

Adventures at 630/850 nm

476 / 352 THz

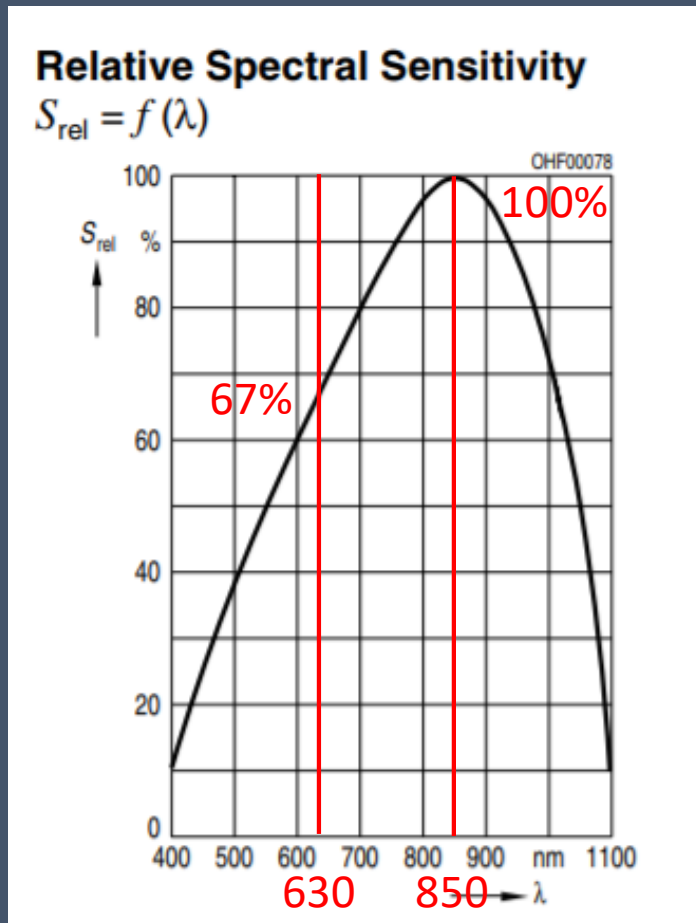
WFOT - K0XL

AURORA 2019

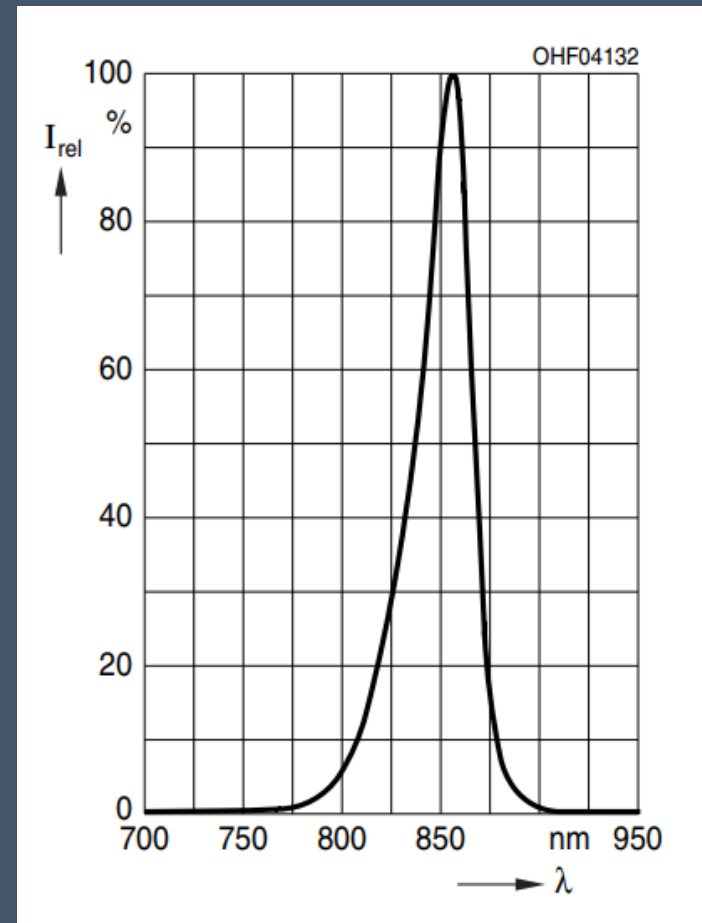


Waren Ferber - WFOT Rob Jahnke - K0XL (2019)

Why 630 / 850 nm ?

