Time Lapses of the Night Sky

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by Lorenzo Comolli

Outline

- Intro: history
- Instruments and techniques: camera, lens, tripod, timer, jpg, ext battery, dew remover, raw, iso, memory, composition, dolly, panning, bulb ramping, magic lantern, hdr, hyperlapse
- Processing: video resolution, speed, compression, virtualdub (+deflicker), renaming files, lightroom, lrtimelapse, multi-track editors, music and licensing
- Sharing and conclusion: Youtube, Vimeo, video file download; articles, forums, authors; other kind of timelapses (geostationary satellites, eclipses, ...)
- Showcase: some of my best timelapses
- Discussion: Q&A, tips for imaging and processing a TL

Introduction

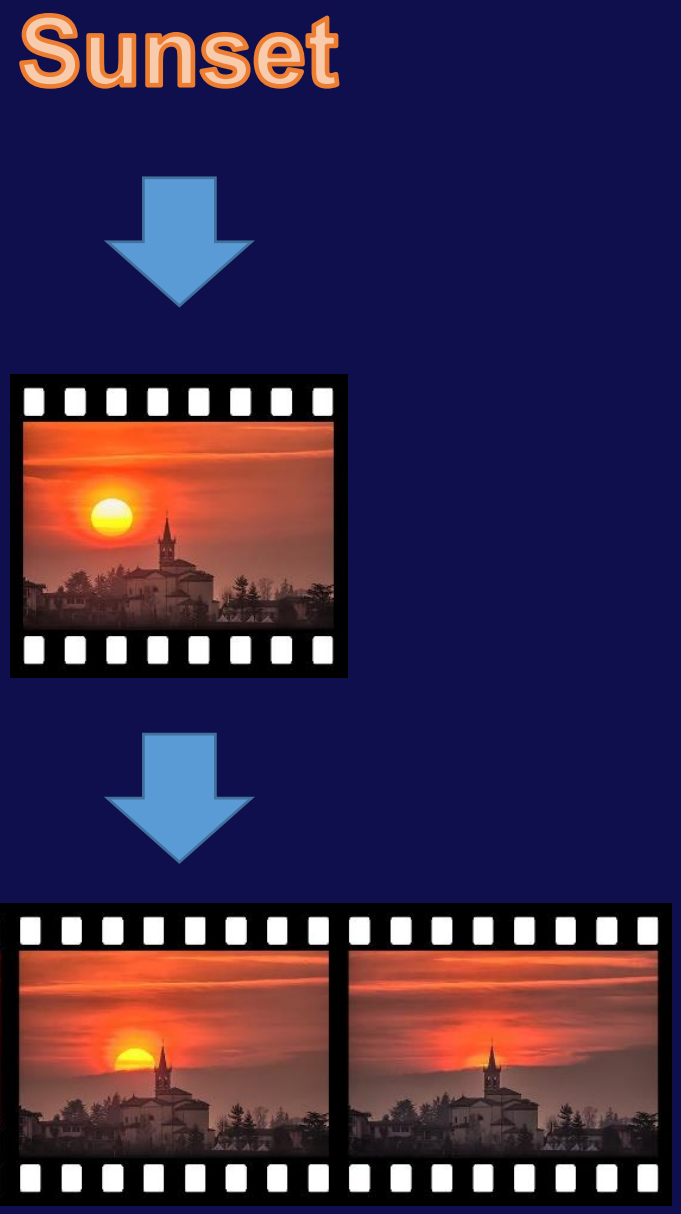
A picture is better that a thousand words...

... a video is better than a thousand pictures!

We see our world in motion, and our brain is much more interested in video respect to still pictures

Time Lapse = intervals of time (in short TL)

A way to accelerate time for slow phenomena (like flower opening, cloud motions, night sky...)



Historical background

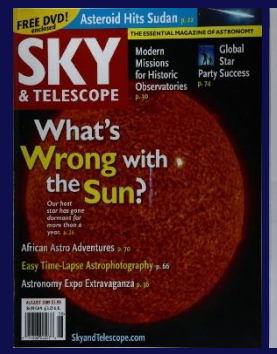
Introduction

Making night sky time lapses before ~2000 was very difficult.

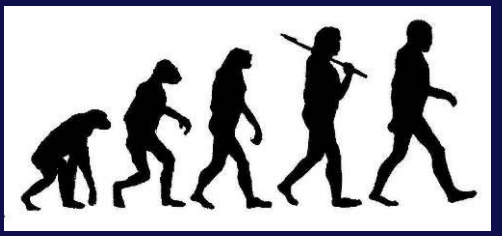
Modified *film* cinecameras were necessary.

AFAIK, no *amateur* produced night sky TLs with film.

- Years ’70-’80: astronomy documentaries used some night sky TLs.
- Year 1992: “Baraka” (film, by Ron Fricke) was released, including many interesting night sky TLs made with film.
- Year 2000s: many digital cameras and modified webcams become common. First trials in astrophotography and also TLs.
- Years 2007-9: articles on astronomy magazines, e.g. “Moving Pictures” on S&T, Aug’09, by L.Comolli and A.Gambaro.
- Year 2012: released “Timescapes” film, by Tom Lowe.



Evolution of amateur TLs



Introduction

- Simple image sequence
- Processing with brightness and contrast
- Addition of a background music
- Advanced processing with PS or other functions
- Composition of many sequences together
- Crop motion of the imaged field
- Panning and dolly
- Out and out short films

~2000

~2010

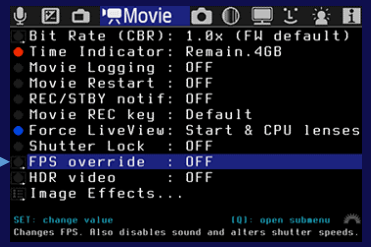
Instruments and techniques

Instruments and techniques

Camera

- Best: modified full frame DSLR
  - H-alpha mods required only for best rendering of nebulas
  - One great choice: Canon 6D (mk1) with Baader filter
- Very good: standard APS-C DSLR
  - My actual choice: Canon 60D unmodified with Magic Lantern
- Average: compact cameras
  - some cameras give decent results
  - best if modified with CHDK
- Bad: smartphones
  - too low sensitivity and high noise
  - quality is improving (e.g. OnePlus One)

- My settings with Canon 60D ML
  - 3200 ISO
  - bulb exposure: 20 s with 20 mm, 30 s with 15 mm, 40 s with 10 mm
  - file format: RAW full (always)
  - focus with 10x live view is very helpful
  - framing with long exposure live view via Magic Lantern (~1s exp)




Canon 350D + Tokina 11mm f/2.8


Canon Ixus 220HS + CHDK

Lenses

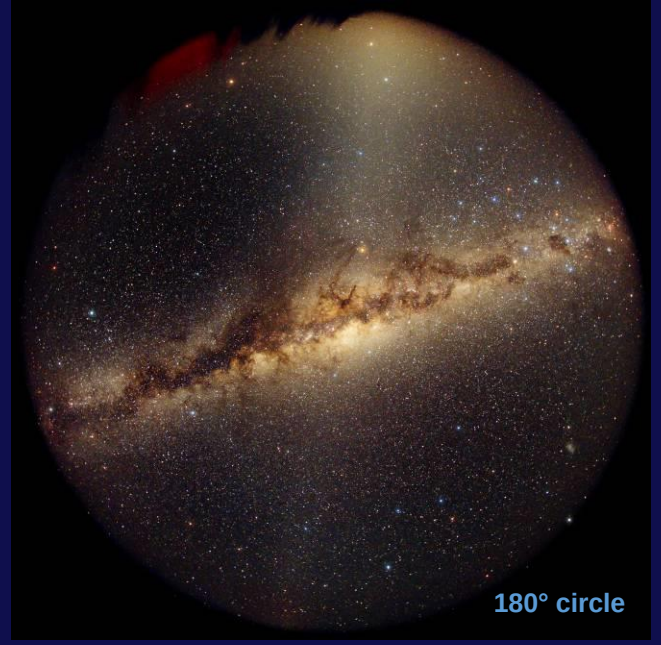
Look for focal length ≤ 20 mm and aperture ≤ f/2.8

Focus: manual is mandatory (block with tape!)

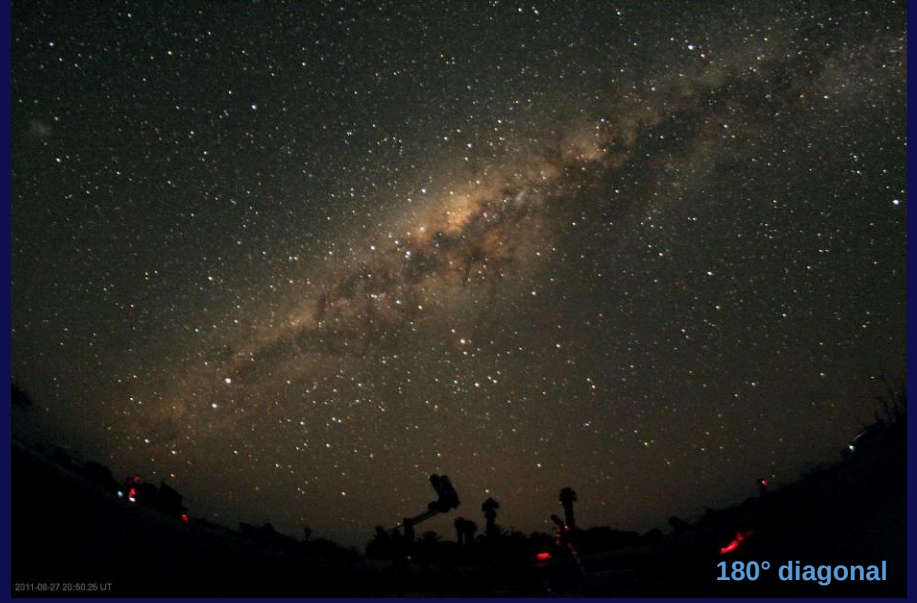
- Best: short and wide
  - full-frame, e.g.:
    - Samyang 14 mm f/2.8 (rect)
    - Canon 15 mm f/2.8 (fish)
    - Sigma 20 mm f/1.8 (rect)
  - APS-C, e.g.:
    - Samyang 8 mm f/3.5 (fish)
    - Samyang 10 mm f/2.8 (rect)
- Good: standard zoom lenses
  - full-frame, e.g.:
    - Canon 24-105 f/4.0
  - APS-C, e.g.:
    - Canon 15-85 f/3.5-5.6
    - Canon 18-55 f/3.5-5.6
- Average: e.g. standard kit lens like Canon 18-55 f/3.5-5.6

Instruments and techniques

Lenses: field of view



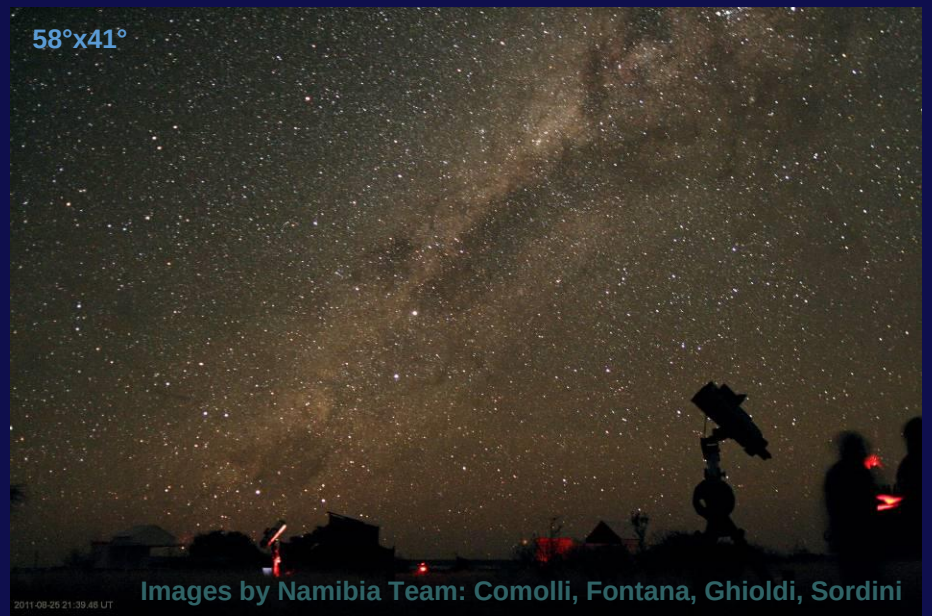
Canon 5D + Peleng 8mm f/3.5



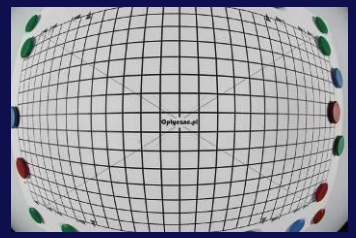
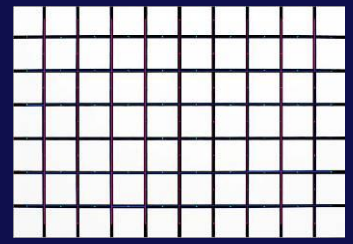
Canon 350D + Samyang 8mm f/3.5

