

Bijlage 7

bij resultaten metingen Windpark N33

Meeden positie zuid T2

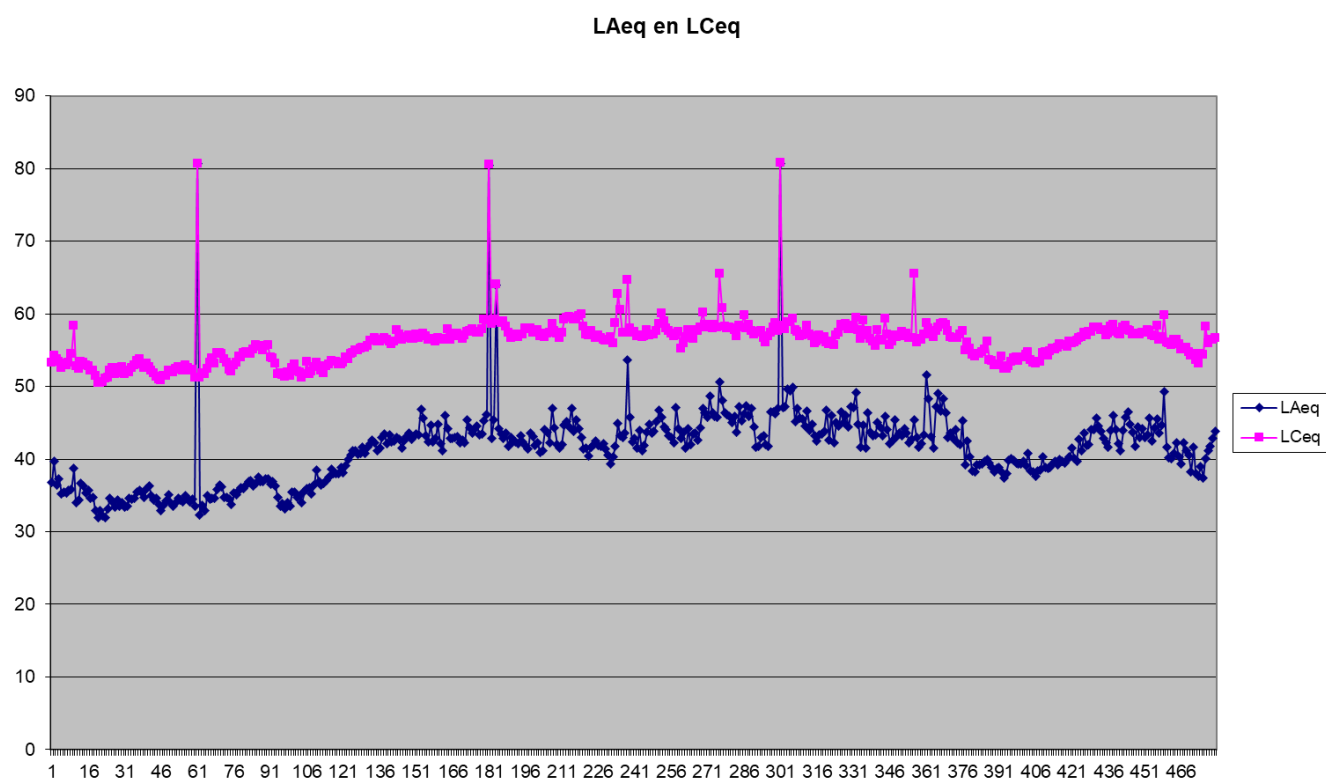
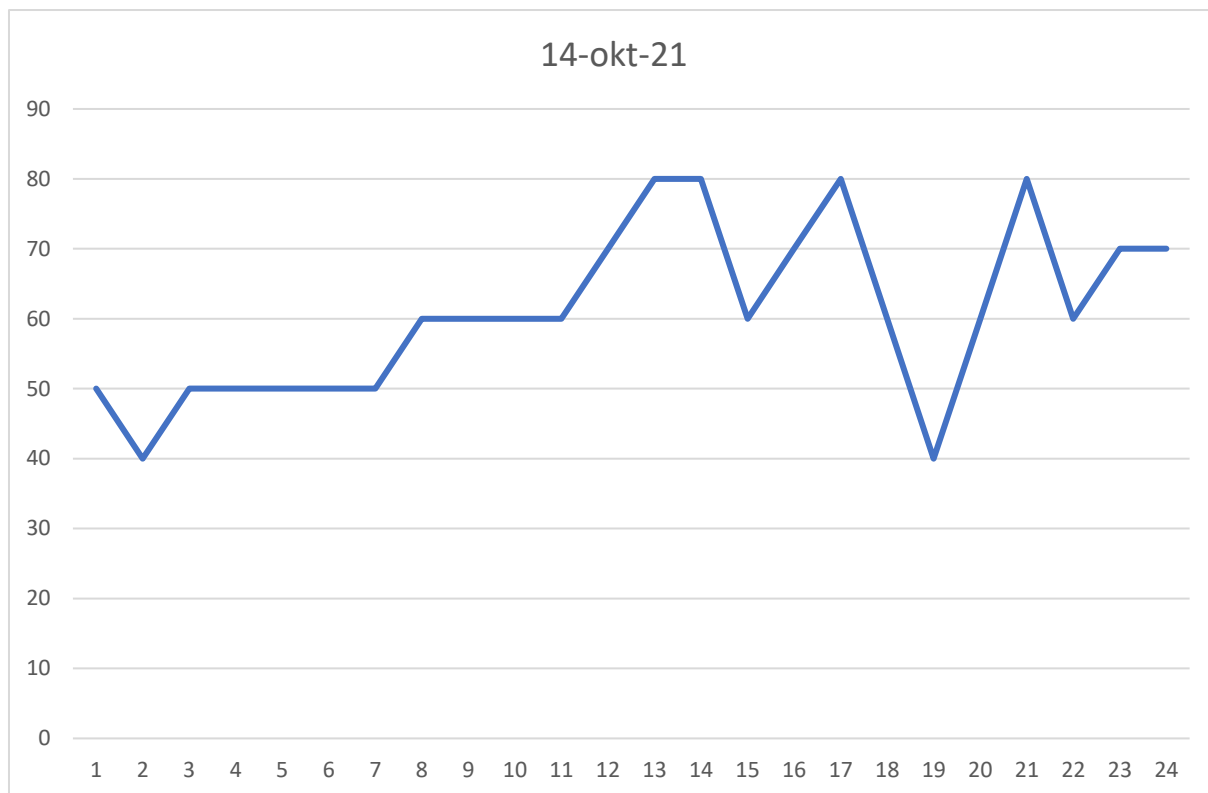
Metingen van 13 oktober t/m 9 november 2021.

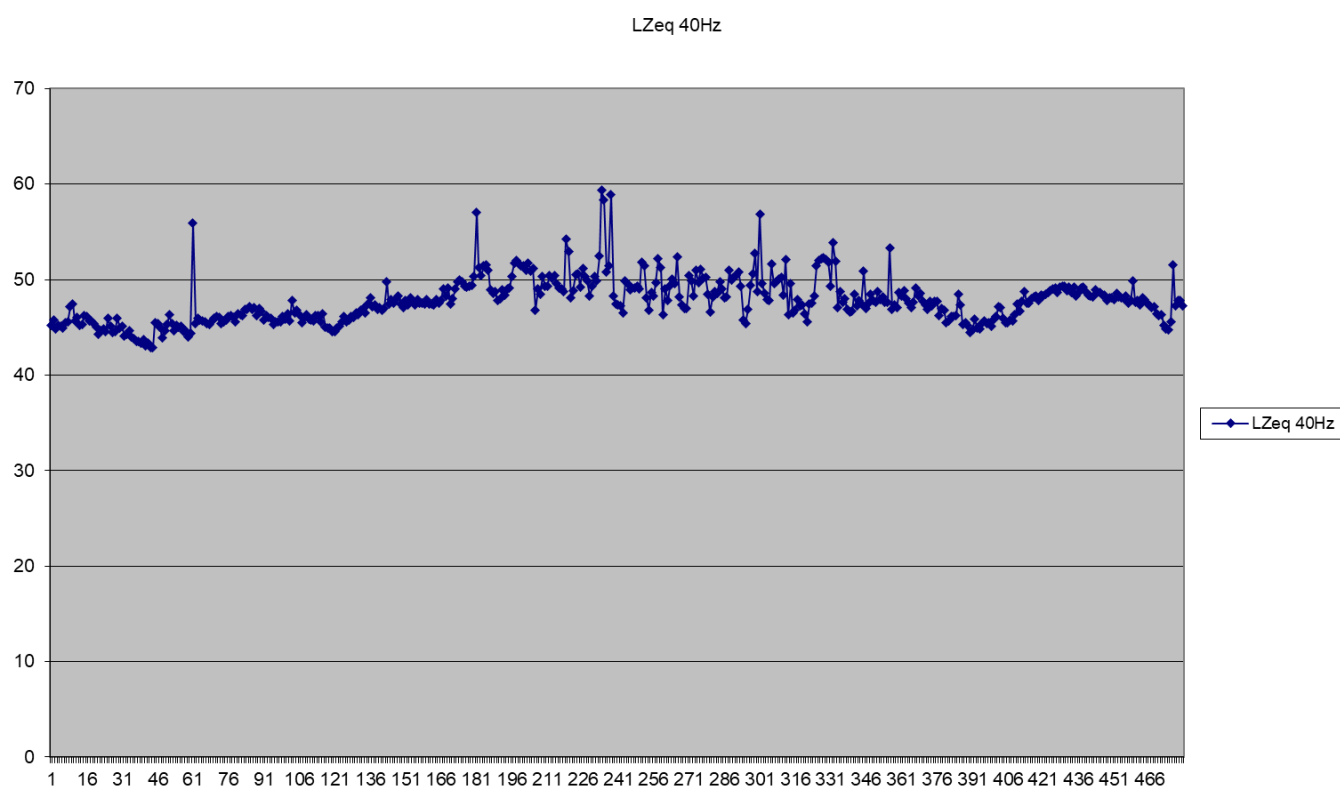
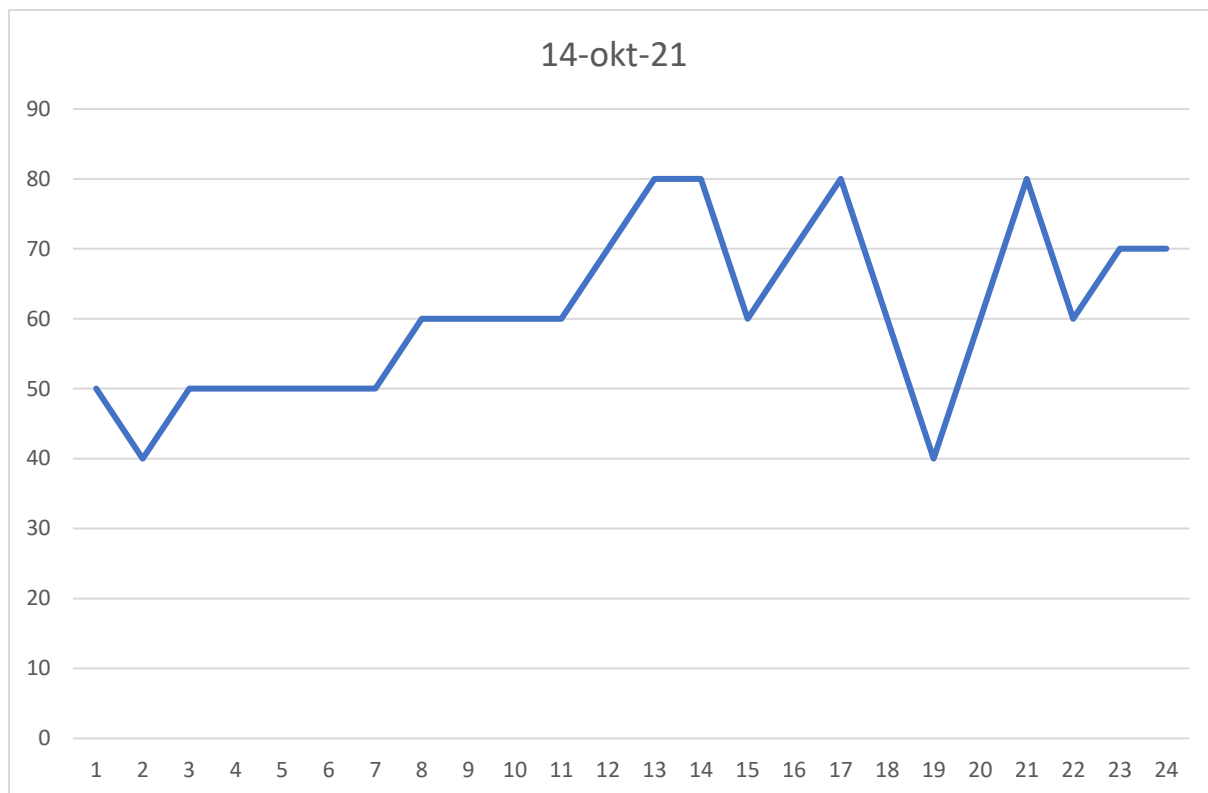
Afstand tot windpark ca. 1000 m.

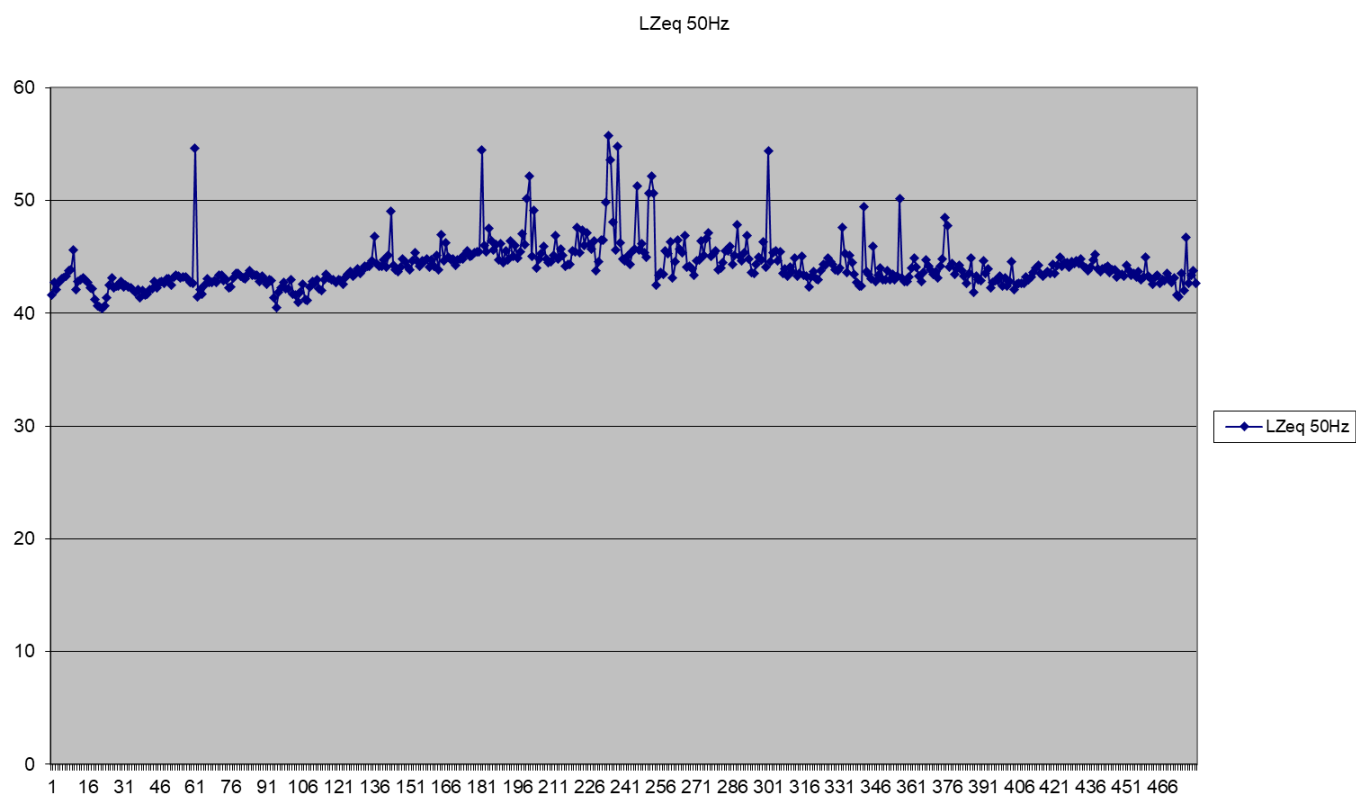
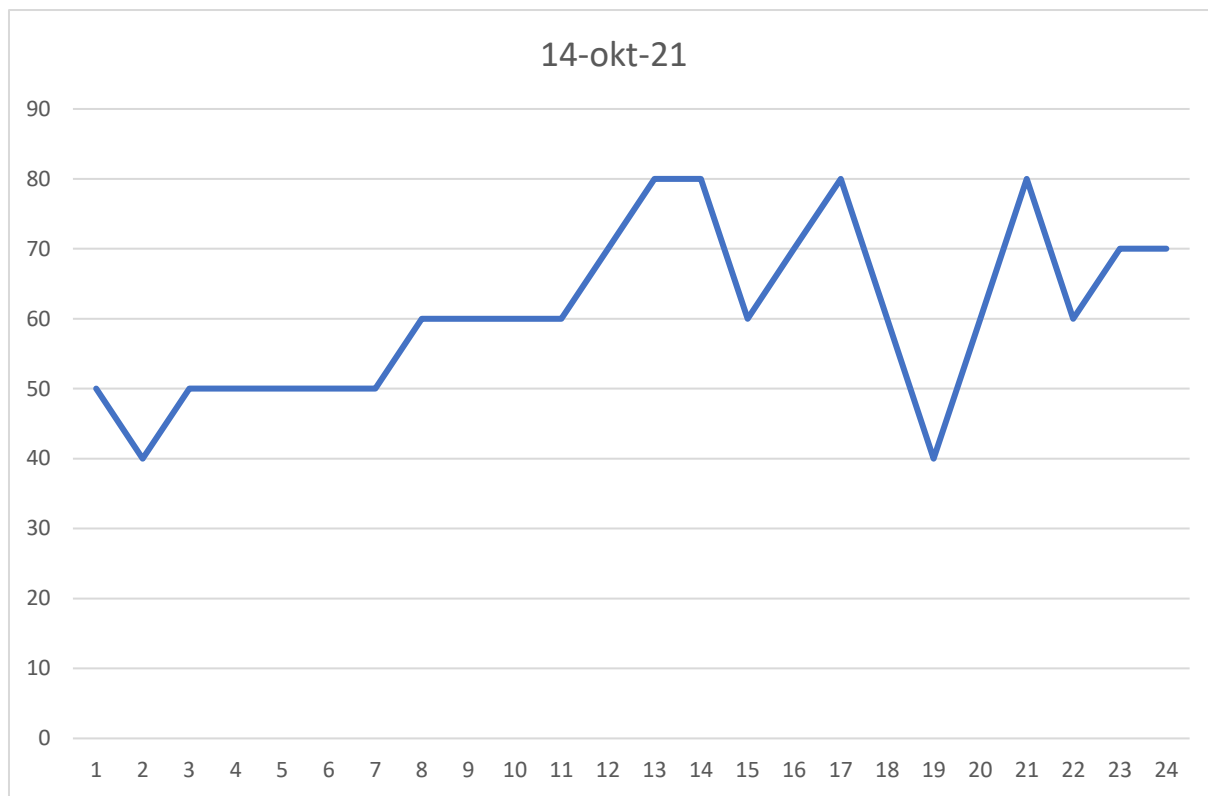
Microfoon niet voor de gevel:
gevelcorrectie van 3 dB niet noodzakelijk.

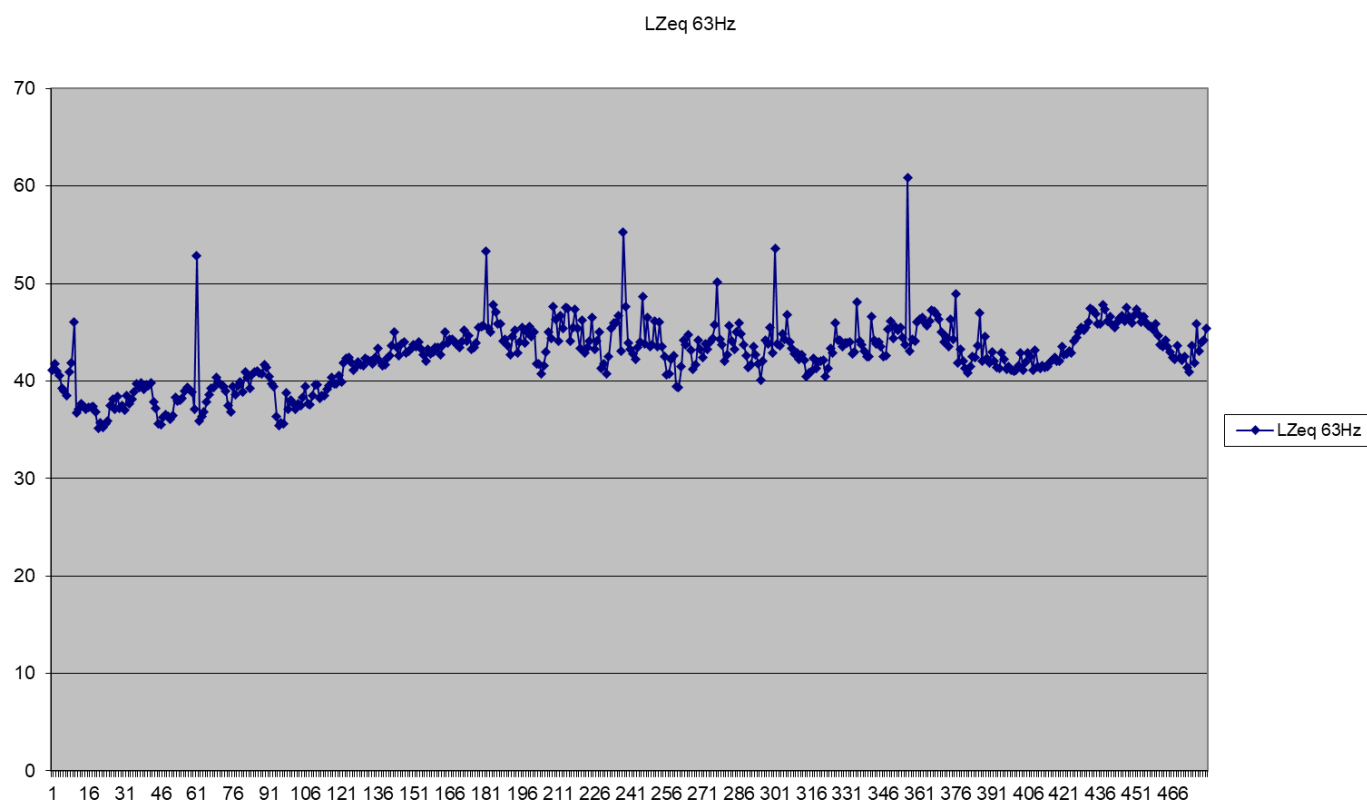
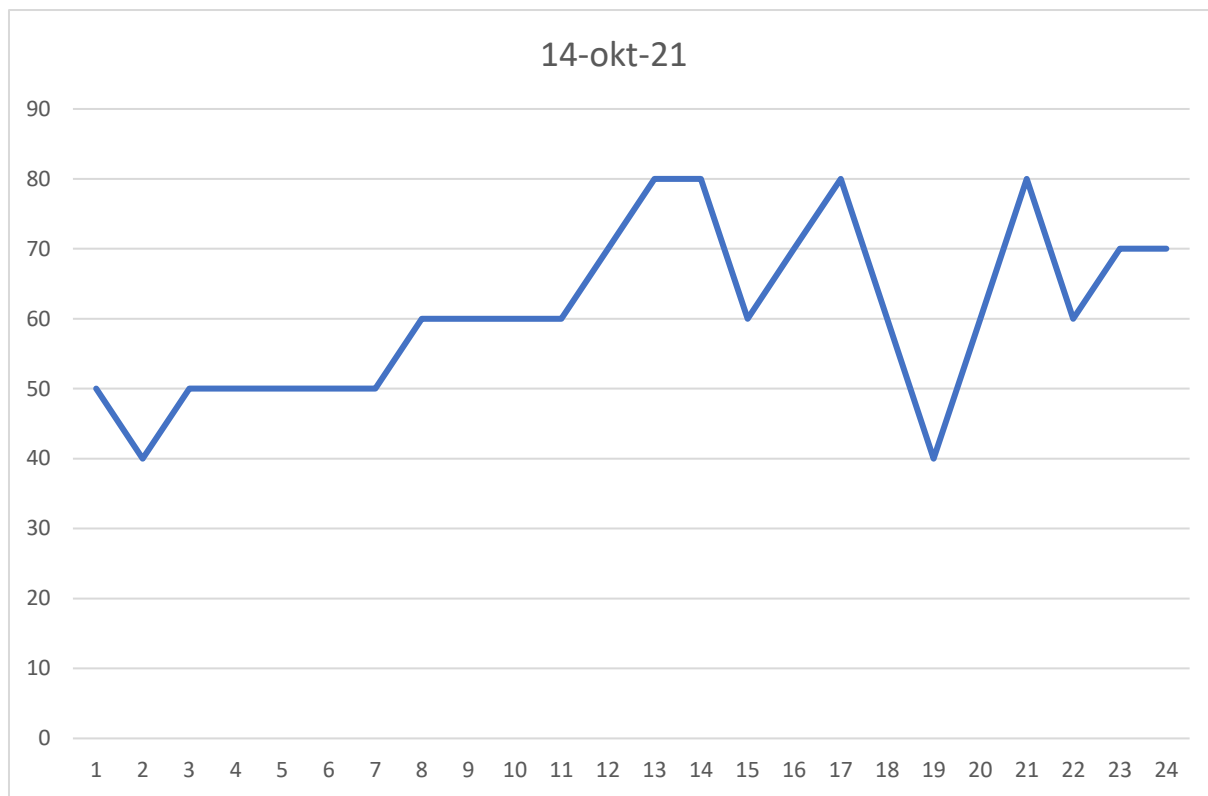
Deze bijlage bestaat uit grafieken met LAeq, LCeq, tertsbanden (40, 50, 63 en 125 Hz) en windsnelheid (t/m p.126). Daarna volgt een selectie van screenshots met spectrale grafieken (spectrogrammen) gemaakt met *SpectrumLab*.

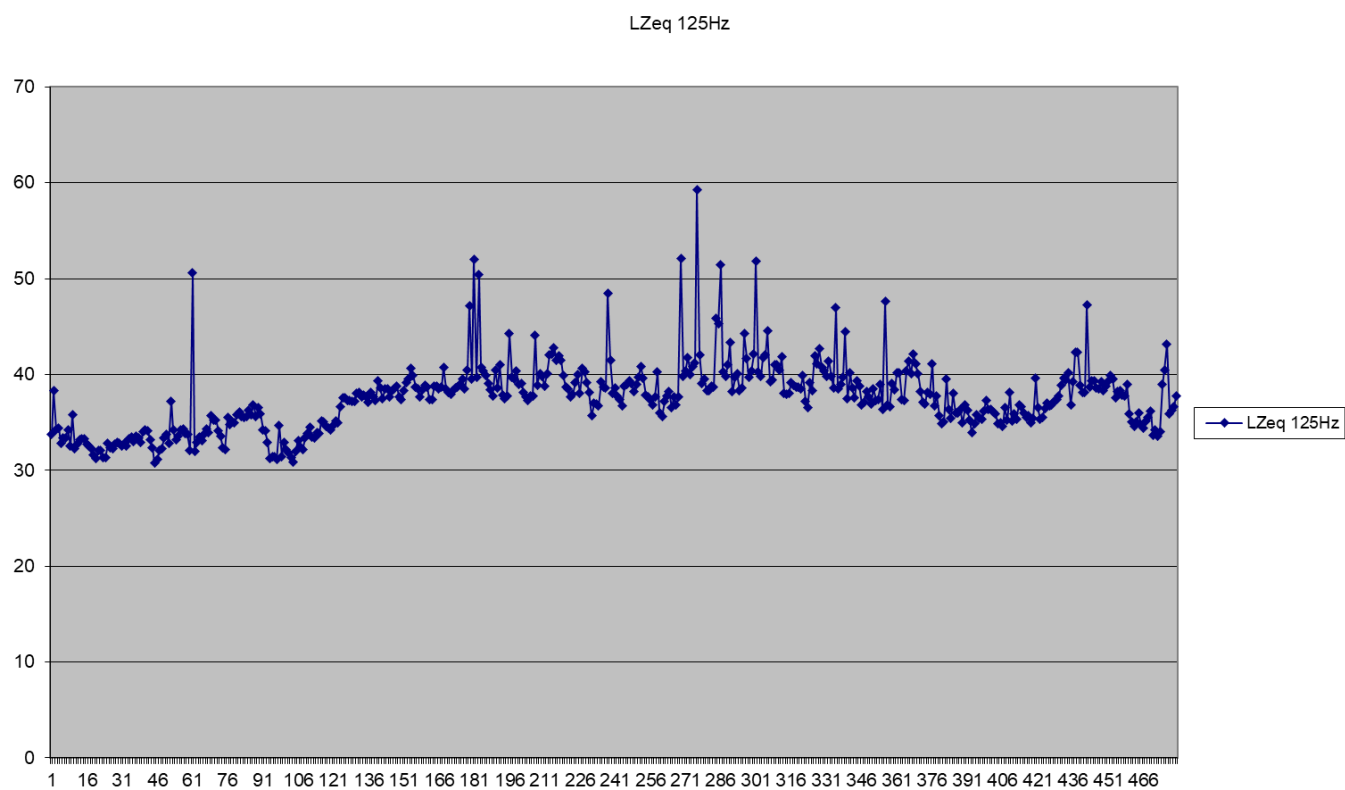
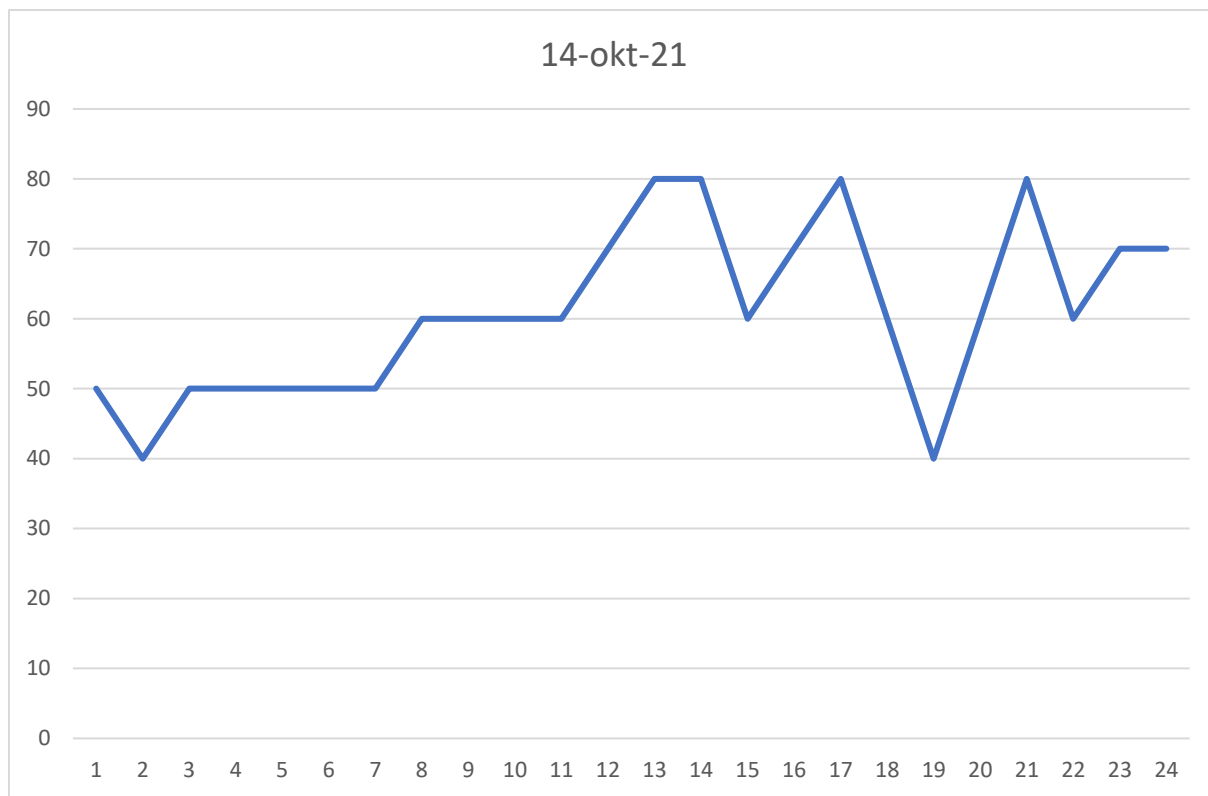
Het is ondoenlijk en onpraktisch om alle resultaten in de vorm van screenshots te presenteren. Daarom heb ik een selectie gemaakt uit het beschikbare materiaal om een aantal opvallende situaties en/of duidelijke veranderingen te laten zien. Er is op deze locatie sprake van zeer duidelijke bromtonen die door de windturbines worden geproduceerd.

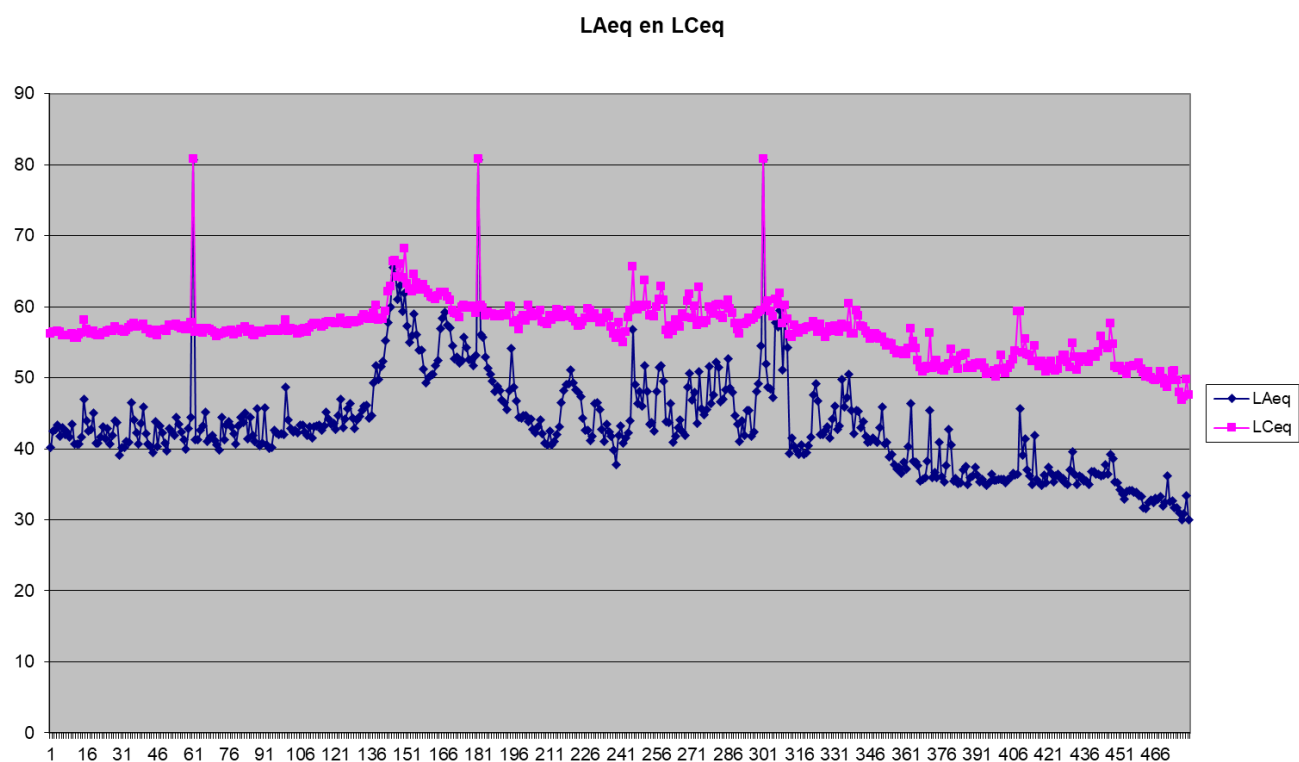
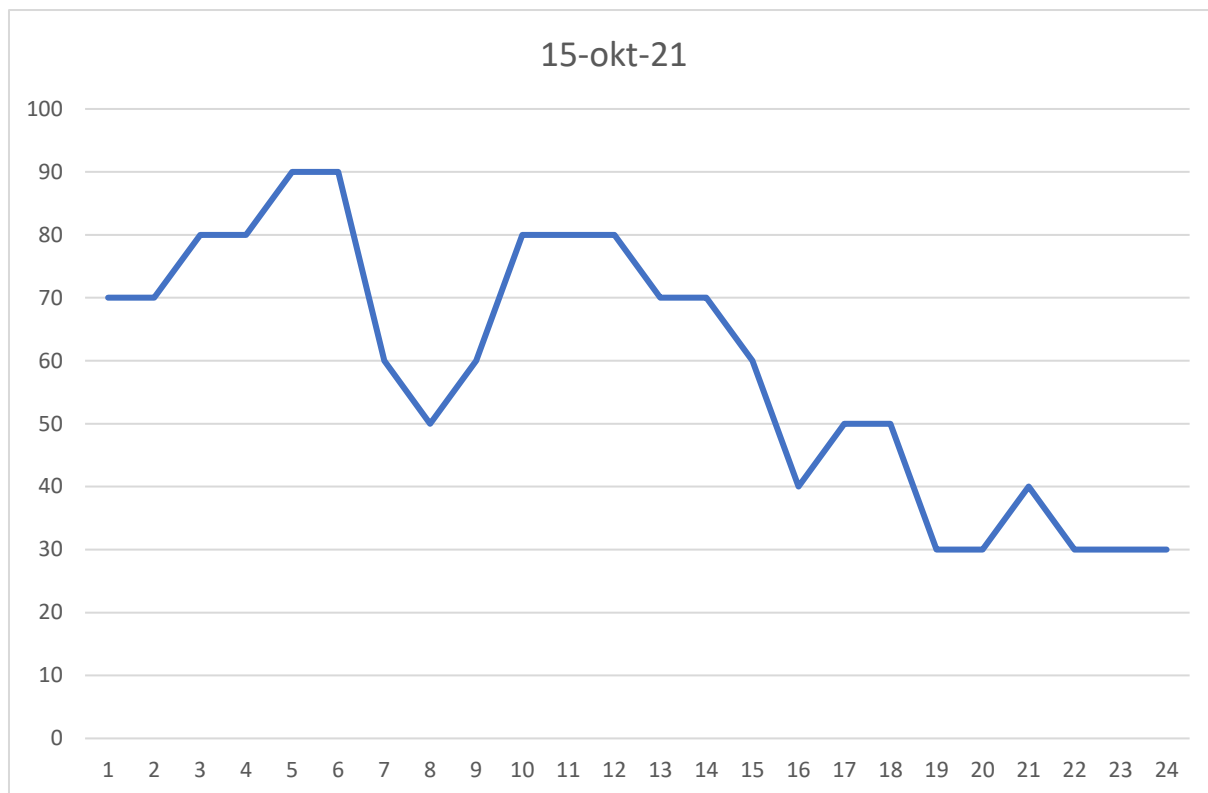


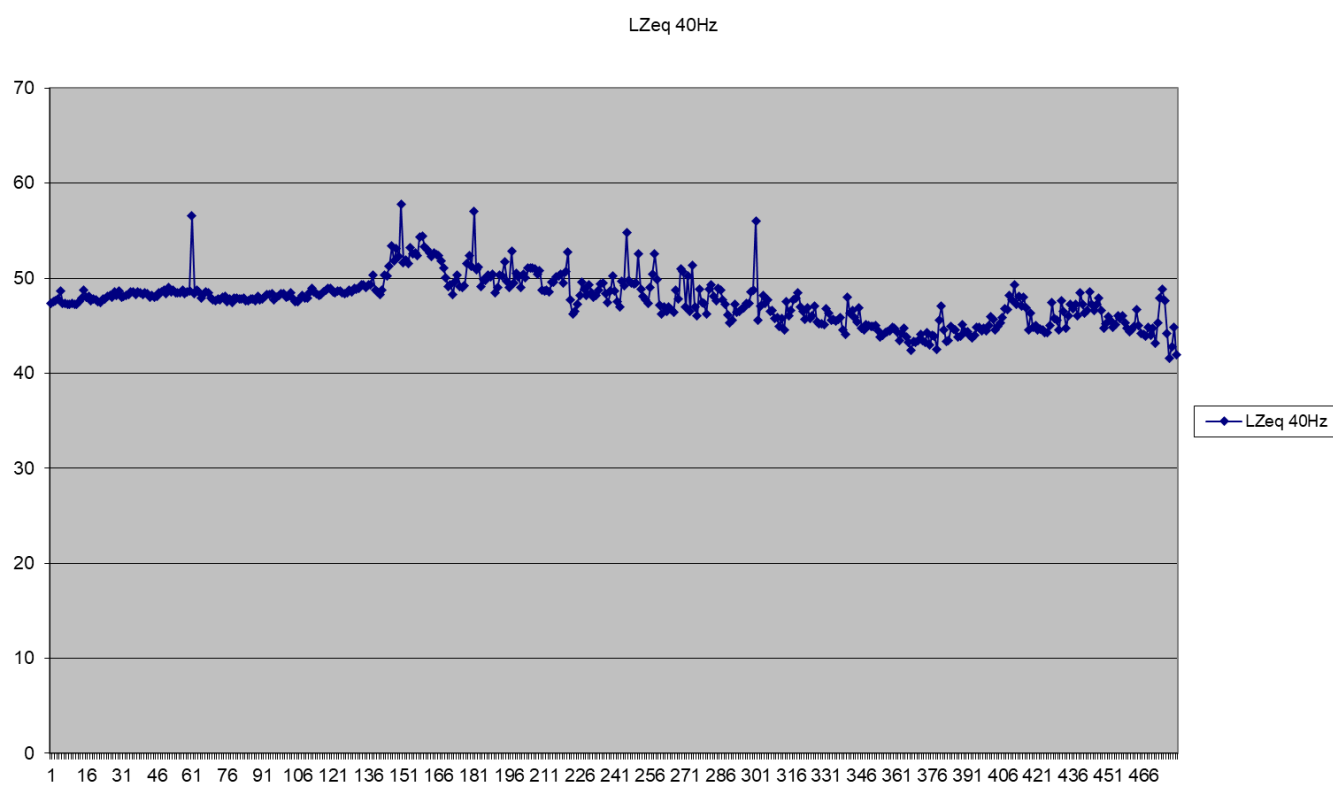
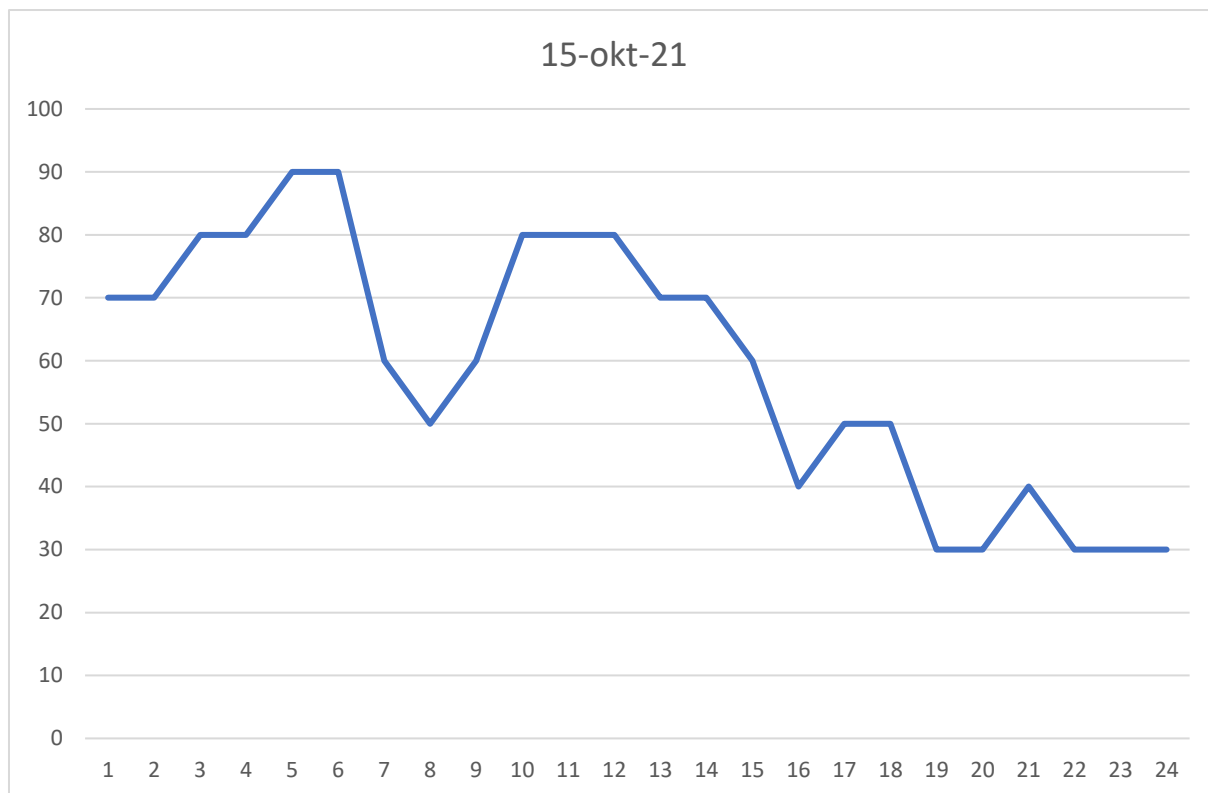


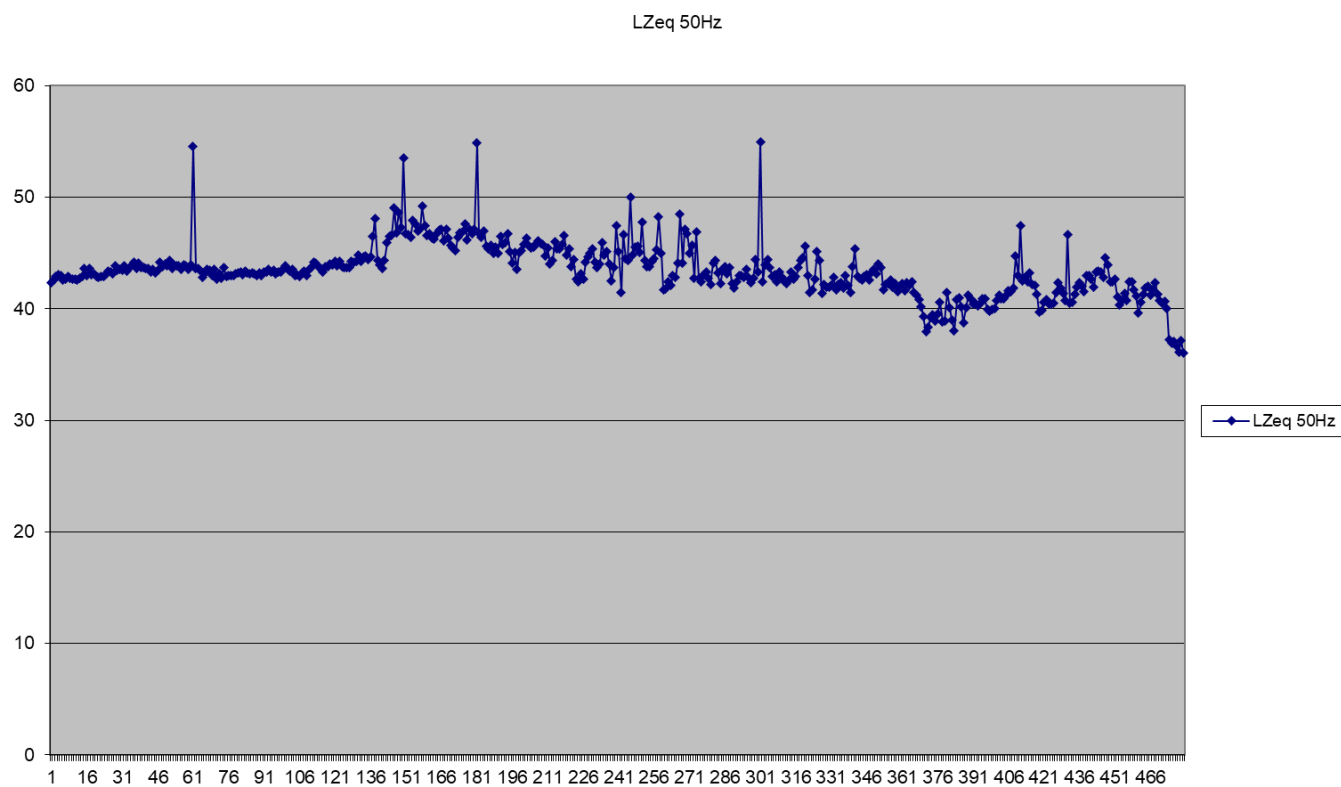
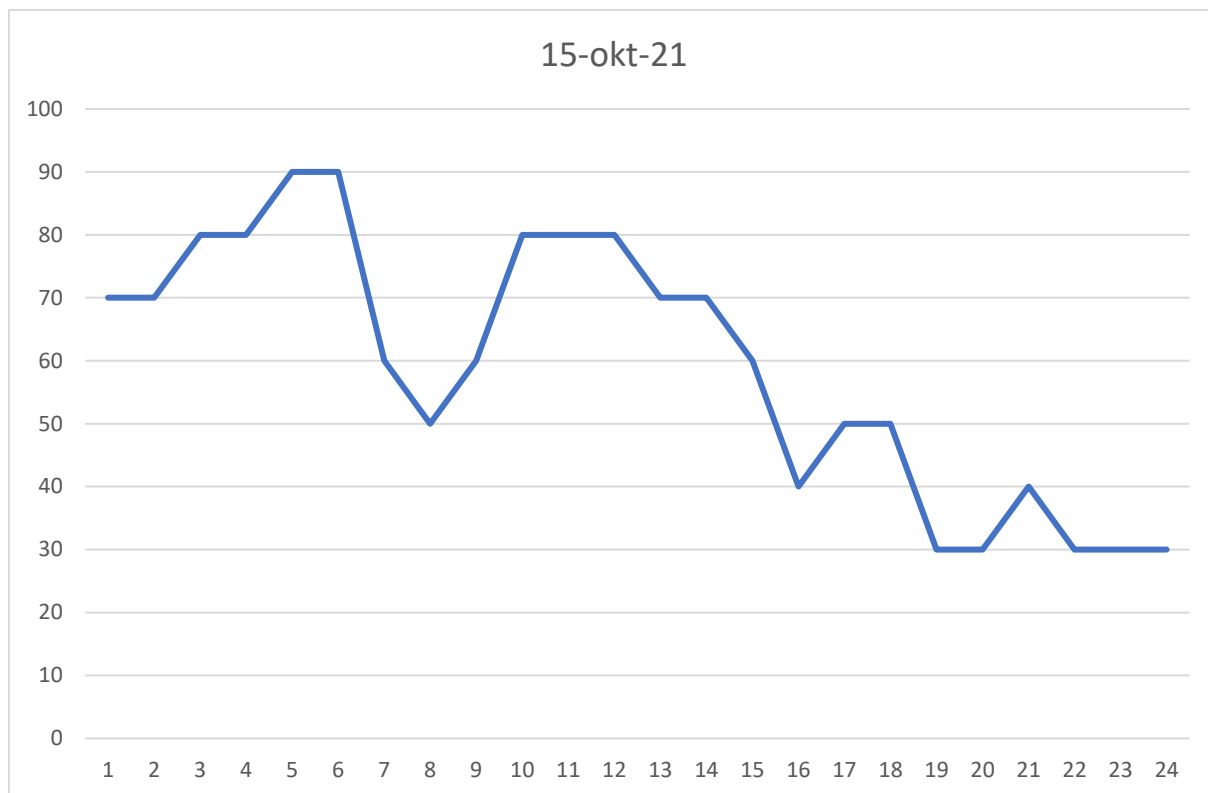


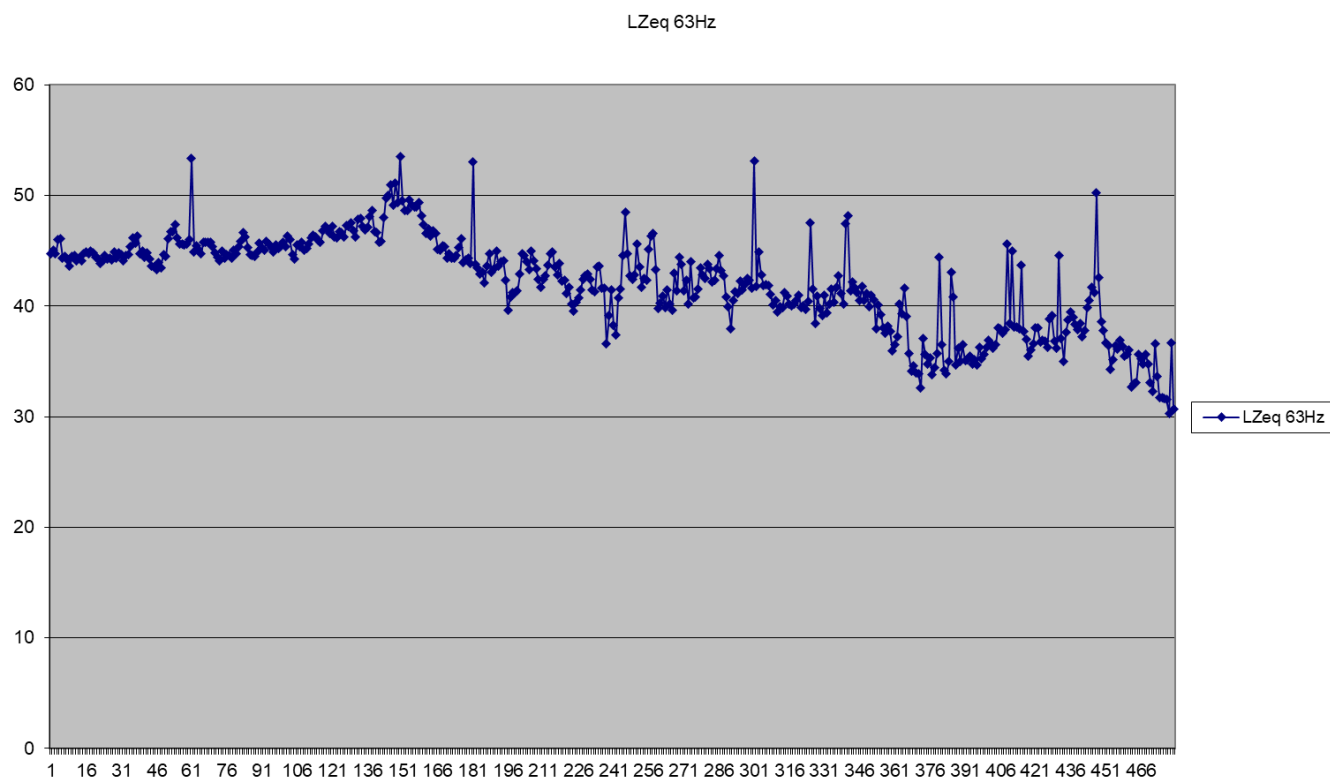
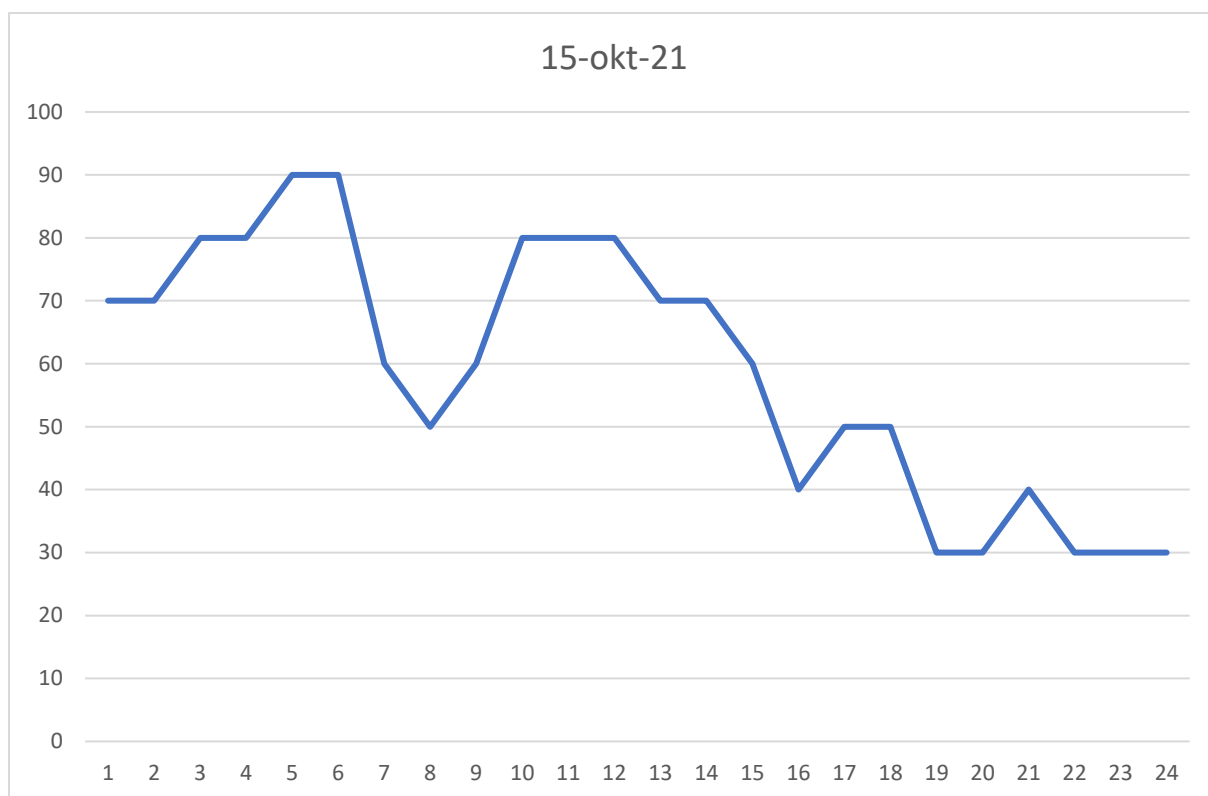


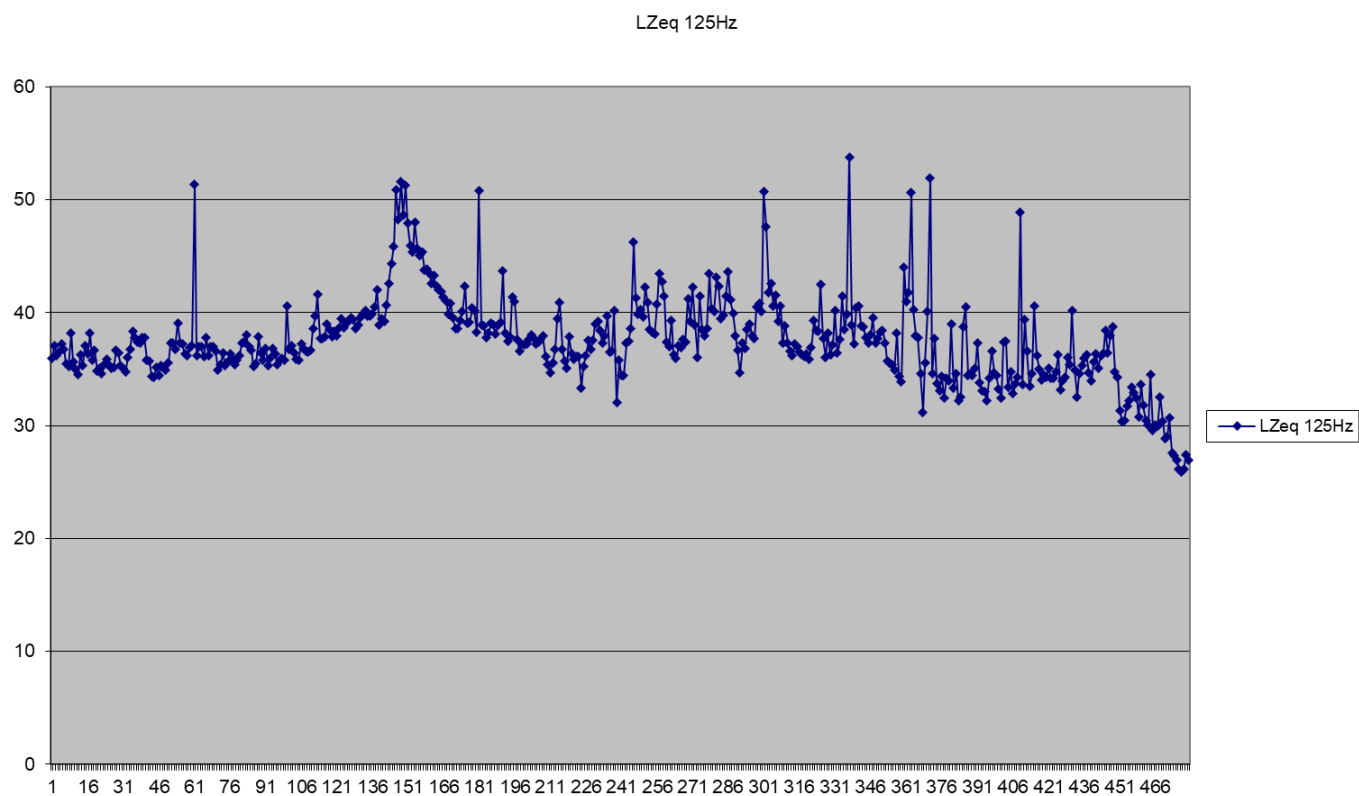
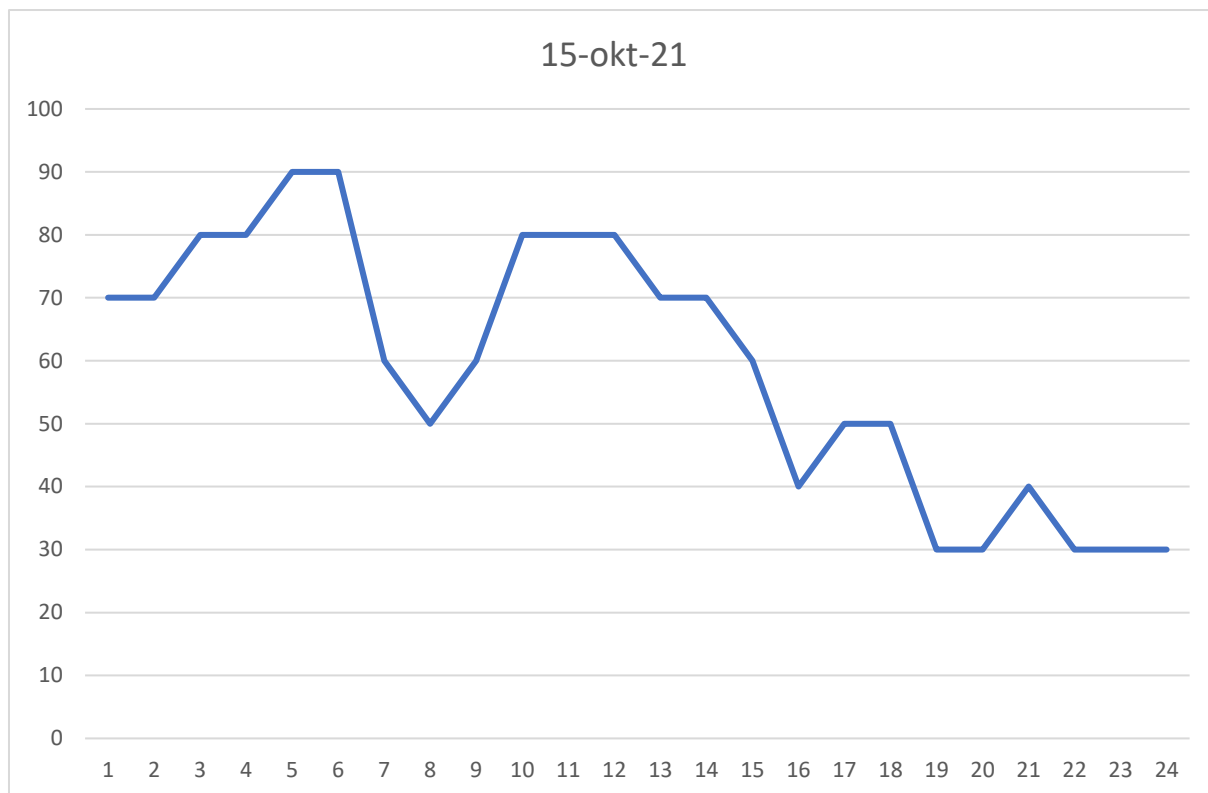


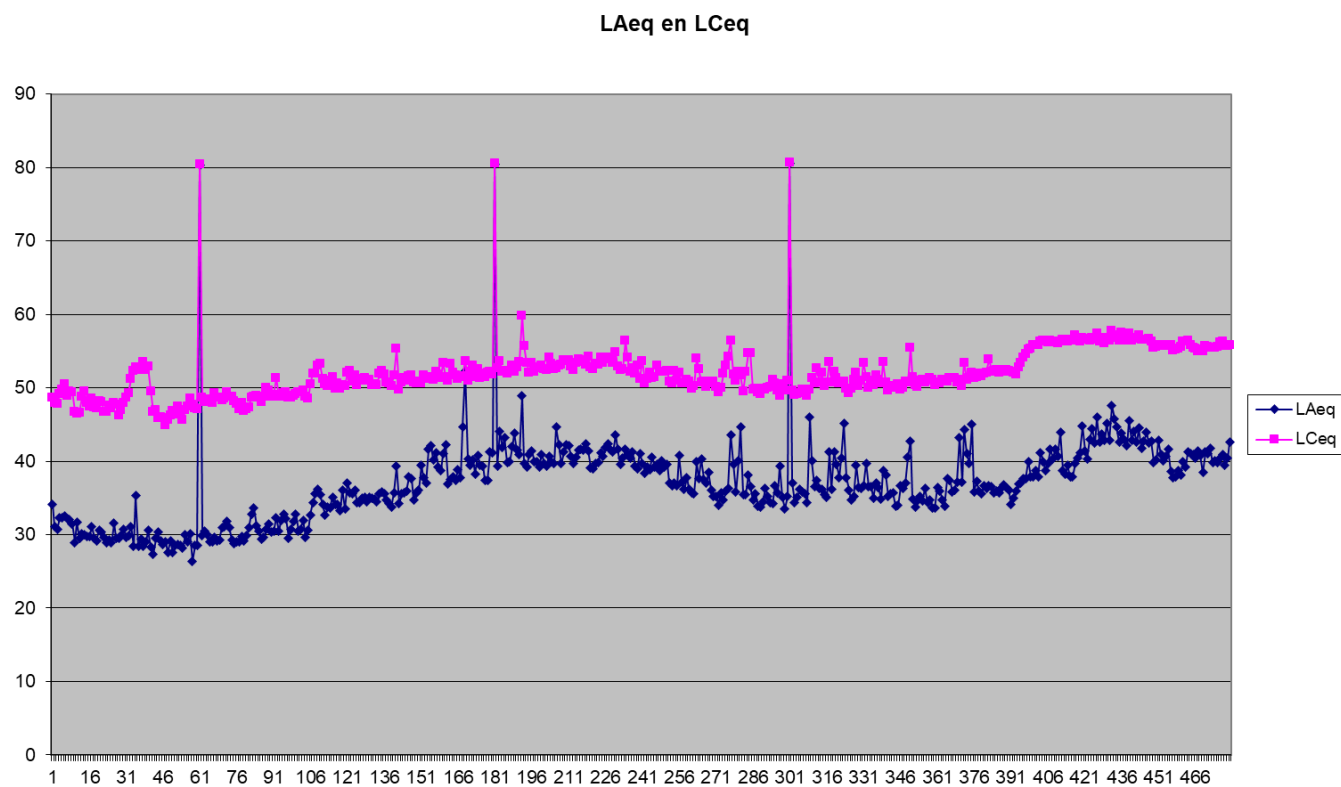
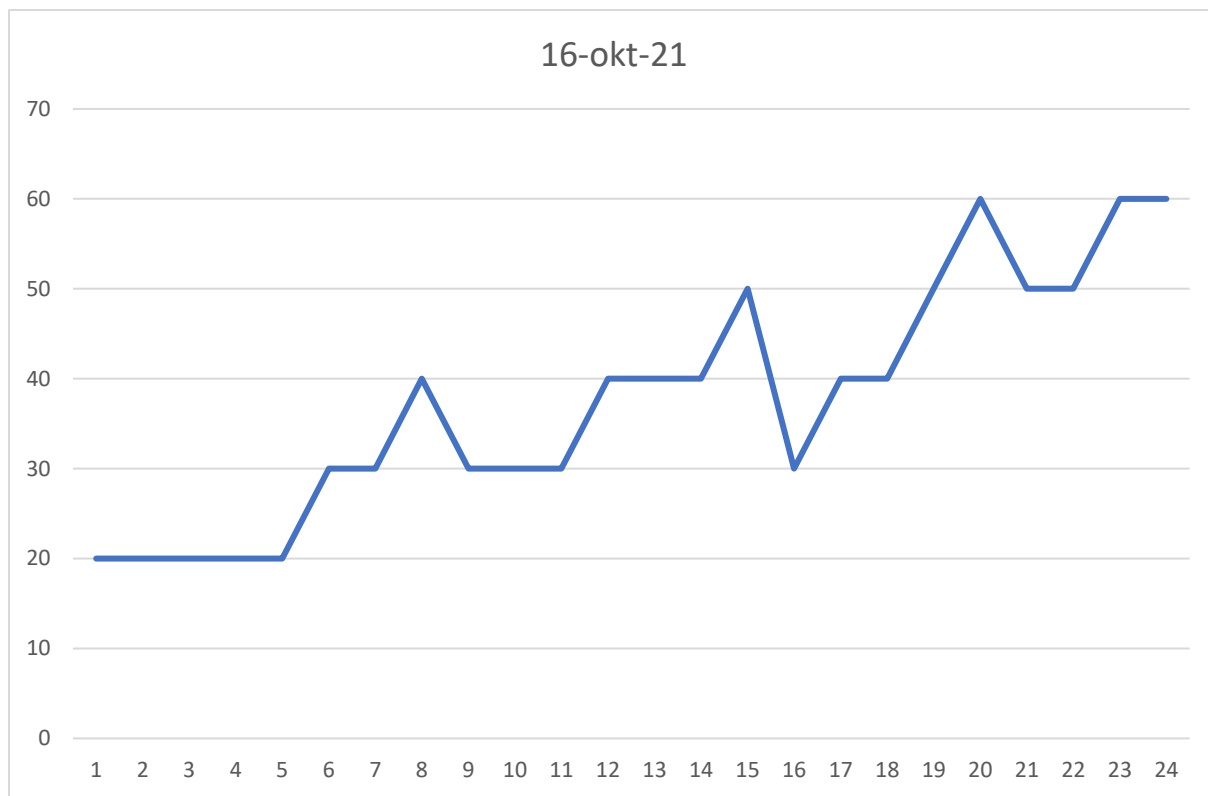


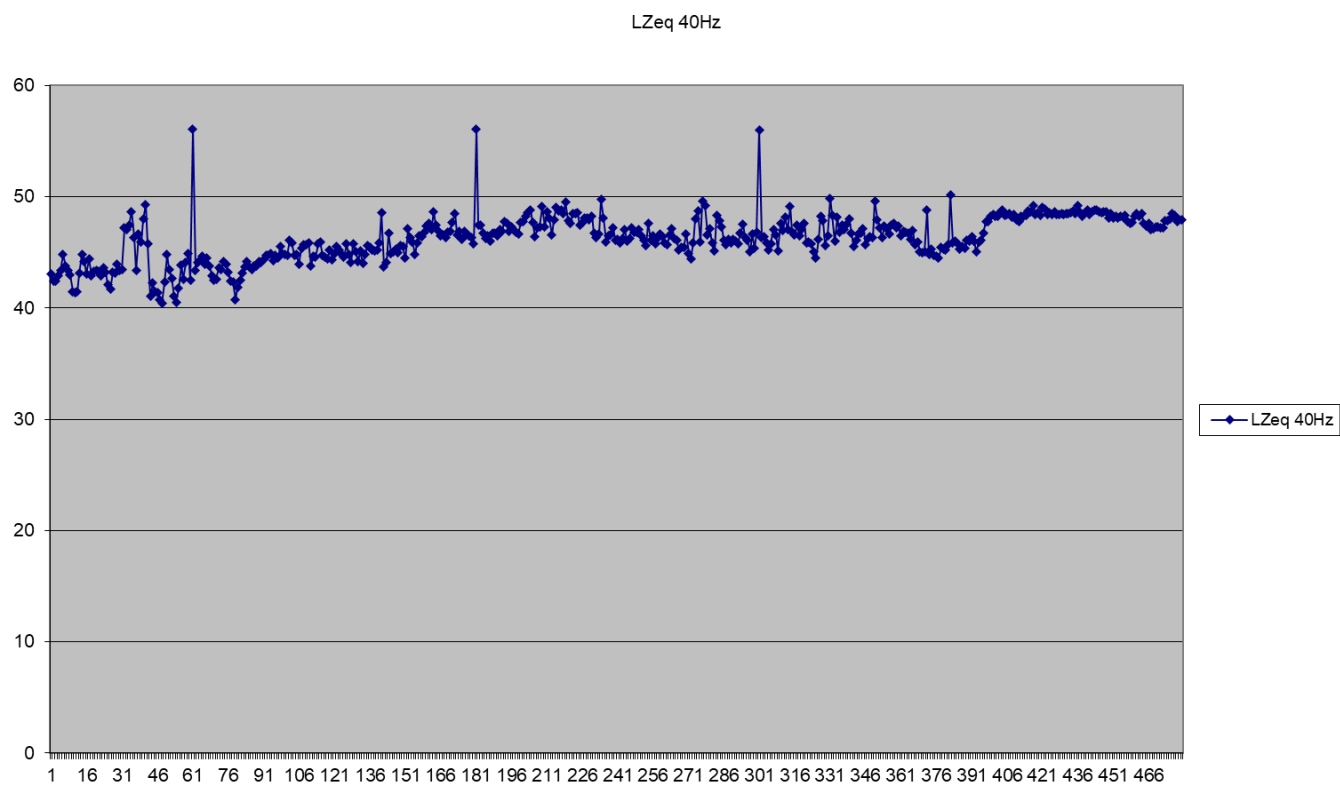
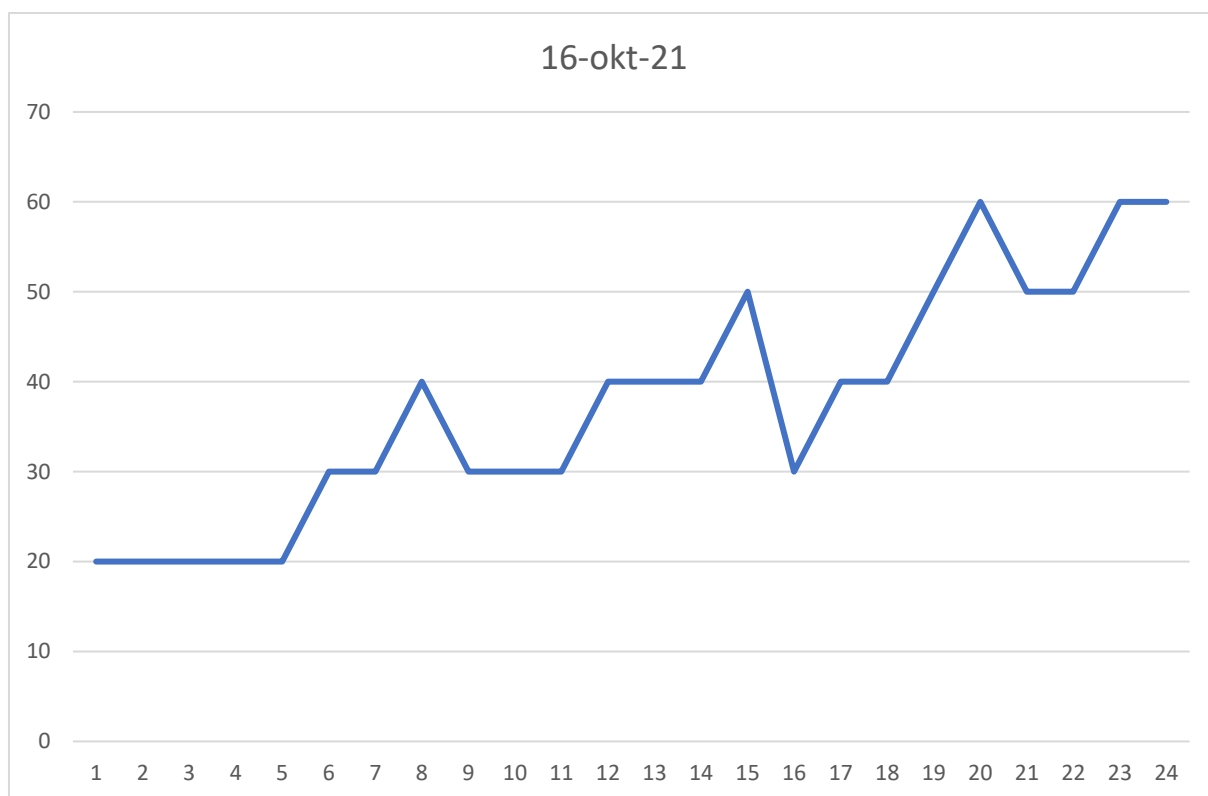