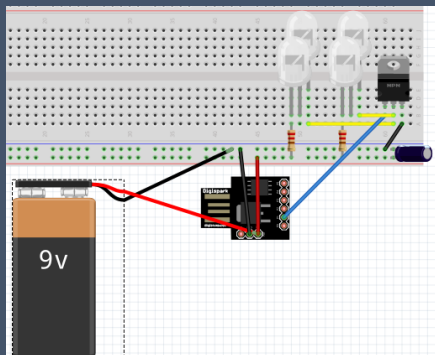


BPW34 Silicon PIN Diode Detector

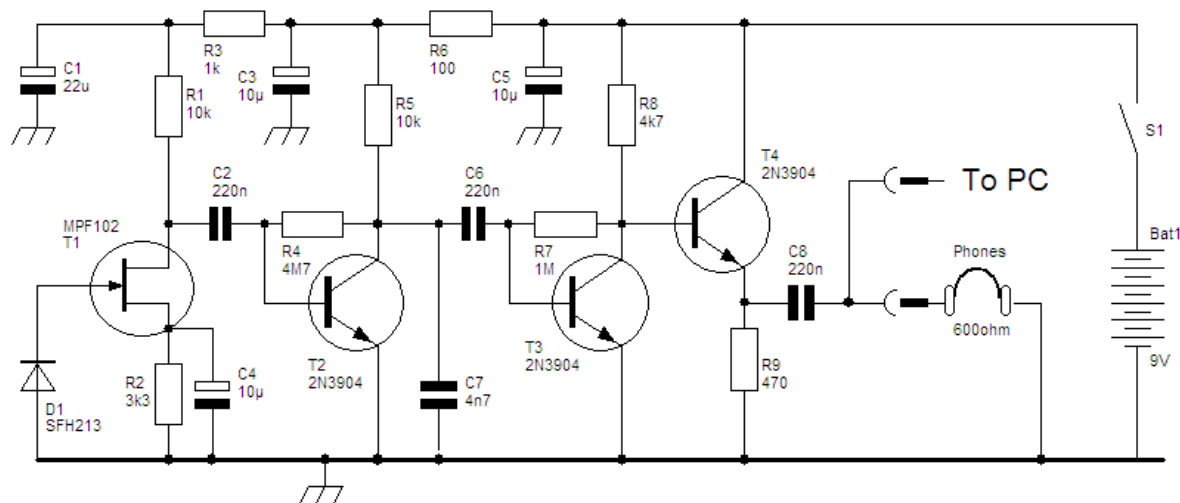


SFH4550 IR LED

WF0T 850 nm Beacon with ATTiny85



2016

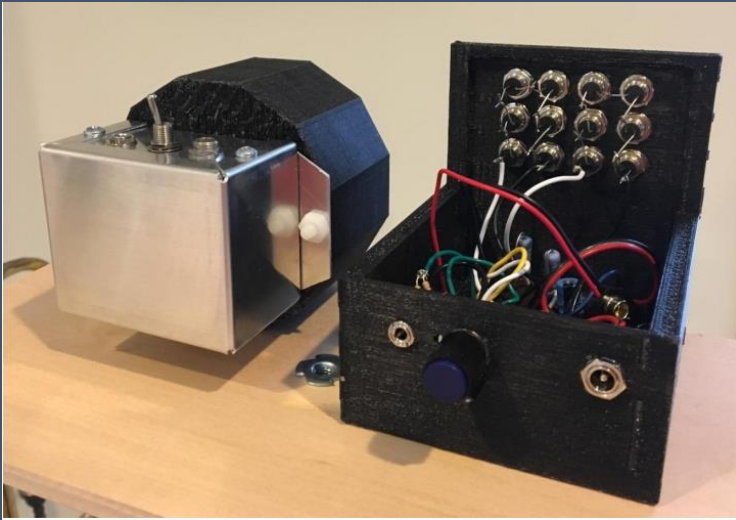


K3PGP derived 481THz receiver

Rev A 10.3.13 G3XBM



WF0T Transmitter/Receiver 2018



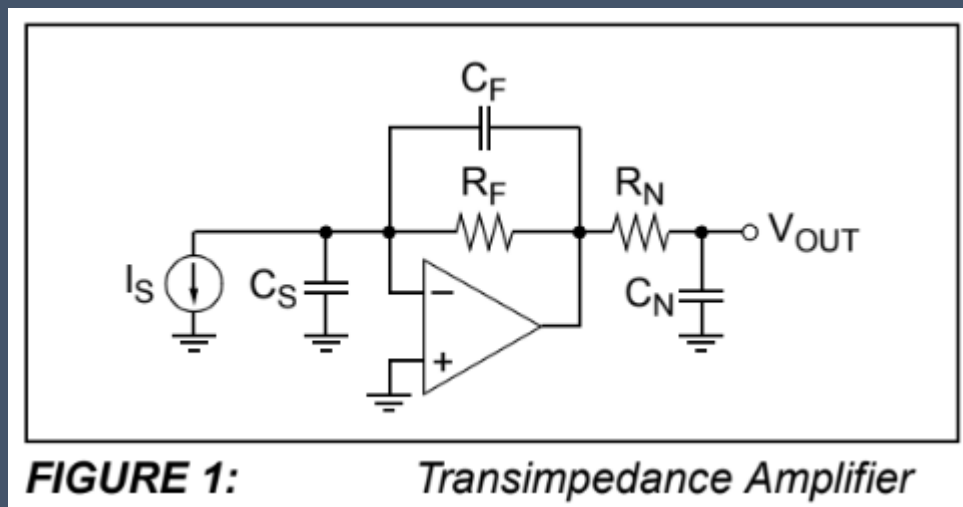
- 555 Timer PWM
- 20% duty cycle
- OpAmp Mic Amp
- 12 SFH4550 IR LEDs
- KA7OEI (K7RJ)
V3.1 Receiver



90 mm fresnel lens
With 50.8 mm focal length

WF0T Activity 2018

- Enhanced ATTiny x5 modulator and microphone amplifier
 - Lowered parts count, easier assembly
- Various Experiments with WA2VOI
- Developed new “Rail” mounting system
 - Stable platform
- Added 8.5 x 11 Fresnel Lens to Receiver
- Exploring simple (cheap) Transimpedance Amplifier Receiver with MCP6021 Op Amp



KOXL Activity

- 2018 Finished first operational system
 - Optimized PWM Modulator for GREAT Audio
 - Demonstrated PSK31 through Optical Link
 - Modified Atomic Beam Flashlight - 850nm CREE LED
 - Five inch Glass lens added to receiver
- May 10, 2018 2 km contact with 30dB+ Gain Margin
- May 11, 2018 635 m contact in DAYLIGHT
 - 30Db+ Gain Margin (or Link Margin if you like)
- Conclusions:
 - 20 km possible during daylight
 - 64 km possible at night

