Correlative Image Processing and Analysis (CIPA)

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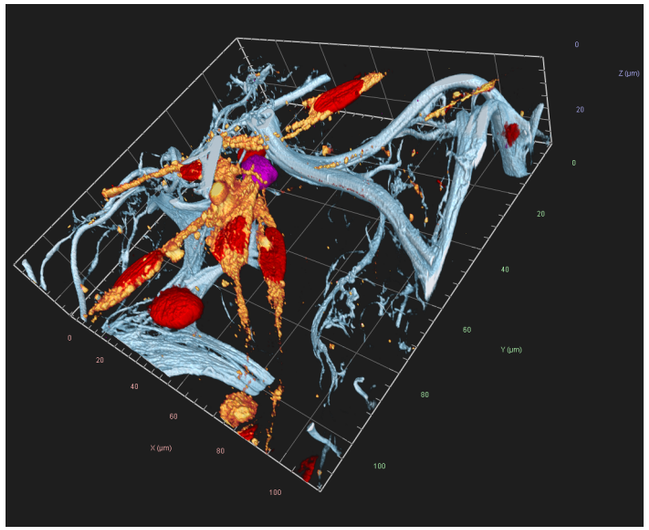
Anders Sjöström, LTH

Start-up: May 2019
Funding: LU central level, FoM and FoS.

CIPA provides access to on-site application expertise and tools but will also establish and further provide researchers with standardized and user-friendly tools and systems for remote access as well as analysis of data.

”Aims to reduce the gap between the amount of acquired and consequently analysed images, e.g., advanced imaging today generates vast amount of data and it is a necessity to segment out scientifically relevant information for further analysis. The currently available instruments for imaging on the microscopy scale show clear trends towards multimodal and multiscale studies of dynamic systems. The output of such experiments is complex three- or four-dimensional arrays of images. Strengthening both the design of appropriate experiments to answer the scientific questions and the retrieval of quantitative information from the images, will strongly increase the quality of the scientific outcome, creating value for both society, industry, and financiers of existing imaging facilities.”



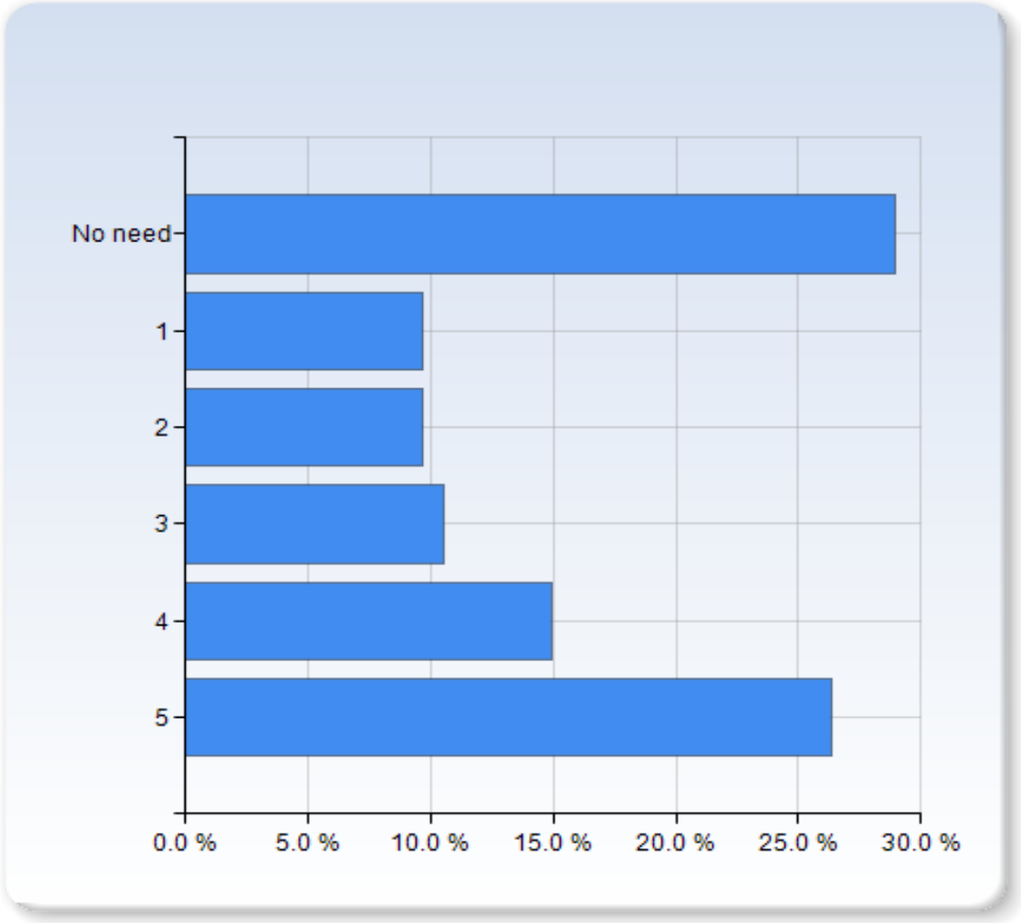
Correlative Image Processing and Analysis

Main activities

- **targeted user support** (55 users: 26 from FoM, 17 FoS, 6 LTH, 5 FoHT, 1 MAX IV),
- **community support**, e.g, software installation (Imaris, Arivis, Vision4D etc),
- **an analysis wiki**, using projects as user cases (eventually editable by all),
- **toolbox** development consisting of e.g., ImageJ and MATLAB-scripts and plugins, as well as an array of different software, both open and closed sources,
- **education and competence development, e.g., workshops, meetings** (including with also other stakeholders such as, SciLifeLab, HALOS, PRESTO and QIM as well as with local Research Infrastructures and stakeholders at and around Lund University, including Humanities lab),
- **outreach activities** and participation in external meetings and workshops,
- **CIPA development** (strategy and organization development).