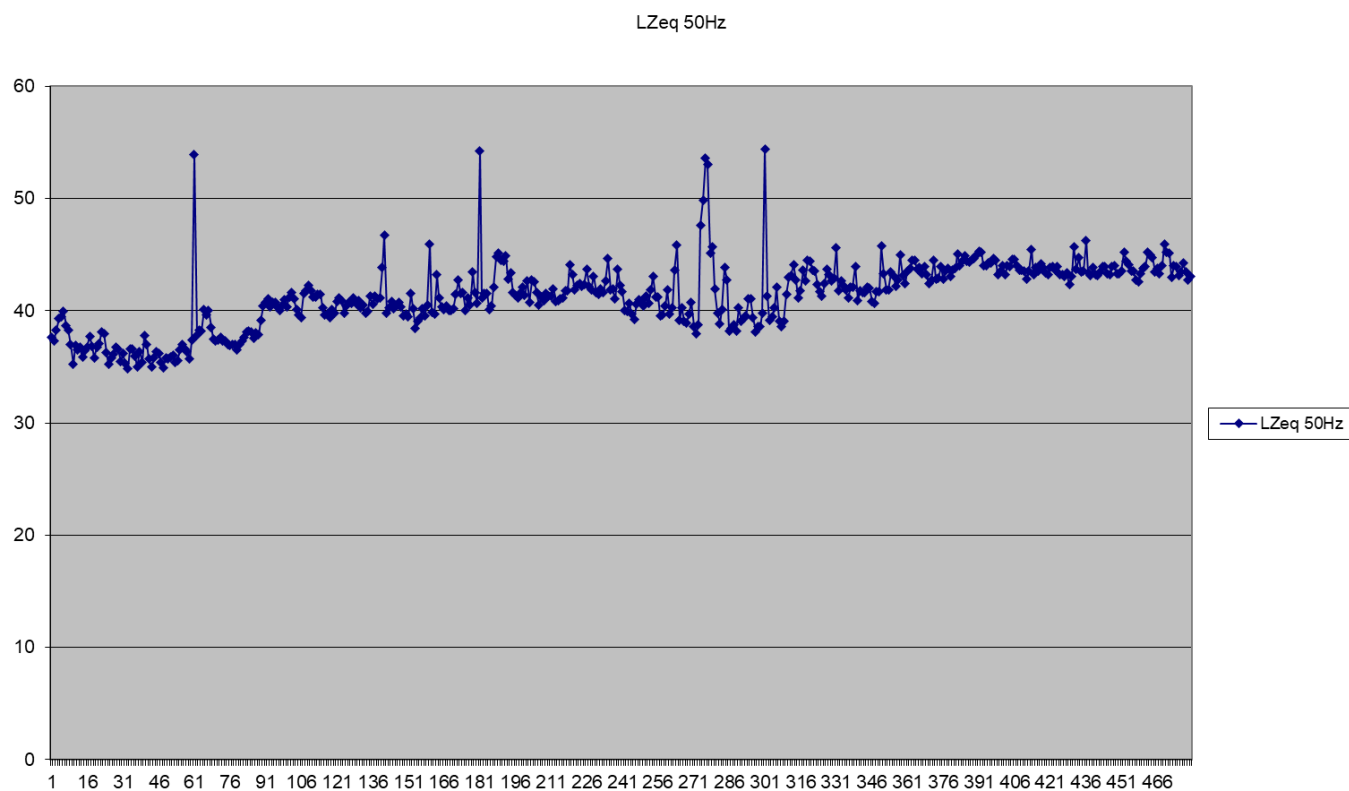
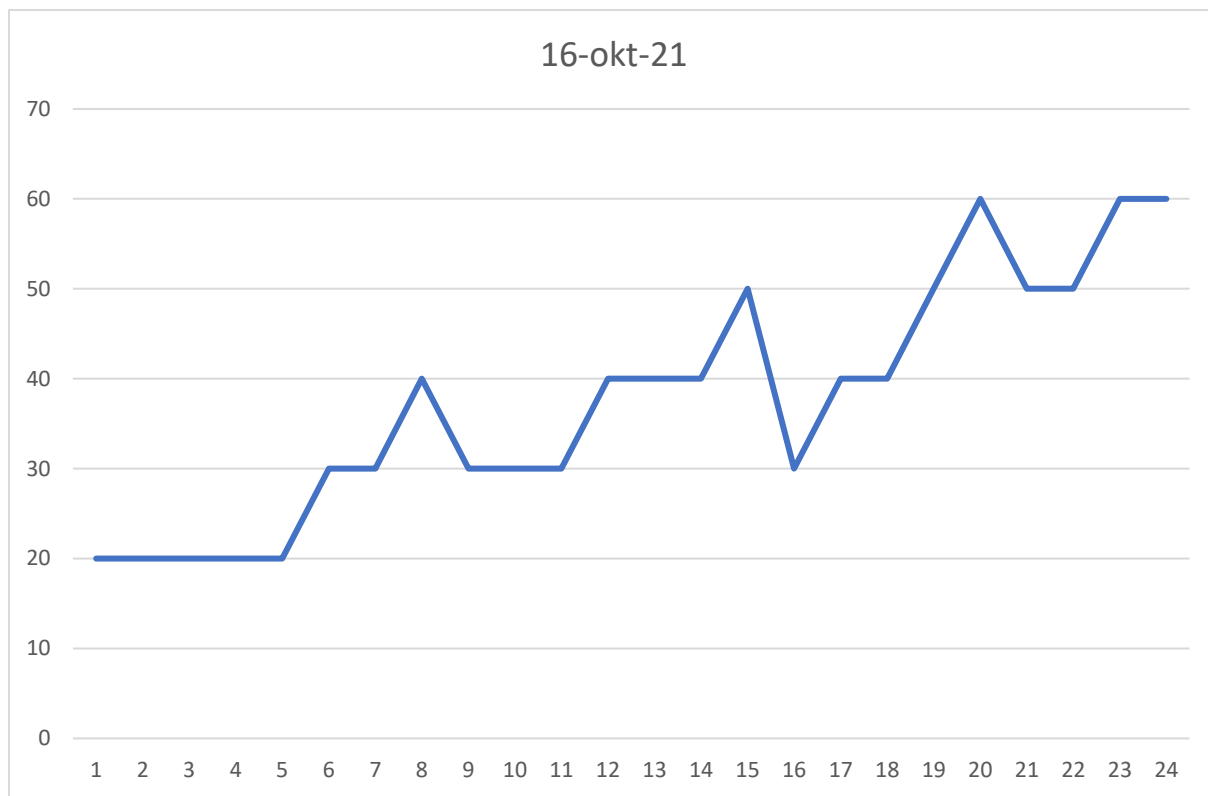


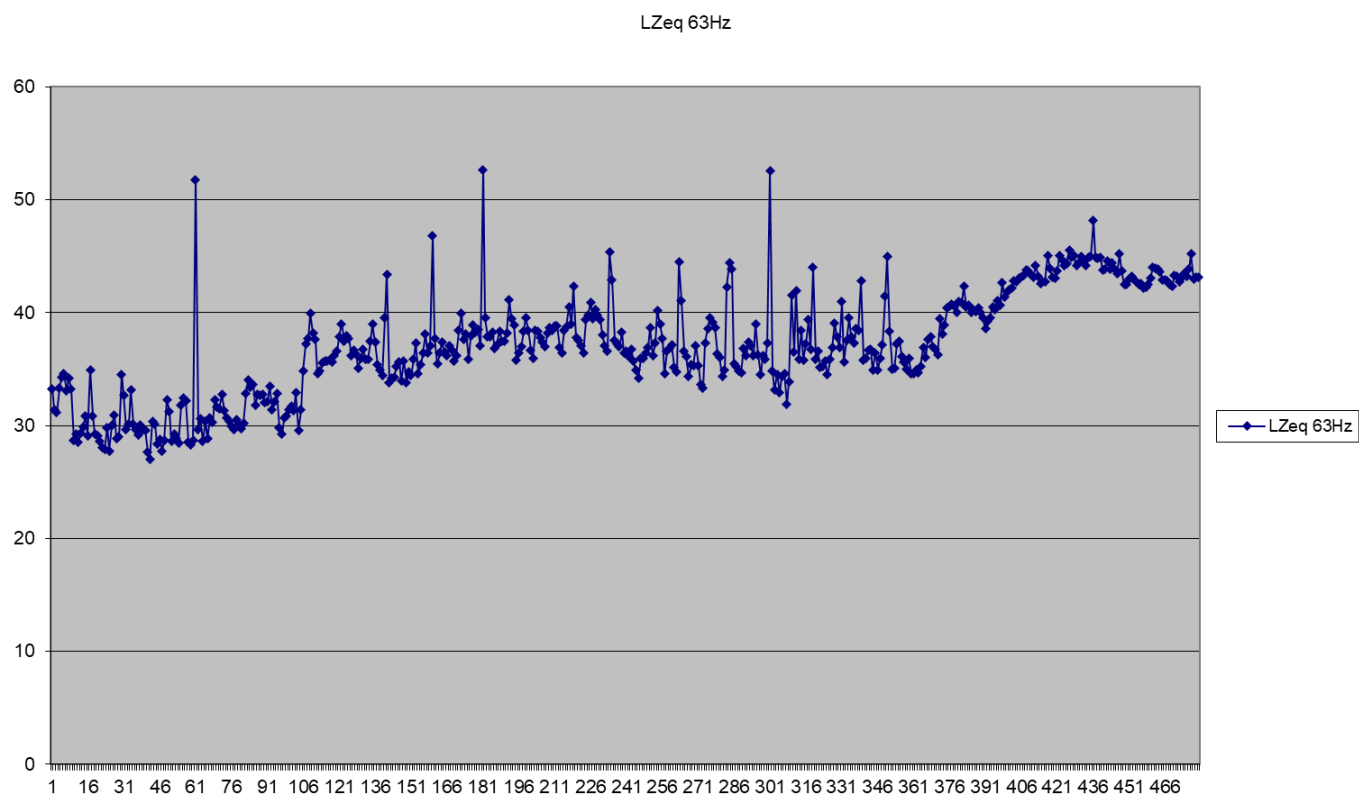
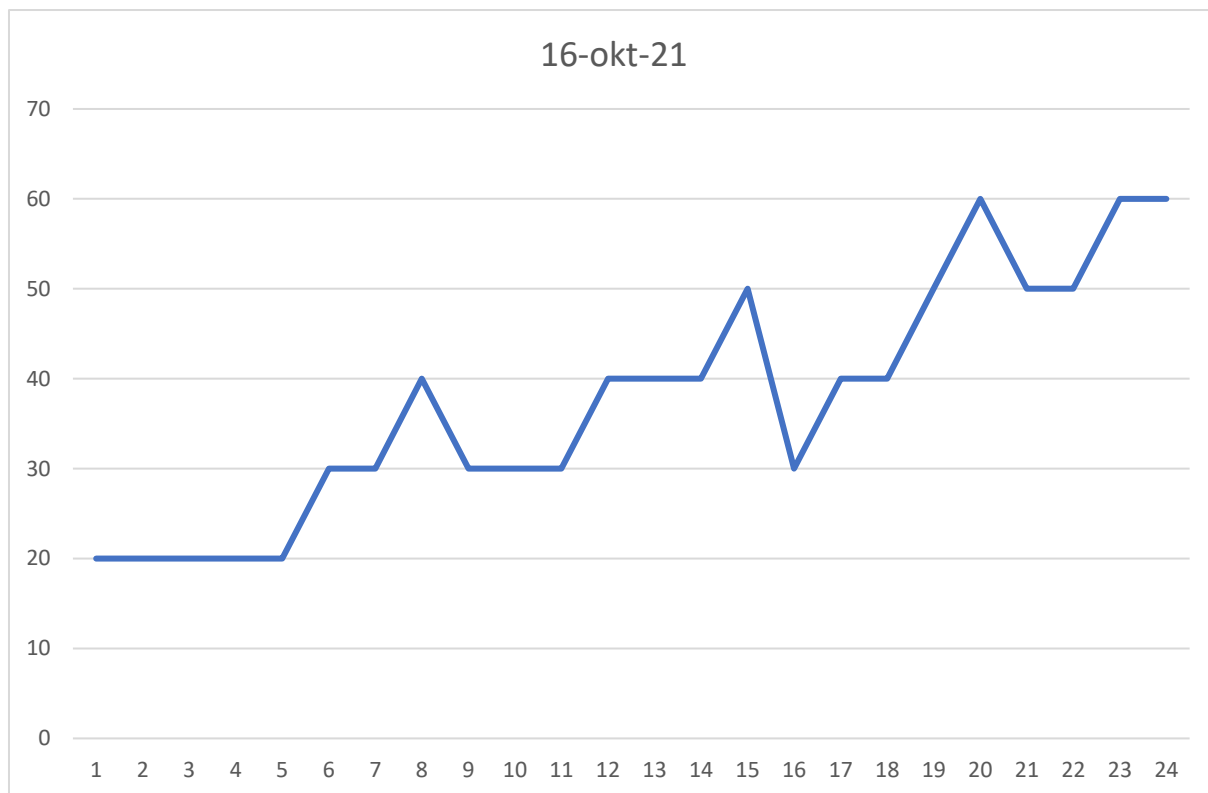


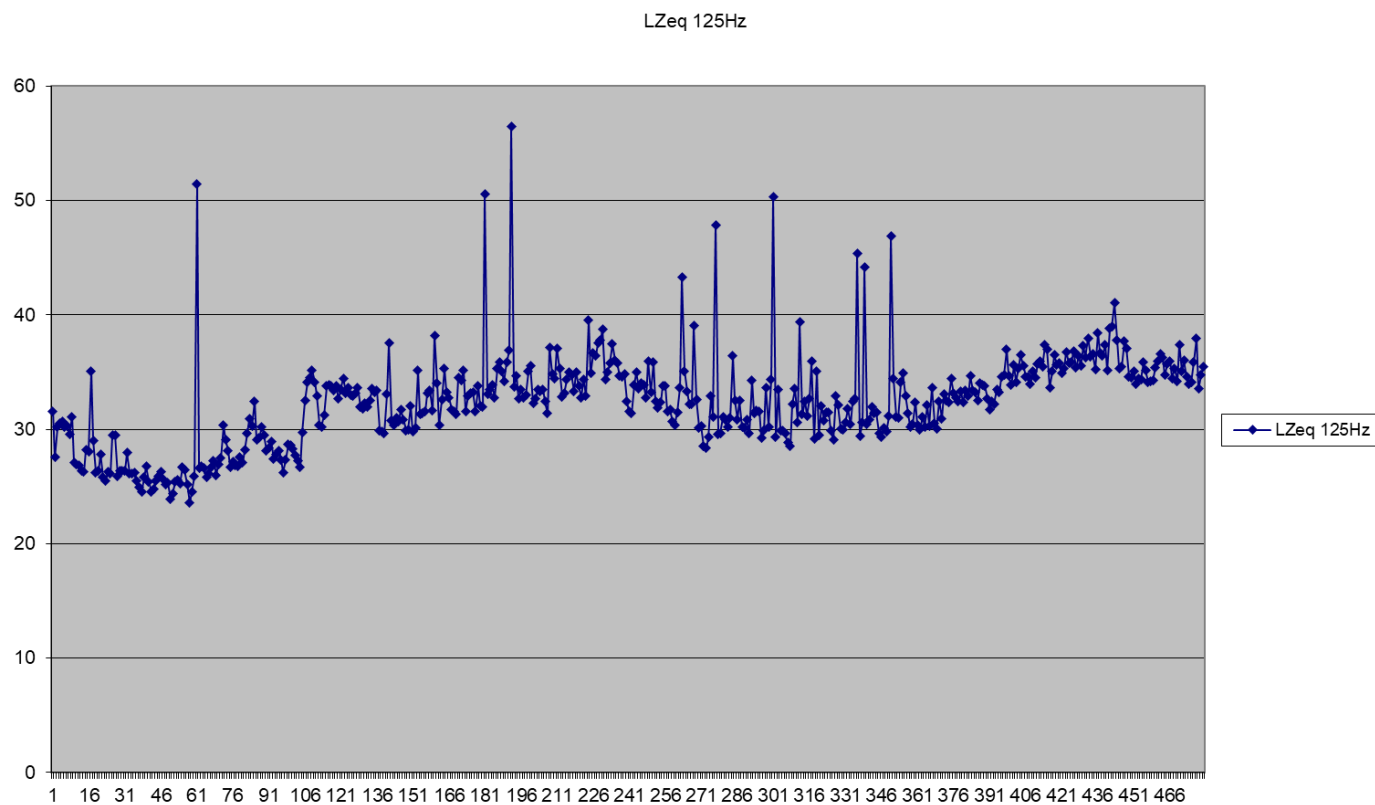
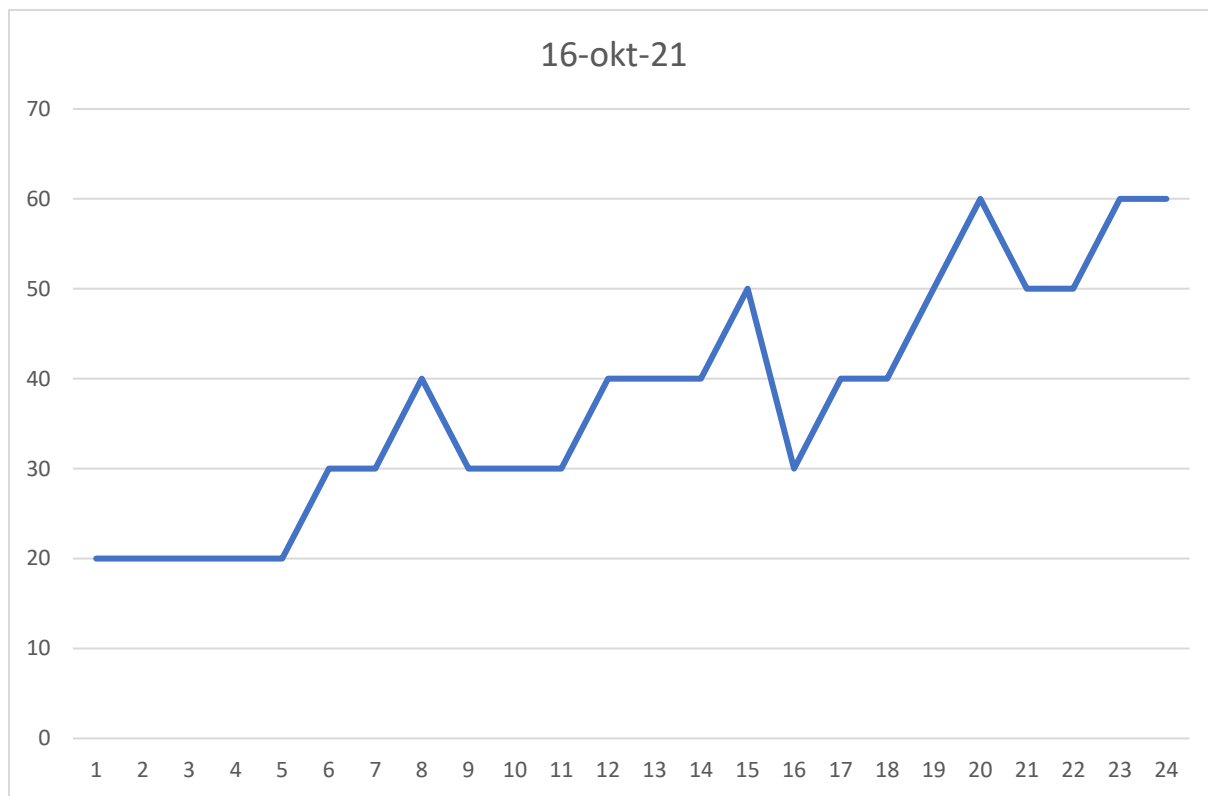


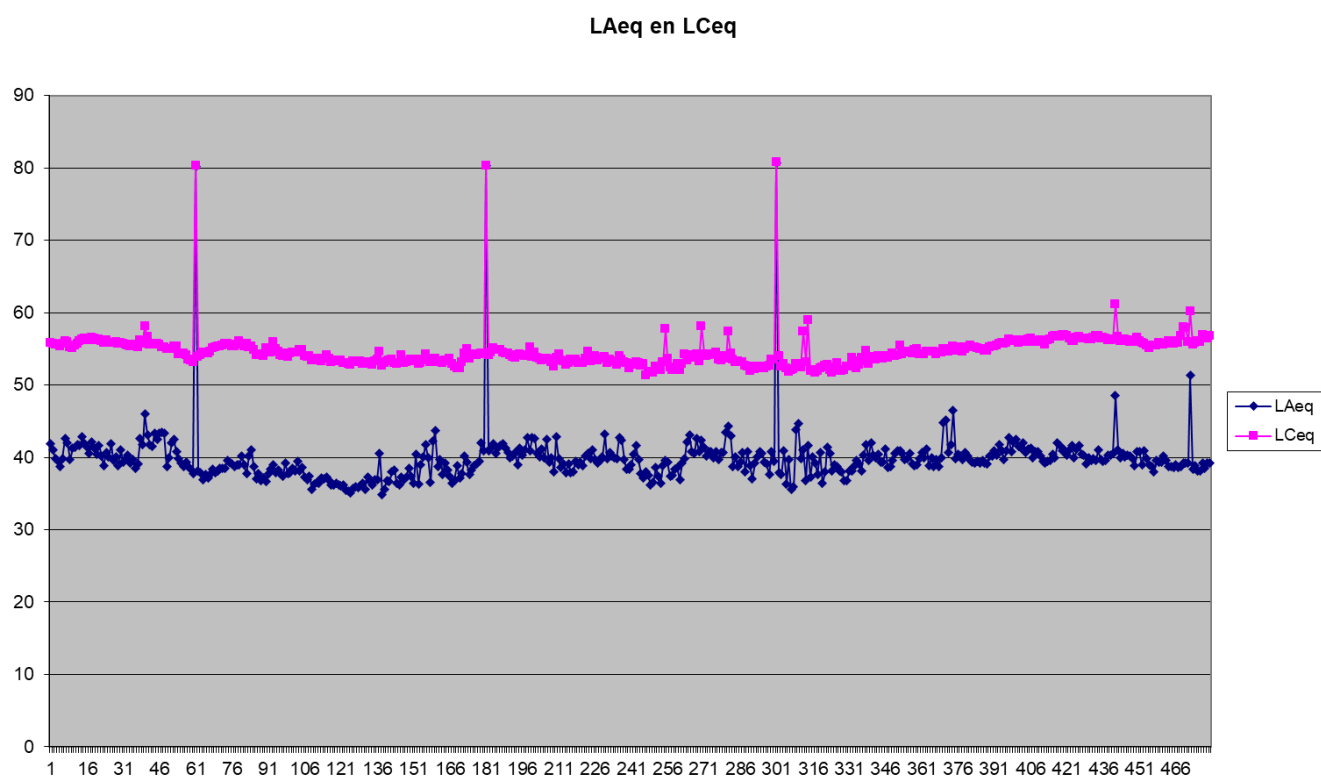
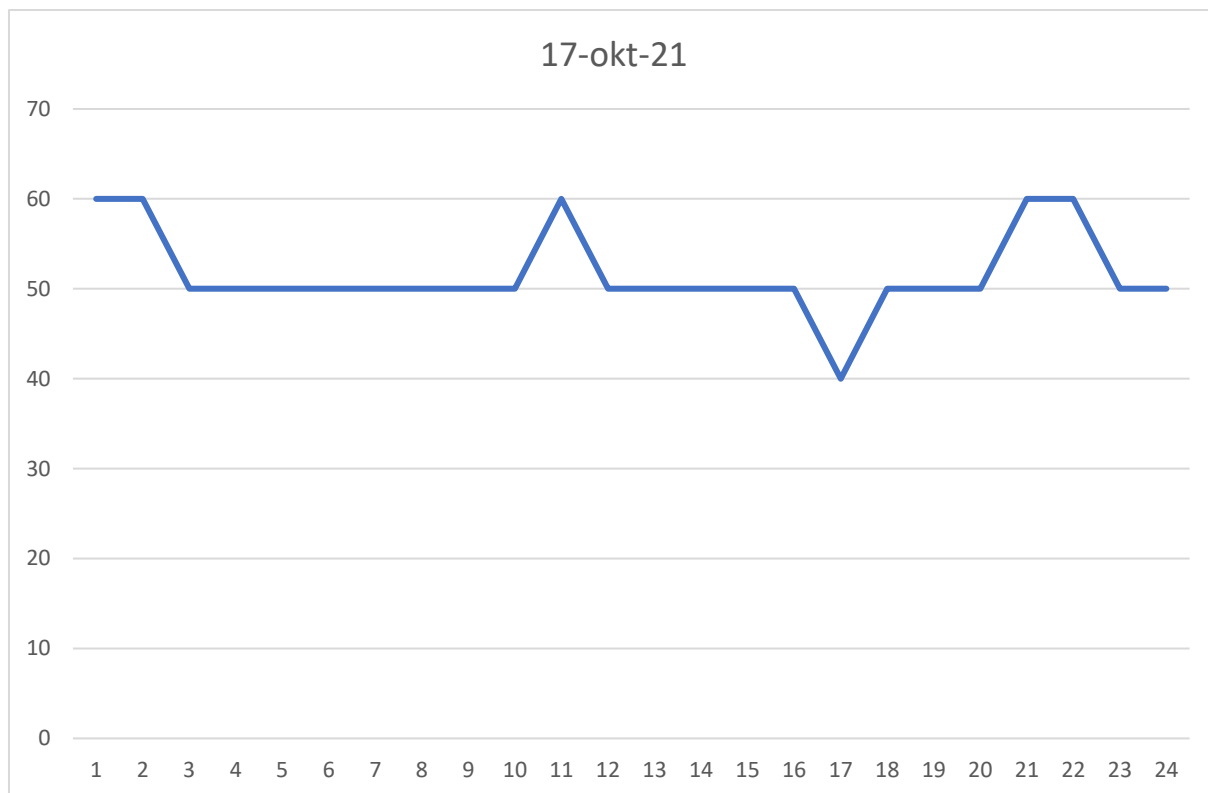


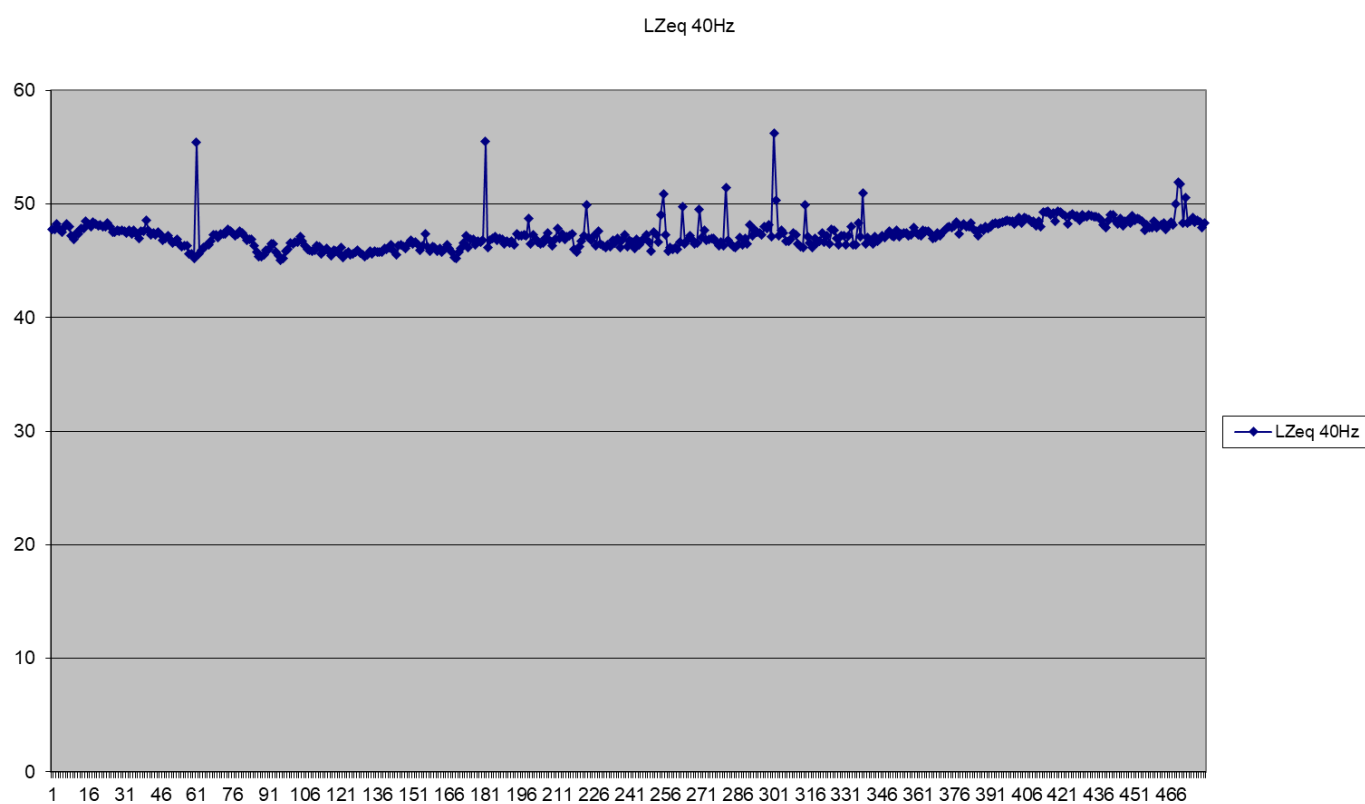
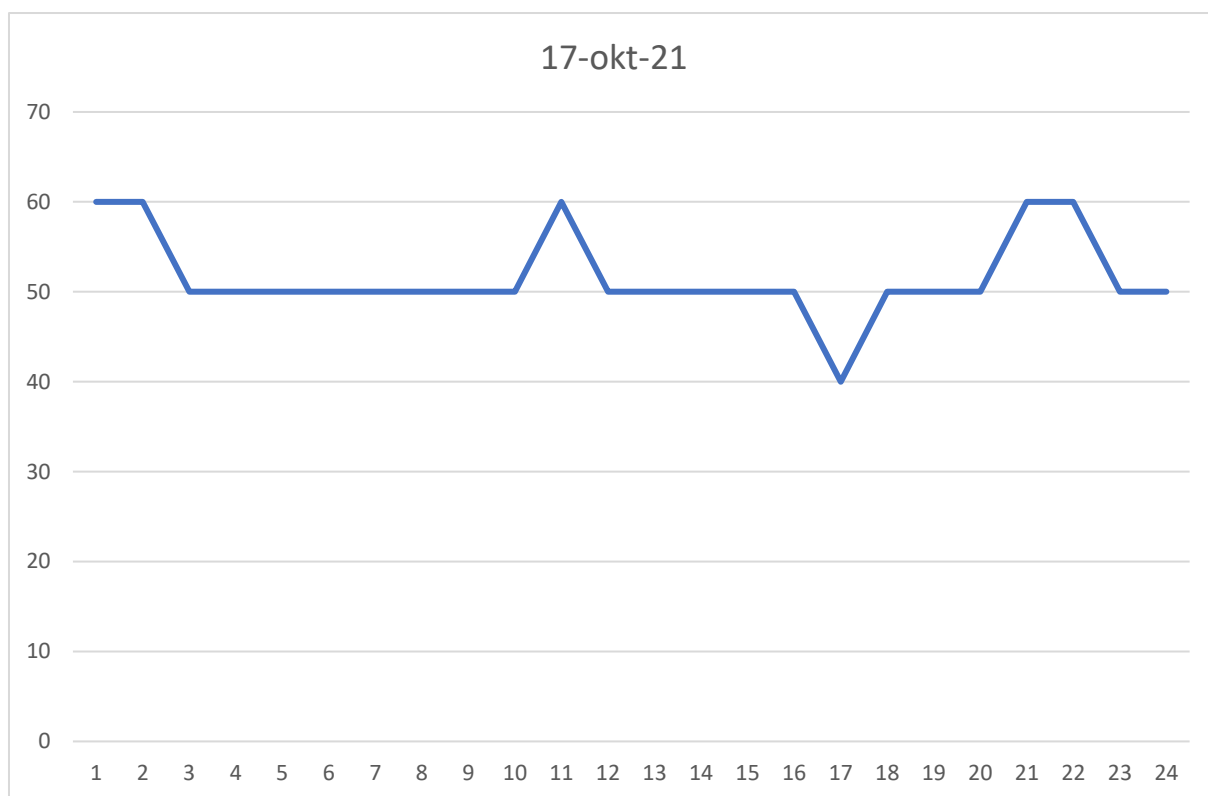


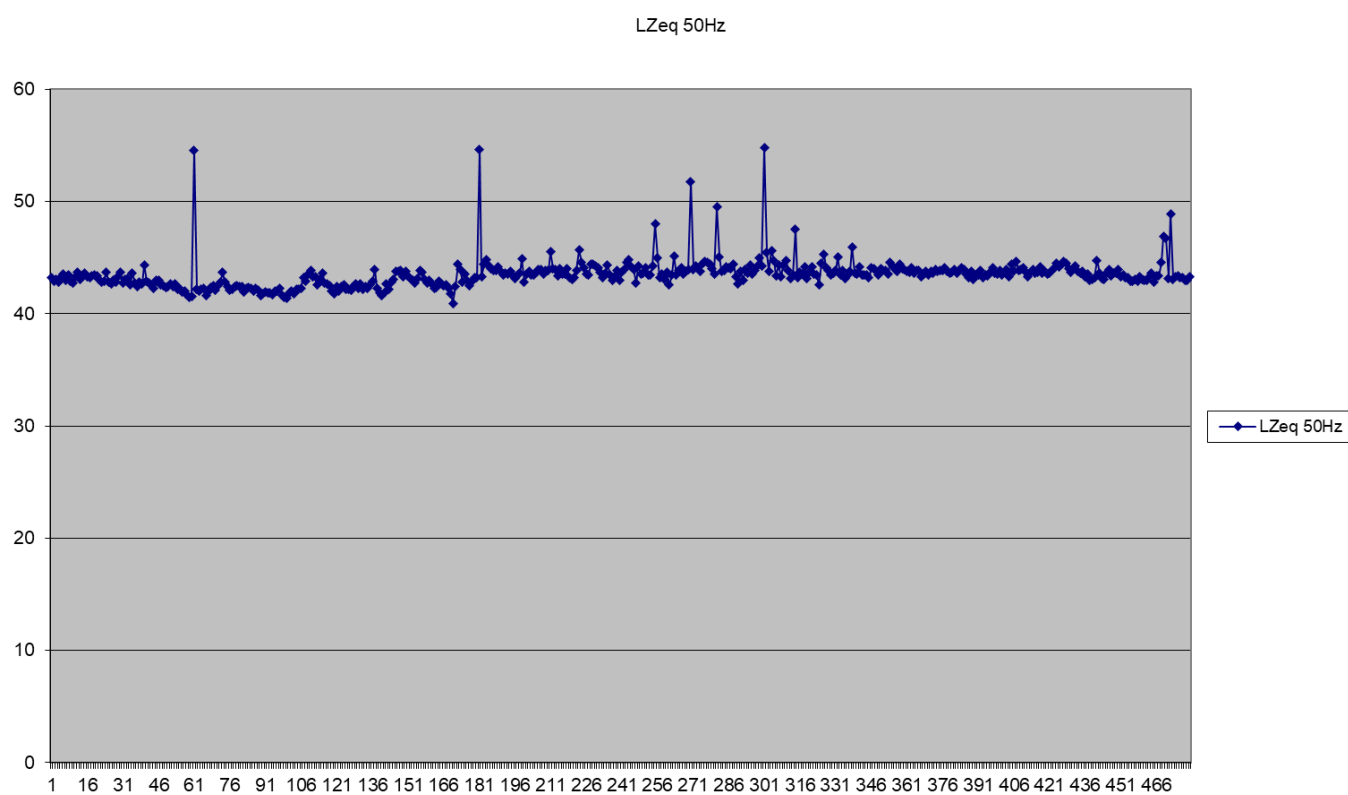
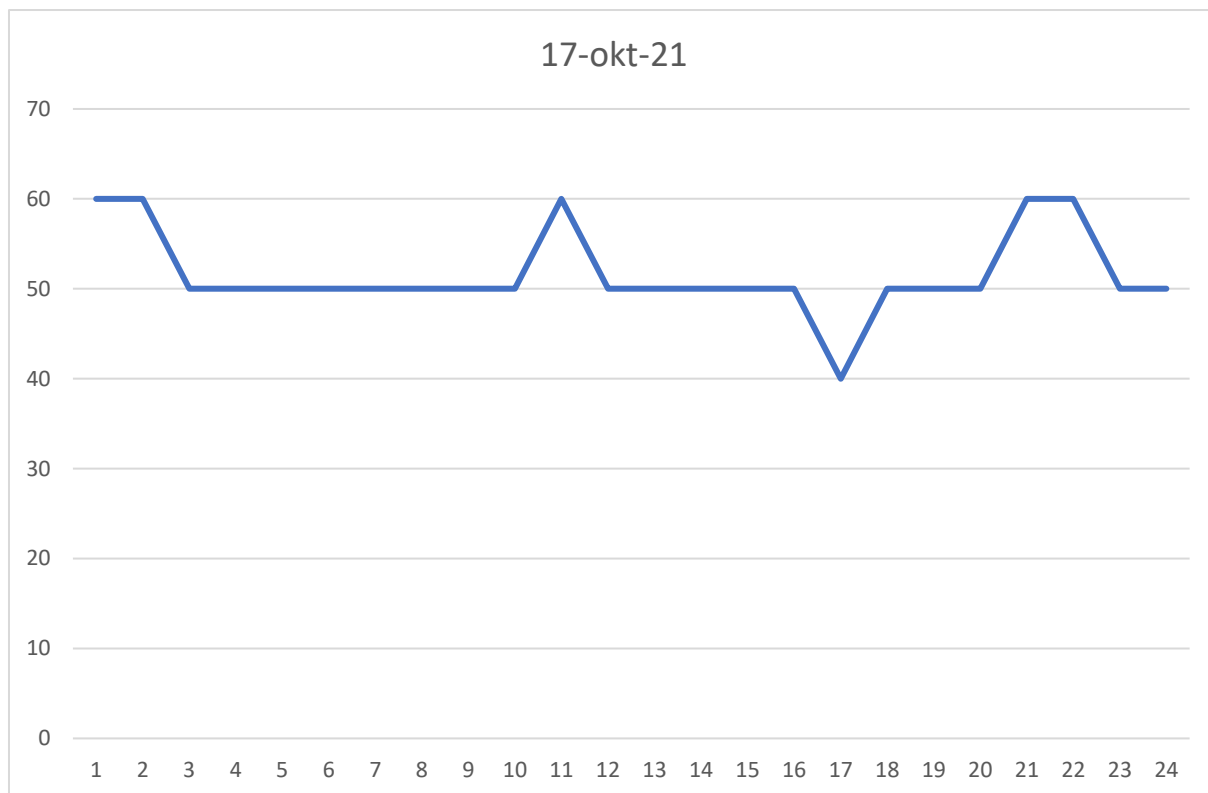


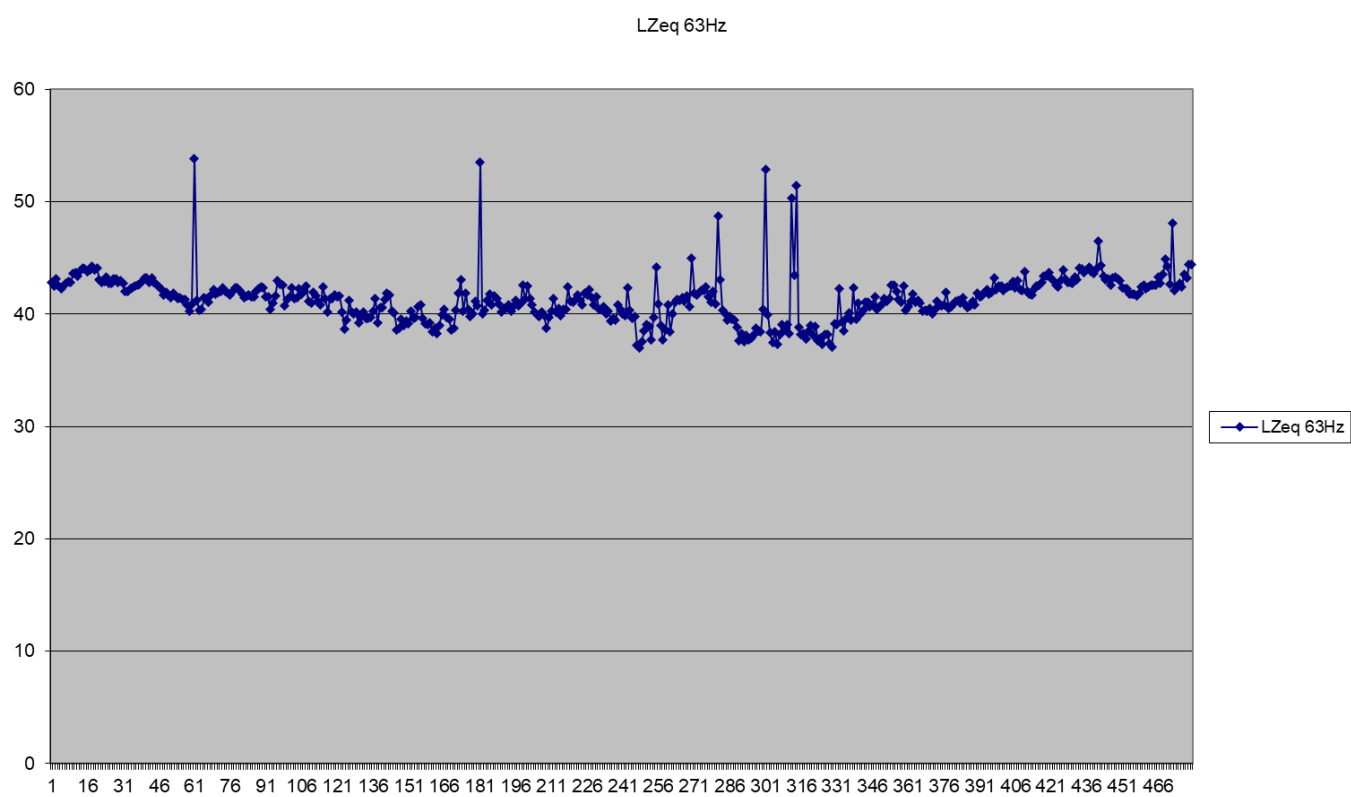
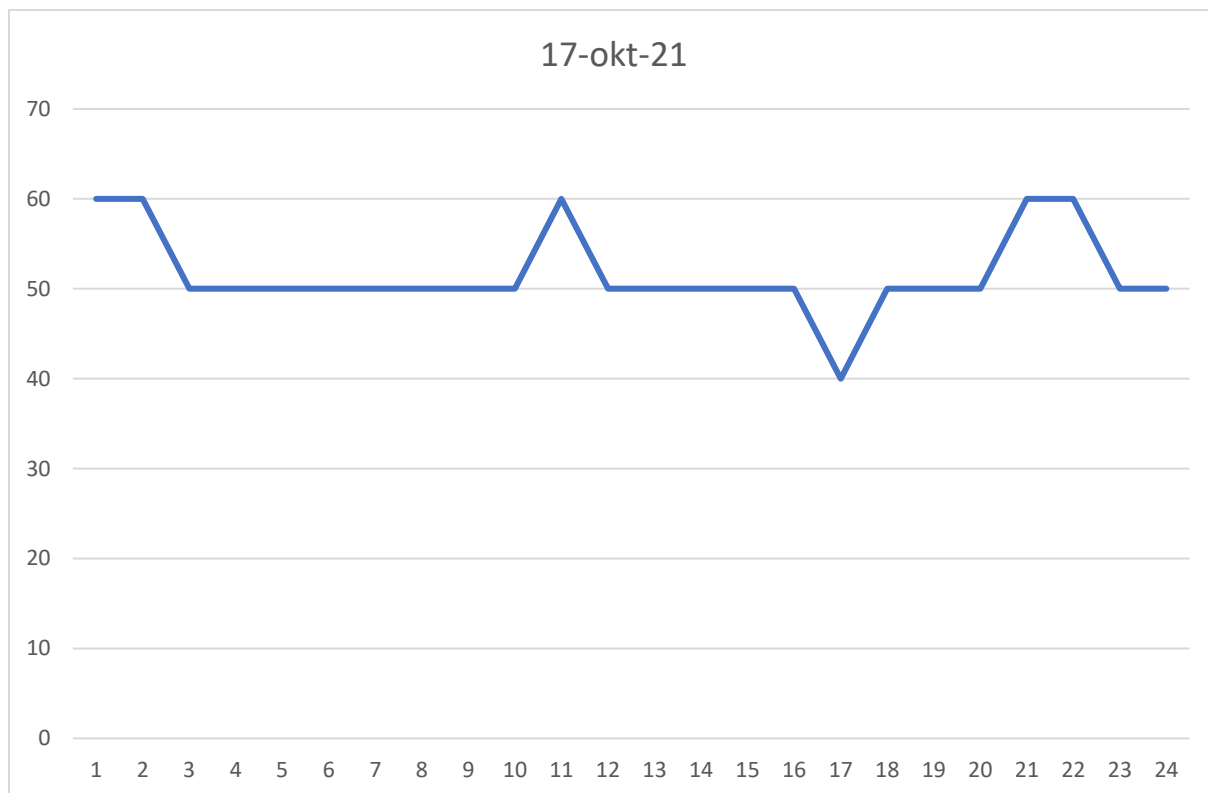


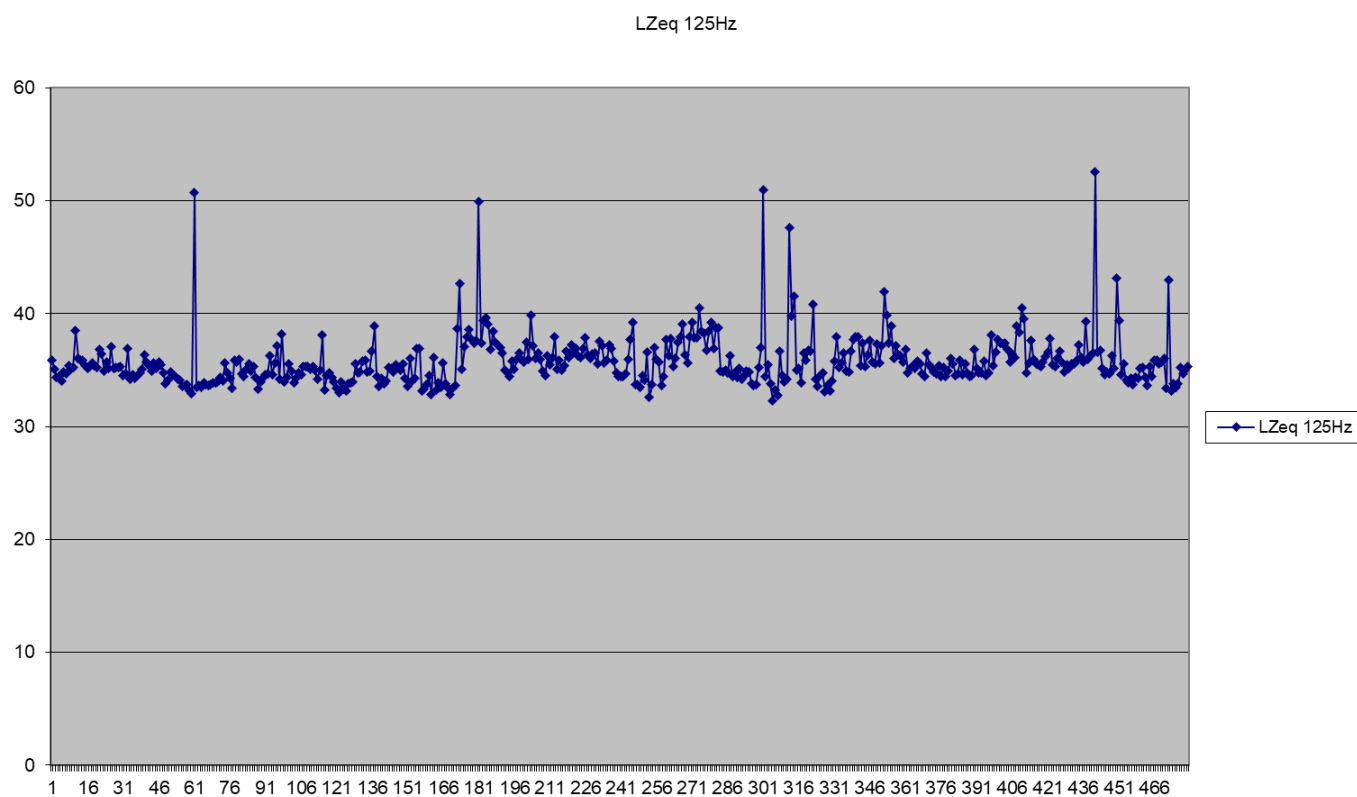
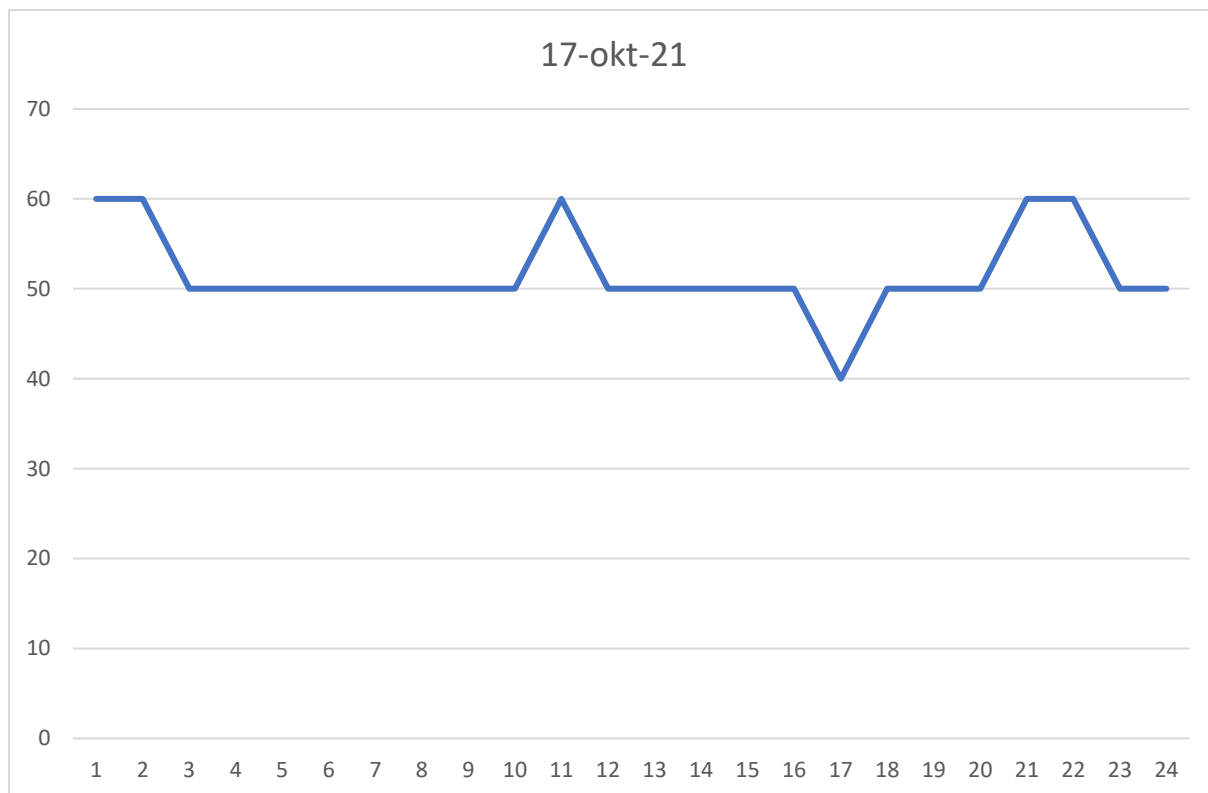


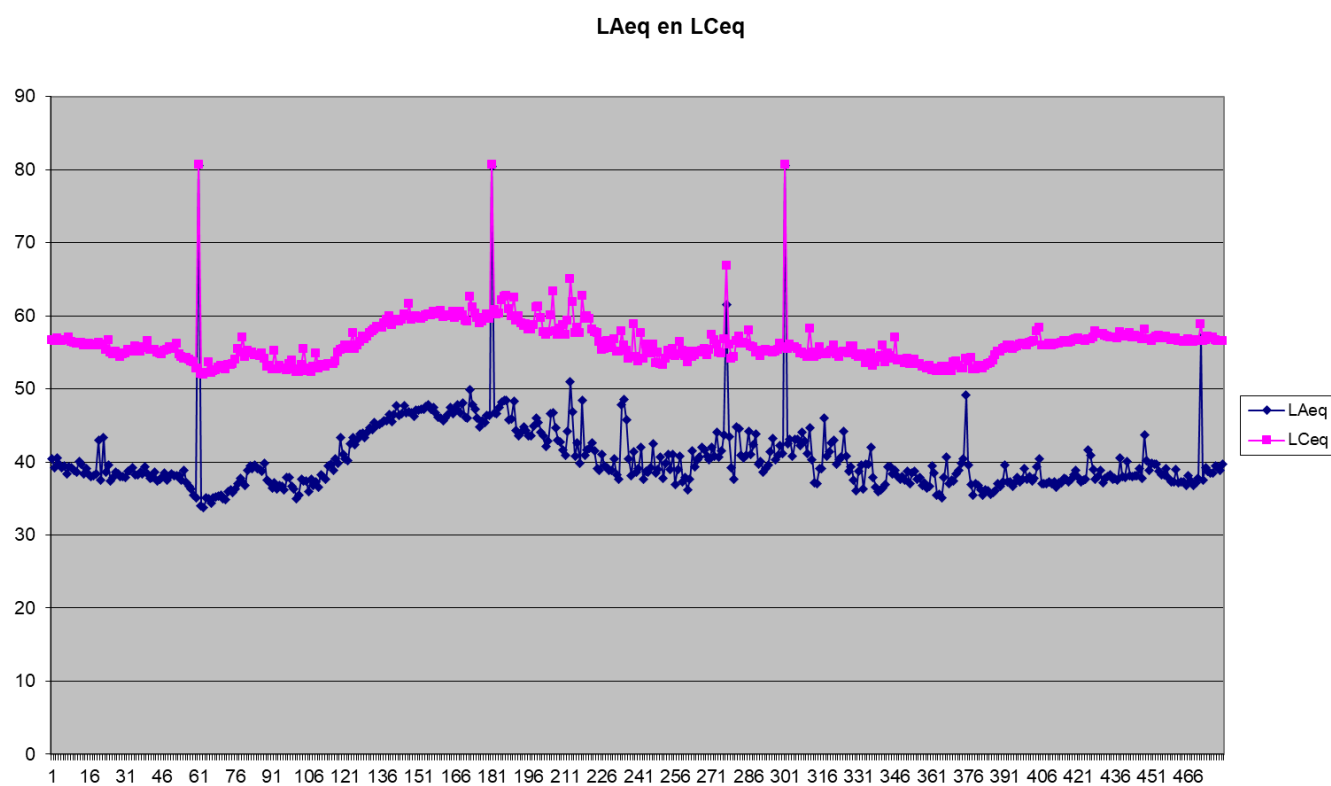
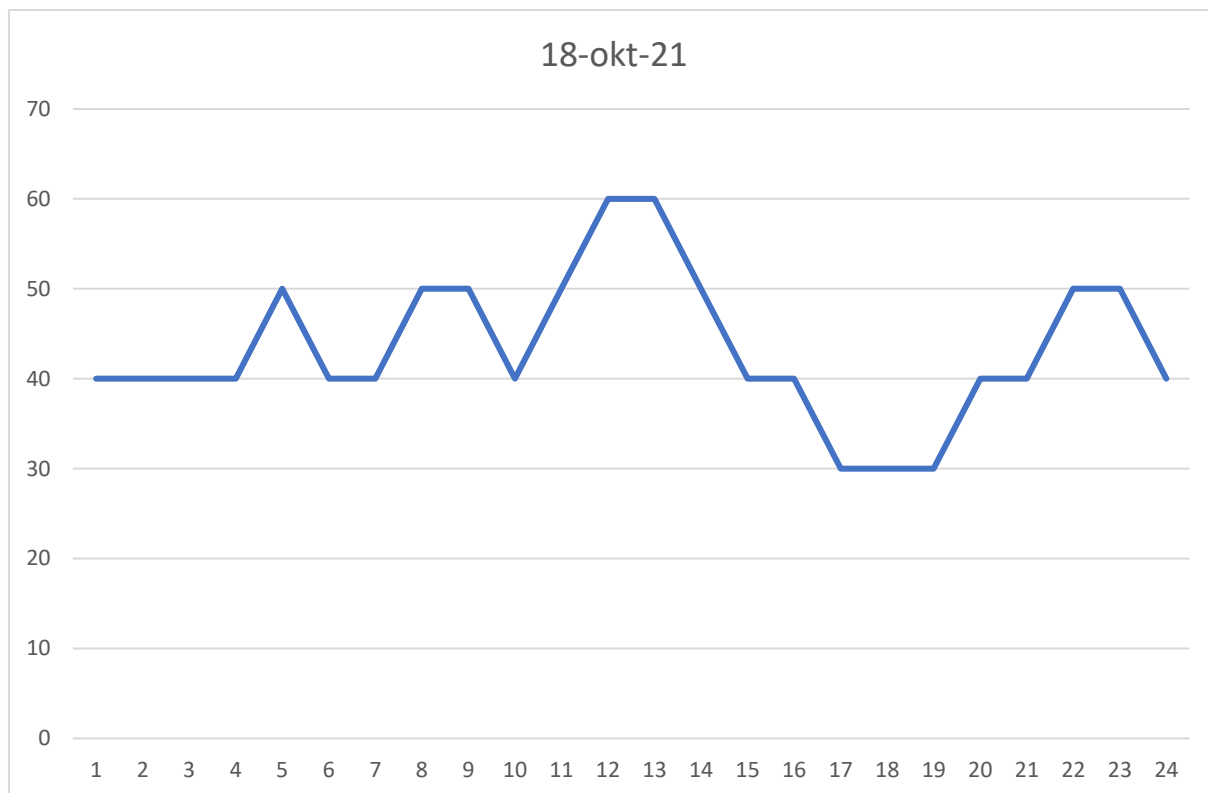


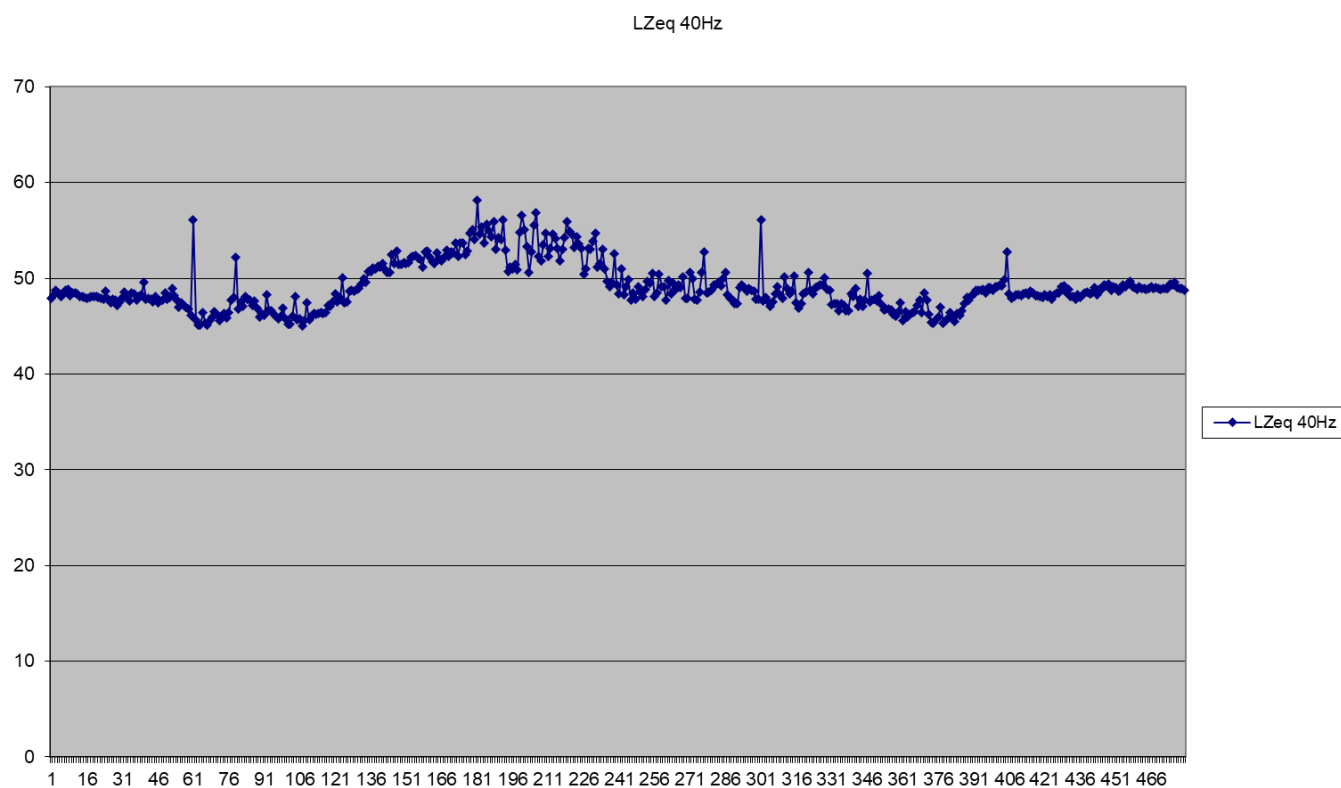
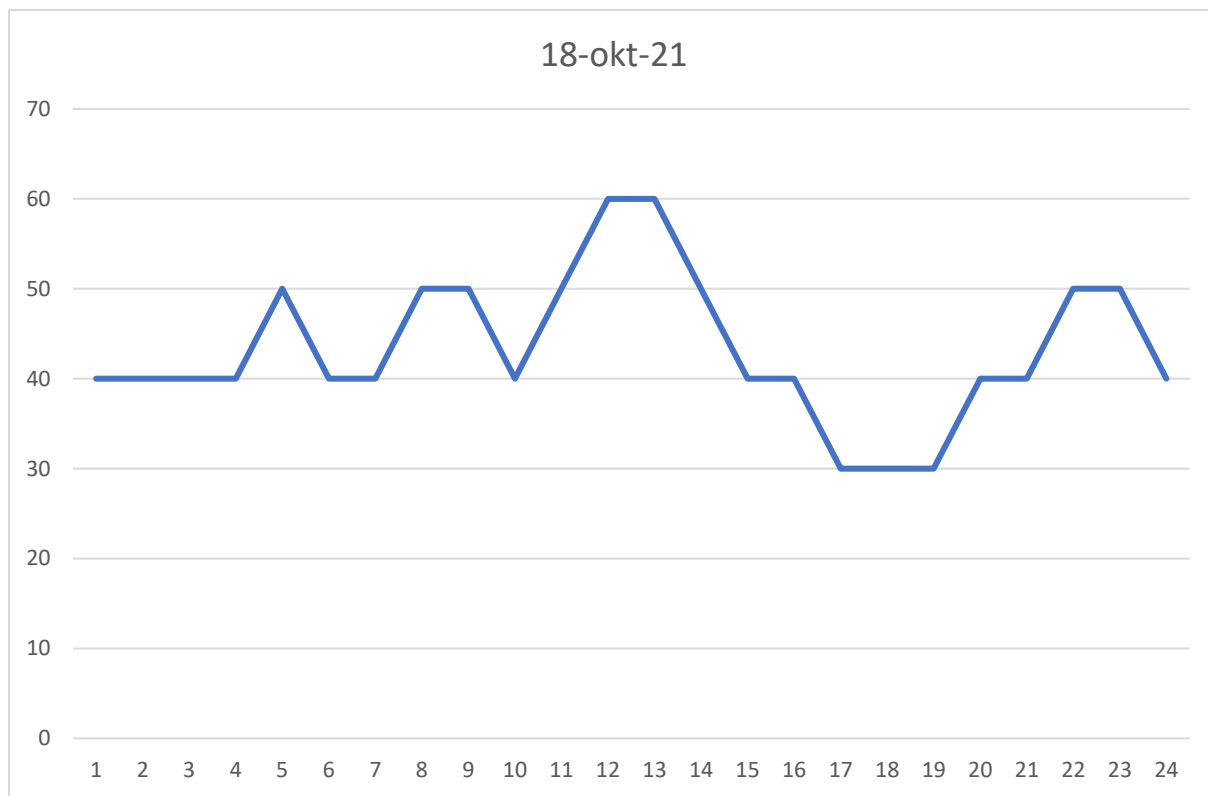


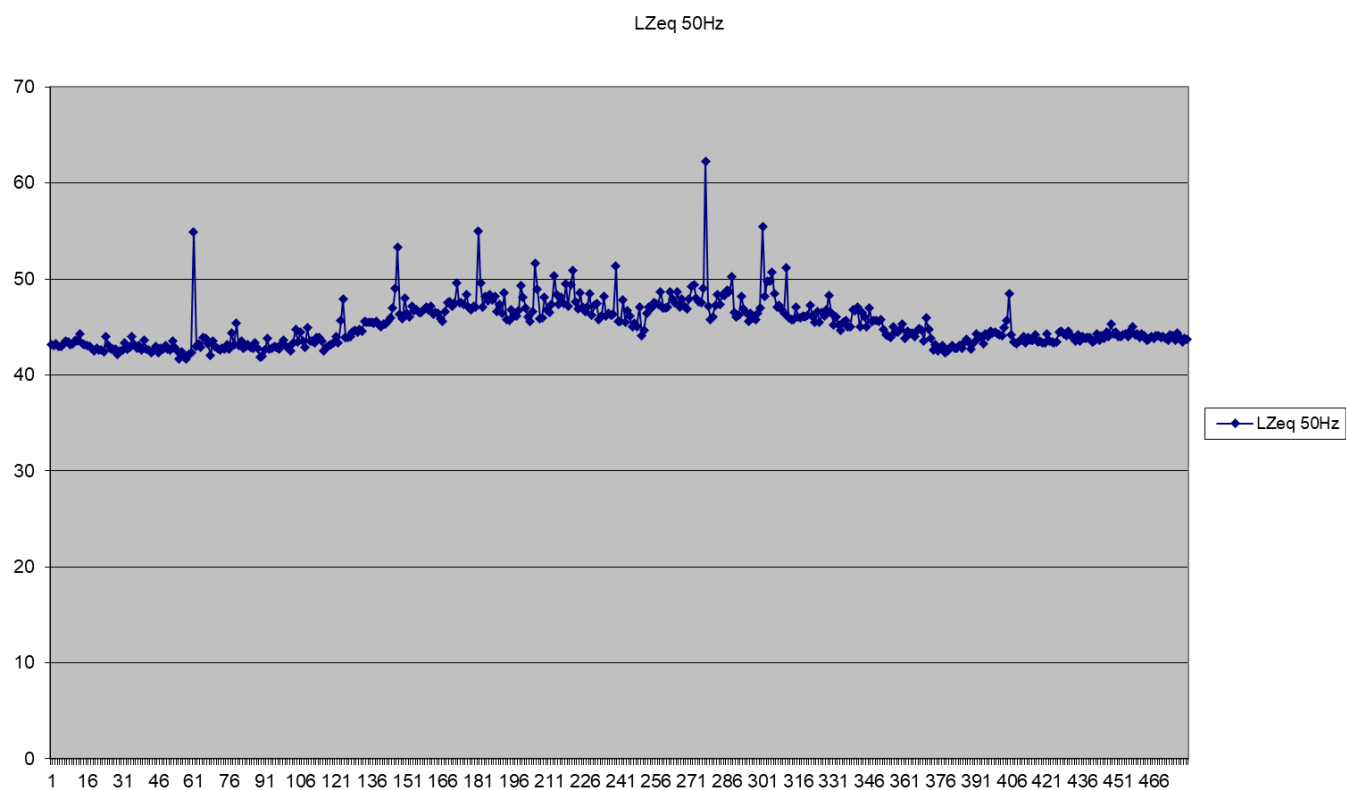
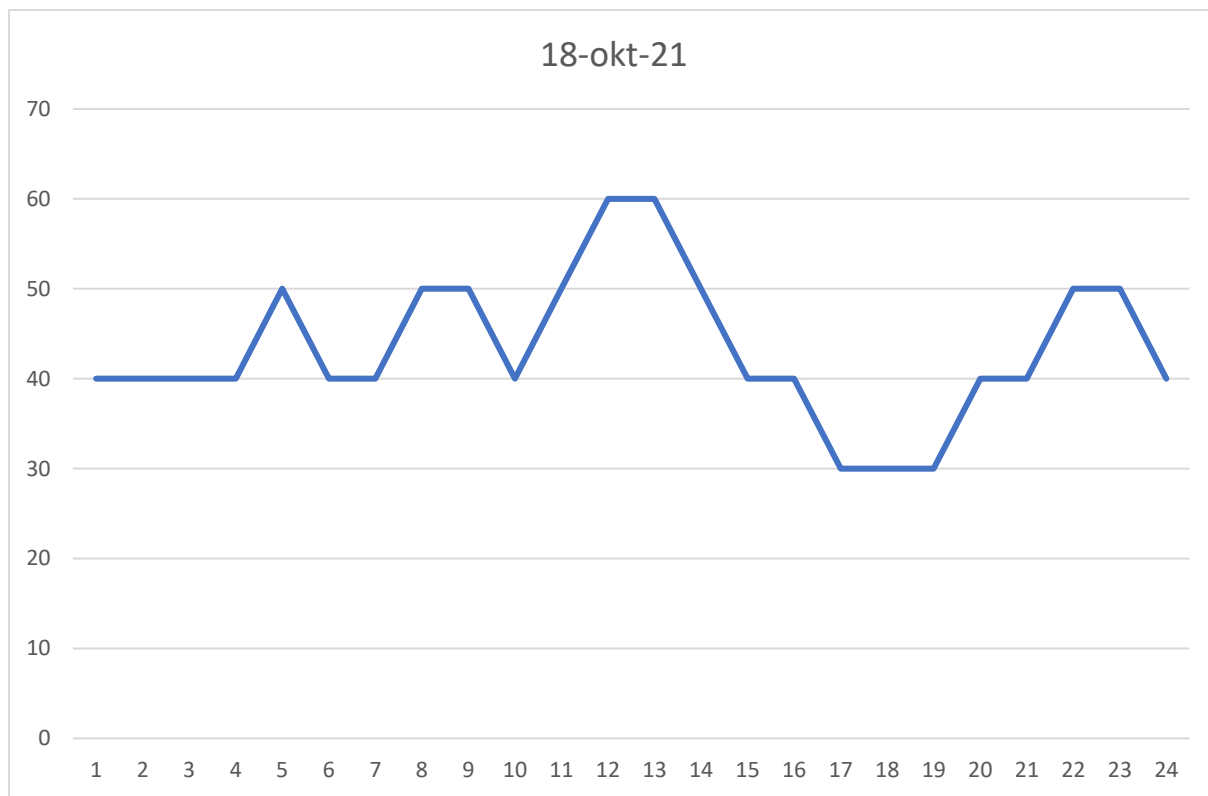


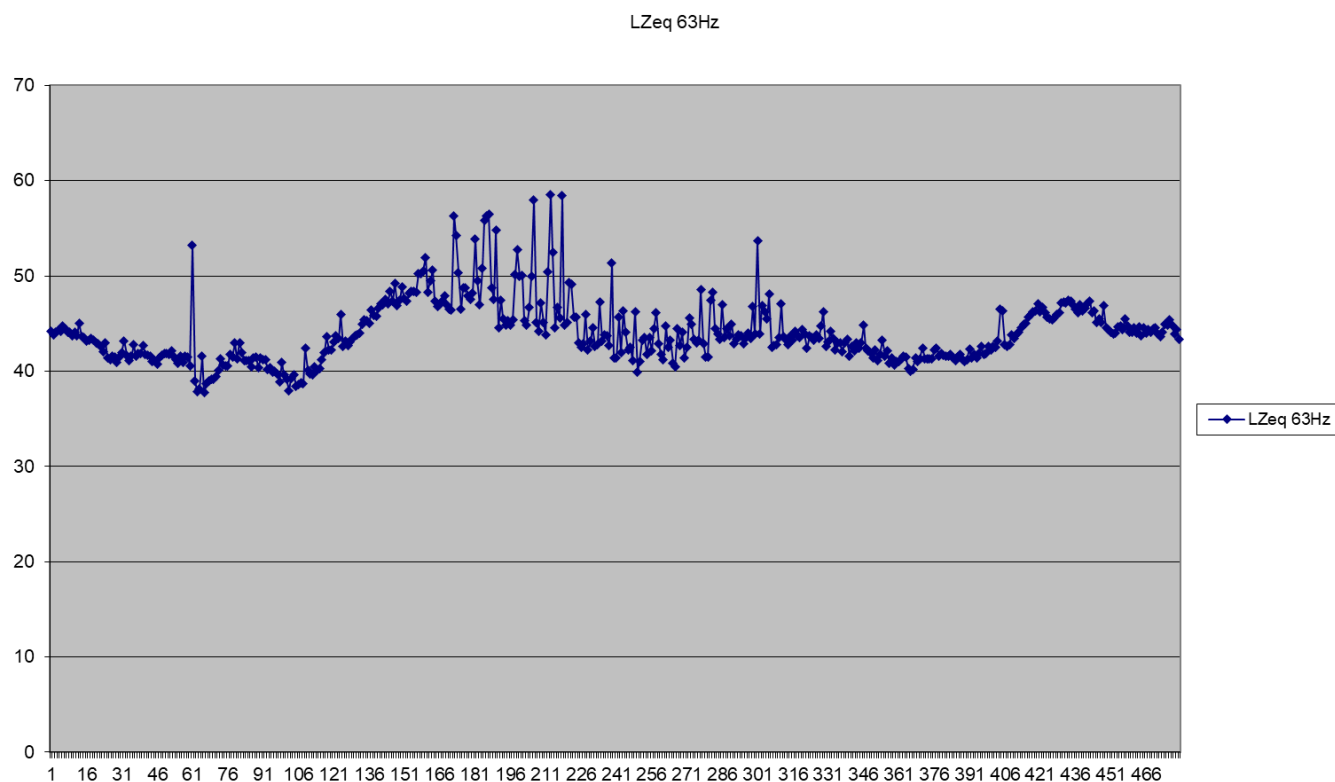
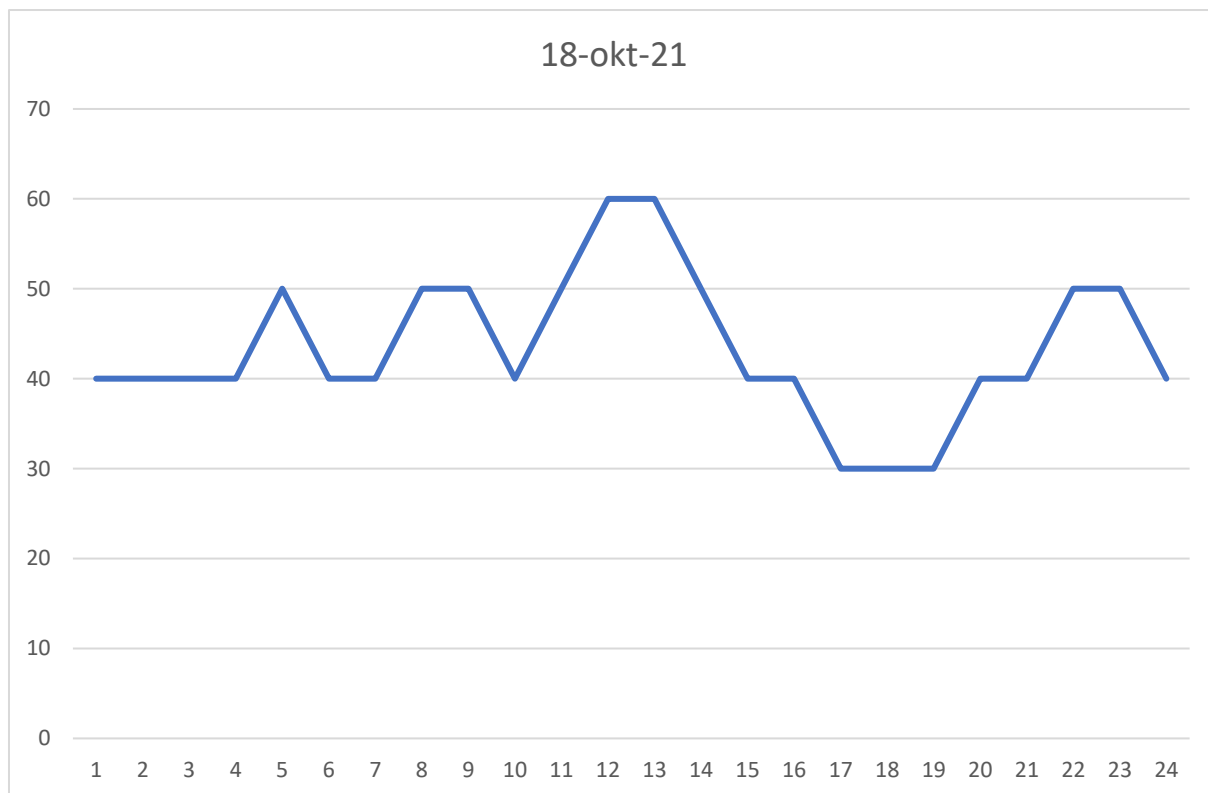


