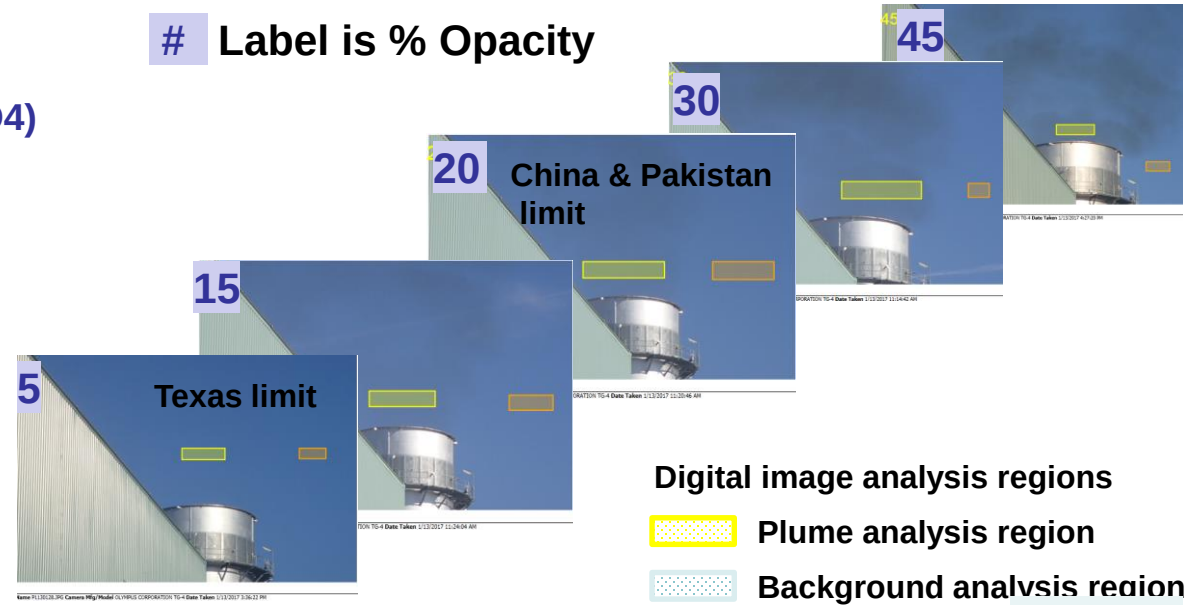


Figure 7.10. Comparison of predicted plume opacities versus H_2SO_4 concentration with those measured by a certified "smoke reader" for a 1300 MW unit with a pollution control system consisting of an SCR followed by a cold-side ESP and an SO_2 scrubber.