Survey by MiCLU and LBIC, autumn 2018

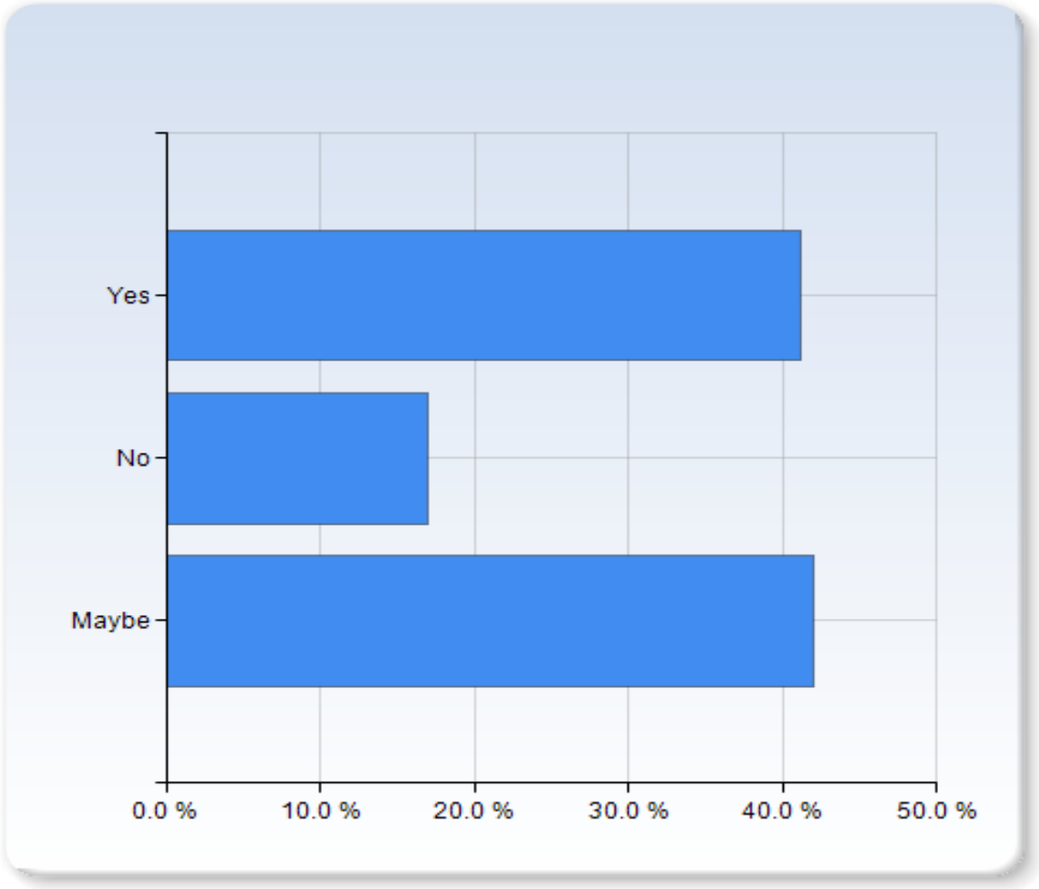
We have the material, but we want assistance with image acquisition and analysis.



3-5=52%

Survey by MiCLU and LBIC, autumn 2018

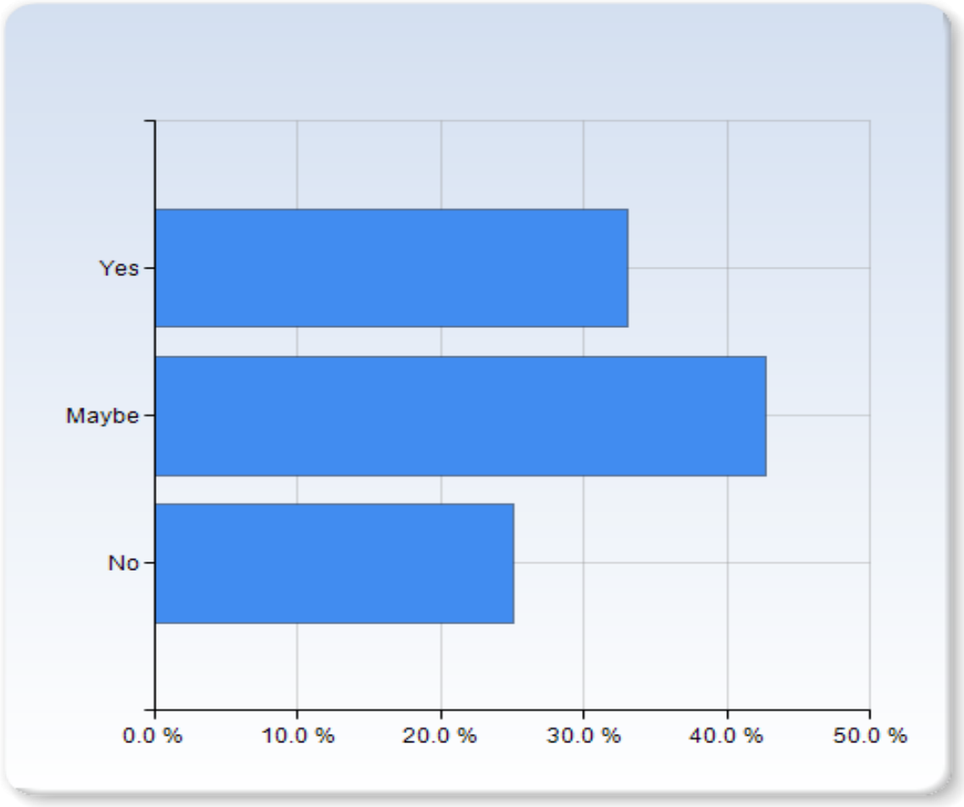
Do you need access to expertise on how to handle or analyse imaging data?