Canon 500D + Canon 15mm f/2.8

Canon 350D + Sigma 20 mm f/1.8 (at f/2.5)

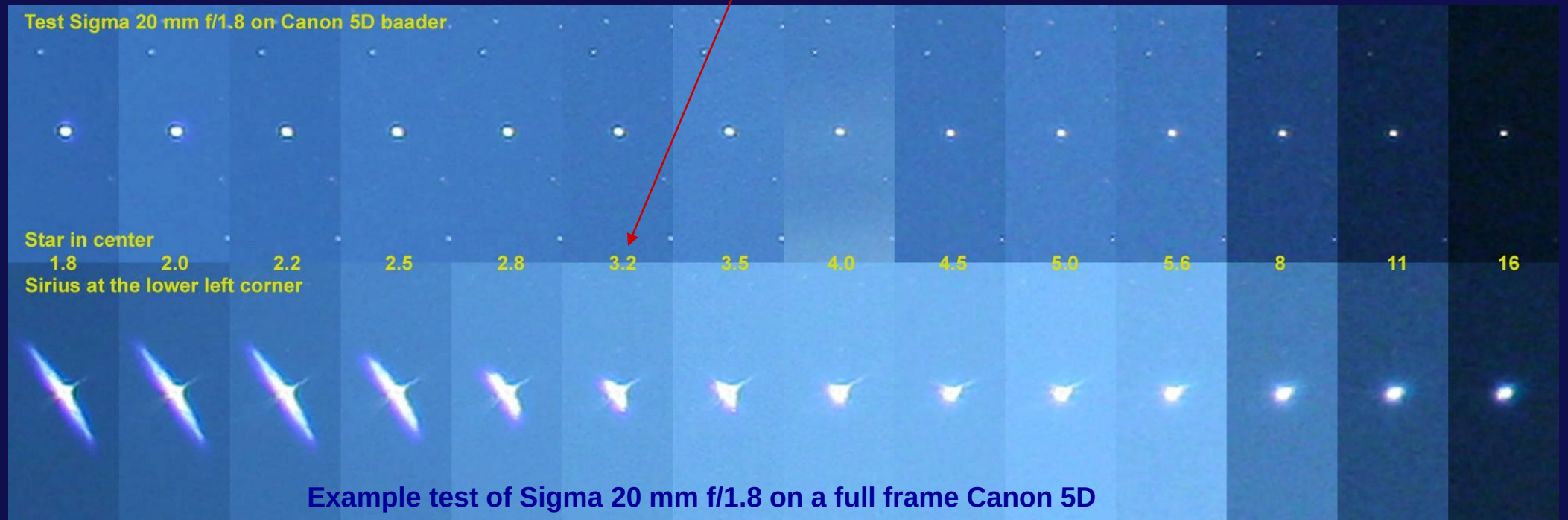


Lenses: type of projection

	Fisheye	**Rectangular**
Pro	Very wide field Better aperture Better quality	More natural projection
Contra	Not so popular projection. Curved horizon (except in the center)	Higher price (at = FL) Closer aperture (at = FL) Longer focal lengths (at = f/)
Distortion		
Example	 **Canon 5D + Canon 15mm f/2.8**	 **Canon 5D + Sigma 20mm f/1.8**

Lens quality

- Since full aperture (or near) is needed, high quality lenses is mandatory, both in center and in the corners.
- High quality means high price
- Lower quality: need to step down
- Perform aperture tests to select the best compromise



Example test of Sigma 20 mm f/1.8 on a full frame Canon 5D

Dream lenses

- Many lenses are available, some are only dreams...

Zeiss 15mm f/2.8 rect
price ~2500 €

Arri-Zeiss Master Prime
e.g. 16mm f/1.3 rect
price ~20000 €

Tripod

- The camera must remain perfectly fixed for all the night, under strong winds and temperature changes.
- Avoid cheap plastic tripods.
- Good choices are Manfrotto tripods and heads.
- Type of heads:
  - 3 axis: more robust
  - ball: easy to point <- my choice: 496 RC2

Timer

Instruments and techniques

Methods for taking image sequences:

- continuous shooting, manual exposure, no pause between frames
- bulb exposure controlled by a remote timer (much better!)
- exposure controlled by modified firmware (e.g. Magic Lantern)
- exposure controlled via USB (with a PC or smartphone)

Timer remote with:
- exposure time
- pause btw shots
- # of shots
- pause before start

Select the proper connector

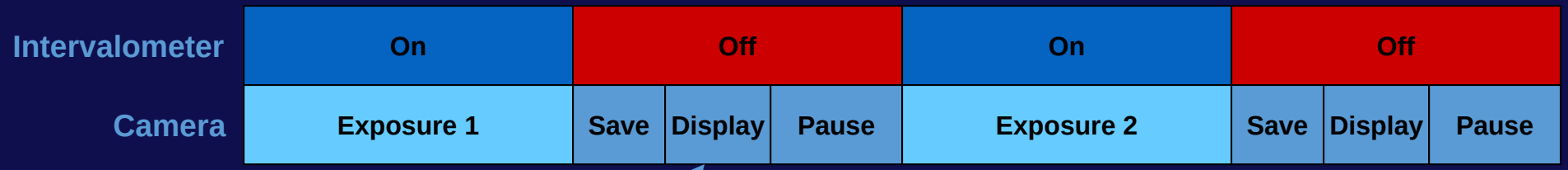
Search "Timer remote 60D" (or your camera) on Ebay or Amazon, prices ~15€

Timer settings for night sky

Instruments and techniques

Example of control cycles for the night, fixed exposure.

No pause and display
Camera must be set to continuous mode

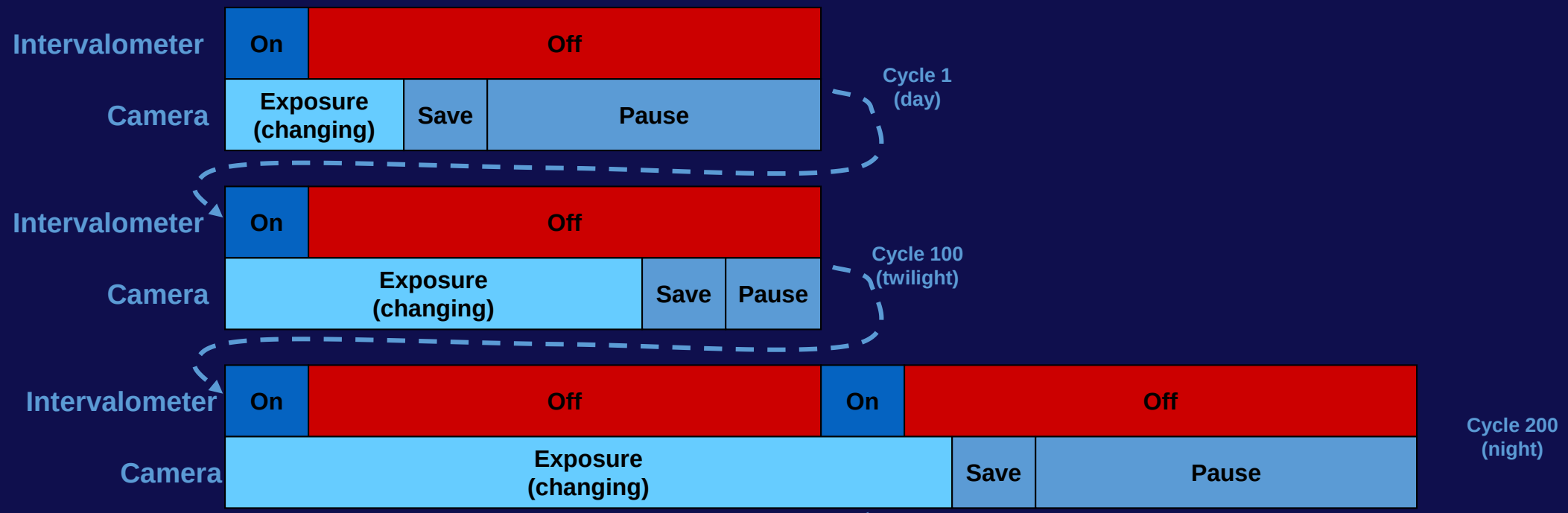


Useful to watch the images without touching the camera
Avoid if powering with the internal battery

Typical values for a dark night sky: 25 s exp, 5 s pause (1 s without display), 3200 ISO, f/2.8

Timer settings for sunset

For sunset a variable exposure is needed (AV mode), but leave enough pause!



Exposure incident !
Now only 1 every 2 images is shot
Resulting TL shows acceleration

Incident example

Dew remover

Instruments and techniques

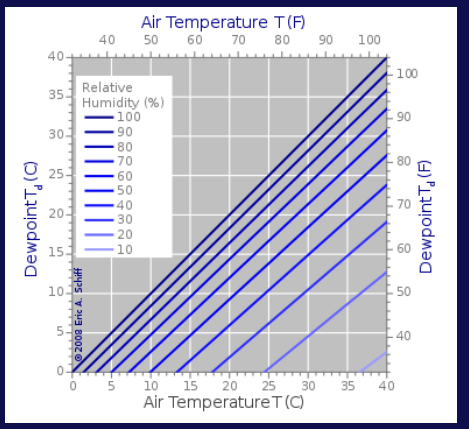
In mid-latitude regions, dew at night is common.

Dew *cannot* be wiped during TLs, it must be prevented.

DIY is easy, but commercial products are available.

Solutions:

- dew strips (~1 W per inch of lens diameter, requires power)
- hand warmers (1 every ~6 h, no power!)
- air blower (requires power and can vignette wide lenses)



DIY dew remover
http://www.astrosurf.com/comolli/strum46.htm

External battery

Instruments and techniques

Internal battery:

- a standard battery can work only for some hours
- some cameras has very long battery duration! E.g. 60D ~8h

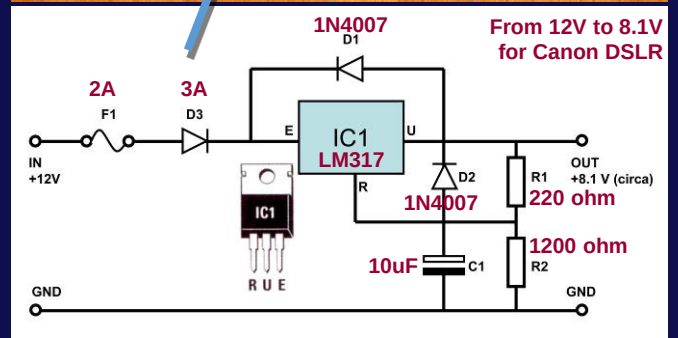
External battery:

- external power supply, connected to a big battery (e.g. a 12 V car battery); useful also for other accessories (dew remover, dolly, ...)
- battery grips, with two standard batteries (2x duration)
- USB power bank for USB powered cameras (e.g. Sony)

Camera	Duration [h]
Canon 350D	2.5
Canon 5D	2.2
Canon 60D	7.8

great !

DIY external power supply



A 50 Ah on the field power for:

- **camera**
- **panning**
- **dew remover**

Ok, you'll not need so many batteries...

