Time Lapses of the Night Sky

CEDIC 2013
by Lorenzo Comolli

Outline

- <u>Intro</u>: examples, history
- <u>Instruments and techniques</u>: camera, lens, tripod, timer, jpg, ext battery, dew remover, raw, iso, memory, composition, dolly, panning, bulb ramping, magic lantern, hdr
- <u>Processing</u>: video resolution, speed, compression, virtualdub (+deflicker), renaming files, lightroom, lrtimelapse, multi-track editors, music and licensing
- <u>Share</u>: Youtube, Vimeo, video file download
- <u>More</u>: articles, forums, authors
- <u>Other</u>: geostationary satellites, eclipses, ...
- <u>Conclusions</u>
- <u>Discussion</u>: 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...)

Example

Autumnal nights

Autumnal nights
http://www.youtube.com/watch?v=bn59B3tXVzA

Historical background

Making night sky time lapses before 10 years ago 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.

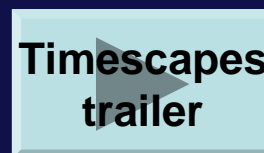Year 1992: "Baraka" (film, by Ron Fricke) was released, including many interesting night sky TLs made with film.

Baraka
clips

Historical background

- Year 2000s: many digital cameras and modified webcams become common. First trials in astrophotography and also TLs.

Webcam ▶

- 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.

A FILM BY TOM LOWE   MUSIC BY JOHN STANFORD
TIMESCAPES

Timescapes trailer ▶

Timescapes trailers
http://www.youtube.com/watch?v=e-GYrbecb88
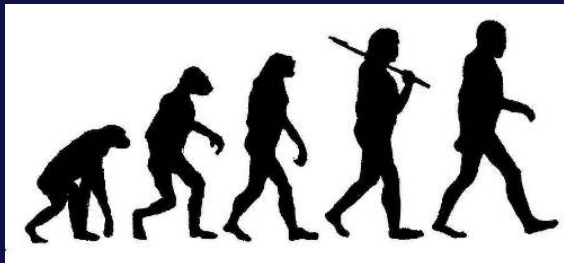http://www.youtube.com/watch?v=EgKXcQ9PLuc

Evolution of amateur TLs

- Simple image sequence ~2000
- 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 ~2010

Instruments and techniques

Basic: the camera

- Any modern DSLR is great. No need for filter modification.

- H-alpha mods required only for best rendering of nebulas.

- Also some compact cameras are ok (e.g. modified with CHDK)

- Settings:
  - ISO 1600 to 3200 ISO
  - bulb exposure (or manual 20-30 s)
  - JPEG small fine (or higher)
  - focus with live view is much helpful
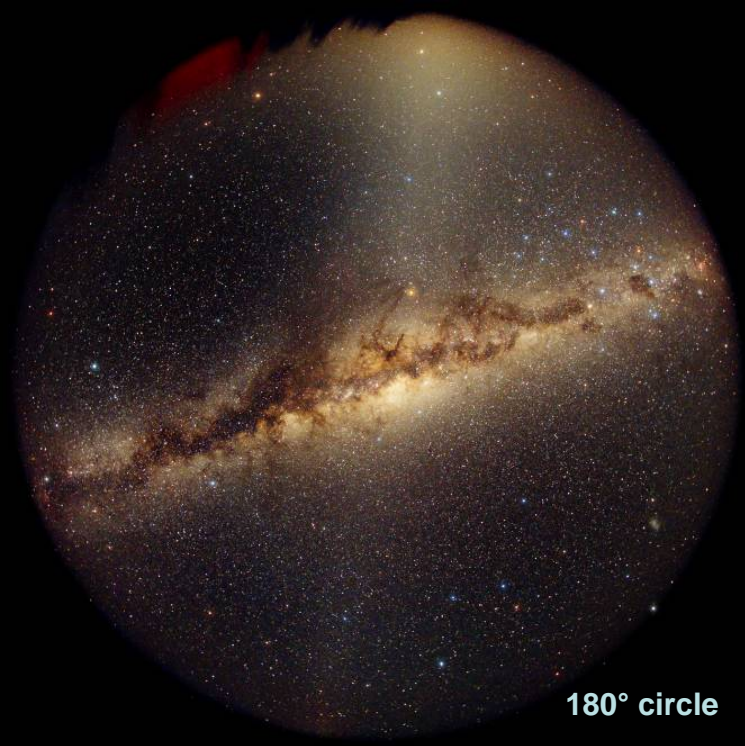
- Best results: full frame sensor

Canon 350D + Tokina 11mm f/2.8

Canon Ixus 220HS + CHDK

Basic: lenses

- Any lens is ok, also a cheap 18-55 f/3.5
- Some lenses are much better:
  - focal length: < 20 mm
  - aperture: < f/2.8
- Focus: manual is necessary (block with tape!)
- Some example:
  - Samyang 8 mm f/3.5 (fish, aps-c)
  - Samyang 14 mm f/2.8 (rect, ff)
  - Canon 15 mm f/2.8 (fish, ff)
  - Sigma 20 mm f/1.8 (rect, ff)

Lenses: field of view

180° circle

180° diagonal

Canon 5D + Peleng 8mm f/3.5

Canon 350D + Samyang 8mm f/3.5
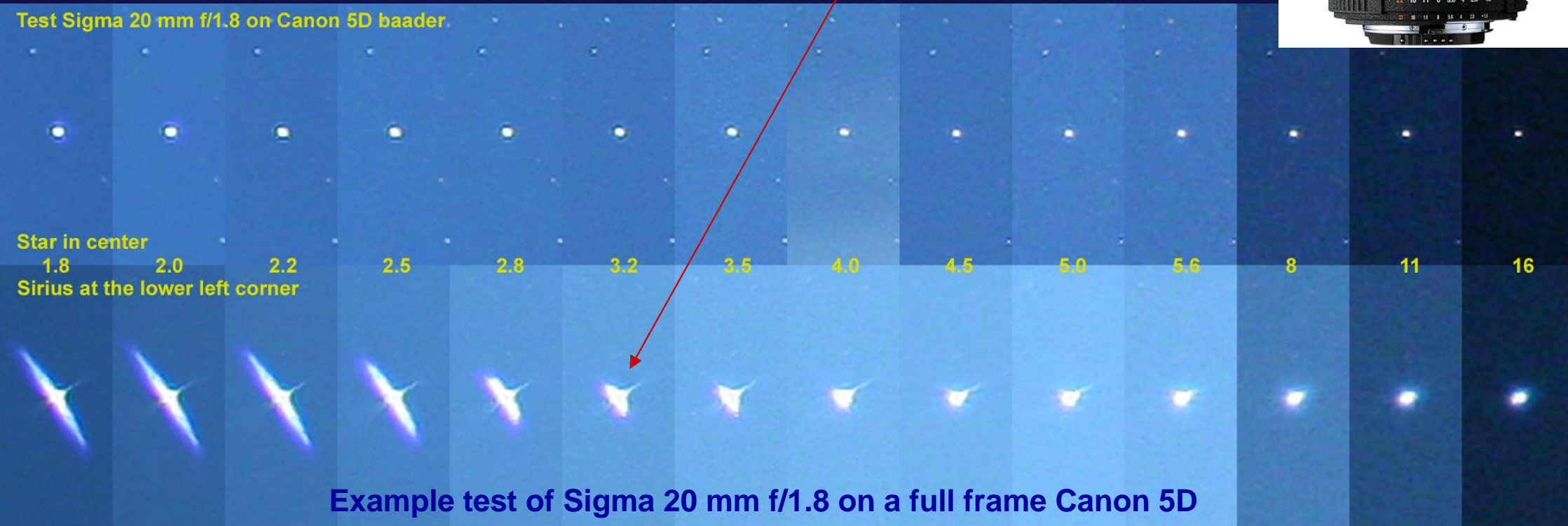
Canon 500D + Canon 15mm f/2.8
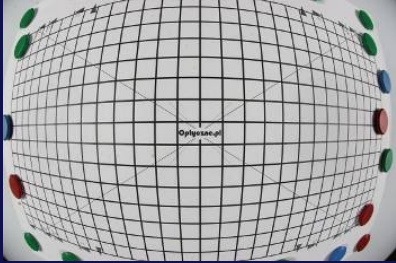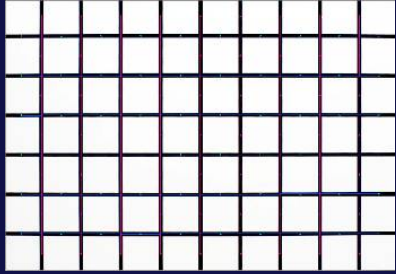
Canon 350D + Sigma 20 mm f/1.8 (at f/2.5)