83% Yes or maybe

Survey by MiCLU and LBIC, autumn 2018

Do you need access to digital storage space for imaging data outside your own group?

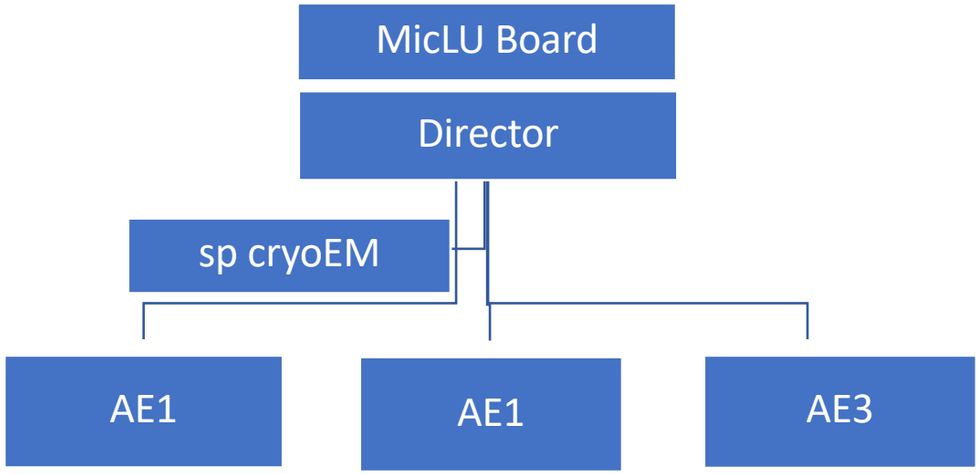


66% Yes or maybe

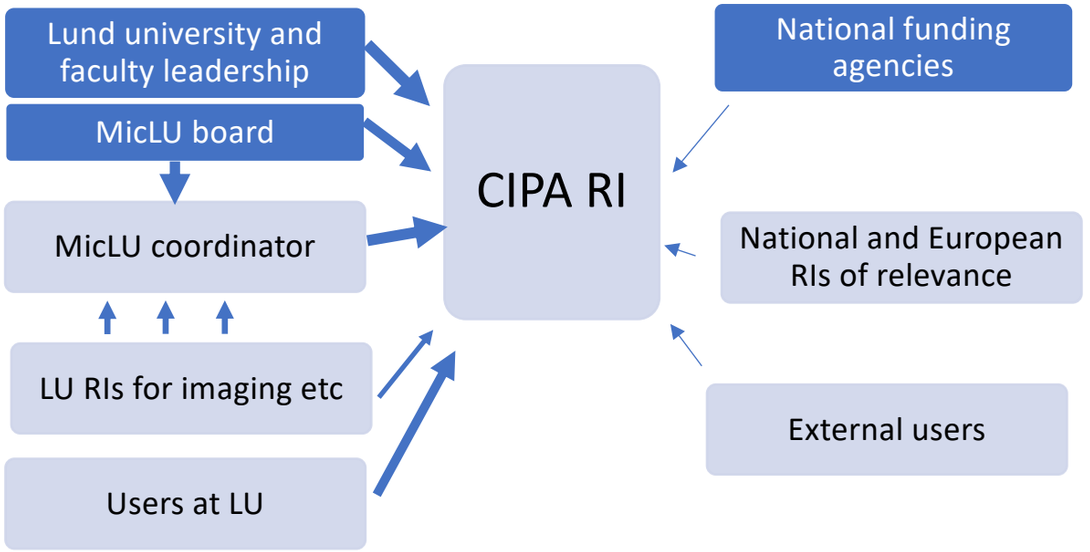
Some of the free text comments from the Imaging and analysis survey 2018

