ESA report – IAWN-related activities in 2016

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Bild: ESA

Outline

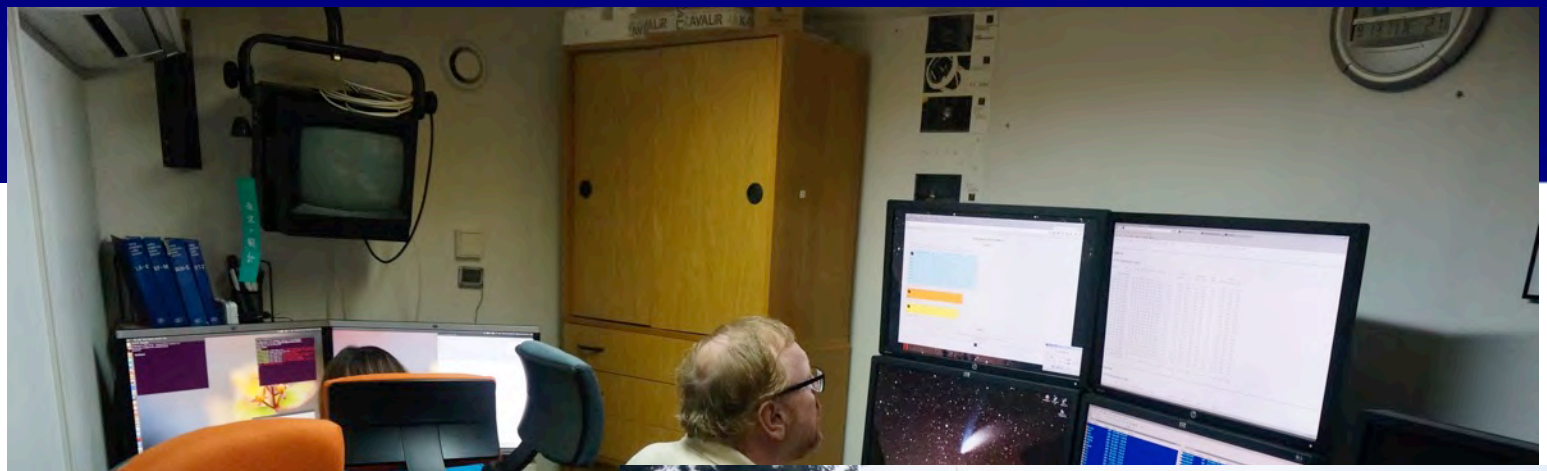
- Observations
- NEODyS and other tools
- Communications and outreach
- Selected internal studies
- Future
- Proposed updates to IAWN webpage
- Items for discussion at this meeting

Observations

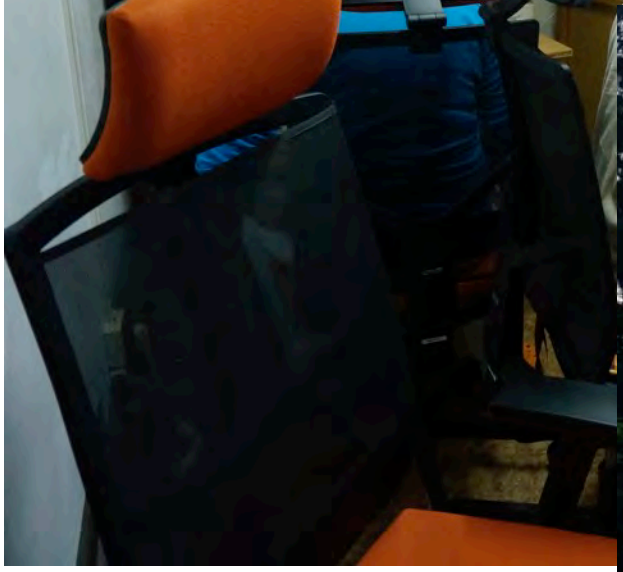
- **Focussing on follow-up**
  - OGS (Tenerife, 1-m aperture) – regularly, 4 nights per month
  - Test-Bed Telescope (Cebreros, Spain, 56 cm f/2.8, 4 deg^2) has started operations, IAU sitecode obtained, first follow-ups. 2nd telescope is in storage, will be installed at La Silla in 2017
  - Klet (CZ, 1-m aperture) – regular follow-ups, every clear night
  - VLT (ESO, Chile, 8 m) – 10 hours per semester for faint (~27 mag) follow-up
  - Calar Alto Schmidt (Southern Spain, 80 cm) – under test, needs better camera
- **Fly-eye telescope for 'wide survey' under development**
  - 1-m aperture, 45 deg^2 field-of-view
  - Design frozen
  - Optical and mechanical components are being manufactured
  - Site selection ongoing (in Europe for 1st telescope. 2nd telescope (pending funding approval at CM16 in Dec 2016): at ESO site in Chile