73°x83°

58°x41°

Images by Namibia Team: Comolli, Fontana, Ghioldi, Sordini

Lenses: type of projection

	Fisheye	**Rectangular**
Pro	Very wide field Better aperture	More natural projection
Contra	Not everybody like this projection. Horizon must be in center not to be distorted.	Higher price (at = FL) Closer aperture (at = FL) Longer focal lengths (at = f/)
Distortion		
Example	\n**Canon 5D + Canon 15mm f/2.8**	\n**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 is high price
- Lower quality: need to step down
- Perform aperture tests to select the best one for you

Test Sigma 20 mm f/1.8 on Canon 5D baader

Star in center

| 1.8 | 2.0 | 2.2 | 2.5 | 2.8 | 3.2 | 3.5 | 4.0 | 4.5 | 5.0 | 5.6 | 8 | 11 | 16 |

Sirius at the lower left corner

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

Advanced 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 €**

Basic: tripod

- The camera must remain perfectly fixed for all the night.
- Avoid cheap plastic tripods.
- Good choices are Manfrotto tripods and heads.
- Type of heads:
  - 3 axis: more robust
  - ball: easy to point

Basic: timer

Methods for taking image sequences:
- continuous shooting, manual exposure, no pause between frames
- <u>bulb exposure controlled by a remote timer (much better!)</u>
- exposure controlled by modified firmware (e.g. Magic Lantern)
- exposure controlled by a PC via USB (comfortless)

Homemade bulb controller

Standard bulb controller

Adapter cable: jack to N3

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, prices 10-15€ from HK

Basic: timer

Example of control cycles for the night, fixed exposure.

Bulb only	Always on					
Camera	Exposure 1	Save	Exposure 2	Save	Exposure 3	Save

No pause and display
Camera must be set to continuous mode

Intervalometer	On	Off			On	Off		
Camera	Exposure 1	Save	Display	Pause	Exposure 2	Save	Display	Pause
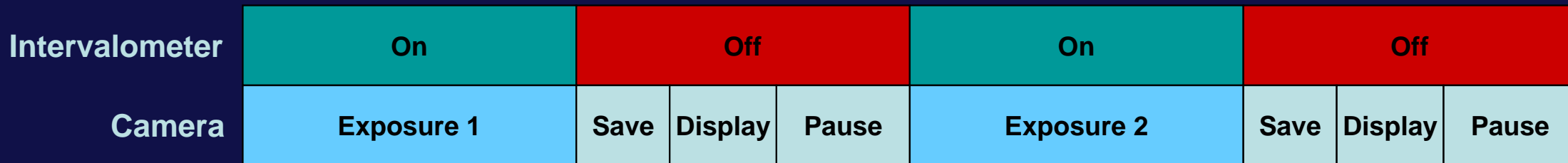
Useful to watch the images without touching the camera
Avoid if power is given by the internal battery

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

Basic: timer for sunset

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

Intervalometer | **On** | **Off** | Cycle 1 (day)

Camera | **Exposure (changing)** | **Save** | **Pause**

Intervalometer | **On** | **Off** | Cycle 100 (twilight)

Camera | **Exposure (changing)** | **Save** | **Pause**

Intervalometer | **On** | **Off** | **On** | **Off**

Camera | **Exposure (changing)** | **Save** | **Pause** | Cycle 200 (night)
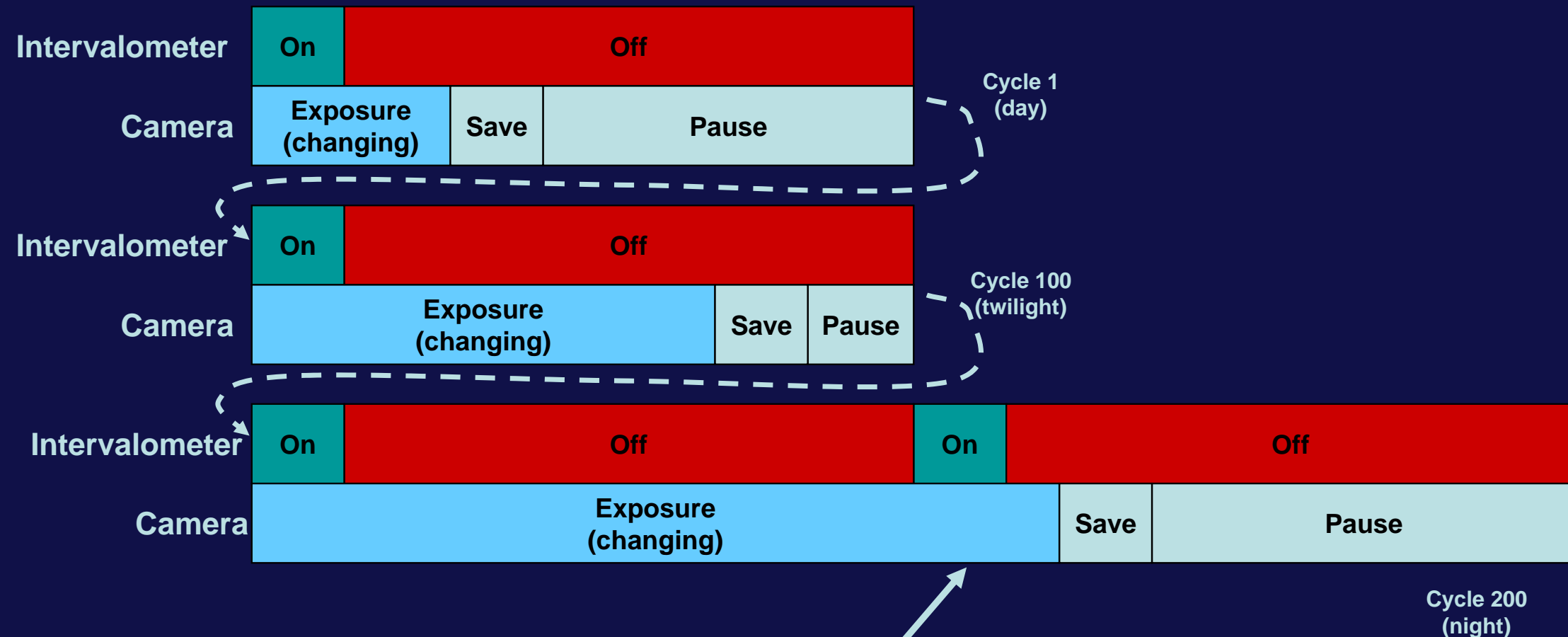
Exposure incident !
Now only 1 of 2 images is shot
Resulting TL shows acceleration

Incident example

Intermediate: dew remover

- 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.

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

Intermediate: external battery

- A standard battery can work only for some hours.
- An external power supply is necessary, connected to a bigger battery (e.g. a 12 V car battery).

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

great !

Empty battery

1N4007
D1

From 12V to 8.1V for Canon DSLR

2A
F1

3A
D3

E

IC1
LM317

U

R

D2
1N4007

OUT
+8.1 V (circa)

R1
220 ohm

IN
+12V

IC1

10uF C1

1200 ohm
R2

GND

GND

R U E
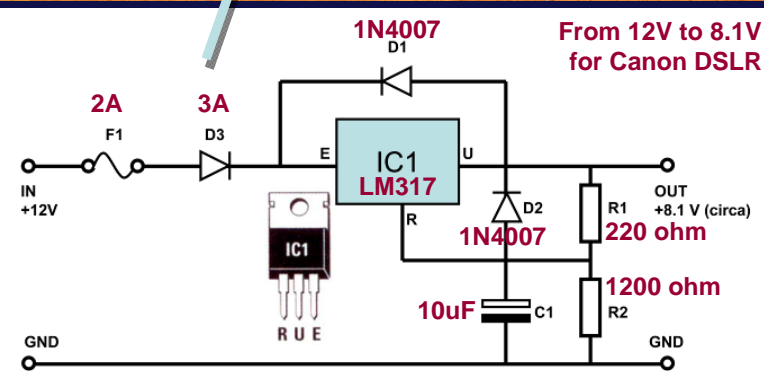
A 50 Ah on the field

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

Intermediate: memory

- A lot of memory space will be needed!

- Table at right: for an "old" 350D; for newer 60D, divide the memory autonomy by a factor of 4.

- My actual choice: 32 GB, CF or SD; using sRAW I run for two nights.