•It would be nice to have better **training in image processing, for both analysis and publication purposes**.
•This is an urgent need for me and my group, shared by many at Lund University! I strongly hope there will be significant resources allocated to creating an **image visualization, processing and analysis infrastructure** in Lund. Not least for the single particle cryo-EM we need skilled expertise that can assist in the **data analysis. Without urgent allocation of these resources Lund University will fall behind and have a very hard time to catch up with other universities in Sweden and not least elsewhere.**
•**The time spent acquiring images is far less than time spent on processing and analysis, a fact that has been overlooked in Lund.** There are many microscopes in Lund but very few places were help with processing and analysis of the data can be found. **An image analysis and visualisation facility linked to the existing imaging infrastructures is desperately needed in Lund.** Organisation could be central but there must be nodes (people) at key locations close to the researchers that need it. This would aid greatly in establishing an imaging culture and promote Lund as a excellent place to conduct advanced imaging. There are many options to how this could be organized and funded, but the key points need to **be openness and accessibility**. Running regular **workshops and open hours** where researchers can come with their data for help with **analysis** would be a good start. This would also serve as an "analysis triage" were the analyst would either help the researcher directly with their question, point to a specific software that could be used for the particular problem or start a **analysis** project if the problem needs more work. I would be more than happy to work towards such a model.
•I strongly hope there will be significant resources allocated to create **an image visualization, processing and analysis infrastructure** in Lund. Not least for the single particle cryo-EM we need skilled expertise that can assist in data analysis. Without urgent allocation of these resources, Lund University will fall behind and will have a very hard time to catch up with other universities in Sweden and internationally. We also need expertise in how to handle biological samples for single particle cryo-EM and we need to invest in at least one decent microscope for setting up and optimizing conditions before analysis at e.g. SciLifeLab singe particle cryo-EM units. Alternatively Lund University directly invests in a state of the art single particle cryo-EM, something that Lund University will have to do sooner or later anyhow. The microscope could be placed at e.g. nCHREM or LBIC and the unit could run in close connection to both LP3 (for protein purification) and the much needed and wanted Lund Univer**sity visualization, processing and analysis infrastructure**.
•some systems might be interesting for me and I do not know about their capabilities/limitations. I'm aware that an inventory exists, but finding solutions to our specific problems is a challenge still. I realize that it may be difficult to find or employ a single person or persons with expertise in all available systems and who could identify solutions every time for all potential users. A start could perhaps be to create **a chat room for imaging at LU - the ”MicLU room**". Something that would work (hopefully) as the platform "Research gate", where users pose a question and whoever has the expertise, time, and energy will pitch in with advice/suggestions/solutions. It could perhaps include not only BIO-imaging, **but also people at LTH** etc.
•Microscopy is still a very important method for us, and **getting help with data analysis is probably the most urgent thing.** I do think that for the needs of biologists in general the existing microscopes are all fine.
•YES. At the moment it's mostly trial and error to be fare. It would be extremely helpful to have access to expertise at the University - sometimes just to ask **"simple" questions.**
•**Always room for improvement but I have yet never met a person from an image facility that can actually do the analysis we need.**
•We are relative newcomers to single particle analysis, so it would be nice to have more local expertise in the use of the software.
•A local computing node with RELION installed would also be great, alternatively an installation at LUNARC.
•We currently have group members working on **developing image analysis but would benefit from additional expertise in the future.**
•Specifically, **statistics on image analysis**
•Yes, expertise is always good. But more important **mathematicians and physicist to assist in programming**.
•Phyton!!!!! It is been used everywhere now...
•help with **matlab**
•For single particle cryoEM
•Could be in the fututе for the data **processing of imaging** data obtained by LA-ICP-MS.

CIPA organisation and governance



CIPA organizational chart. The number or Application Experts (Aes) will grow over time and the long-term vision is to host a broad set of AEs needed by LU.



The governance structure of CIPA with the main factors of influence.

Present: The MiCLU board is from 2021 partly renewed and consists of Heiko Herwald, Gunnar Gouras, Marie Dacke and Reine Wallenberg. Director Kajsa M. Paulsson is attached to the board with no right to vote.

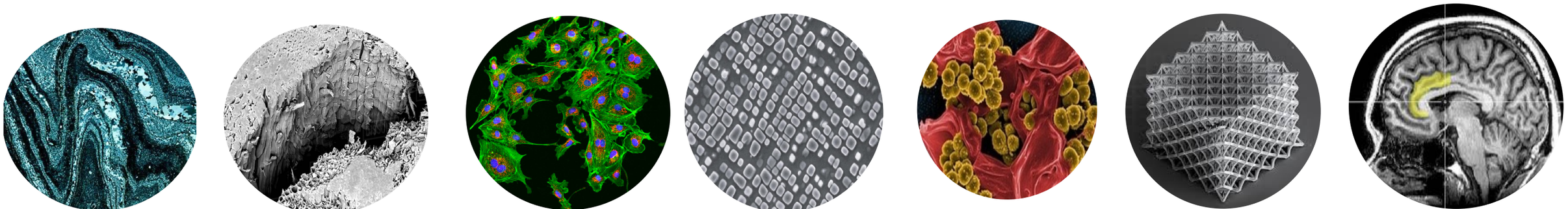
To come: A CIPA steering committee (SC) with representatives from FoS, FoM, LTH, FoHT and MAX IV. LUNARC and MiCLU, and representatives from e.g., QIM, COMPUTE and ADMIRE will be attached to the SC but with no right to vote.

The main role of MicLU is to provide planning for good access at Lund University to advanced equipment and methods in microscopy and microscopic analysis.

The Microscopy Community at Lund University (MiCLU) is promoting imaging, including correlative 3D imaging with microscopy and microscopic analysis at Lund University. The main role of MiCLU is to provide planning for good access at Lund University to advanced equipment and methods in microscopy and microscopic analysis. MicLU coordinate skills and other resources for imaging with microscopy and related image analysis in all fields at Lund University, e.g. soft matter, hard materials, life sciences, condensed matter.

MicLU has the following tasks:

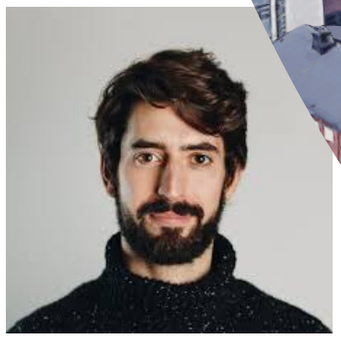
1. To be an advisory body to the Vice Chancellor and Faculty Deans at Lund University
2. To co-ordinate existing infrastructure, aiming at efficient use and maximal availability
3. To monitor, on a yearly basis, the current needs, and suggest actions for maintaining state-of-the-art facilities
4. To follow the technological development and plan for emerging and future infrastructure needs
5. To co-ordinate initiatives for applications to external funding bodies
6. To when needed act as a Lund University node for national infrastructure
7. To work for coordination and synergism between imaging resources at LU, MAX IV and ESS as well as other regional and national infrastructures



How to reach CIPA?