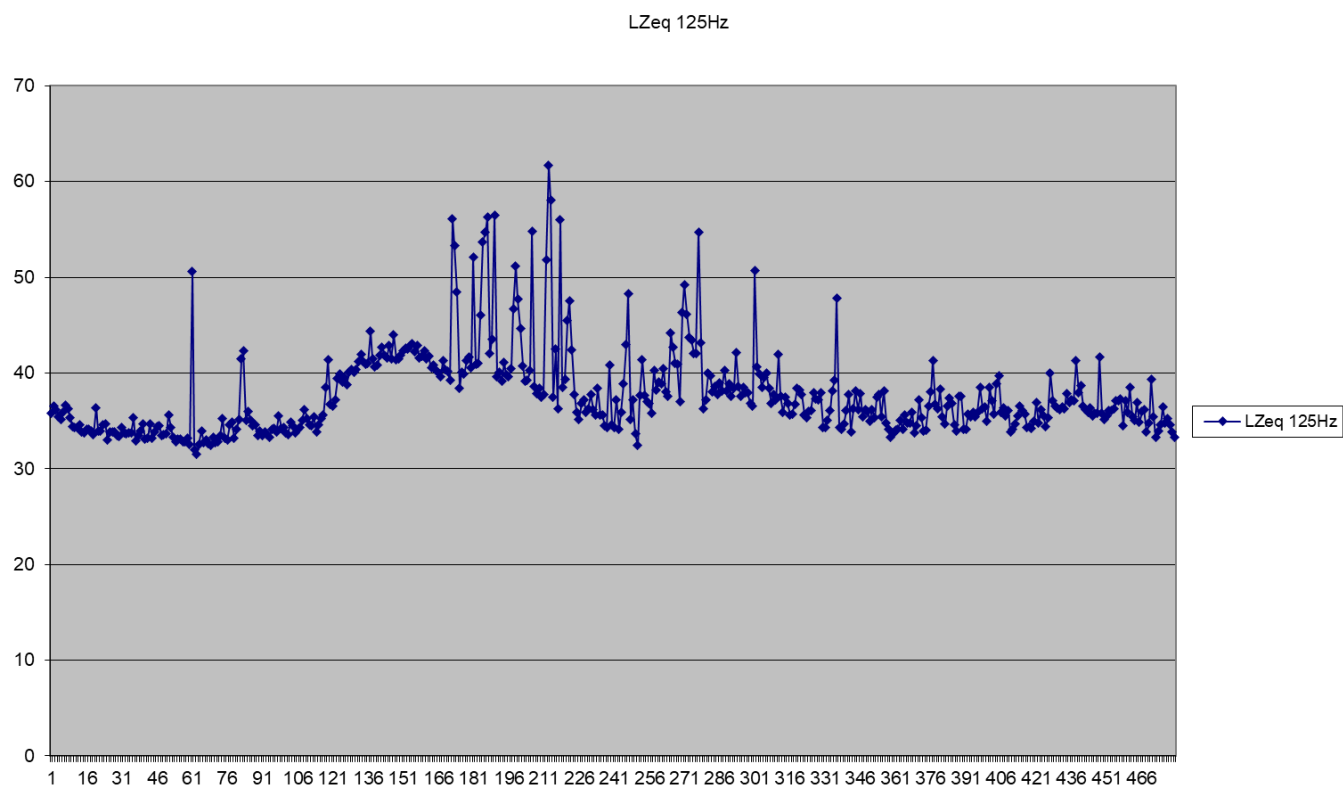
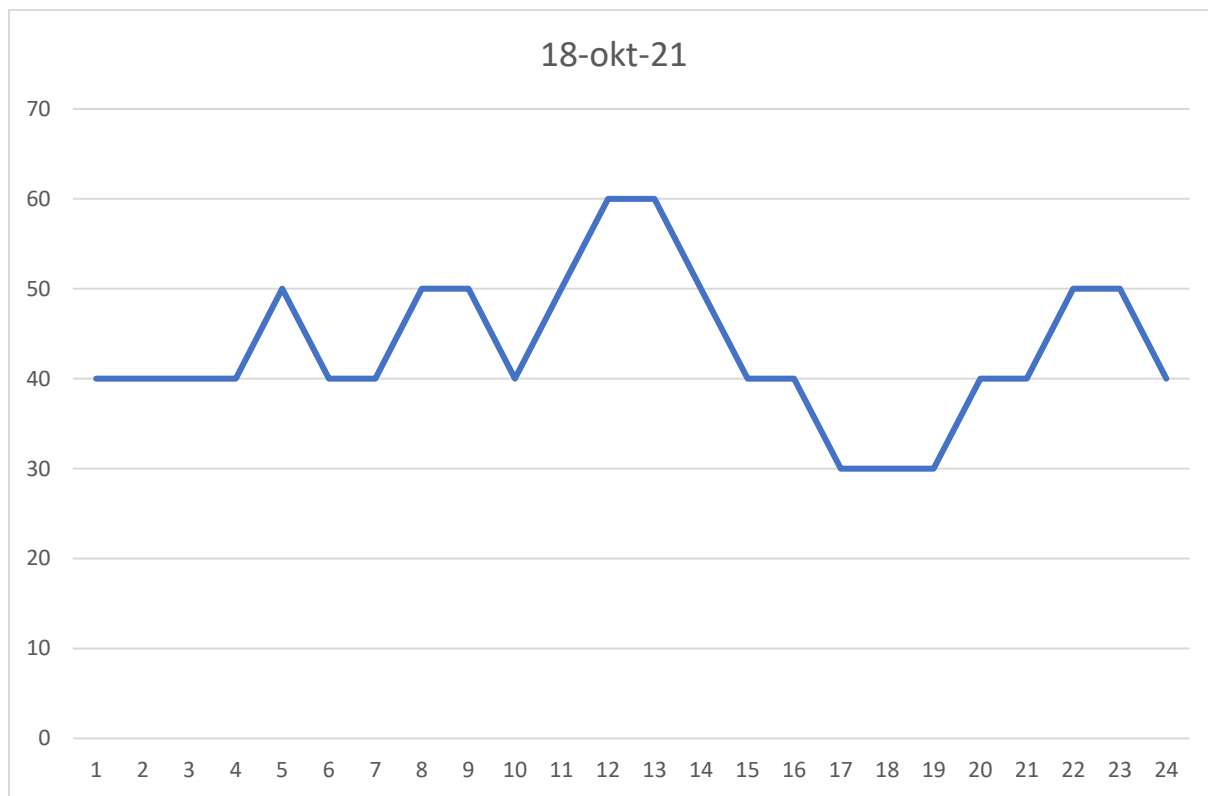


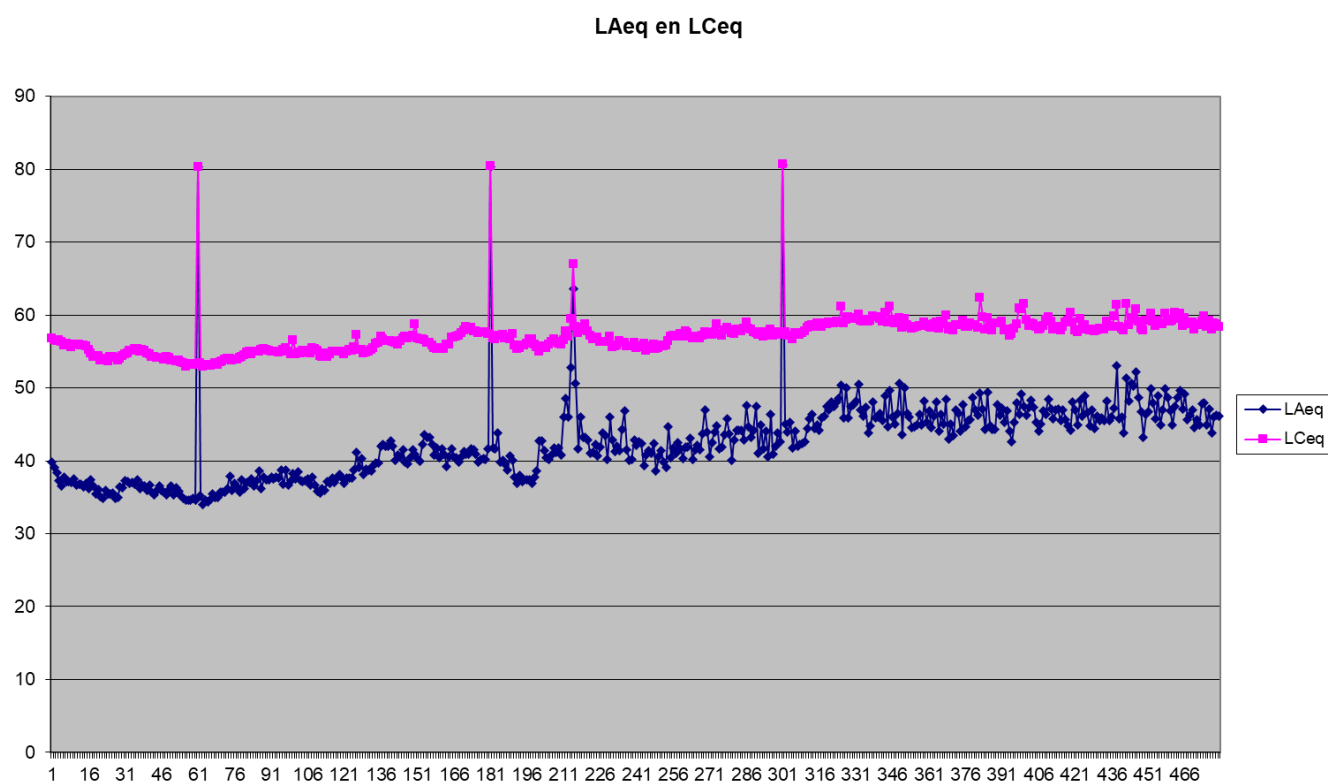
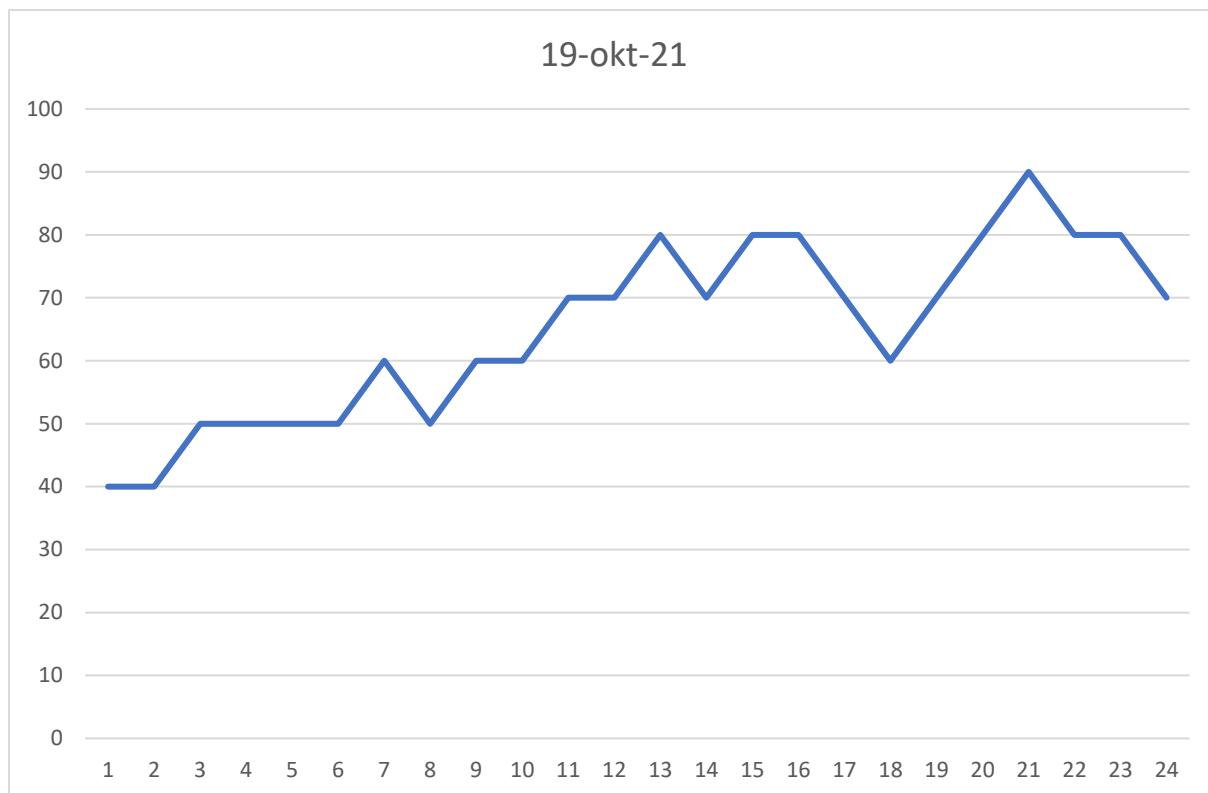


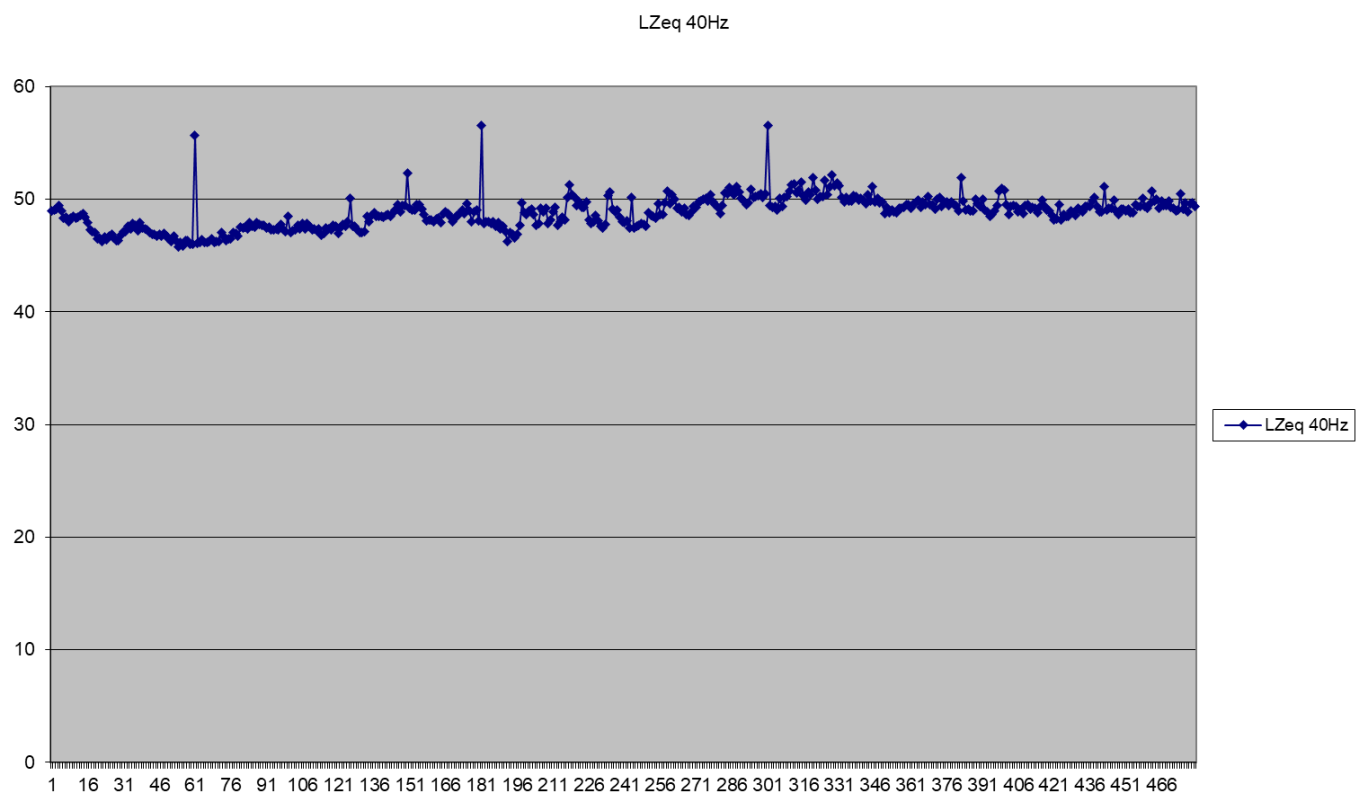
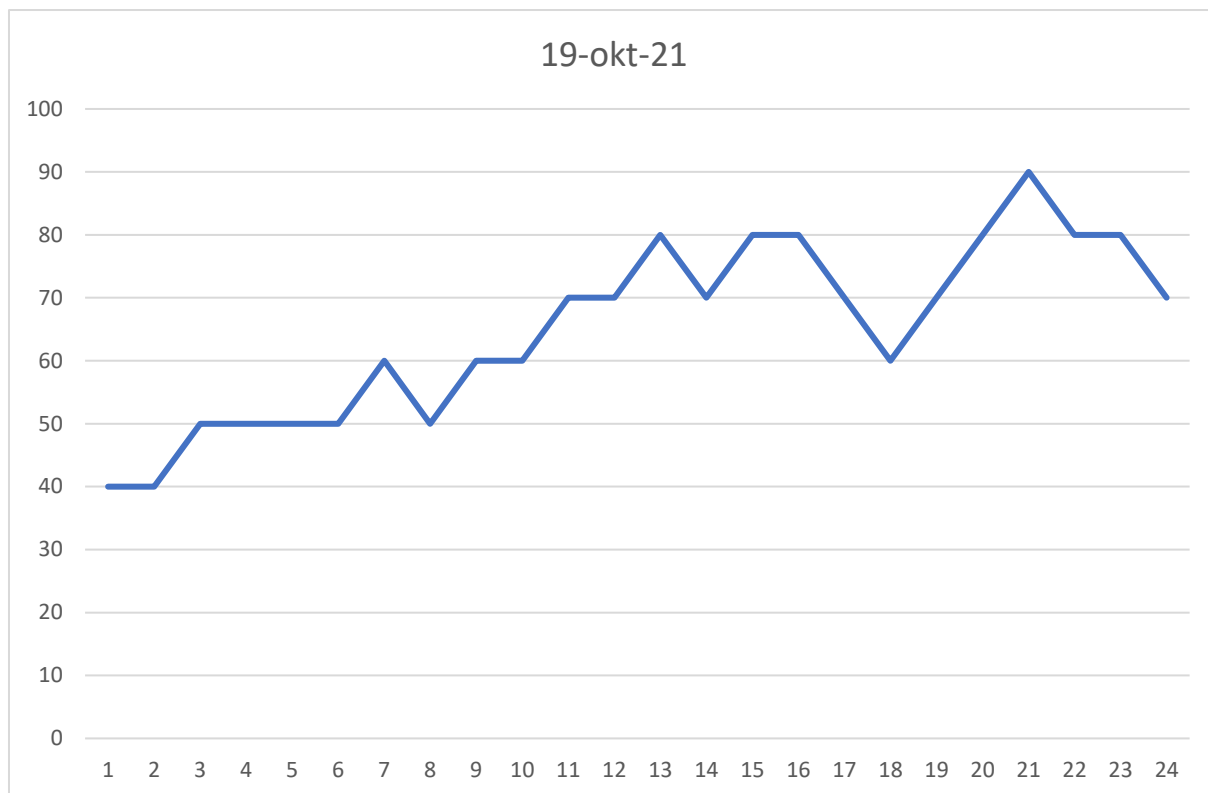


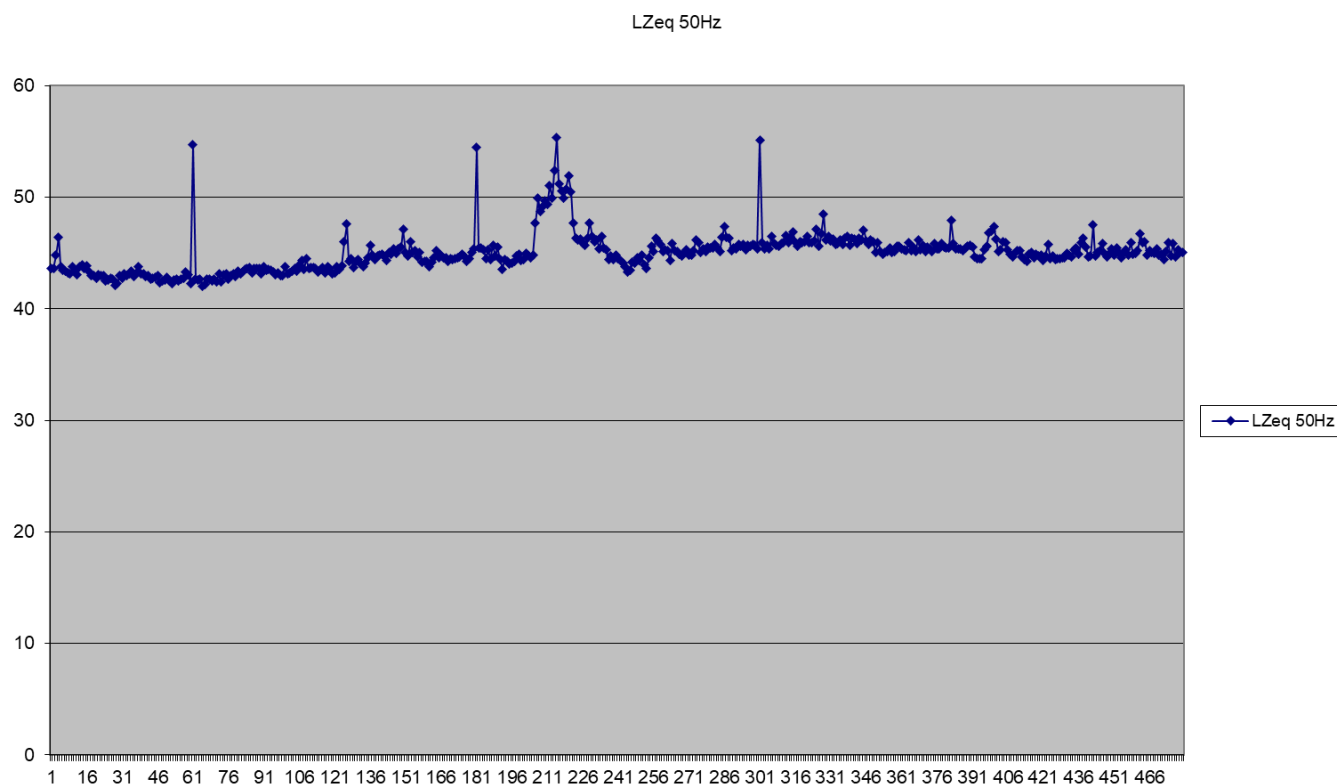
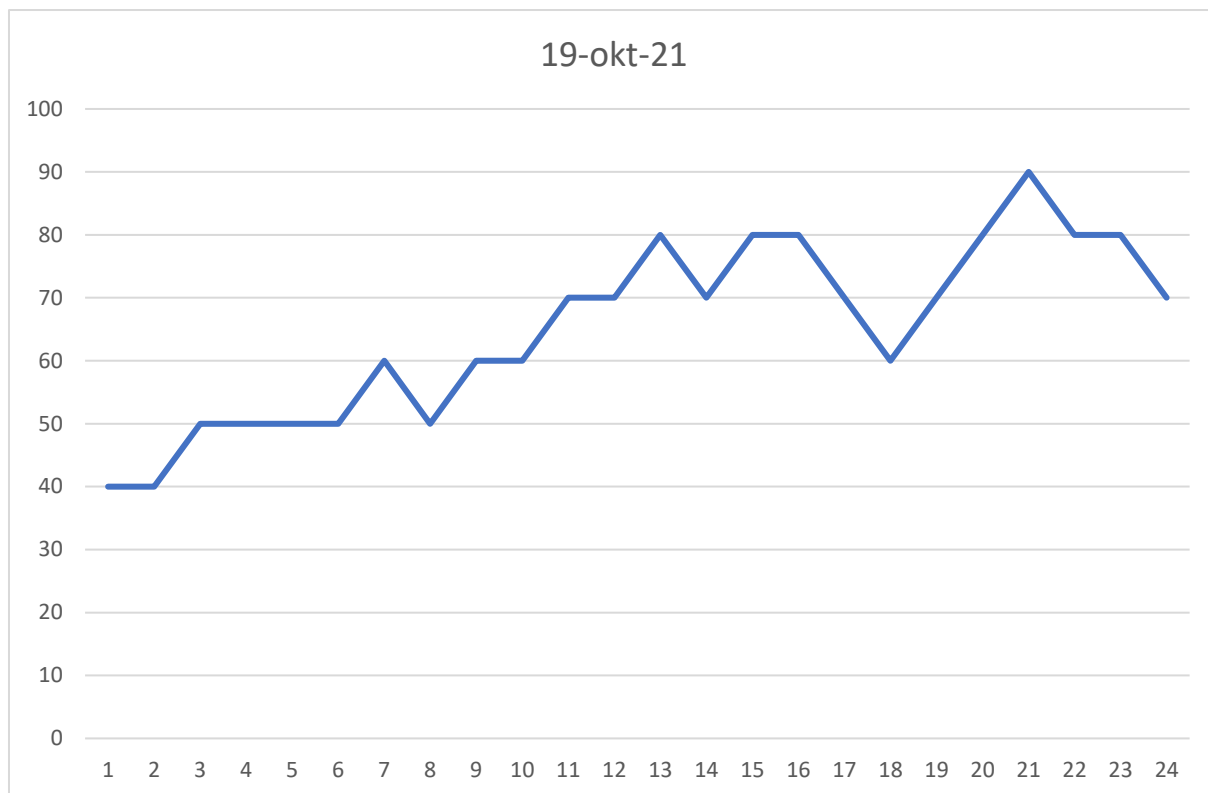


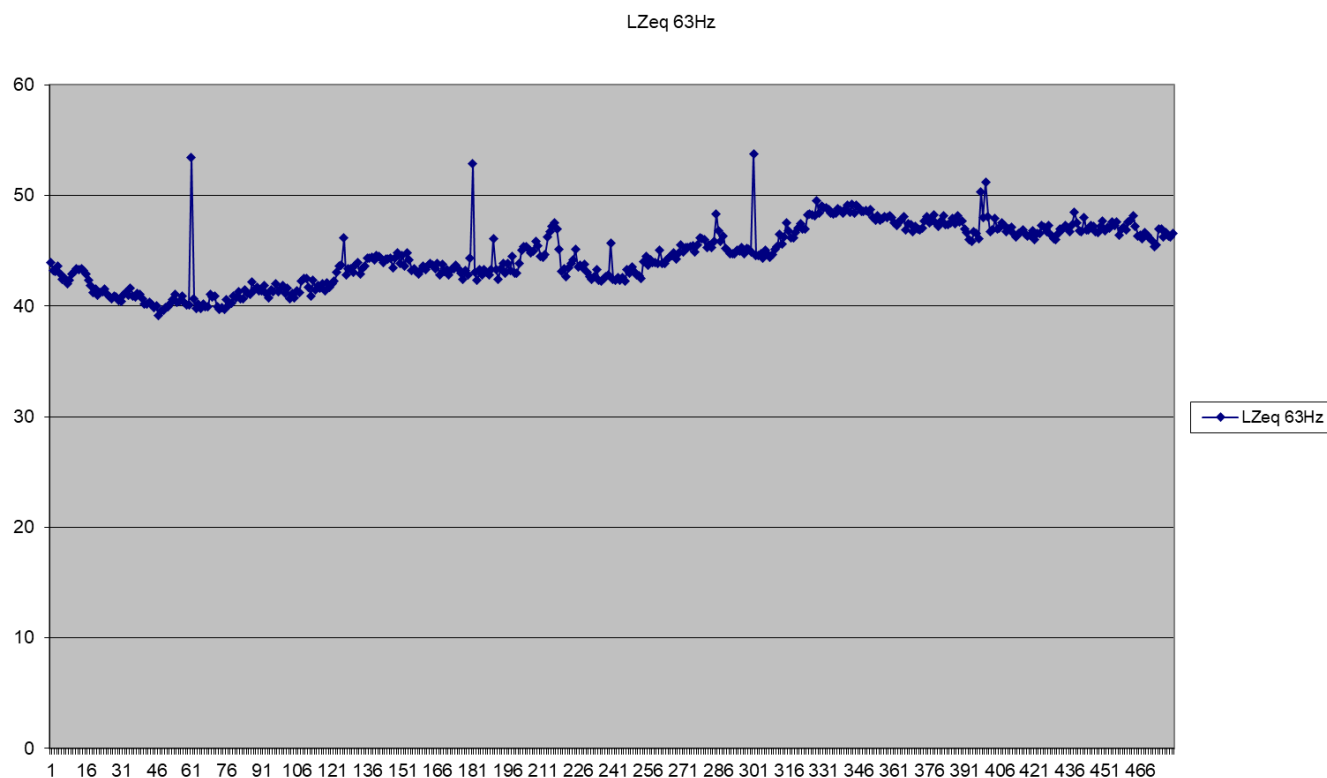
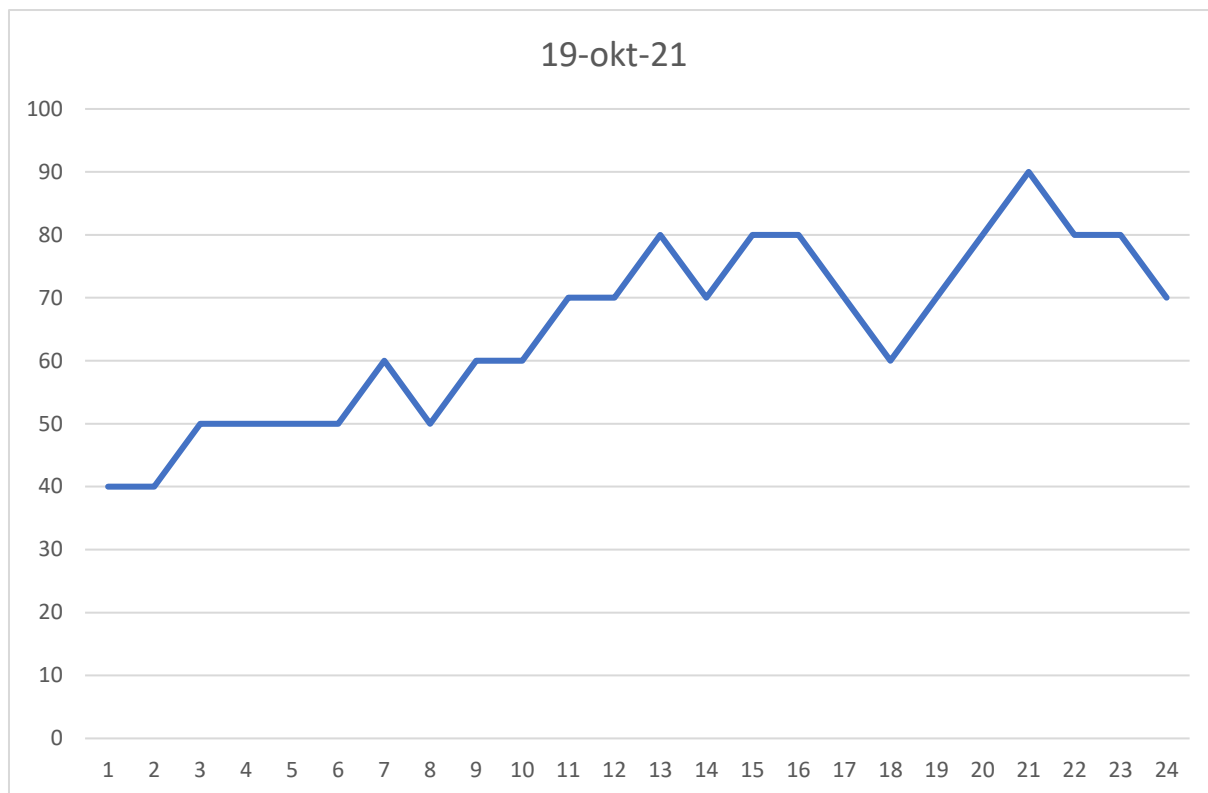


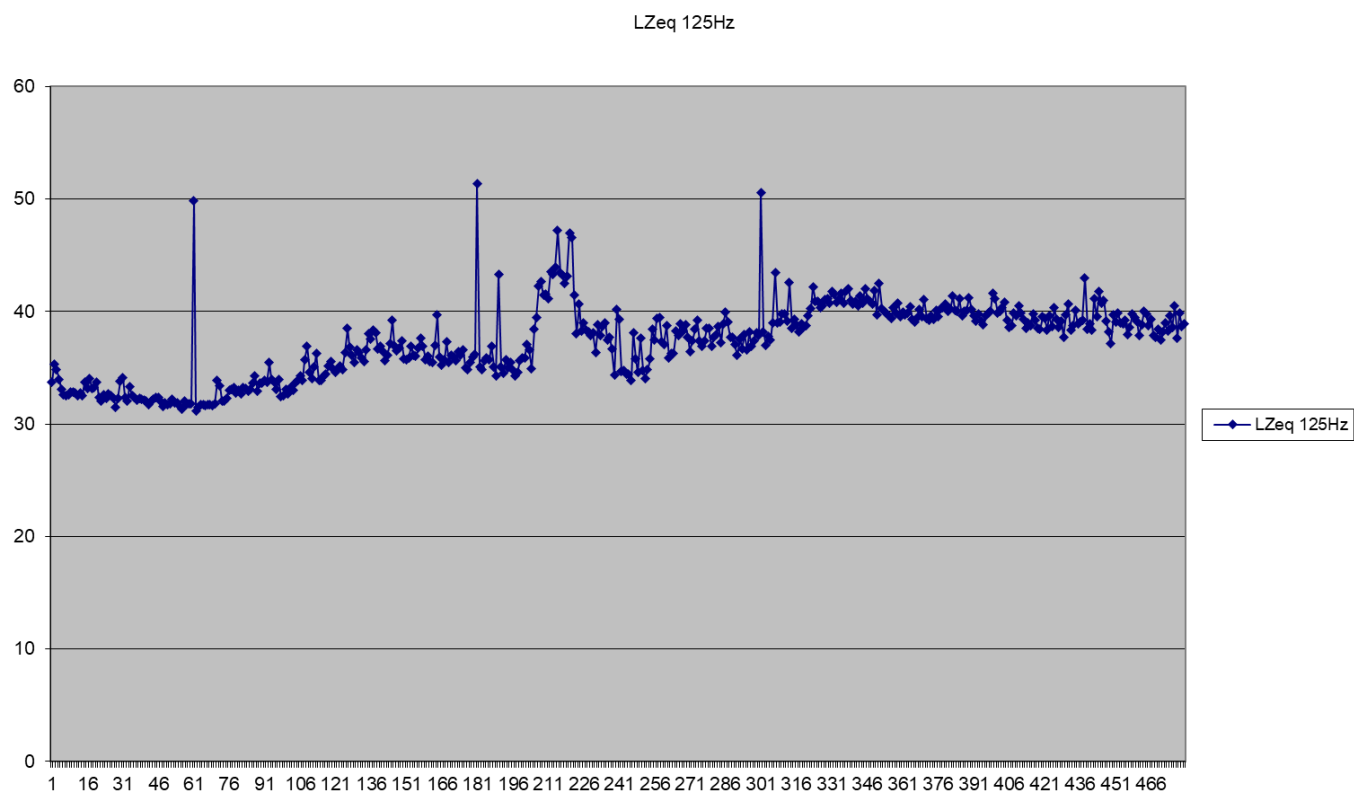
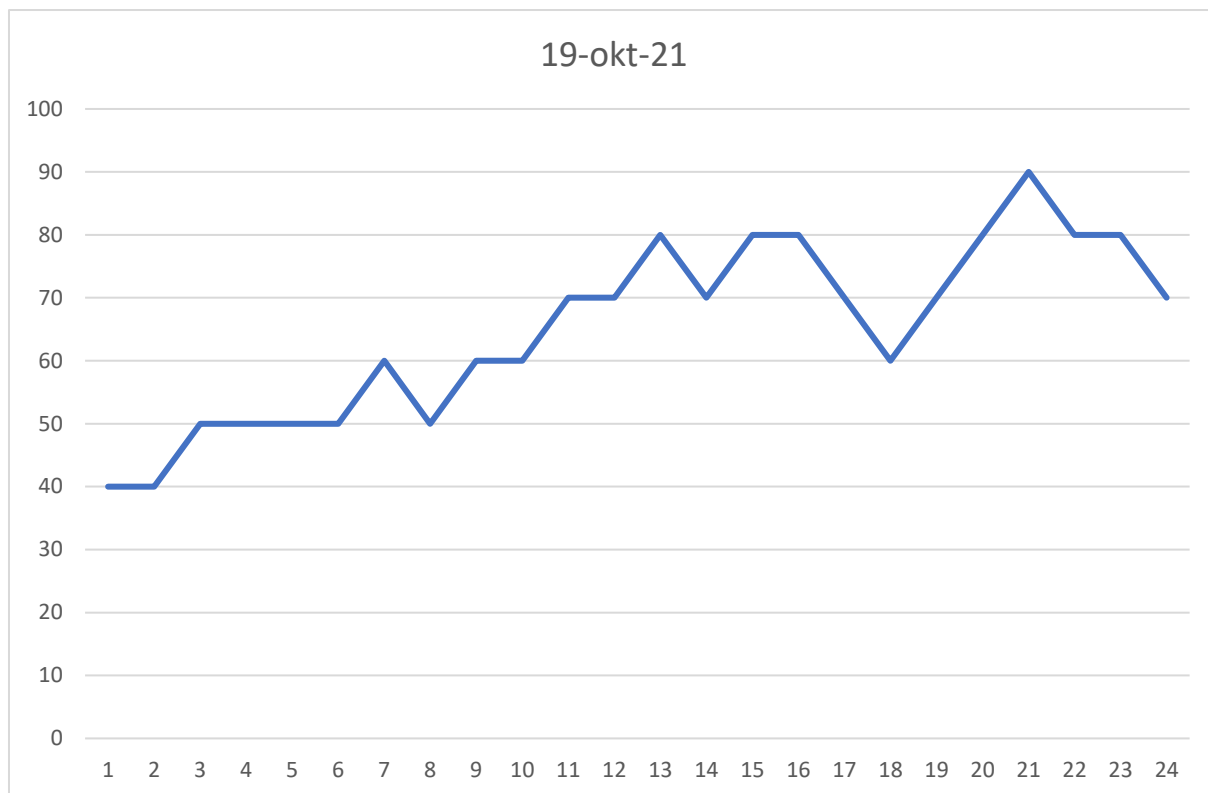


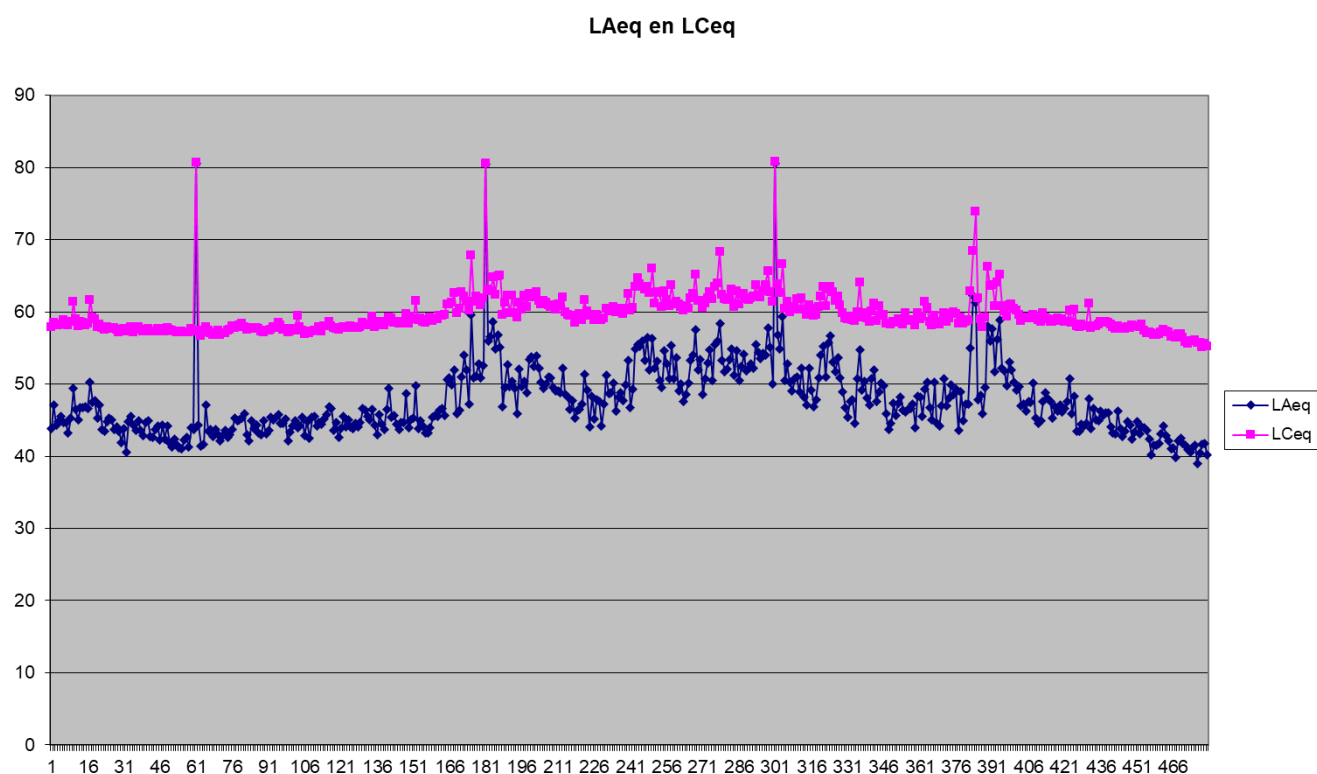
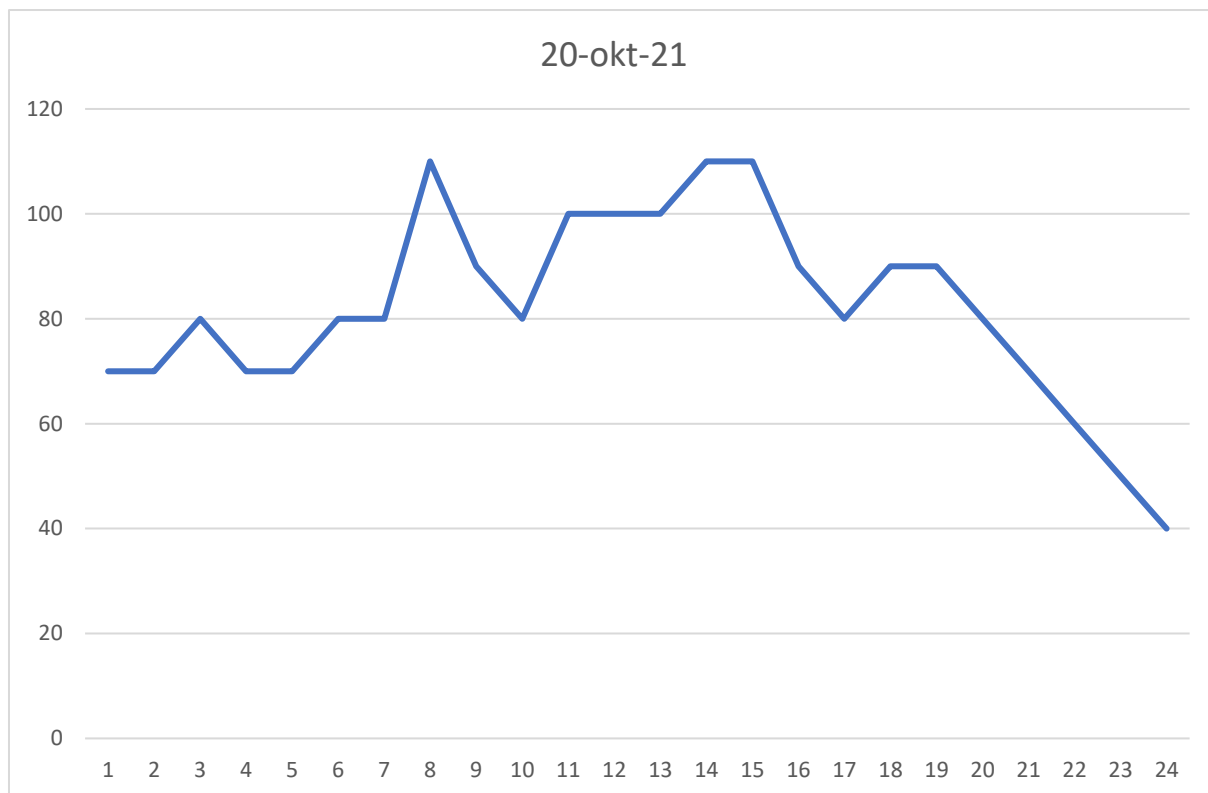


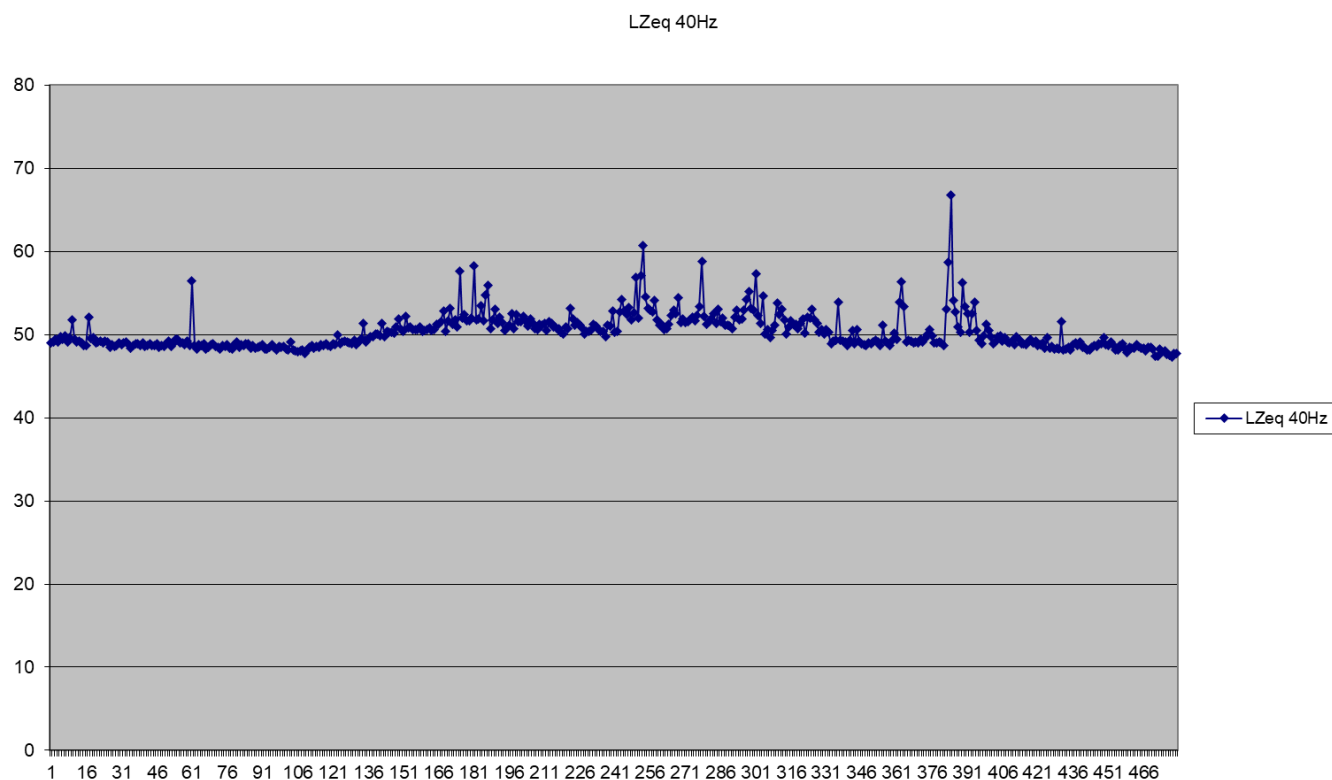
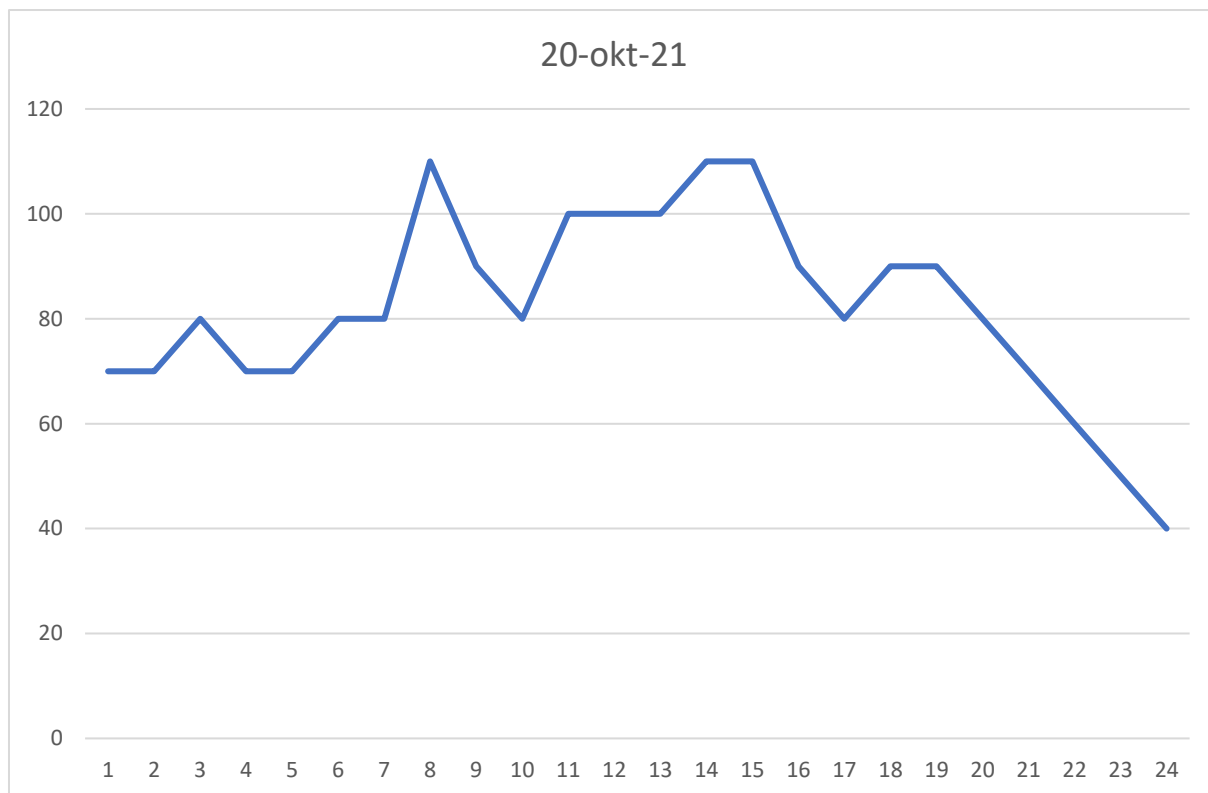


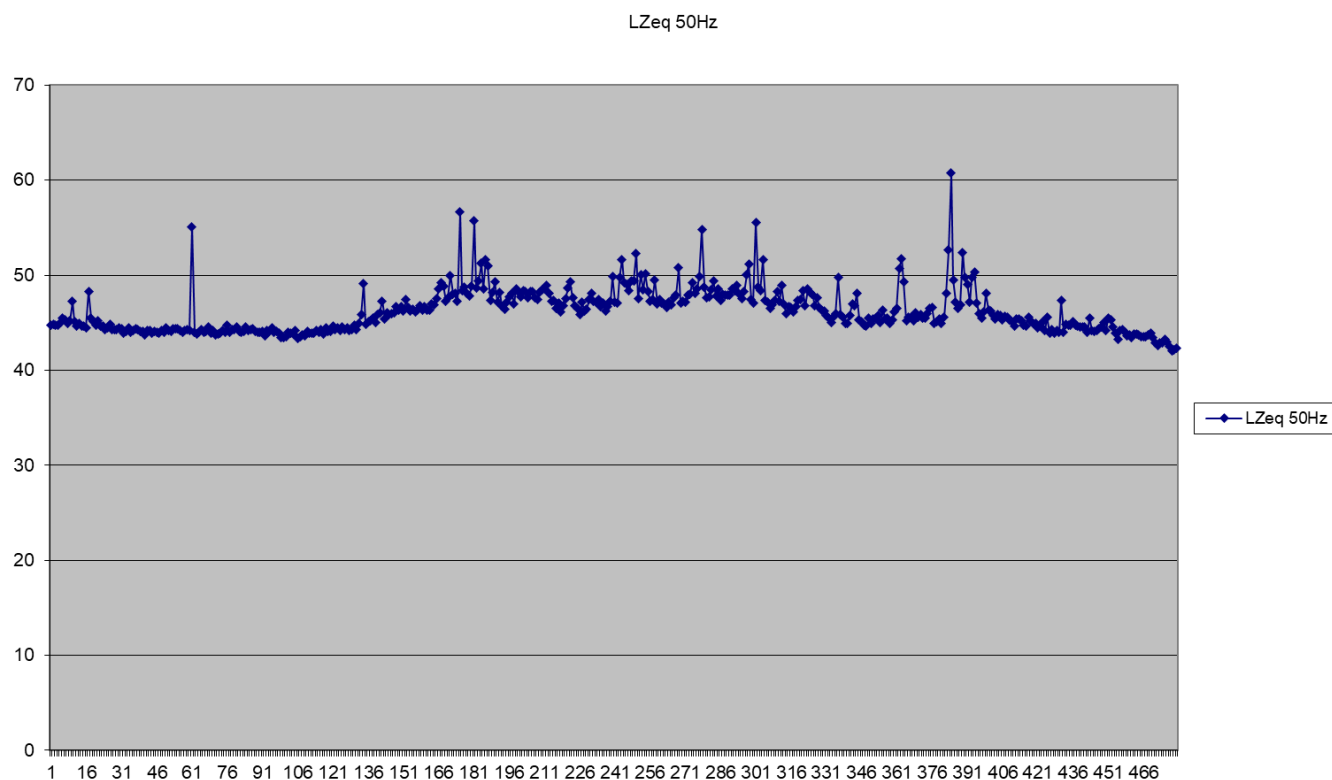
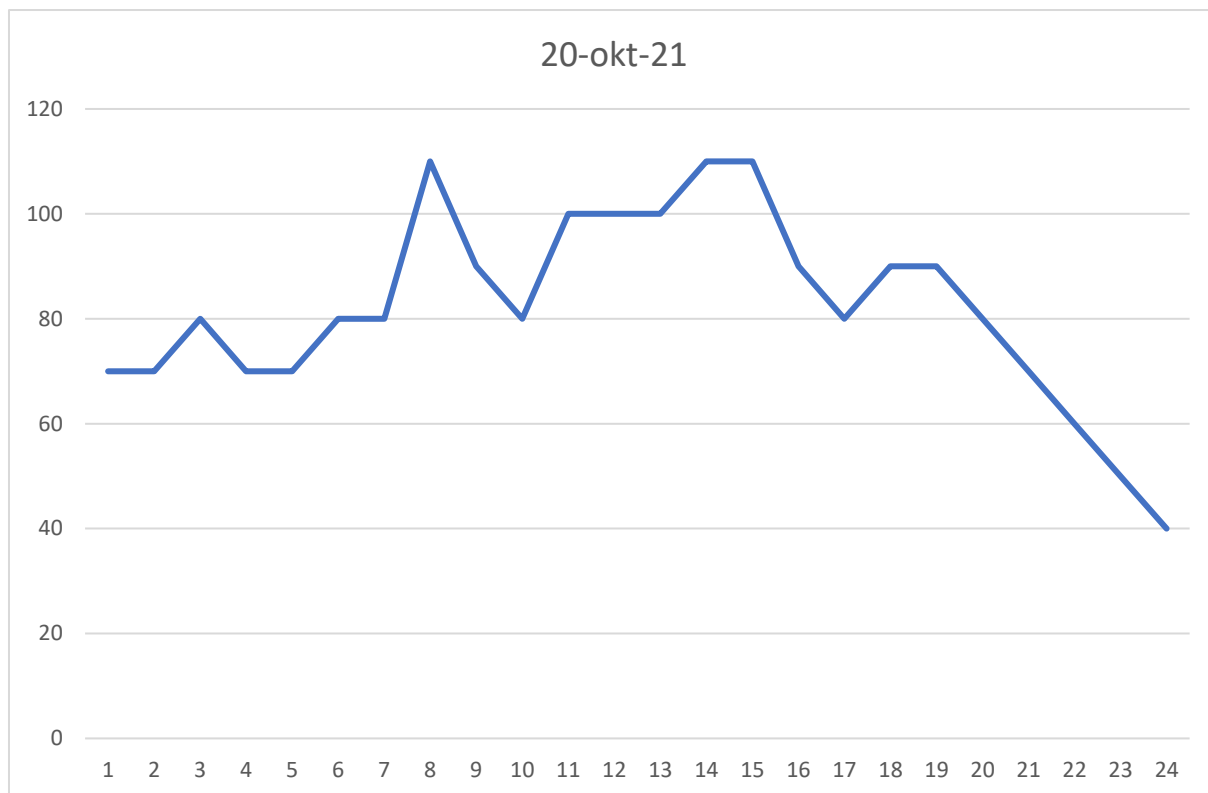


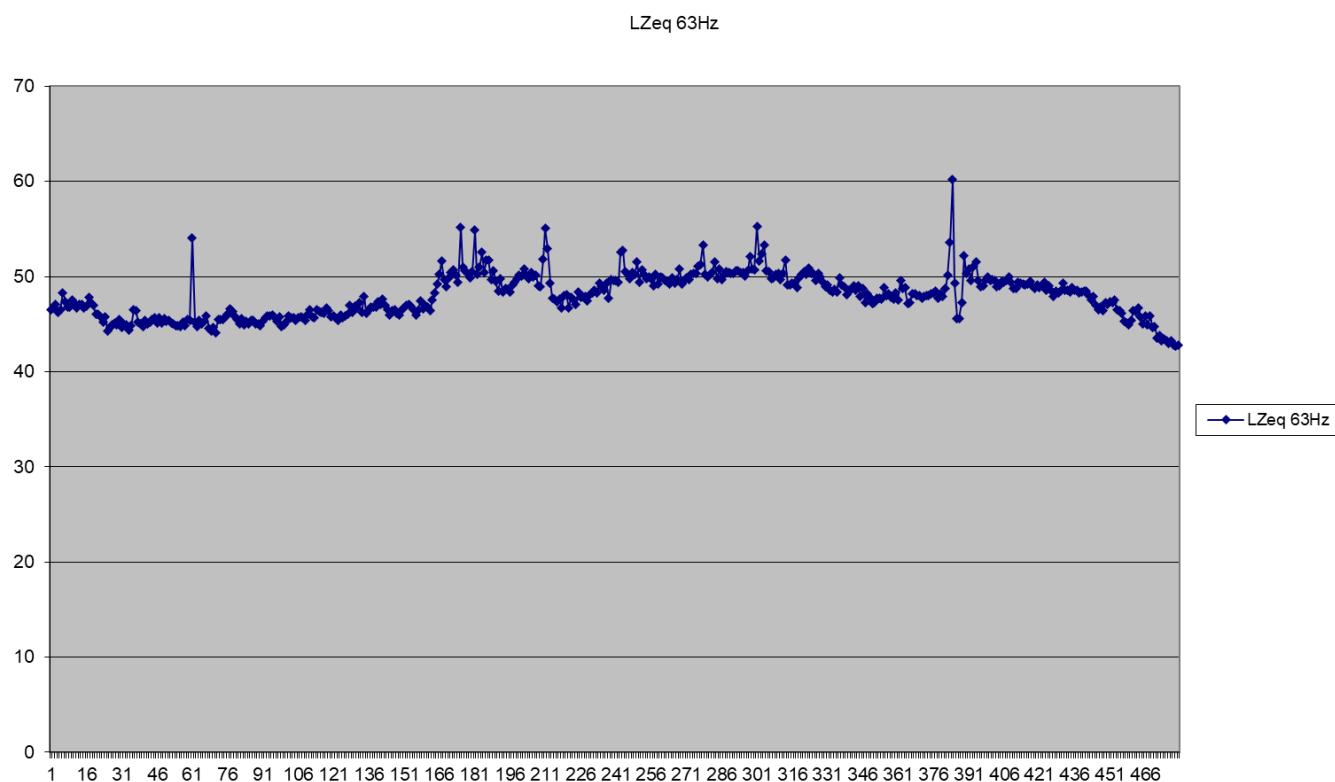
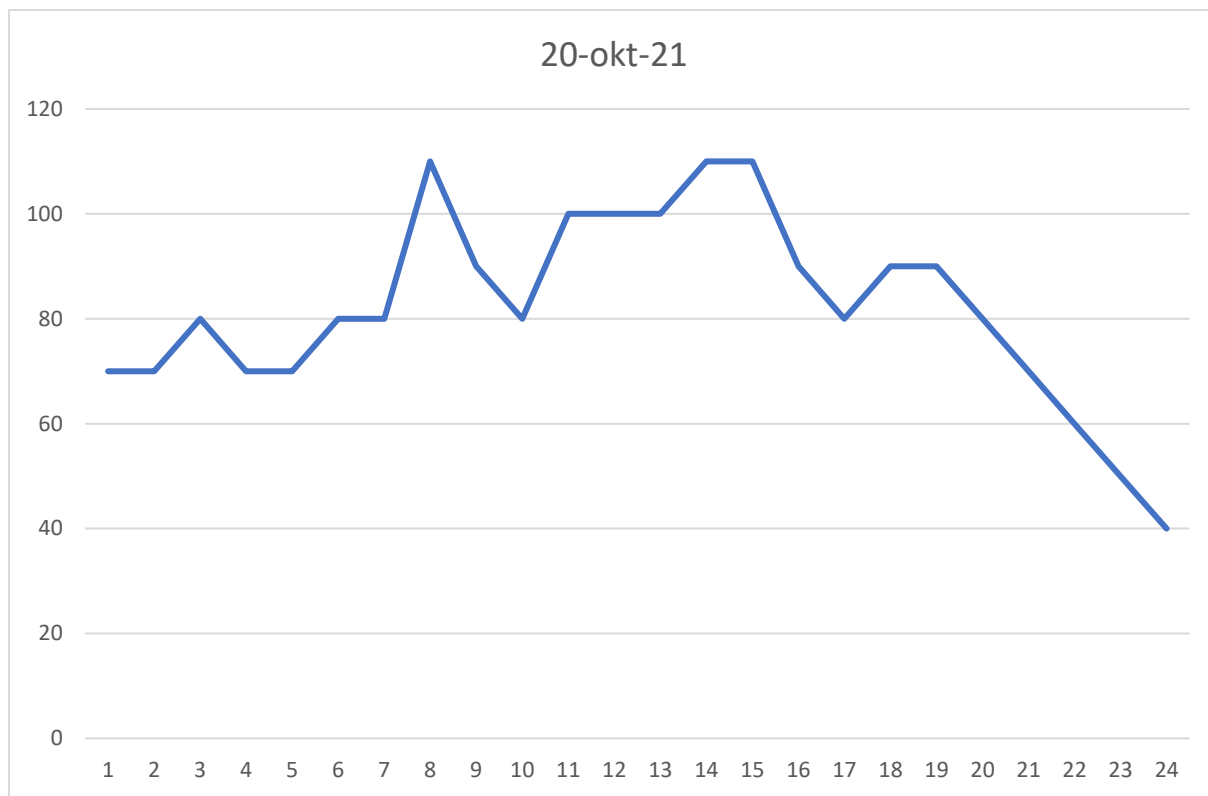


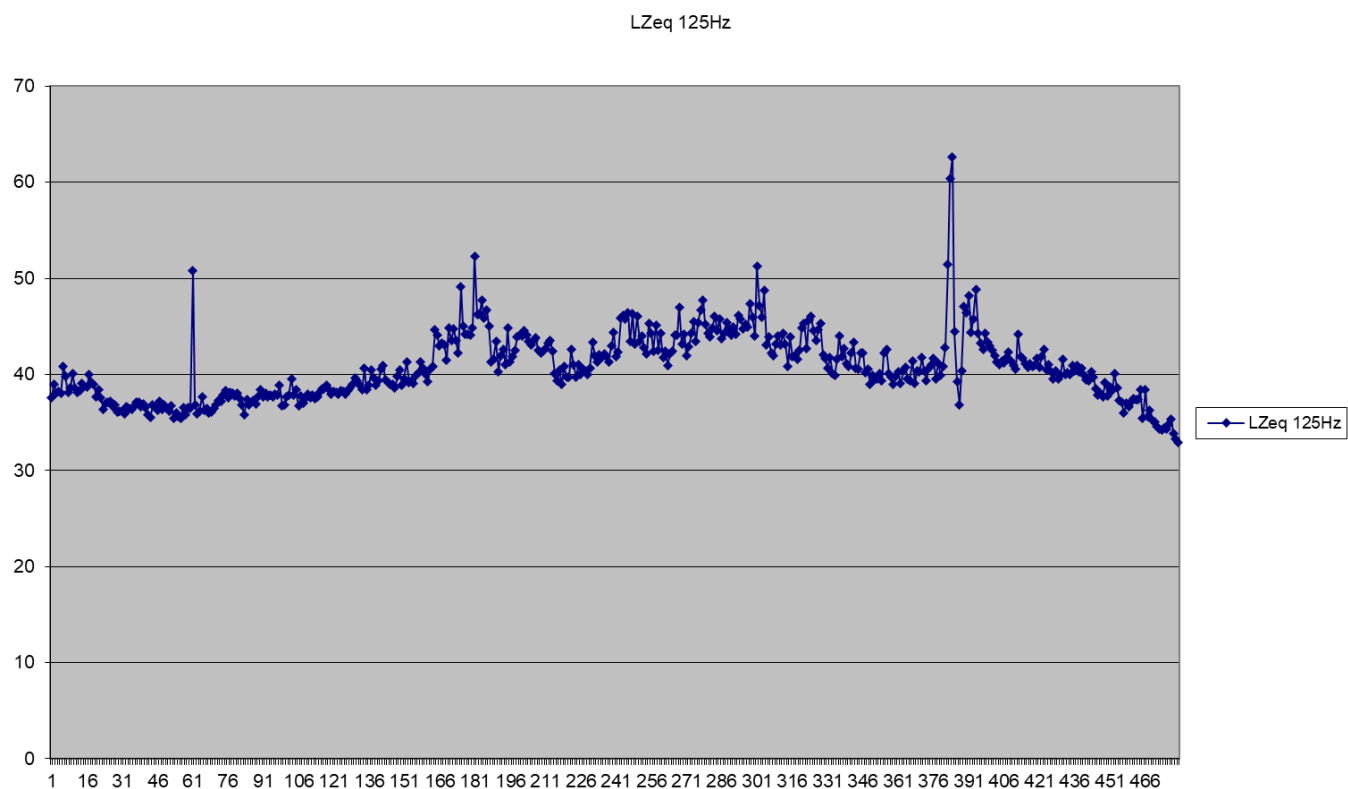
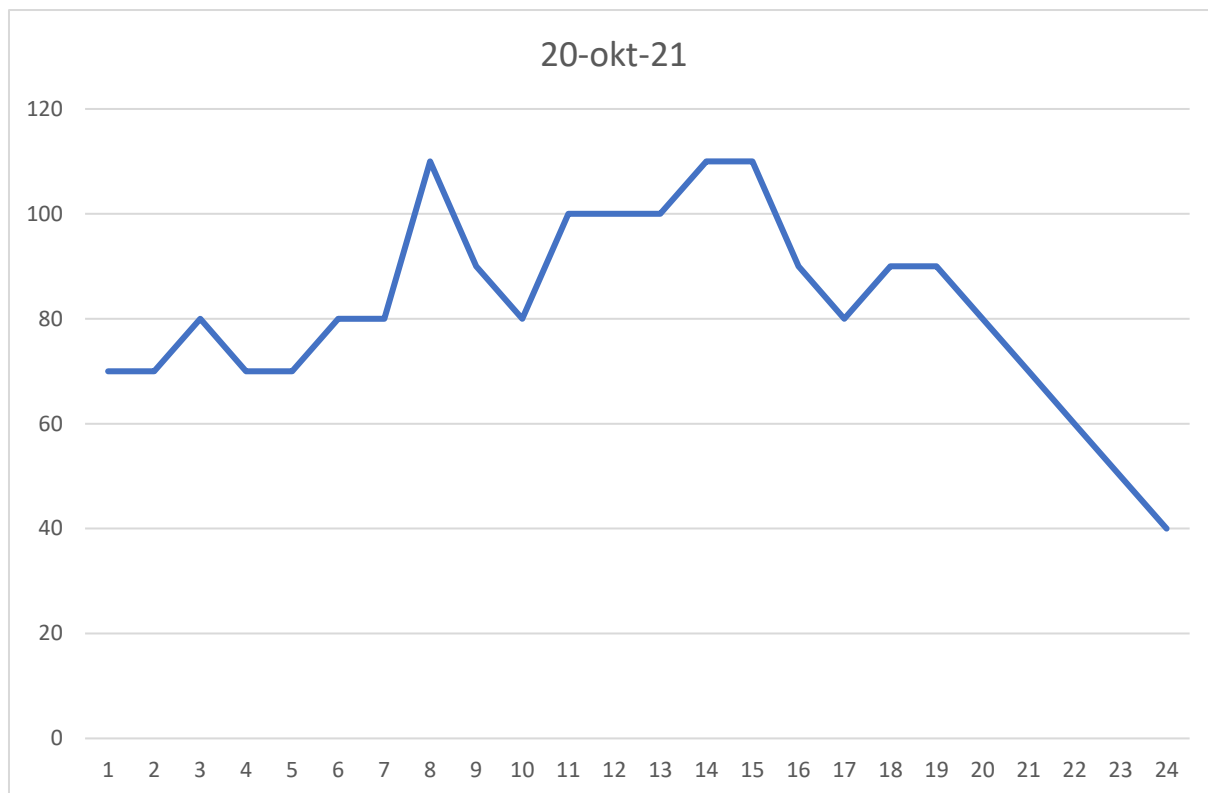


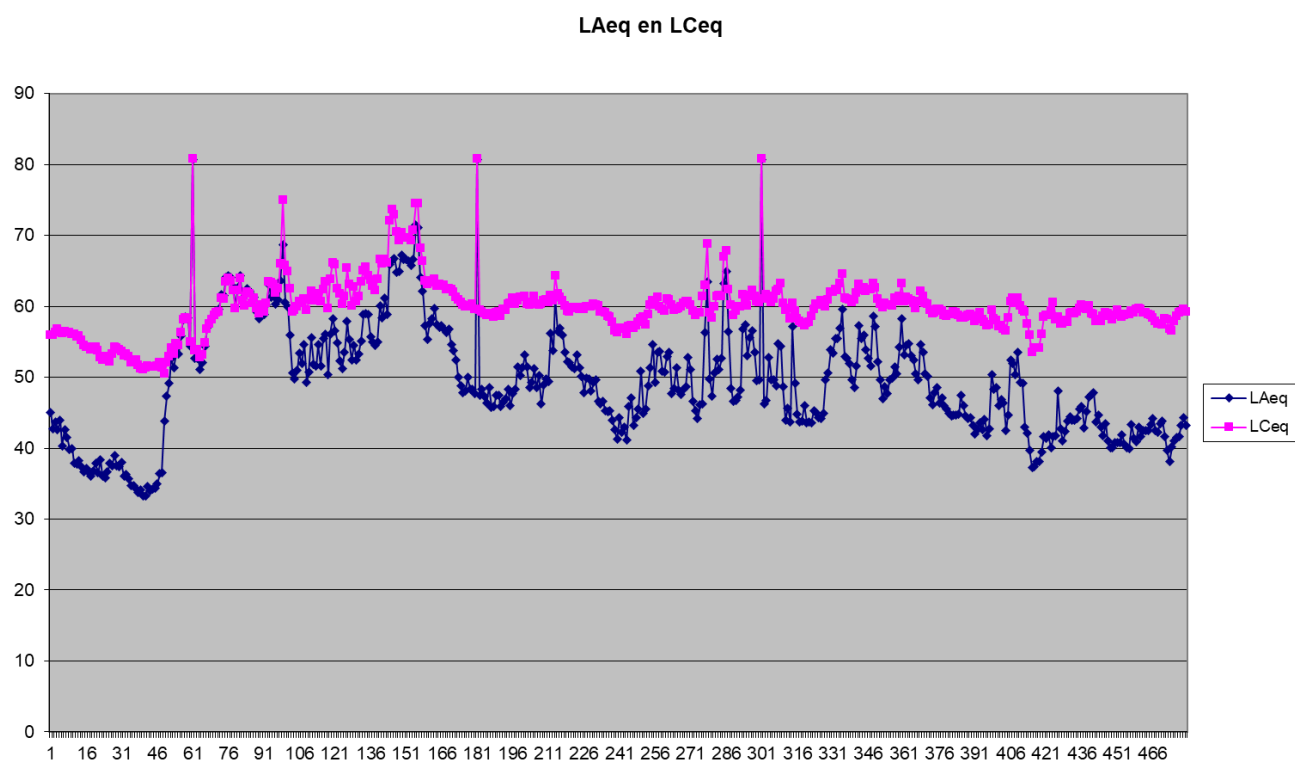
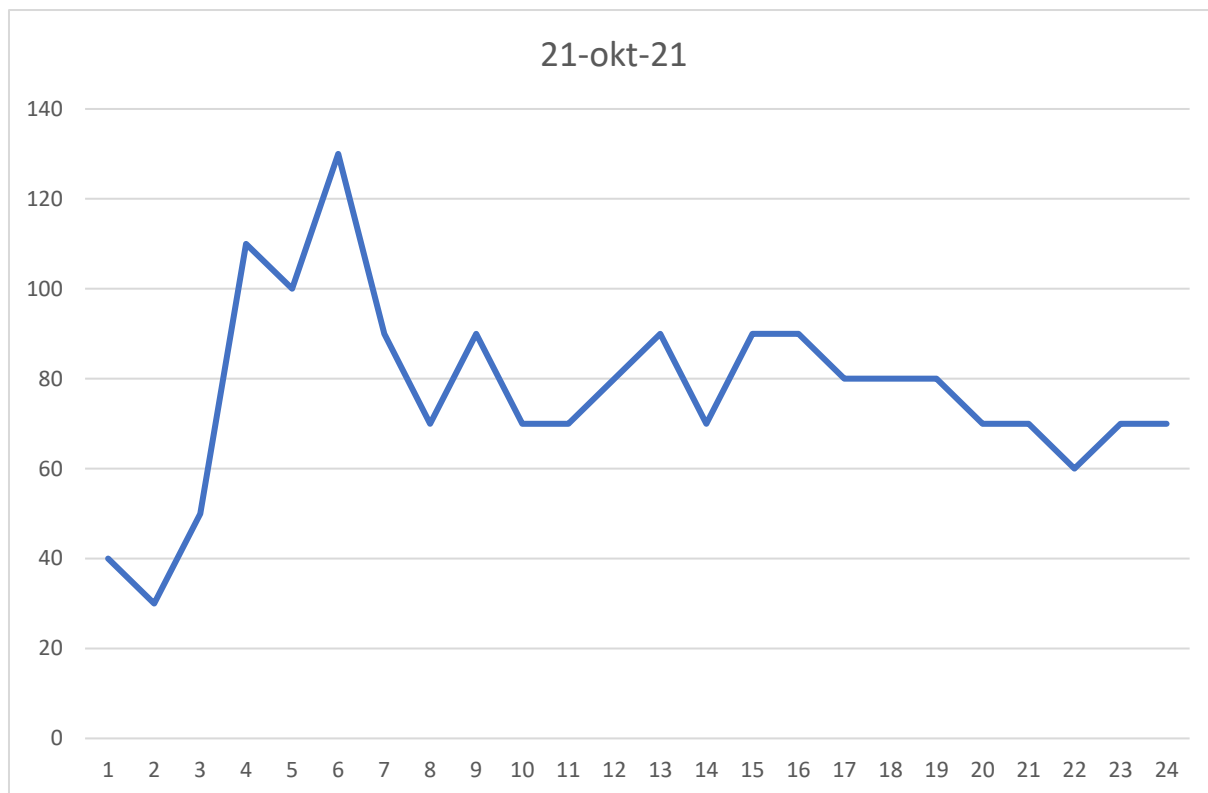