Typical image dimension and autonomy for an 8 Mpix Canon EOS 350D			
Quality	Size [MB]	Number of images on a 2 GB memory	Hours of autonomy with 30 s exp
Raw	7	289	2.4
Large Hi	3	675	5.6
Large Low	1	2024	16.9
Mid Hi	0.8	2530	21.1
Mid Low	0.6	3373	28.1
Small Hi	0.4	5060	42.2
Small Low	0.2	10120	84.3

After a night of work...
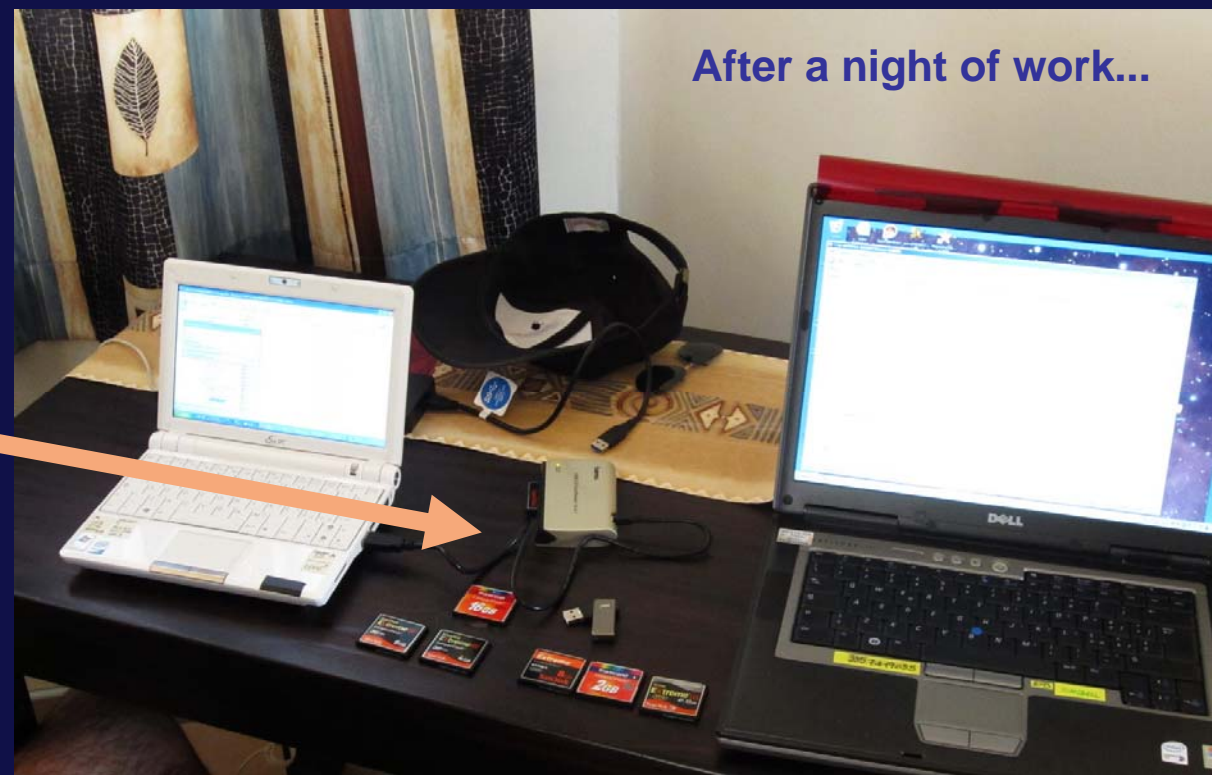
Advanced: RAW format

- RAW format contains much more information that can be "developed".
- Because of short exposures, hard processing is needed and a JPG will suffer.
- RAW will give superior results.
- Drawbacks:
  - much more memory needed
  - raw conversion needed (can be slow)
- Advice:
  - novice: start with JPG
  - my actual selection: all RAW, and if available sRAW (small RAW)

zoom

RAW image
(patterned with squares)

RGB composition

Decomposition in color planes
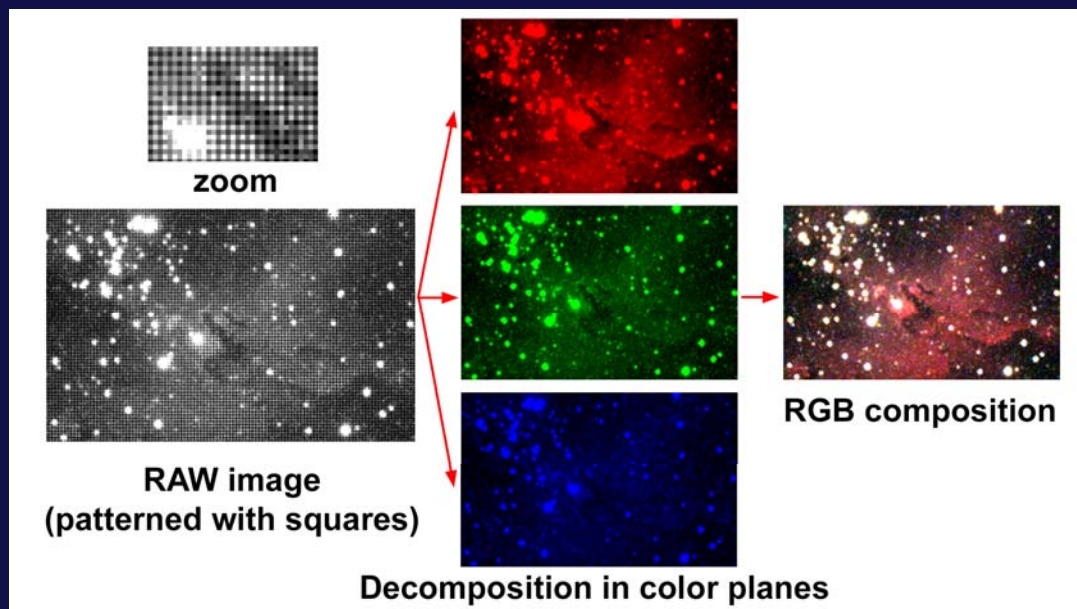
Advanced: best ISO setting

- Gain and read noise test (example with 60D)