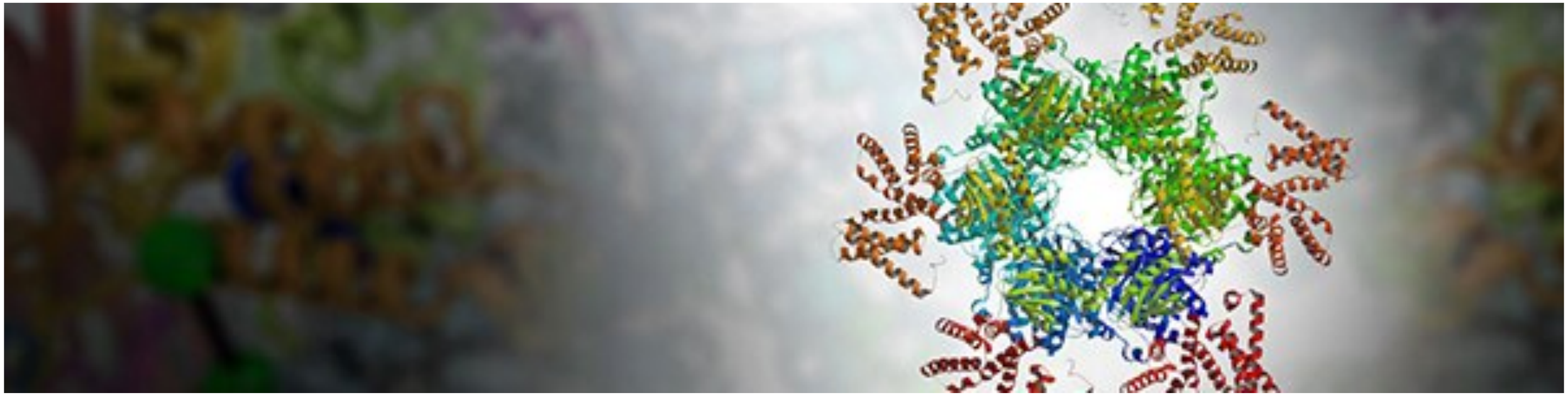
- BMC C14 (C1439a), drop-in hours Wednesdays 08:00-12:00 + workstation at C13

- Carl Troein, carl@thep.lu.se
- Jonas Ahlstedt, jonas.ahlstedt@med.lu.se
- Anders Sjöström, anders.sjostrom@lunarc.lu.se



- *Kajsa M. Paulsson, kajsa_m.paulsson@med.lu.se*

Markel Martinez-Carranza,
markel.martinez_carranza@med.lu.se



Single particle cryoEM

Need for:

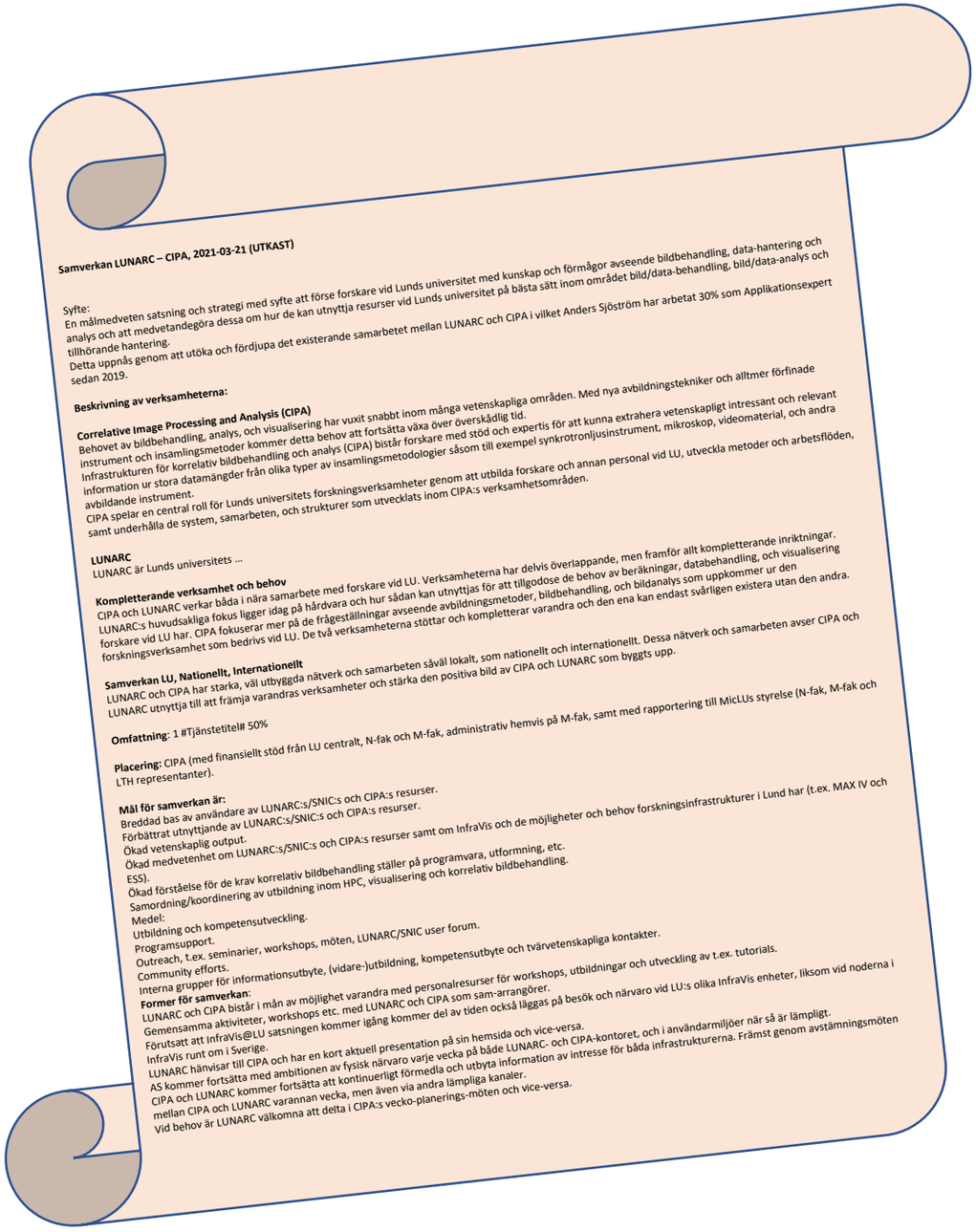
- Software
- Hardware
- Expertise for sample prep, experiments and analysis