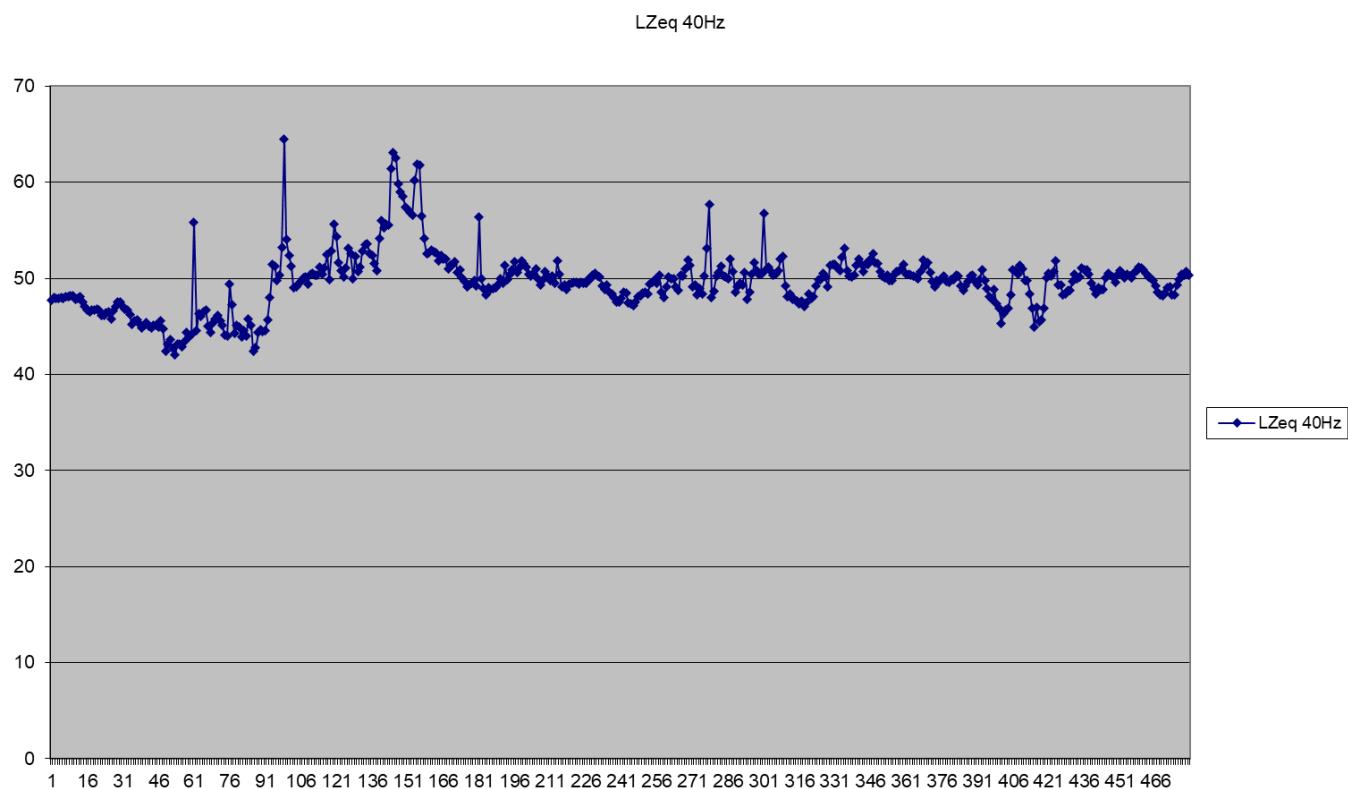
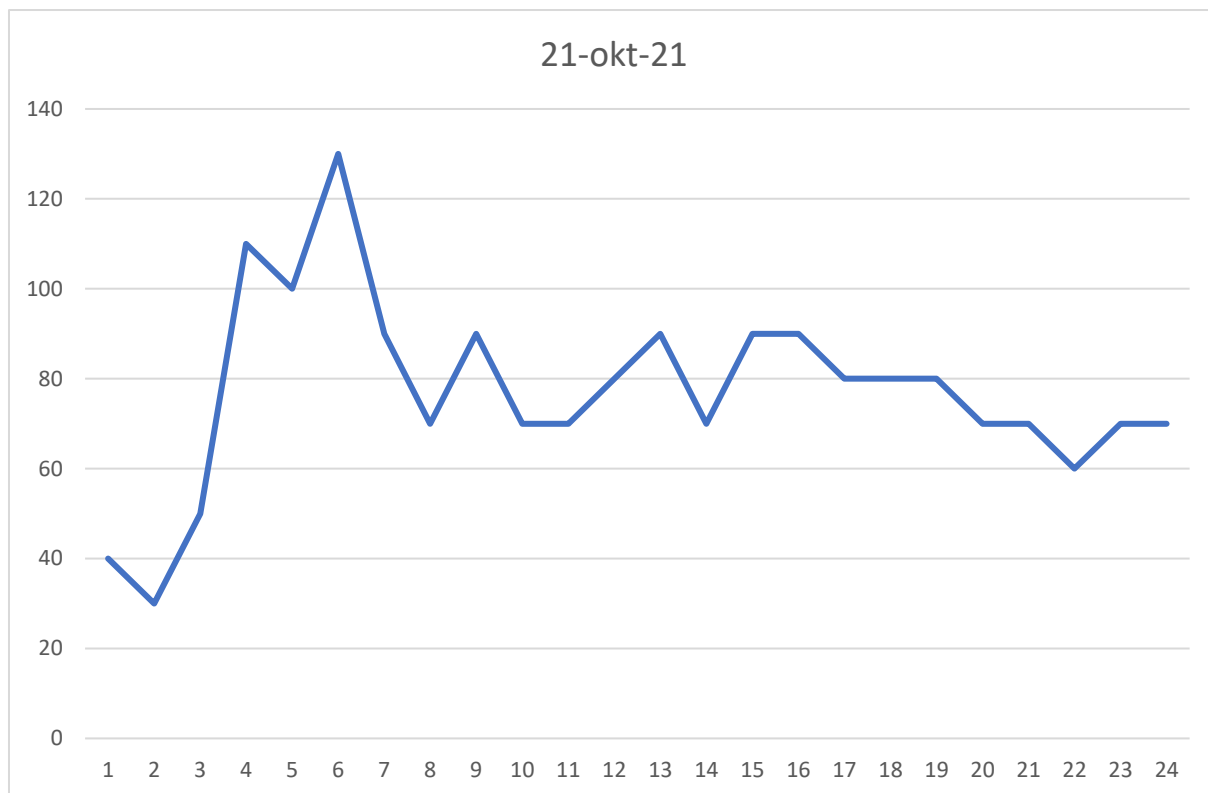


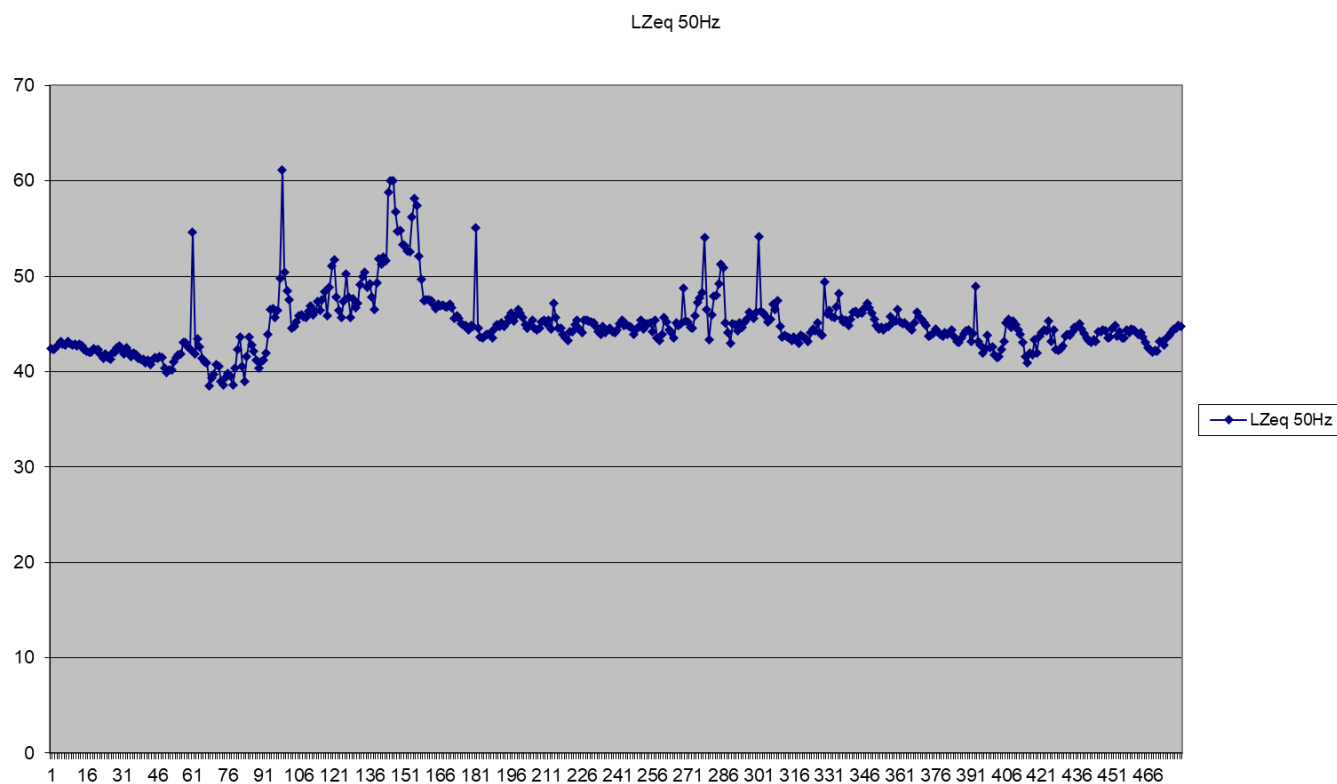
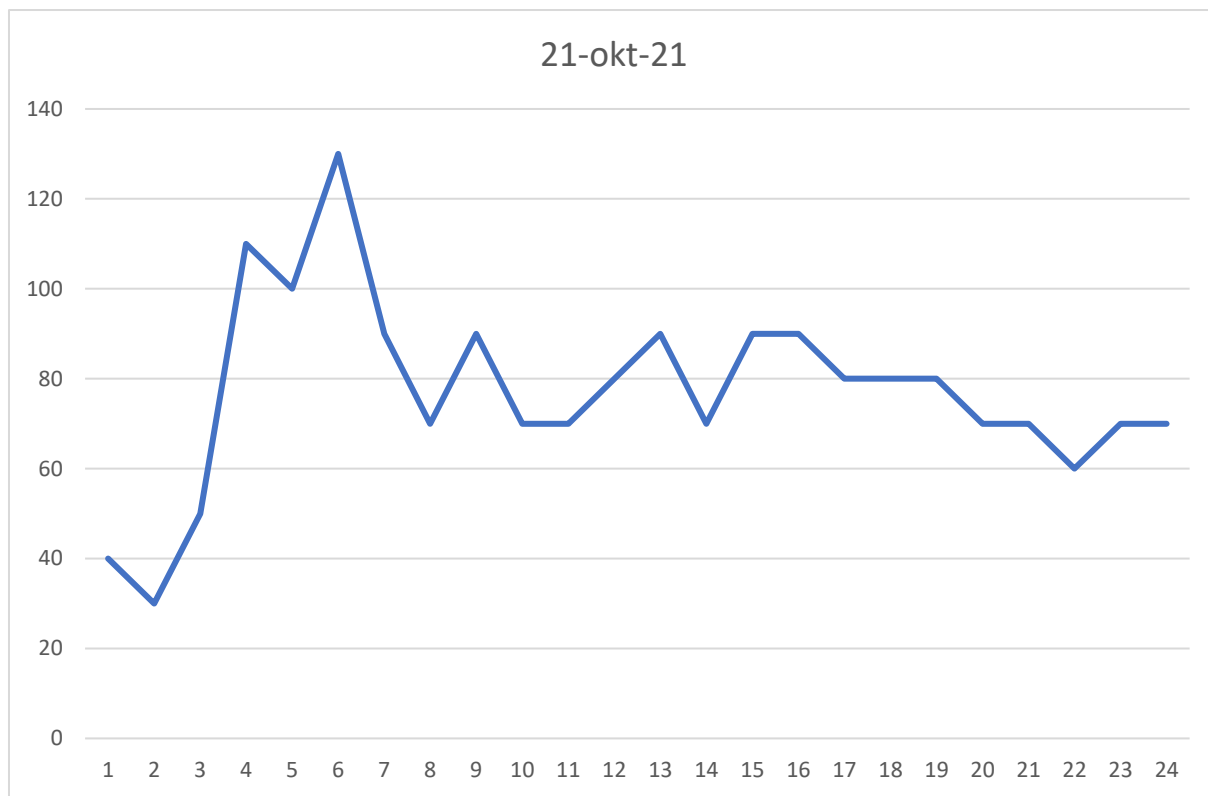


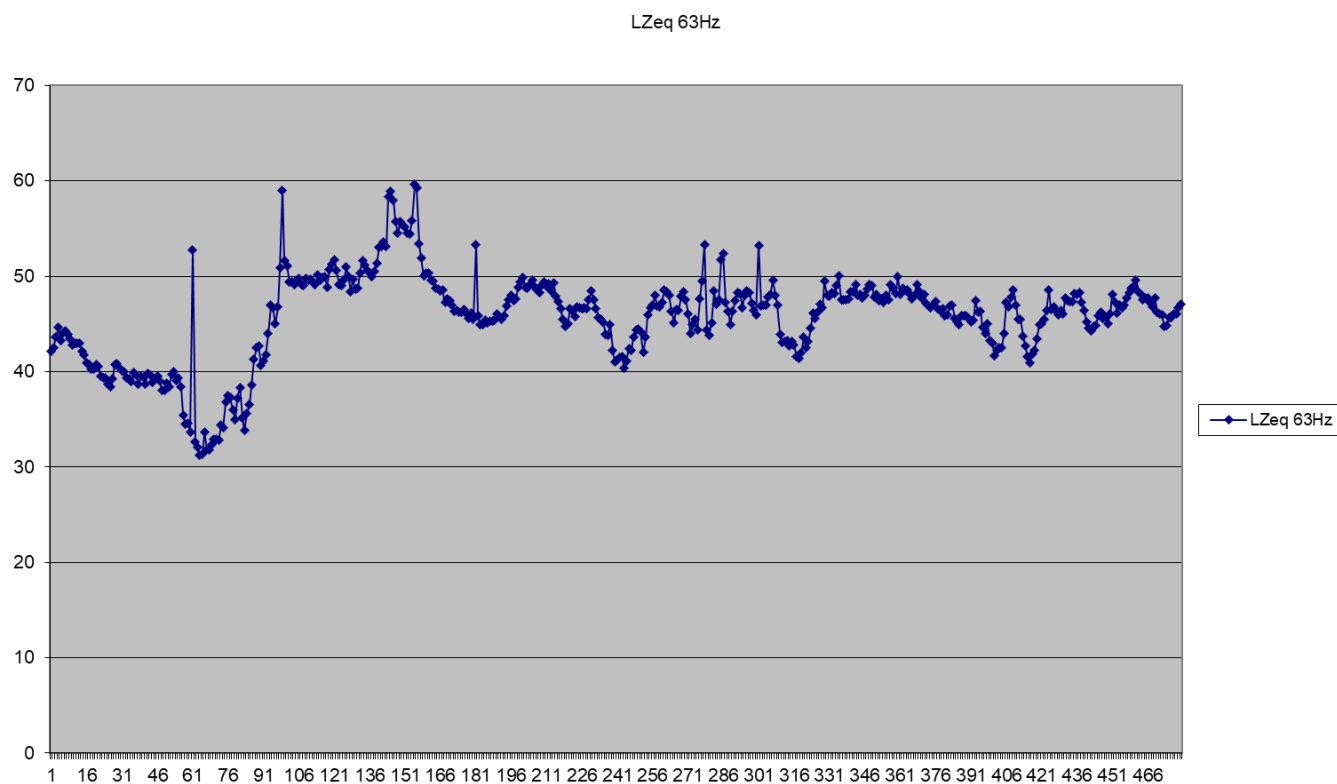
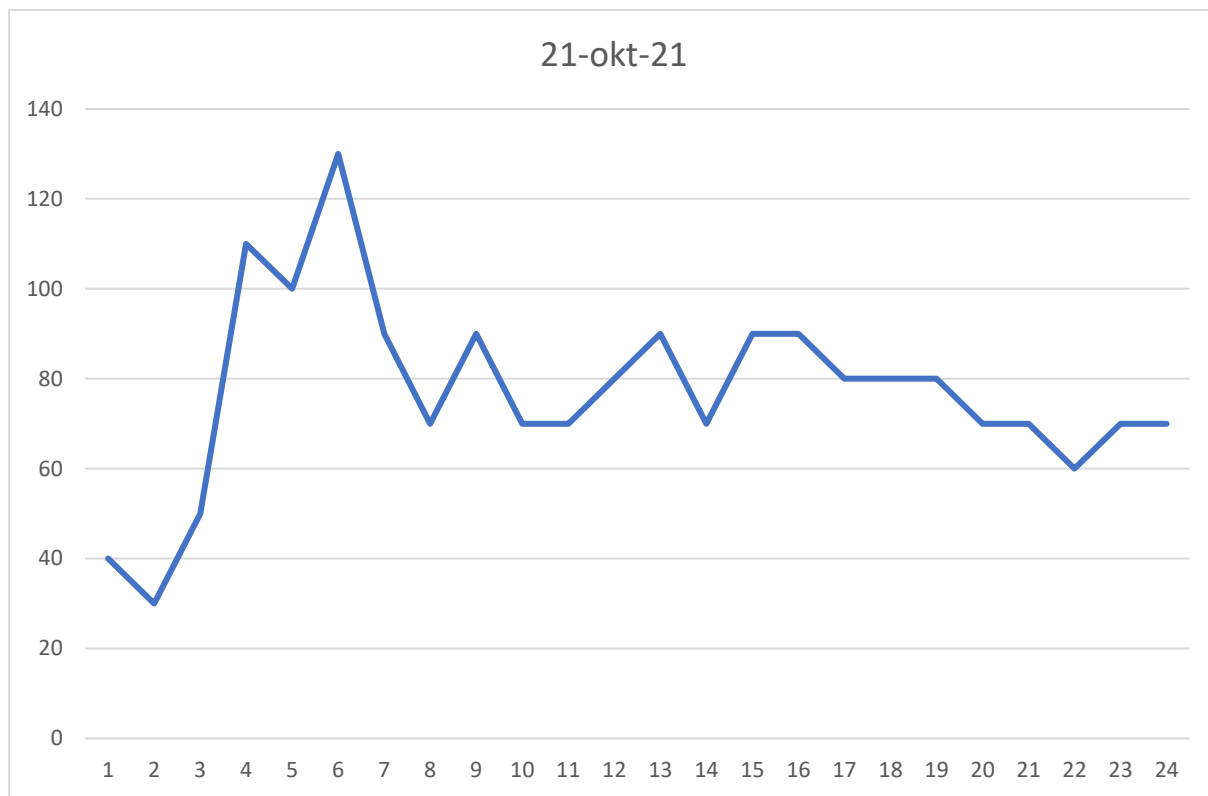


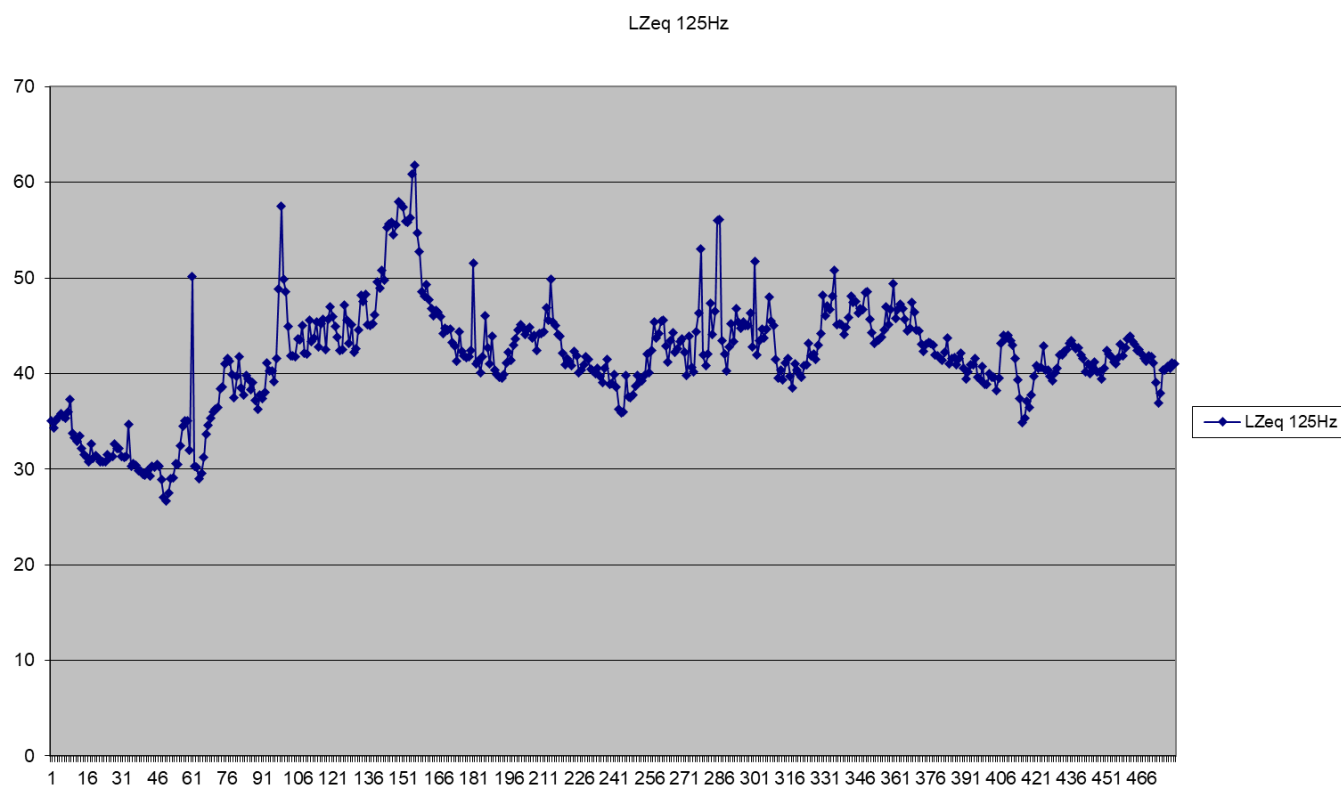
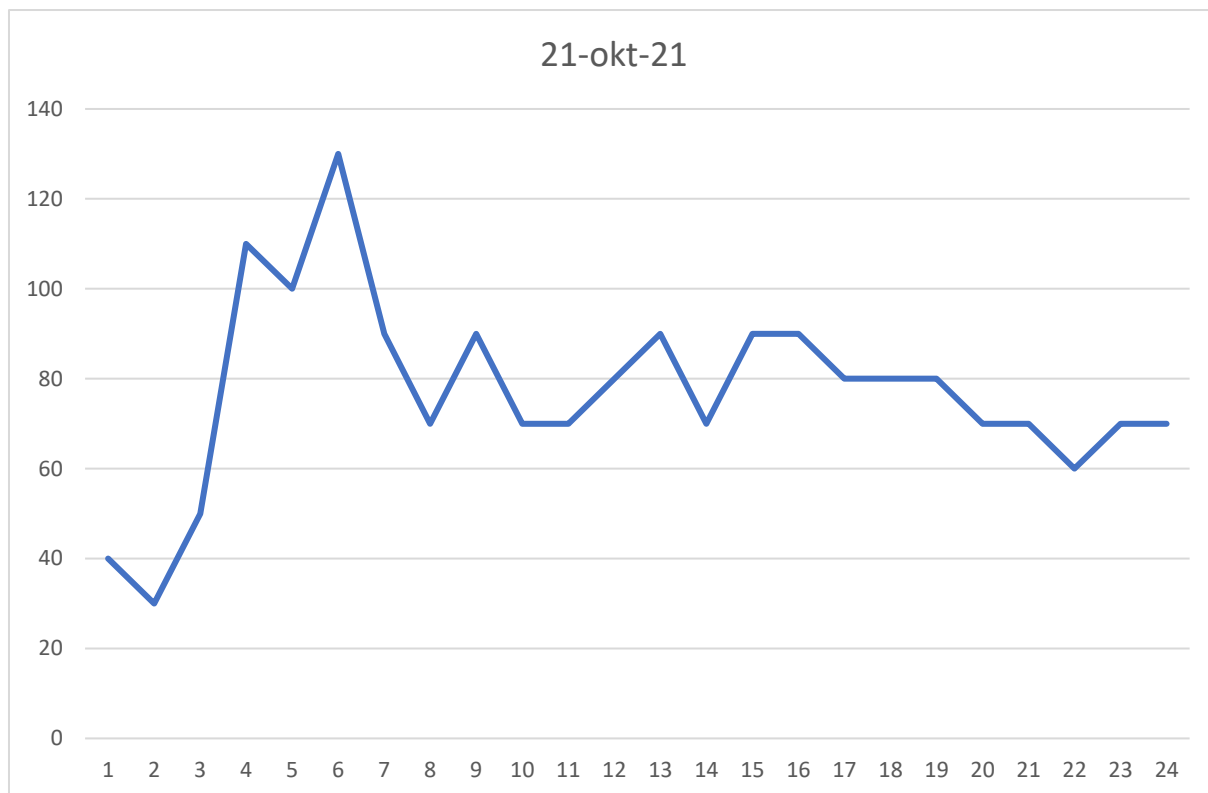


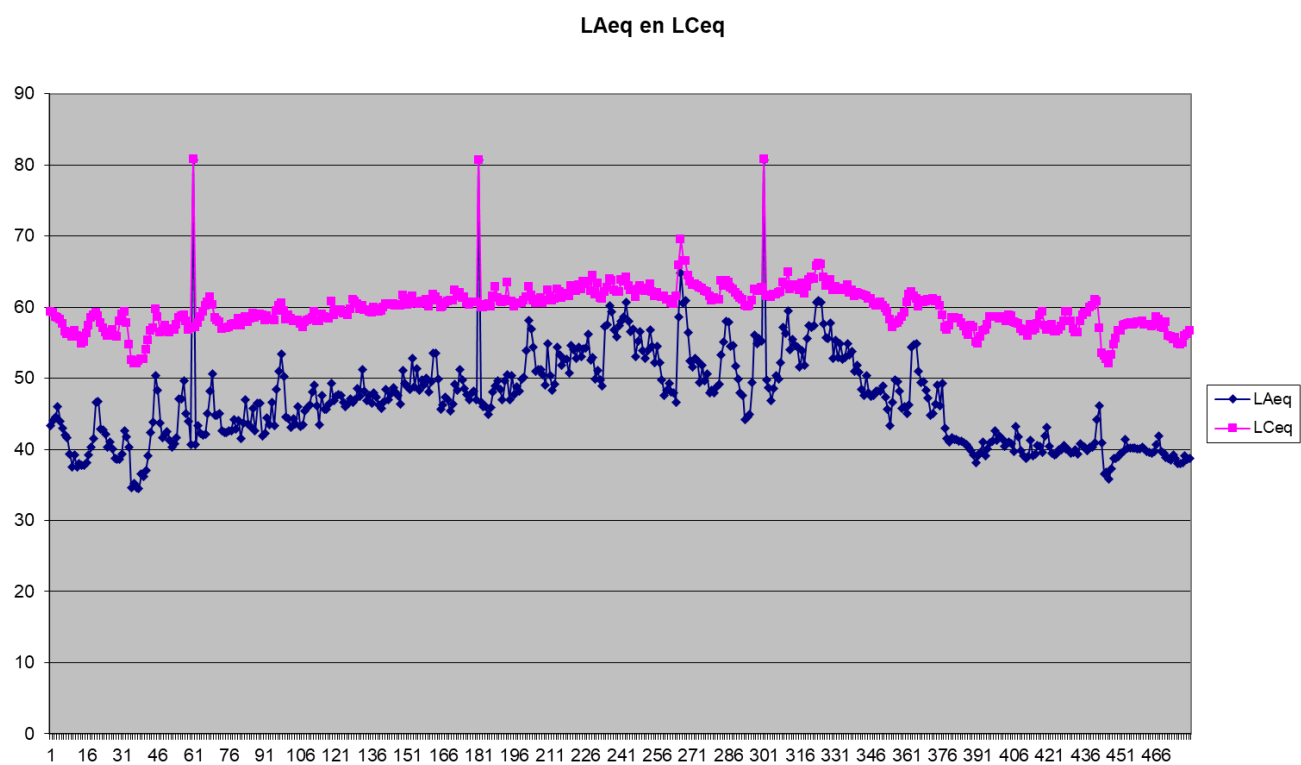
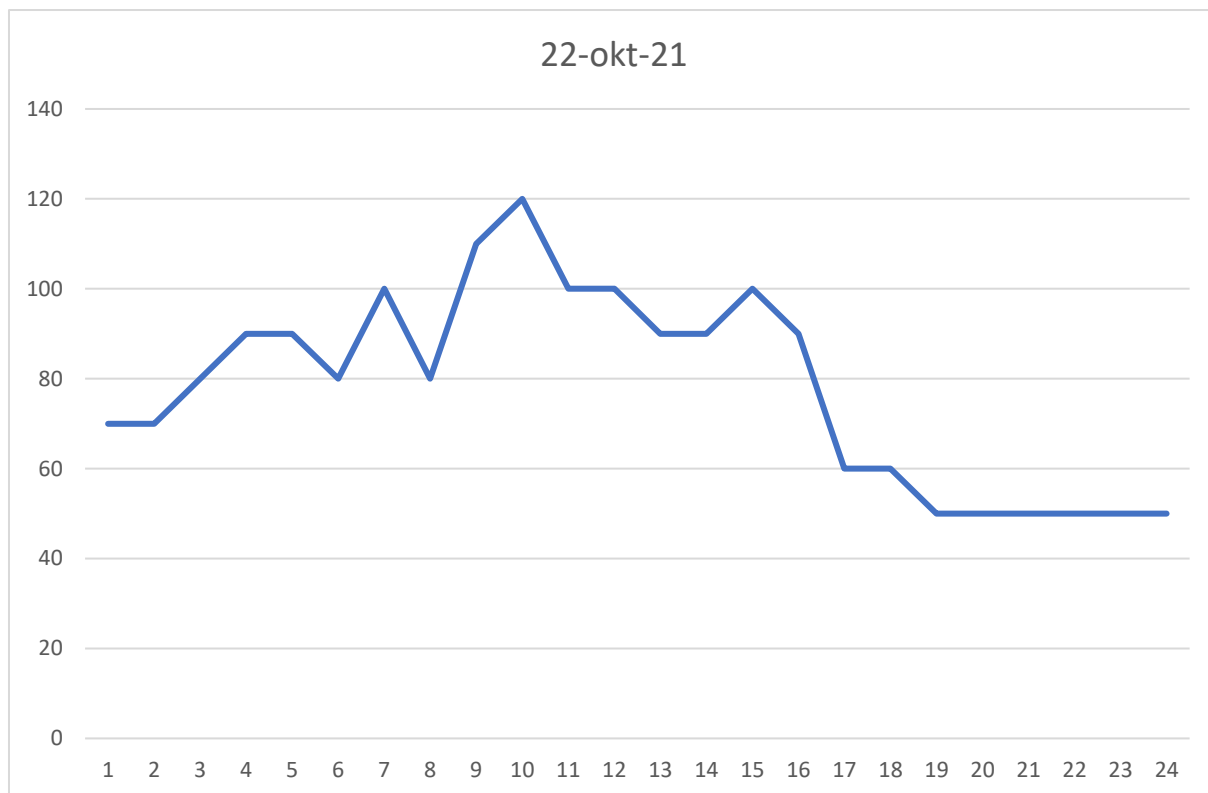


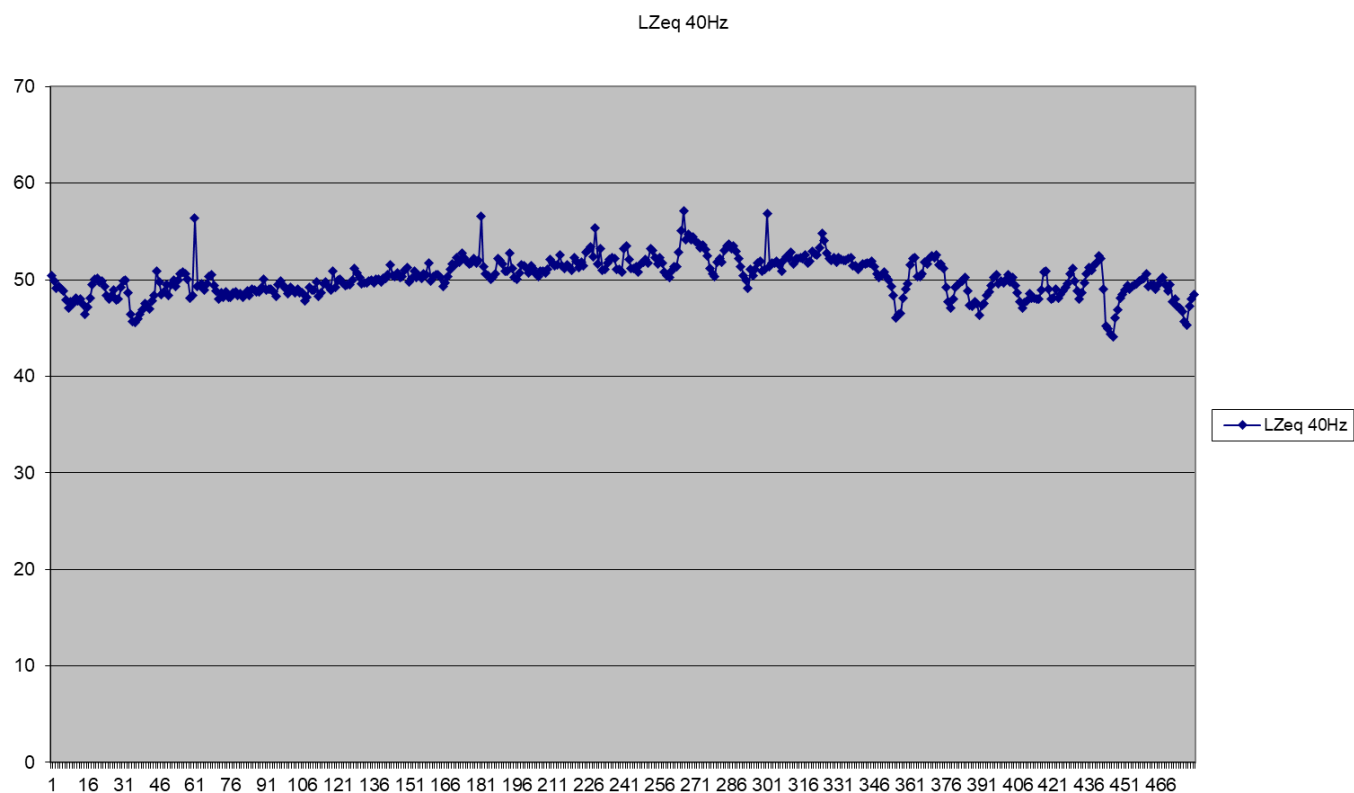
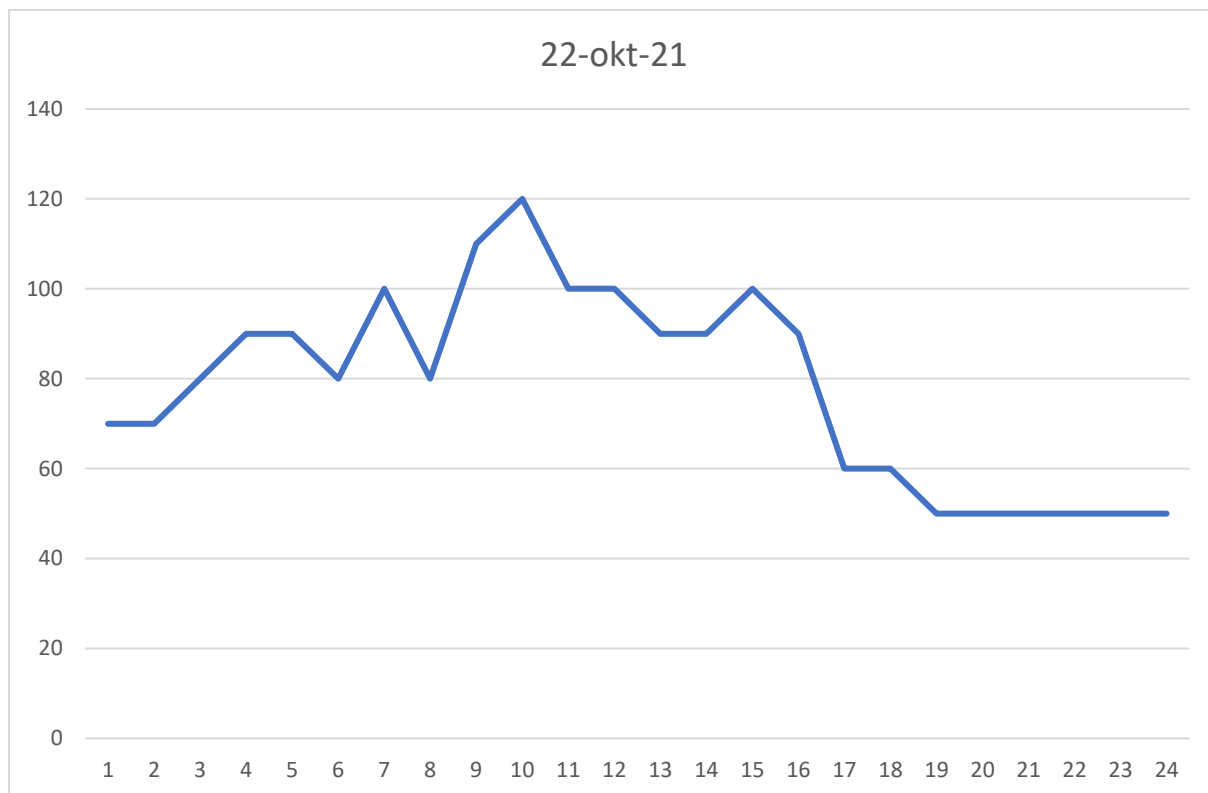


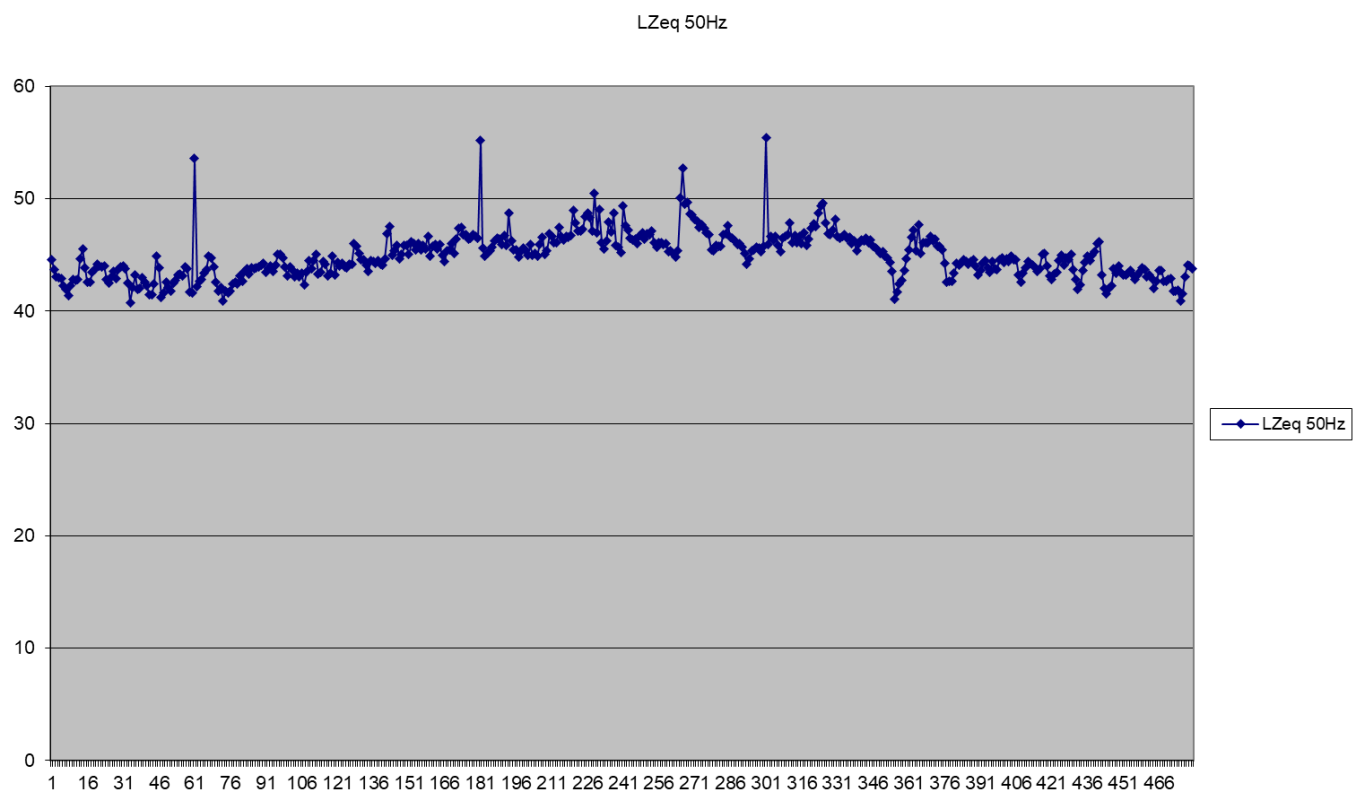
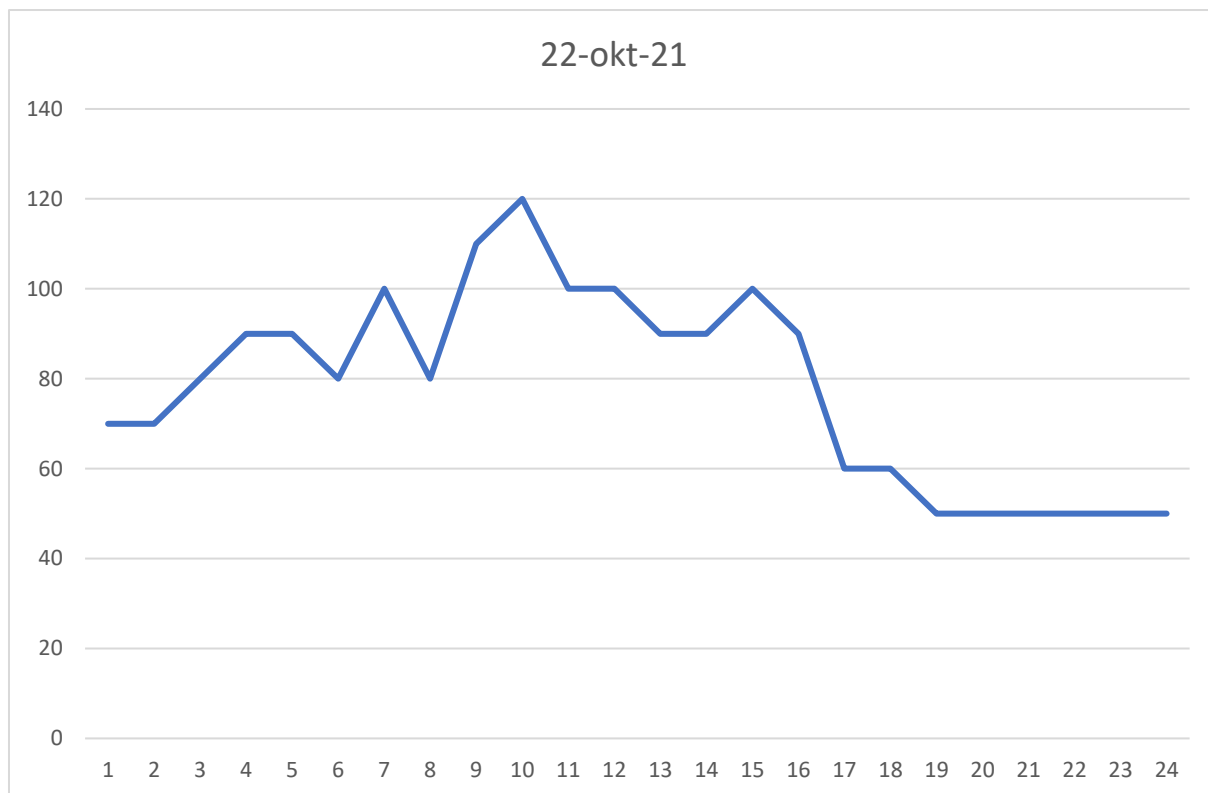


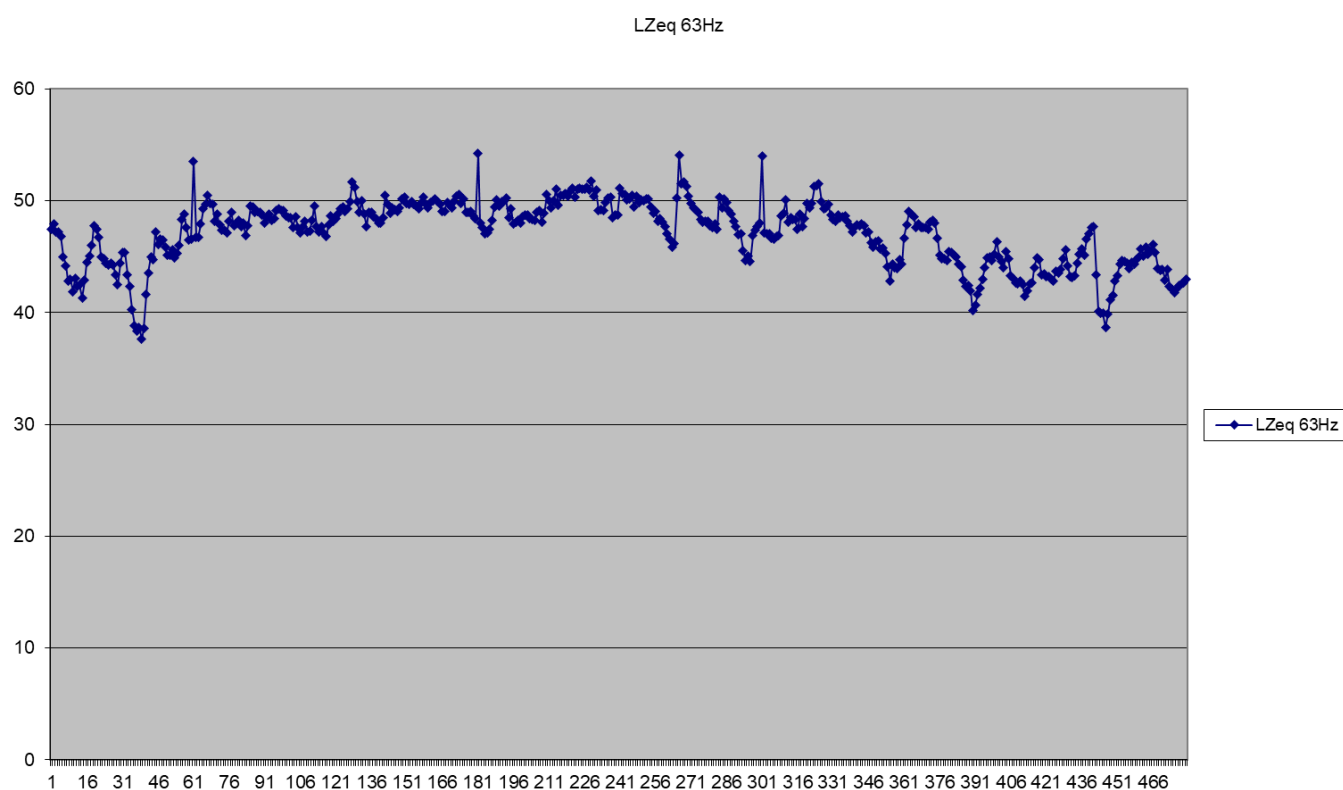
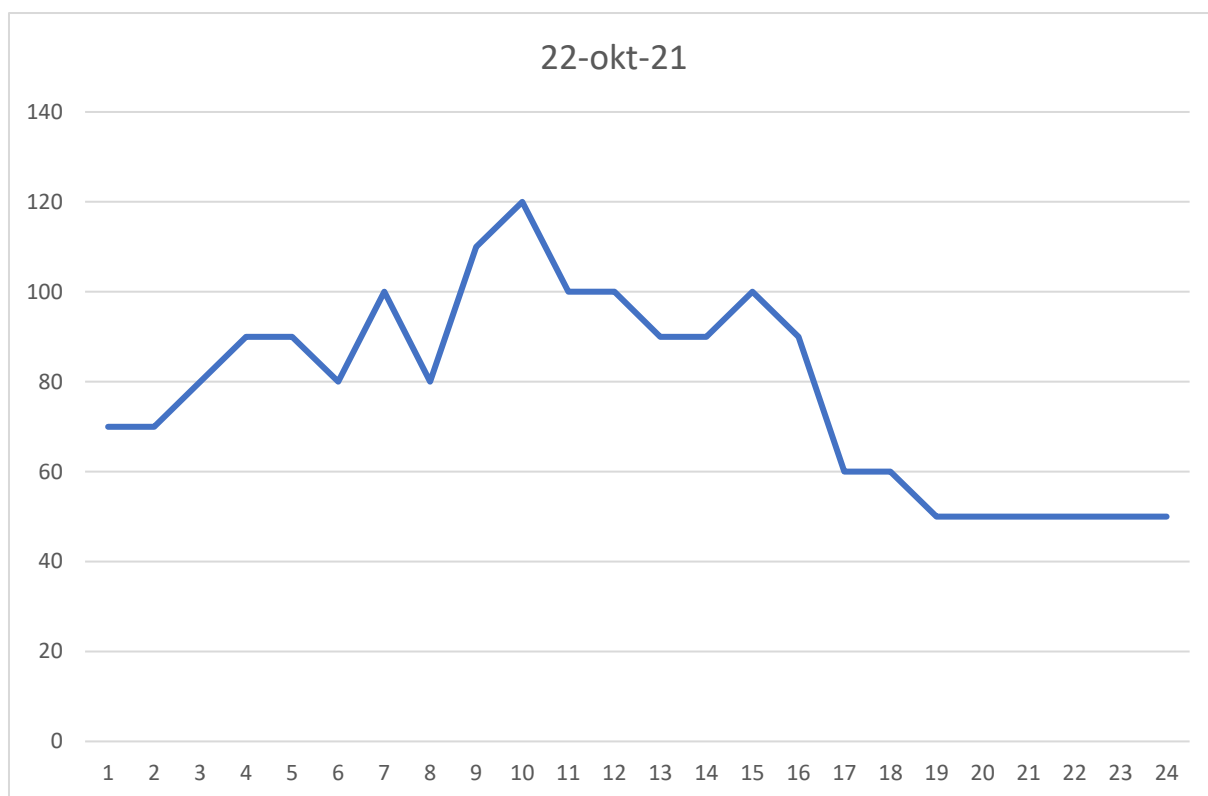


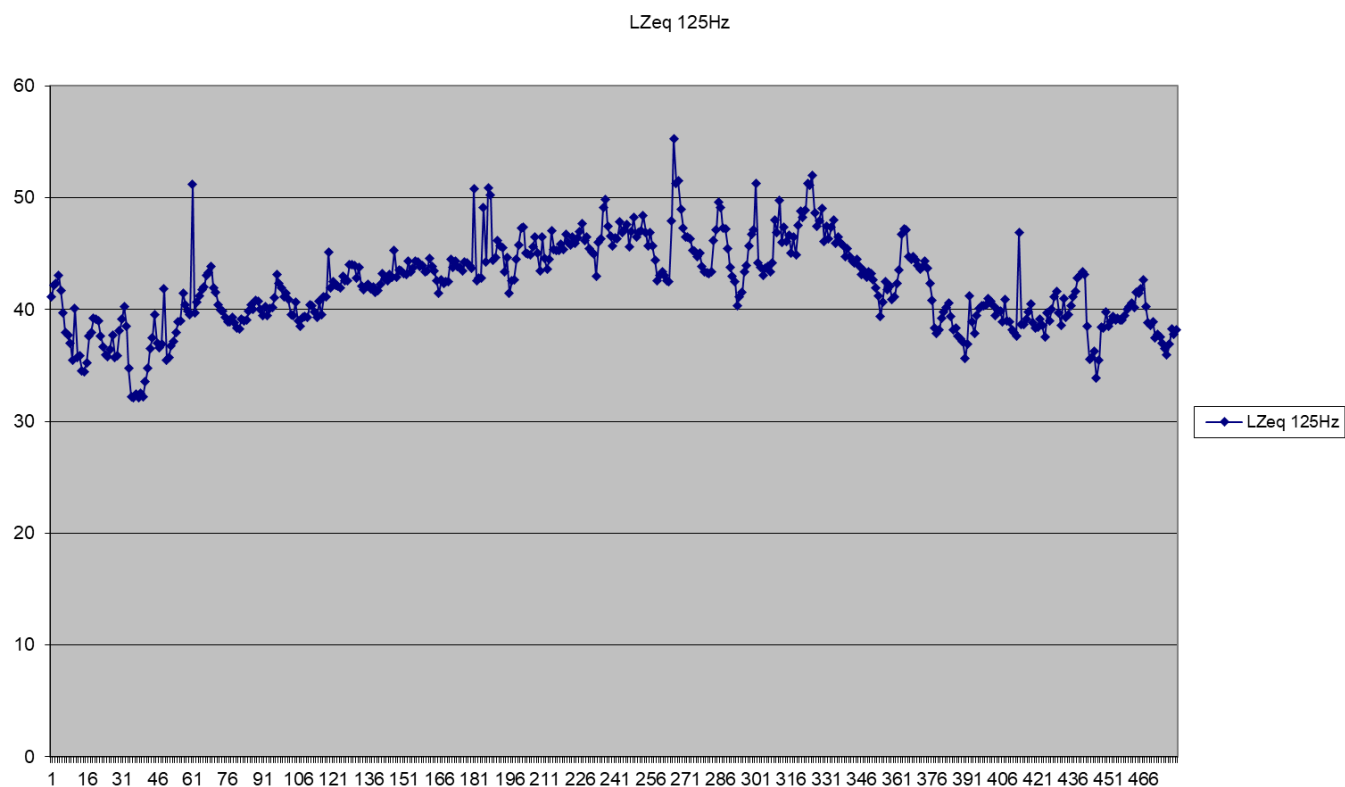
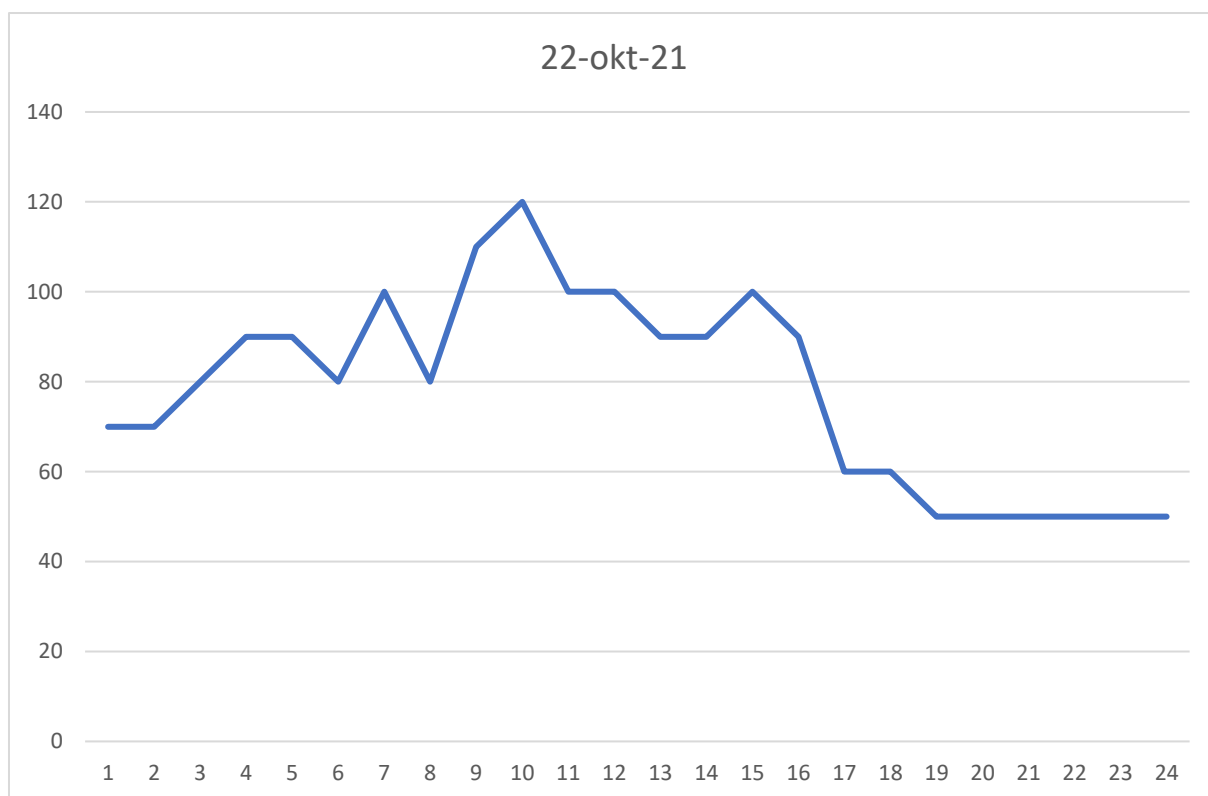


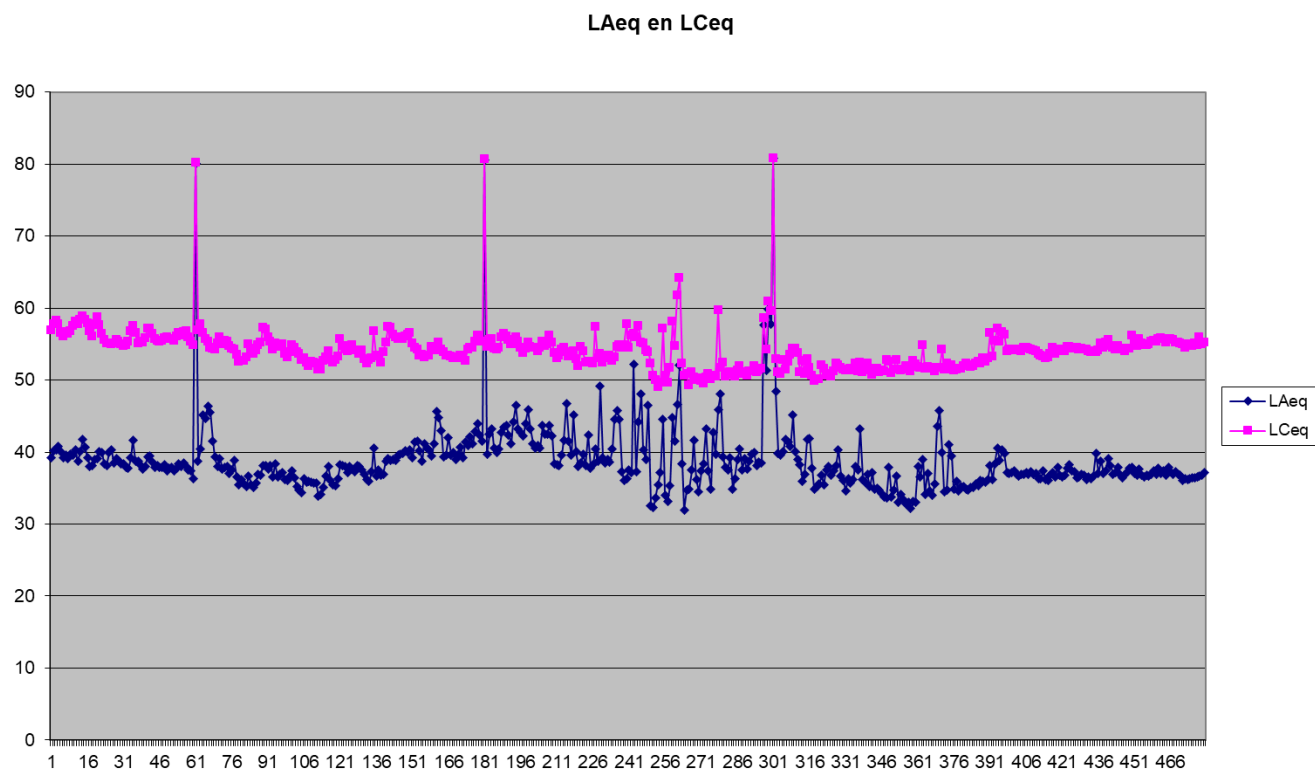
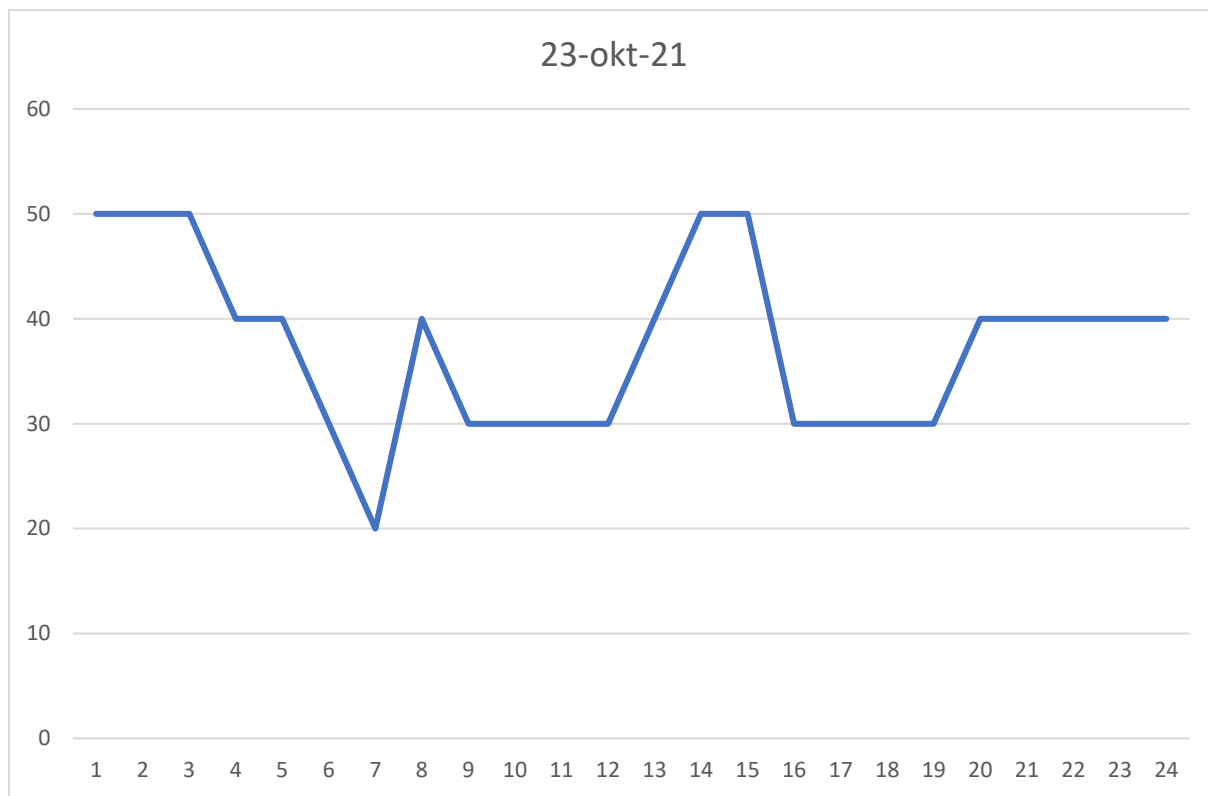


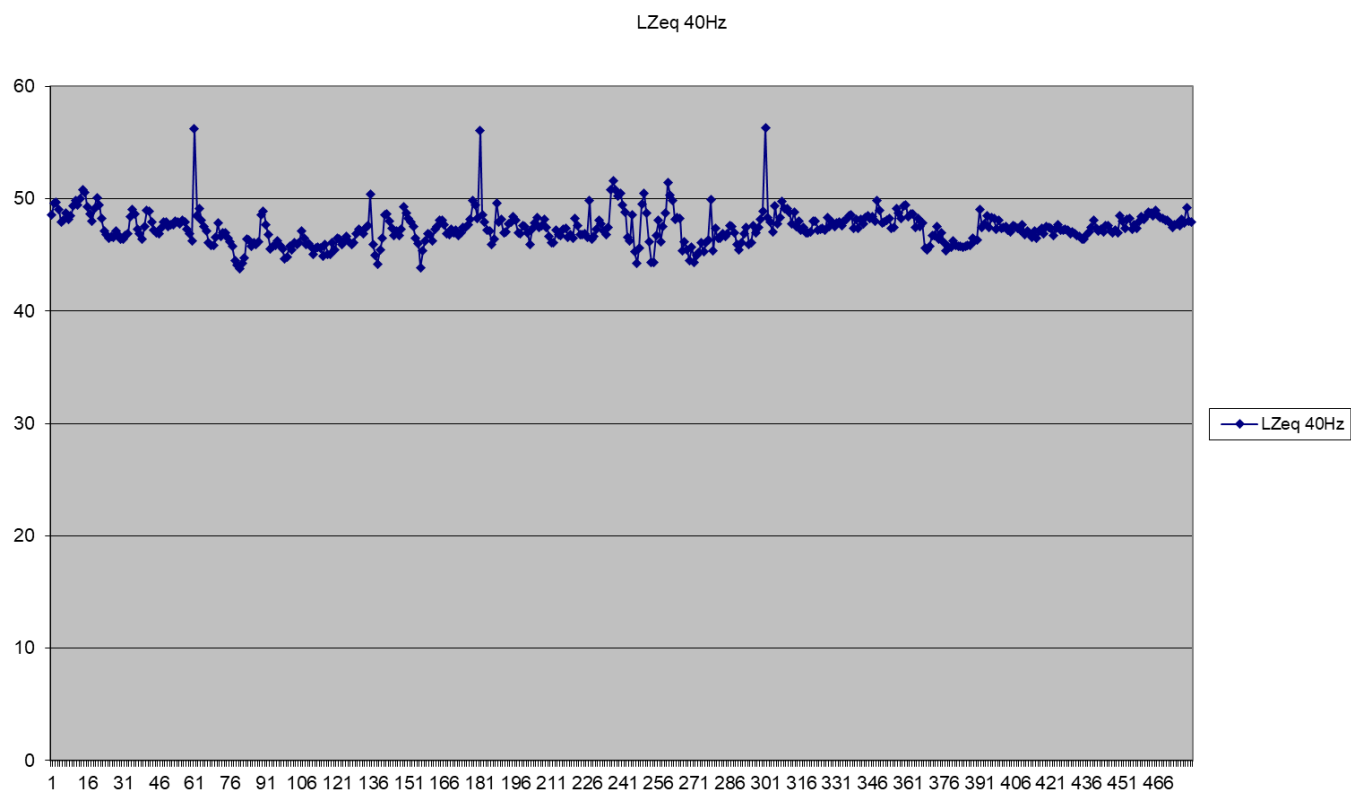
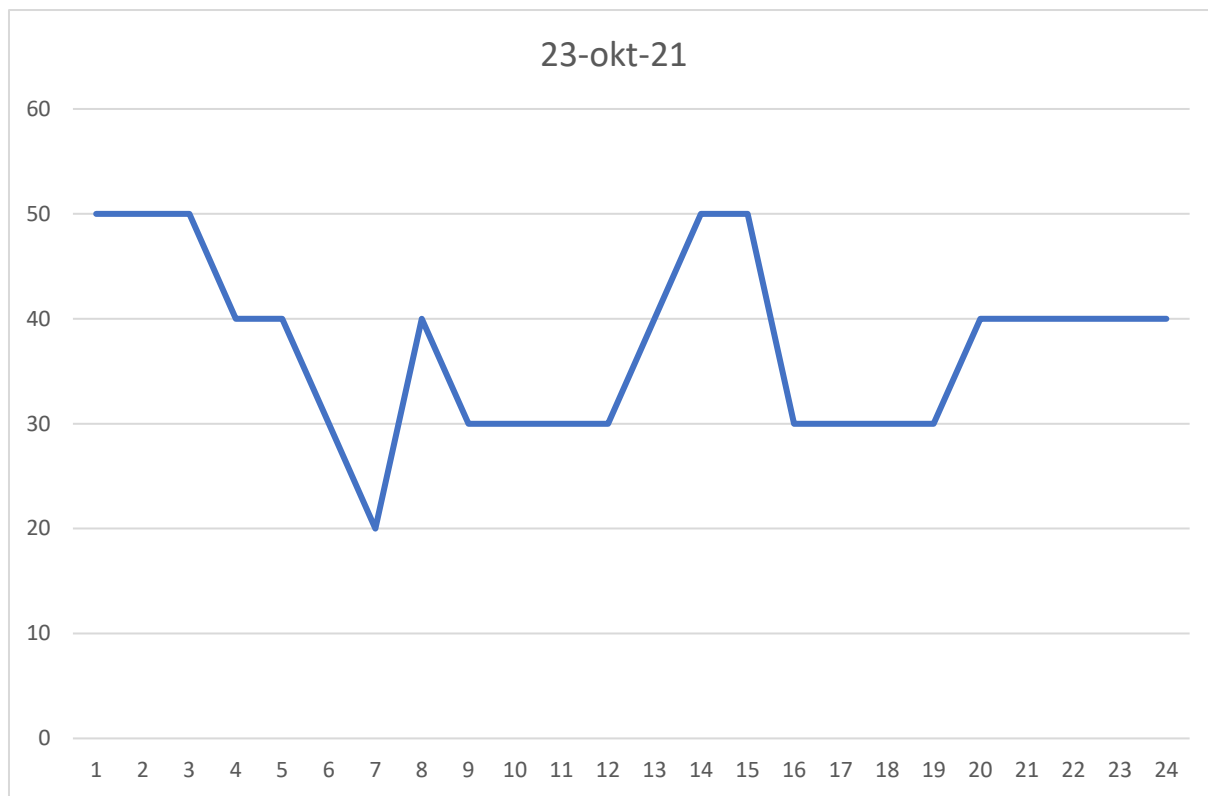


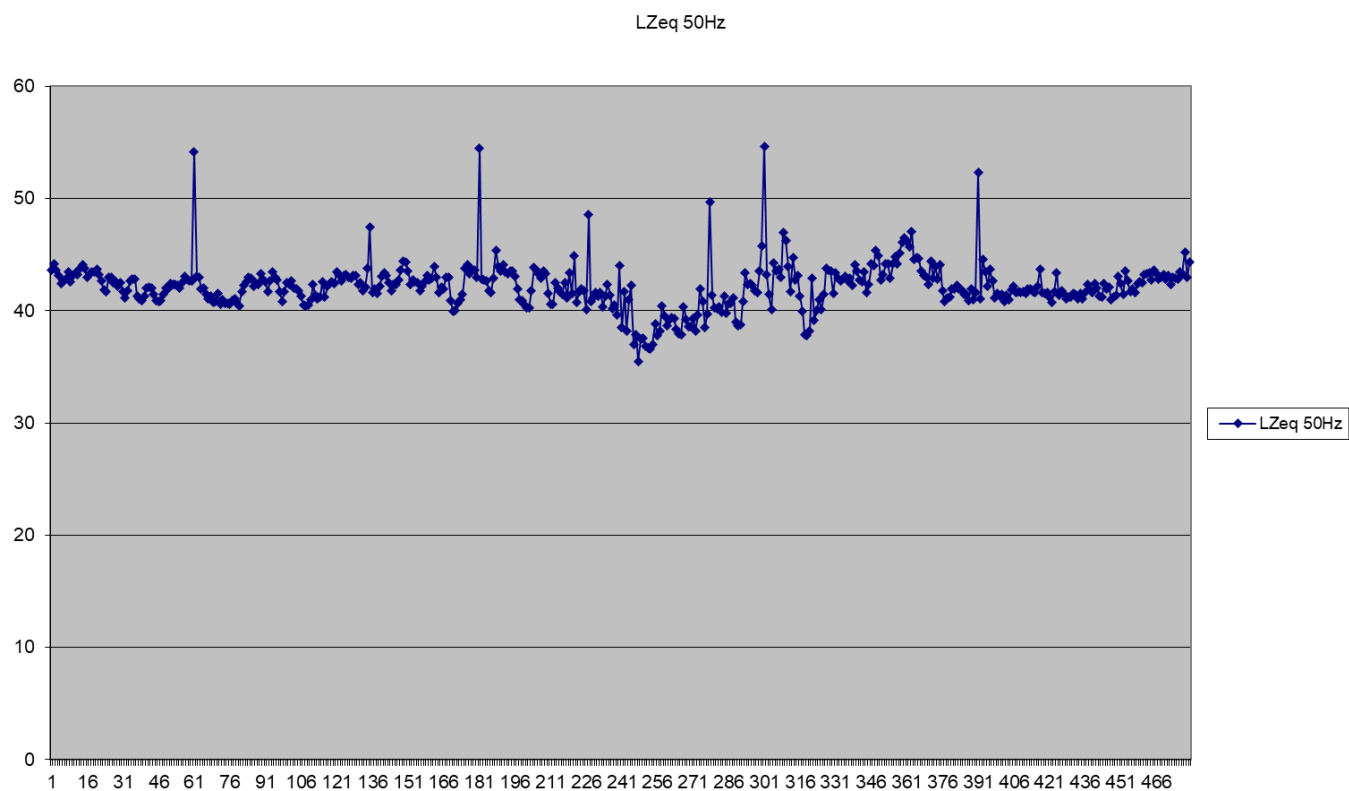
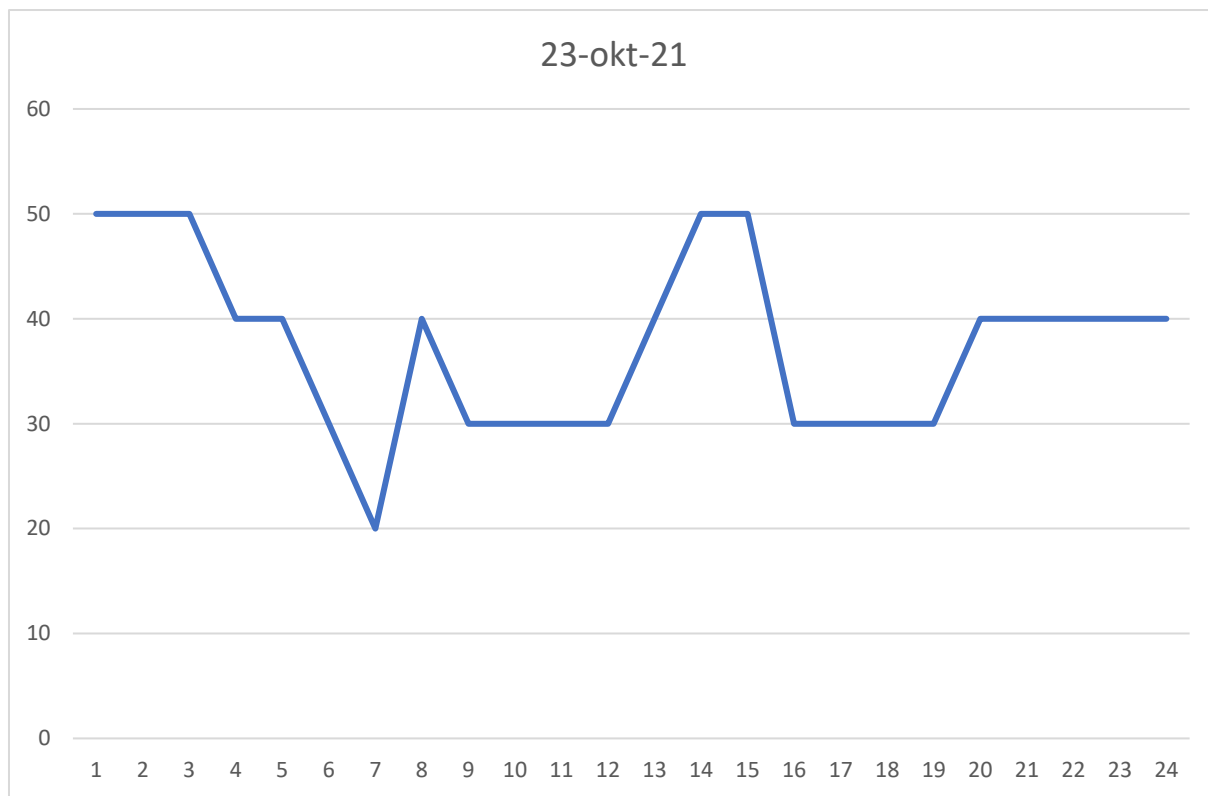