CM16 = Council meeting on Ministerial level of ESA

Milos Tichi in the control room of the Klet observatory

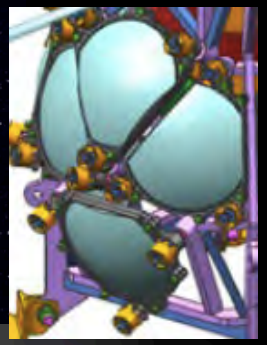


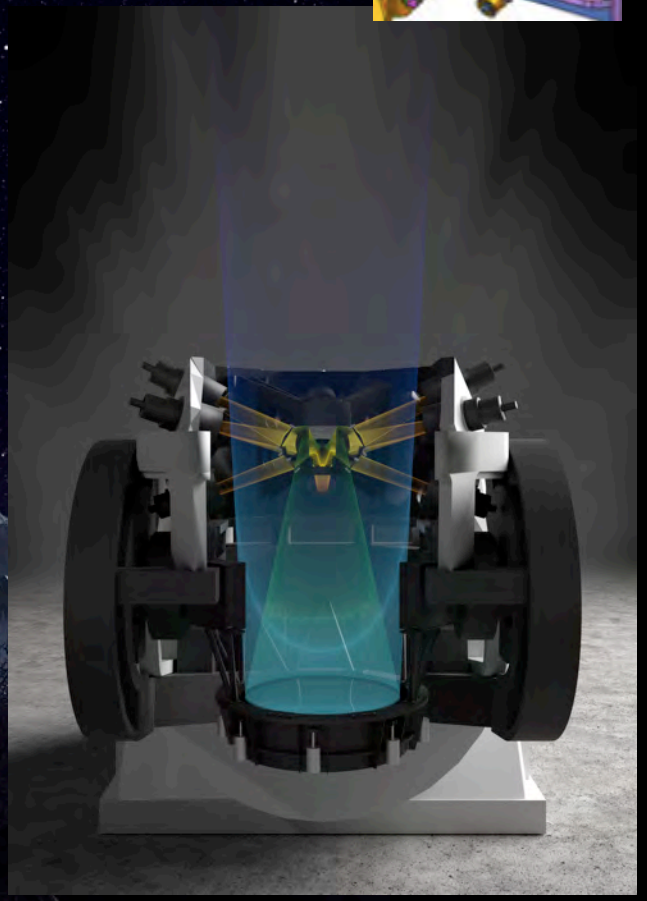
Milos Tichi in the control room of the Klet observatory



Detlef's camper van next to the Klet observatory

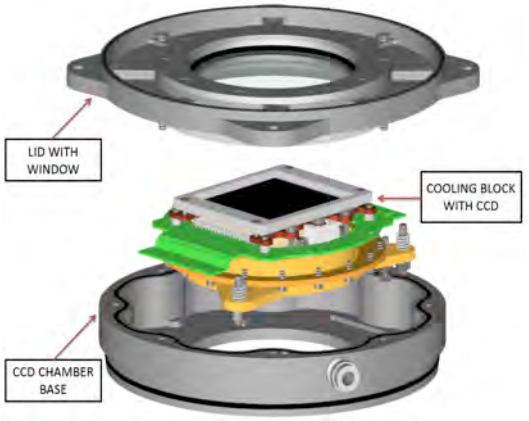
Observations – fly-eye telescope





Observations – fly-eye telescope

Prototype (2015)