cryoEM@Lund University part of SciLifeLab from 2021!

Collaborations are important for CIPA

Some examples: A joint Teams platform with QIM is set up, information is exchanged, and joint activities are planned with e.g., ADMIRE and HALOS (including a summer school week in image analysis (SEP, 2021).

With LUNARC is a deepened collaboration at the moment being formalized. The collaboration will increase the use and awareness of the computational resources available at LU and provide an understanding of how to make the most use of them to the individual researcher.



Samverkan LUNARC – CIPA, 2021-03-21 (UTKAST)

Syfte:
En målmedveten satsning och strategi med syfte att förse forskare vid Lunds universitet med kunskap och förmågor avseende bildbehandling, data-hantering och analys och att medvetandegöra dessa om hur de kan utnyttja resurser vid Lunds universitet på bästa sätt inom området bild/data-behandling, bild/data-analys och tillhörande hantering.
Detta uppnås genom att utöka och fördjupa det existerande samarbetet mellan LUNARC och CIPA i vilket Anders Sjöström har arbetat 30% som Applikationsexpert sedan 2019.

Beskrivning av verksamheterna:

Correlative Image Processing and Analysis (CIPA)
Behovet av bildbehandling, analys, och visualisering har vuxit snabbt inom många vetenskapliga områden. Med nya avbildningstekniker och alltmer förfinade instrument och insamlingsmetoder kommer detta behov att fortsätta växa över överskådlig tid.
Infrastrukturen för korrelativ bildbehandling och analys (CIPA) bistår forskare med stöd och expertis för att kunna extrahera vetenskapligt intressant och relevant information ur stora datamängder från olika typer av insamlingsmetodologier såsom till exempel synkrotronljusinstrument, mikroskop, videomaterial, och andra avbildande instrument.
CIPA spelar en central roll för Lunds universitets forskningsverksamheter genom att utbilda forskare och annan personal vid LU, utveckla metoder och arbetsflöden, samt underhålla de system, samarbeten, och strukturer som utvecklats inom CIPA:s verksamhetsområden.

LUNARC
LUNARC är Lunds universitets …

Kompletterande verksamhet och behov
CIPA och LUNARC verkar båda i nära samarbete med forskare vid LU. Verksamheterna har delvis överlappande, men framför allt kompletterande inriktningar. LUNARC:s huvudsakliga fokus ligger idag på hårdvara och hur sådan kan utnyttjas för att tillgodose de behov av beräkningar, databehandling, och visualisering forskare vid LU har. CIPA fokuserar mer på de frågeställningar avseende avbildningsmetoder, bildbehandling, och bildanalys som uppkommer ur den forskningsverksamhet som bedrivs vid LU. De två verksamheterna stöttar och kompletterar varandra och den ena kan endast svårligen existera utan den andra.

Samverkan LU, Nationellt, Internationellt
LUNARC och CIPA har starka, väl utbyggda nätverk och samarbeten såväl lokalt, som nationellt och internationellt. Dessa nätverk och samarbeten avser CIPA och LUNARC utnyttja till att främja varandras verksamheter och stärka den positiva bild av CIPA och LUNARC som byggts upp.

Omfattning: 1 #Tjänstetitel# 50%

Placering: CIPA (med finansiellt stöd från LU centralt, N-fak och M-fak, administrativ hemvis på M-fak, samt med rapportering till MicLUs styrelse (N-fak, M-fak och LTH representanter).

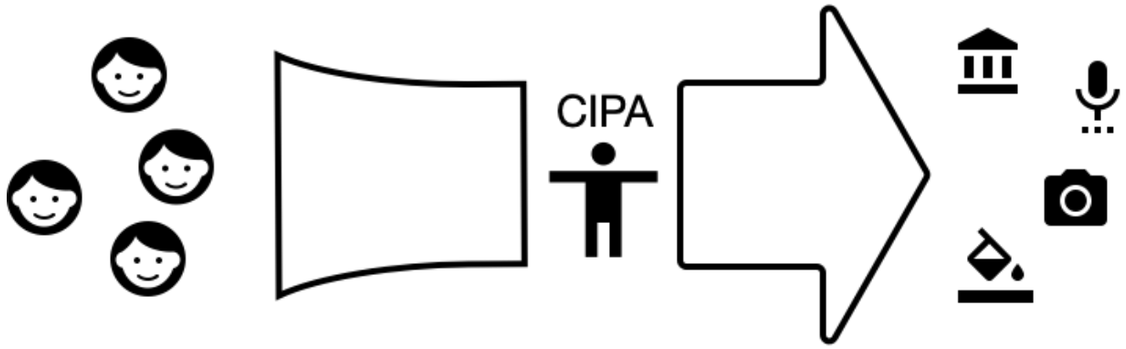
Mål för samverkan är:
Breddad bas av användare av LUNARC:s/SNIC:s och CIPA:s resurser.
Förbättrat utnyttjande av LUNARC:s/SNIC:s och CIPA:s resurser.
Ökad vetenskaplig output.
Ökad medvetenhet om LUNARC:s/SNIC:s och CIPA:s resurser samt om InfraVis och de möjligheter och behov forskningsinfrastrukturer i Lund har (t.ex. MAX IV och ESS).
Ökad förståelse för de krav korrelativ bildbehandling ställer på programvara, utformning, etc.
Samordning/koordinering av utbildning inom HPC, visualisering och korrelativ bildbehandling.
Medel:
Utbildning och kompetensutveckling.
Programsupport.
Outreach, t.ex. seminarier, workshops, möten, LUNARC/SNIC user forum.
Community efforts.
Interna grupper för informationsutbyte, (vidare-)utbildning, kompetensutbyte och tvärvetenskapliga kontakter.