Memory cards

After a night of work in Namibia 2011

- Large memory cards are needed!
- Table for reference (night sky and HDR).
- My actual choice: 32 GB. With 60D and RAW I work for one full night.
- Large Hard-Disks are needed for storage. Now I use many 4 TB hdd (and make regular backups!).
- In the past, with small cards and HD, I've used JPG

Maximum number of images and time duration of a timelapse				Night sky			Sunset in HDR		
				Card size [GB]:	32		Number of exp:	3	
				Exposure [s]:	32		Time interval [s]:	10	
Camera	Mpix	File format	File size [MB]	Images	Duration [h]	TL duration at 25fps [s]	Image groups	Duration [h]	TL duration at 25fps [s]
Canon 60D	18	RAW	24.6	1301	11.6	52.0	434	1.2	17.3
		JPG	6.4	5000	44.4	200.0	1667	4.6	66.7
Canon 5D mk4	30	RAW	43.5	736	6.5	29.4	245	0.7	9.8
		JPG	17.4	1839	16.3	73.6	613	1.7	24.5
Nikon D800	36	RAW	41.3	775	6.9	31.0	258	0.7	10.3
		JPG	16.3	1963	17.5	78.5	654	1.8	26.2

RAW format

In short: RAW will give superior results.

RAW format contains much more information respect to JPG, extraction by “developing”.

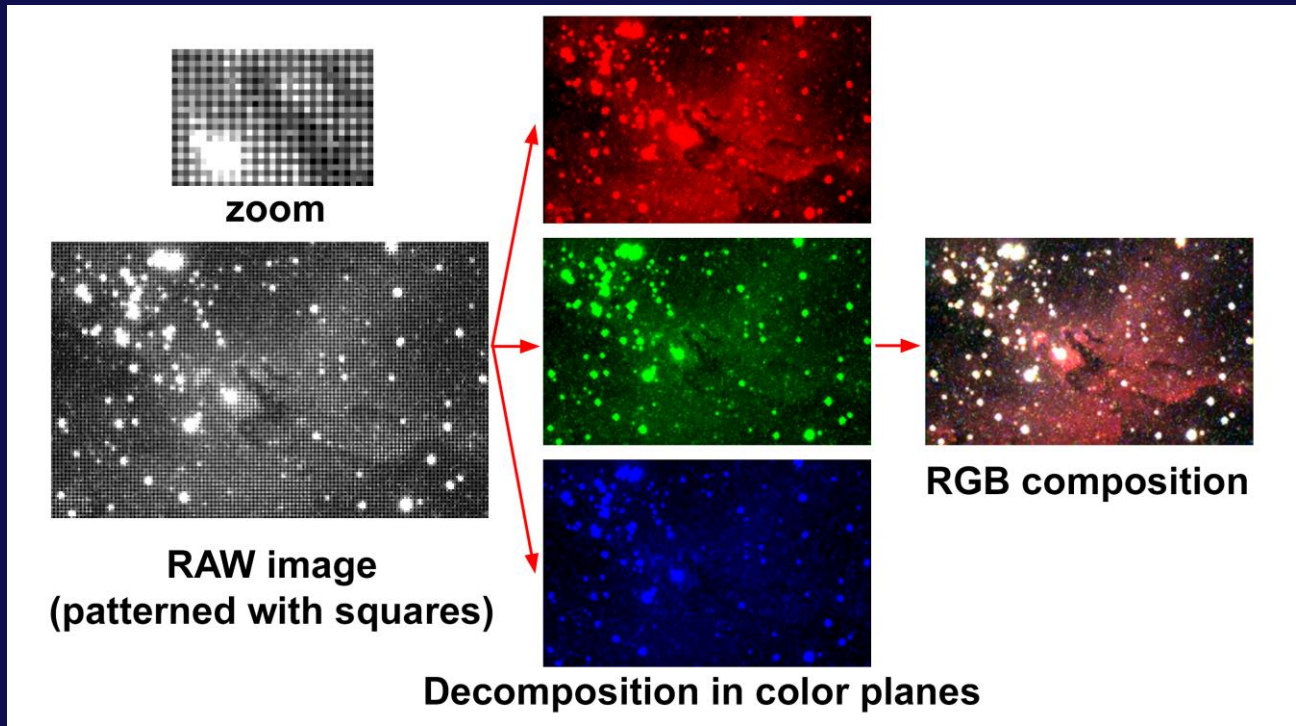
Heavy processing is needed and a JPG will suffer.

Drawbacks:

- larger memory space is needed
- RAW development requires more processing time and power

Advices:

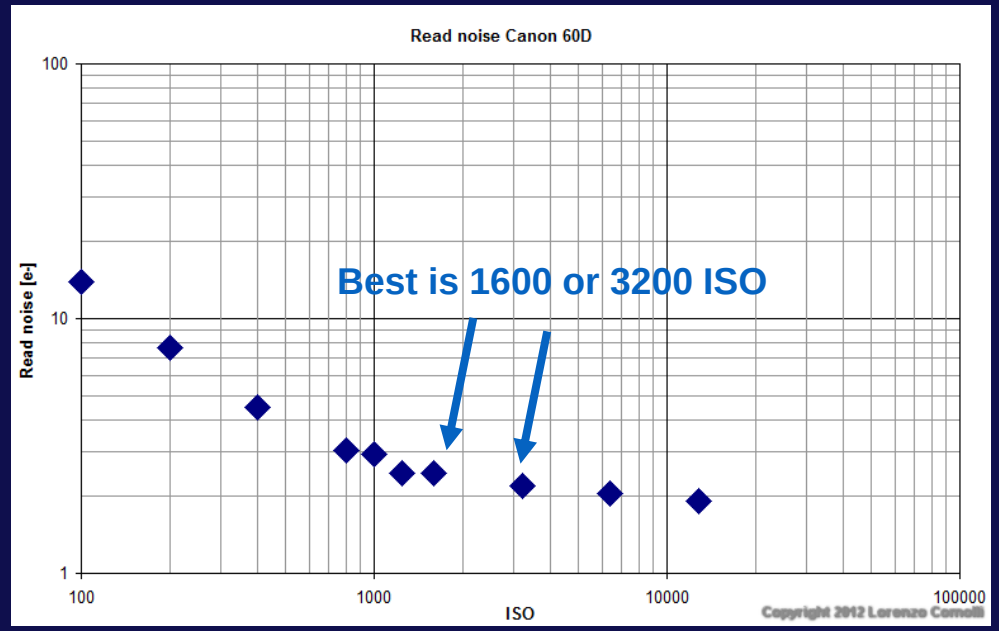
- avoid JPG
- my actual choice: always RAW
- avoid sRAW because it is not RAW!



Best ISO setting

Instruments and techniques

Select the ISO looking at the Read Noise graph.



Results and list of the tested cameras

Here are all the tested cameras (ordered by introducing year). Click for detailed results. Here are only a few main results

Camera	Year	Lowest read noise [e-]	Highest advised ISO	Best approx dynamic range [dB]	ISO at unity gain
Sony A7s	2014	0.85	25600-51200	82.5	4529
Sony A6000	2014	2.16	3200-6400	75.9	865
Sony NEX-6	2012	2.45	800	77.1	904
Canon EOS 5Dmk3	2012	1.96	12800	65.9	500
Canon EOS 6D	2012	1.81	6400	68.7	575
Canon EOS 60D RAW	2010	1.99	1600-3200	64.7	205
Canon EOS 60D sRAW	2010	4.04	1600	79.8***	846
Canon EOS 60D mRAW	2010	3.48	1600	78.9***	794
Pentax K-x	2009	5.33*	1600	69.0	887
Canon EOS 5Dmk2	2008	3.15	1600	67.3	409
Canon EOS 450D (modified with a Baader filter)	2008	3.12	1600	62.5	235
Nikon D90	2008	3.61*	1600	73.7	1298
Canon EOS 20Da	2005	3.52	1600	63.7	1284
Canon EOS 5D (modified with a Baader filter)	2005	4.80	1600	63.9	1713
Canon EOS 350D (CHDK firmware)	2005	4.15	1600	62.6	1075
SBIG STL 11000 (an astronomical CCD)	~2005	9.59	-	75.3	-
...more coming... do you want your camera tested? Contact me!					

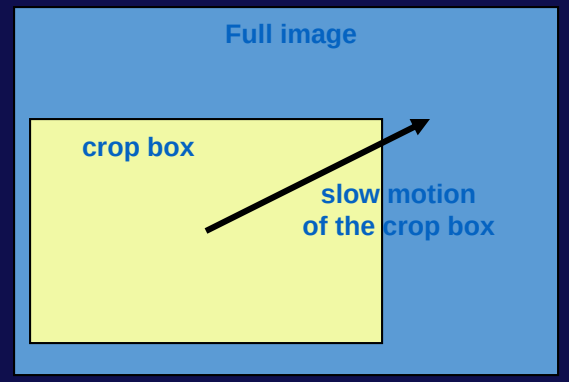
More tests http://www.astrosurf.com/comolli/strum43.htm

Panning and dolly

To add even more dynamics in the video and to amaze the watcher, a slow motion of the camera is great.

Type of motions:

- motion of a crop window in a static video; no hardware needed
- rotation; a panning head is needed (1 or 2 axis)
- translation; a dolly is needed (length ~1 meter)



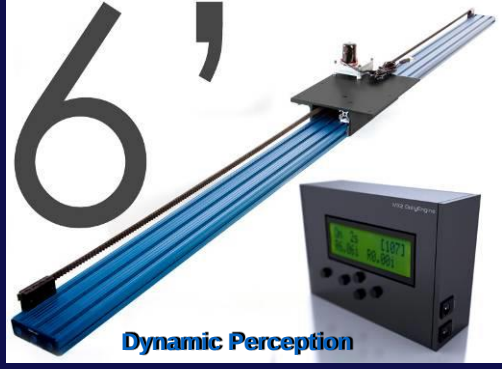
Panning
+Dolly

Panning and dolly on the market

Instruments and techniques

Some available products on the market:

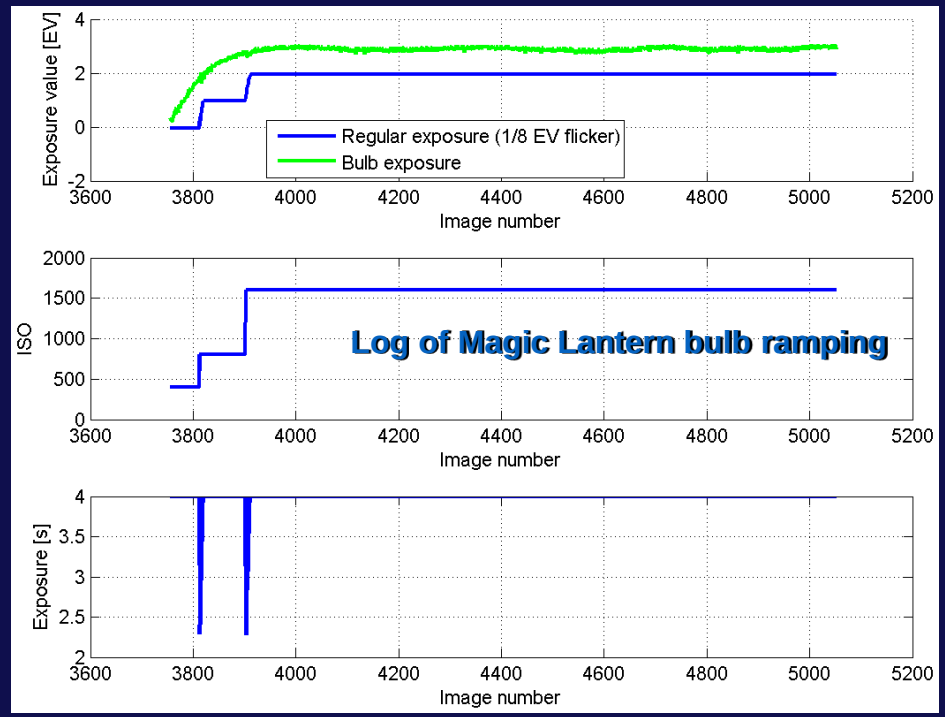
- Dolly:
  - Dynamic Perception Stage Zero Digital (~700€)
  - Starworks Sky Trail (~650€)
  - Proaim Line Slider (~380€)
  - Neewer GP-80QD (~240€)
- Panning 1 axis
  - Starworks 360° Panoramic Head (~400€)
  - Astro (~200€)
  - Vixen Polarie (~400€)
  - Ioptron Sky Tracker (~400€)
  - Radian (~150€)
  - ... and many star trakers
- Panning 2 axes
  - Merlin pano head (~200€)
  - SkyWatcher All View (~500€)
  - Emotimo (~900€) (also 3 axis)
- Advanced:
  - Kessler (€€€!)