 # Label is % Opacity



Digital image analysis regions

Plume analysis region

Background analysis region

GE Power

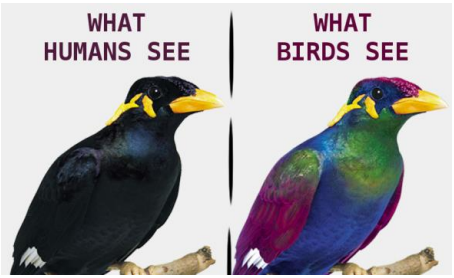
Gil Kraemer

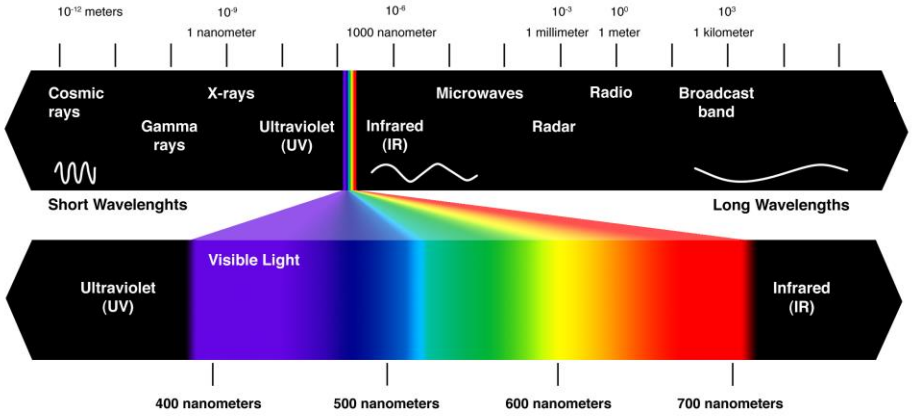
Future Now: PM Speciation

- Measuring PM Concentration via Light Scatter & Energy Emittance

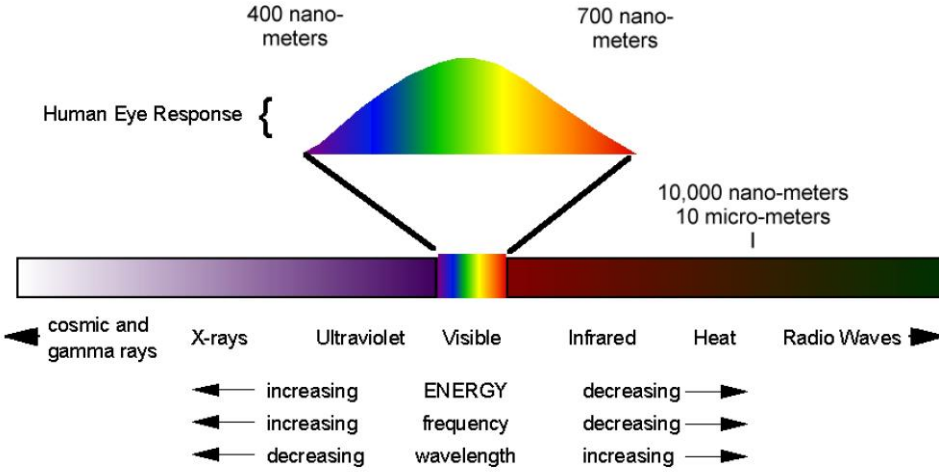
Light Wavelength

Sony CCD Based Cameras “see” an wider spectrum than does the human eye, like birds “see” more UV



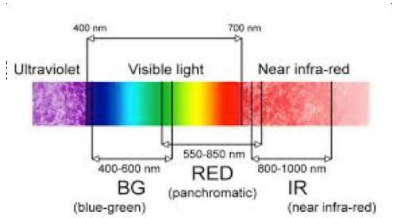


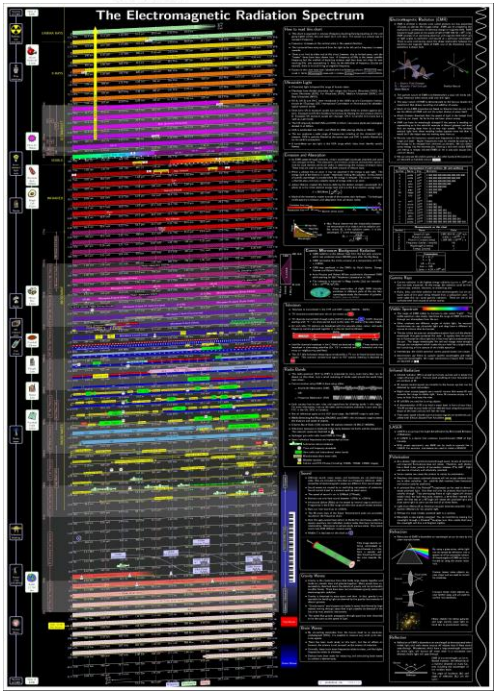
Sony CCD Based Cameras “see” from the non-visible UV to the non-visible IR spectrum and 1080P is dense enough to measure scatter in all directions.