Read noise Canon 60D

Best is 1600 or 3200 ISO

Noise test 60D, constant exp*ISO, resampled at 1920 pix width

30 s	400 ISO
15 s	800 ISO
8 s	1600 ISO
4 s	3200 ISO
2 s	6400 ISO
1 s	12800 ISO

200 % crop

Small stars are lost

| 400 ISO | 800 ISO | 1600 ISO | 3200 ISO | 6400 ISO | 12800 ISO |

More tests
http://www.astrosurf.com/comolli/strum43.htm
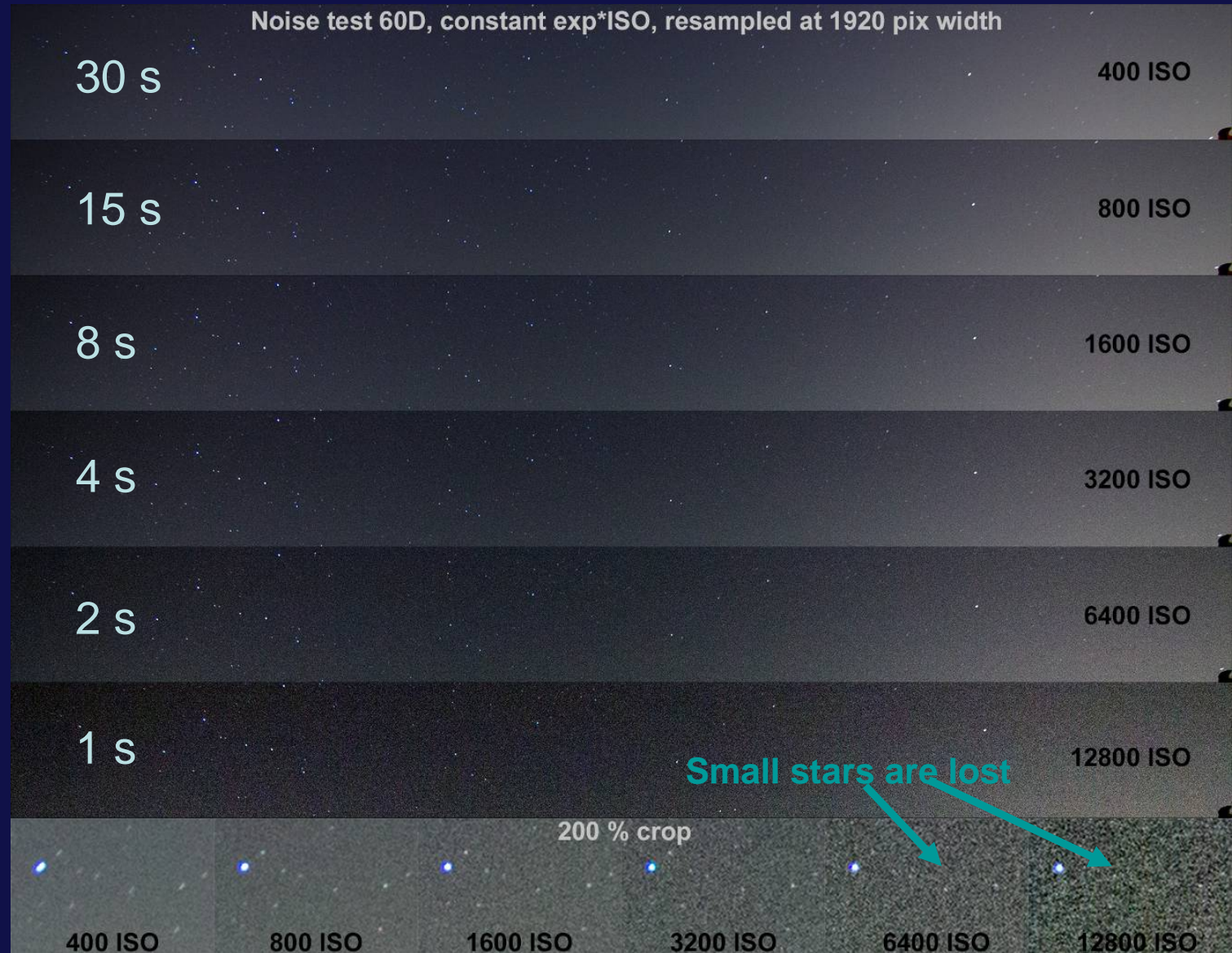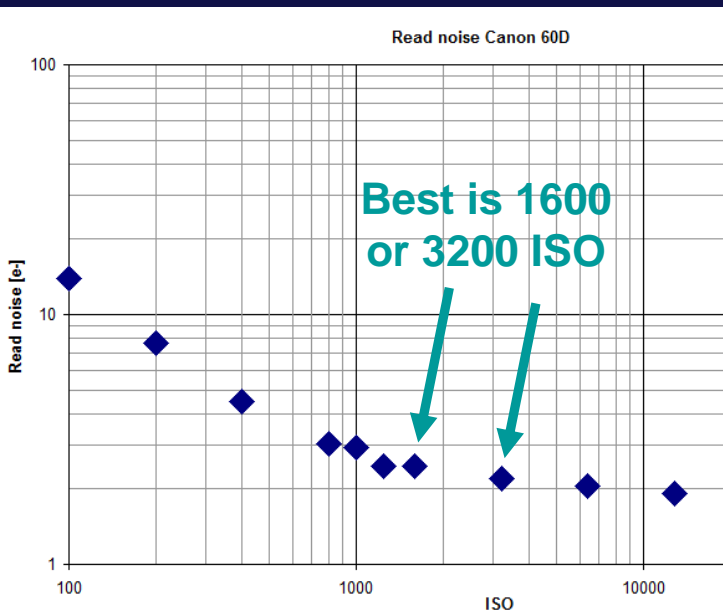
Advanced: panning and dolly

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

- Type of motions:

  - <u>motion of a crop window</u> in a static video; no hardware needed

  - <u>rotation</u>; a panning head is needed (1 or 2 axis)

  - <u>translation</u>; a dolly is needed (length ~1 meter)

Full image

crop box

slow motion of the crop box

Panning +Dolly

Homemade dolly

Panning head 1 axis horizontal
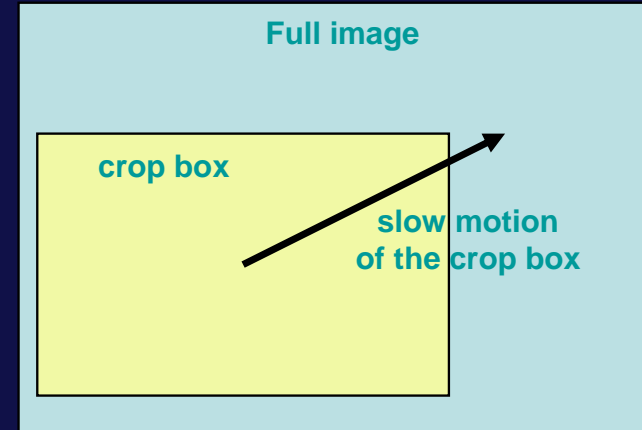
Advanced: panning and dolly

Some available products on the market:

- Dolly:
  - Dynamic Perception Stage Zero (~900€)
  - Starworks Sky Trail (~430€)
- Panning 1 axis
  - Starworks 360° Panoramic Head (~350€)
  - Astro (~200€)
  - Vixen Polarie (~400€)
  - Ioptron Sky Tracker (~400€)
  - Radian (~150€)
- Panning 2 axes
  - Merlin pano head (~200€)
  - SkyWatcher All View (~500€)
  - Emotimo (~900€) (also 3 axis)
- Advanced:
  - Kessler (€€€!)

Dynamic Perception

Starworks

Starworks

Vixen

SkyWatcher

Ioptron

Kessler

Emotimo

Radian

Merlin

Astro
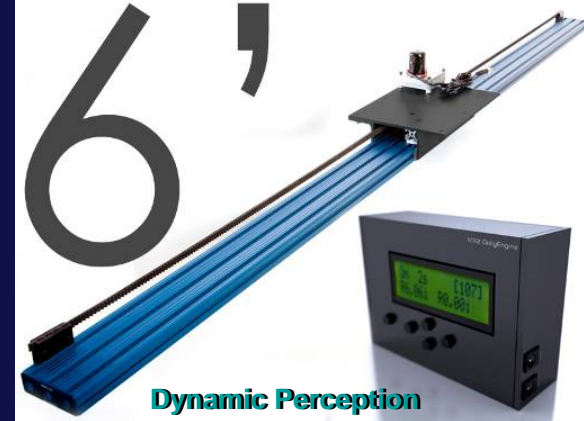
Advanced: bulb ramping

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

- Needed:
  - <u>exposure</u> time must increase from e.g. 1/500 s to 30 s
  - <u>ISO sensitivity</u> must increase from e.g. 100 to 1600 ISO

- Solutions:
  - <u>AV mode</u>: it doesn't work! Flickering, darkness, ...
  - <u>bulb ramping</u> in ML: it uses bulb above 1/10 s to make short increments

- Post-processing: a good deflickering software anyway is needed.

Flickering example
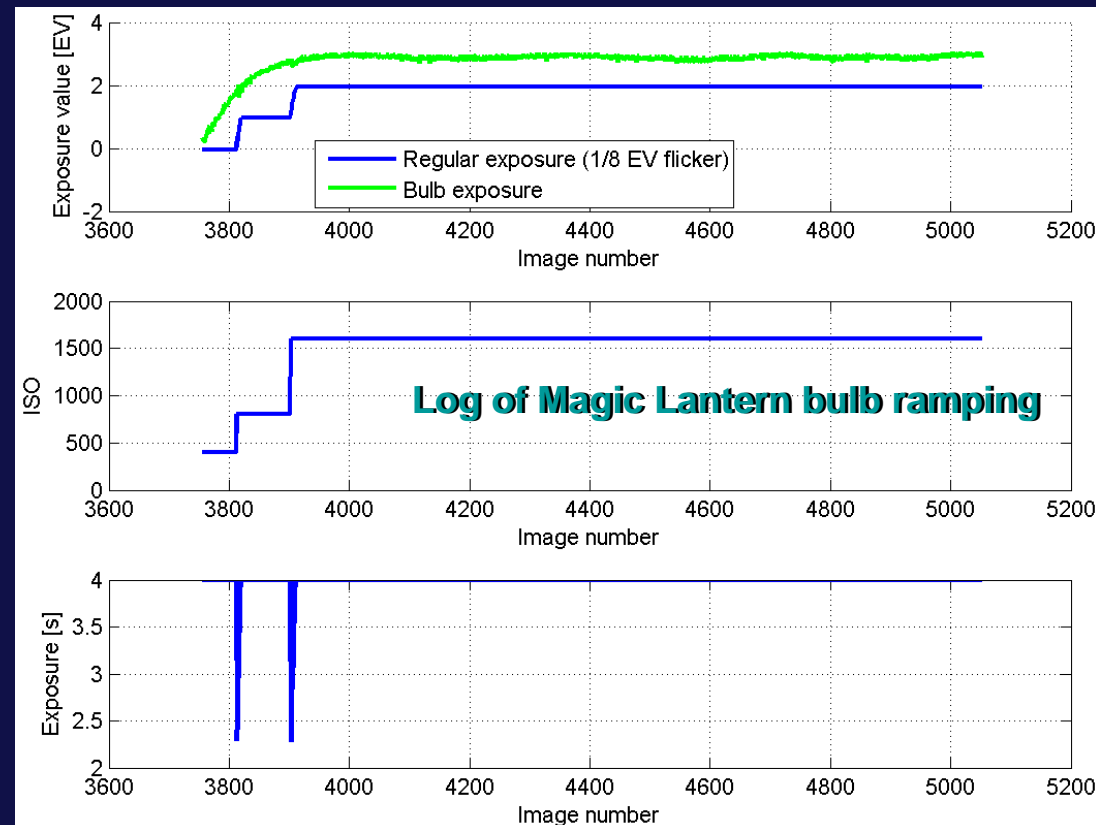
Log of Magic Lantern bulb ramping