Bulb ramping

The “holy grail” of any timelapser is a perfect transition from day to night.

- Needed:
  - exposure time must increase from e.g. 1/500 s to 30 s
  - ISO sensitivity must increase from e.g. 100 to 1600 ISO
- Solutions:
  - AV mode: it doesn’t work! Flickering, darkness, ...
  - bulb ramping in ML: it uses bulb above 1/10 s to make short increments
- Post-processing: a good deflickering software anyway is needed.

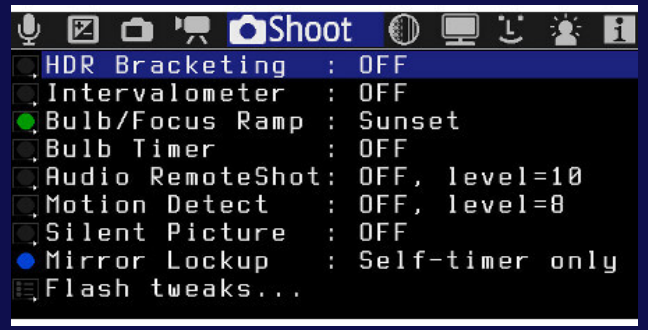


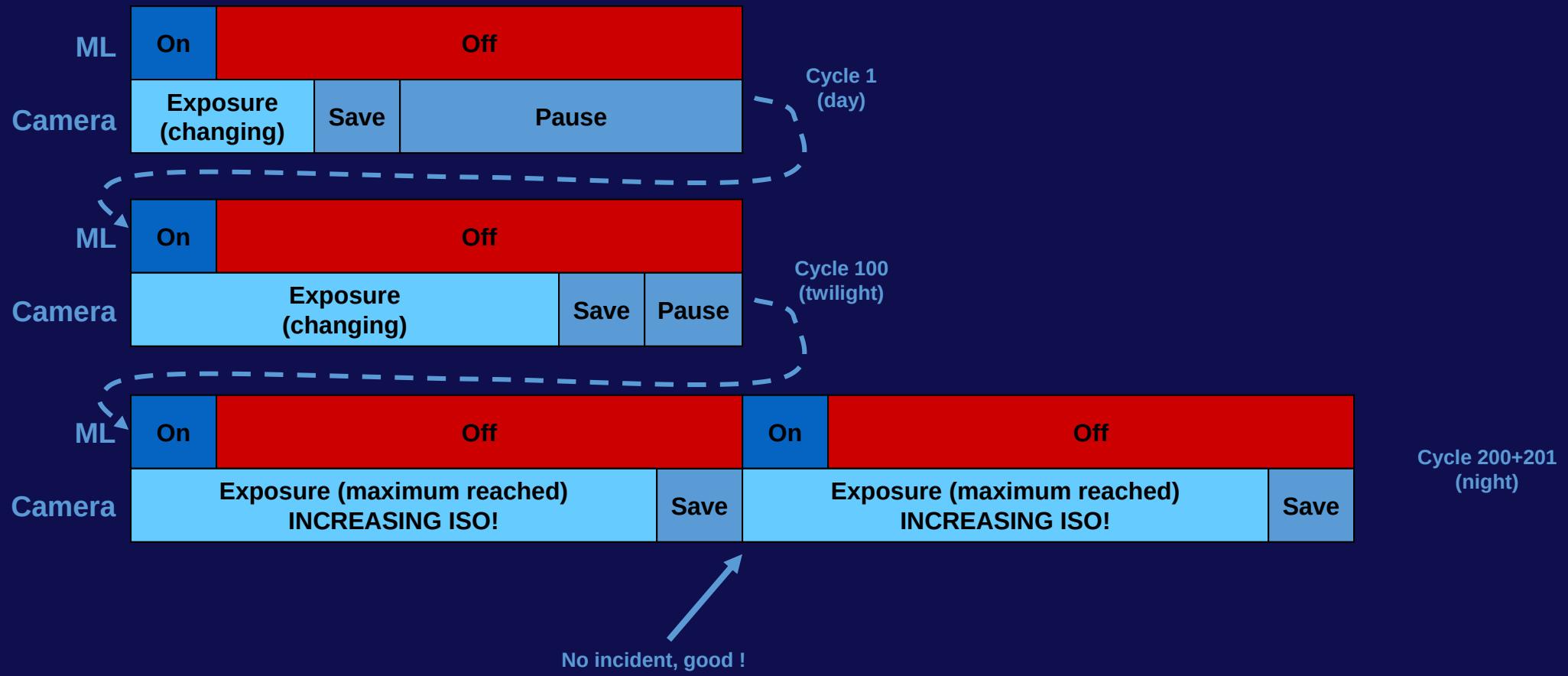
Flickering example

Magic Lantern bulb ramp

Instruments and techniques

In Magic Lantern set the Bulb Ramp to "Sunset" mode





Magic Lantern and CHDK

Some Canon cameras can be modified by using modified firmware.

- Advantages: 1000+ !!!
- Do at your risk (very low risk imho)
- Examples:
  - internal timer with bulb
  - bulb ramping for sunset/sunrise
  - long exposure for live view

CHDK
http://chdk.wikia.com/wiki/CHDK
ML
http://www.magiclantern.fm/

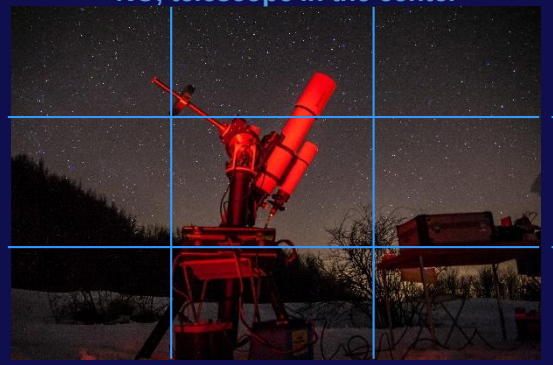
Firmware	Supported cameras (at 20/1/2018)
Magic Lantern	5D Mark II, 5D Mark III, 6D, 7D, 50D, 60D, 500D, 550D, 600D, 650D, 700D, 1100D, EOS M soon: 70D, 100D, 1200D, 450D
CHDK (Canon Hack Development Kit)	Nearly all compact Powershot and IXUS cameras Some older DLRL (350D, 400D, 450D) (limited functions)

Composition rules

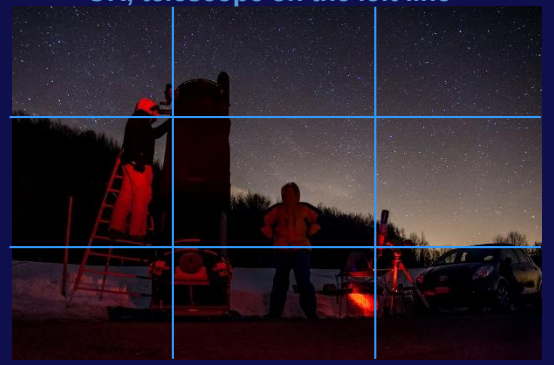
Instruments and techniques

- Composition is fundamental to get great timelapses
- Standard rules apply, e.g.:
  - rule of thirds
  - foreground
  - framing
  - experiment !
- Composition rules are difficult to explain, just try and compare your single image results with others (e.g. in landscape photography forums)

NO, telescope in the center



OK, telescope on the left line



NO, no clear subject in the foreground

OK, eye capturing subject

NO, crooked horizon

OK

Use a flash-bubble level or the internal level

Note about natural colors

On the web you'll find night skies of any color...

Natural colors are highly advisable, i.e.:

- grey or pale brown night sky
- pale blue sky ONLY when the Moon is in the sky
- pale yellow Milky Way and zodiacal light

Use standard automatic daytime white balance.

If shooting in RAW, you can correct during processing.

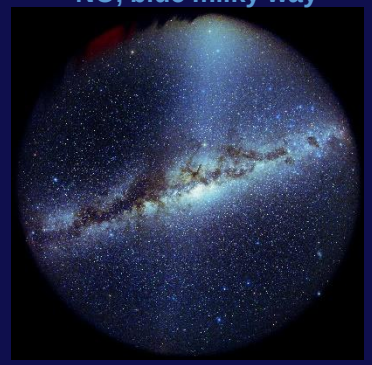
NO, blue sky without Moon

OK

Moon before set: OK pale blue

After Moon set, pale brown

NO, blue milky way



OK, yellow milky way

Night sky Hyperlapse

Instruments and techniques

VERY difficult technique

- to capture
- to process

Impressive results!

Capture:

- shot long exposures
- move the tripod ~30 cm for every shot....
- ... while keeping nearly exactly the same sky field... (or the same foreground object)
- ... repeat 100-200 times for hours...

Processing:

- standard timelapse processing, plus...
- frame alignment using warp stabilizer (in Adobe After Effects)

Software: Adobe After Effects

HDR timelapses

Instruments and techniques

In the night, HDR is nearly useless.

HDR is great when huge brightness differences are present, e.g. sunset.

Use AEB on your camera with +/- 2 stops

Software: Photoshop HDR, SNS-HDR Pro, PhotoMatix, ...

Processing

Video resolution, aspect ratio, framerate, …

Processing

Resolution: selecting the best resolution is a compromise between quality and usability: high resolution -> best quality vs. low usability

Actual standard, advised:

- Full HD, 1920x1080 pixel (or 1080p)

Other possibilities:

- 4K (UHD), 3840×2160 pixel (or 2160p) -> future
- HD Ready, 1280x720 pixel (or 720p)
- 1620x1080 or 1080x720 have 3:2 aspect ratio

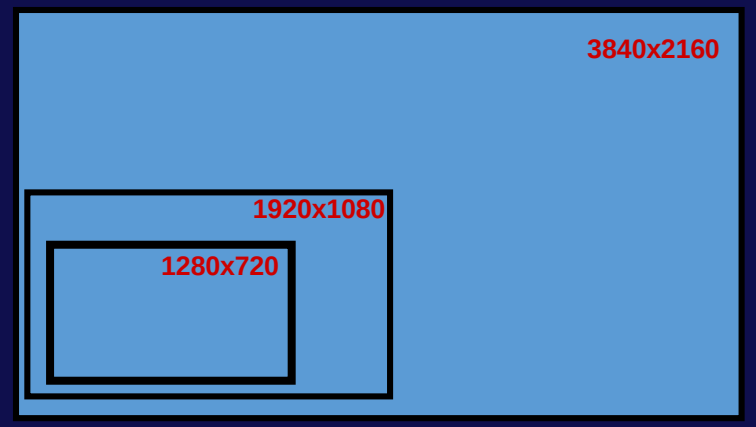
Aspect ratio: Full HD is 16:9 (ratio 1.78); DSLR is 3:2 (ratio 1.5); compact camera is 4:3 (ratio 1.33); actual TV and PC monitors are 16:9.

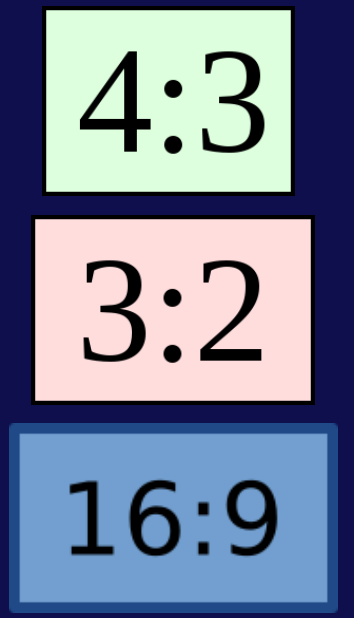
- Advised: 16:9

Framerate: European standard is 25 fps (advised), US is 30 fps.

Progressive/interlaced: present and future is progressive -> 1080p

Online, accepted values: nearly all of the above are accepted (excluding interlaced).





Speed factor

Processing

A time lapse compresses a long time into a short time.

The speed factor (or acceleration factor) of the TL is:

speed = (true time) / (time lapse time) = (cycle time) * (framerate)

Examples:

Subject	Speed [x]	Exp [s]	Pause [s]	Cycle [s]	Framerate [fps]	Duration [s] (for 3 h TL)	TL duration [h:mm] (for 15 s clip)
Night sky	750	25	5	30	25	14.4	3:08
Sunset	250	AV	-	10	25	43.2	1:03
Daylight	125	AV	-	5	25	86.4	0:32
Northern lights	30	5	1	6	5	360	0:08

Video compression

Processing

A video must be compressed to reduce the huge file size.