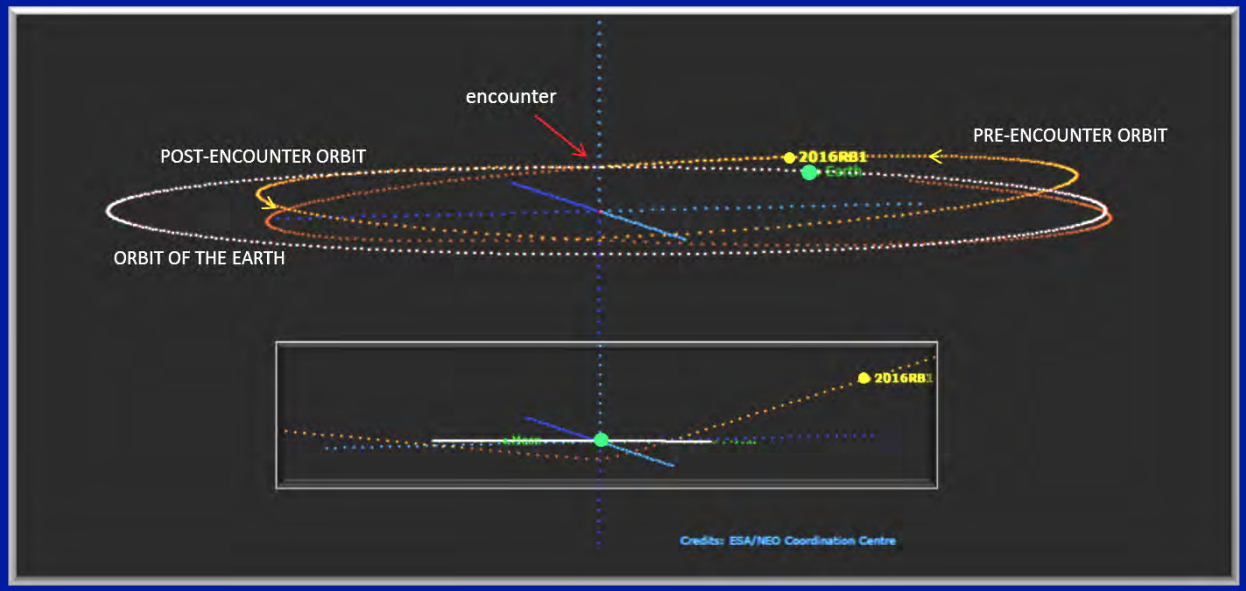
"Our" fly-eye

ESA-SSA-NEO-HO-0279, p. 7

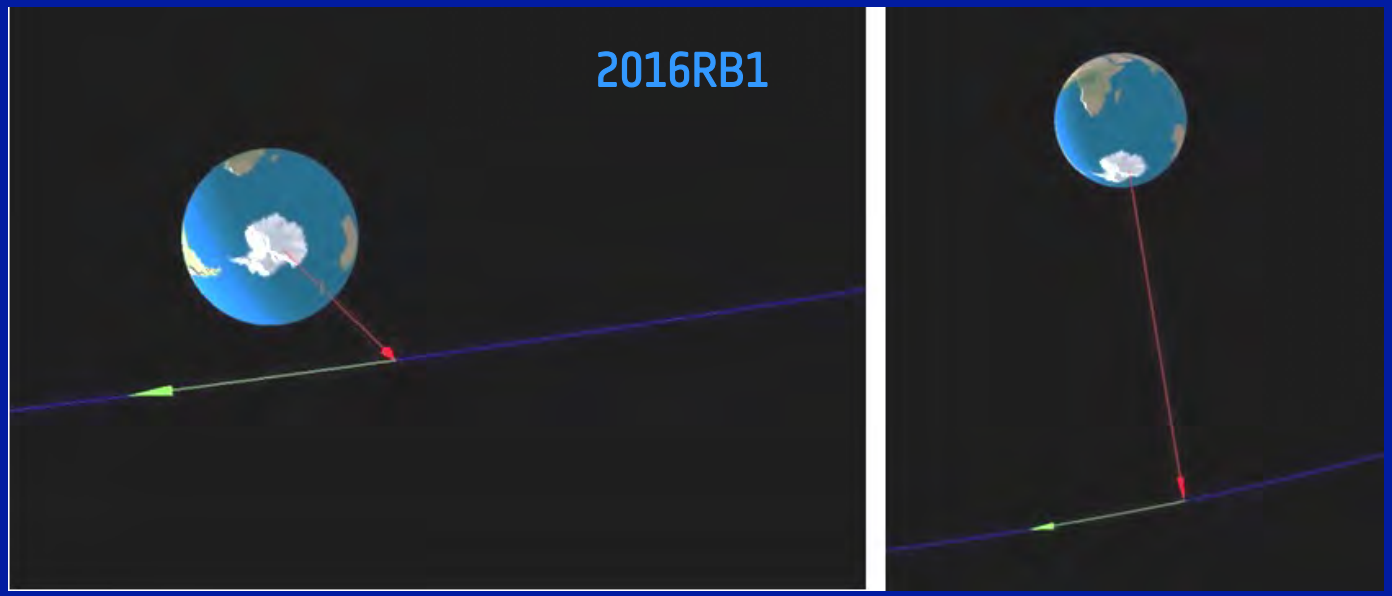
NEODyS and other s/w tools

- **Preparation for moving NEODyS to ESRIN is ongoing**
  - Follows proposal in UN working groups that NEODyS needs 'proper funding'
  - Code is being refactored to qualify as 'operational software' following ESA standards – Orbit Determination function basically done; Impact Monitoring function part of an upcoming contract starting in 2017
  - Based on OrbFit and EU-funded orbit computation library; well documented and tested
- **Orbit Visualisation Tool**
  - A new visualisation tool based on modern WebGL technology has been prepared and is ready to be installed on our web pages
  - Uses correct geometry, including Earth rotational state
- **Impact corridor**
  - A tool to visualize impact corridors was developed by the Pisa team
  - This will *not* be publicly available!
- **Star chart tool**
  - Web-based planetarium s/w visualizing NEOs (including Earth perturbation)

NEODyS and other s/w tools



Orbit Visualization Tool



NEODyS and other s/w tools

Impact Corridor

NEODyS and other s/w tools

Impact Corridor

Communications, public outreach

- **Risk communications workshop at ESRIN, Italy, 20/21 Nov 2015**
  - SSA-P2NEOI-RP-001/1.1, Oct 2016
  - Participants from earthquake warning community, science journalists, asteroid experts
  - Lessons learned: Risk scales need more work; training exercises should involve the real audience; avoid probabilities.
- **Monthly newsletter**
  - Provided via http://neo.ssa.esa.int
  - Up-to-date information, highlights, on NEO topics

Communications, public outreach

- **Support to the Asteroid Day**
  - Press conference at ESA in Feb 2016
  - Support to activities in Germany (Heidelberg, Munich) and Italy (Rome); web activities
- **Information distribution to emergency response agencies**
  - Was formalized in a document presented and agreed by Delegates from ESA member countries
  - SSA-NEO Information Plan, ESA-SSA-NEO-PL-0017
  - We have 'impact warnings' and 'information release'
  - 'impact warning': >=1 % impact probability within the next 50 years
  - 'information release': Anything that we expect to attract public attention

Communications, public outreach

Figure 11 - Contradicting news appearing on the press one month before the L'Aquila earthquake

Figure 13 - The NEO Coordination Centre monthly newsletter and the Daily Minor Planet layouts