Advanced: ML timer

Magic Lantern and Sunset mode
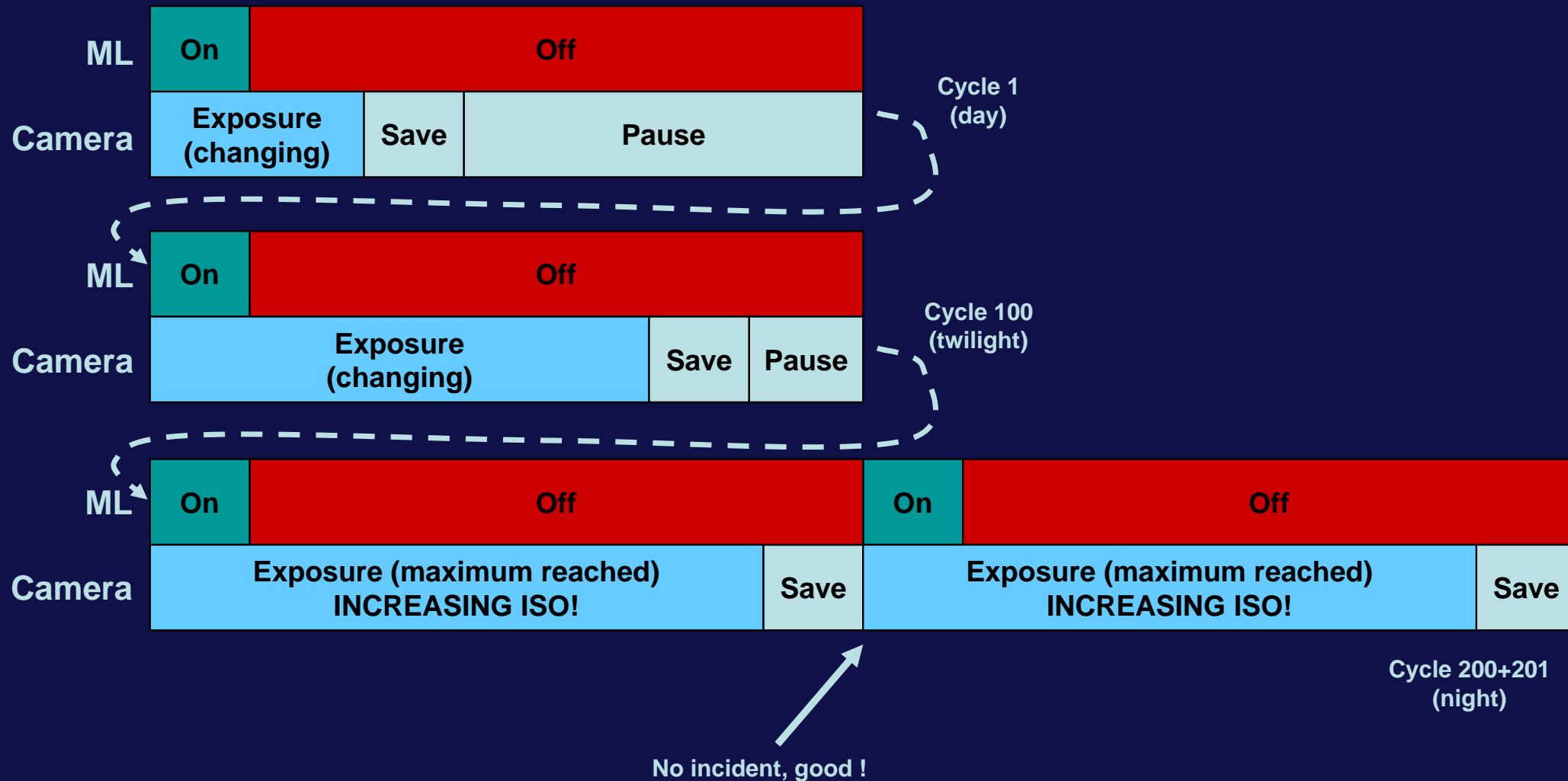
Advanced: Magic Lantern and CHDK

- Canon cameras can be modified by using modified firmware.
- Advantages: 1000+ !!!
- Do at your risk
- 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
Magic Lantern	5Dmk2, 50D, 60D, 500D, 550D, 600D soon: 5Dc, 1100D, 5Dmk3, 7D, 6D, 650D, EOS-M
CHDK (Canon Hack Development Kit)	Nearly all compact Powershot and IXUS cameras Some older DLRL (350D, 400D, 450D) (limited functions)

Composition rules

- 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)

Use a flash-bubble level or the internal level

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

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

  - blue sky ONLY when the Moon is in the sky

  - pale yellow Milky Way and zodiacal light

NO, blue sky without Moon

OK

Moon before setting: OK blue

After Moon setting, pale brown

NO, blue milky way
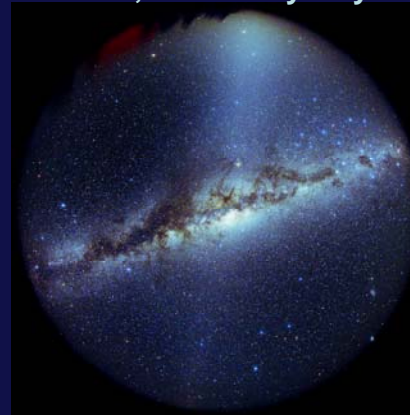
OK, yellow milky way

Advanced: HDR

- In the night, HDR is nearly useless.
- HDR is great where huge brightness differences are present, e.g. sunset.
- Use AEB on your camera with +/- 2 stops

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

-2 stop

0 stop

+2 stop

HDR merge

Processing

Processing basic: video resolution, fps, ...

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:

- HD Ready, 1280x720 pixel (or 720p)
- 1620x1080 or 1080x720 have 3:2 aspect ratio
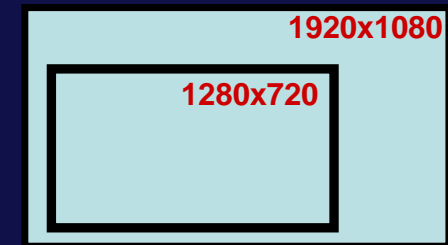
Aspect ratio: Full HD is 16:9 (ratio 1.78); DSLR is 3:2 (ratio 1.5); compact camera is 4:3 (ratio 1.33); actual TV and PC monitors are 16:9.

- Advised: 16:9 (or at least 3:2).

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).

1920x1080

1280x720

4:3

3:2

16:9

Processing basic: speed factor

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

The speed (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 rec)	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

Processing basic: compression

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

Example (with 25 fps, 24 bit RGB)

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

Best actual codecs:

- h264 (best quality/size ratio, heavy computing power, x264 free)
- Xvid (very good, slightly better 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)