Former för samverkan:
LUNARC och CIPA bistår i mån av möjlighet varandra med personalresurser för workshops, utbildningar och utveckling av t.ex. tutorials.
Gemensamma aktiviteter, workshops etc. med LUNARC och CIPA som sam-arrangörer.
Förutsatt att InfraVis@LU satsningen kommer igång kommer del av tiden också läggas på besök och närvaro vid LU:s olika InfraVis enheter, liksom vid noderna i InfraVis runt om i Sverige.
LUNARC hänvisar till CIPA och har en kort aktuell presentation på sin hemsida och vice-versa.
AS kommer fortsätta med ambitionen av fysisk närvaro varje vecka på både LUNARC- och CIPA-kontoret, och i användarmiljöer när så är lämpligt.
CIPA och LUNARC kommer fortsätta att kontinuerligt förmedla och utbyta information av intresse för båda infrastrukturerna. Främst genom avstämningsmöten mellan CIPA och LUNARC varannan vecka, men även via andra lämpliga kanaler.
Vid behov är LUNARC välkomna att delta i CIPA:s vecko-planerings-möten och vice-versa.

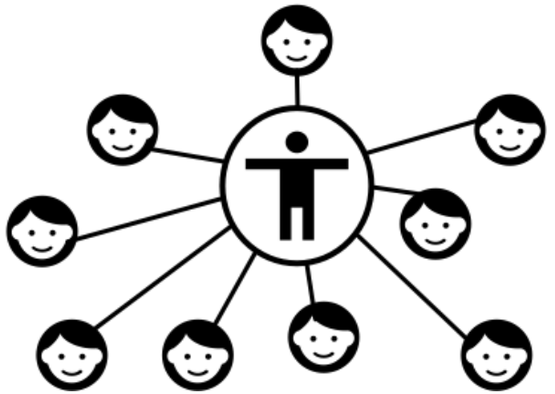
CIPA services and areas – the CIPA users defines the services

CIPA is more than the services used directly for your specific tasks and scientific questions, CIPA is also…

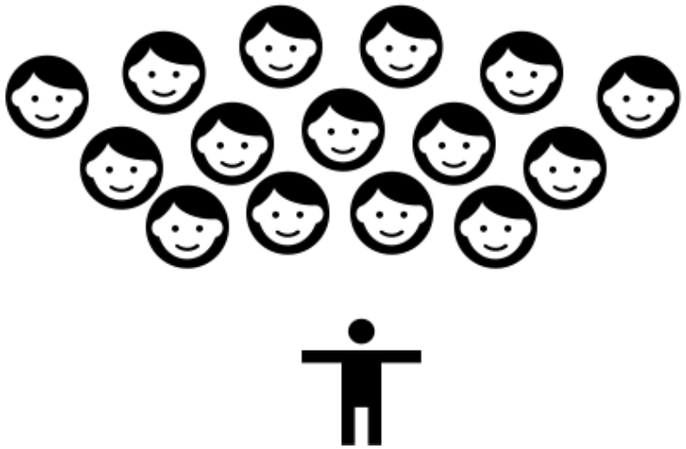
Conduit between researchers and resources