Selected internal studies

- **Optimizing survey pixel scales**
  - "Influence of telescopic pixel scale on the accuracy of a NEO orbit determination", ESA-SSA-NEO-RP-0163, 2016 Jun, J. Otto
  - Analyzes orbit inaccuracies depending on pixel scale of survey telescope
  - What's the consequence for when a follow-up has to occur?
- **Compiling risk scales; proposing an update to the Broomfield scale**
  - "The asteroid impact threat – from physical parameters to information"; ESA-SSA-NEO-RP-0165, 2016 Aug, F. Stadler
  - Summarizes existing risk scales from the asteroid, tsunami, earth-quake communities
  - Defines shortcomings and proposes improvements
  - Proposes an update to the Broomfield scale
  - Depending on impact location, we should generate maps with disaster category (needs still more understanding on impact effects; and an engineering tool)

Selected internal studies

Detectable magnitude for a given telescope/exposure time combination with different pixel scales – and time to latest follow-up

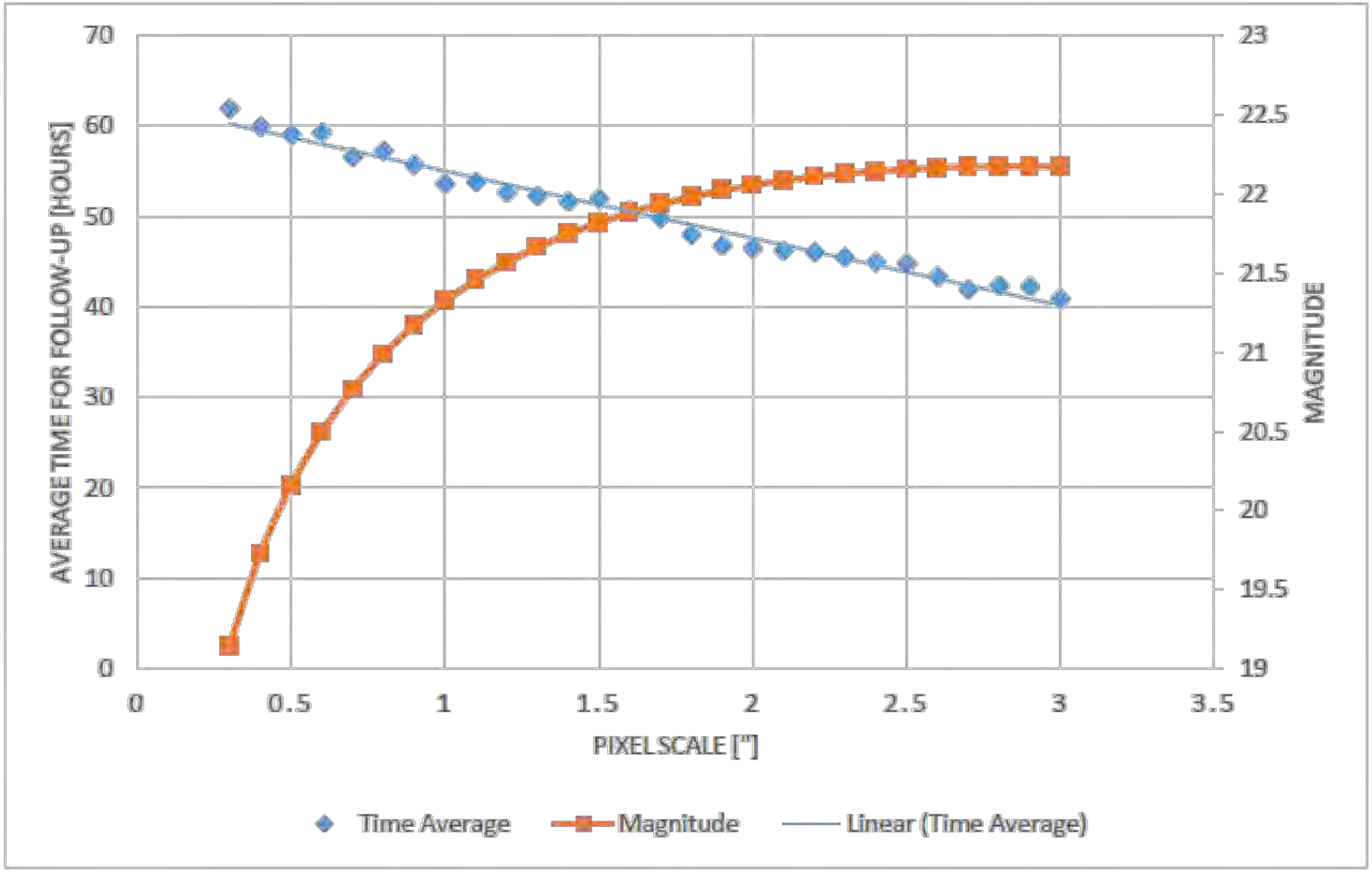


Figure 9–1: Time Average and Magnitude over Pixel Scale for 2016 EV27 at 2016 03 01

Selected internal studies

Impact damage scale is color-coded – and effects depend on distance to impact/ airburst and topography