X264 (select VFW-version-x86)
http://komisar.gin.by/
Xvid
http://www.xvid.org/

Processing basic: Virtualdub

- All needed:
  - JPG files
  - Virtualdub (free)
  - Xvid codec (free)
- Example workflow:
  - load first image
  - reduce image size
  - set brightness
  - set frame rate
  - set compression (Xvid)
  - save as avi
- Drawbacks:
  - only single sequences can be produced
  - very simple image processing
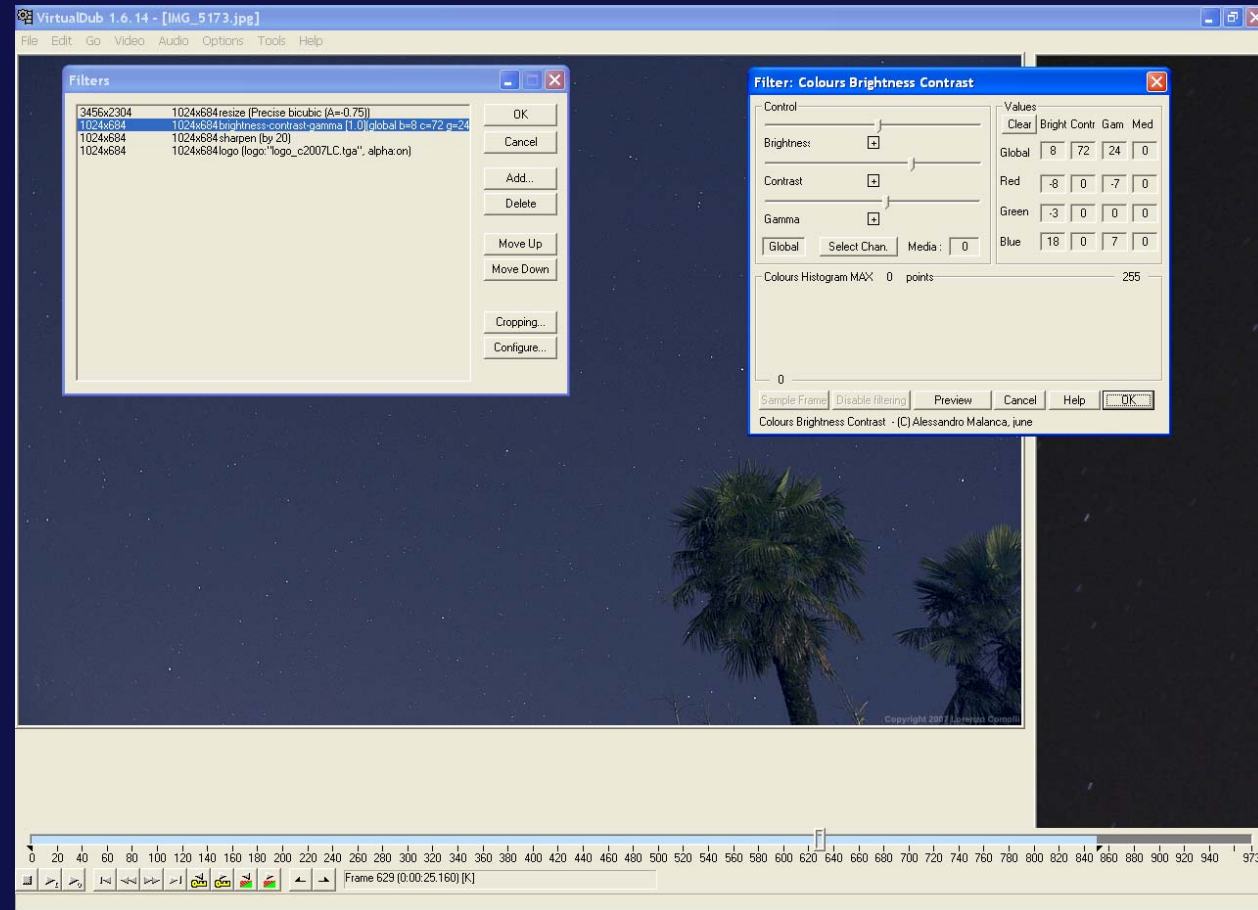
Example of processing

Virtualdub
http://www.virtualdub.org/
Xvid
http://www.xvid.org/

Processing basic: renaming

- VirtualDub requires consecutive file names, but:
  - the camera rewind to 0 after 10000 shots
  - sometimes you need to remove an image
- So renaming is necessary.
- Free software:
  - A.F.5 Rename your files
  - FastStone (useful not only for renaming, but also for selection)

A.F.5 Rename your files
http://www.fauland.com/af5.htm
FastStone
http://www.faststone.org/

Processing intermediate: star trails

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.

Softwares: StarStaX, StarMax, StarTrails

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

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

Example of processing

3. **Stack**

http://markus-enzweiler.de/StarStaX/StarStaX.html
http://ggrillot.free.fr/astro/starmaxEng.html
http://www.startrails.de/html/software.html
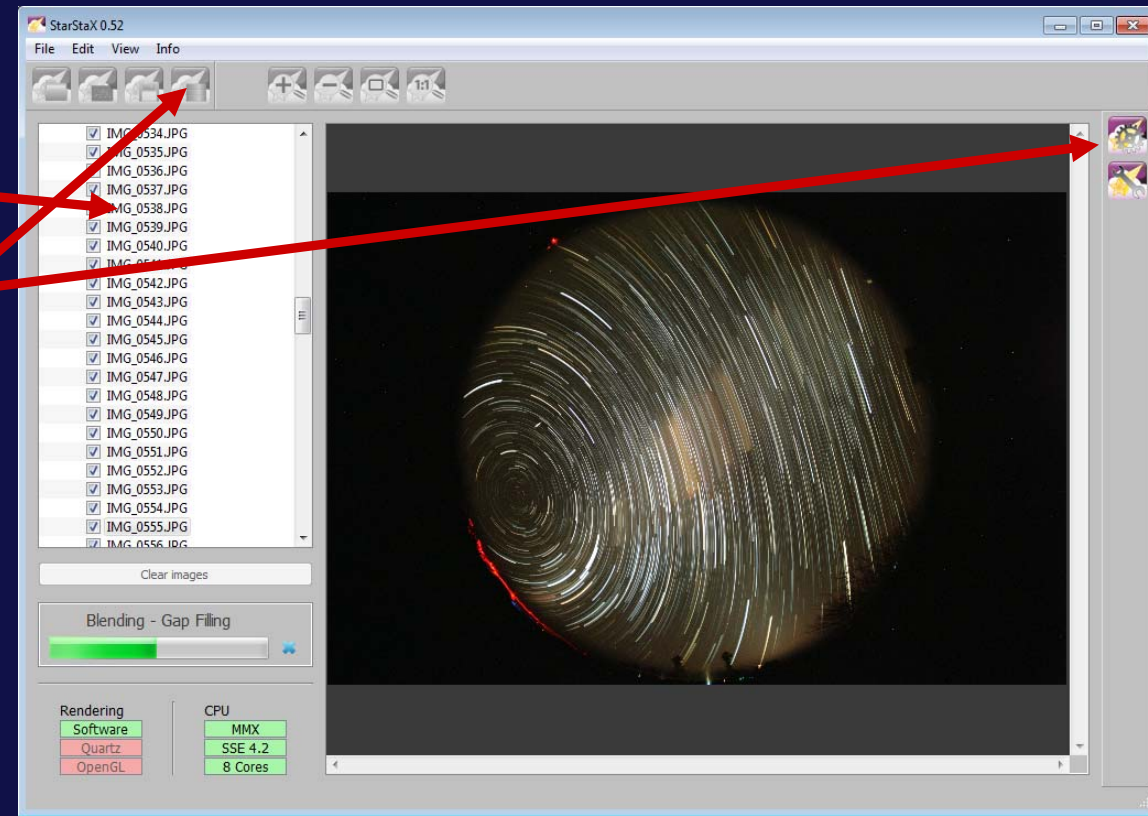
Processing intermediate: Deflicker in VD

Deflickering can be done in Virtualdub by adding a "filter"

- MSU Deflicker
  - very simple
  - corrects only small flicker
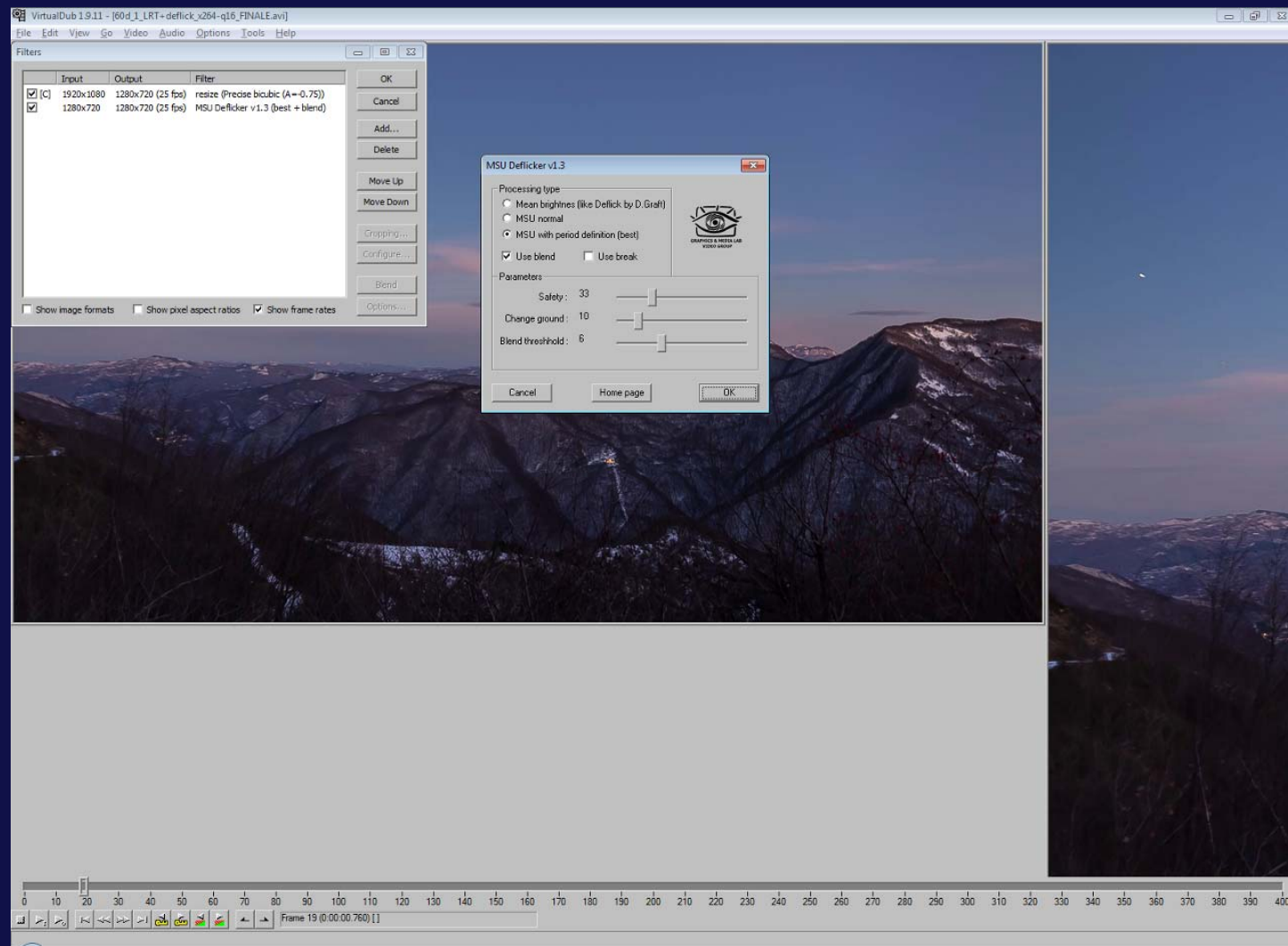
MSU Deflicker
http://www.compression.ru/video/defli
cker/index_en.html