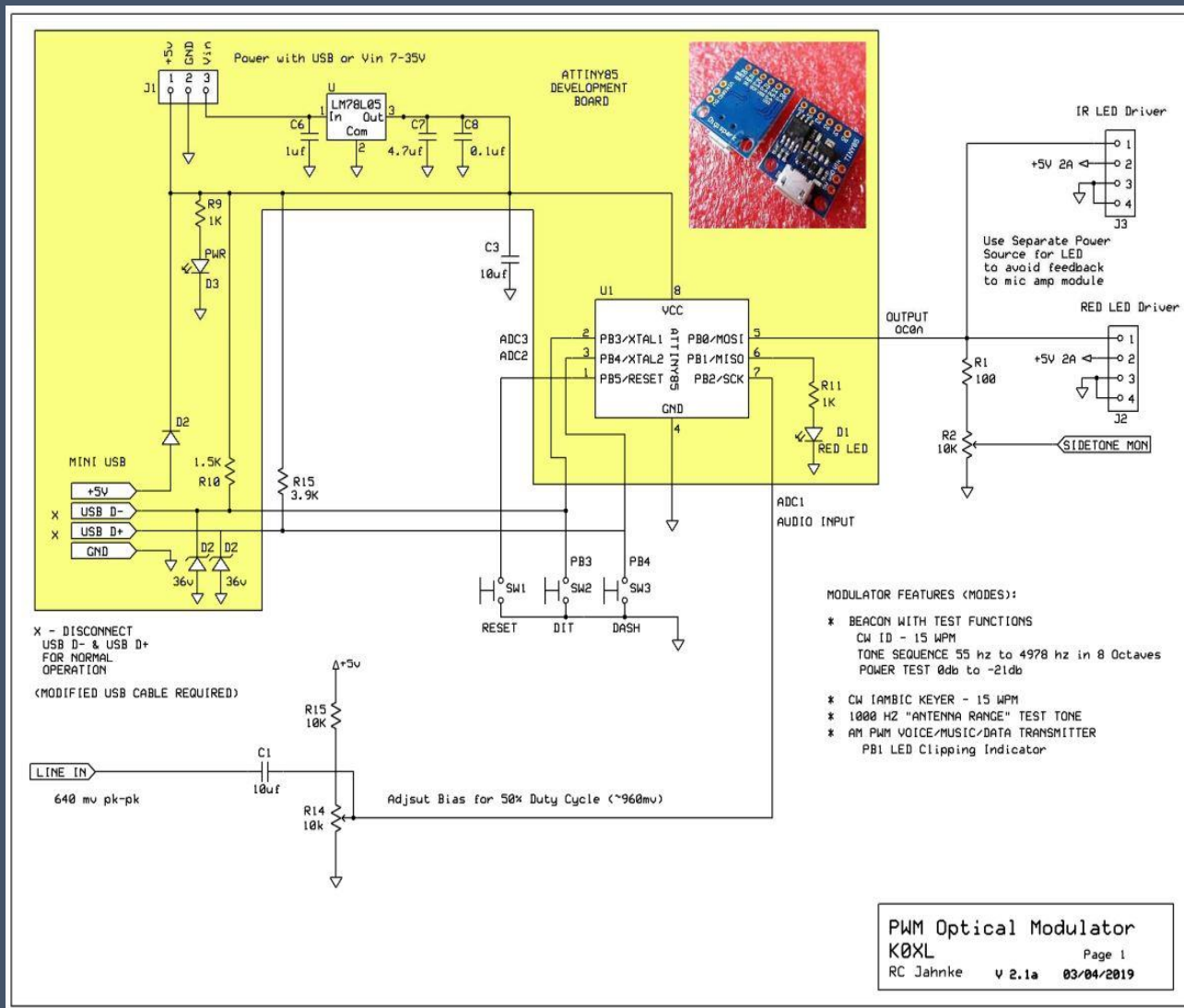
2018 Optical System



Grand Marais Field of View

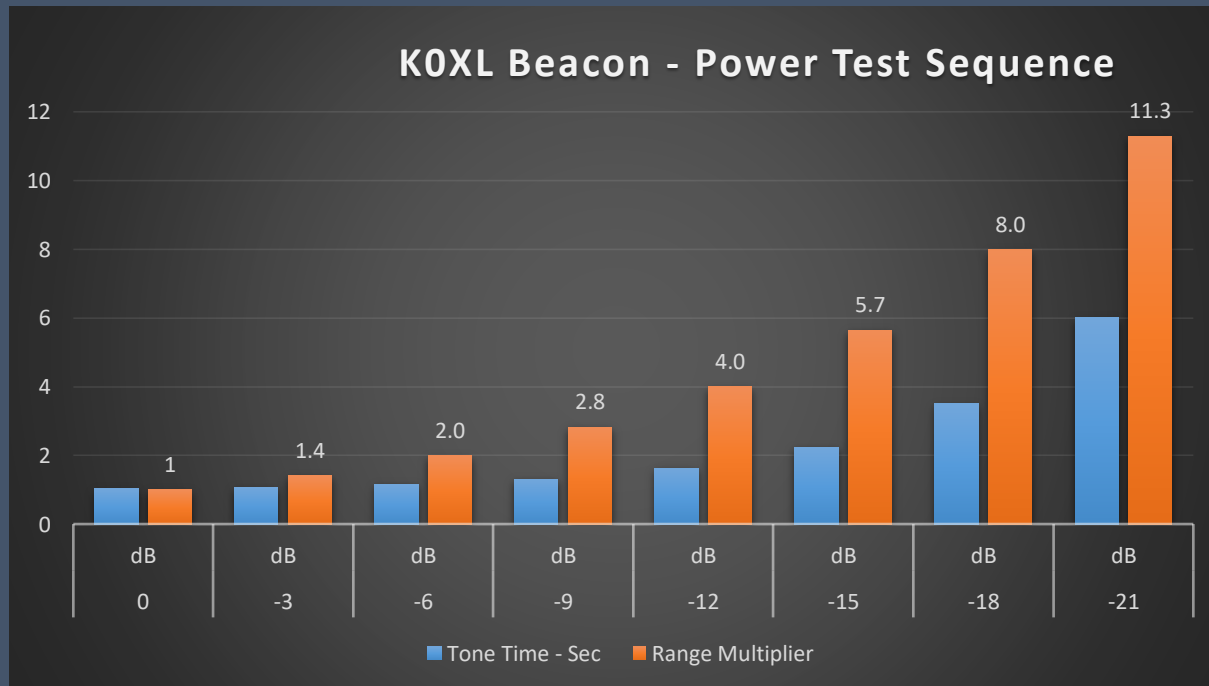


ATTiny85 Beacon - Modulator



K0XL Beacon

- CW 15wpm “Hello de K0XL/B”
- Tone Test 55, 110, 220, 440, 880, 1760, 3520, 4979, 55 hz
- Power Sequence



KOXL Activity

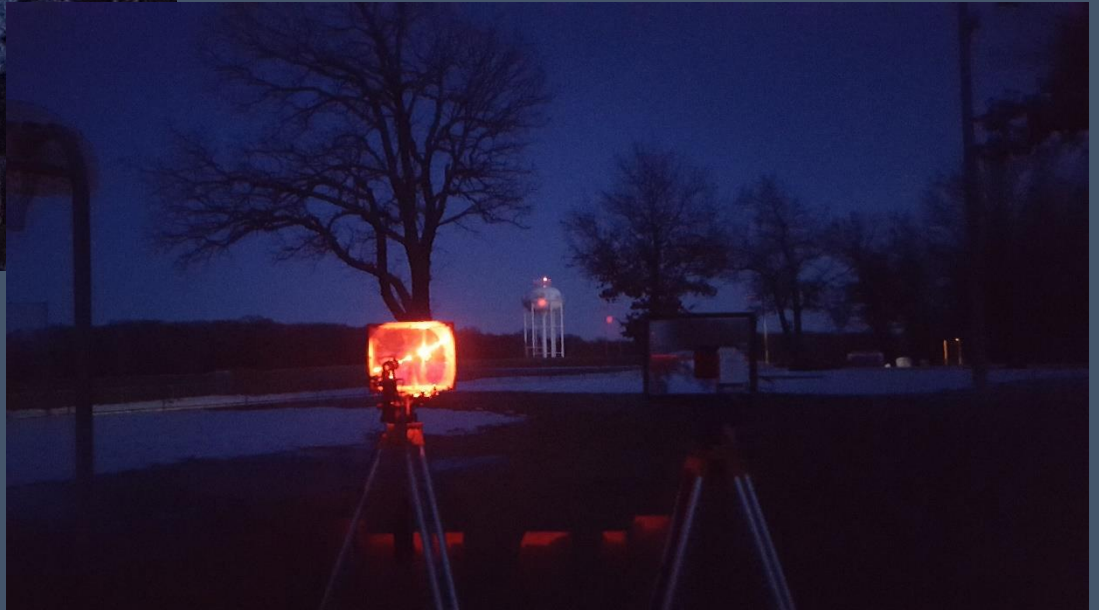
- 2019 Many Refinements
 - Adopted Warren's new "Rail" design
 - Added a second 630 nm and 850 nm Flashlight
 - Built two more ATTiny85 Modulators
 - Adopted 8.5 x 11 Page Magnifiers for Xmit & Rcv
- Achievements:
 - Demonstrated PSK31 and Digital SSTV (EasyPal)
 - Bounced Beacon & Music off Trees 1800 ft away
 - Bounced Beacon & Music off Water Tower from 1050 ft
 - Bounced Beacon & Music off Water Tower - 4 km path
 - Bounced Beacon off Clouds at 900ft, 1400ft, & 2100 ft Alt
 - Beam aimed 30 degrees above horizon – 8400 ft (2.5km) path