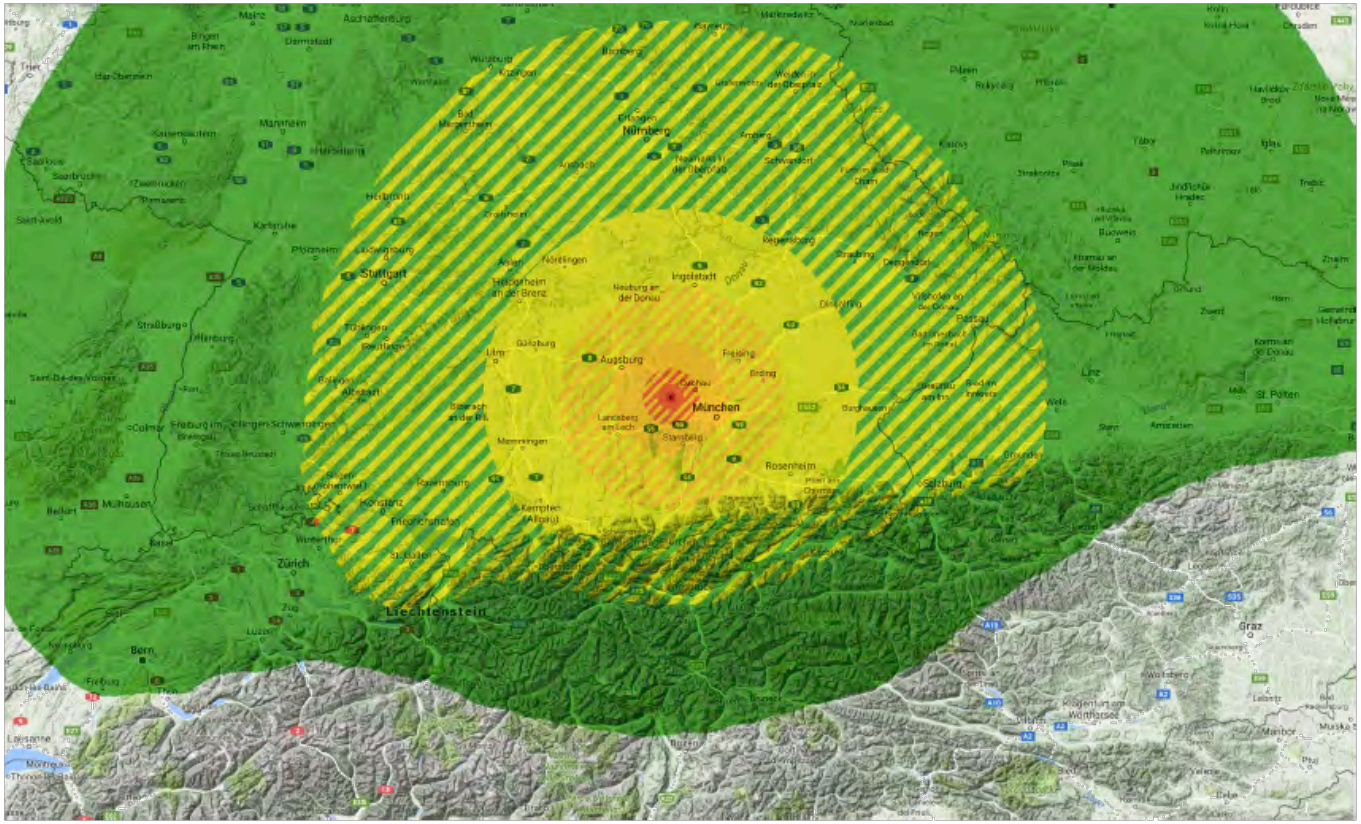


Fig. 7.3.: Zone map for impact of 10^{15} J impactor in Munich, Germany. Due to the Alps and other elevated areas, the zones are irregular in shape (zone shapes are qualitative). Map background: [23].

Selected internal studies

Color is mapped to a verbal description of the effects; differentiate between water and land impacts

Extract from proposed scale

land impact

impact energy	distance from impact center in km												
	0.2	0.5	1	2	3	7	15	30	60	100	200	400	1000
10^{15} J													
10^{16} J													
10^{17} J													
10^{18} J													

water impact

impact energy	distance from impact center in km												
	5	10	20	50	100	200	400	700	1000	3000	7000	15000	30000
10^{15} J													
10^{16} J													
10^{17} J													
10^{18} J													

Fig. 7.2.: Mapping key for land and water impacts.
Water impact effects are based on an ocean depth of 3688 m at the impact site and may differ significantly depending on actual ocean depth and terrain.

- **land impact**
  Strong heat.
  Beaufort number 1 winds (light air).
- **water impact**
  Noticeable wave, but no damage.
  Papadopoulos–Imamura stage III tsunami (weak).

3. **weak** (yellow)
   - **land impact**
     First degree burns if exposed.
     Beaufort number 1 winds (light air).
   - **water impact**
     Noticeable wave, may be observed on the shore. Some light boats slightly carried onto the shore.
     Papadopoulos–Imamura stage IV tsunami (largely observed).
4. **detrimental** (orange - yellow)
   - **land impact**
     Third degree burns, grass and deciduous trees ignite if exposed.
     Beaufort number 3 winds (gentle breeze).
   - **water impact**