Networking and facilitating contact



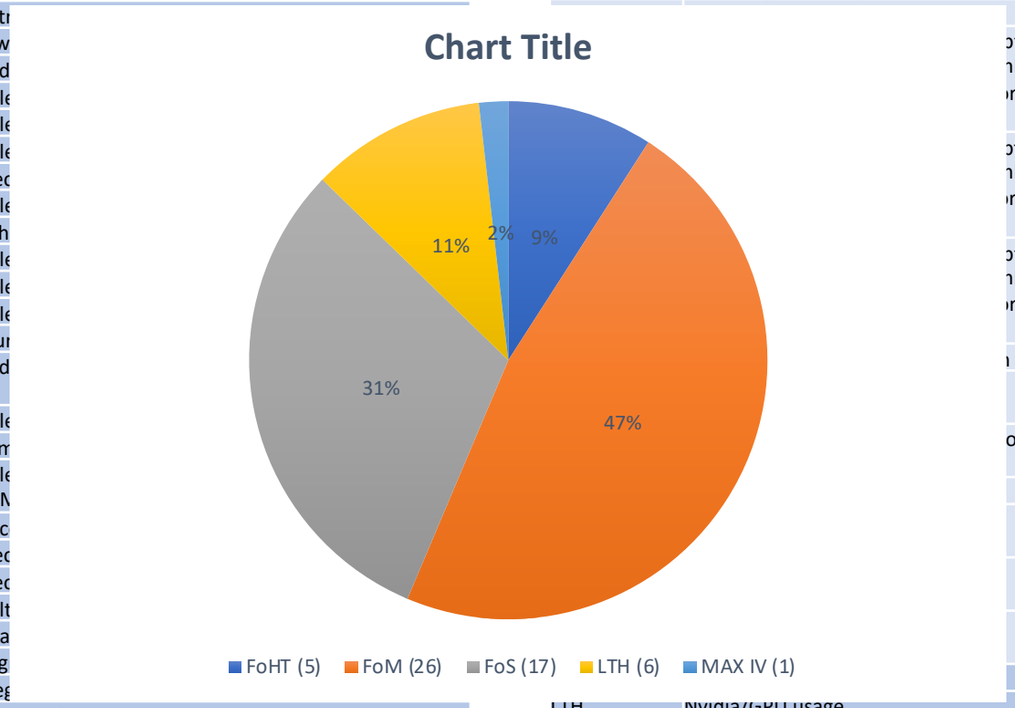
Arranging workshops and courses



One-on-one education

CIPA users come from many different areas

Faculty	Service and if relevant software	Area
FoHT	Photoscan	Archaeology
FoHT	Photoscan	Archaeology
FoHT	Access, projekthantering, licencing	Archeology
FoHT	PhotoScan, access, usage	Archeology
FoHT	PhotoScan, access, usage	Archeology
FoM	Scipion, Relion	Infection Medicine
FoM	CryoSPARC	Matr
FoM	MATLAB/LUNARC	Airw
FoM	MATLAB Astra Toolbox	Med
FoM	Arivis	Mole
FoM	Arivis, FIJI	Mole
FoM	Arivis	Mole
FoM	VivoQuant	Infec
FoM	FIJI, Arivis	Mole
FoM	Arivis, Imaris	Path
FoM	Arivis, Imaris	Mole
FoM	Arivis, FIJI, VivoQvant	Mole
FoM	Arivis, FIJI, VivoQvant	Mole
FoM	Imaris Medicine,	Neur
FoM	Has exchanged data and discussed needs during the autumn.	Med
FoM	DNA distribution in cells, quantification	Mole
FoM	3D reconstruction of engineered tissues	Stem
FoM	IT and data pipeline	Mole for M
FoM	Arivis Introduction	Muc
FoM	MAG3 image analysis	Infec
FoM	IHC quantification	Infec
FoM	Imaris spine counting Neuroinflammation,	Mult
FoM	Spine and dendrite analysis in Imaris	Basa
FoM	CT/MR quantification support	Diag
FoM	MATLAB, licencing, access	Integ
FoM	MATLAB, access, and cost questions	Airway Inflammation and Immunology



Faculty	Service and if relevant software	Area
FoS	Photoscan	Physical Geography and Ecosystem Science
FoS	Photoscan	Physical Geography and Ecosystem Science
FoS	Amira, CATMAID	Functional zoology
FoS	Photoscan	Physical Geography and Ecosystem Science
FoS	Photoscan/IDL	Physical Geography and Ecosystem Science
FoS	Arivis, segment 3D print	Geology
		Geology, Paleontology
	otical photothermal nbine this method r CT with maybe	Biodiversity and Ecosystem services in a Changing Climate
	otical photothermal nbine this method r CT with maybe	Biodiversity and Ecosystem services in a Changing Climate
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	n Orange.	Centre for Environmental and Climate Science
		Biodiversity and Ecosystem services in a Changing Climate
	on	Systemic Radiation Therapy Group LUCC - Lund University Cancer Centre
		Astro
		Biodiversity and Ecosystem services in a Changing Climate
		Biodiversity and Ecosystem services in a Changing Climate
		installation, licencing Biodiversity and Ecosystem services in a Changing Climate¬†
		Mathematics
LTH	Nvidia/GPU usage	Mathematics
LTH	MATLAB	Structural Mechanics
LTH	TEM quantification	Solid State Physics
LTH	Accessfrågor och MATLAB	Diagnostic Radiology
LTH	MATLAB	SolidMech
MAX IV	Analysis of XAS data, adaptation of software.	Balder beamline

Future work

"Meeting the need for competence regarding image processing and analysis."

For the coming phase of image analysis at LU, not least in the light of a potential national visualisation infrastructureof, we see a number of areas in need of targeted resources, education and development of tools, including

- multidimensional spectroscopy analysis (FoS, FoM)
- tomographic analysis (FoM, FoS, LTH)
- video analysis (FoS, HT).

CIPA will include
- *competence development of users*
- *software development*
- *direct user support*

Access to CIPA
- *CIPA will use a case management system for the more advanced support.*
- *User fees will be introduced for more advanced support*
- *Increased visibility*

Planned and coming activities
- *A previously postponed joint workshop to be co-hosted by ADMIRE, MicLU and CIPA, will be given in 2021*
- *A MATLAB workshop series called "Mondays with MATLAB" is planned during 2021*
- *A workshop on Image Analysis and Processing will be arranged together with HALOS (UHH, DTU)*
- *A summer-school will be arranged between HALOS, QIM and CIPA*
- *If the propsal for InfraVis is approved, CIPA will coordinate the different components of InfraVis@LU and will, together with LiU and UU, take a supporting coordinating role working together with Chalmers in a management team for the whole consortium of 9 Swedish partner organizations.*
- *CIPA is working together with Umeå University to create a proposal for a EuroHPC Joint Master in HPC, providing access to education in HPC thereby expanding the pool of competences within HPC particularly within Life Sciences and fields not traditionally using HPC*