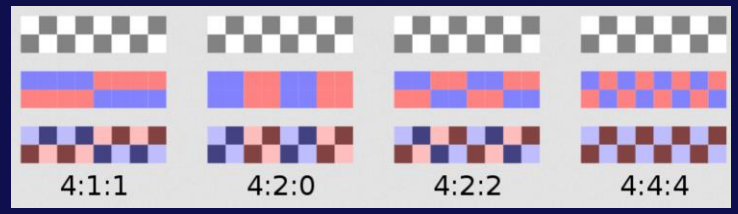
Example with 25 fps, RGB 8 bit/ch:

Resolution [pix]	3840x2160	1920x1080	1280x720
Single image [Mpix]	8.3	2.07	0.92
Single frame file size, uncompressed [MB]	24.8	6.21	2.76
5 min video, file size, uncompressed [GB]	186	46.6	20.7
5 min video, file size, compressed [GB]	~4	~1	~0.3

A CODEC must be used to compress the video. Best actual CODEC:

- H.265 (new, not supported by old sw, support 8K and 444 chroma subsampling, x265 free)
- ProRes (proprietary by Apple, quality oriented, support 8K and 444 chroma subsampling)
- H.264 (best quality/size ratio, heavy computing power, x264 free)
- XviD (based on H.263, very good, good quality on gradients, faster, open source)
- DivX (similar to XviD but not open source)
- Mjpeg (each frame is a jpeg image, better quality, low compression)

chroma subsampling



x265 (select X265vfw x86)
http://mpxplay.sourceforge.net/
x264 (select VFW-version-x86)
http://komisar.gin.by/
XviD
http://www.xvid.org/

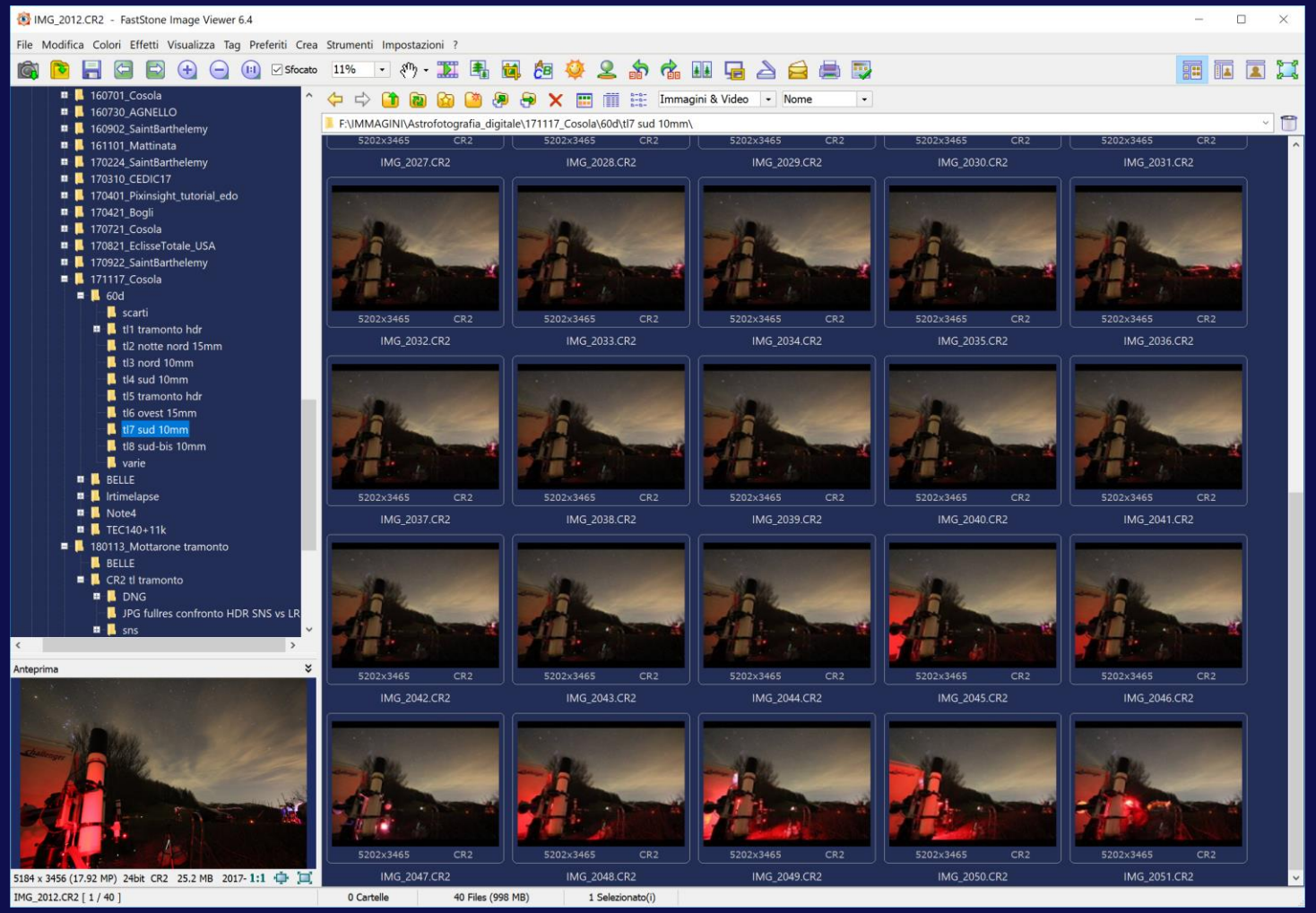
Image preview and renaming

Processing

FastStone

- free
- very fast in reading any file format
- renaming and resampling functions

FastStone
http://www.faststone.org/



Simple workflow: Fastone+Virtualdub

Processing

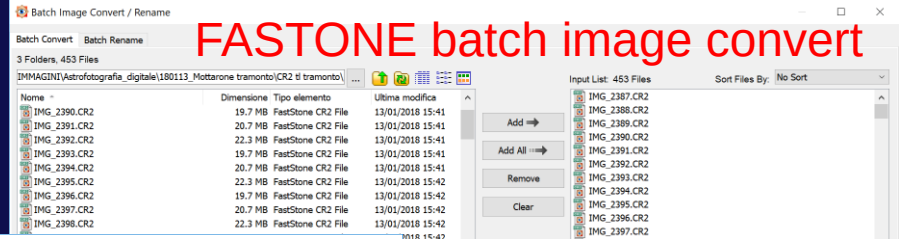
FastStone

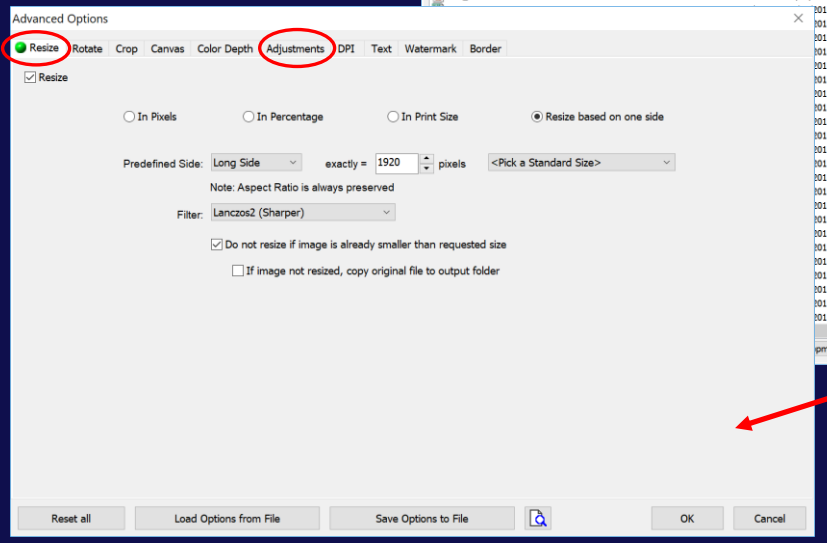
- Batch Image Convert/Rename
  - conversion of RAW images to JPG
  - simple processing (color, contrast,...)
  - resizing (to 1920x1280)
  - (renaming with consecutive numbers)

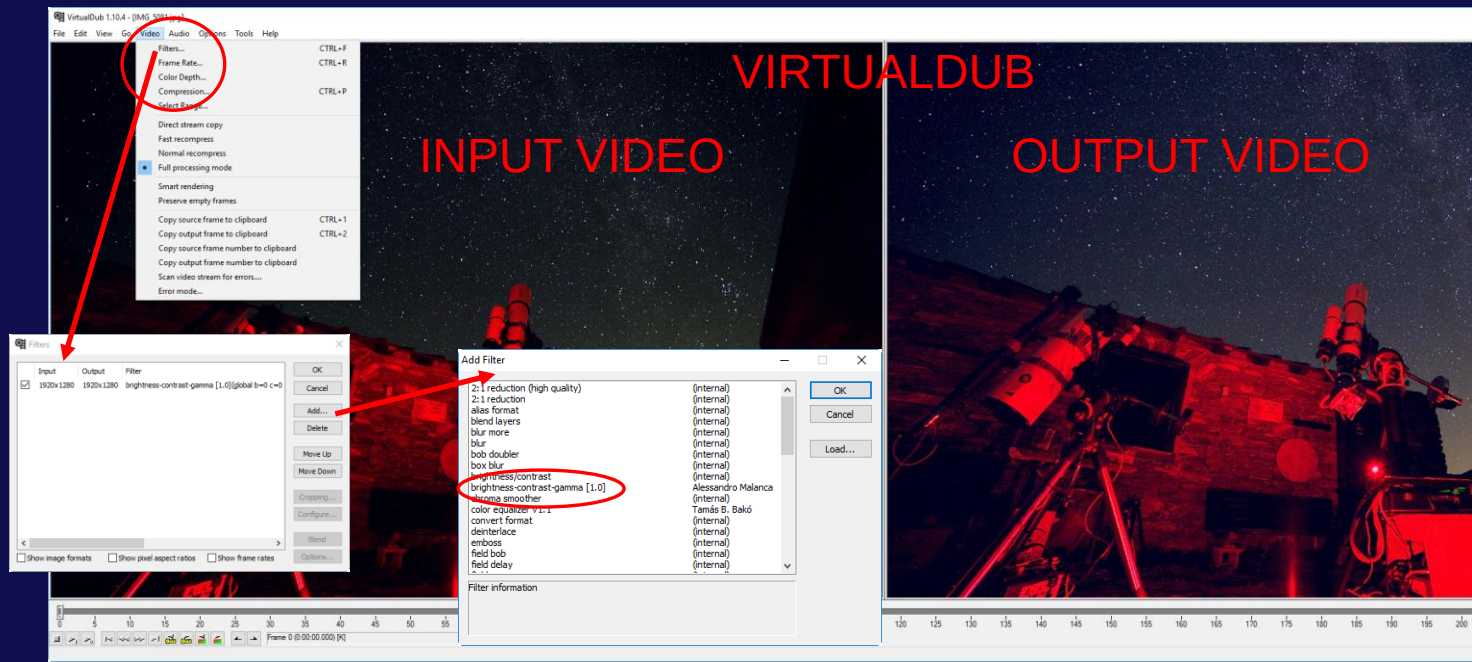
Virtualdub

- open the first image in the series (the others will automatically load)
- Video>Filters
  - levels, brightness/contrast, resize, crop 16:9, ...
  - plugins: "Brightness-contrast-gamma", "MSU Deflicker", ...
- Video>FrameRate
  - Change frame rate to 25 fps
- Video>Compression
  - select a codec and options (quality -> high)
  - (before install the desired codec, e.g. XviD, x265)
- File>Save as AVI

FastStone (free)
http://www.faststone.org/
Virtualdub (free)
http://www.virtualdub.org/