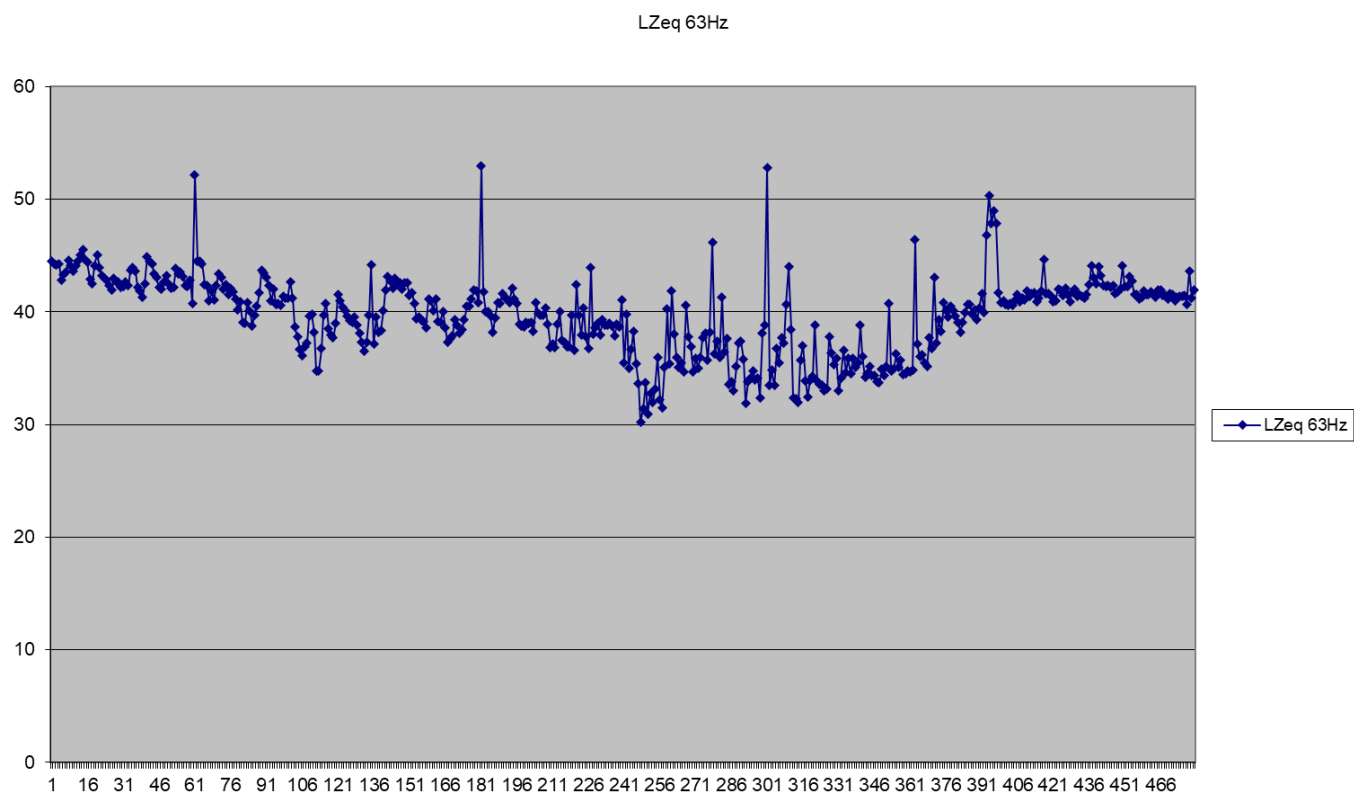
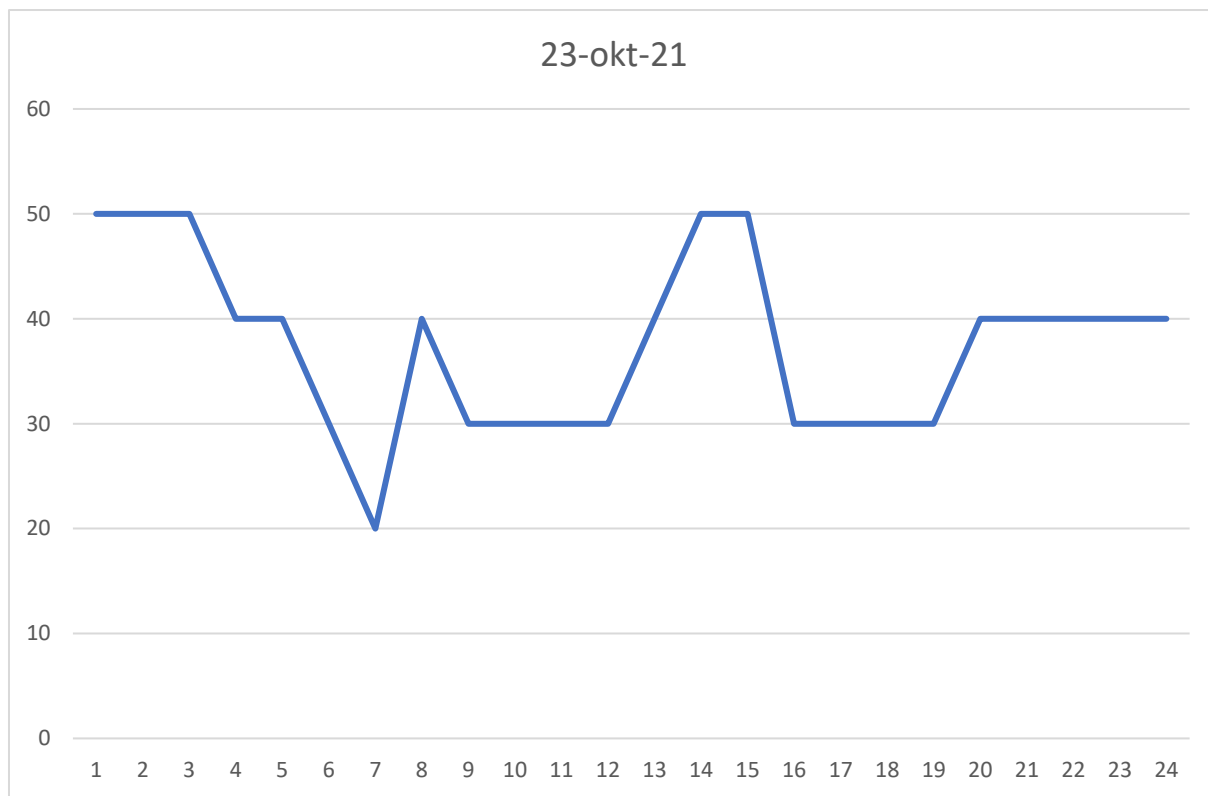


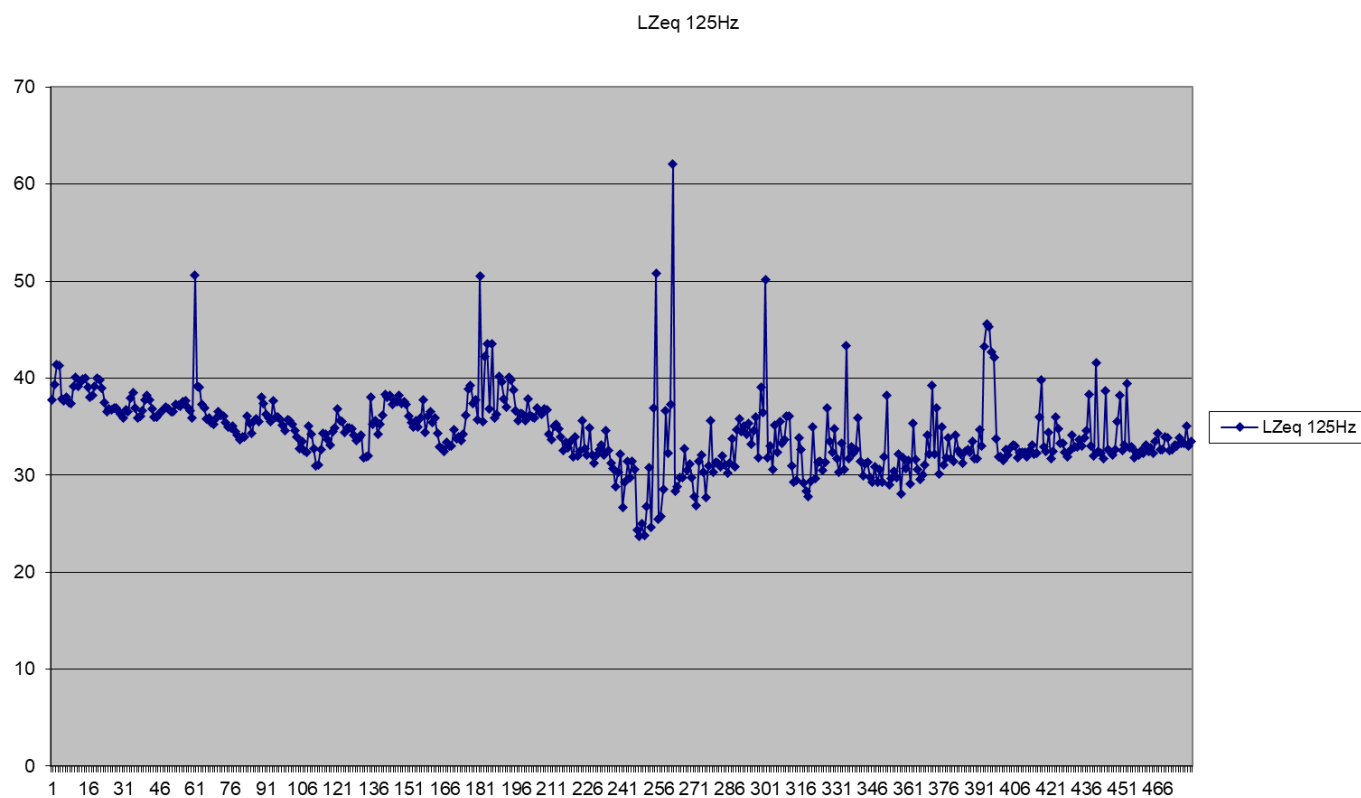
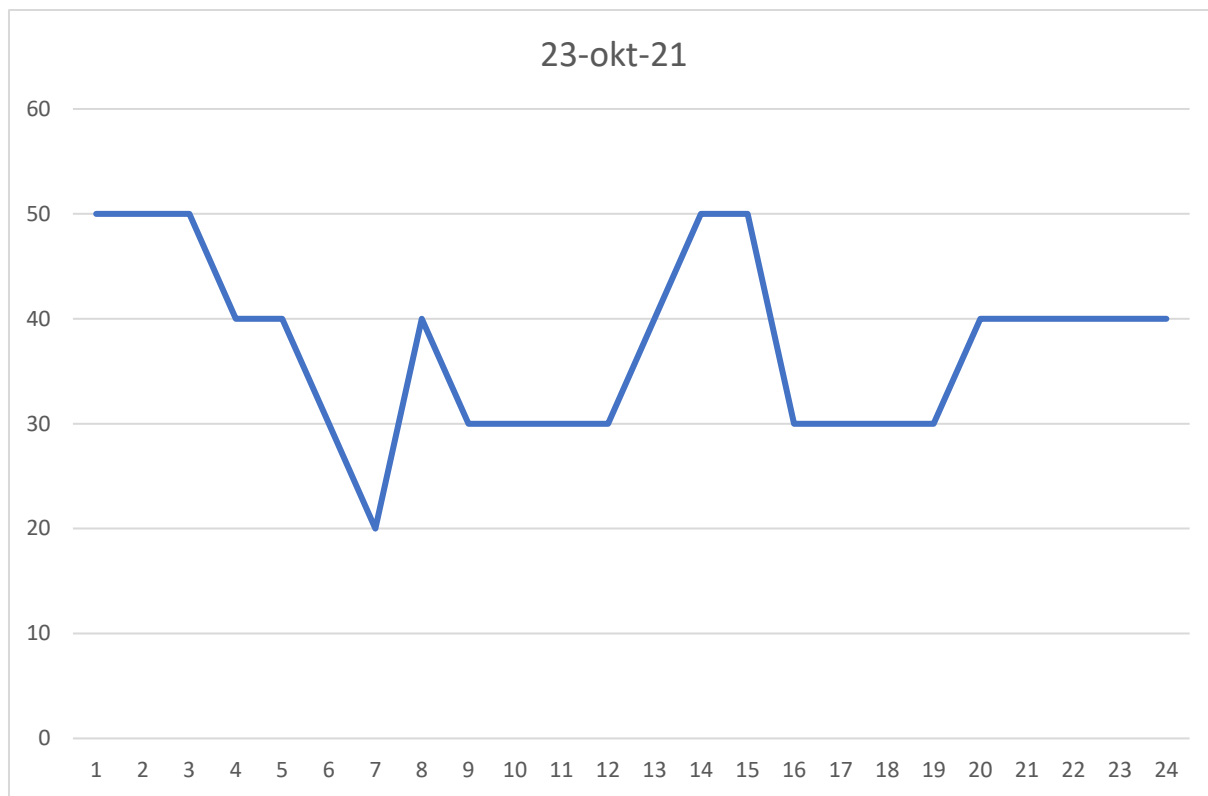


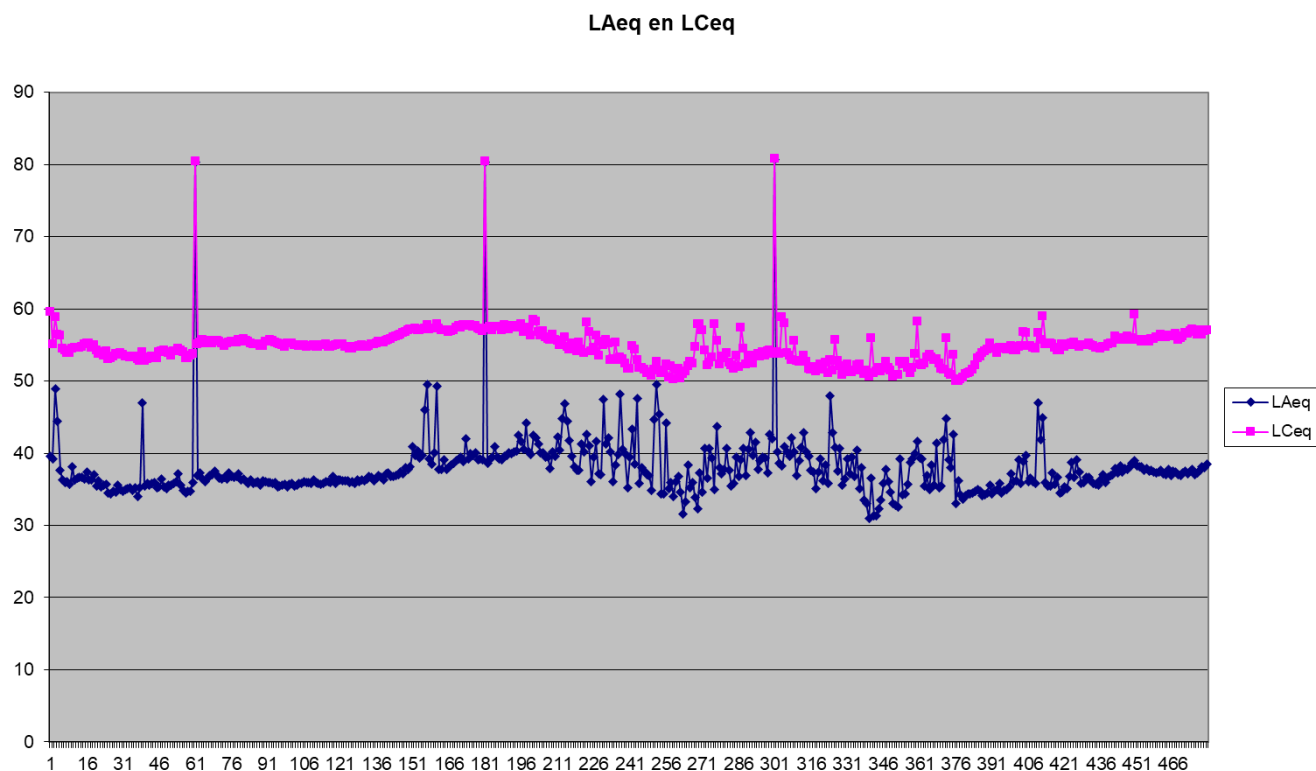
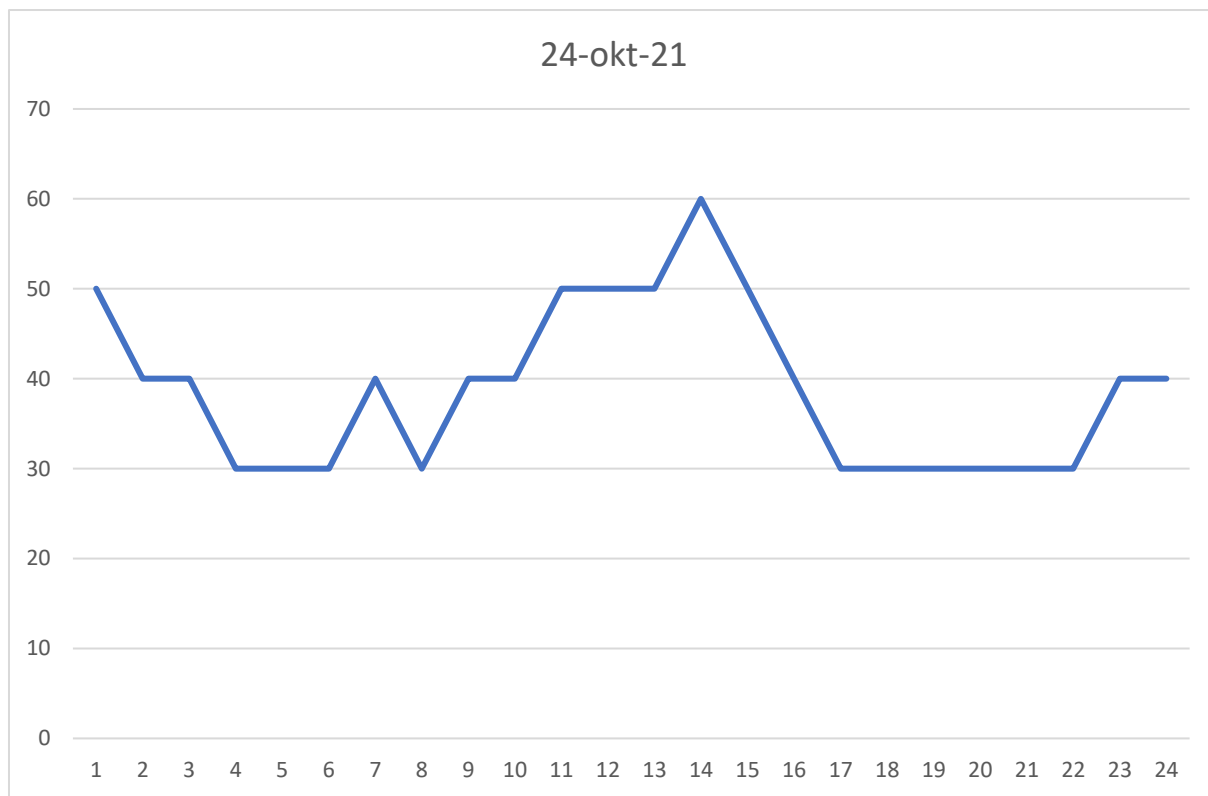


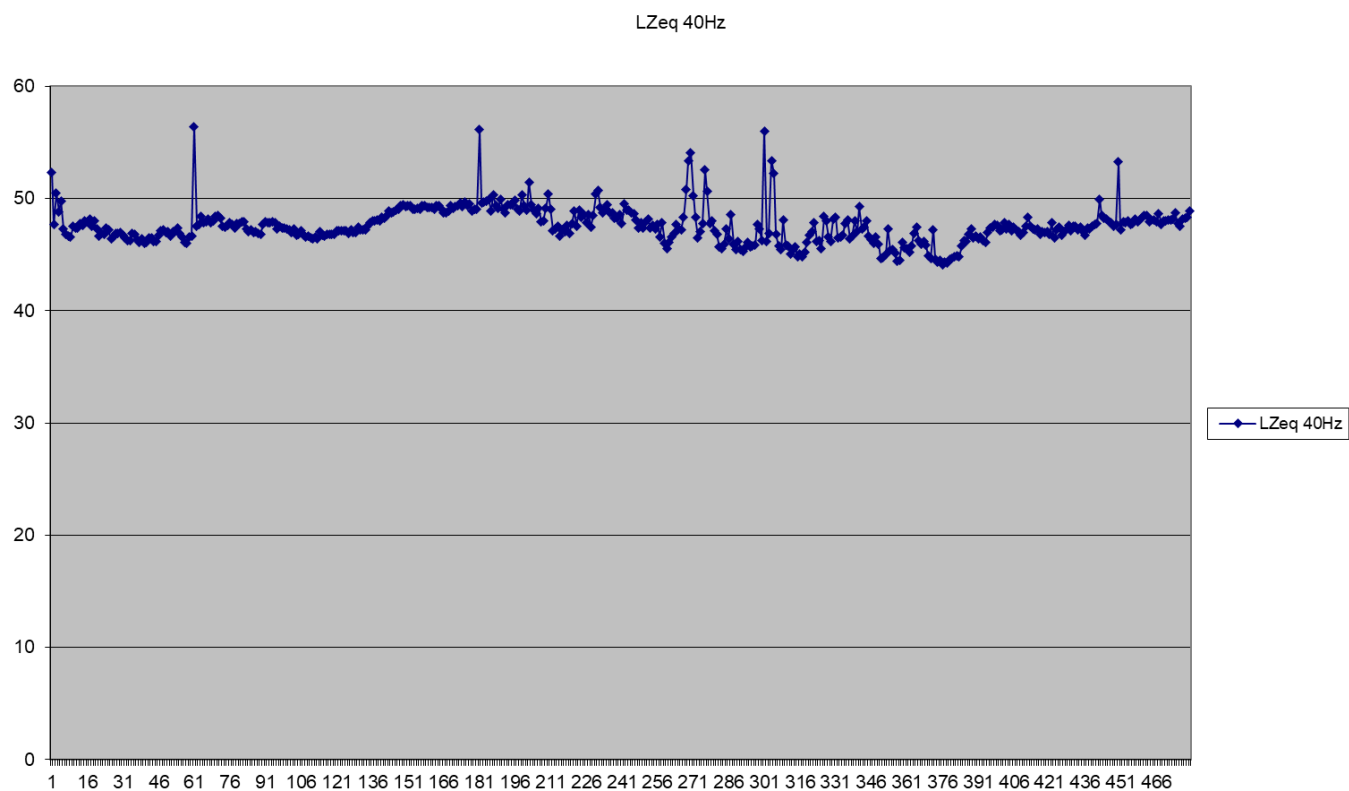
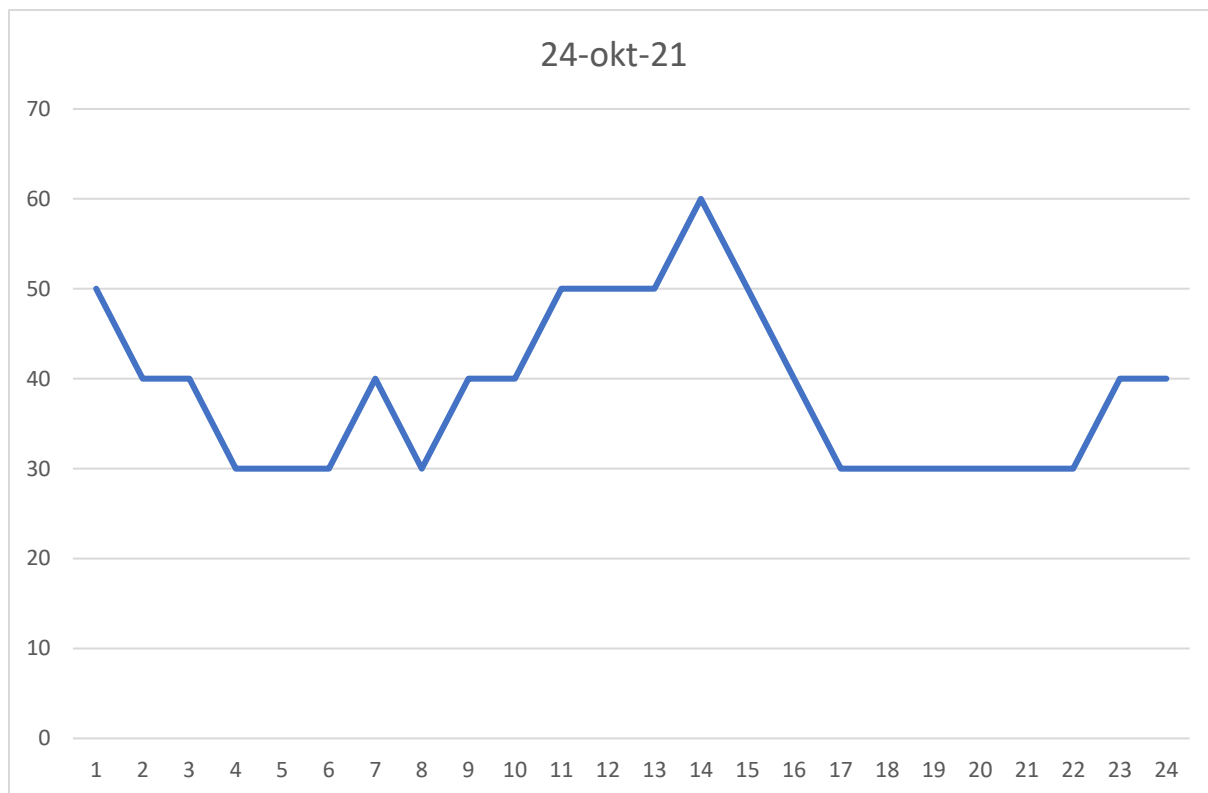


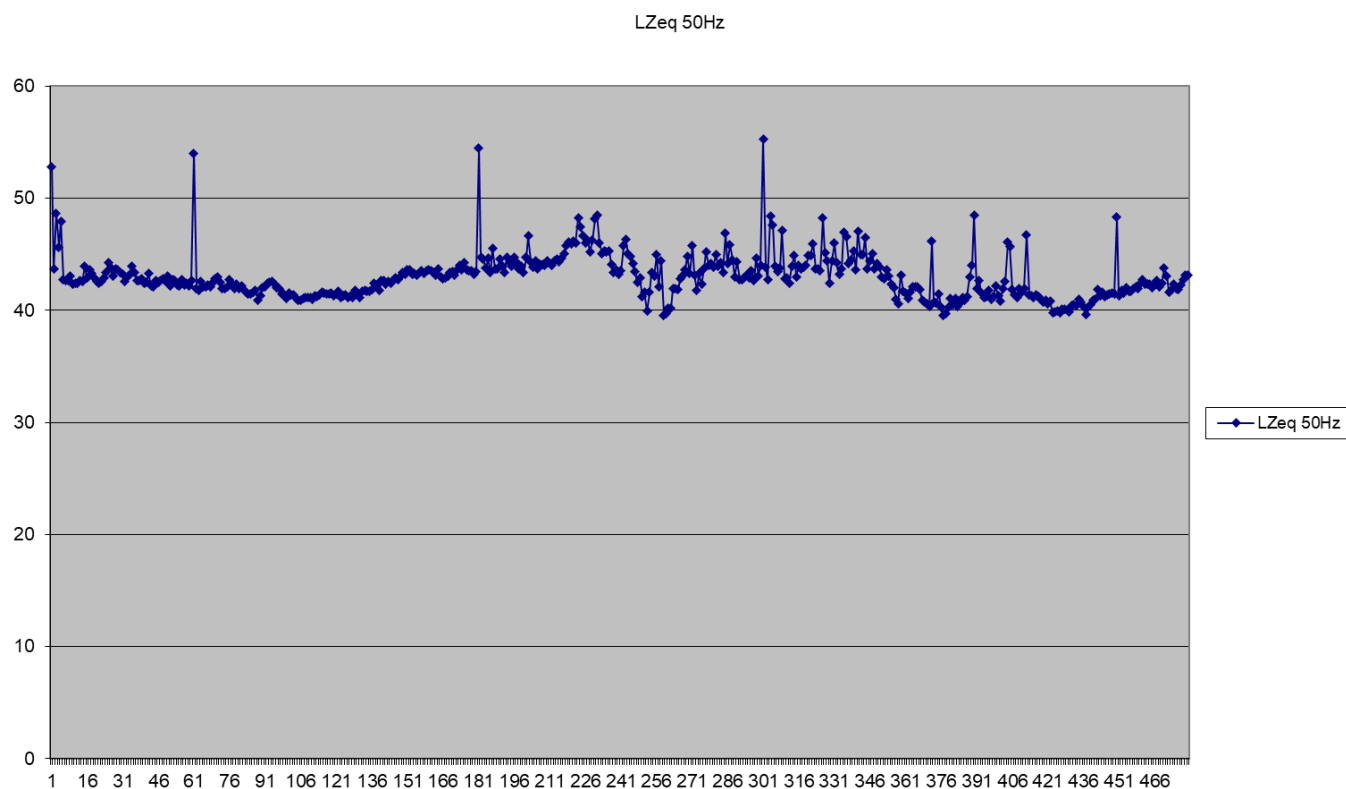
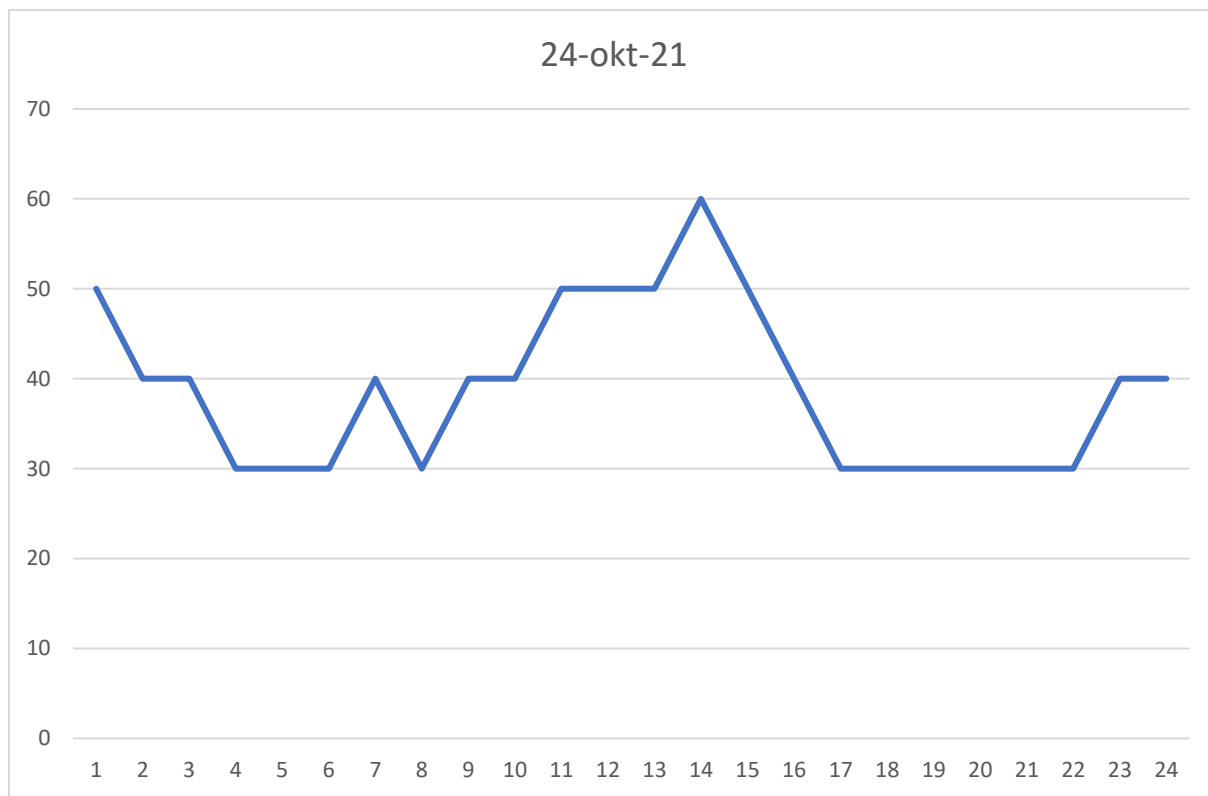


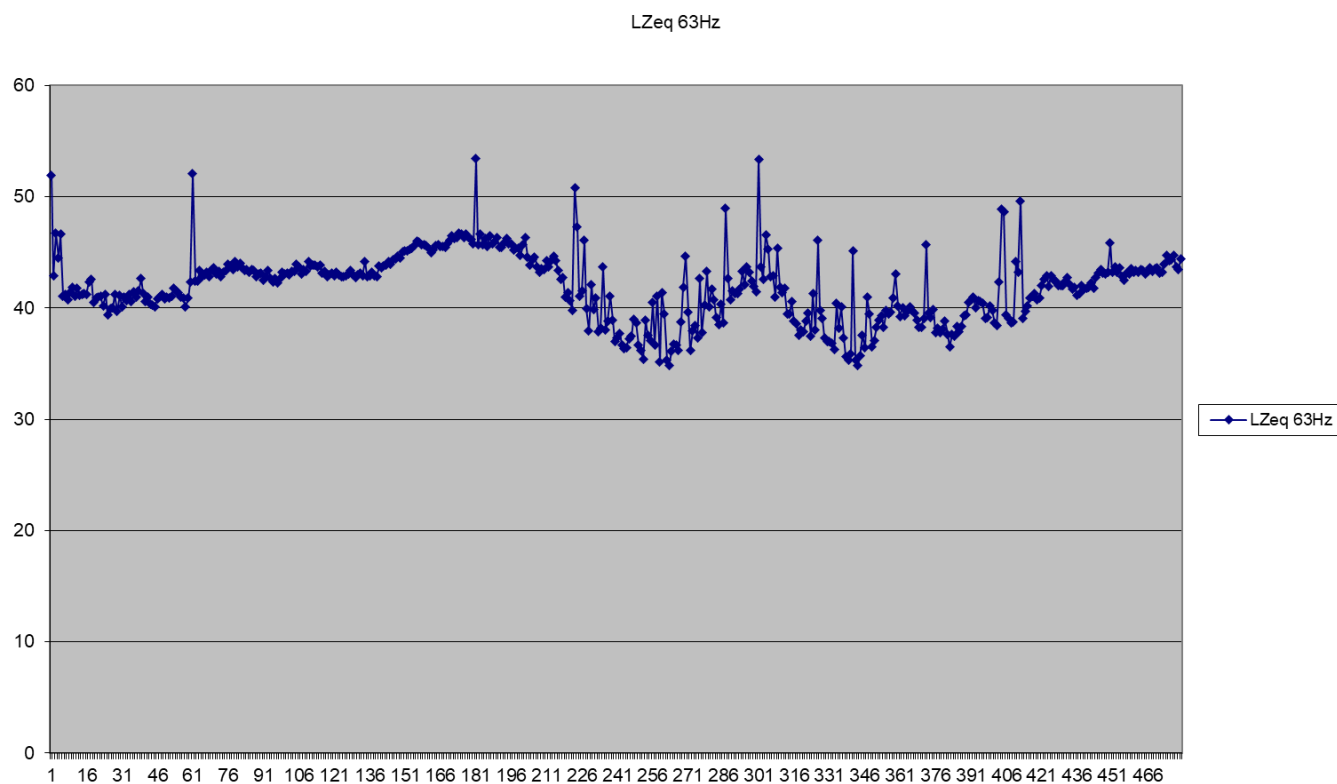
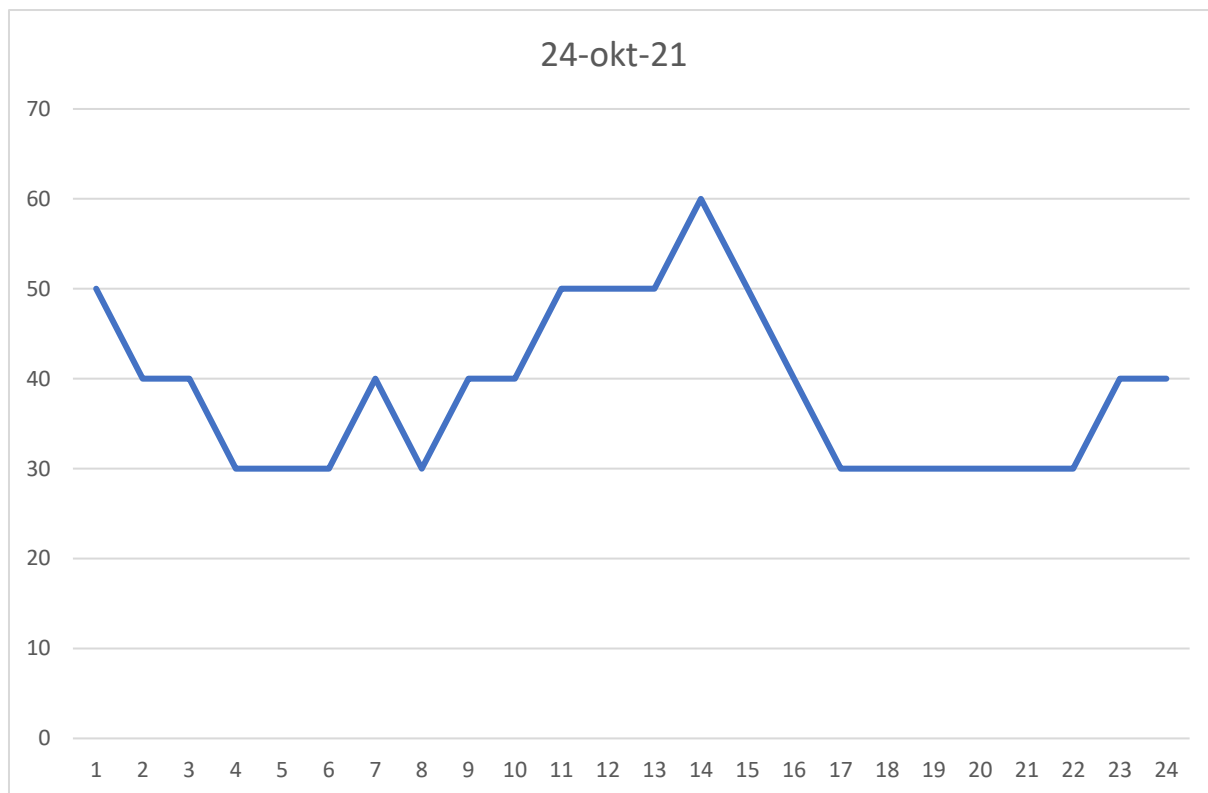


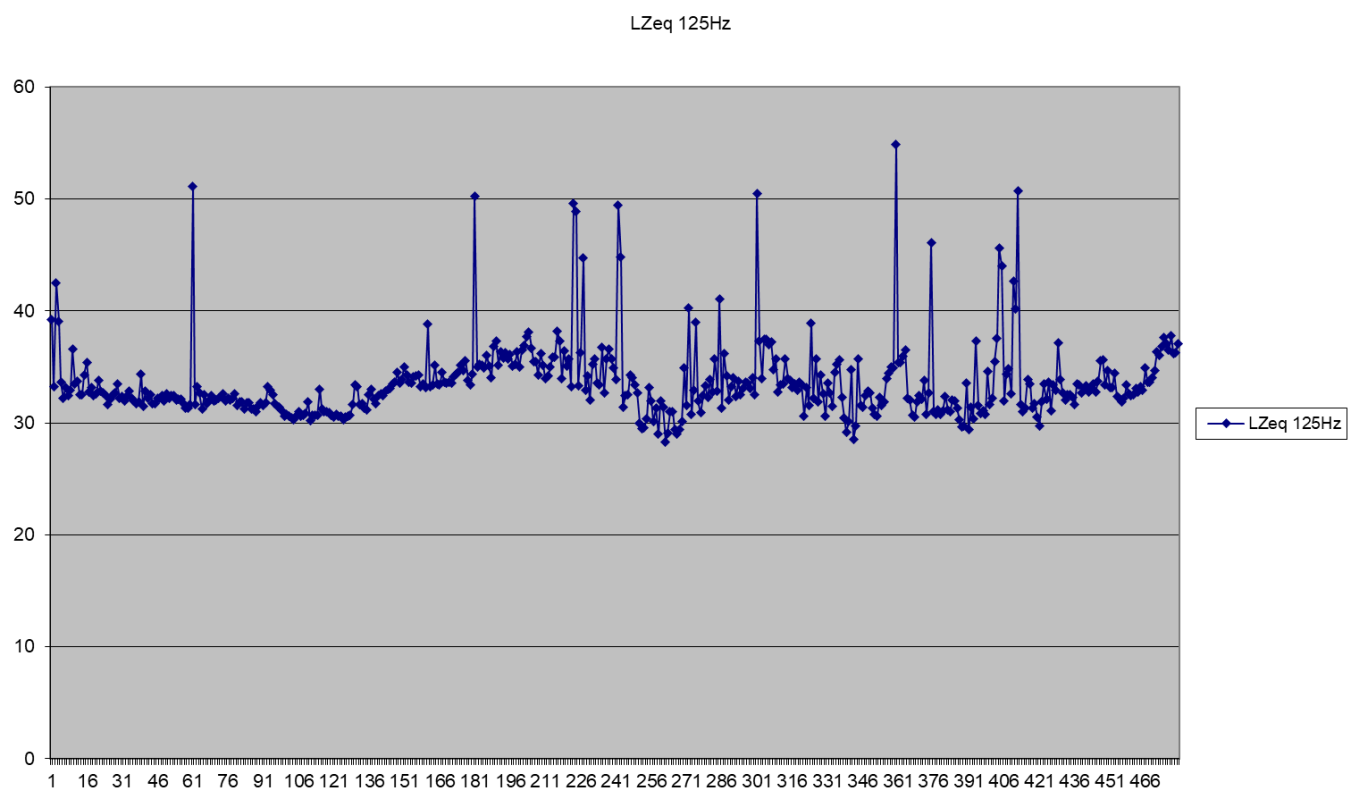
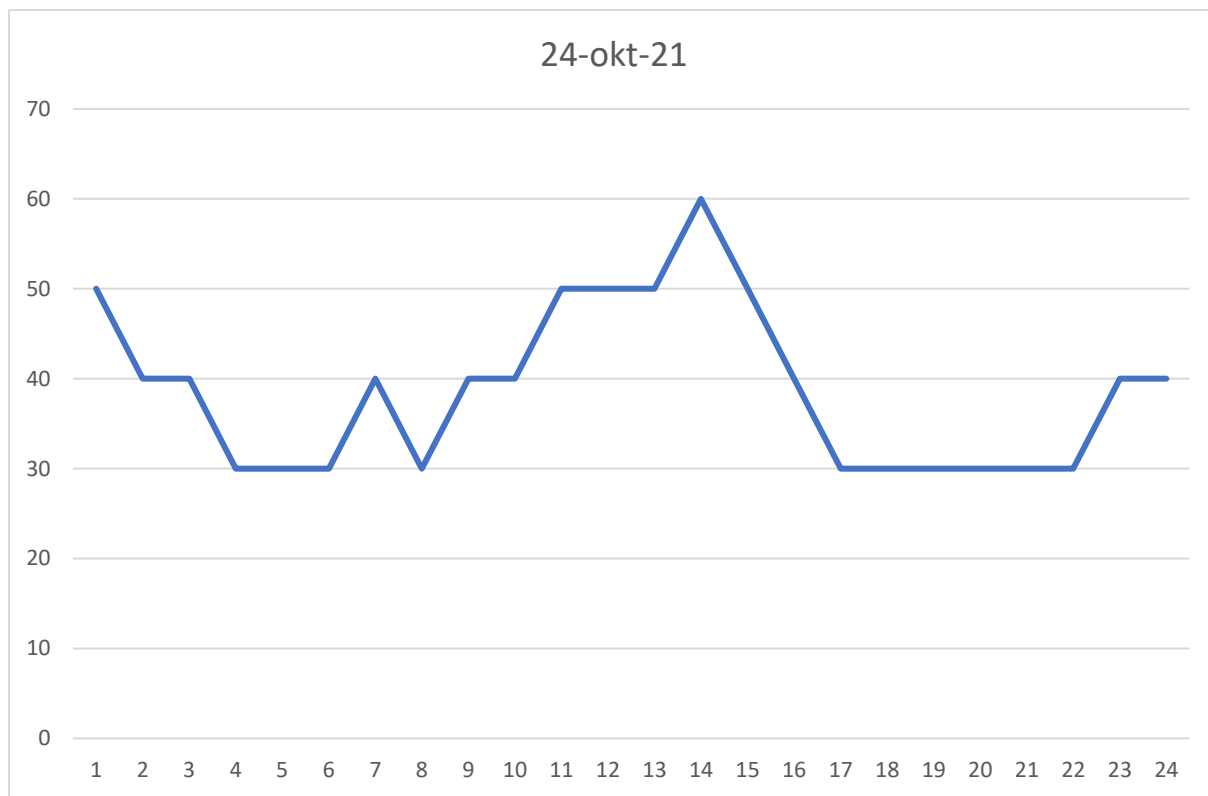


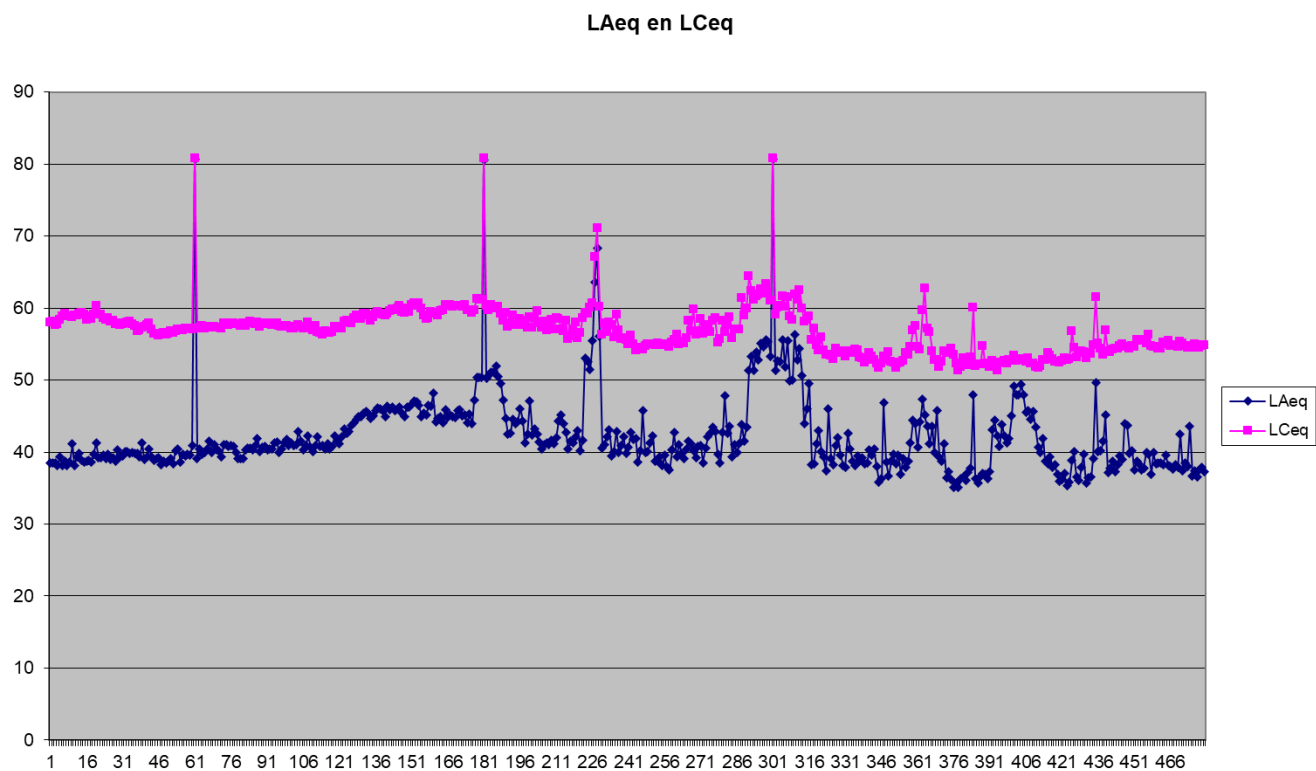
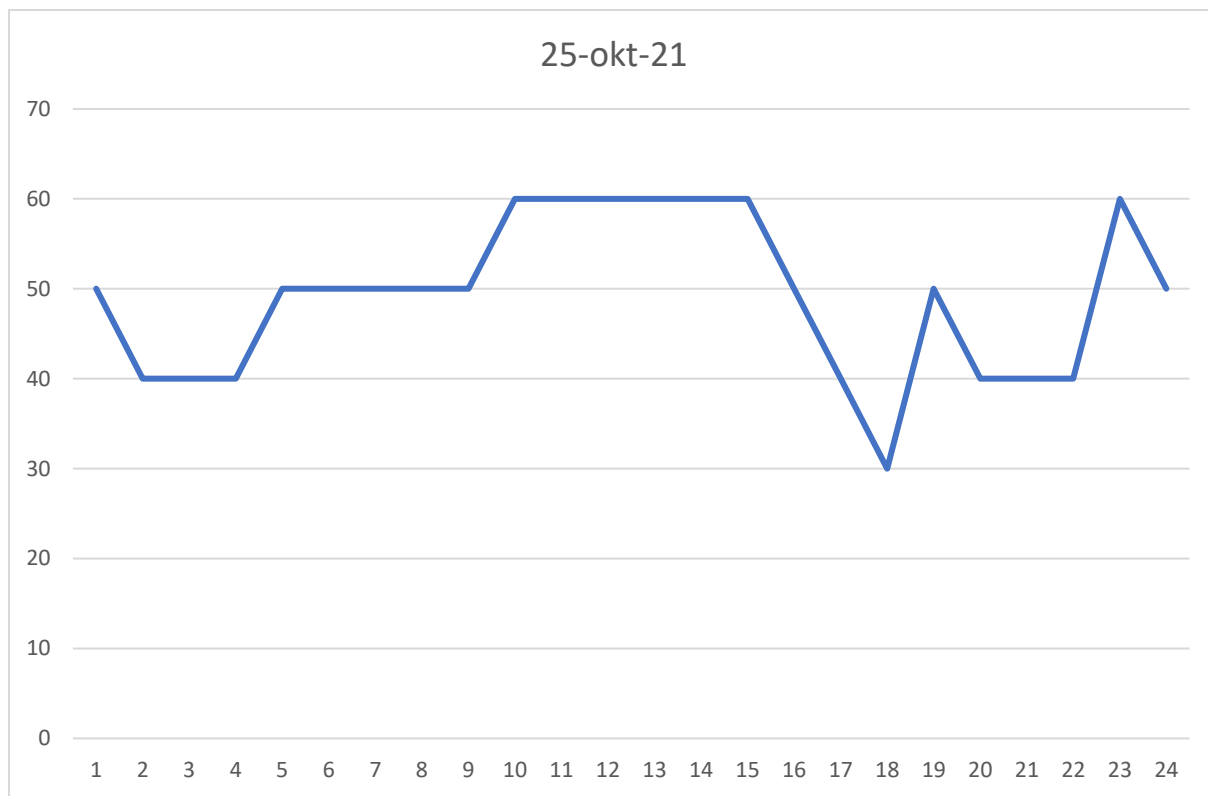


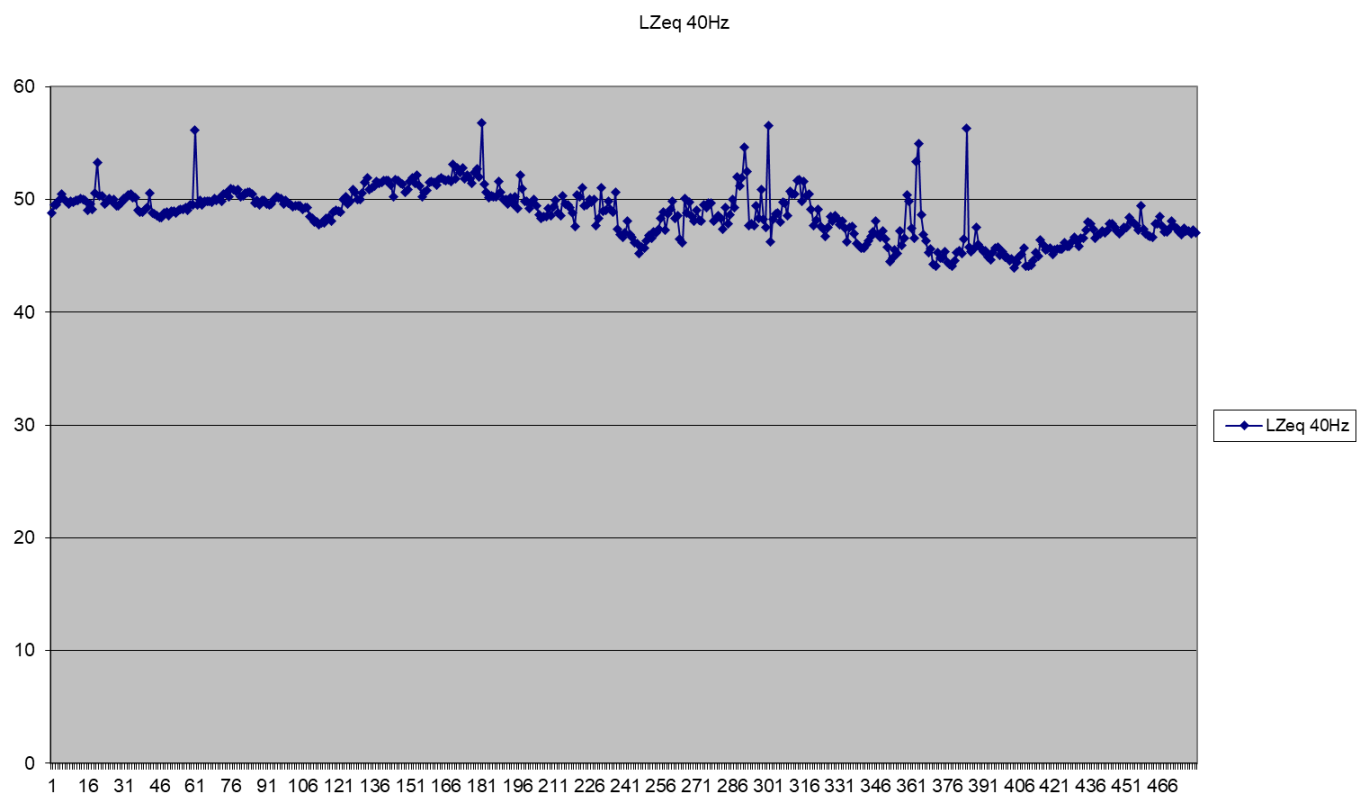
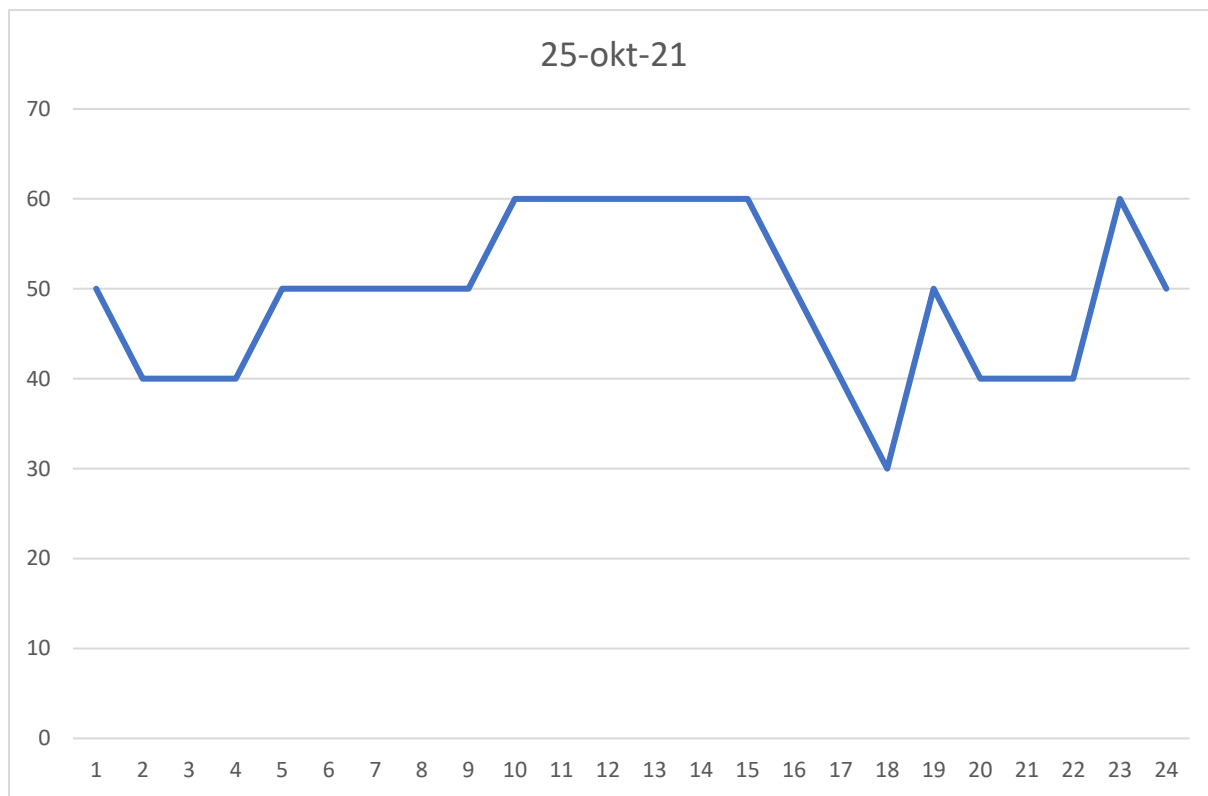


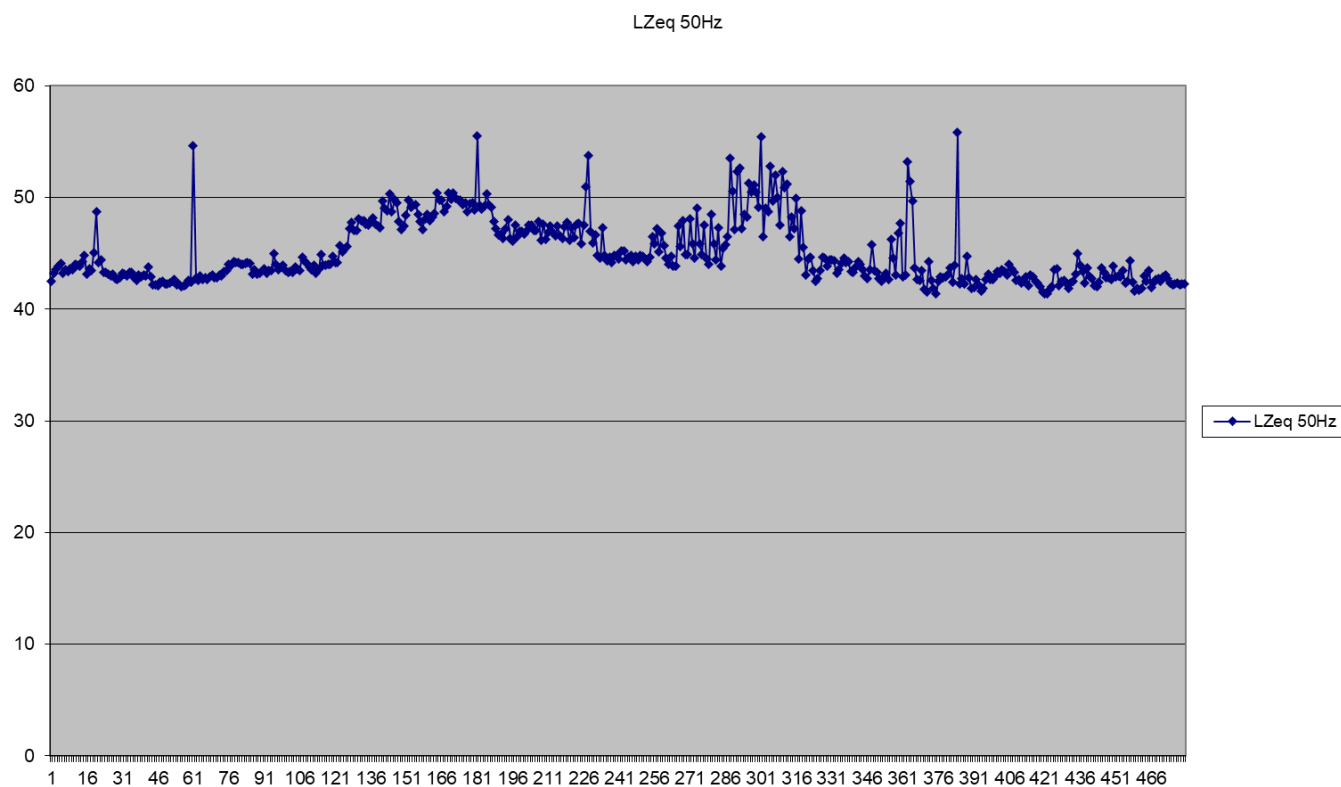
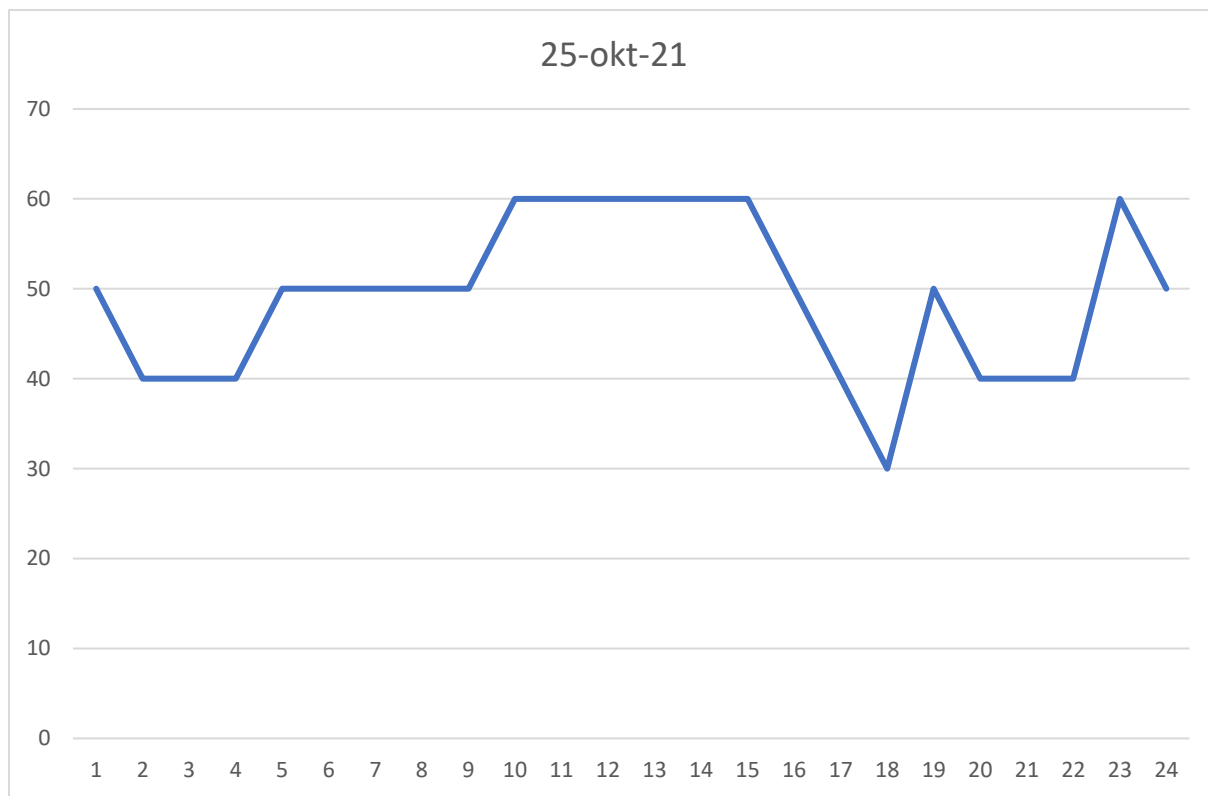


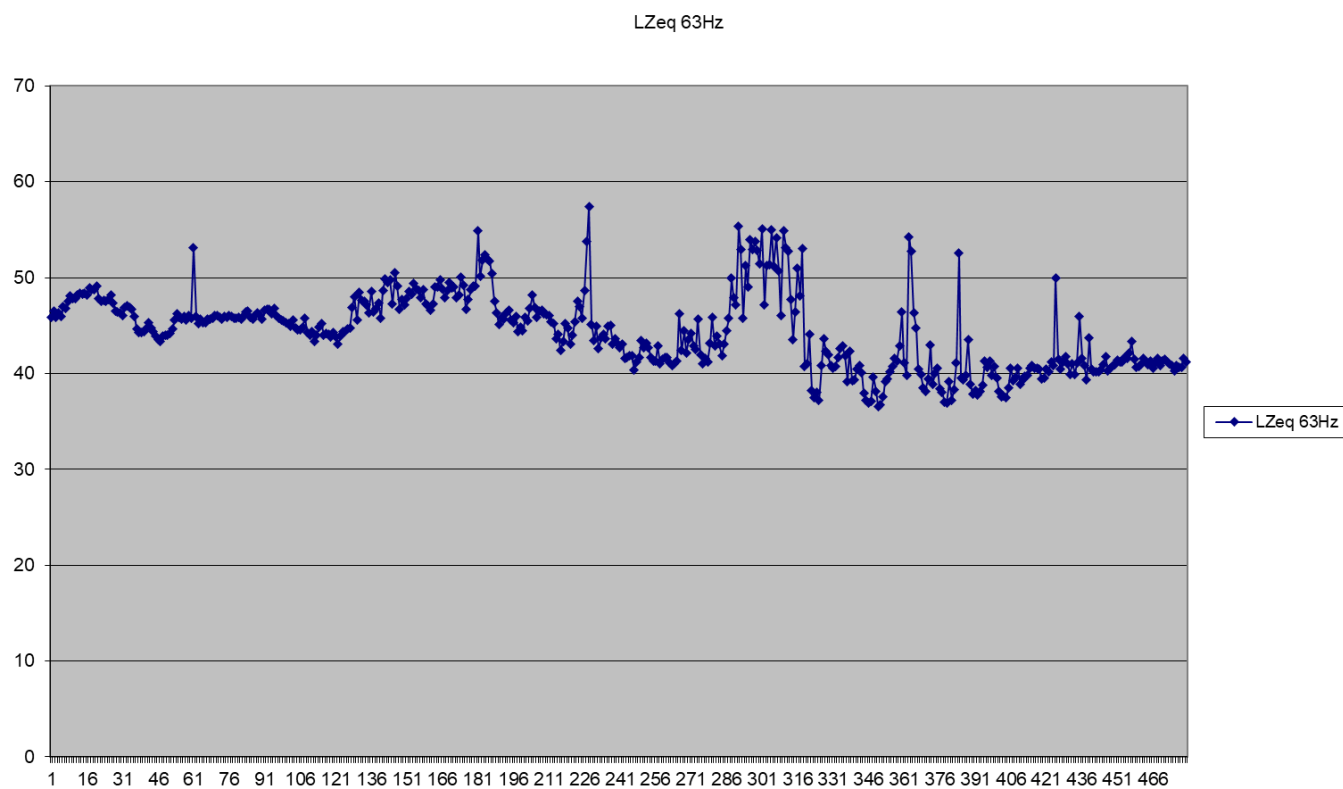
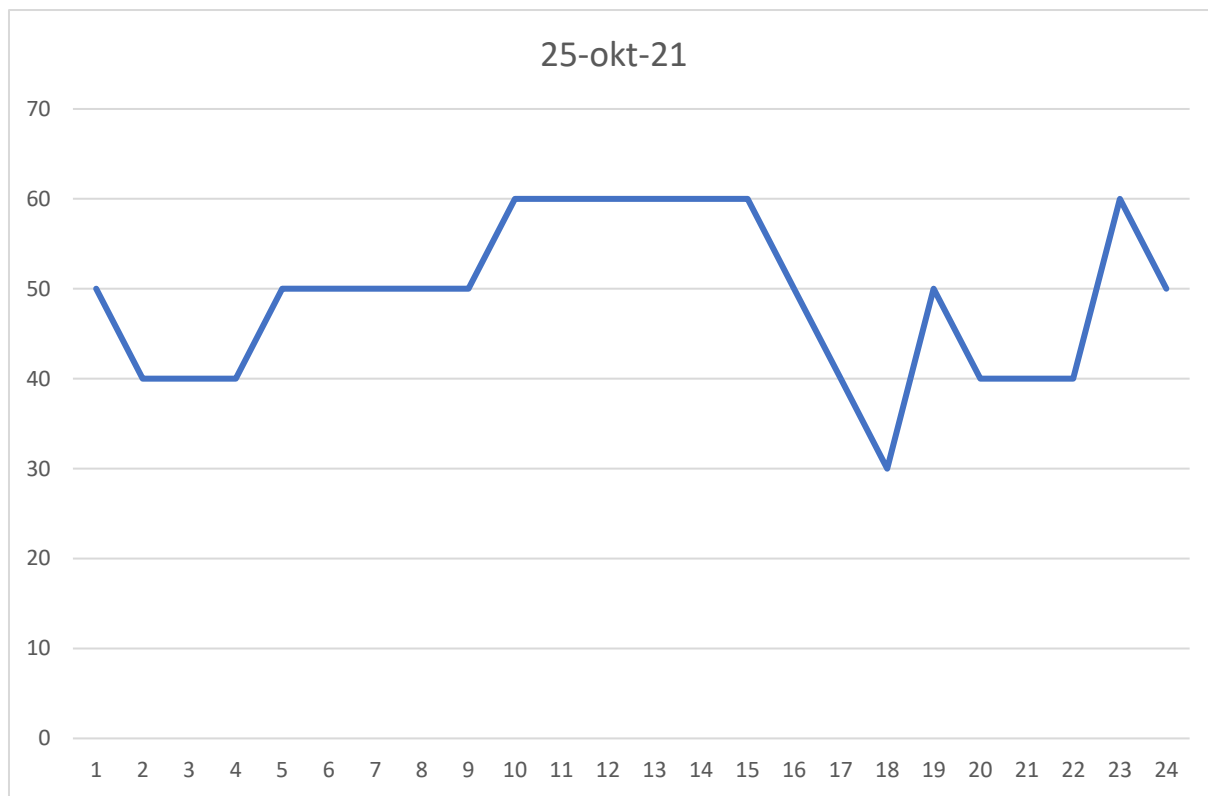


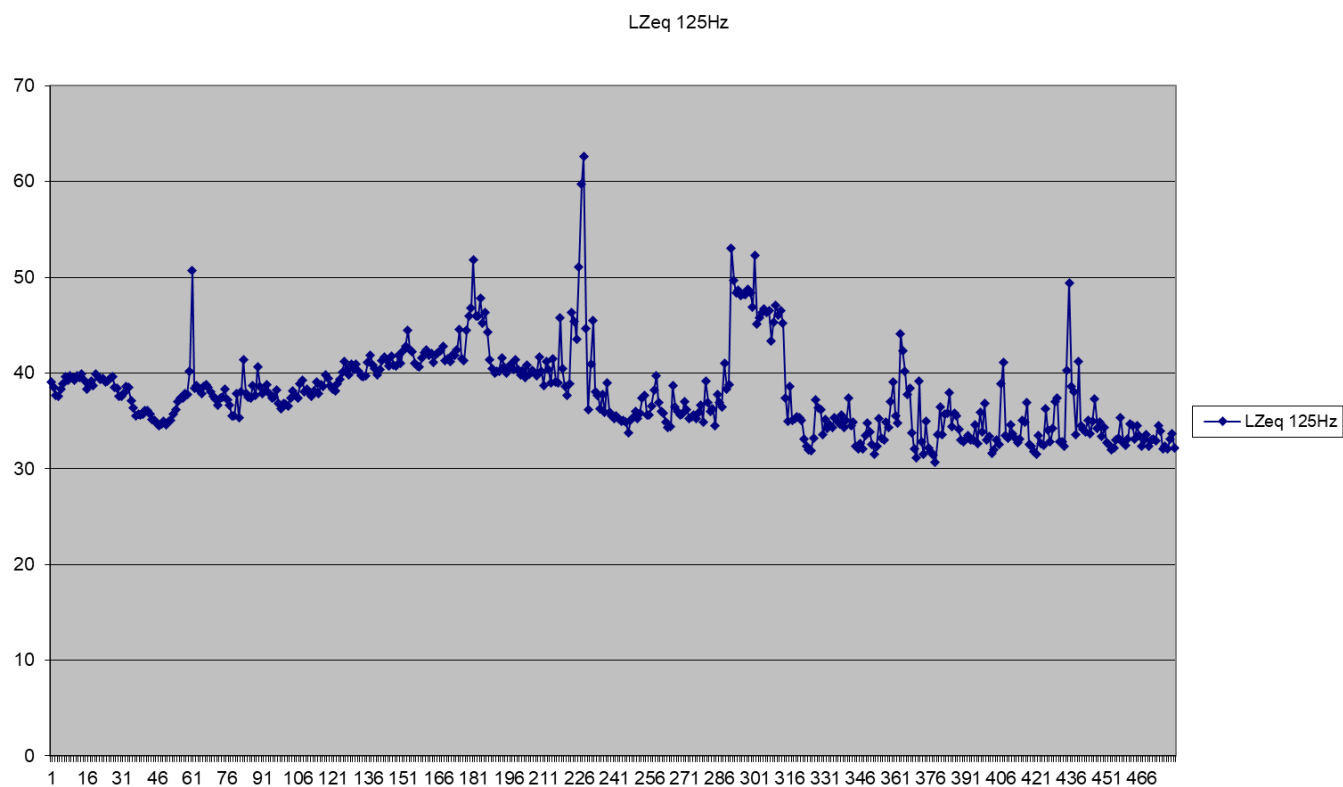
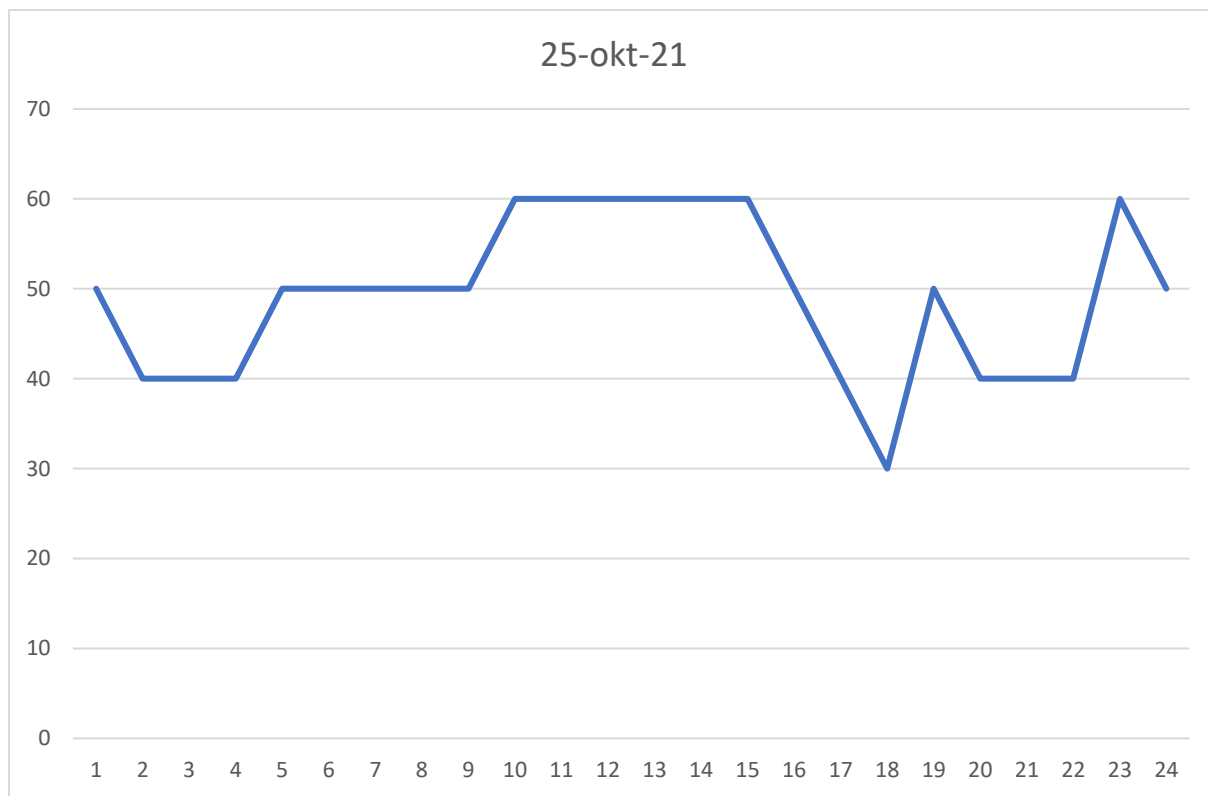