Advanced processing: Adobe Lightroom

- RAW files cannot be imported directly into Virtualdub
  - Lightroom has an integrated raw developer (like Camera Raw)
- Also JPG processing can be better done respect to Virtualdub
- MP4 video output can be obtained (use the LRTimelapse templates)

Example of processing
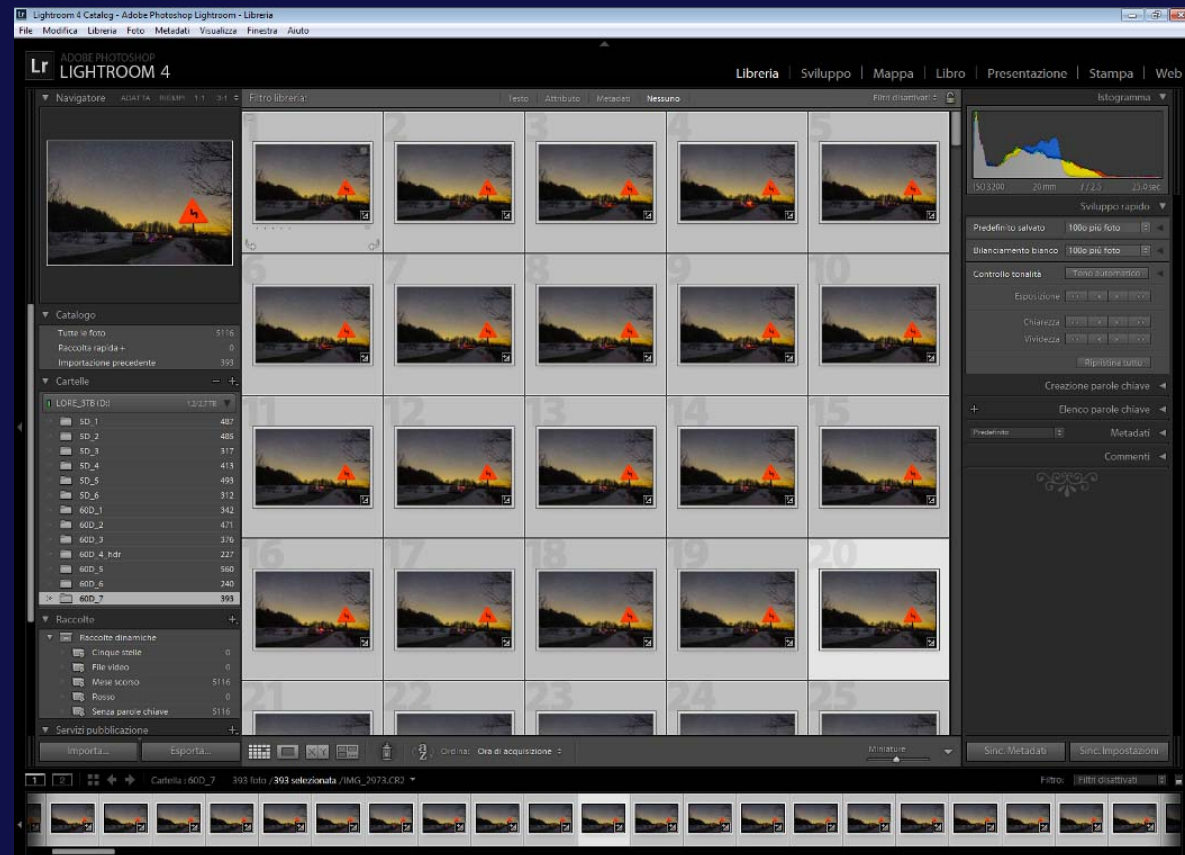
Advanced processing: LRtimelapse

- Able to cure flickering in day-nights transitions
- Works better with RAW files
- Lightroom is needed
- Workflow is not simple
- free only for <400 images

Example of corrected flickering

http://www.lrtimelapse.com/

Workflow

Image preview

Correction needed

Brightness curve

File list

Constant brightness output

Advanced processing: multi-track editors

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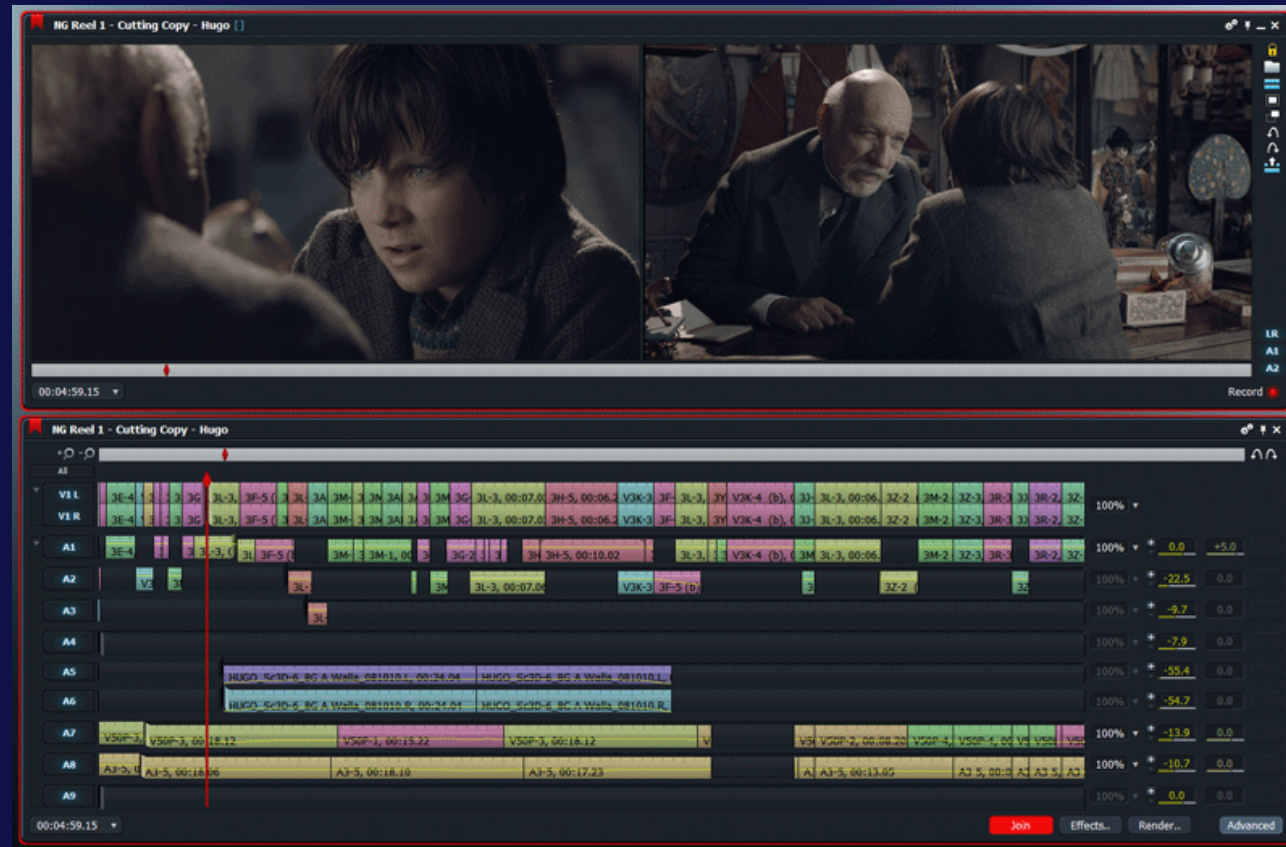- Titles and text addition

Softwares:

- commercial: Adobe Premiere, Sony Vegas, Final Cut, Pinnacle Studio
- free: Lightworks

Notes:

- complicated !
- but powerful !