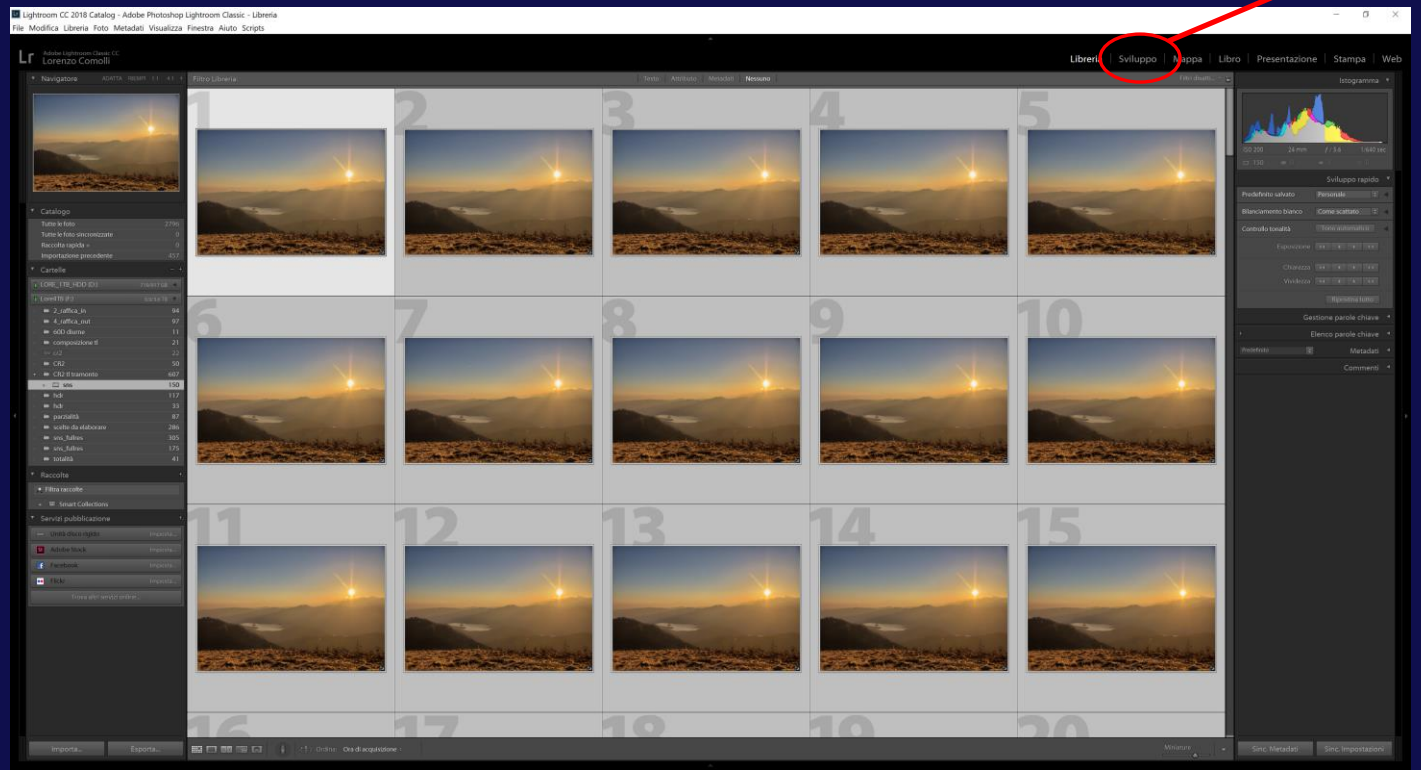


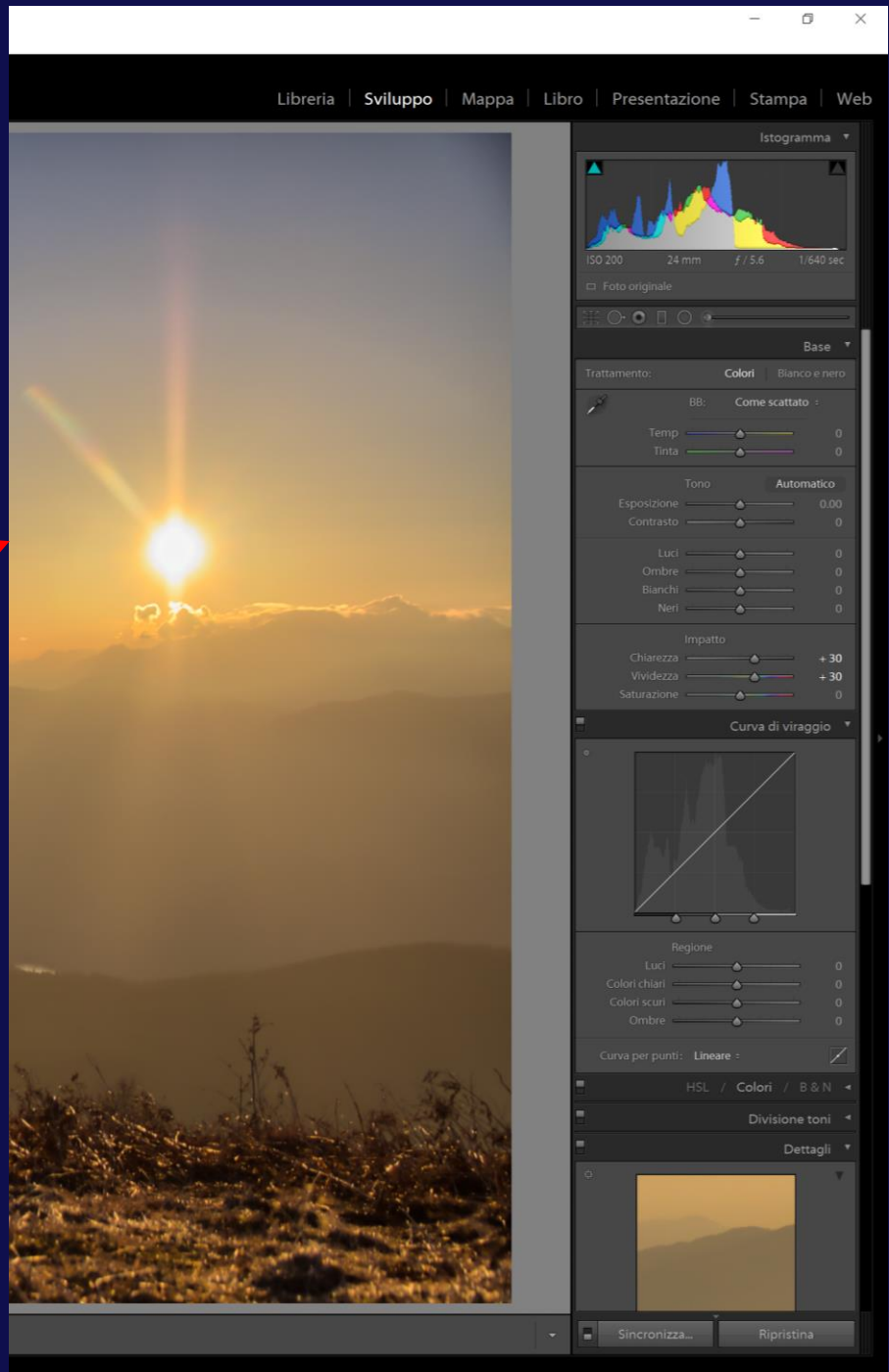
Adobe Lightroom

Processing

Most powerful solution for time lapses

- development of RAW files
- powerful processing (hot pixel removal, color, light and shadows, clarity, vibrance, curves, noise reduction, distortion and vignetting, ...)
- export to single images or video via LRTimelapse plugin





LRTimelapse

Processing

Main use:

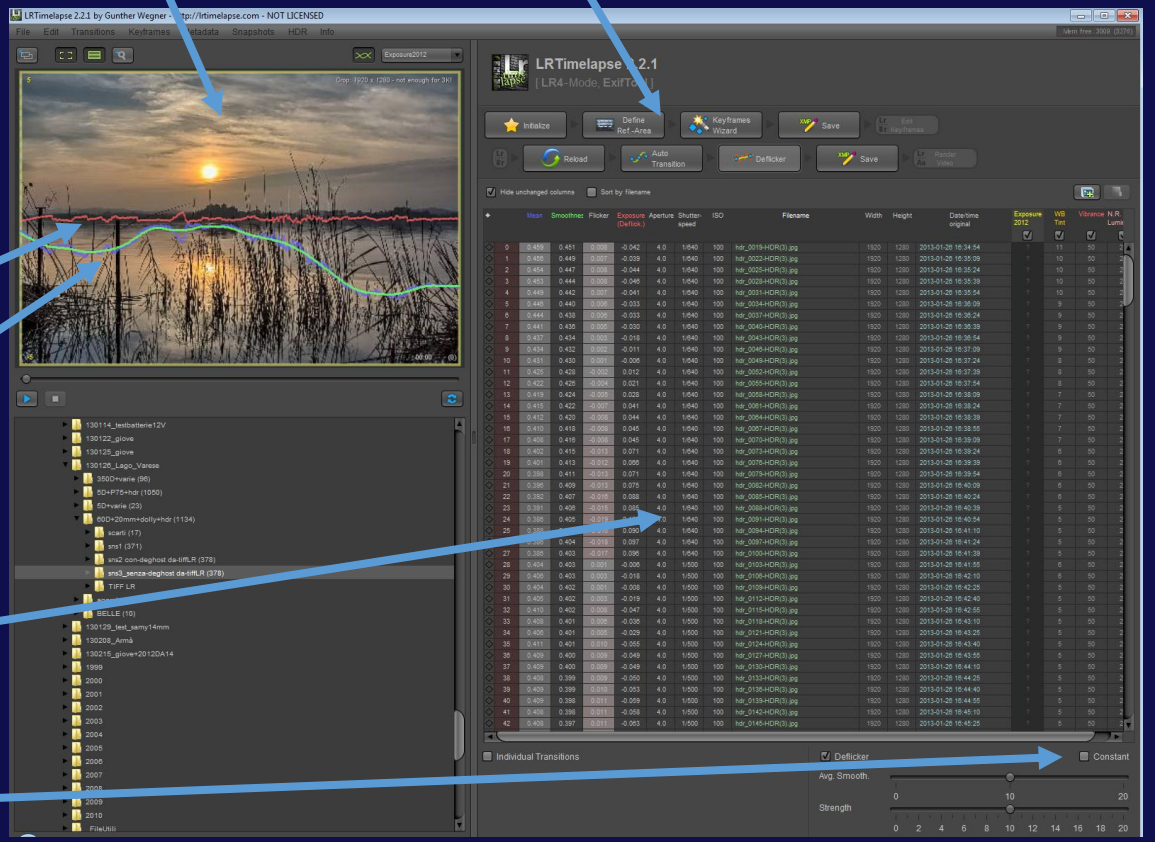
- deflickering in day-nights transitions
- video production from Lightroom export plugin

Notes:

- Better with RAW files
- Lightroom is needed
- Workflow is not simple (first follow the online tutorial)
- free only for <400 images and 1080p