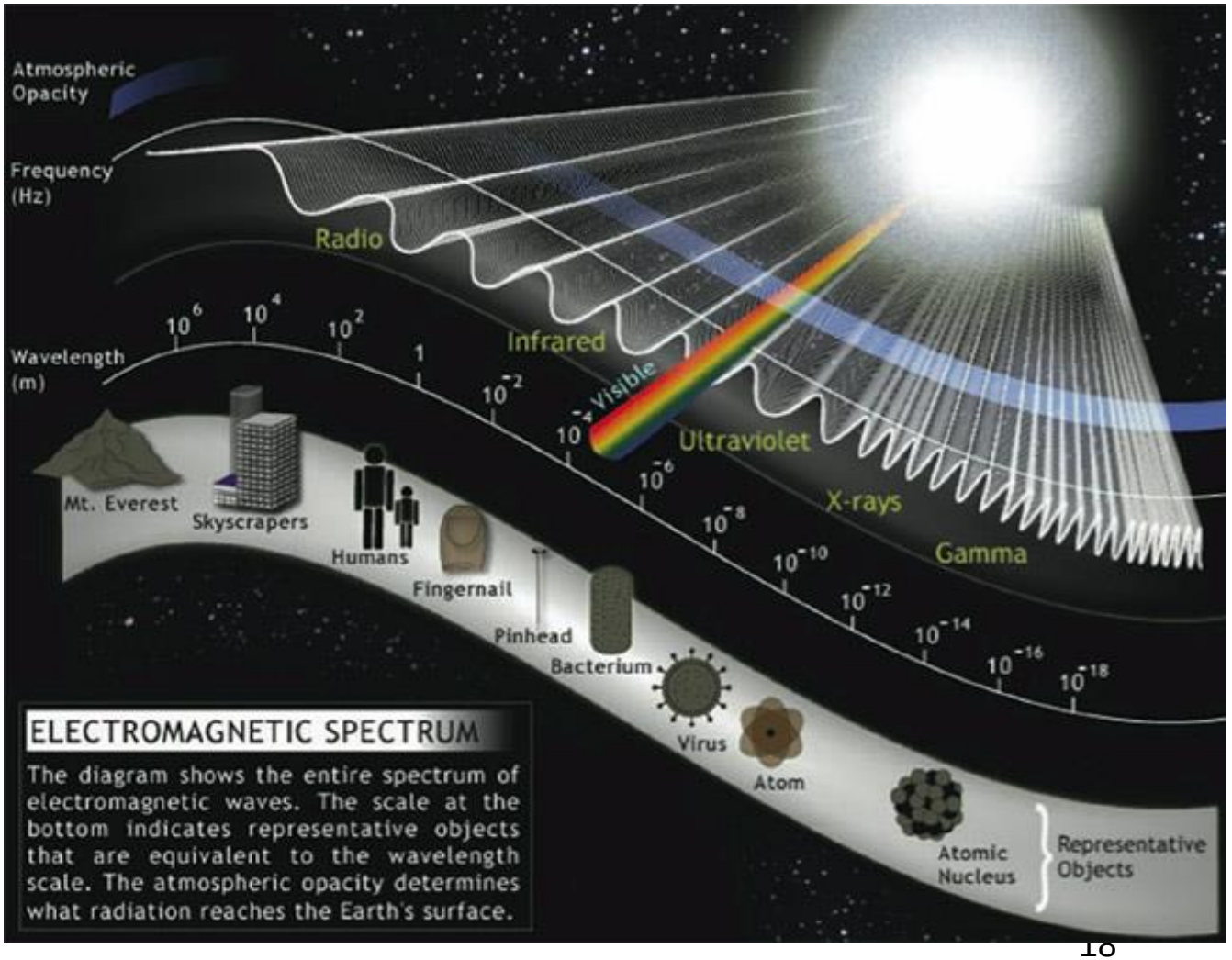
Foundational Physics Principles Universally apply to plumes, e.g. as particle size decreases energy emittance and frequency increase .