Lightworks

Advanced processing: background music

- *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://www.jamendo.com/
- Many others sell royalty-free music:
  - http://www.thebluemask.com/
  - http://www.mobygratis.com/

*Common creative license:
- all CC can be freely listened
- not all can be used as a background !

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

Sharing and conclusions

Sharing online

- Online sharing is fundamental nowadays
- Videos are very large! E.g. 500 MB
- Options:
  - Youtube
  - Vimeo
  - file on personal website

Video

Suggested similar videos

Resolution

Views

Like

User comments

Sharing: choice comparison

	Youtube	Vimeo	Personal website
Max res (free / pay)	4K (4096x3072) -	720p (1280x720) 1080p (1920x1080)	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	15 min or unlimited	unlimited	unlimited
Audience	Everybody	Advanced	Your friends
Embeddable?	Yes	Yes (free: only 720p)	-
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 objective at full aperture minus one stop
2. on a tripod
3. with a fully charged battery
4. empty memory
5. JPG low resolution and low quality setting
6. 15 s fixed exposure (manual mode)
7. 400 ISO (if from city, 1600 ISO if dark sky)
8. continuous shooting mode
9. point on a clear night sky with the horizon on the lower border
10. focus and disable auto-focus
11. shot a single test image for evaluating the exposure and focus
12. plug in the bulb controller, push and let in the continuously pressed position
13. let the camera work for an hour or two
14. copy the images on your PC
15. mount them in a video file using a software like VirtualDub
16. enjoy!

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/ (only in Italian)
- Authors
  - just subscribe on Youtube or Vimeo to your preferred authors to receive notification of new videos.

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.>>*
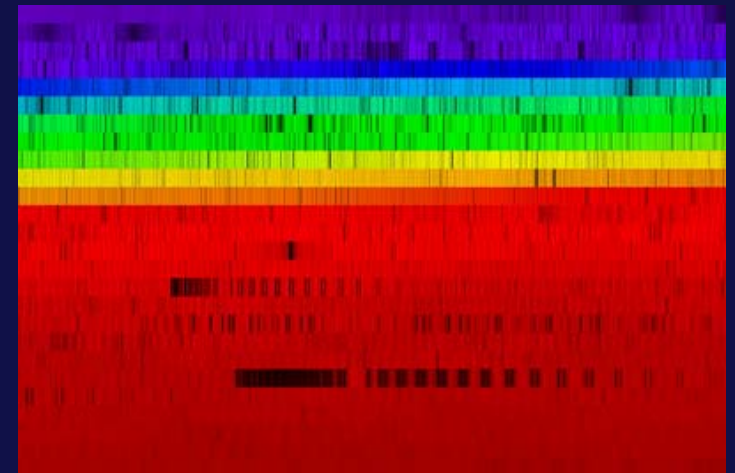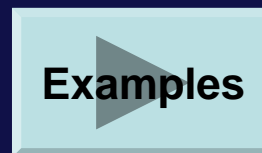*Niels Bohr (Nobel in Physics, 1922)*
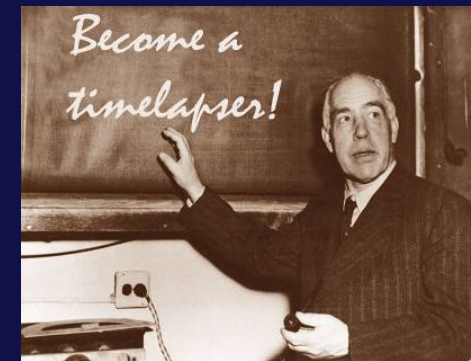
Other kind of astronomical timelapses

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

Imagination is the only limit!

Examples

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

Autumnal Nights

http://www.youtube.com/watch?v=bn59B3tXVzA

Alpine Sky

http://www.youtube.com/watch?v=Cr-KKAn2Lz4

Day and Night on Monte Generoso

http://www.youtube.com/watch?v=okNBmkSGmaY

Under the Northern Lights

http://www.youtube.com/watch?v=00UC9Z3EXkw

Under the Namibian Sky - The Movie

http://www.youtube.com/watch?v=EM5IM5WEY3Q

Some great videos on the web

Helvetia's Dream from Alessandro Della Bella
http://vimeo.com/52123602

Sub Zero from Randy Halverson
http://vimeo.com/20062206

The Mountain from TSO Photography
http://vimeo.com/22439234

In The Land Of The Northern Lights from Ole C. Salomonsen
http://vimeo.com/21419634

Earth from Michael König / ISS crew
http://vimeo.com/32001208

Sunset & Sunrise of Korea from Kwon, O Chul
http://vimeo.com/56494865

ESOcast 19
http://www.youtube.com/watch?v=8Gbl2wQ-YeM

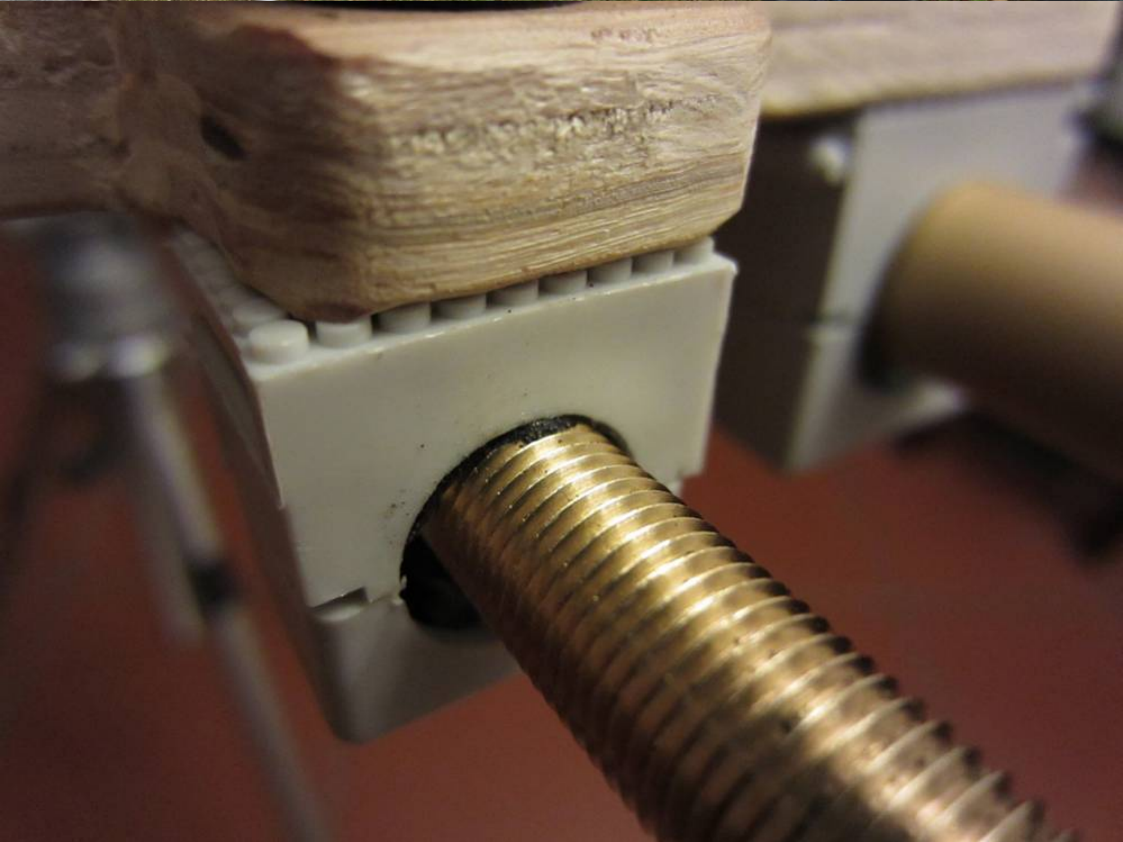*Look also to other videos of the same authors!*

Discussion

- Questions?
- Tips

Additional material

DIY Dolly

Panning