2019 Optical System



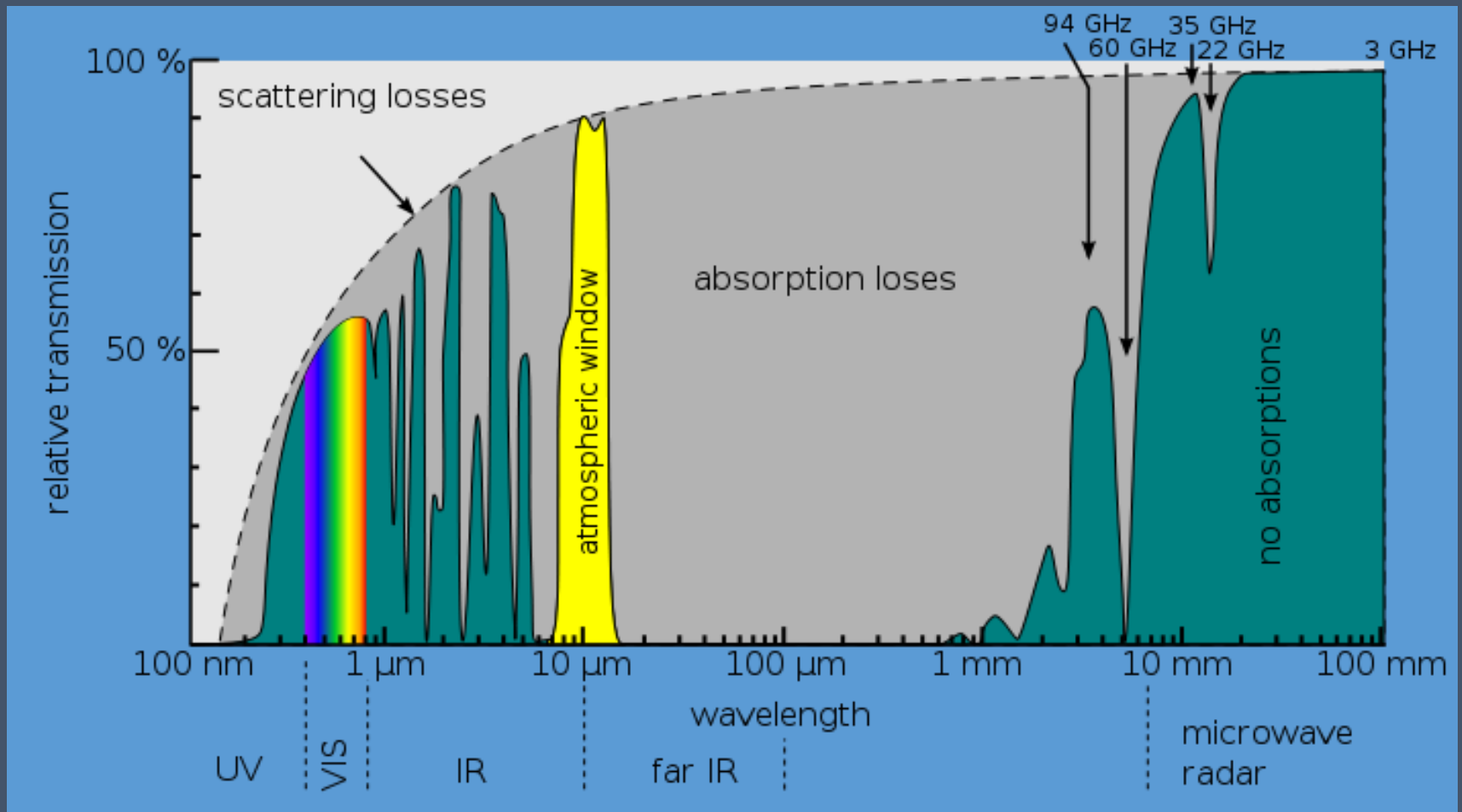
Cloud Bounce

Water Tower Experiment



10ft Square “Spot” on Water Tower

Atmospheric Absorption



https://commons.wikimedia.org/wiki/File:Atmospheric_window_EN.svg

Scattering Losses

Visibility (km)	dB/km 785 nm	dB/km 1550 nm	Weather
0.05	340	340	Fog
0.2	85	85	
0.5	34	34	
1	14	10	Haze
2	7	4	
4	3	2	
10	1	0.4	Clear
23	0.5	0.2	

Comparison of laser beam propagation
at 785 nm and 1550 nm in fog and haze
for optical wireless communications
Isaac I. Kim, Bruce McArthur, and Eric Korevaar

February 2001
Optical Access Incorporated
10343 Roselle Street
San Diego, CA 92121

TABLE 2. Visual range conditions and attenuation from extremely clear to dense fog (based on the International Visibility Code).