Alternative: TLTools, free, does not require LR

LRTimelapse
http://www.lrtimelapse.com/
TLTools (free)
http://www.tltools.it/



Processing

Multi-track editors

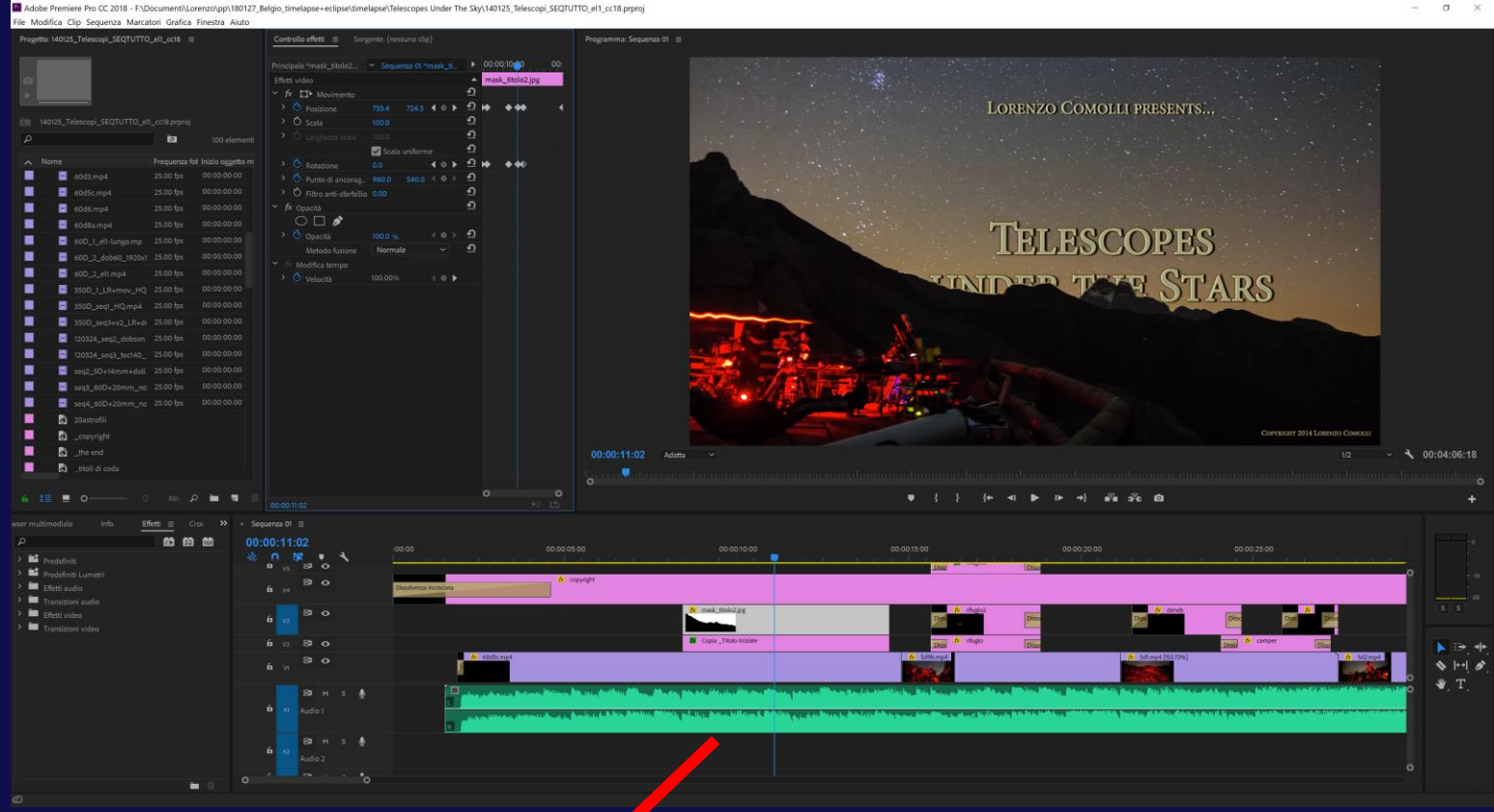
- Single sequences must be joined
- Transitions must be added
- Music has to be synchronized to video
- Titles and text addition

Software:

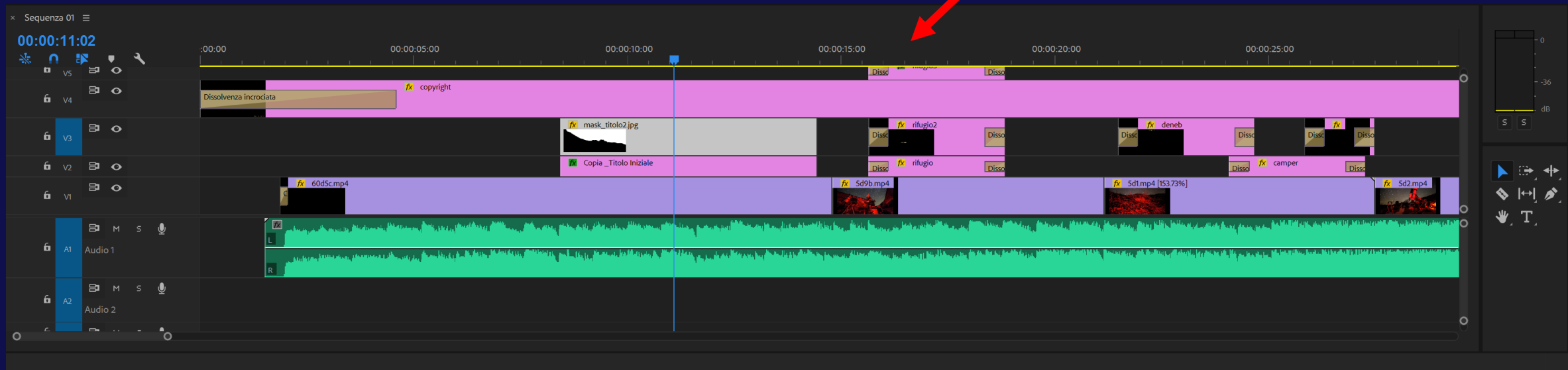
- commercial: Adobe Premiere, Sony Vegas, Final Cut, Pinnacle Studio, ...
- free: VLMC, Shotcut, Natron, Kdenlive, Openshot, ...

Notes:

- steep learning curve!
- but powerful !



Premiere



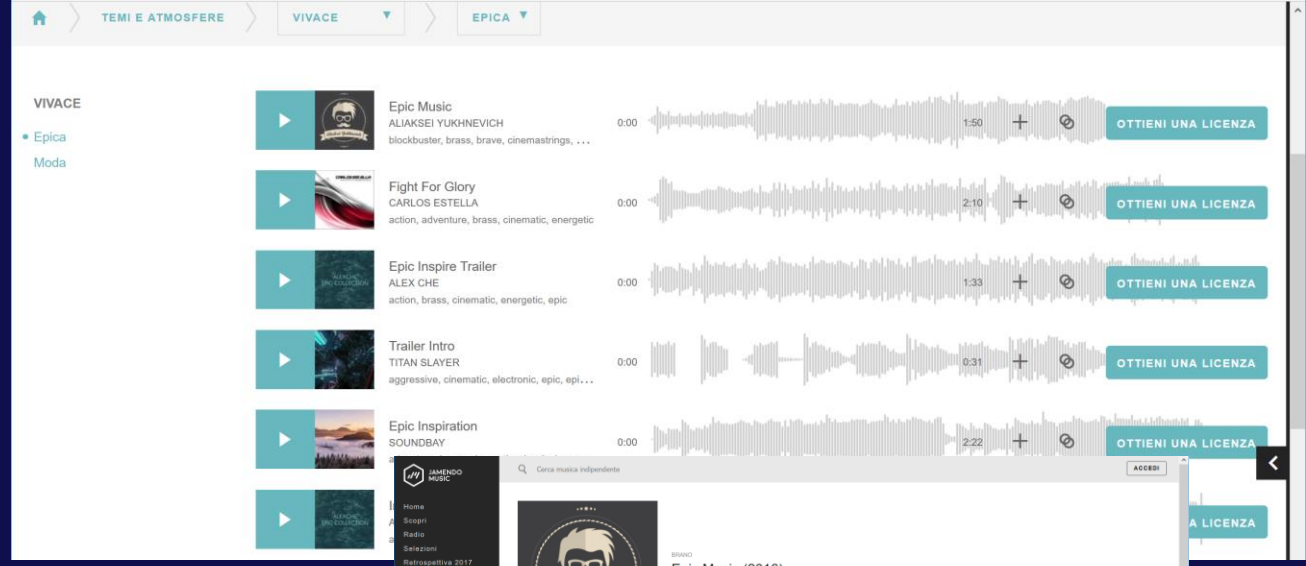
Background music

Processing

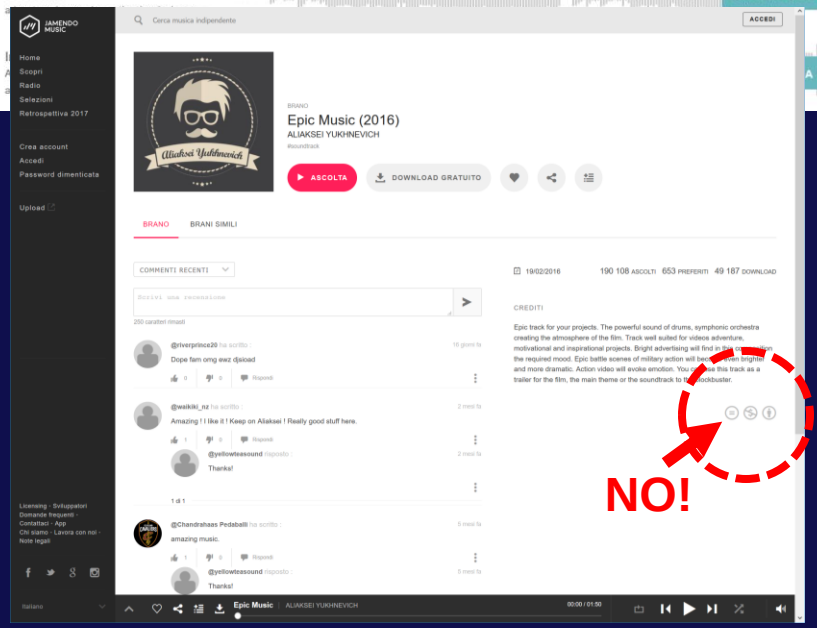
- *My preferred genres: ambient, piano, classic*
- You cannot use any music, royalties should be paid. Youtube easily find frauds.
- Many websites share free music*:
  - http://freemusicarchive.org/
  - http://www.jamendo.com/
  - https://www.youtube.com/audiolibrary/music
- Many others sell royalty-free music:
  - http://www.thebluemask.com/
  - http://www.mobygratis.com/
  - *http://licensing.jamendo.com/*

*Common creative license:

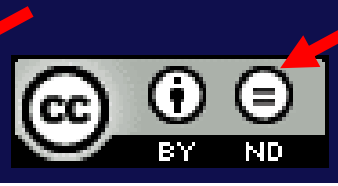
- all CC can be freely listened
- not all can be used as a video background !



Jamendo Licensing (not free)



Jamendo Music (free)



NO!

You can copy, distribute, advertise and play this track as long as you:

- Give credit to the artist
- Don't alter, transform or build upon this album
- Don't use this album for commercial purposes

YES

You can copy, distribute, advertise and play this track as long as you:

- Give credit to the artist
- Don't use this album for commercial purposes
- Distribute all derivative works under the same license

Byproducts: star trails

Processing

Star trails can be easily obtained from sequences of images made for timelapses (excluding panning and dolly).

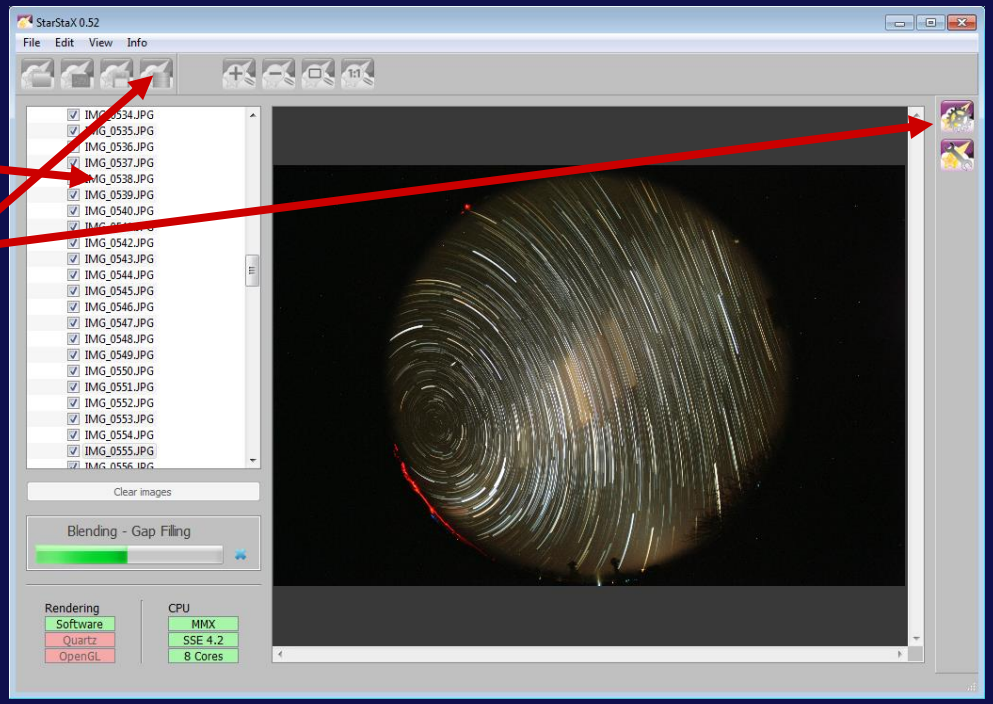
Even timelapses of forming startrails can be obtained (incremental star trails).