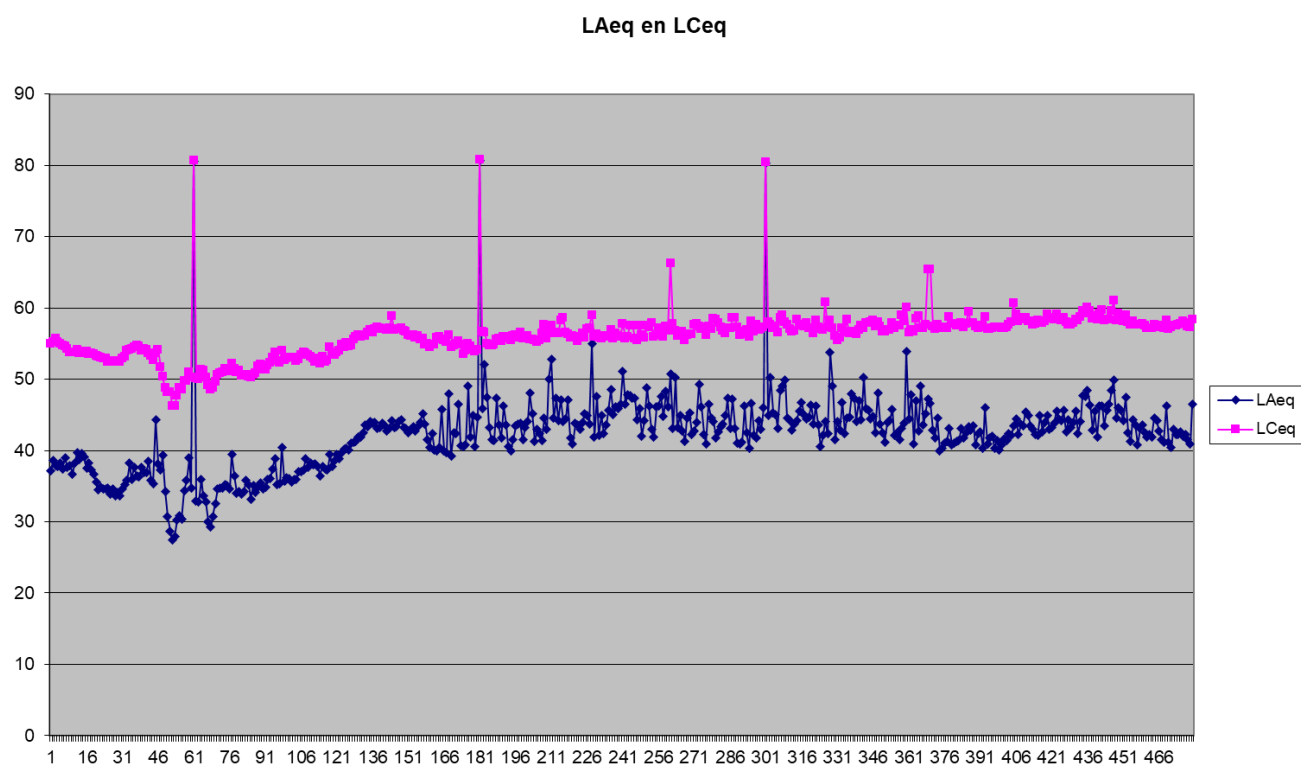
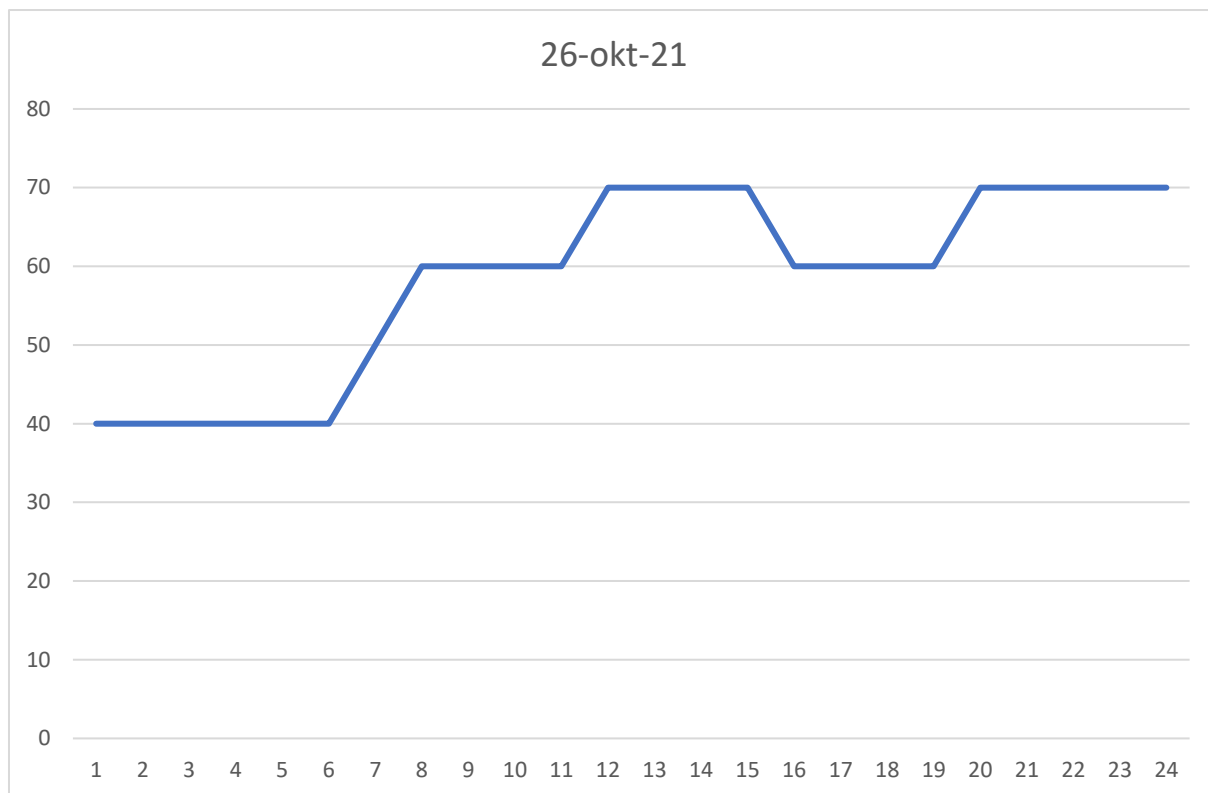


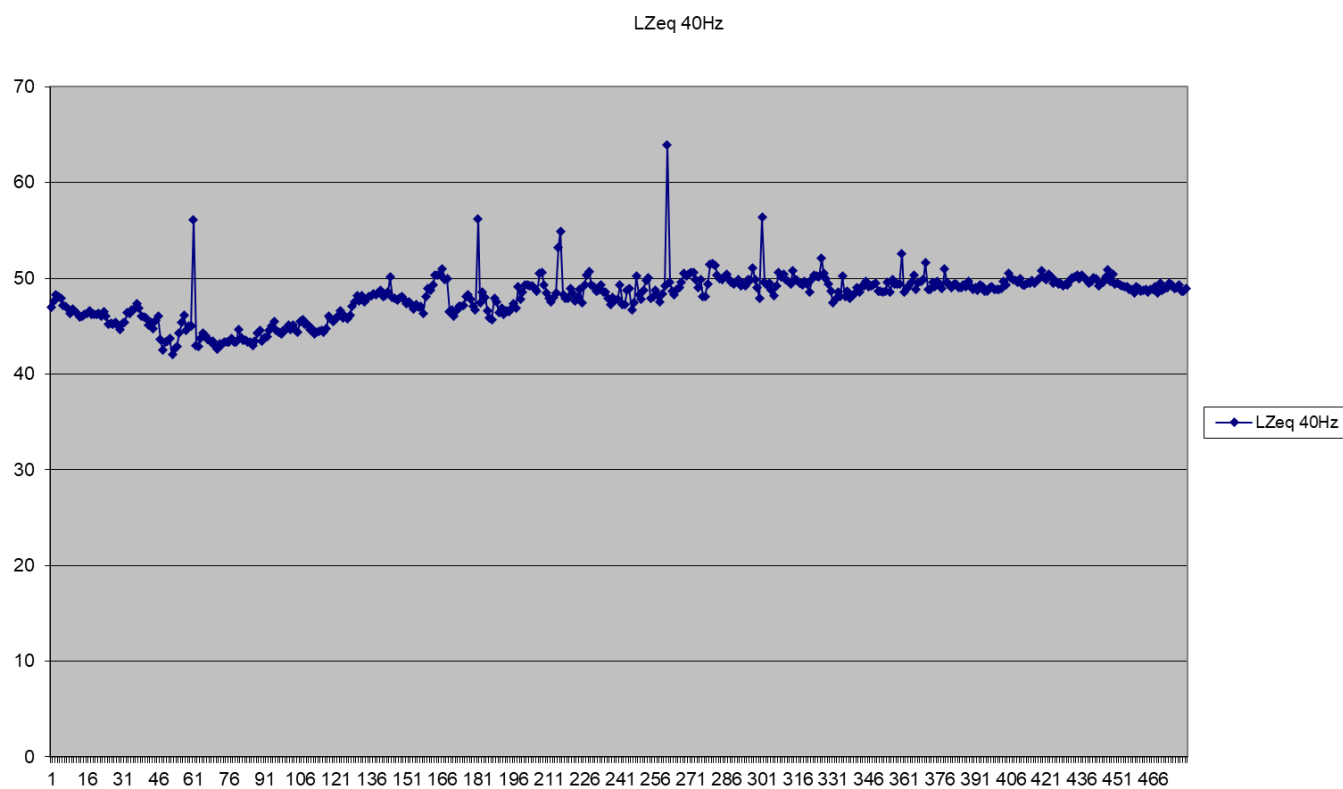
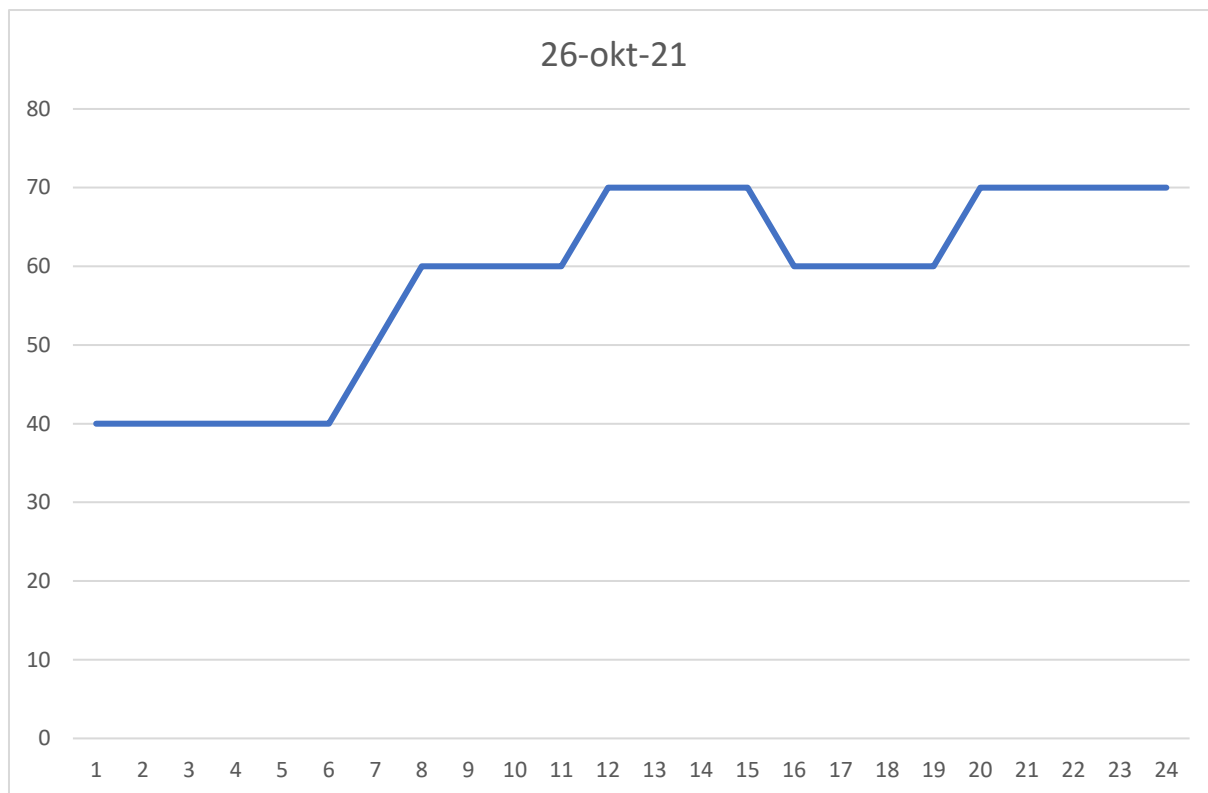


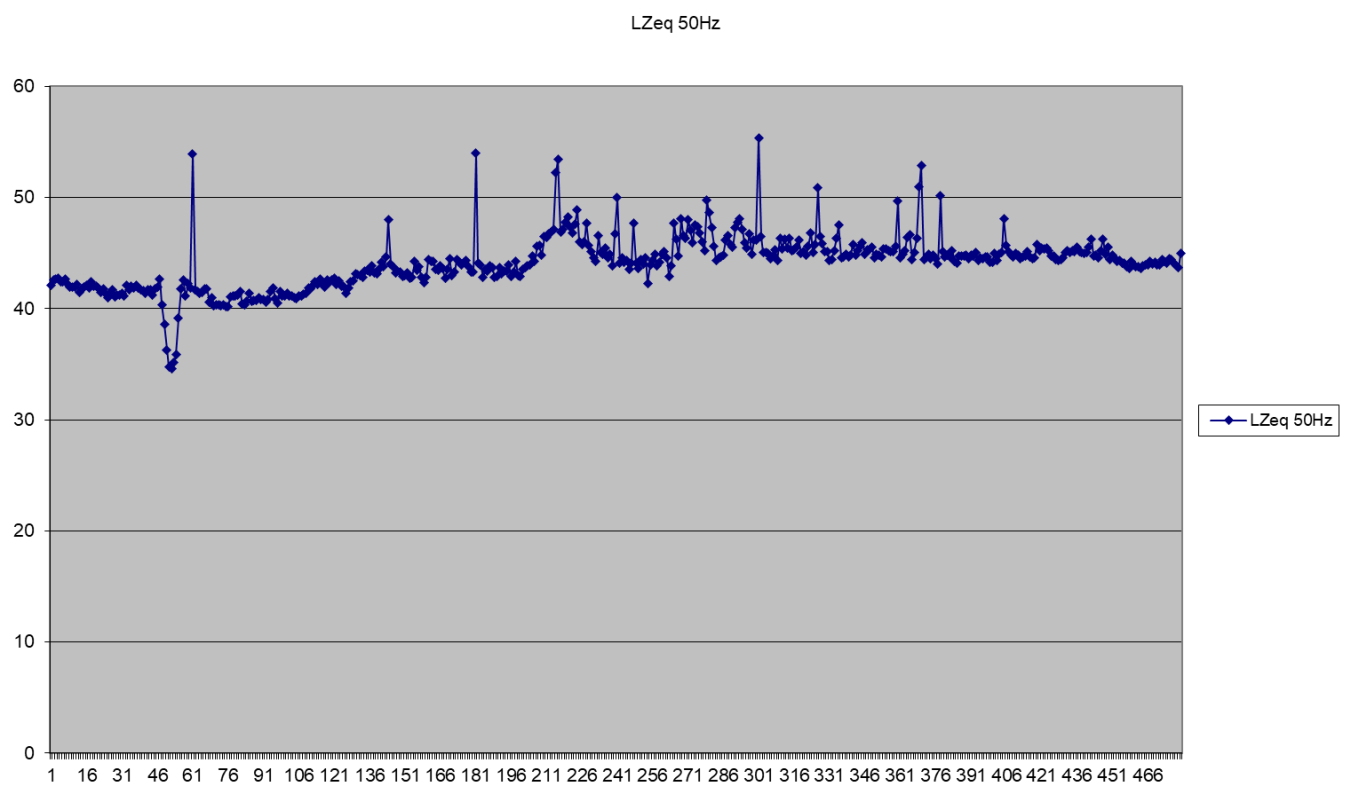
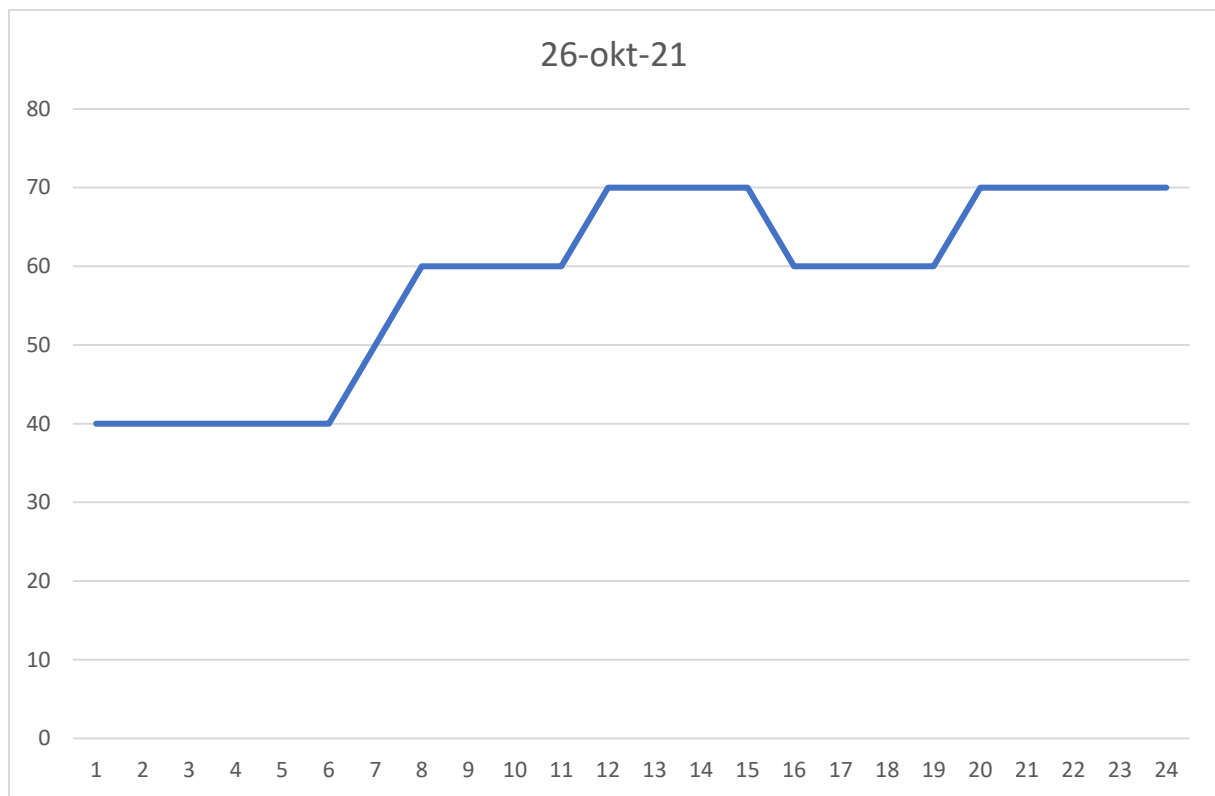


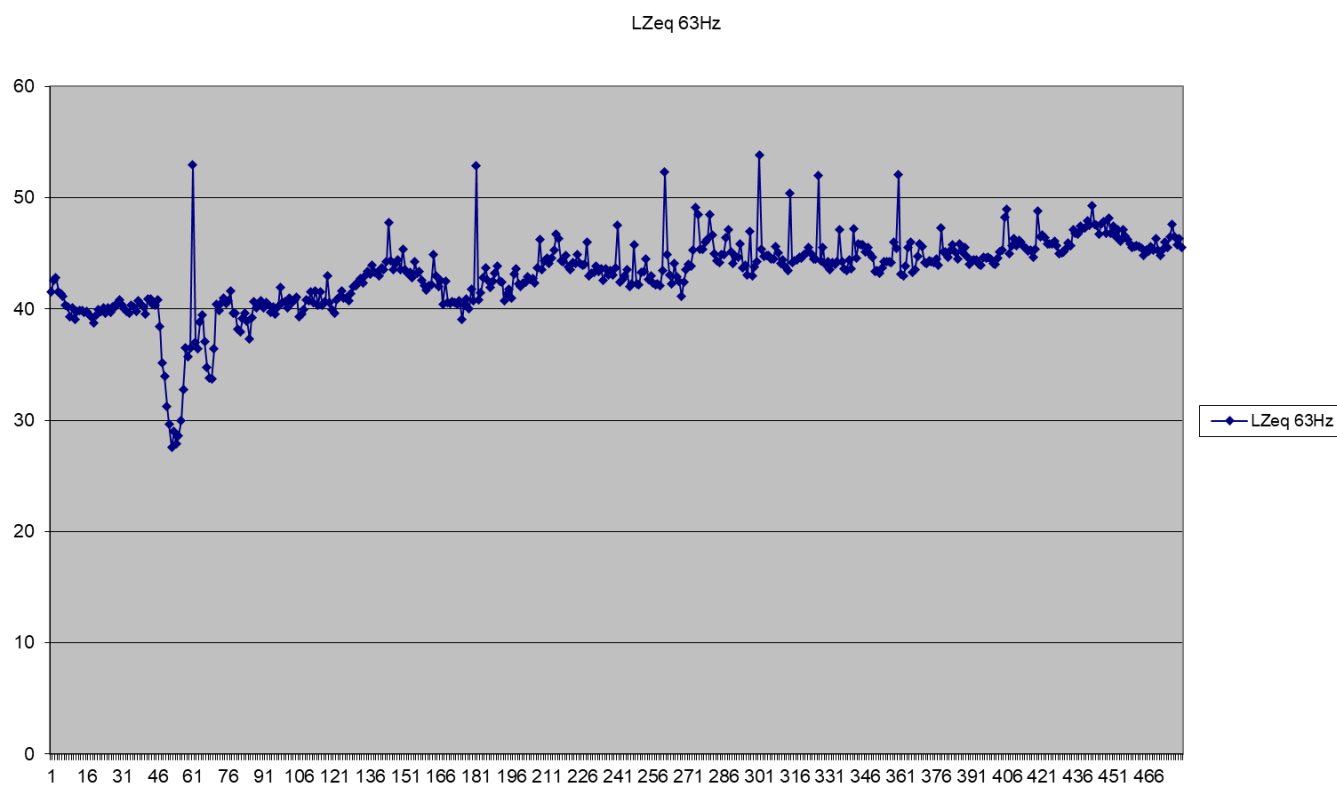
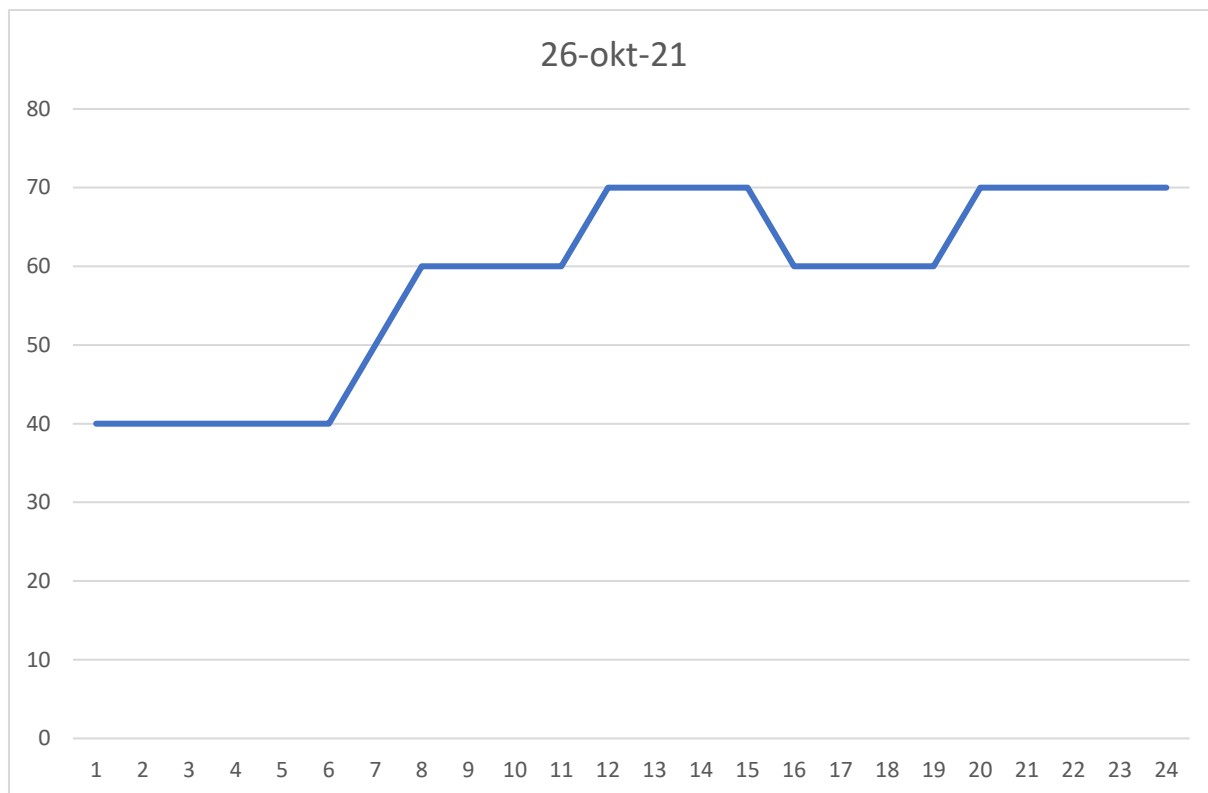


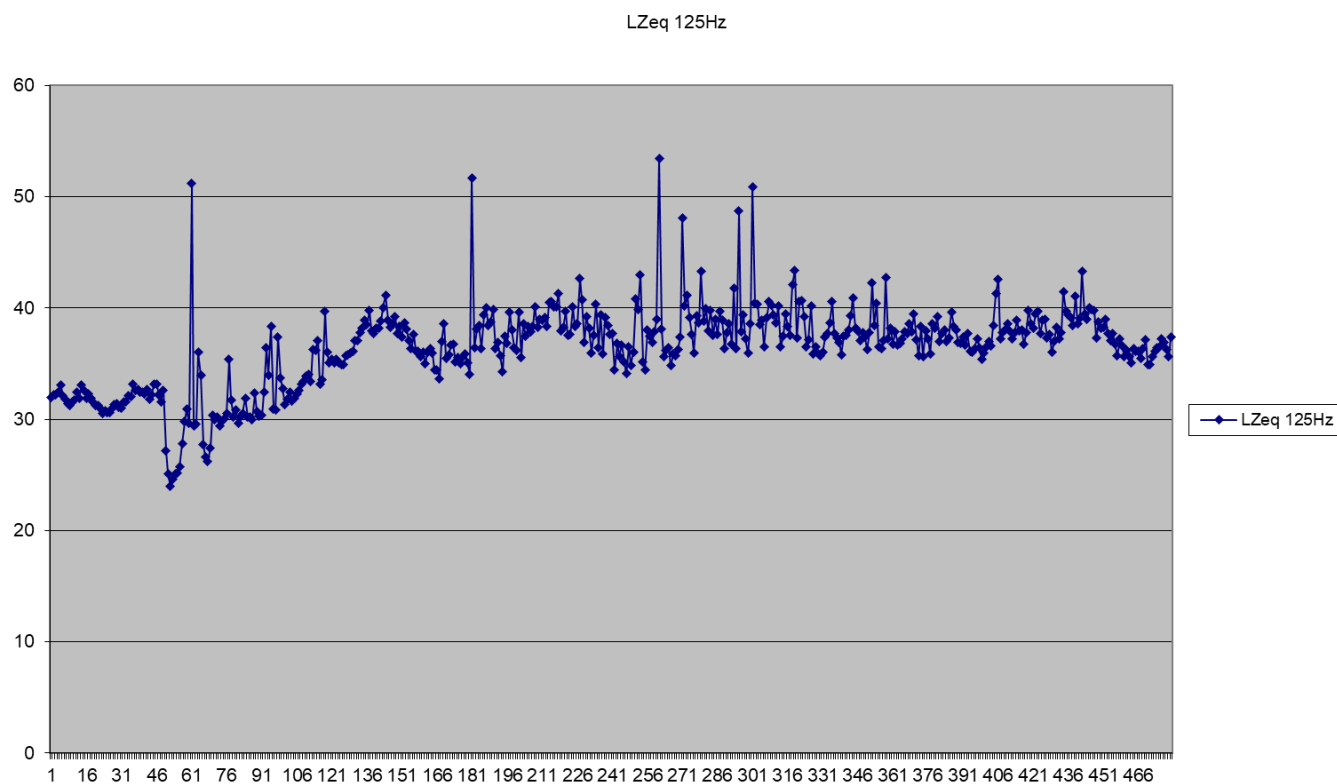
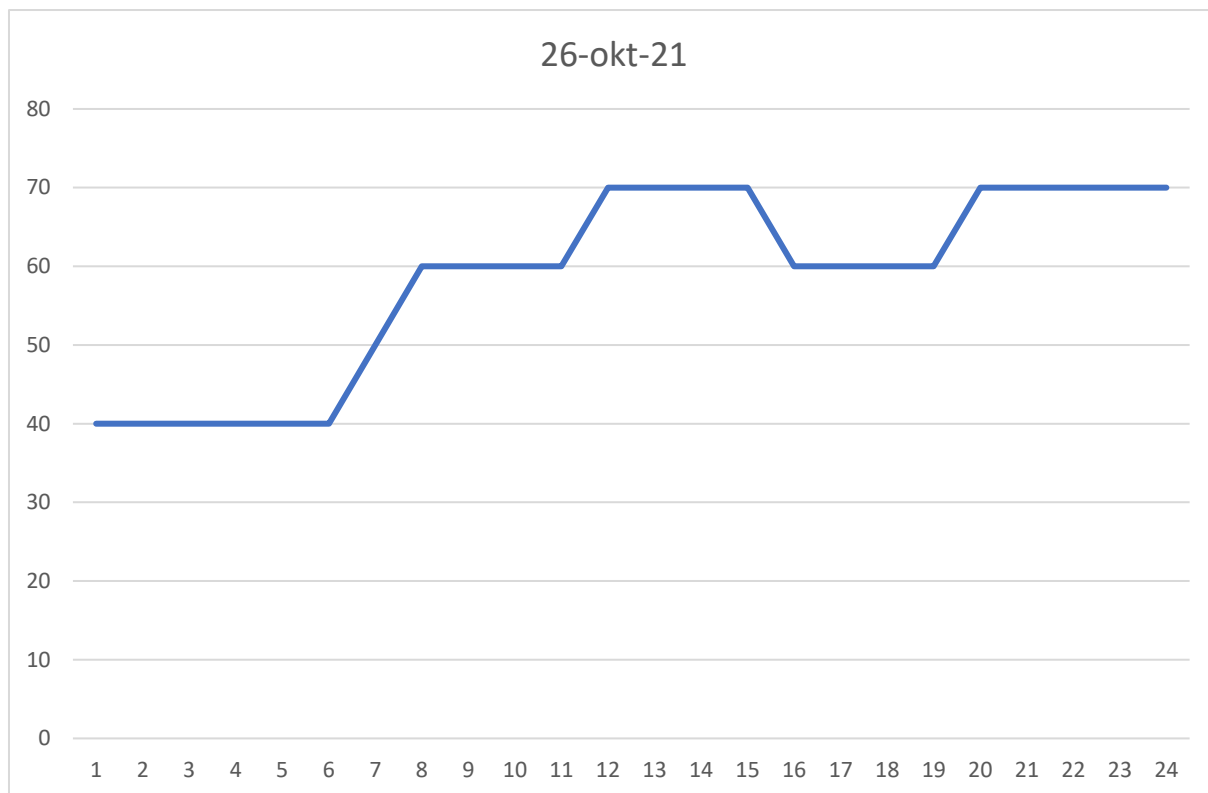


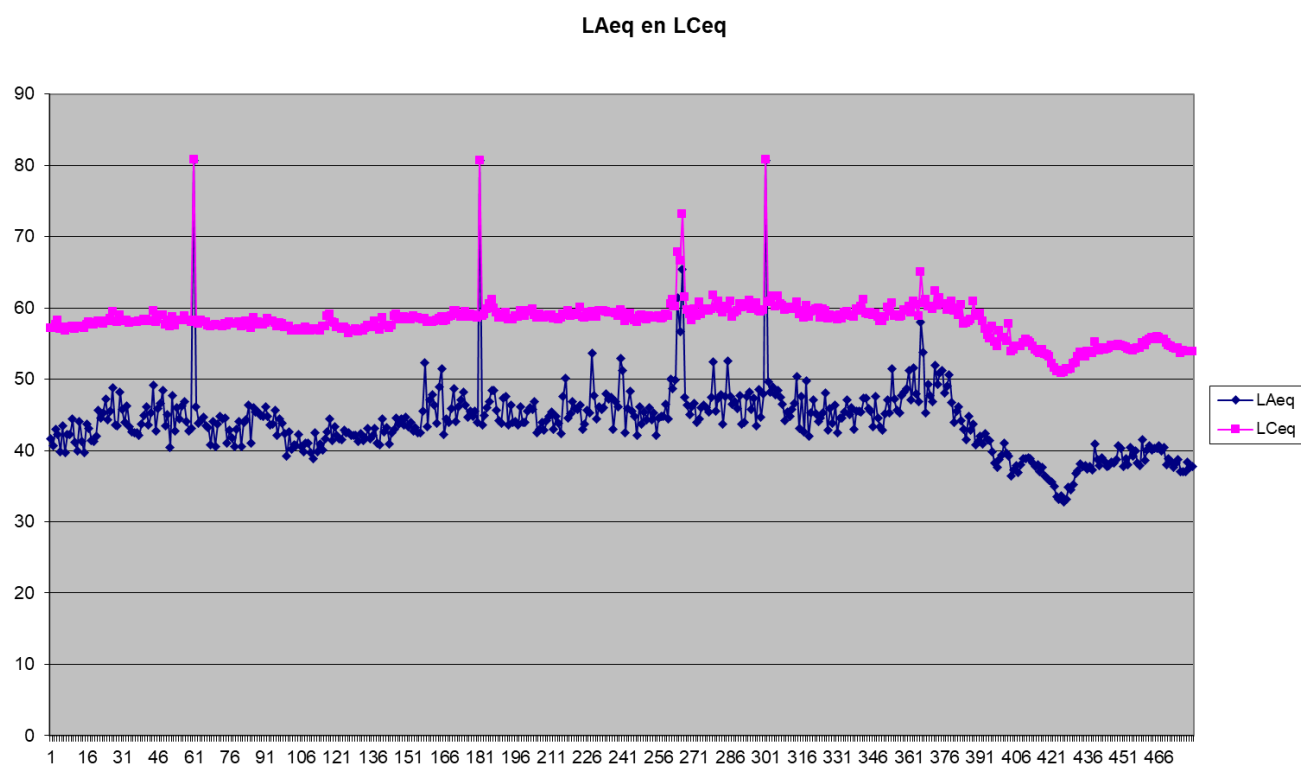
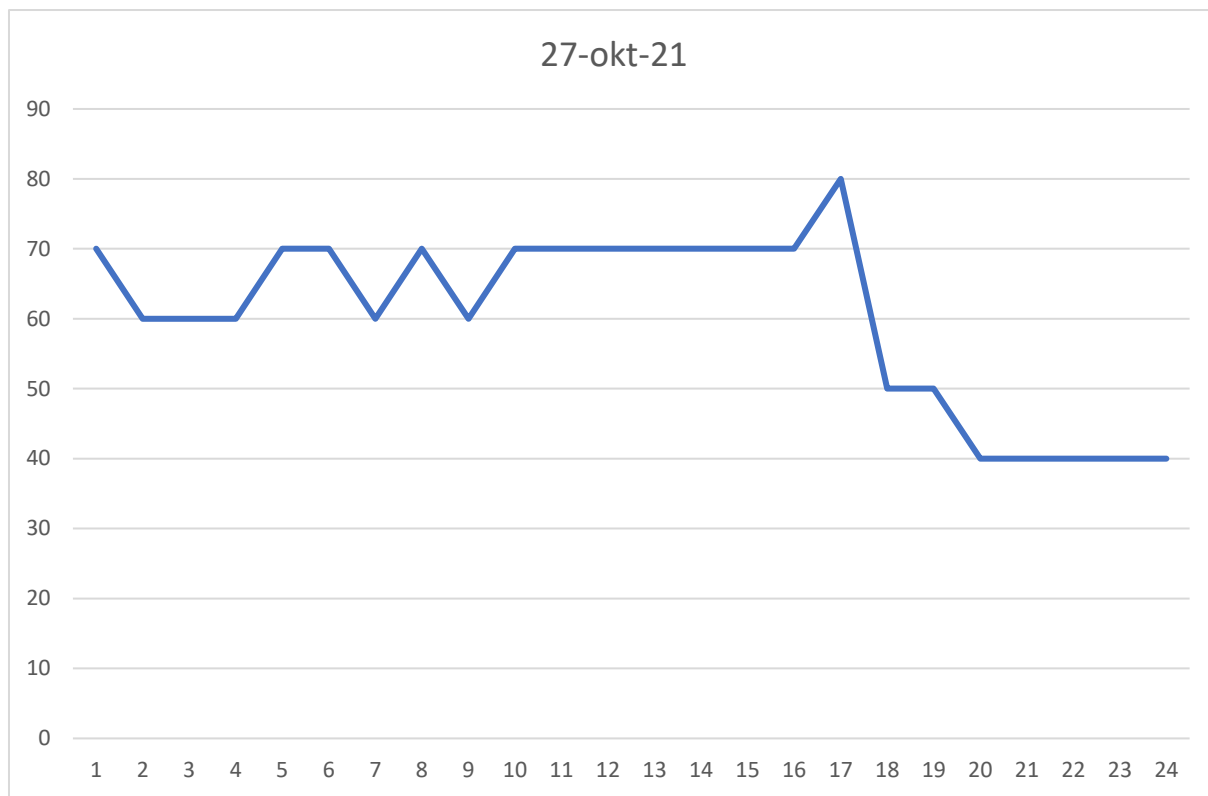


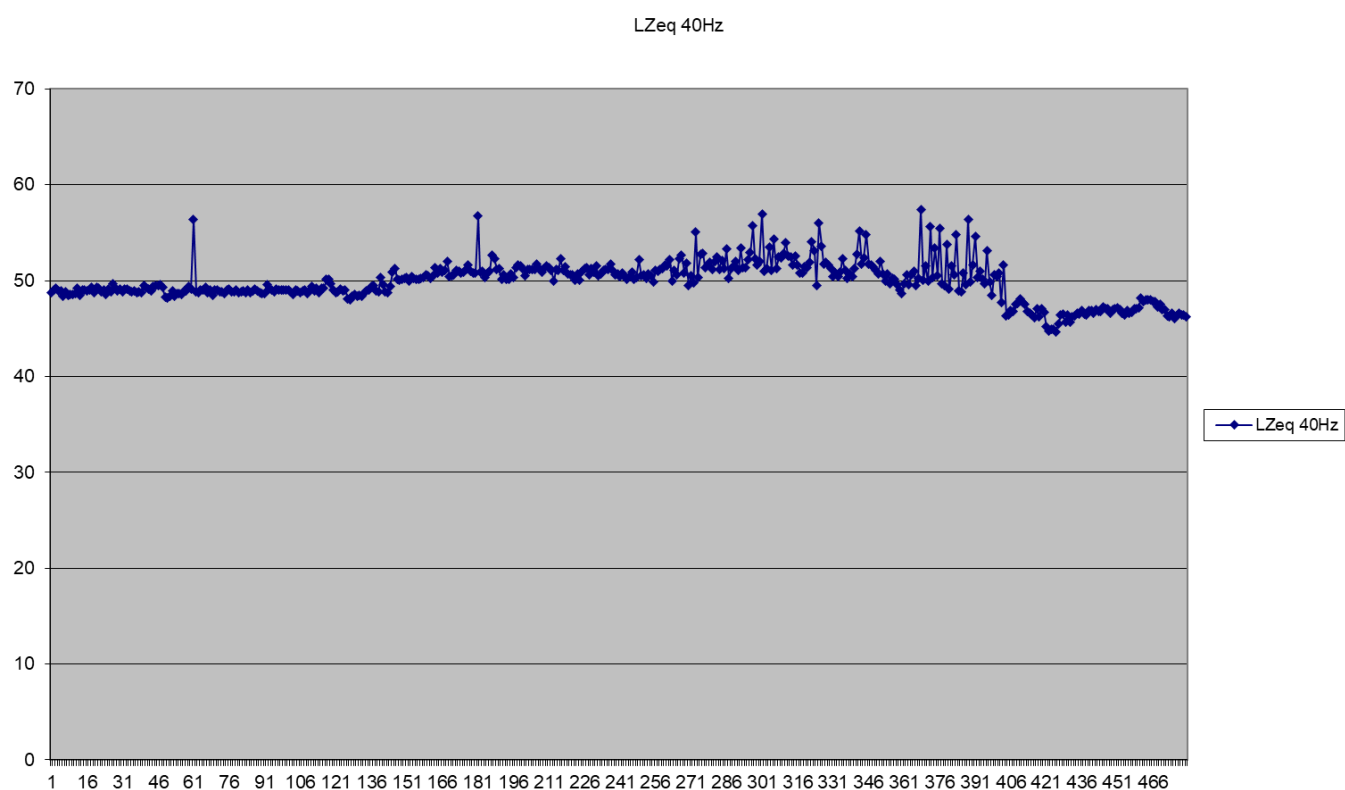
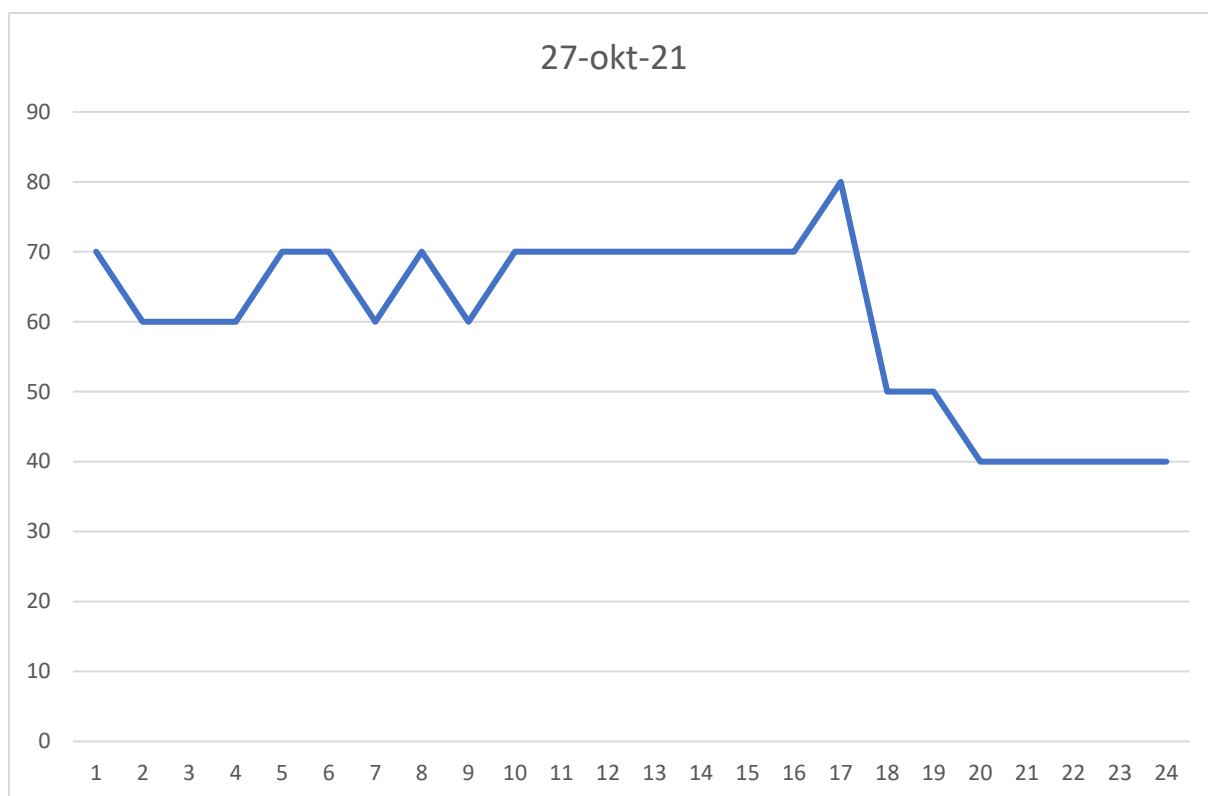


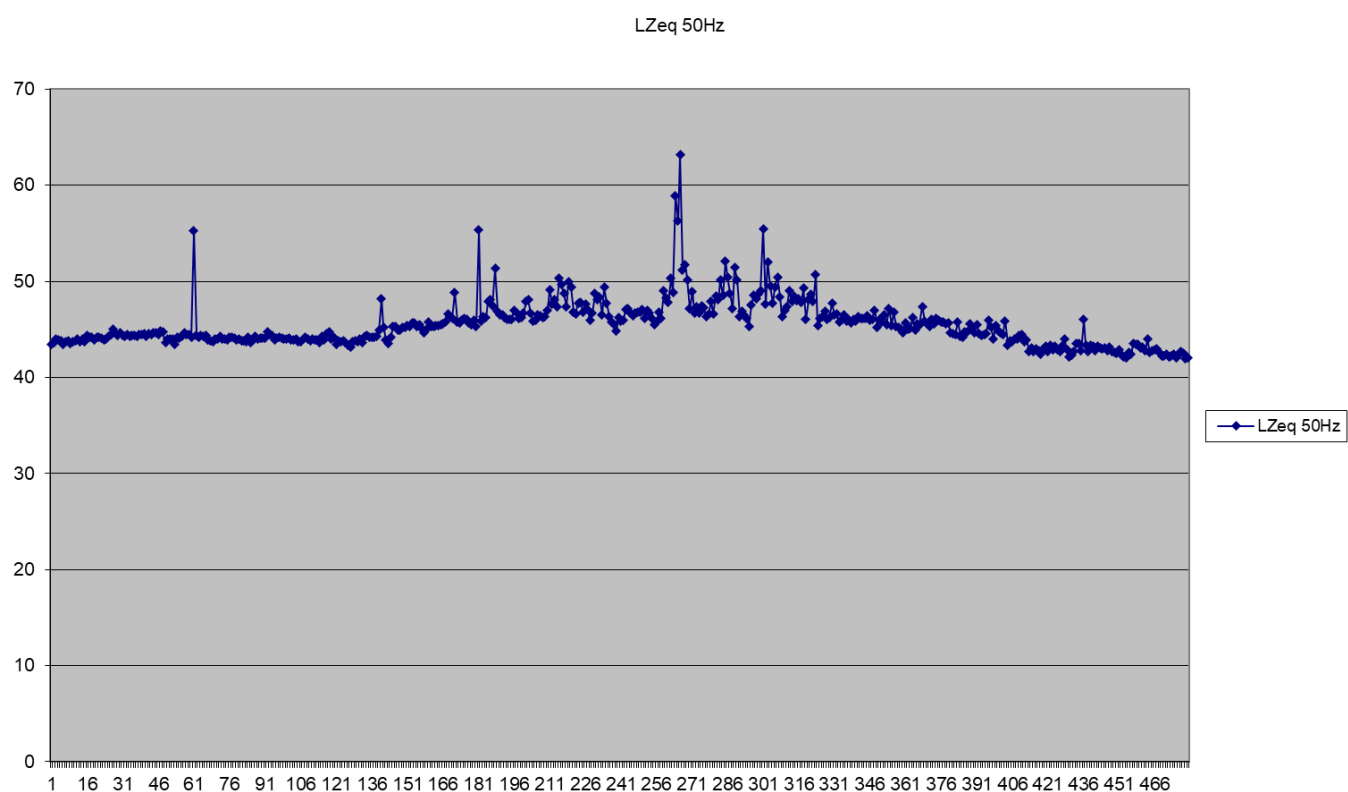
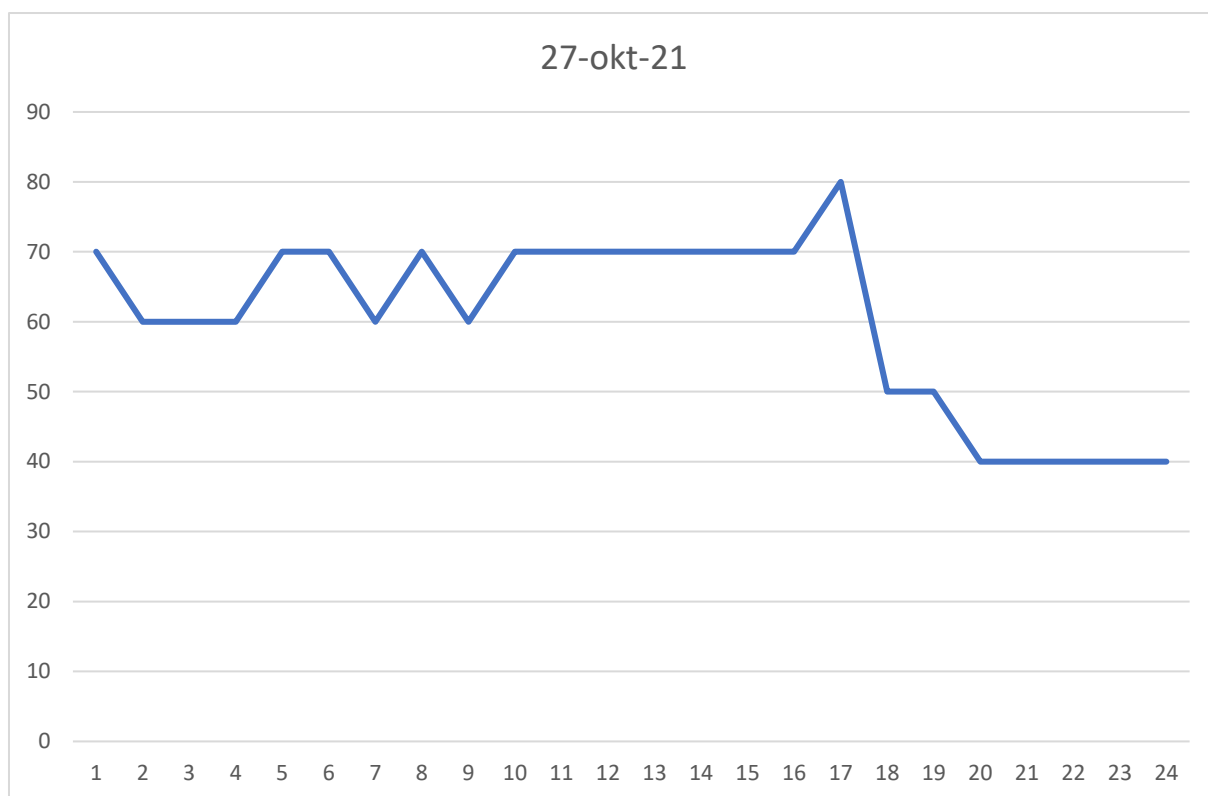


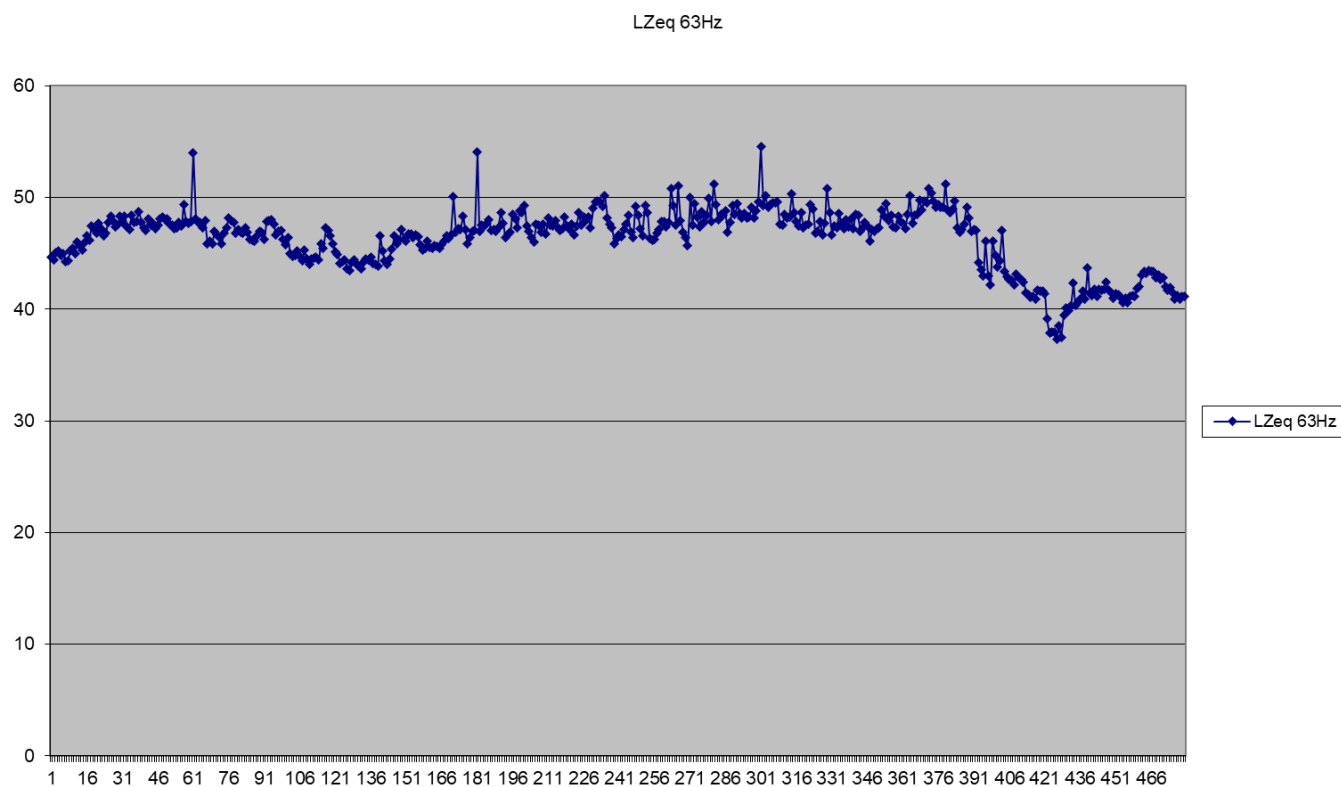
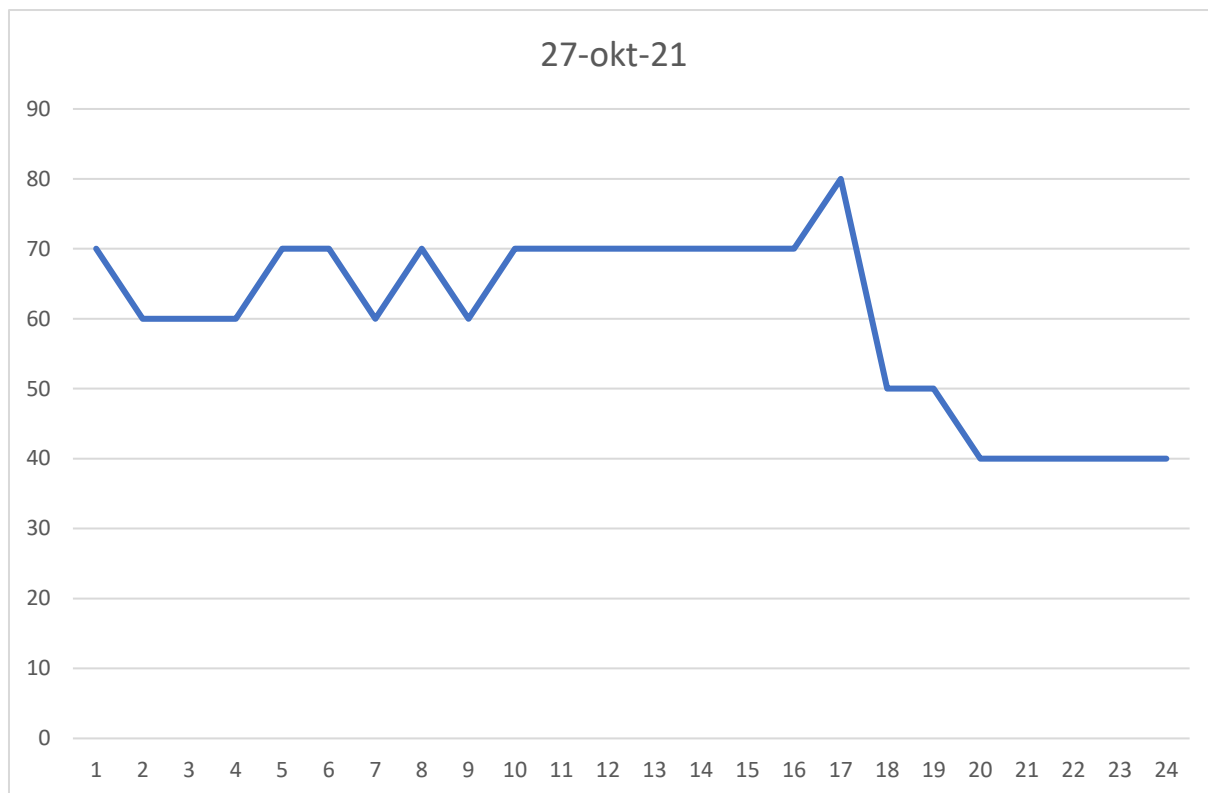


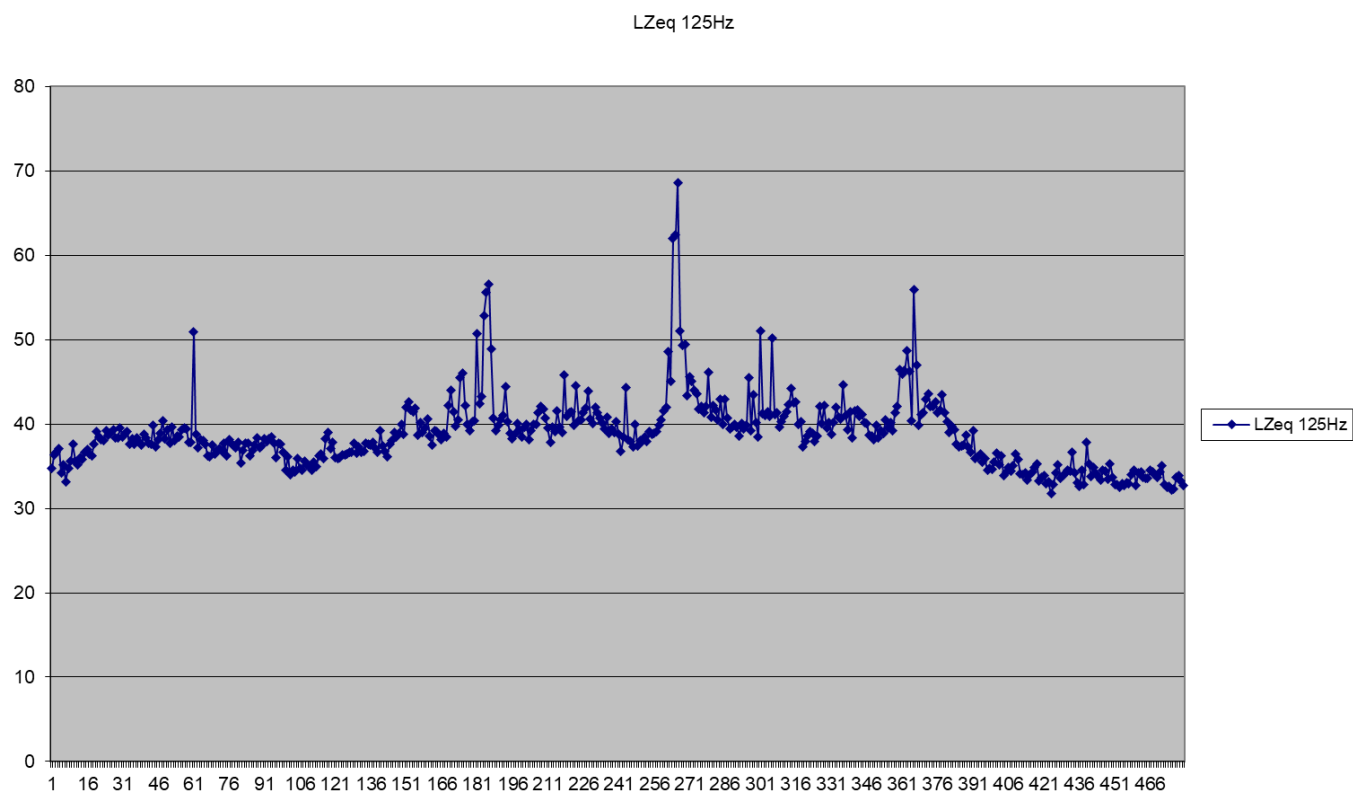
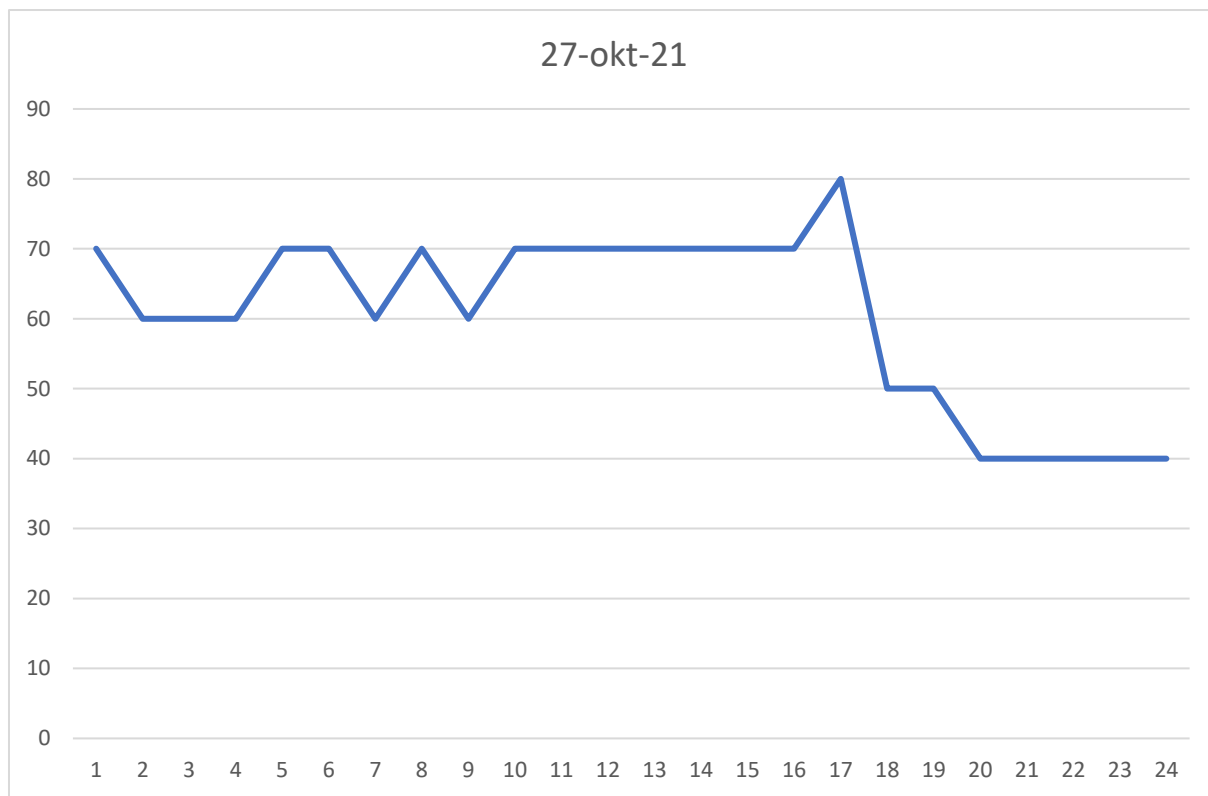


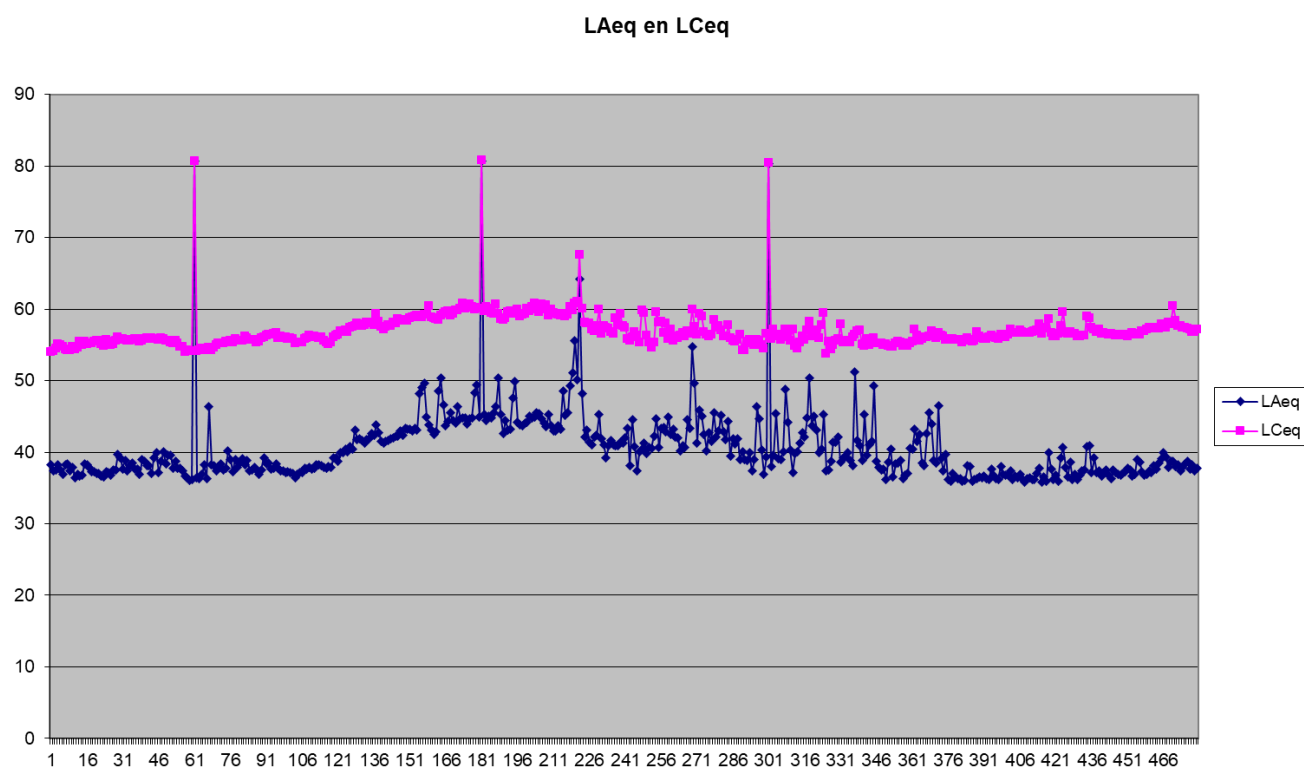
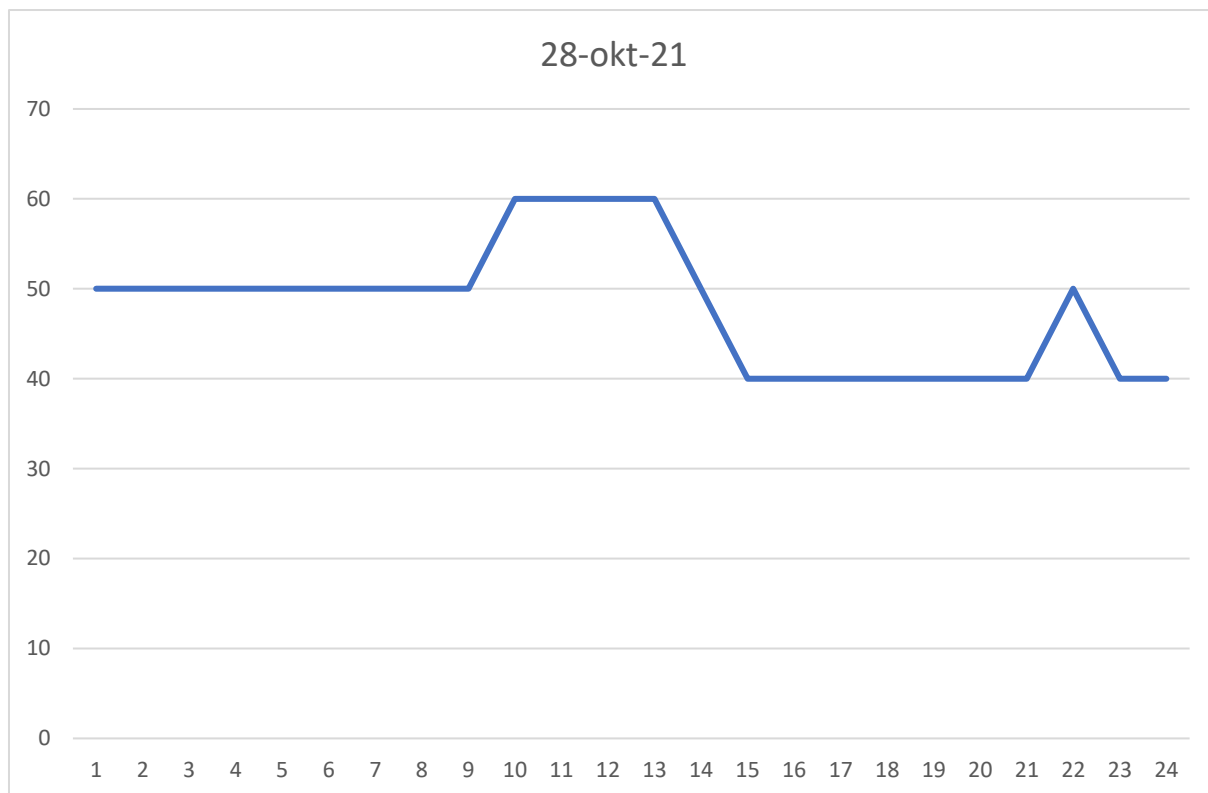


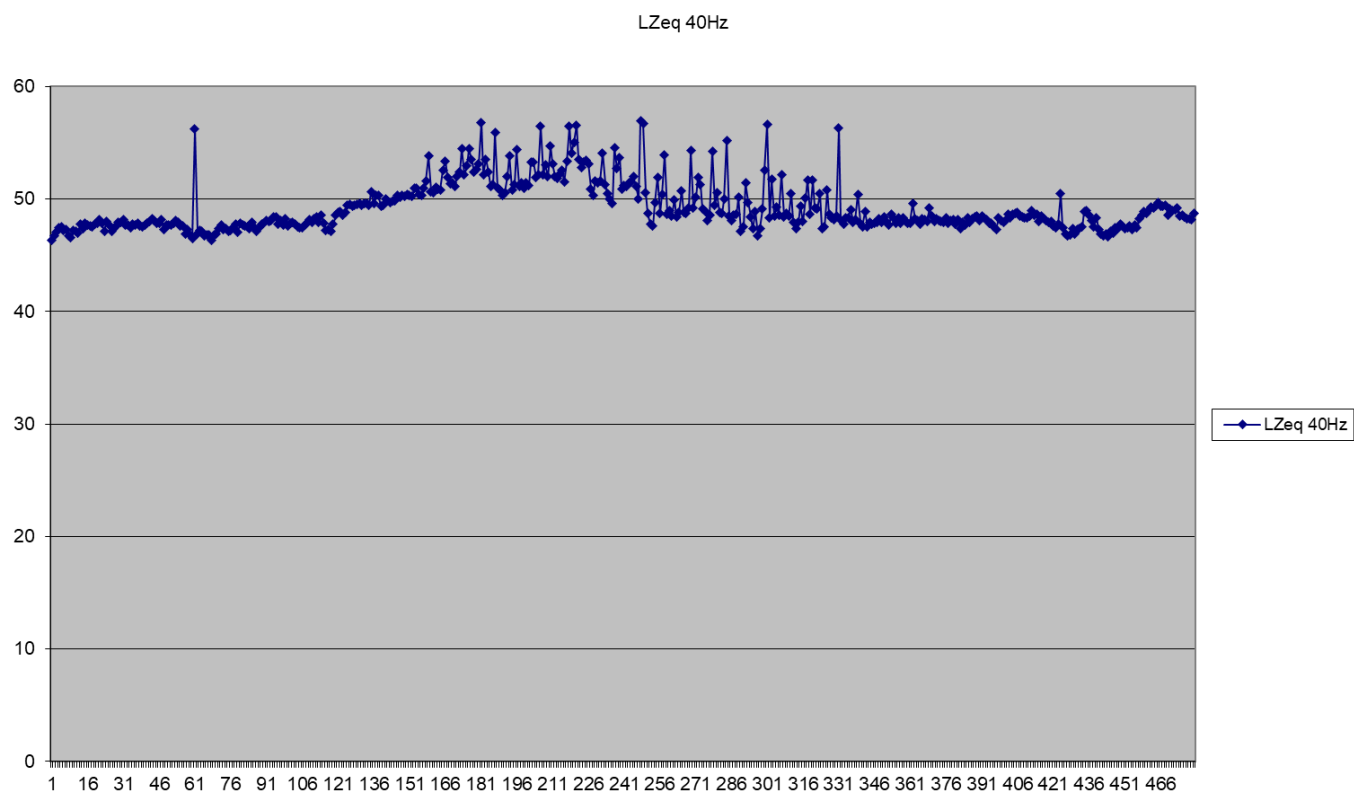
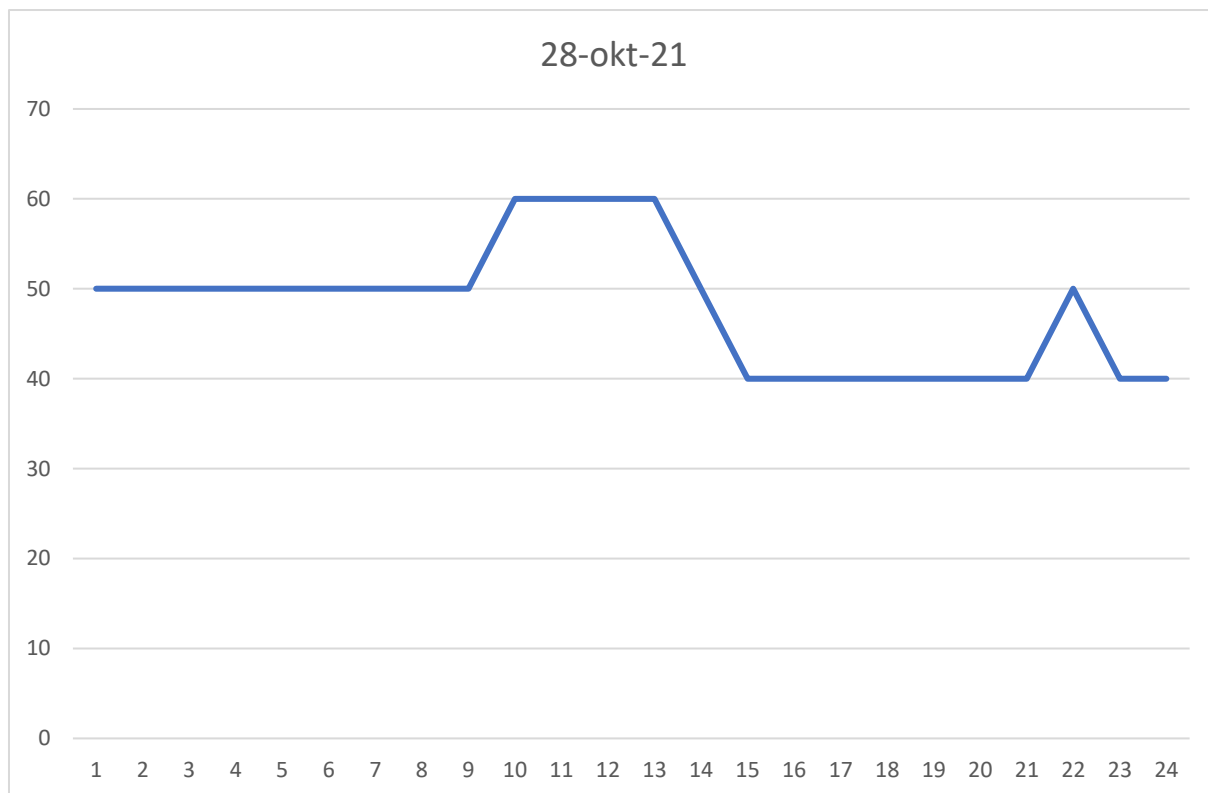