     Limited flooding of coastal land and structures. Many light vessels carried inland.
     Papadopoulos–Imamura stage V tsunami (strong).
5. **harmful** (orange)
   - **land impact**
     Clothing and trees ignite if exposed.
     Beaufort number 3 winds (gentle breeze).
   - **water impact**
     Many light vessels carried inland. Some wooden structures destroyed.
     Papadopoulos–Imamura stage VI tsunami (slightly damaging).
6. **severe** (dark orange - orange)
   - **land impact**
     Firestorm. Glass windows shatter.
     Beaufort number 8 winds (gale), Saffir-Simpson category 1 winds (very dangerous winds, some damage).
   - **water impact**
     Some people carried away to sea. Most light vessels damaged, some large vessels carried ashore. Many floating structures carried out to sea. Many wooden structures damaged or carried out to sea.
     Papadopoulos–Imamura stage VIII tsunami (heavily damaging).

This part of the scale needs to be refined with a detailed assessment of impact energy versus effects.

Future

- **ESA will have a 'council meeting on ministerial level' in Dec 2016**
  - To agree the funding for Period 3 of ESA's SSA programme (2017-2020)
  - We request an increase of resources by a factor of 4
  - Focus in SSA-NEO will be to migrate NEODyS to ESA, start operations of the first fly-eye telescope, get a second fly-eye telescope on the Southern hemisphere
  - AIM (Asteroid Impact Mission, ESA's contribution to AIDA) will be proposed as part of a 'Space Traffic Management' activity
- **Other activities**
  - We have requested funding for a "MIAPP Planetary Defence Workshop" for 2018
  - MIAPP (http://www.munich-iapp.de/) provides funding for 4-week long workshops in Munich, Germany
  - More details see next slide