All Consumer Cameras Record UV, VL, IR, Spectrums

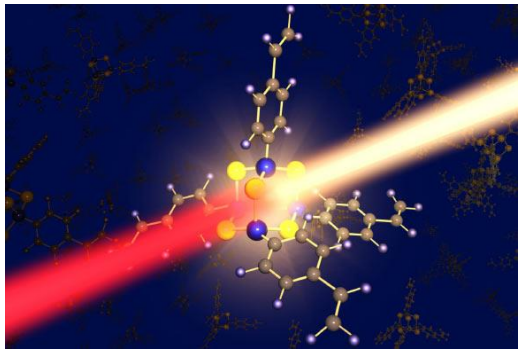




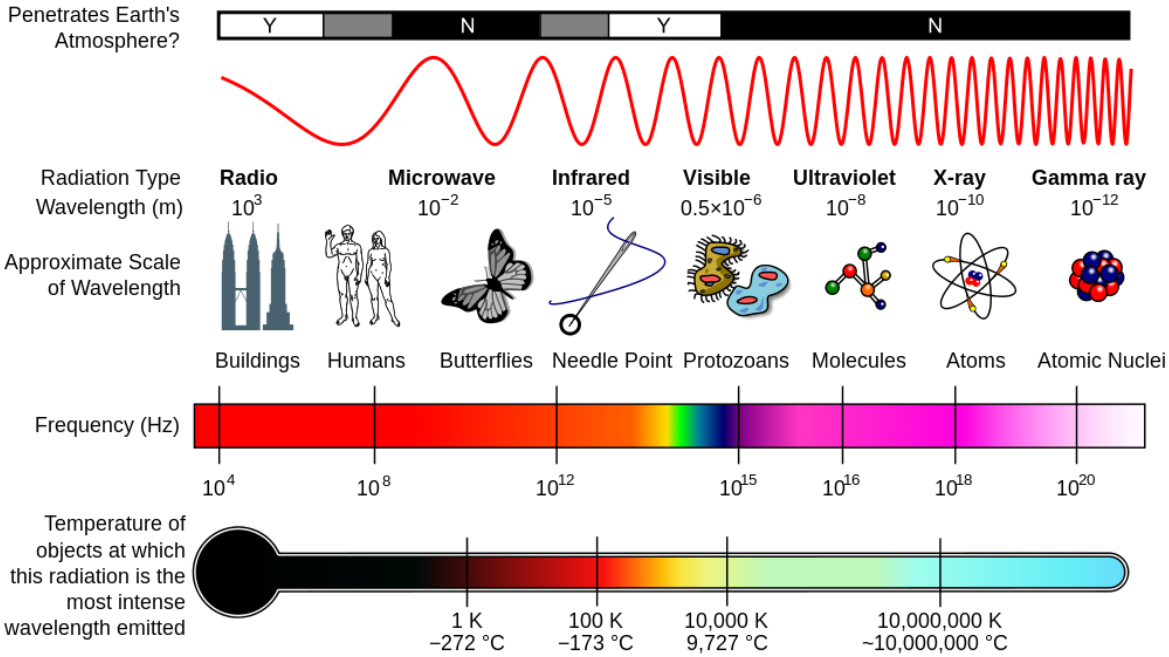
Opacity, blended with UV/VL/IR light generates expected energy profile



Digital Images Contain The Building Blocks



Light Scatter is a well known Measurement Principle, As Particle size = Wave length = known Scatter (LiDAR)



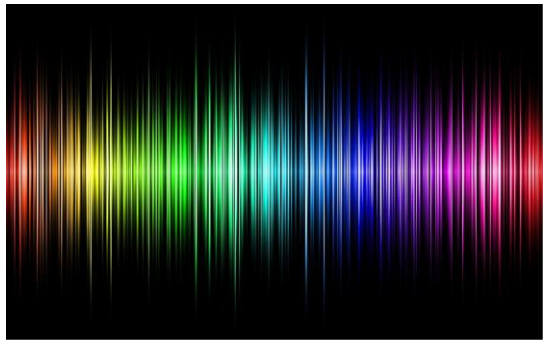
Temperature change measurement is the baseline for all FTIR based Optical Gas Imaging