Software: StarStaX, StarMax, StarTrails

1. drop here the images (for best results use hires images)

2. Select "lighten" or "gap filling" (+cumulative output)

3. Stack



http://markus-enzweiler.de/StarStaX/StarStaX.html
http://ggrillot.free.fr/astro/starmaxEng.html
http://www.startrails.de/html/software.html

Video review and playing

Processing

My choice: VLC media player

- able to play ANY video codec without the need to install on the PC
- review your final product carefully before uploading
- play to share your video with friends during presentations like this :-)
- set options to play automatically:
  - full screen
  - no title
  - automatic rewind

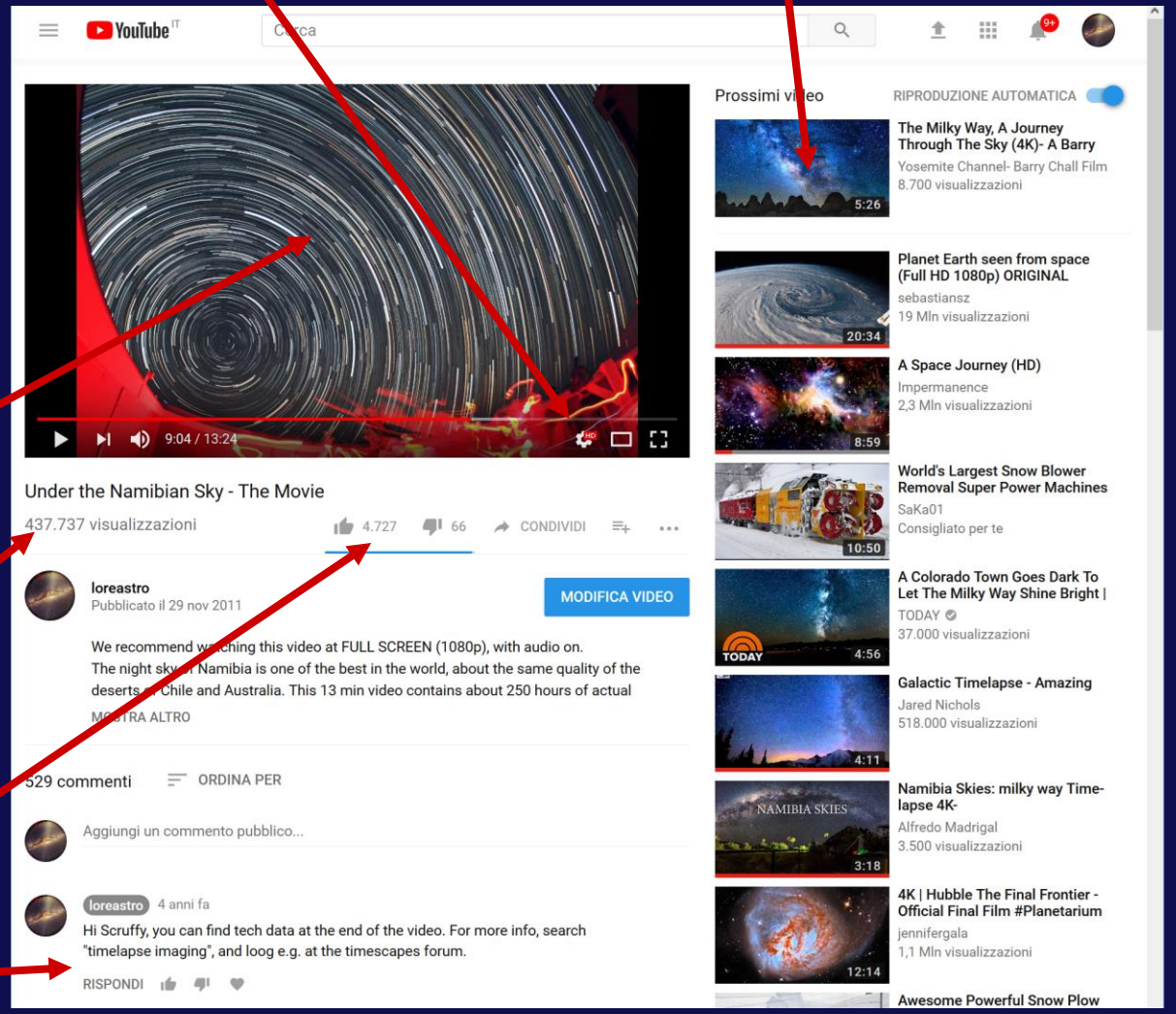
https://www.videolan.org/

Sharing and conclusions

Sharing online

Sharing and conclusions

- Online sharing is fundamental nowadays
- Videos are very large! E.g. 0.5 - 2 GB
- Options:
  - Youtube
  - Vimeo
  - file on personal website



Sharing: choice comparison

Sharing and conclusions

	Youtube	Vimeo	Personal website
Max res (free / pay)	8K (7680x4320) -	4K (4096x2160) -	No limit
File size (free / pay)	No limit	0.5 GB/video – 0.5 GB/week 5 GB/video – 5 GB/week	Depends
Quality (free/pay)	Intermediate	Good	Best
Time limit	unlimited	unlimited	unlimited
Audience	Everybody	Advanced	Your friends
Embeddable?	Yes	Yes	-
My choice	*x*		*x*

101: A simple exercise

As a simplified first trial, try this steps to immediately get a result.

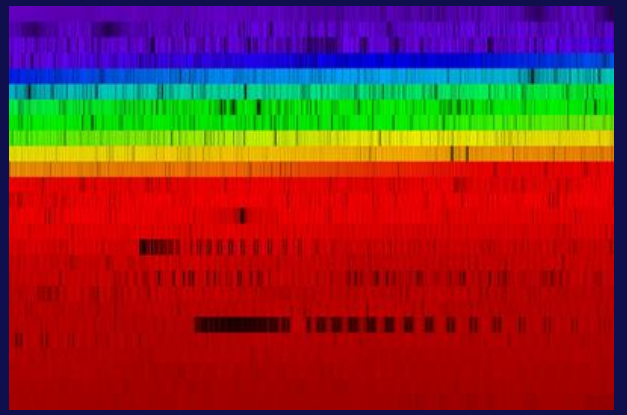
1. Set your DSLR with a wide field lens at full aperture (e.g. 18 mm f/3.5)
2. on a tripod
3. with a fully charged battery
4. empty memory
5. JPG or RAW setting
6. 20 s fixed exposure (M, manual mode)
7. 400 ISO from light polluted city, 3200 ISO from a dark sky
8. continuous shooting mode
9. point on a clear night sky with the horizon on the lower border
10. focus on a star with live view (and disable auto-focus on the lens)
11. shot a single test image and carefully inspect looking for correct exposure and focus
12. plug in the bulb controller, push and let in the continuously pressed position
13. let the camera work for 2 hours
14. copy the images on your PC
15. mount them in a video file using the simplified workflow (Fastone+VirtualDub)
16. enjoy!

Other kind of astronomical timelapses

- Geostationary satellites
- Eclipses (lunar and solar)
- Spectra
- Sunrise/sunset
- Asteroids / comets
- Planets (conjunctions, occultations, rotations)

Imagination is the only limit!

Spectrum Example



More info

- Articles
  - “Moving Pictures”, S&T, Aug’09, by L.Comolli and A.Gambaro
- Books? AFAIK not yet anything about Night Sky TLs.
- Forums
  - http://forum.timescapes.org/phpBB3/index.php (and look especially to the Showcase)
  - http://timelapseitalia.com/forum/ (Italian)
  - https://timelapsenetwork.com/forum/ (English)
- Authors
  - just subscribe on Youtube or Vimeo to your preferred authors to receive notification of new videos.

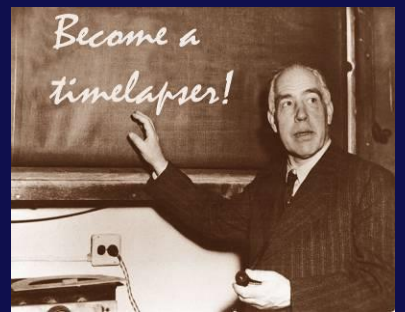
SKY & TELESCOPE

tli Time Lapse ITALIA

How to improve? Carefully observe/study master works! And try!

Remember: *<<An expert is a person who has made all the mistakes that can be made in a very narrow field.>>*

Niels Bohr (Nobel in Physics, 1922)



Conclusions

- Be aware: timelapsing produce dependence !
- A new form of astroimaging, captivating everybody
- Good:
  - not so expensive instrumentation
  - great results
- Bad:
  - lot of time for imaging
  - lot of time for processing

Some of my videos

Telescopes under the Sky
https://www.youtube.com/watch?v=-cev4bTycLg
4:06

Ice in the night
https://www.youtube.com/watch?v=k0Hxing7-V0
3:50

Diavolezza - Above the Glacier
https://www.youtube.com/watch?v=bPuDqmwCUY4
1:50

Under the Northern Lights
http://www.youtube.com/watch?v=00UC9Z3EXkw
7:17 (0-3/4.45-end)

Under the Namibian Sky - The Movie
http://www.youtube.com/watch?v=EM5lM5WEY3Q
13:24 (0-3.30/7-9/11-end)

Autumnal Nights
http://www.youtube.com/watch?v=bn59B3tXVzA
3:19

Alpine Sky
http://www.youtube.com/watch?v=Cr-KKAn2Lz4
4:39

Total Solar Eclipse USA 2017
(soon online)
2:24

Lights in the sky
https://www.youtube.com/watch?v=D1kXmoVOPoc
2:12

Geostationary satellites - 10-11 October 2009
https://www.youtube.com/watch?v=o00pwbZF94U
0:57

Discussion

- Questions?
- Tips?

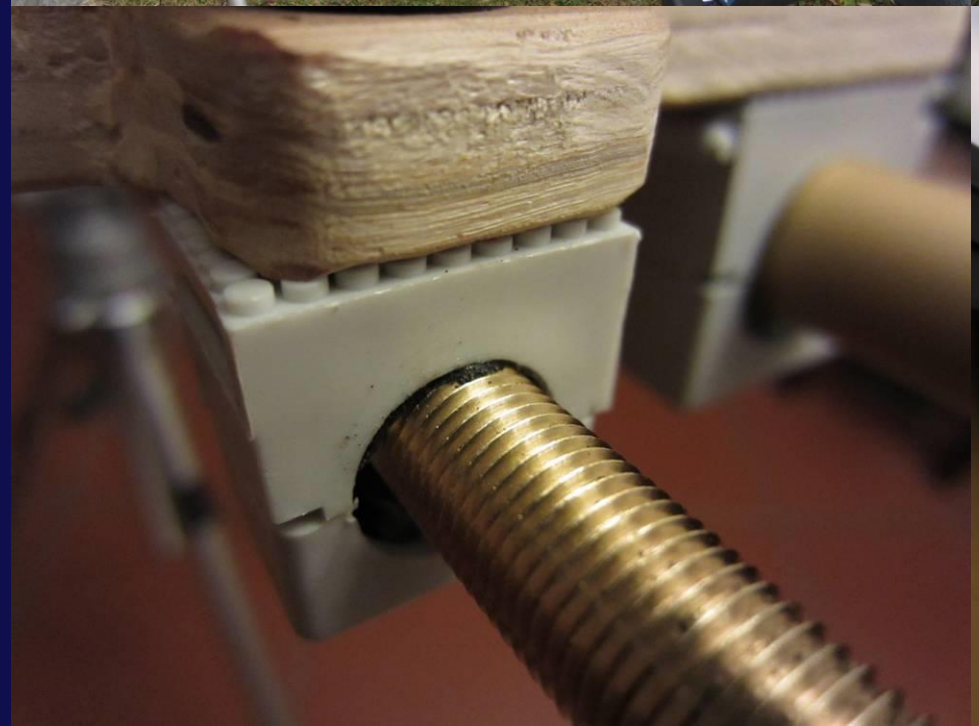
More videos on my website > Time-lapse: http://www.astrosurf.com/comolli/index2.htm

or my Youtube channel: https://www.youtube.com/loreastro

Any question: comolli@libero.it

Additional material

DIY Dolly



Panning