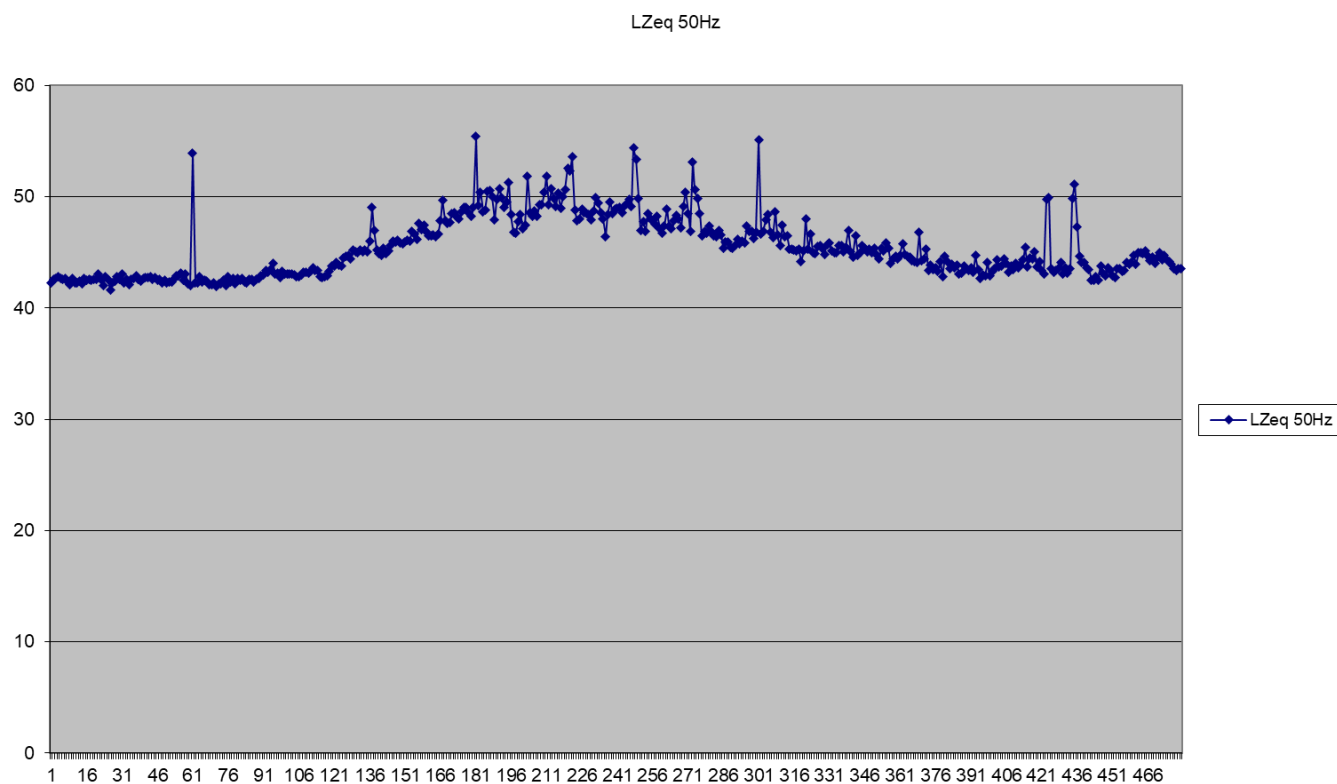
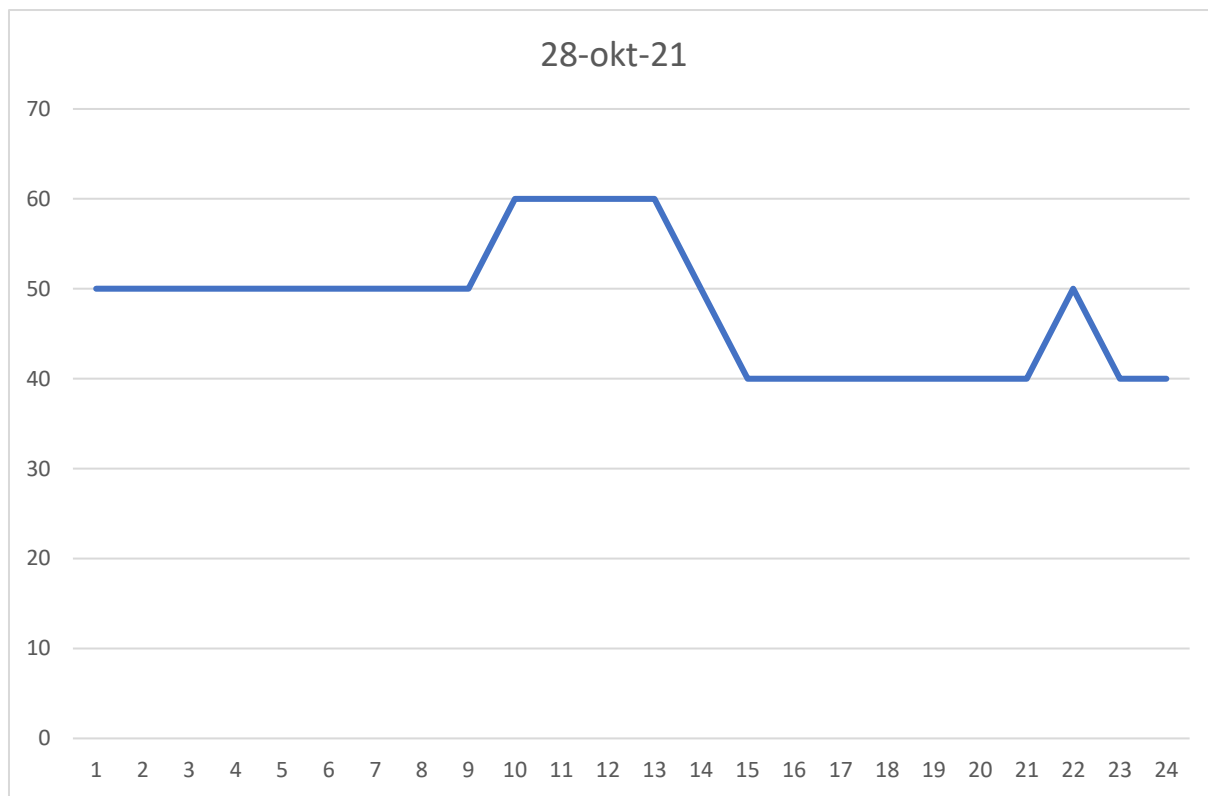


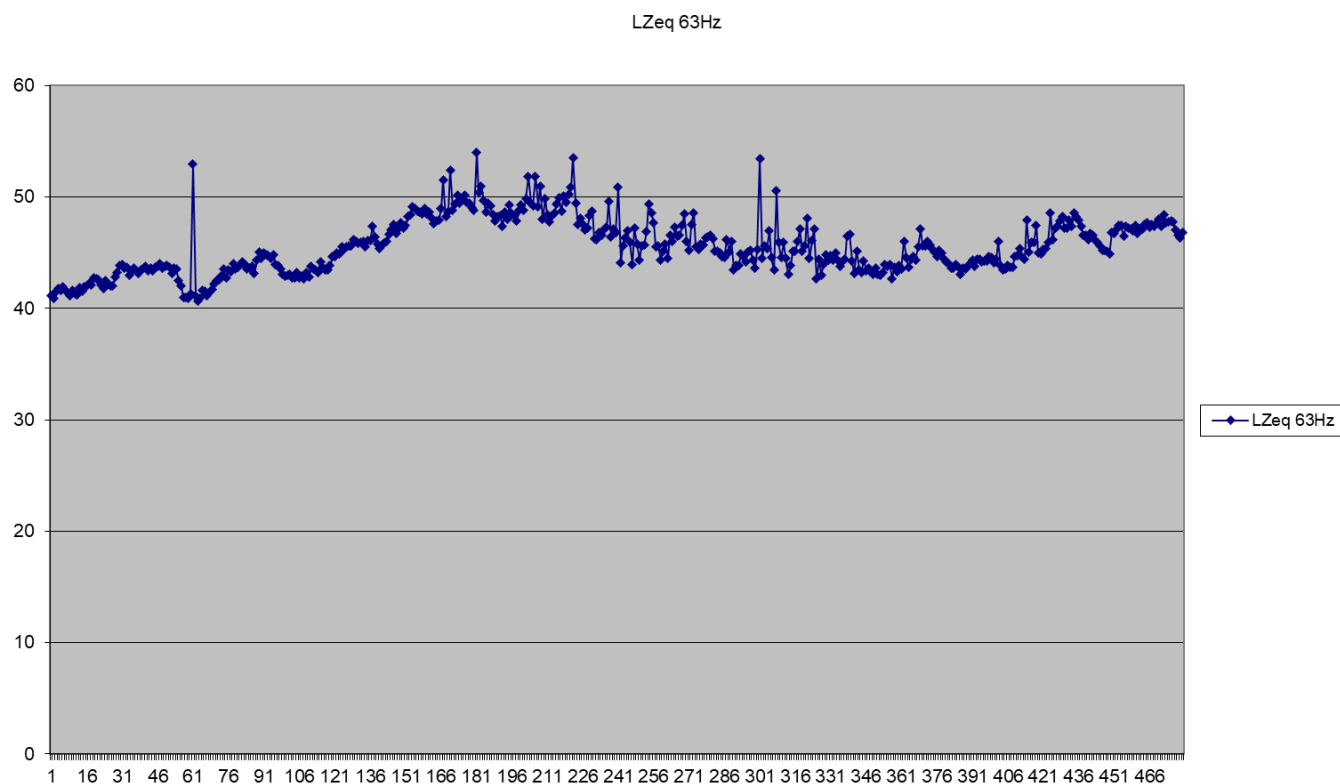
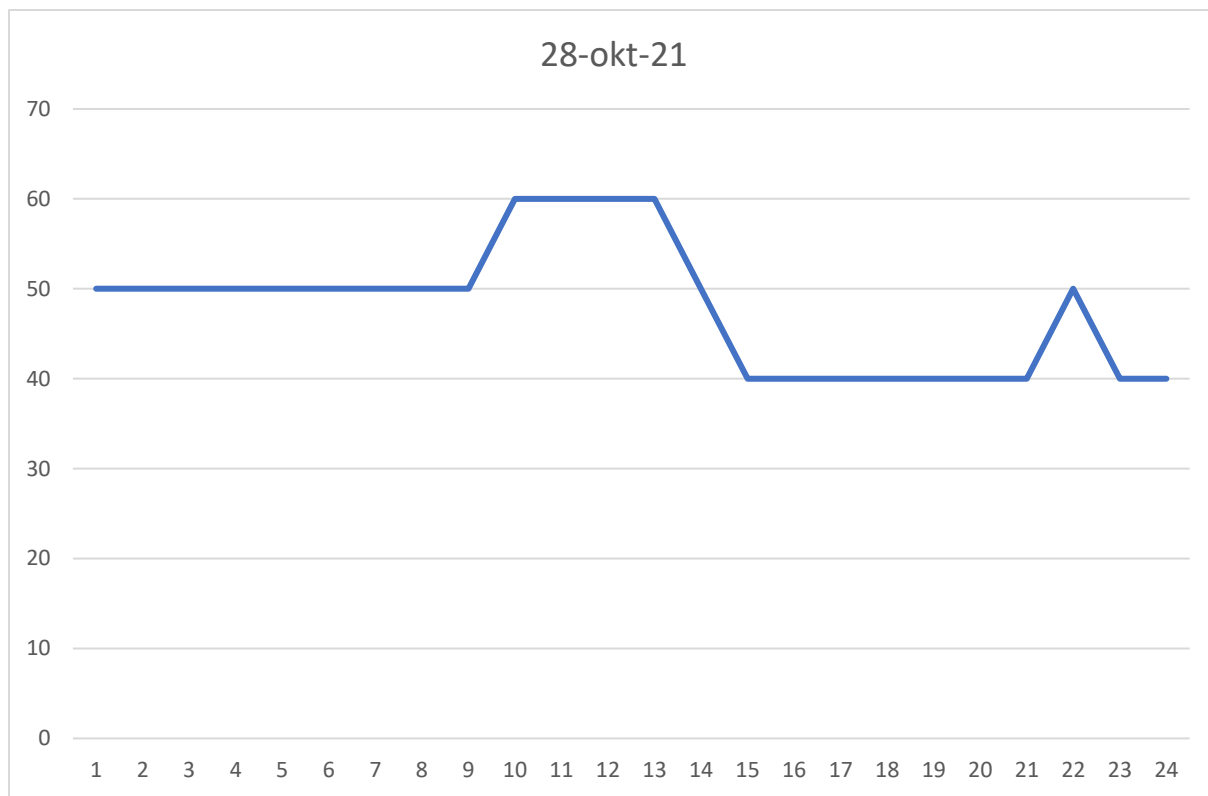


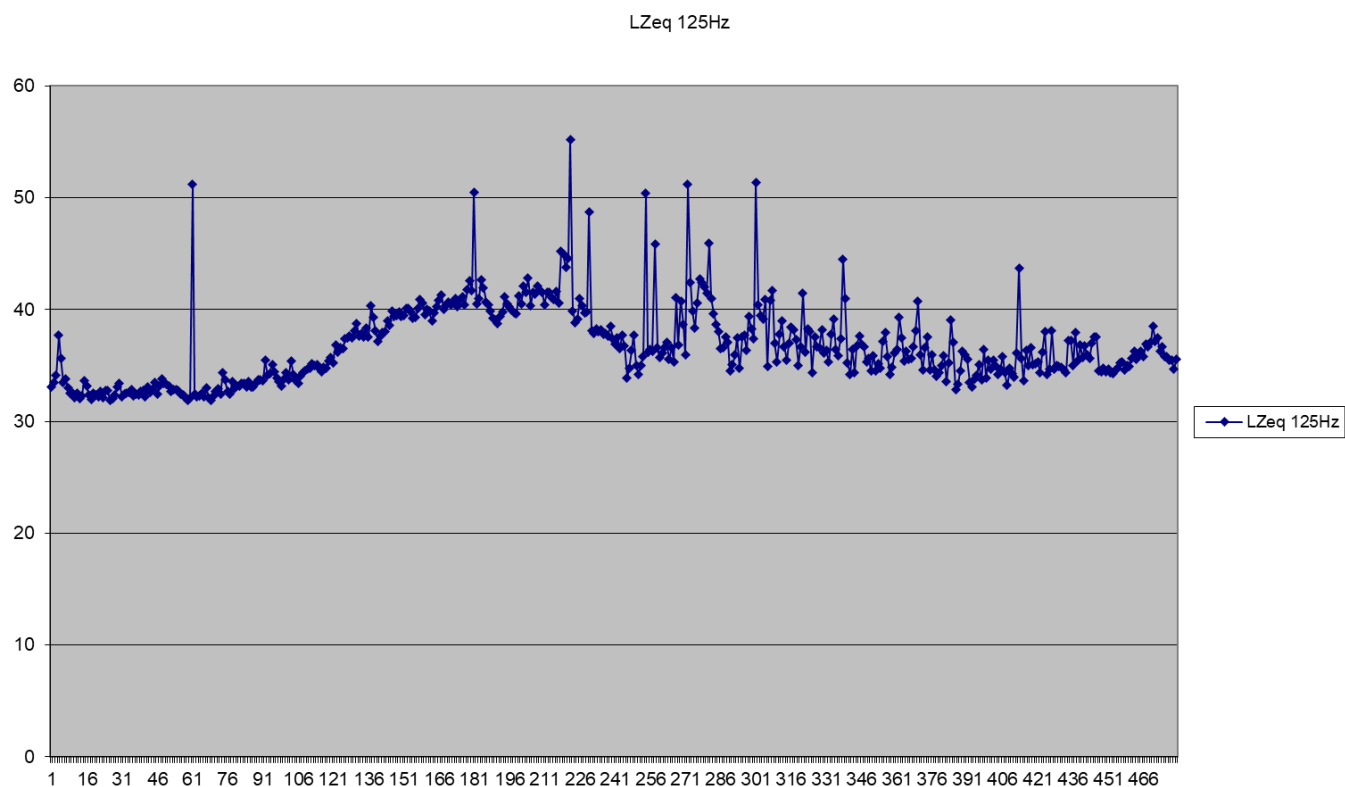
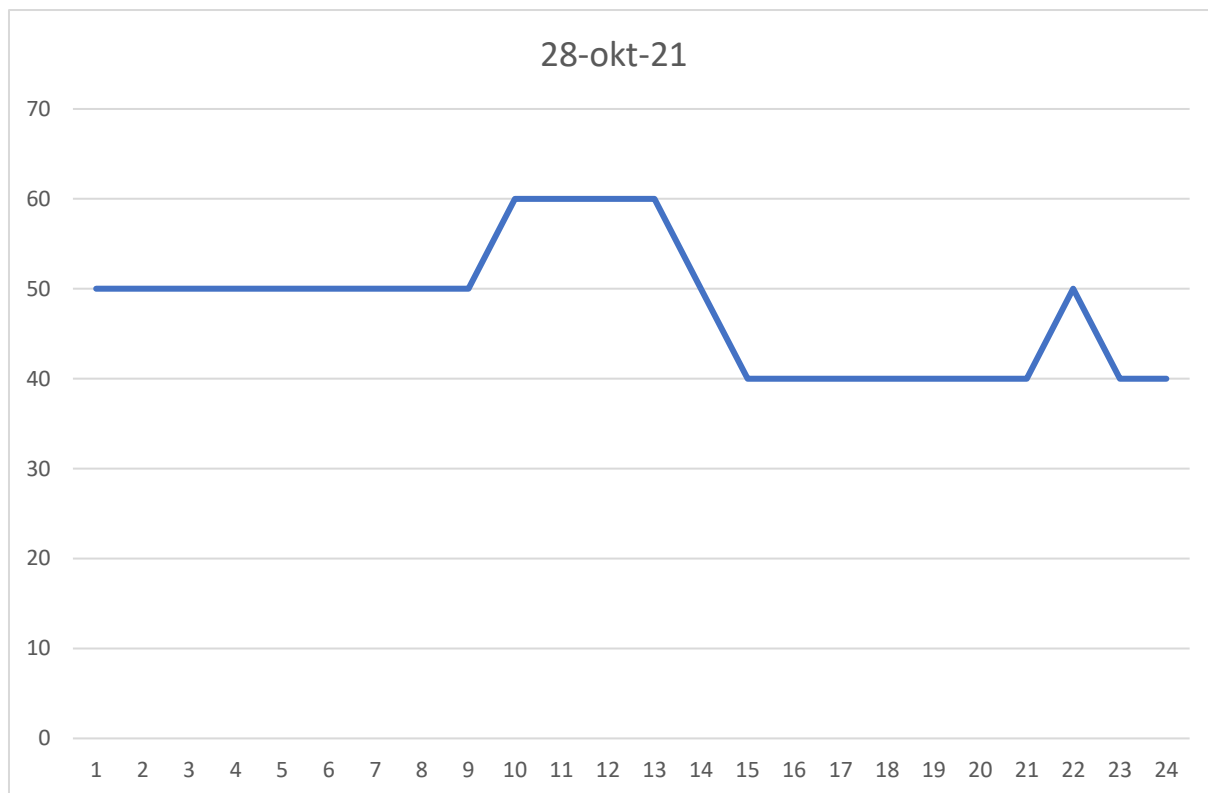


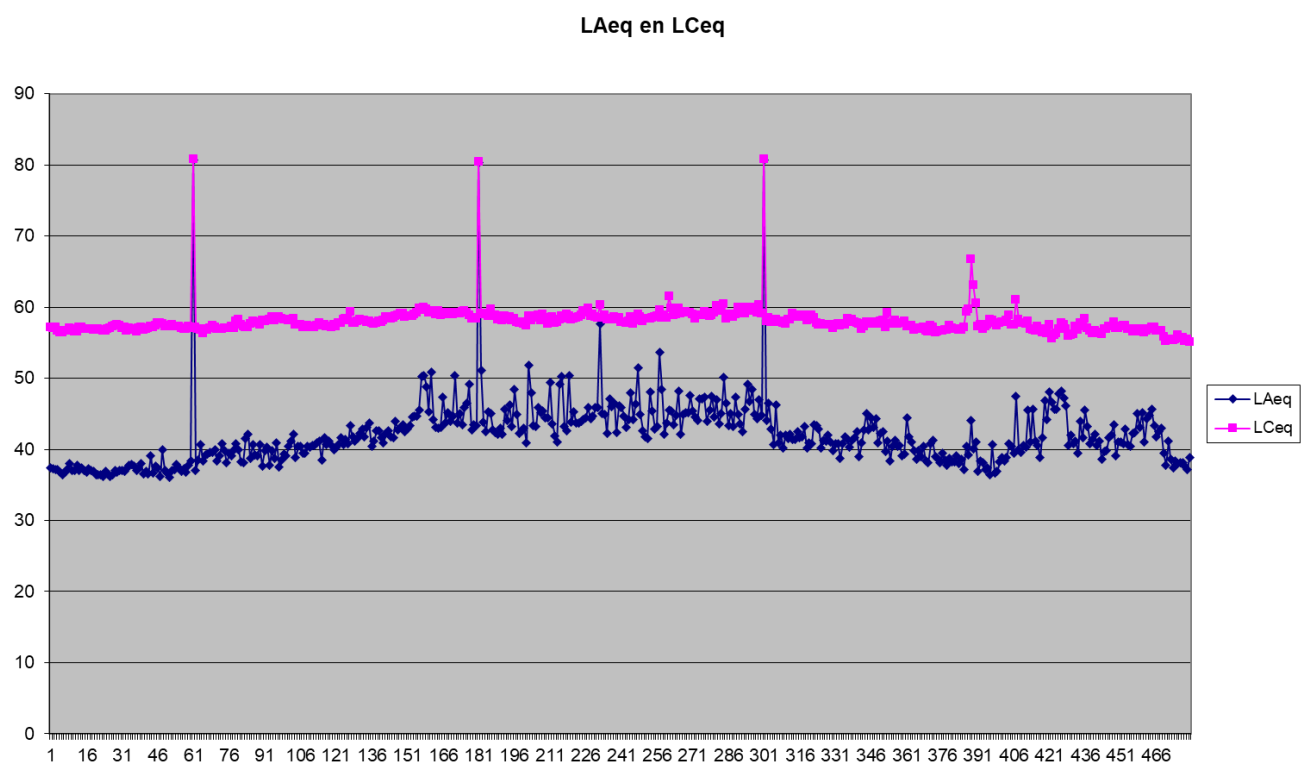
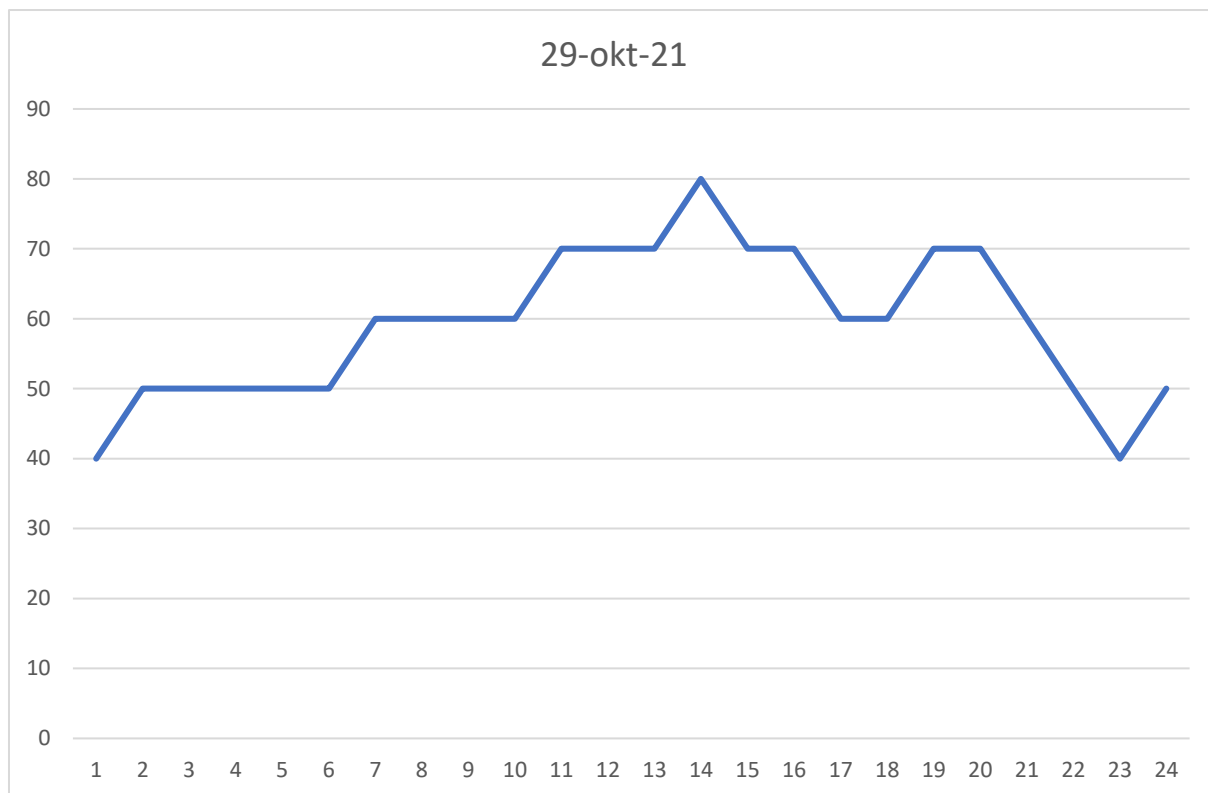


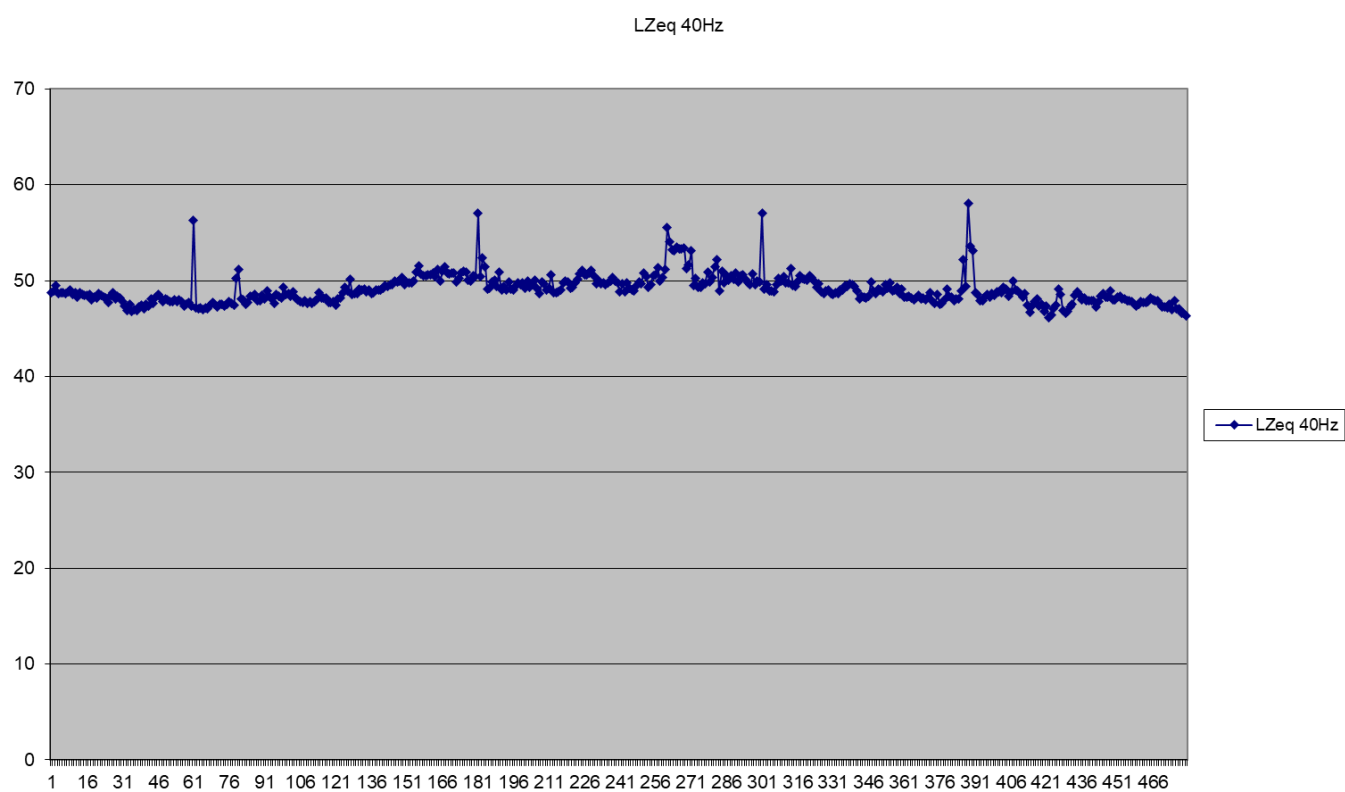
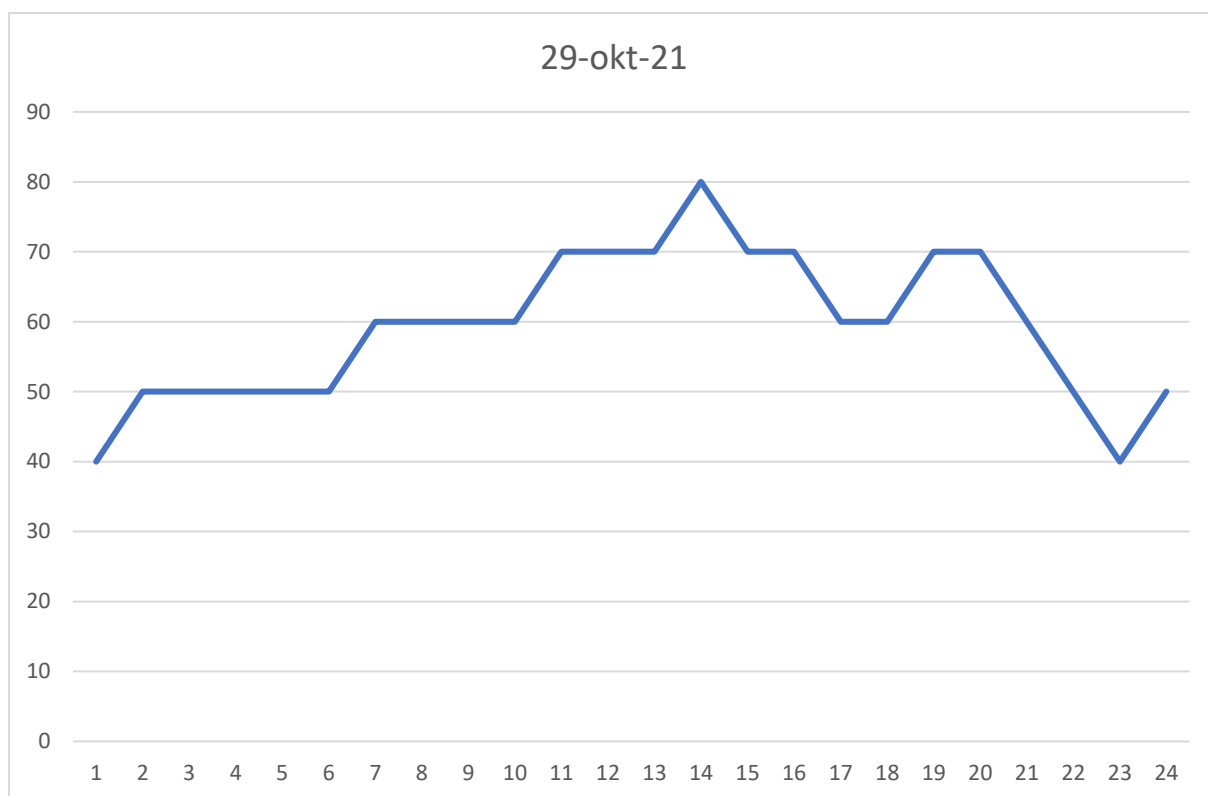


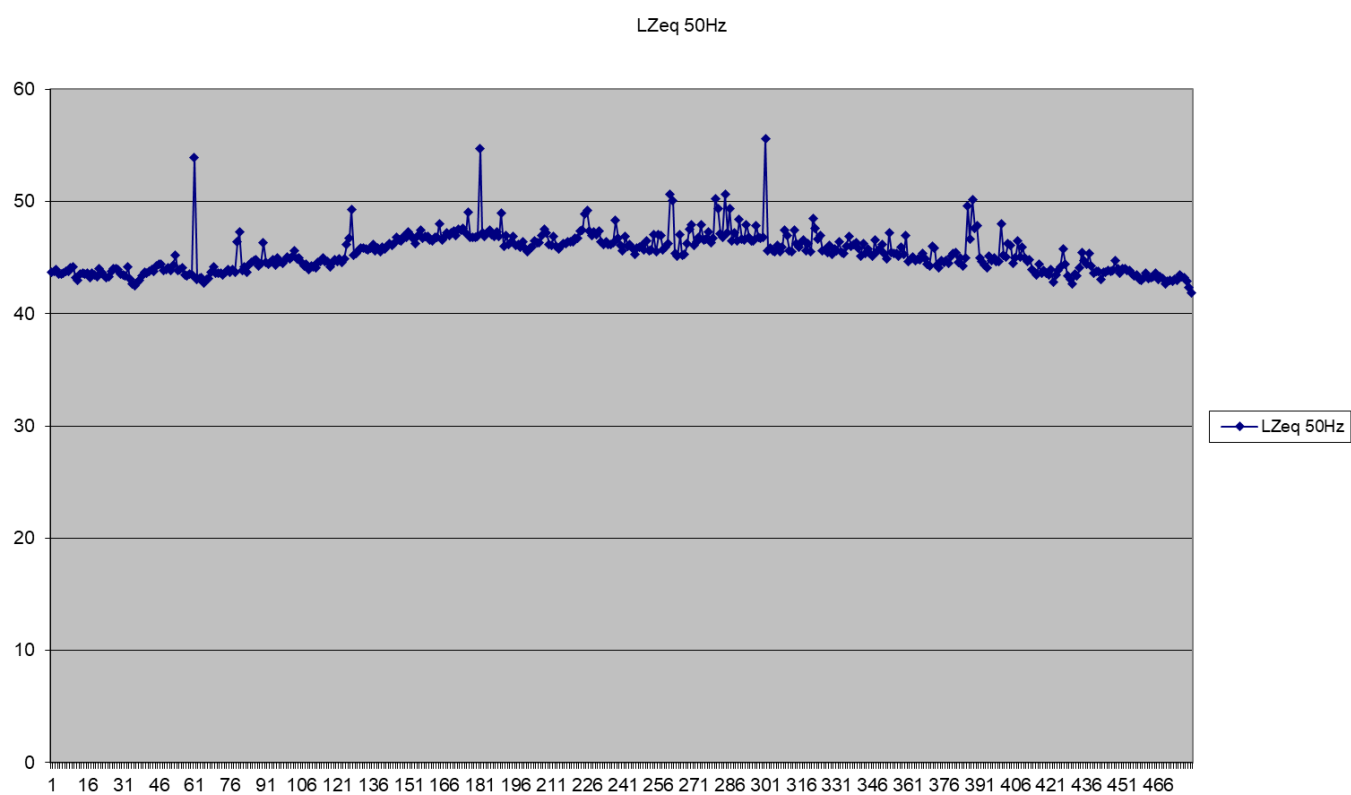
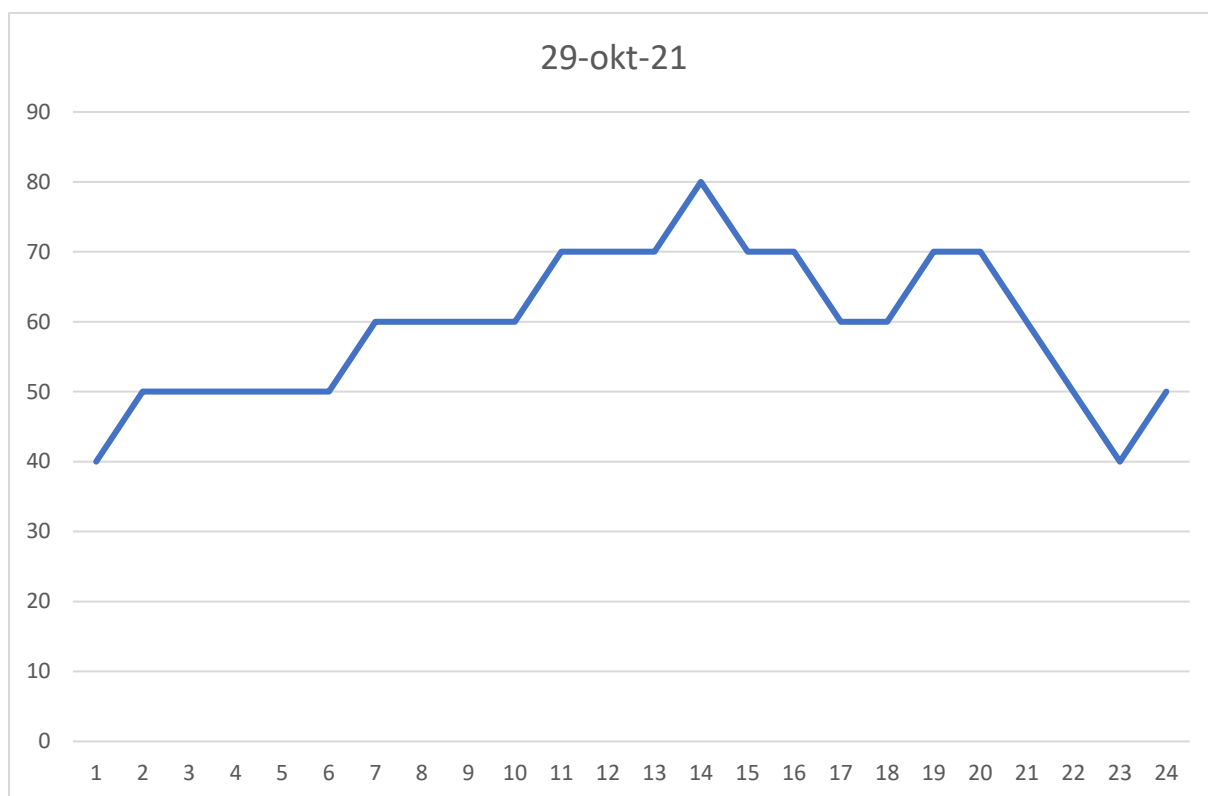


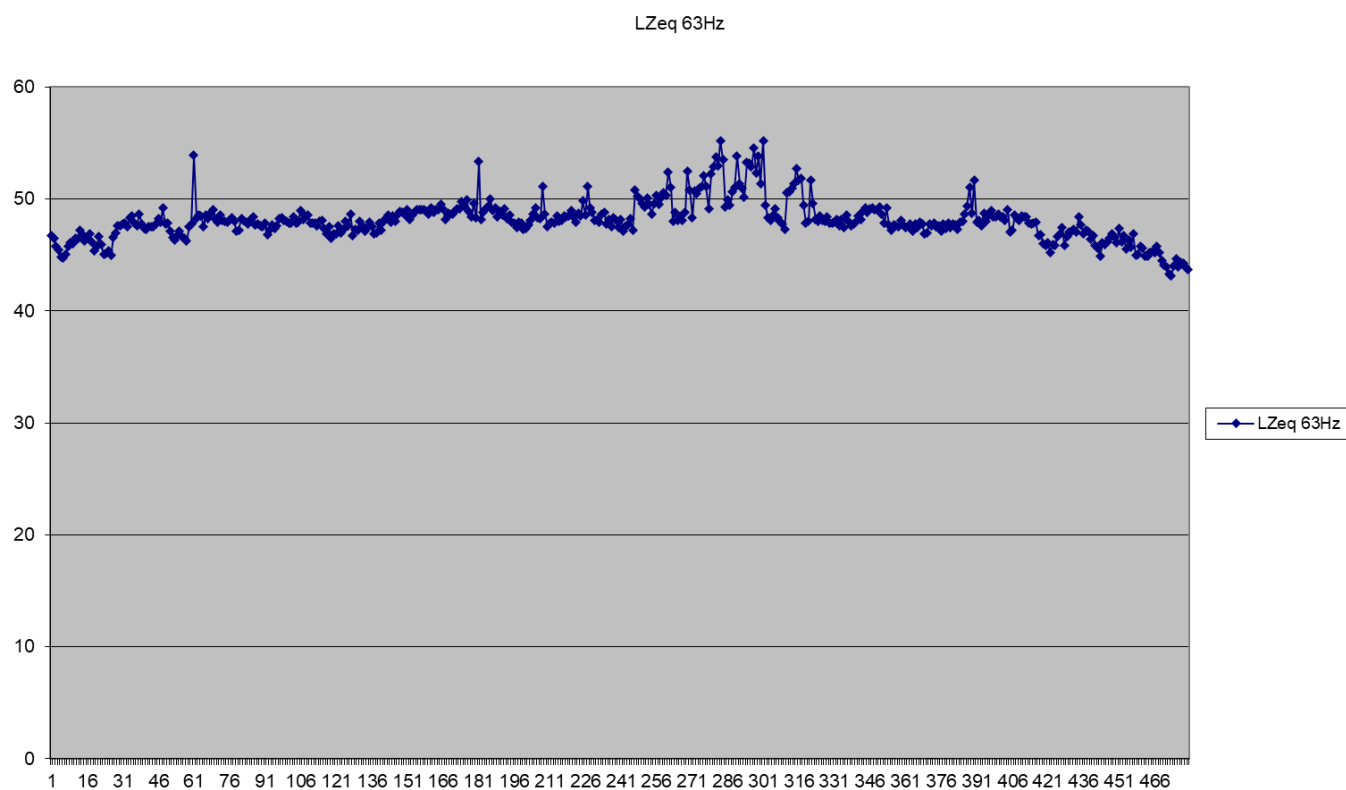
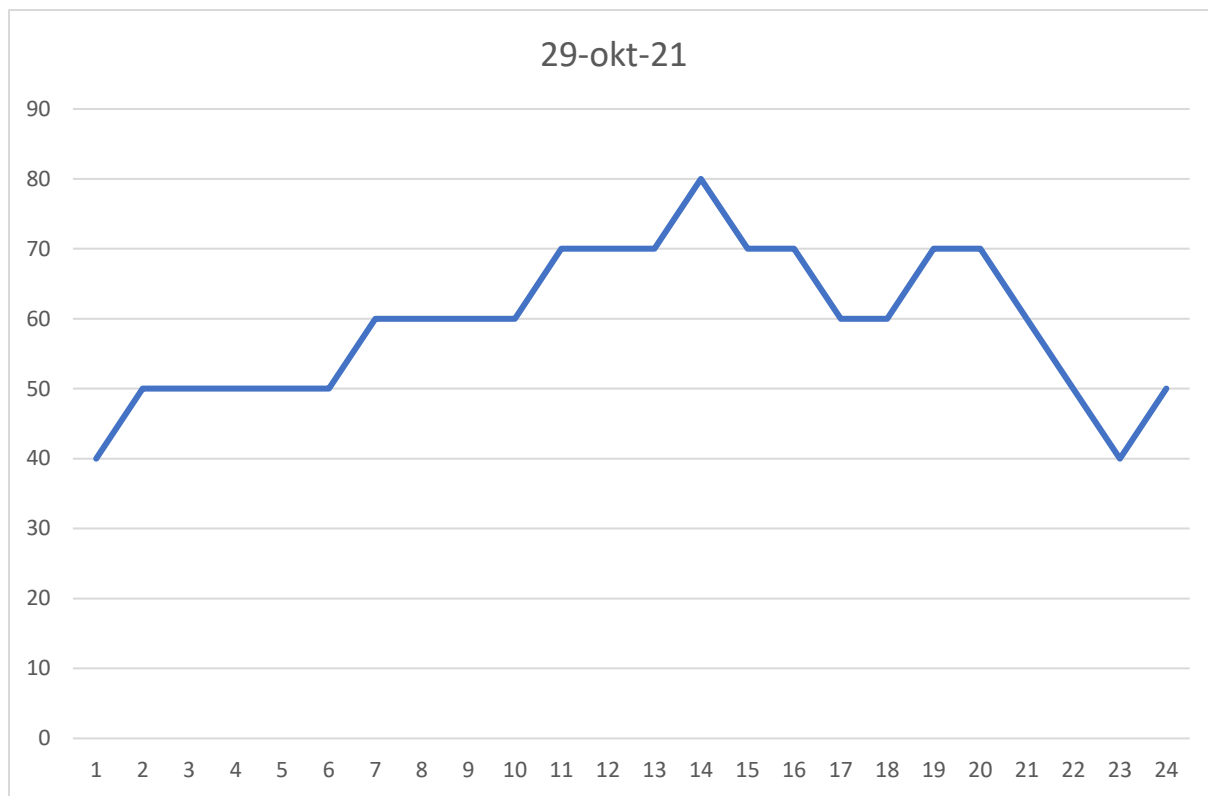


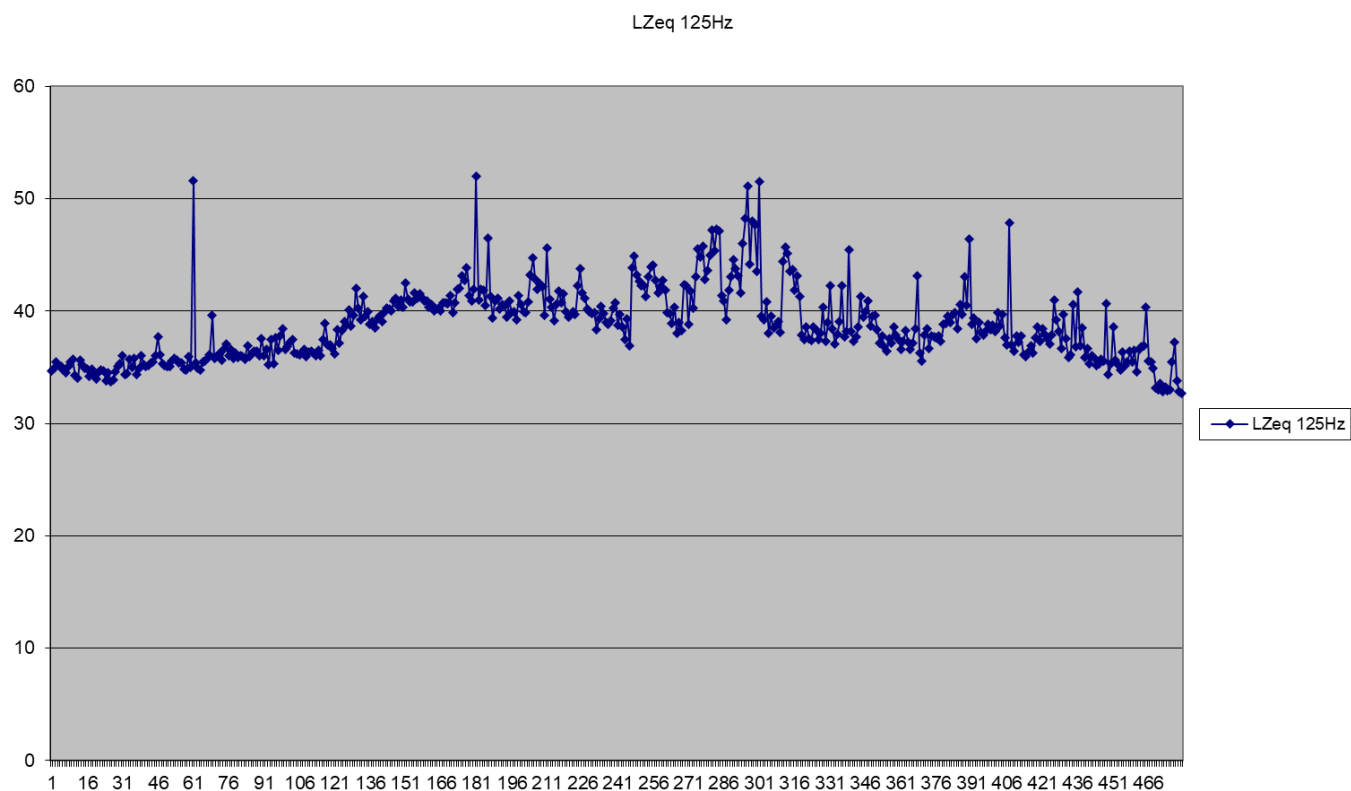
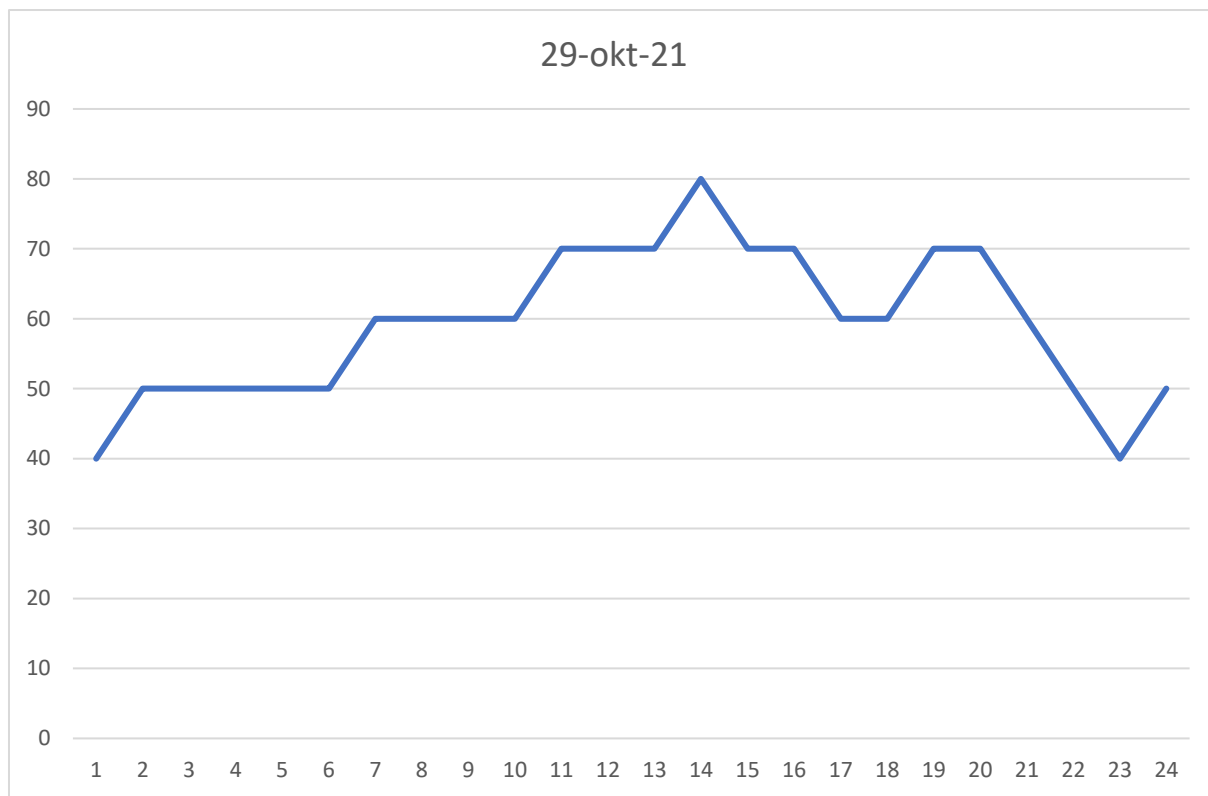


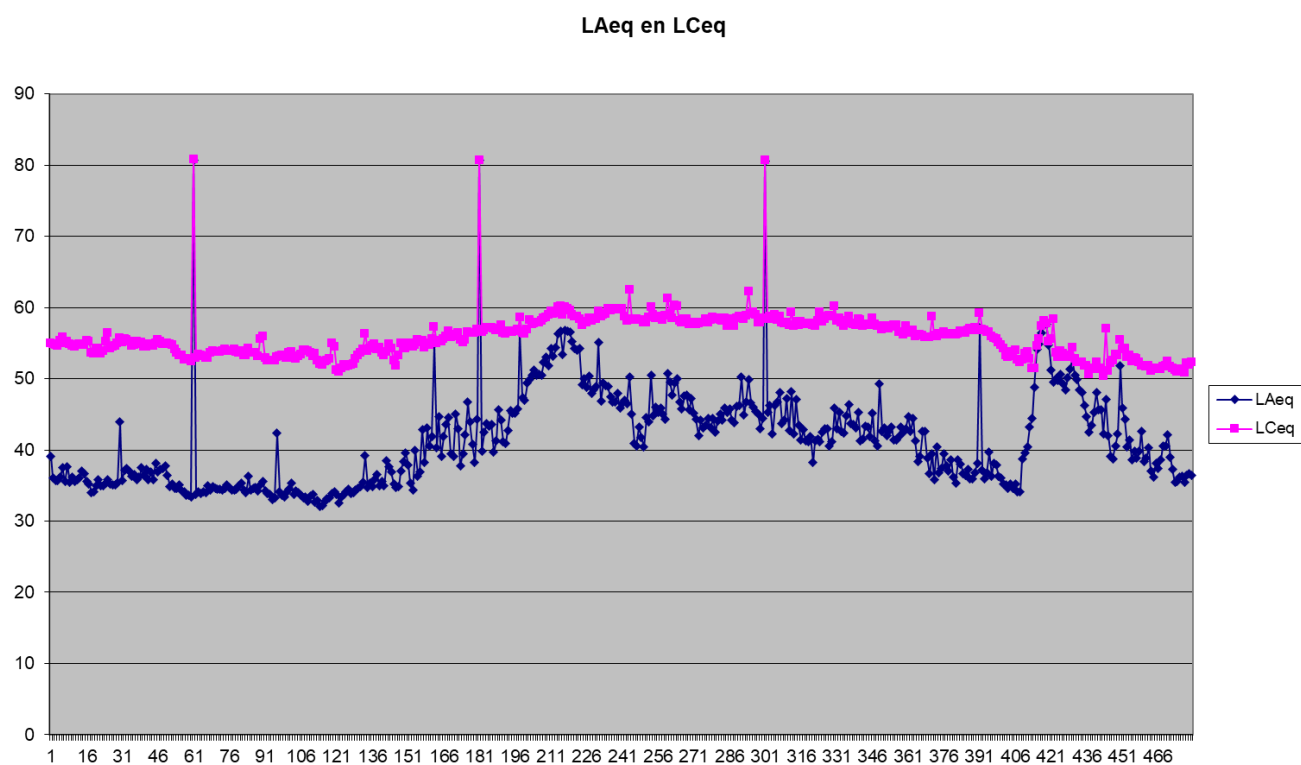
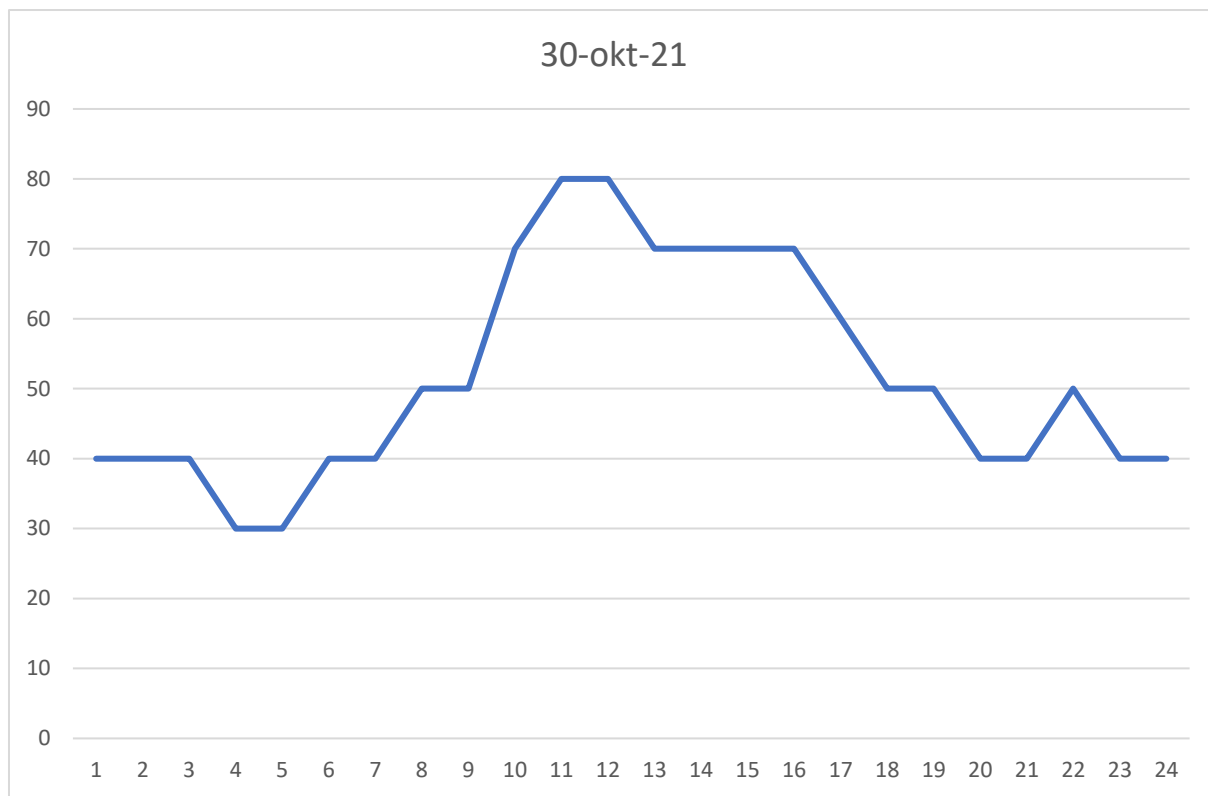


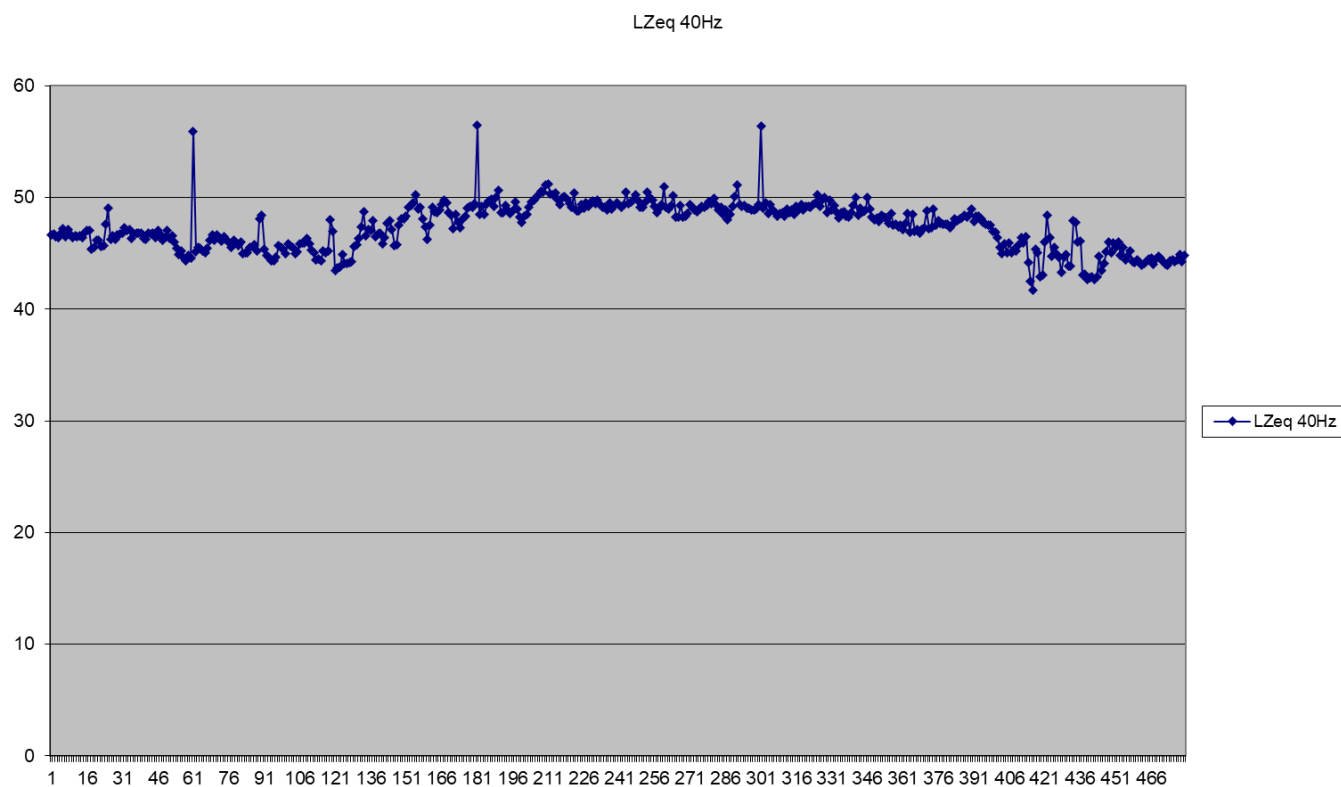
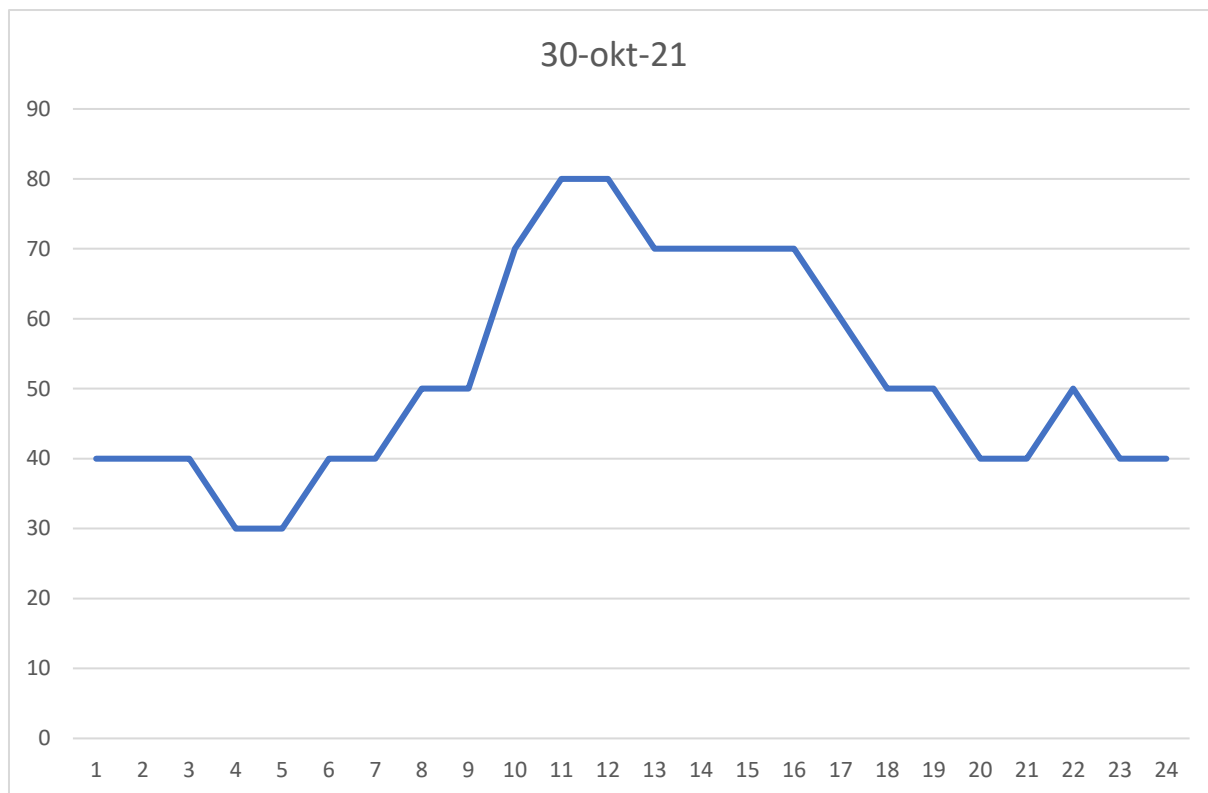


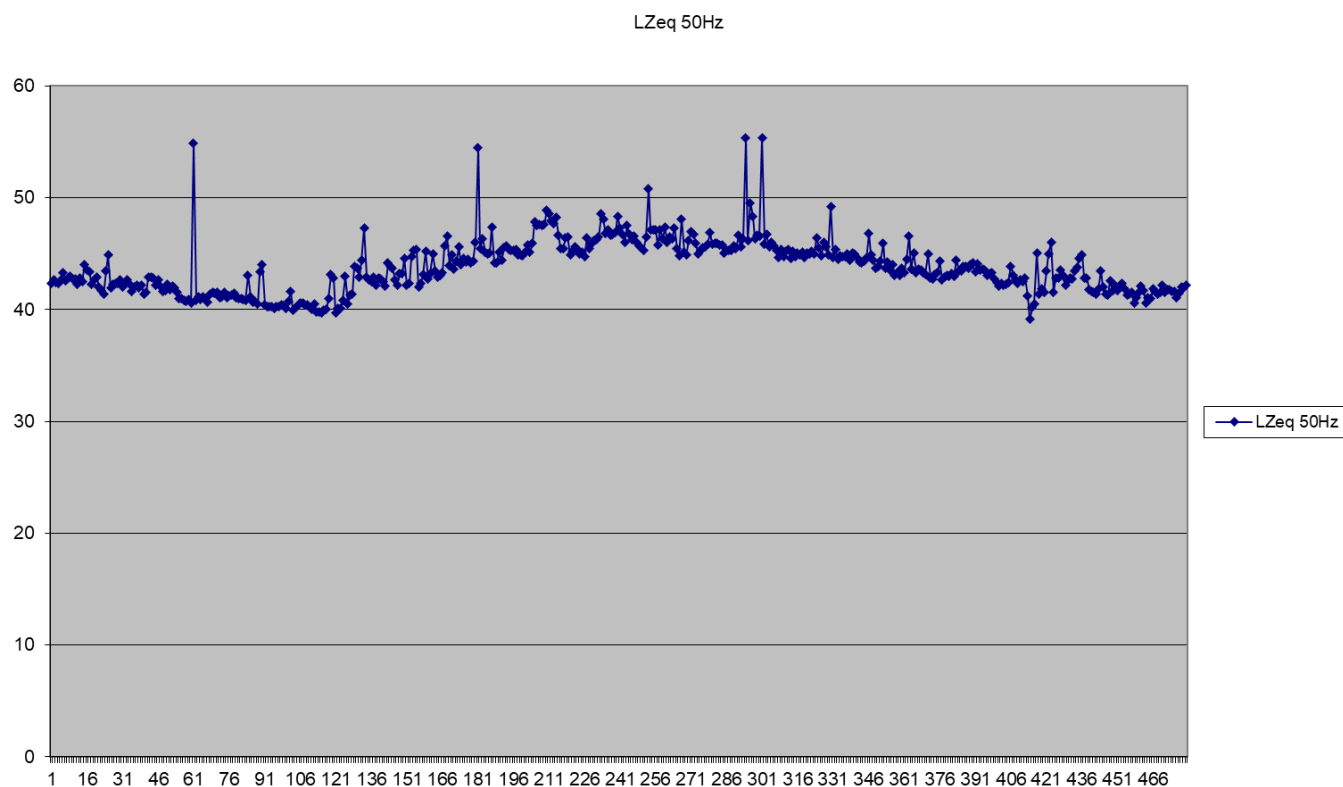
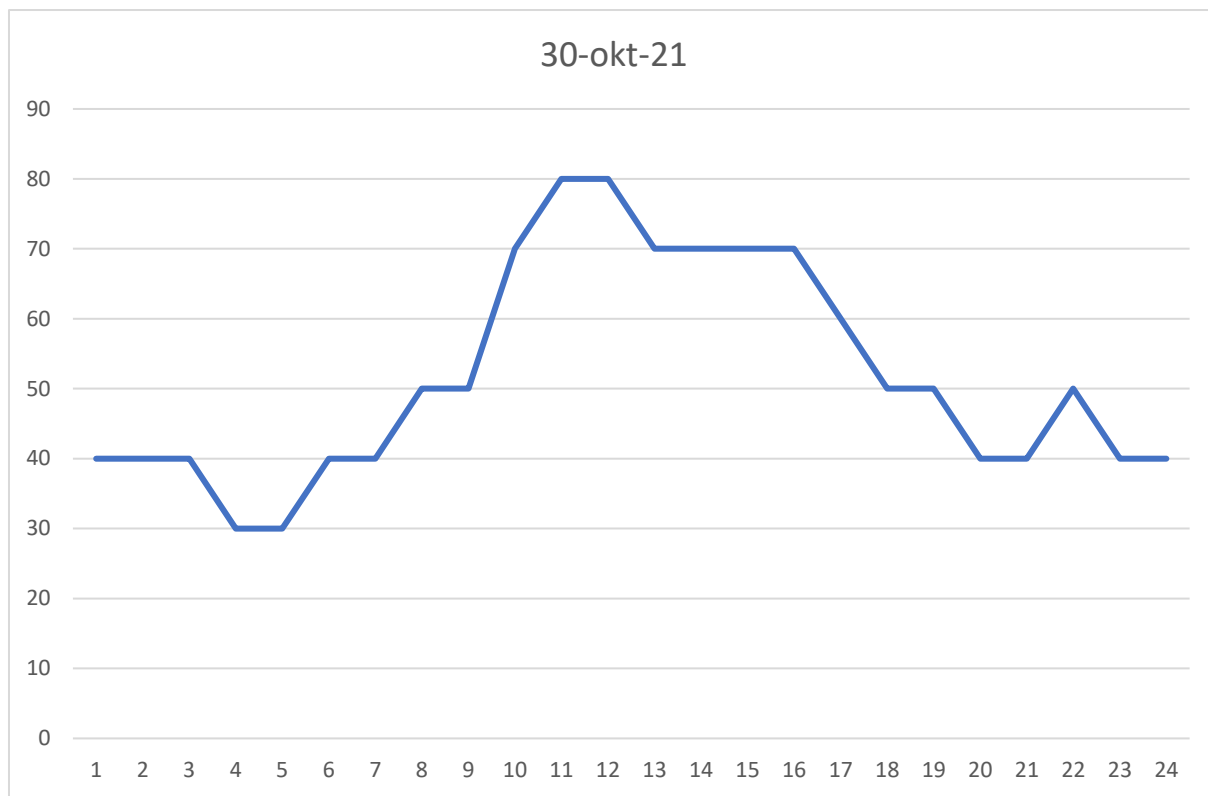


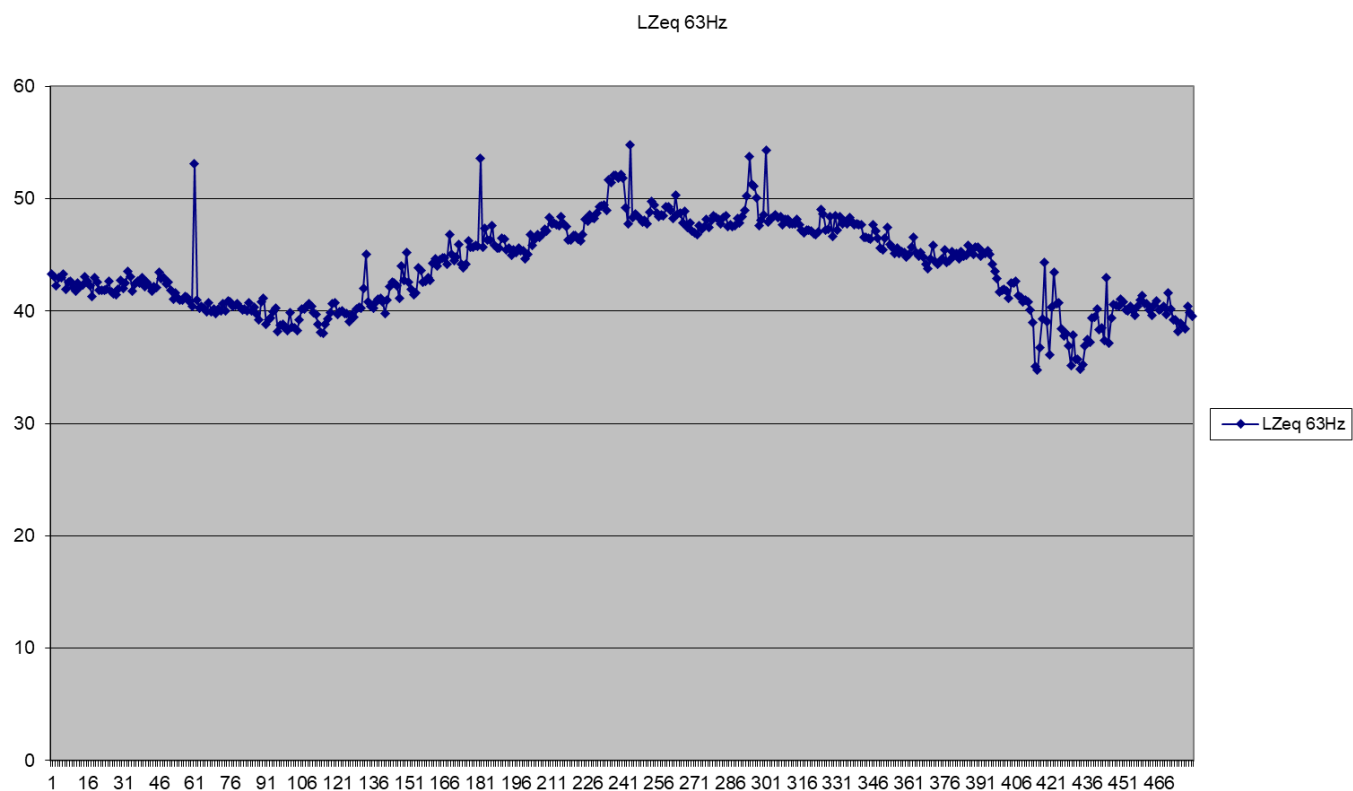
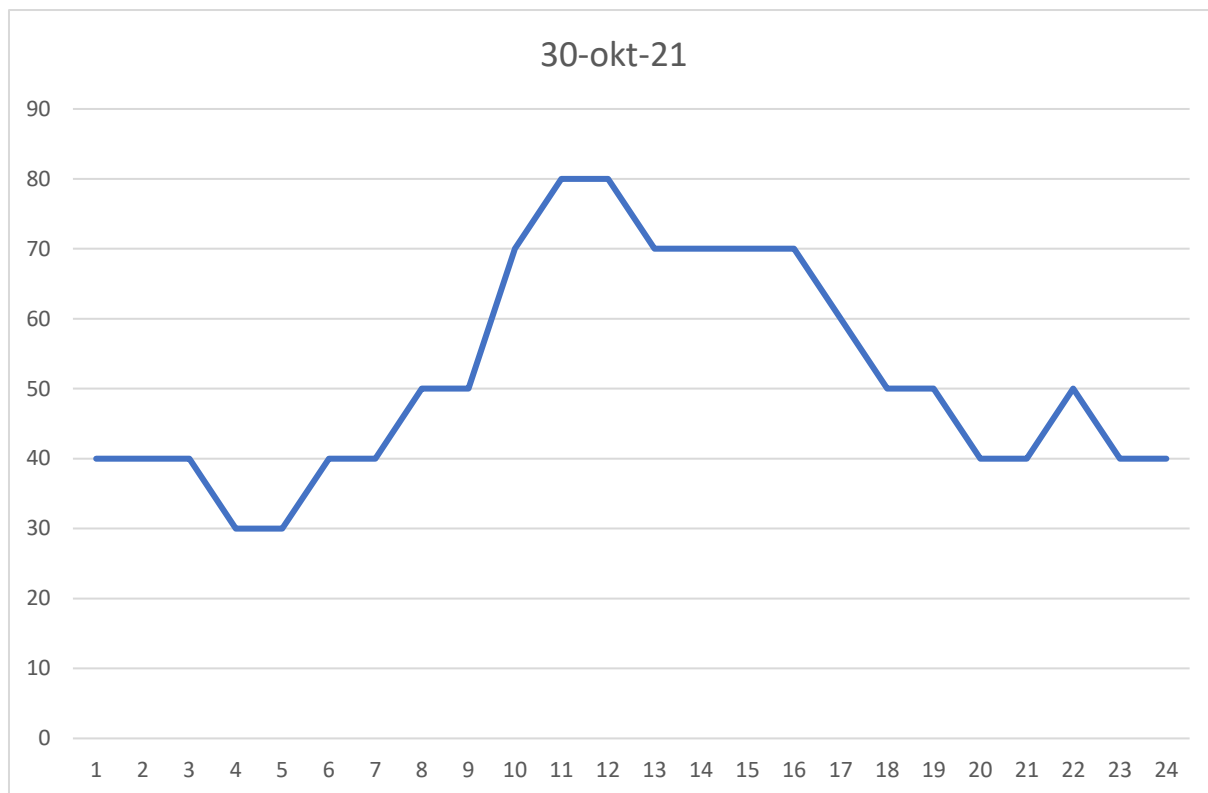