MIAPP workshop proposal

- **Topics:**

Our primary science goals at the workshop are to address and develop techniques to reduce the remaining uncertainties in determining the Earth's impact hazard due to unknown or imprecisely measured parameters in the:

- physical properties of asteroids
- dynamical and taxonomic structure of the asteroid belt
- the delivery of near-Earth asteroids (NEA) to the inner solar system
- completeness of known NEA statistics
- physical properties and orbital distribution of NEAs
- chaos in the solar system and predictability of asteroid impacts
- current models of the impacting asteroid population

The workshop will also have several other important goals including

- expanding international cooperation in impact hazard reduction and response
- improving the scientific and public perception of the impact risk
- developing concepts for ground and space-based surveys in the years beyond LSST
- considering if surveys can be improved to more efficiently identify impactors
- evaluating current initiatives for asteroid deflection
- developing a pathway to eliminating the risk of an asteroid impact for the next century
- providing feedback to the UN-sanctioned International Asteroid Warning Network and Space Mission Planning Advisory Group

MIAPP workshop proposal

- **Proposers:**
  - Andreas Burkert, Ludwig-Maximilian Universität München, Germany
  - Robert Jedicke, University of Hawaii, USA
  - Detlef Koschny, Technical University Munich, Germany, and ESA
  - Eileen Ryan, NM Institute of Mining and Technology/Magdalena Ridge Observatory, USA
  - Richard Wainscoat, University of Hawaii, USA
- **Committed participants:**
  - See next page

MIAPP workshop proposal

Person	Organization	Country	Main expertise
Kelly Beatty	Sky & Telescope	USA	Public outreach
Bill Bottke	SwRI	USA	Population models
Peter Brown	Western U.	Canada	Impact effects
Camilla Colombo	U. Southampton	UK	Deflection
Marco Delbo	Nice Observatory	France	Physical properties
Josef Durech	Charles U.	Czech Republic	Physical properties
Peter Fierlinger	TUM	Germany	
Mikael Granvik	U. Helsinki	Finland	Population models
Alan Harris	DLR	Germany	NEOShield-1 coordinator
Olivier Hainaut	ESO	France	Observations
Ellen Howell	U. Arizona	USA	Remote characterization
Lynn Jones	LSST	USA	Observations
Phiipp Maier	MPIA Garching	Germany	Population models, deflection
Amy Mainzer	JPL	USA	Space-based IR observations
Marco Micheli	ESA	Italy	Observations
Andrea Milani	U. Pisa	Italy	Orbital dynamics
Hong-Kyu Moon	Korea Space Science Inst.	Korea	Observations
Nick Moskovitz	Lowell Observatory	USA	Remote characterization
Thomas Muller	MPI	Germany	Physical properties
Petr Pravec	Ondrejov Observatory	Czech Republic	Physical properties
Ulrich Walter	TUM	Germany	Orbital dynamics
NASA Planetary Defense Coordination Office	NASA Headquarters	USA	Policy

Proposed updates to IAWN webpage

- We should have a top-level menu item "Terms of reference of IAWN" (currently hidden in 'FAQ')
- We should have a top-level menu item "How to become a member of IAWN" (currently hidden in 'FAQ')
- We should have top-level links to short summaries of previous meetings, where we provide recommendations (e.g. to use a certain albedo when converting H-magnitudes to sizes)
- We propose to add a page for 'relevant documents' to link to internal reports and/or theses which are not published elsewhere

Items for discussion

- We discussed earlier which albedo to use for the conversion of H-mag to size. Let's briefly discuss this again, agree on a value, and put it in the report from this IAWN meeting so that we can all refer to it. Our proposal: open (0.1?, 0.14?, always a range?) – discuss!
- As discussed earlier: Flyby distances of asteroids during close approaches should always be given as the distance to the Earth's surface, not Earth's center – do you all agree?
- Both of these should go (visibly!) on the web page
- We propose a comparison run between existing impact corridor tools