Description	Visual range	Loss (dB km ⁻¹)
Dense fog	40–70 m	250–143
Thick fog	70–250 m	143–40
Moderate fog	250–500 m	40–20
Light fog	500–1000 m	20–9.3
Thin fog	1–2 km	9.3–4.0
Haze	2–4 km	4.0–1.6
Light haze	4–10 km	1.6–0.5
Clear	10–25 km	0.5–0.1
Very clear	25–50 km	0.1–0.04
Extremely clear	50–150 km	0.04–0.005

ATMOSPHERIC LASER COMMUNICATION
NEW CHALLENGES FOR
APPLIED METEOROLOGY
BY KENNETH W. FISCHER,* MICHAEL R. WITIWI, JEFFREY A. BAARS/ AND T. R. OKE
May 2004

Key Components



\$0.70

SFH4550 850nm LED
6 degree beam width
100 ma



\$1

CREE LUXEON 3W 630/850 LED
120 degree beam width
1000 ma



\$1.50

ATTiny85



\$0.50

BPW34 Silicon PIN Diode Detector



\$5 - \$10

Carson DM-21
8.5 x 11
Page Magnifier
320mm focal length

Next Steps

- Use Power meter to optimize LEDs/Driver/Lenses
- More DAYLIGHT Experiments
- Test all modes at 10 km
- Expedition to Duluth
 - 10km, 20km, 30km, 40km, 50km
 - Tx/Rcvr at Enger Tower (Elev 600 ft above water level)
 - Tx/Rcvr ROVER along South Shore
- Interested ???

Resources

- WF0T Blog on Light Communications Experiments
 - <http://wf0t.blogspot.com>
- KA7OEI Optical Communications website
 - http://modulatedlight.org/optical_comms/optical_index.html
- G3XBM Blog
 - <http://g3xbm-grp.blogspot.com/2013/03/k3pgp-optical-receiver-optimised.html>
- DigiKey - MN based electronic parts
 - <http://www.digikey.com>
- Digispark ATtiny85 USB development board and additional shields
 - <http://digistump.com>
- F1AVY – Amateur Laser Experiments (site is in French, use Google Translate)
 - <http://f1avyepto.wifeo.com>
 - Cloud bounce presentation available
- Fritzing – Hardware and Circuit board tool
 - <http://fritzing.org>
- Cloud cover reports – Aviation Weather Center & CheckWx.com
 - <https://aviationweather.gov/metar>
 - <http://www.checkwx.com/weather>

Appendix

- K0XL Beacon/Modulator Schematic (pdf)
- K0XL ATTiny85 Beacon Code (.ino)
- K0XL LED Constant Current Driver Schematic/Data (pdf)
- KA7OEI (K7RJ) Receiver Schematic (pdf)
- Transmitter and Receiver FOV (pdf)
- Water Tower Experiment (pdf)
- Cloud Bounce Experiment (pdf)

Duluth Expedition

Enger Tower Do you see a Possible Problem ?