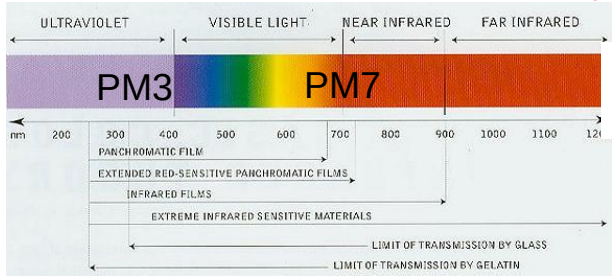
Each Pixel holds the values to measure scatter, temp change

Patent Pending, Magic Software

Cameras the human operates

Document Light Scatter the human can not see and





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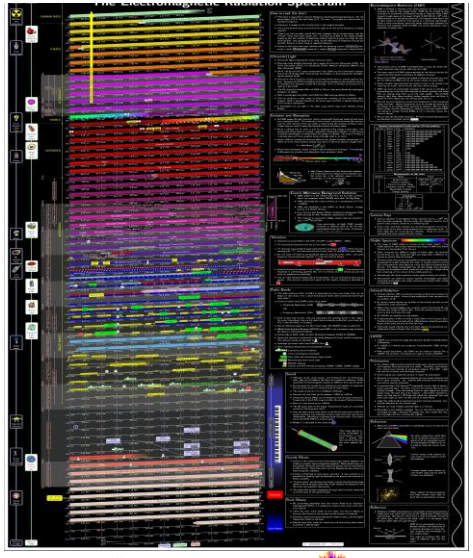
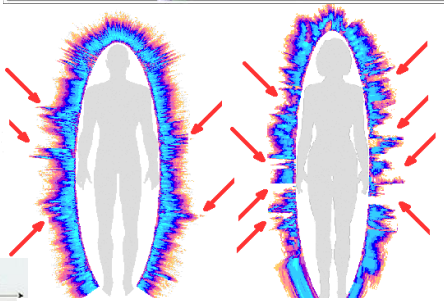
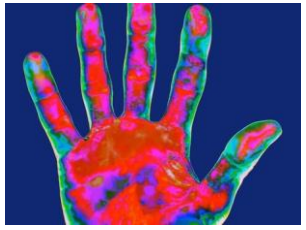
Energy/Intensity Level the human can not feel





Temperature delta's the human can not feel



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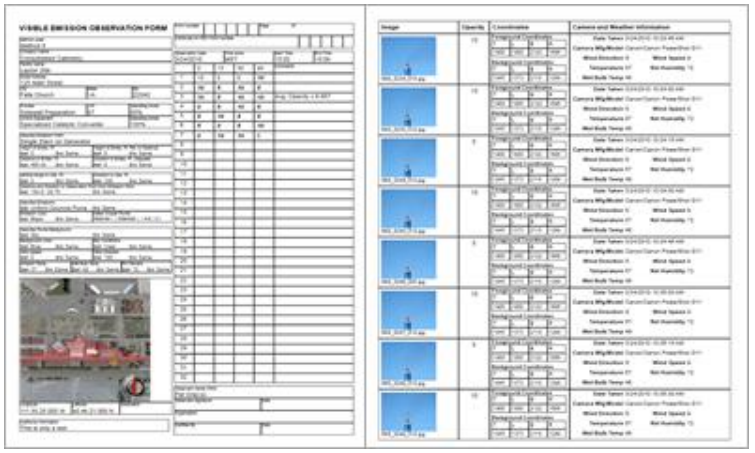

In Selected ROI's

30 % Opacity
PM < 3m @ 20%
PM 3-7m @ 35%
PM > 7m @ 45%

Automated Visible Emissions Monitoring and Electronic Reporting of Visible Emission Surveys (Method 22) Opacity Observations (Method 9) Stack/Flare Watch (custom)

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