Duluth Expedition

There are Alternatives Enger Tower Pavilion



Duluth Expedition

There are Alternatives Abandoned School



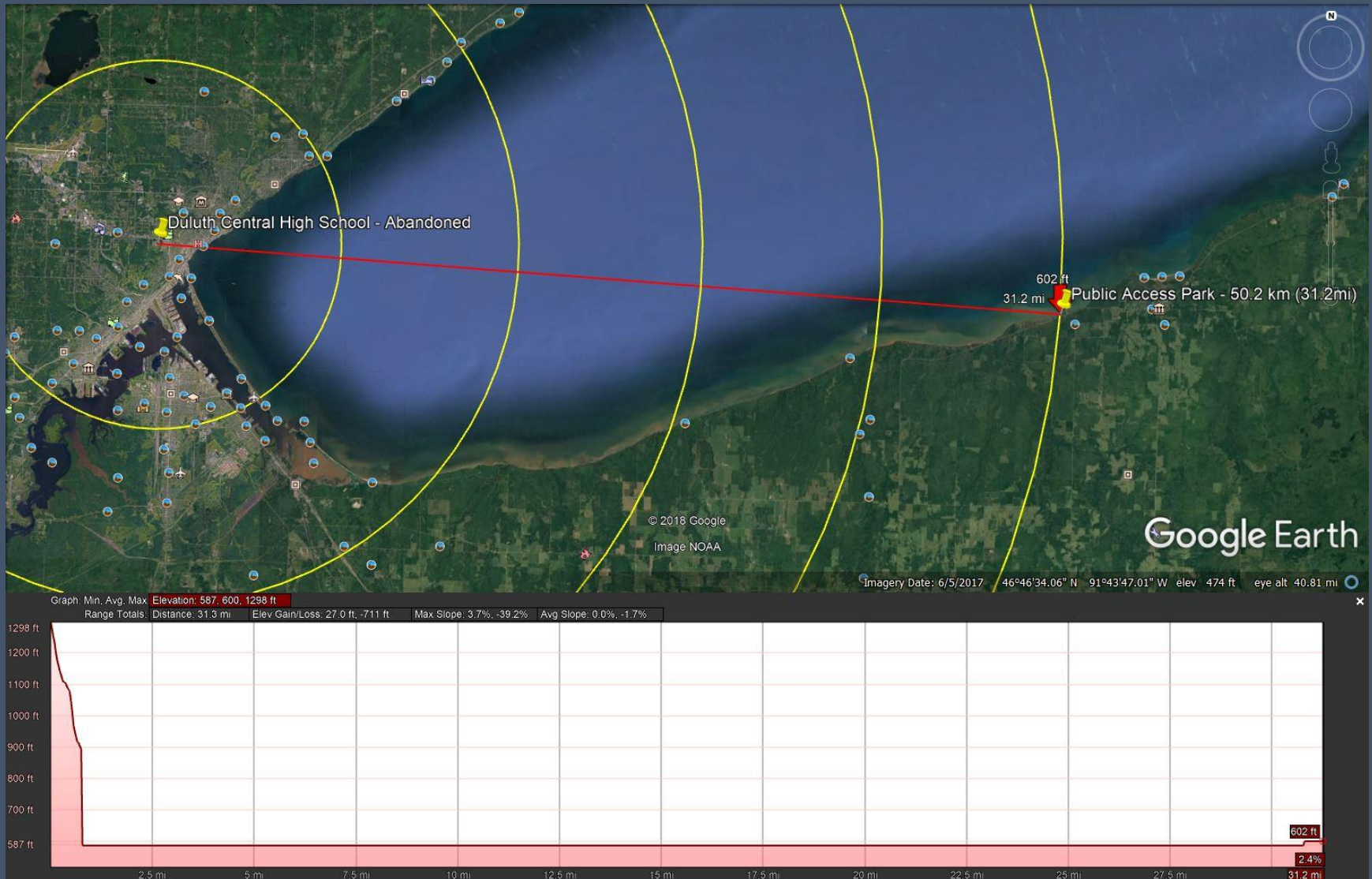
Duluth Expedition

There are Alternatives OOPS



BUT .. We have permission to park at the gate and carry equipment in!

Duluth Expedition – 50 km Path



Duluth Expedition – 50 km Path

Calculate the Line of Sight & Radio Horizon

Antenna height (h)

feet 

Calculate

Reset

Result

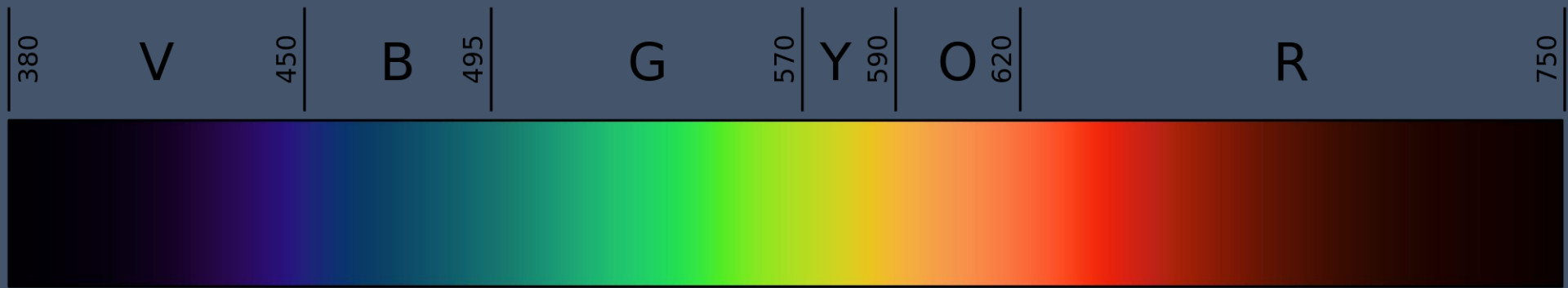
Line of Sight distance (d_l)

km

Radio horizon - Service range (d_r)

km

<https://www.everythingrf.com/rf-calculators/line-of-sight-calculator>



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