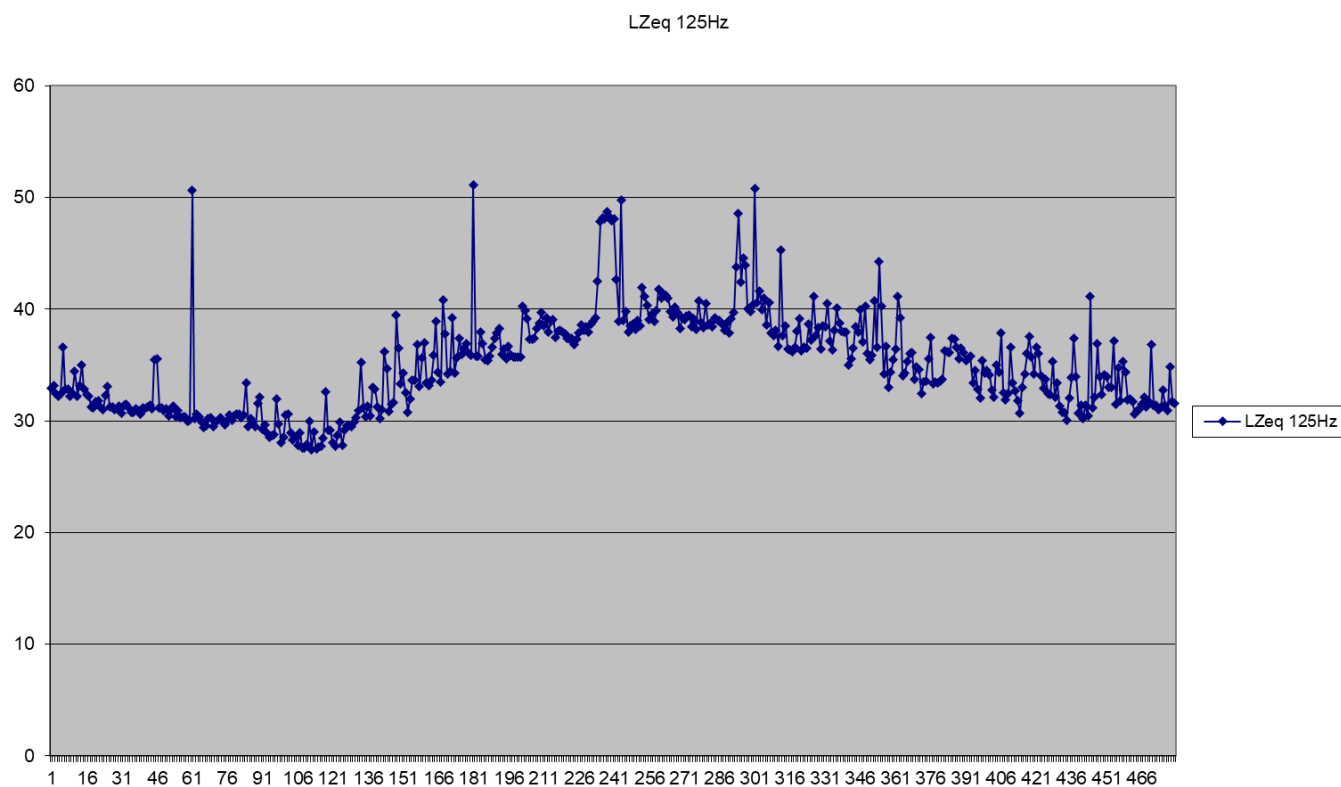
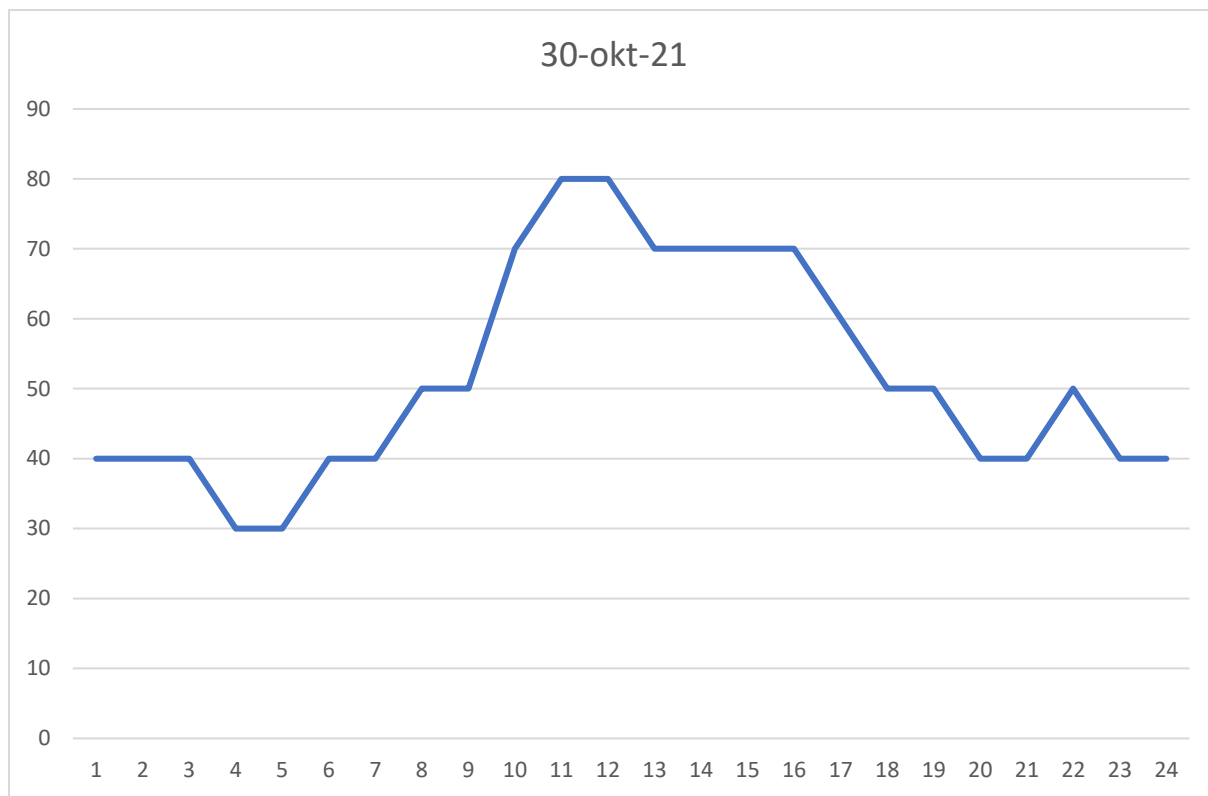


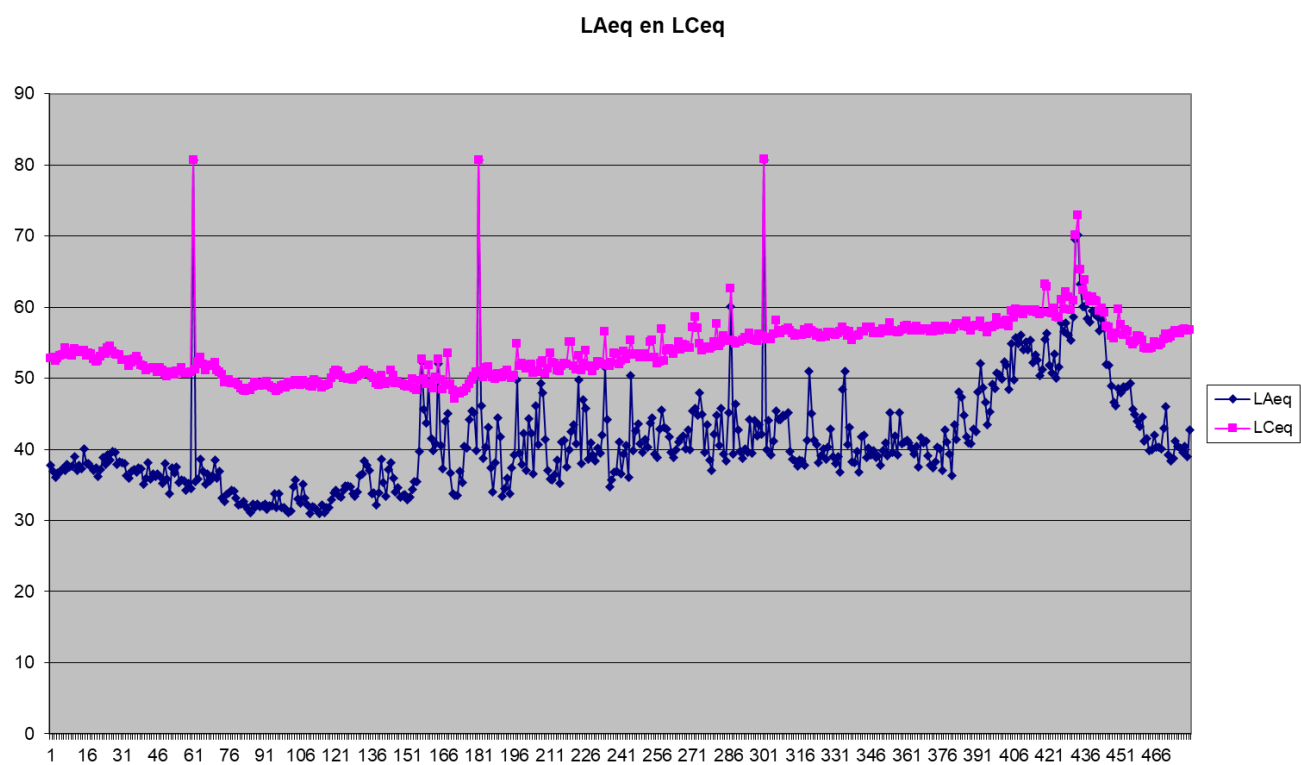
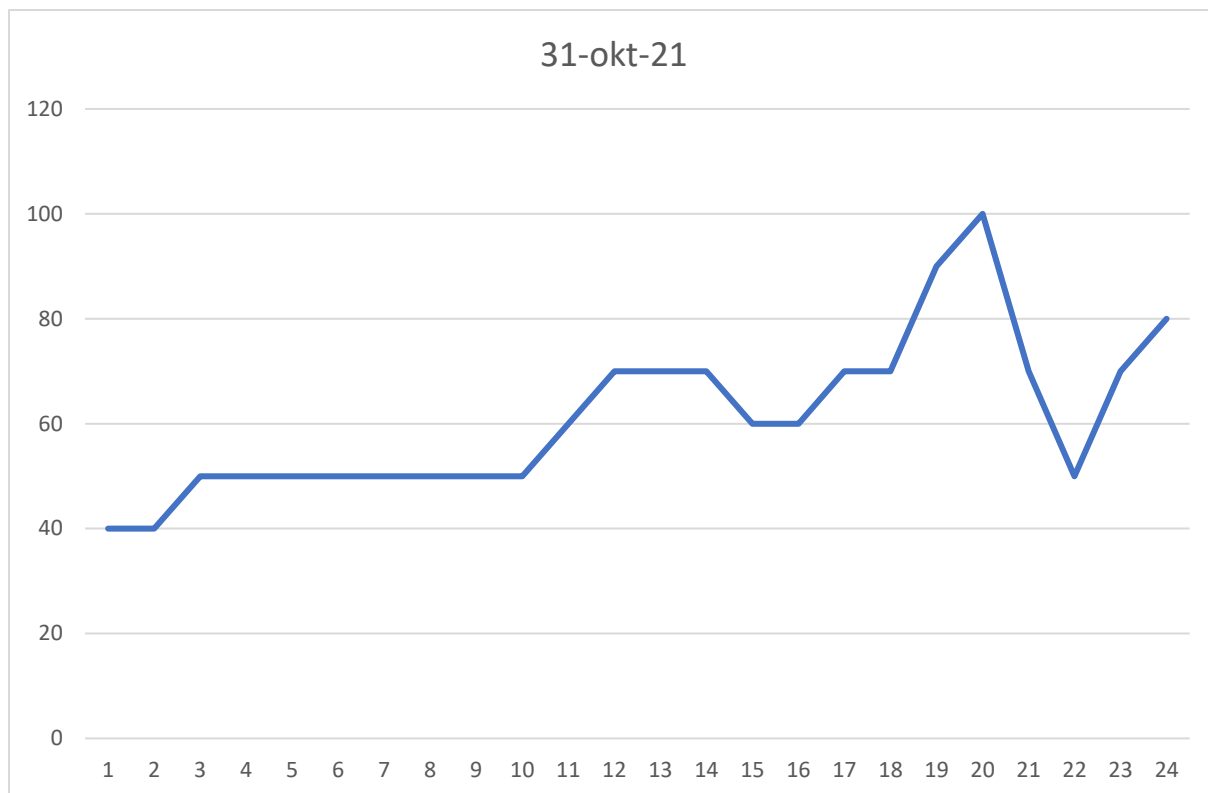


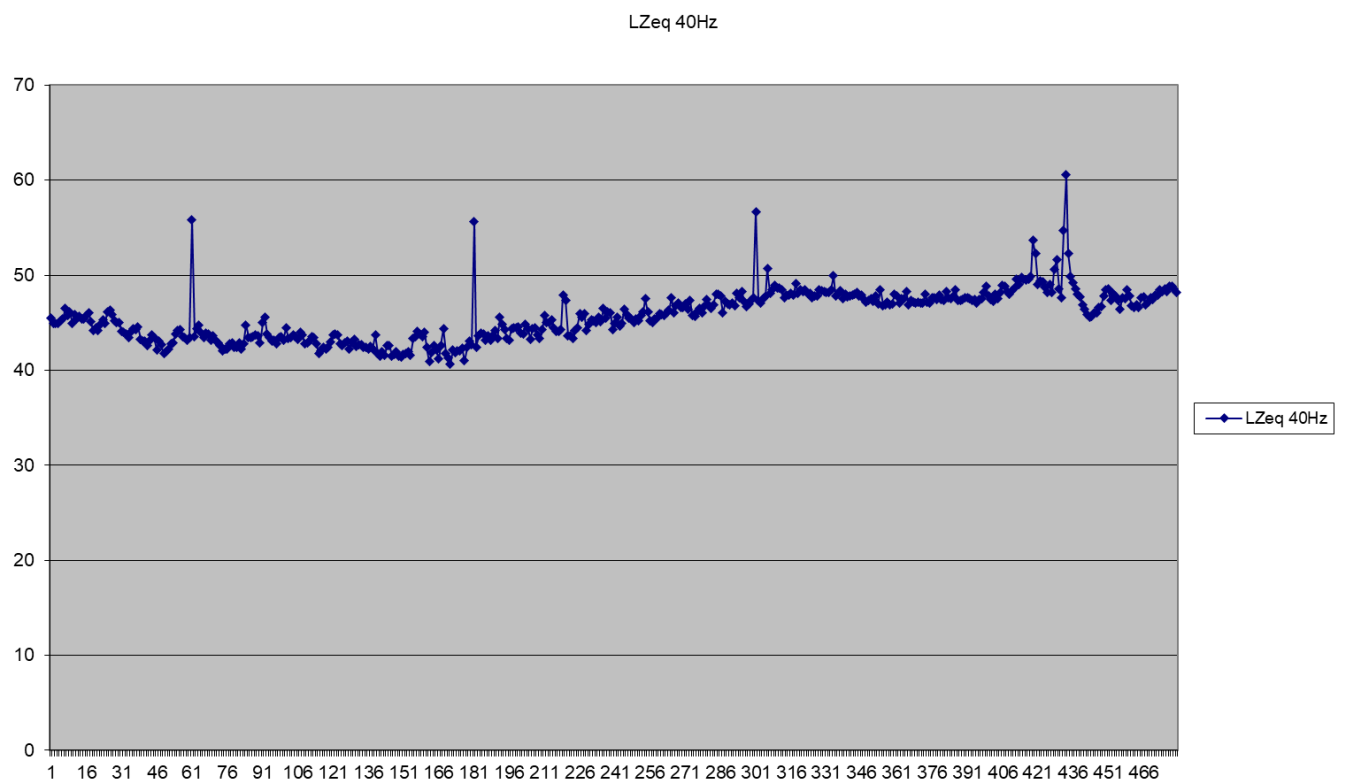
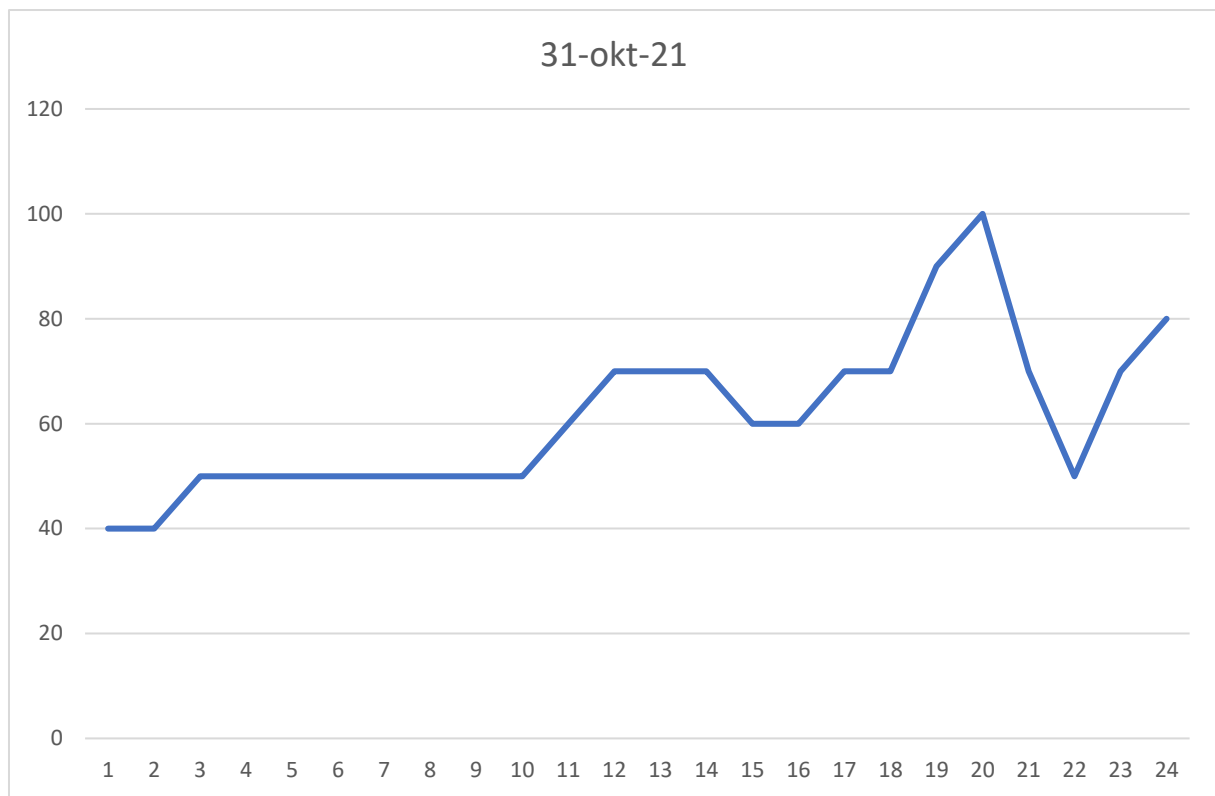


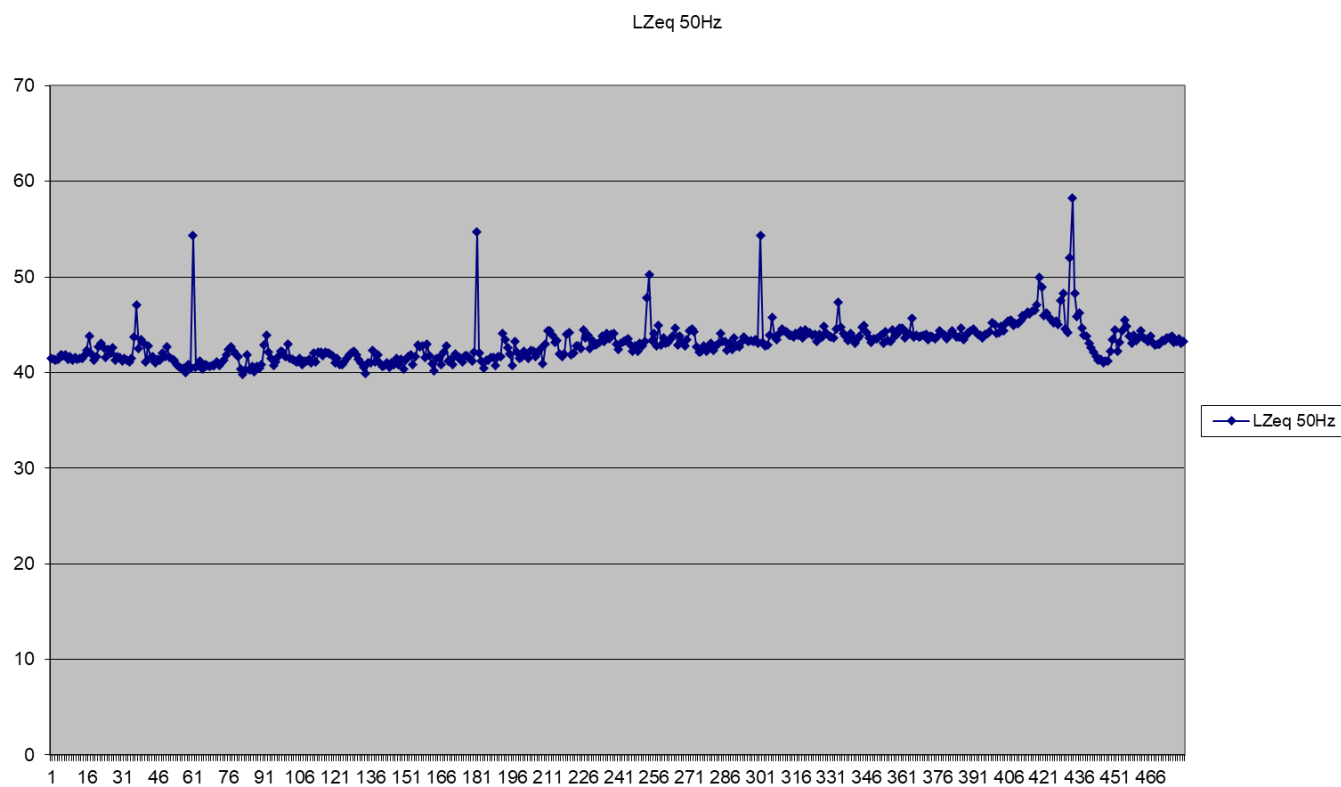
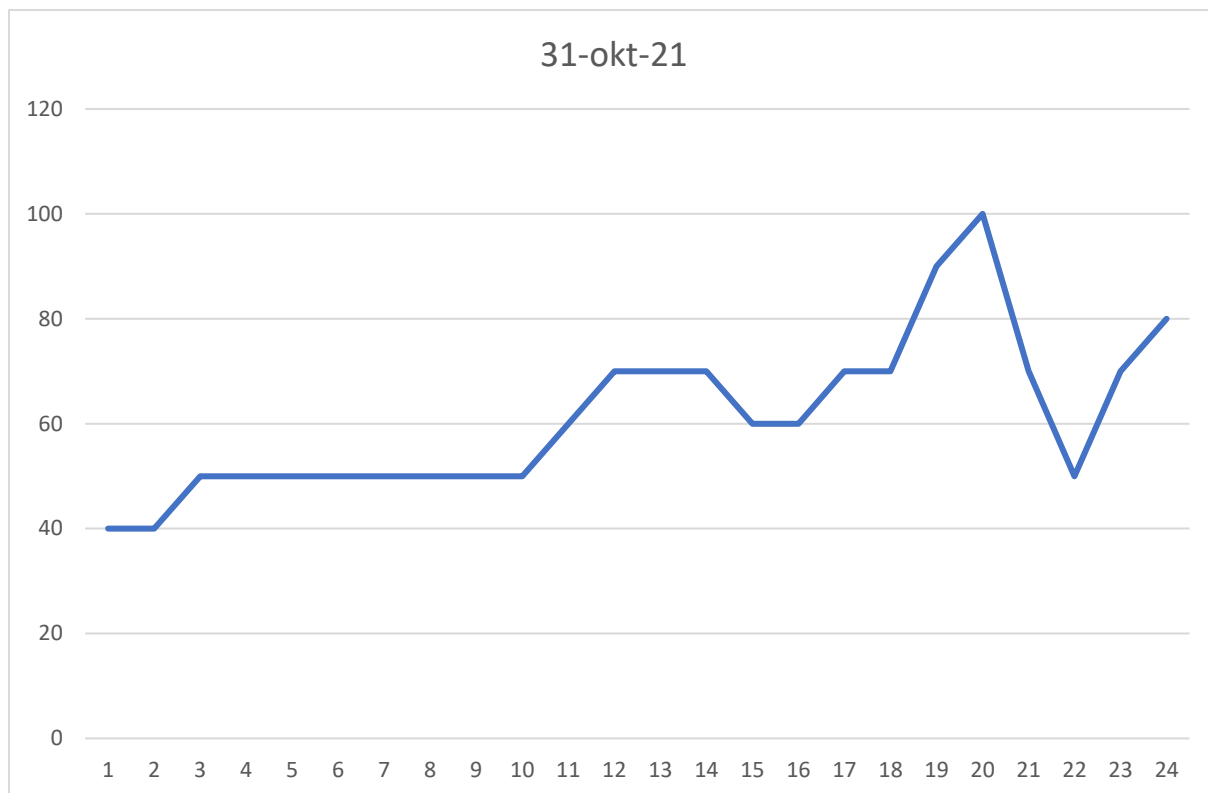


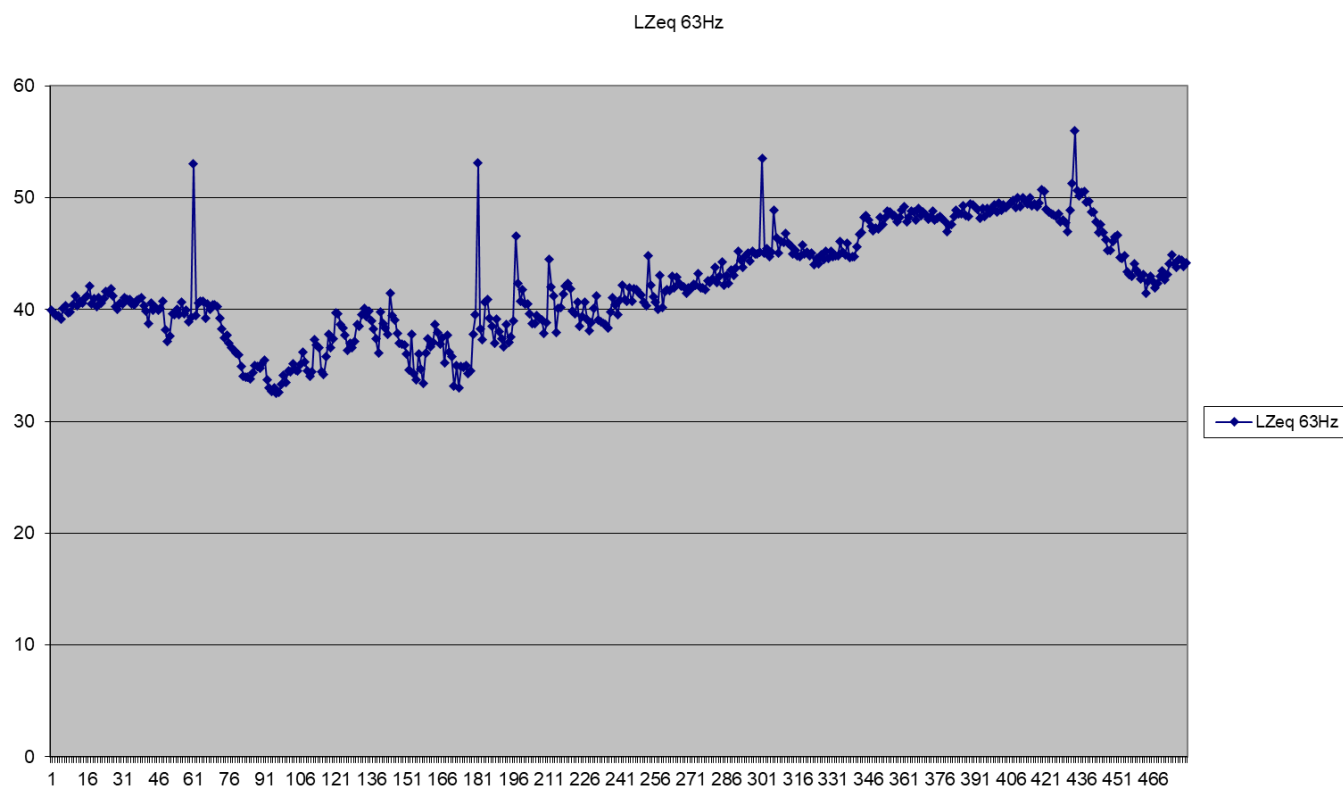
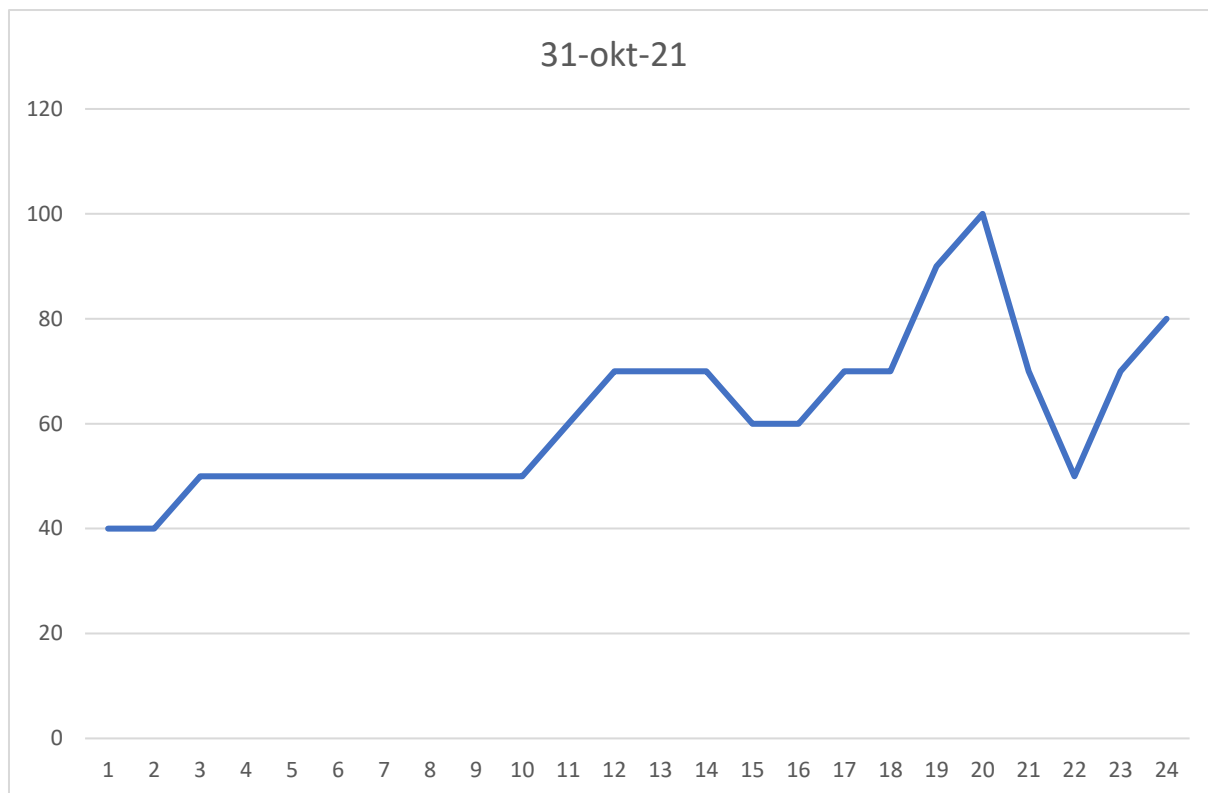


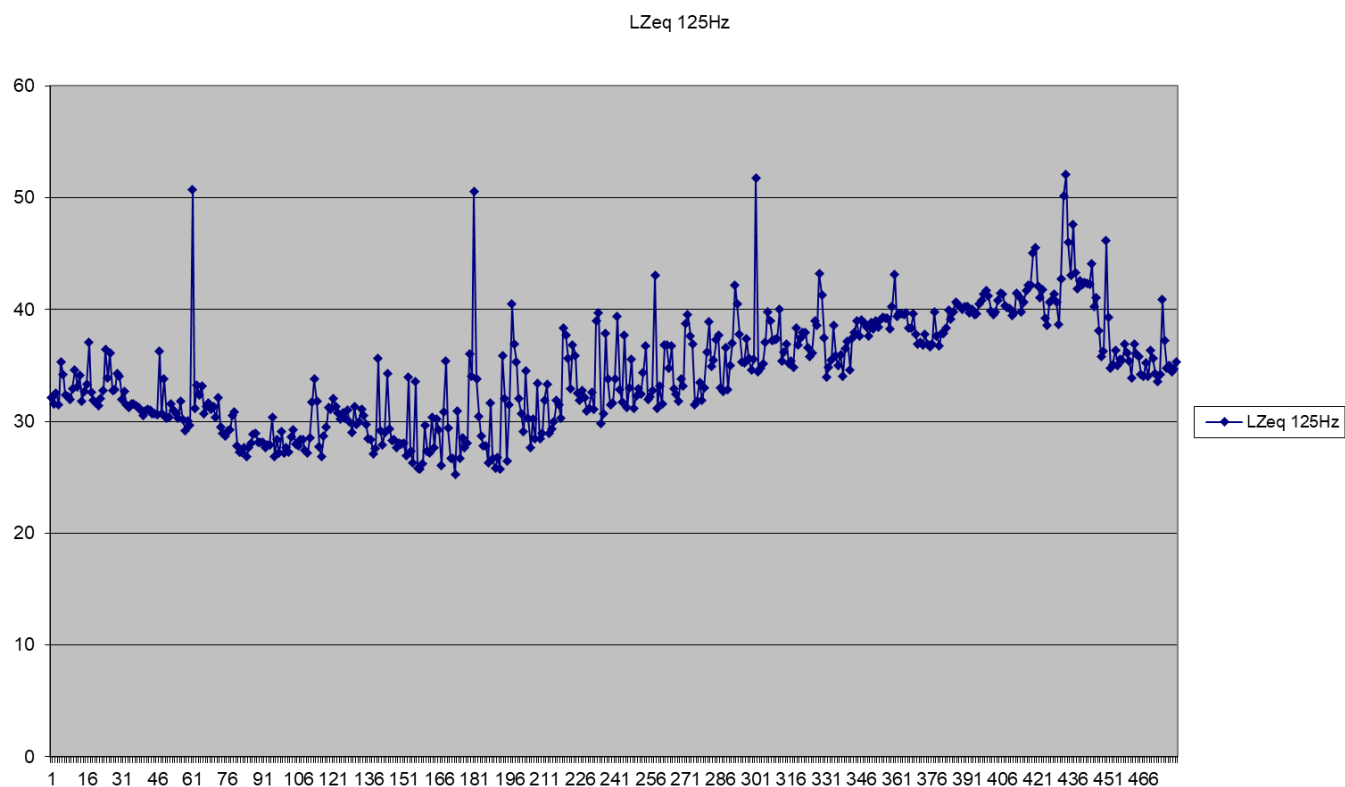
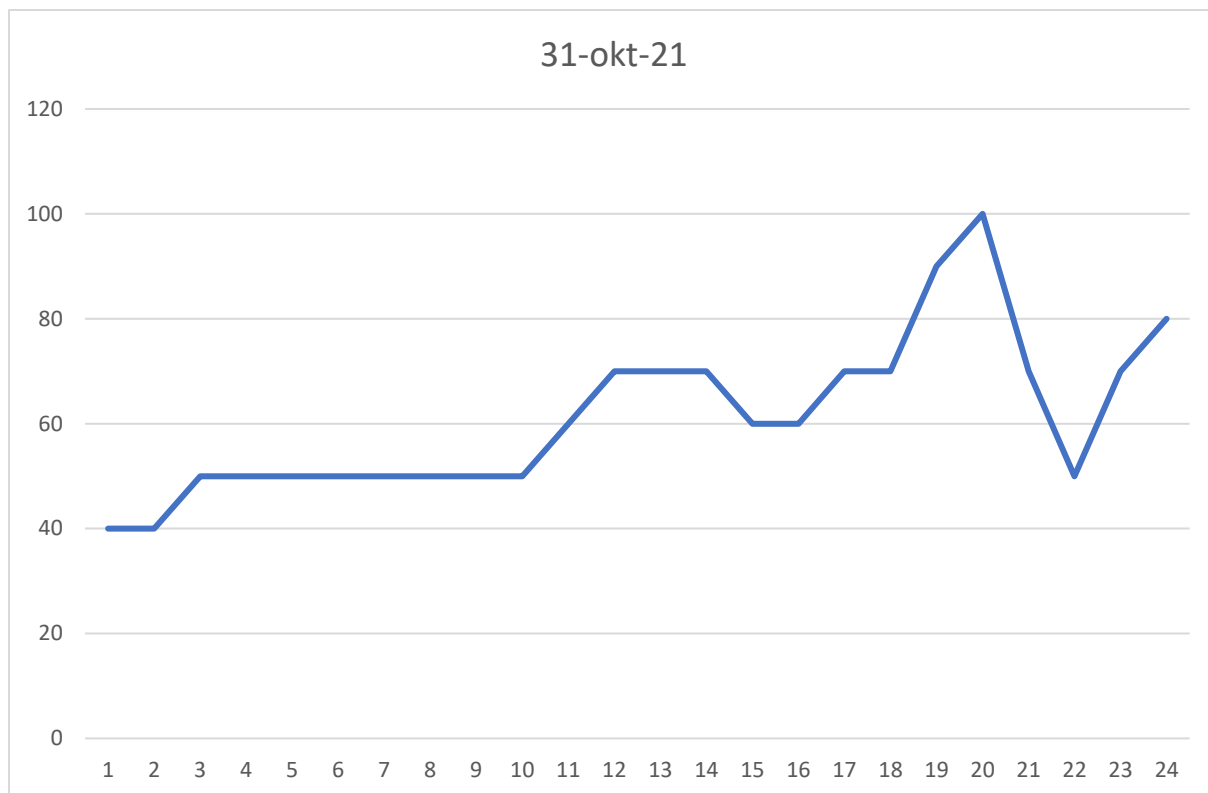


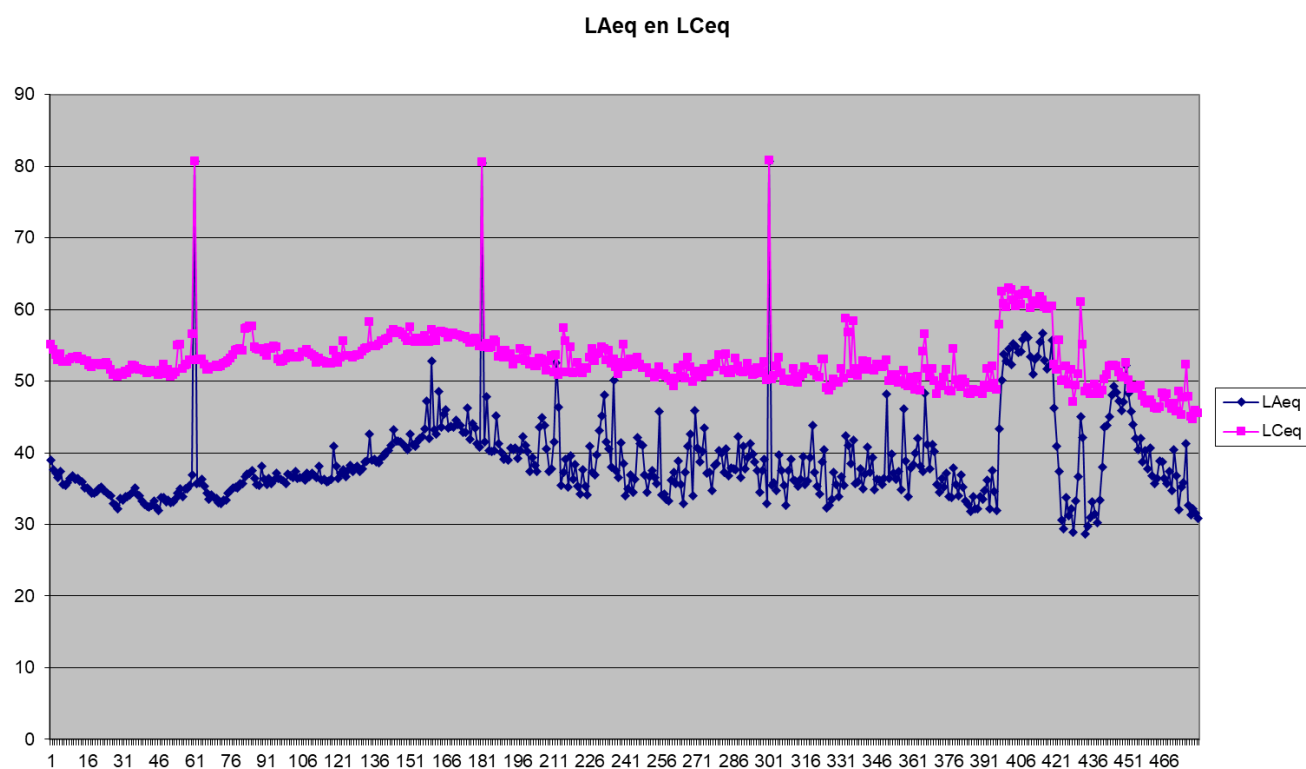
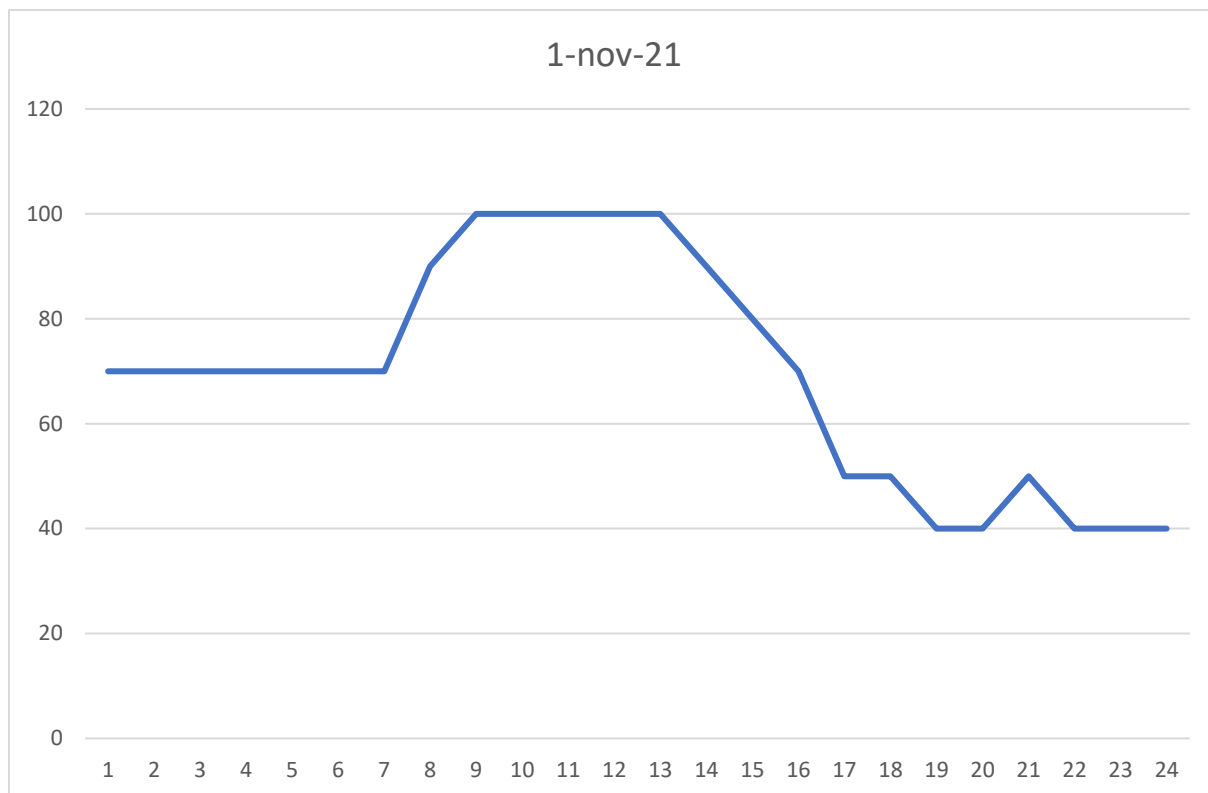


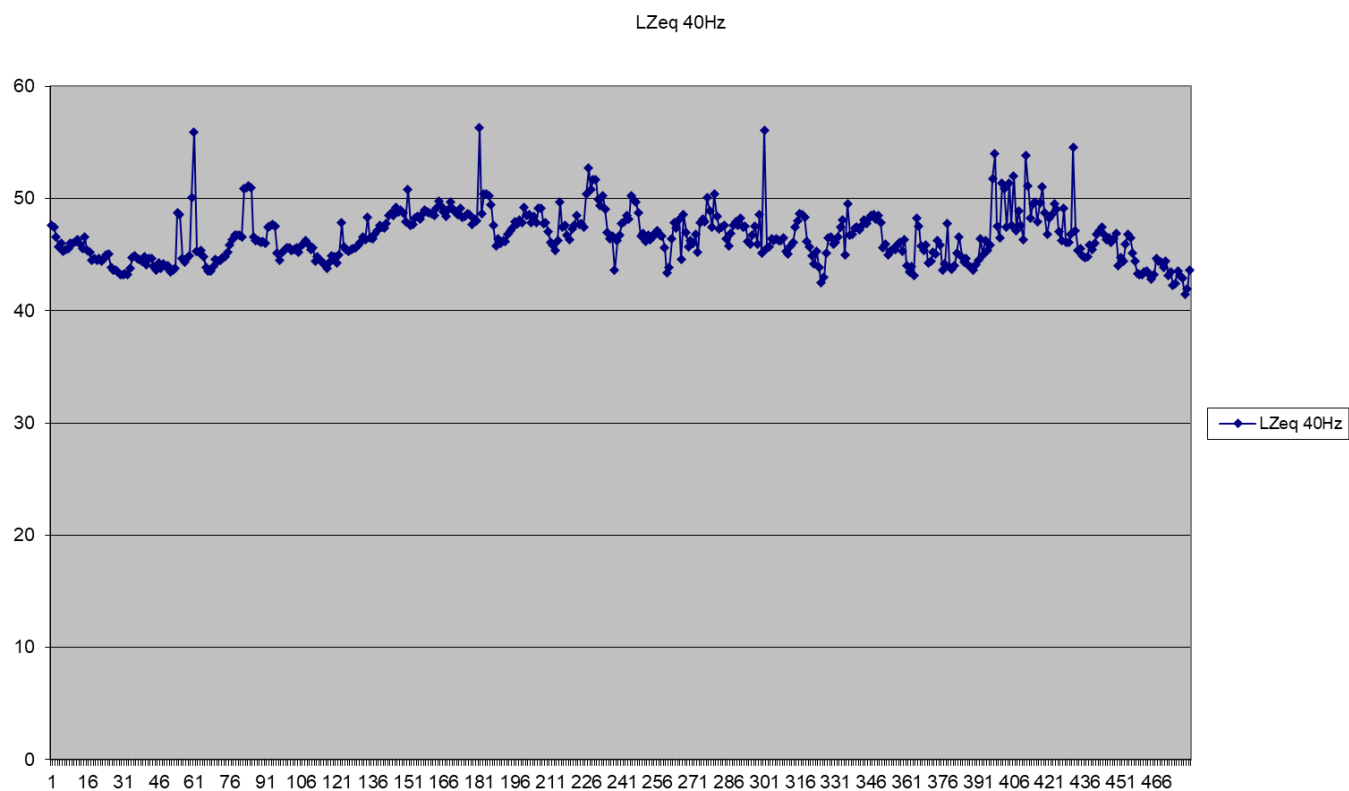
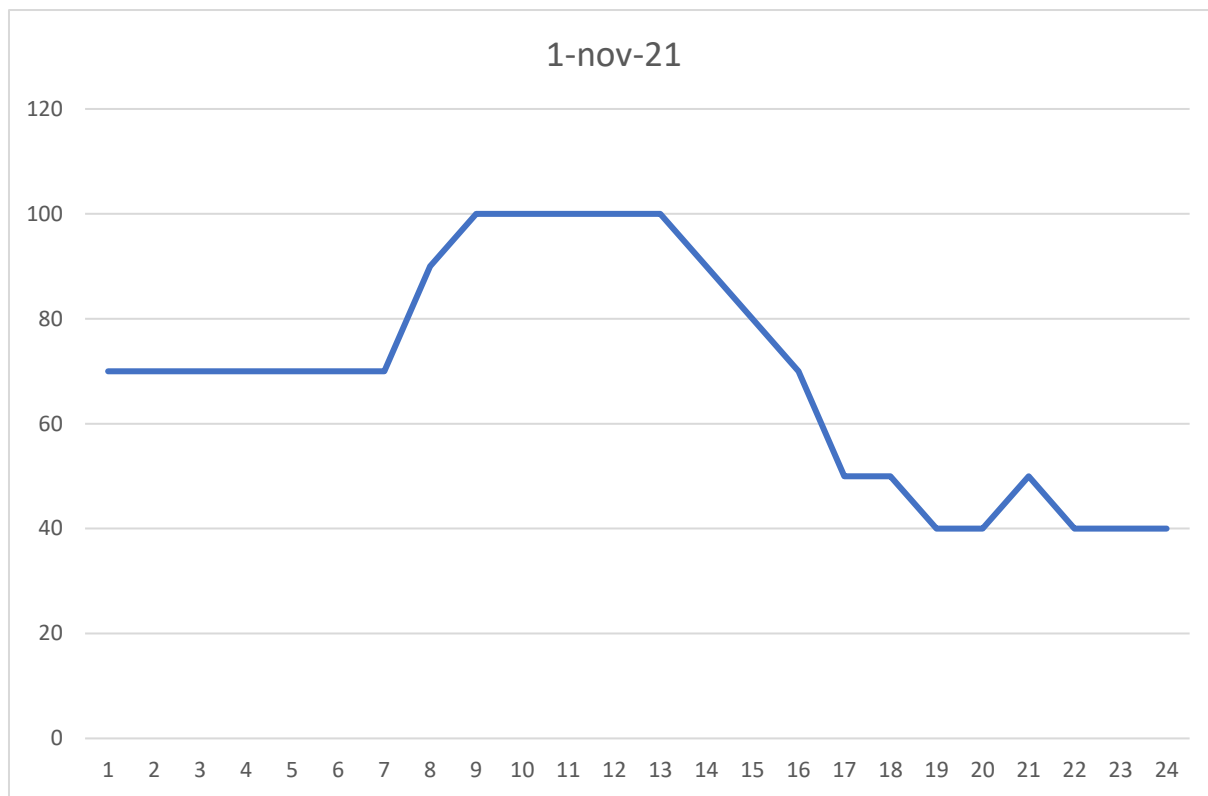


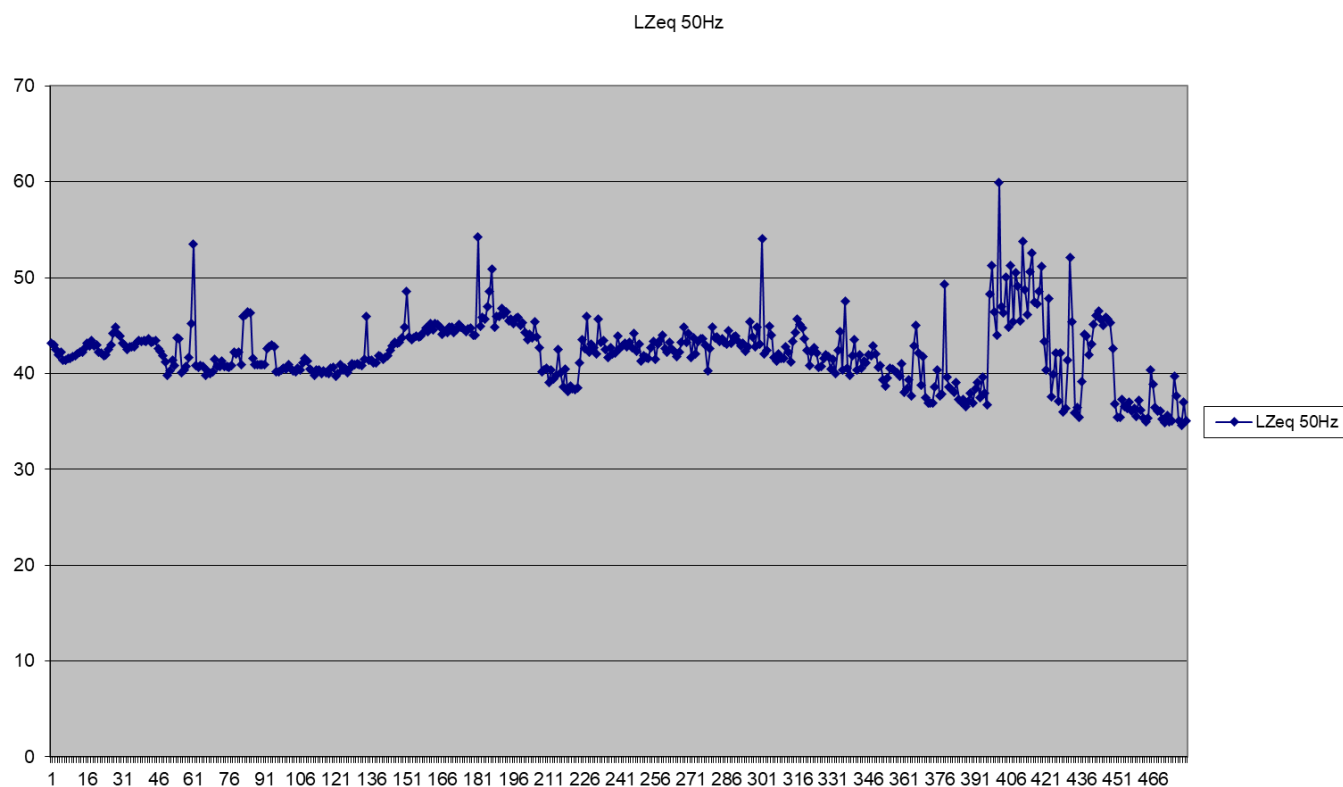
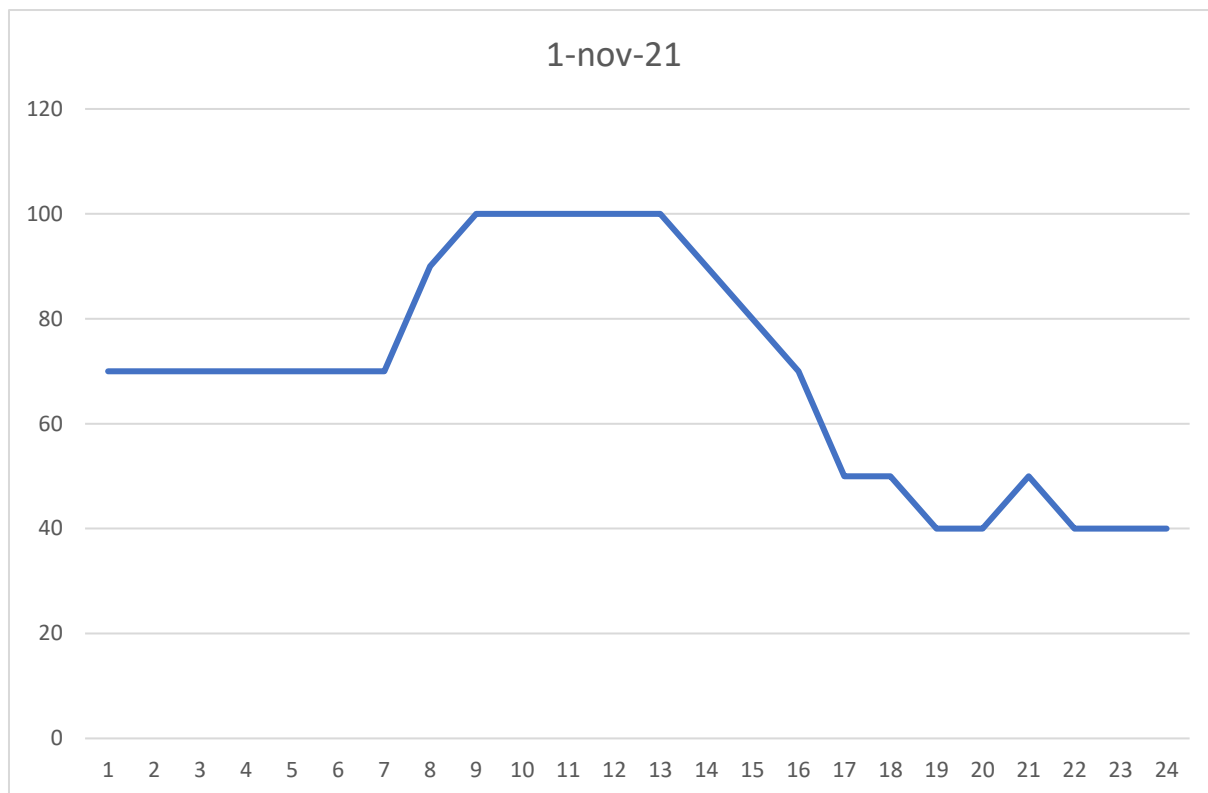


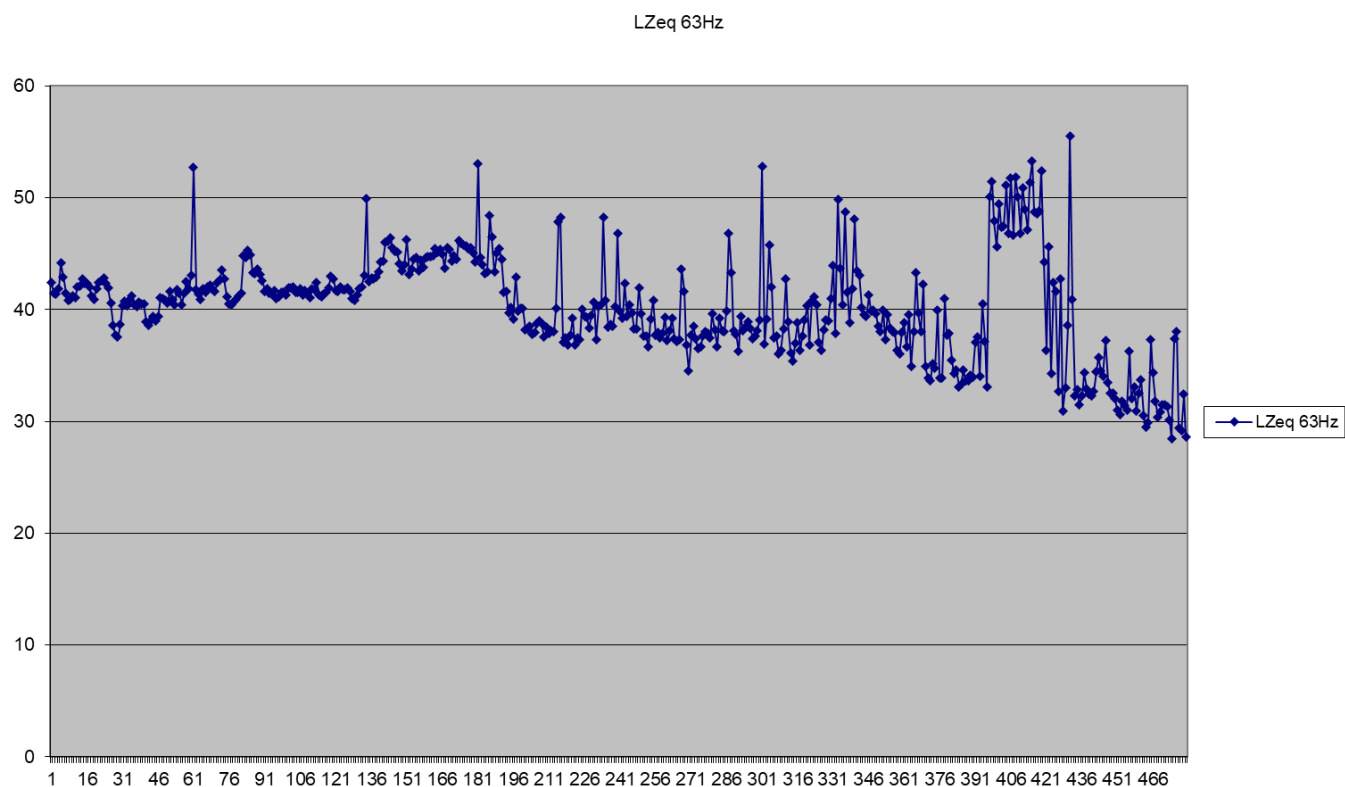
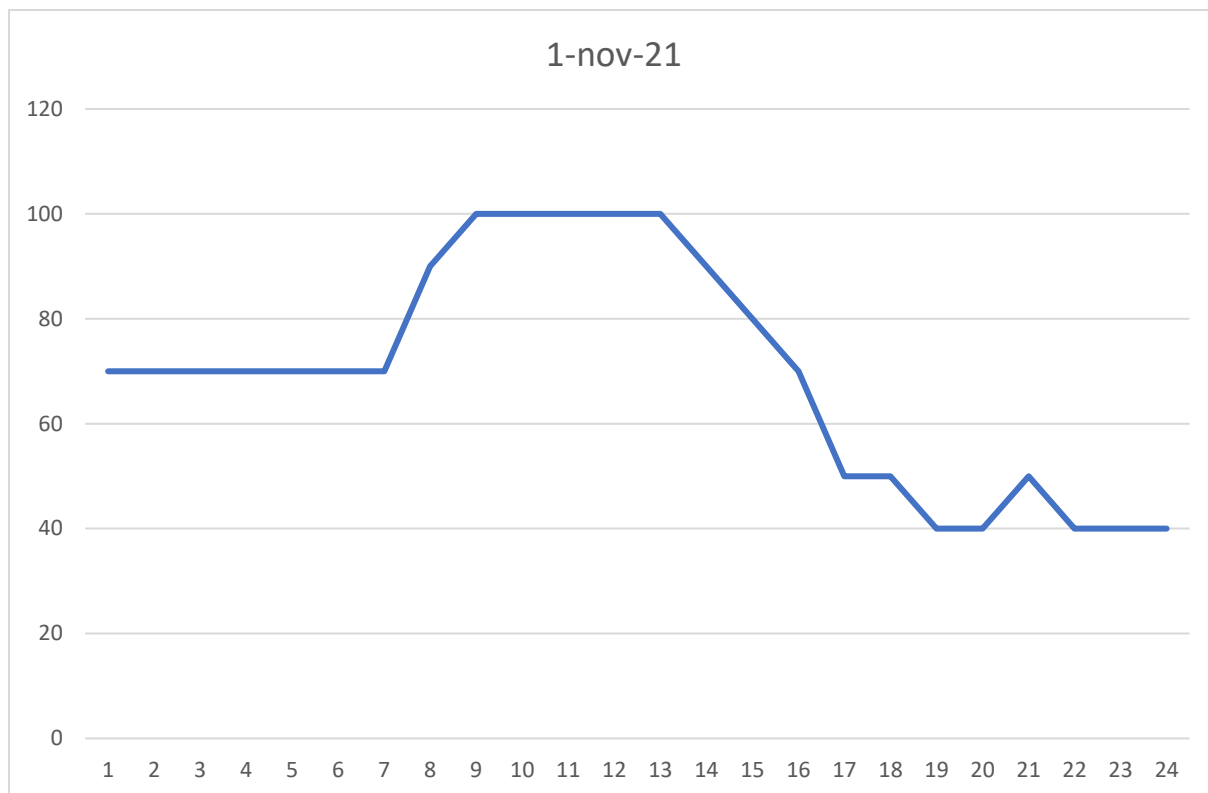


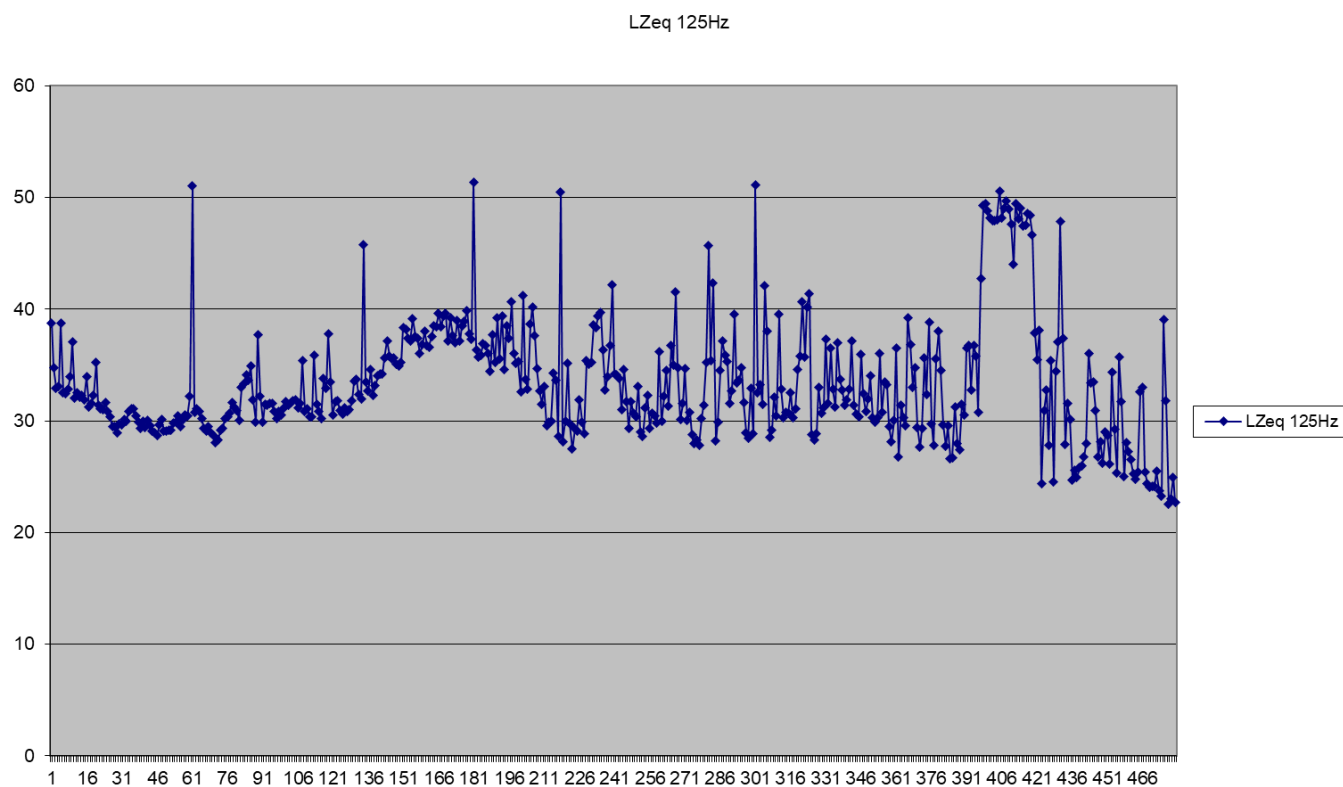
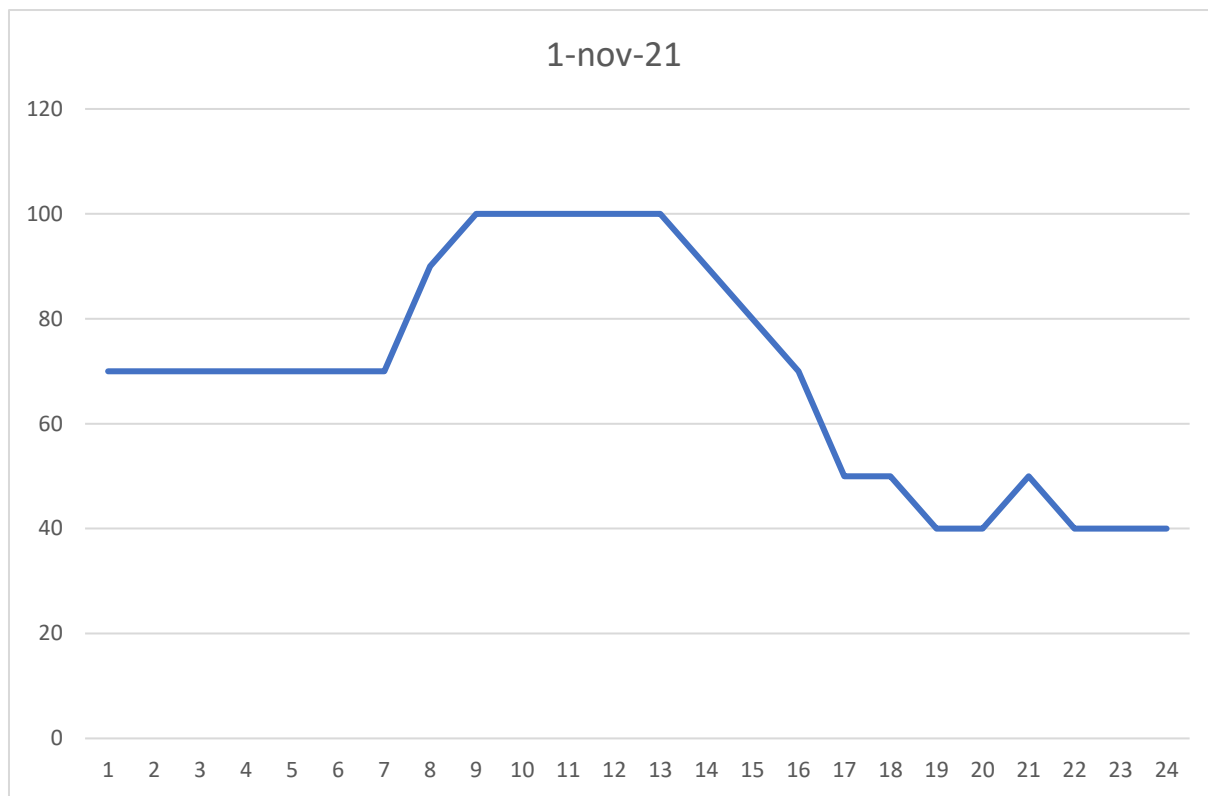


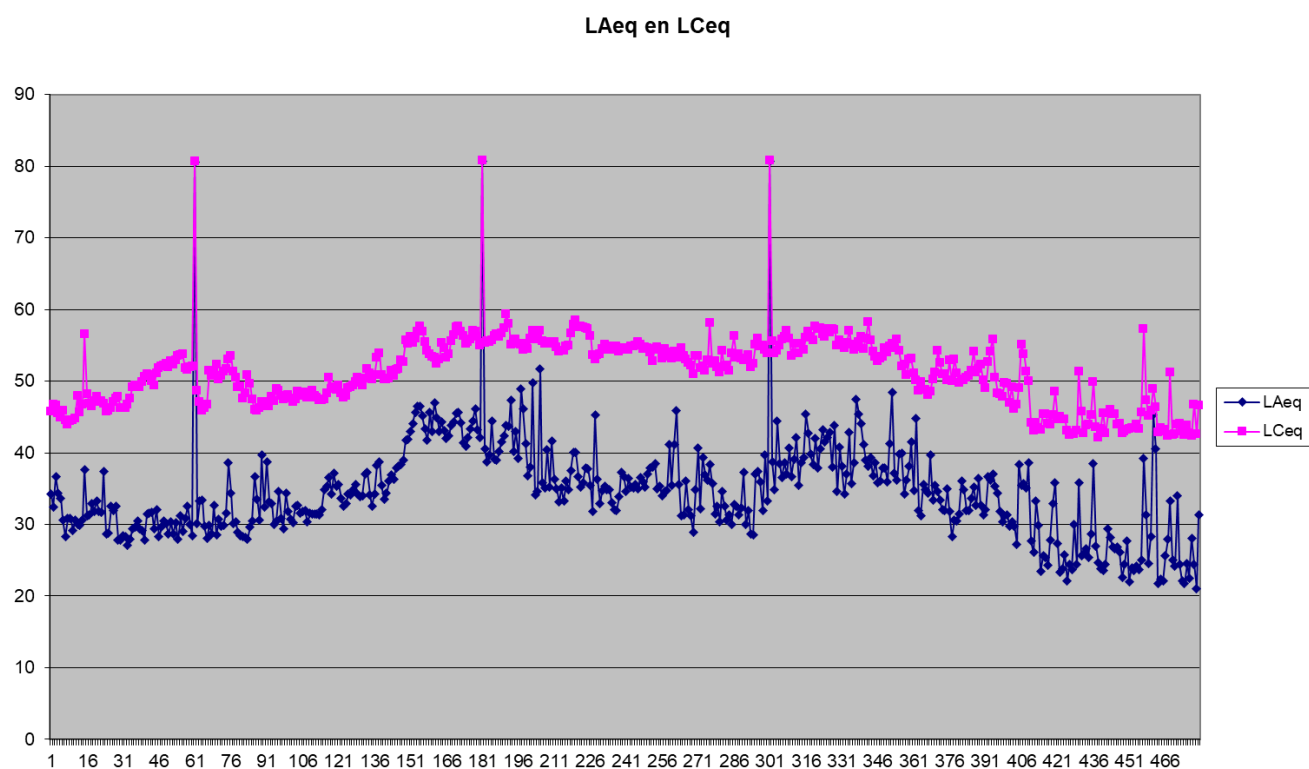
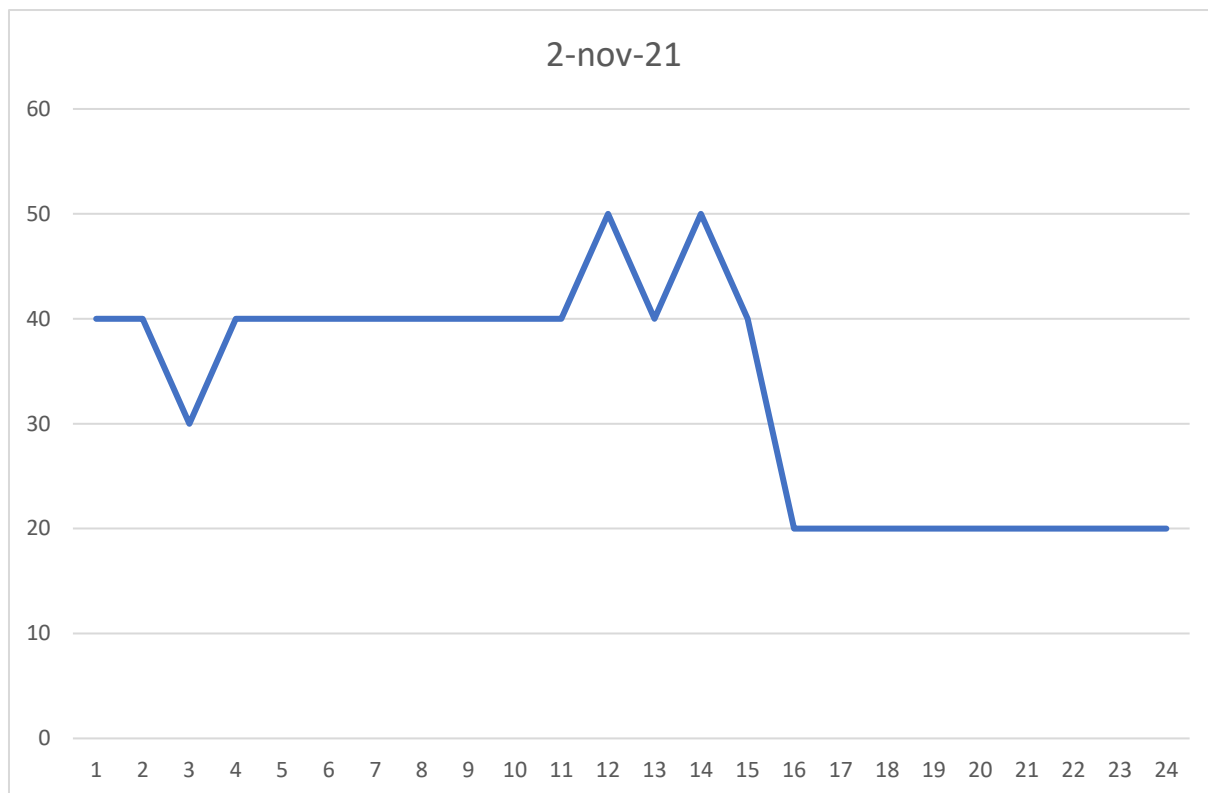


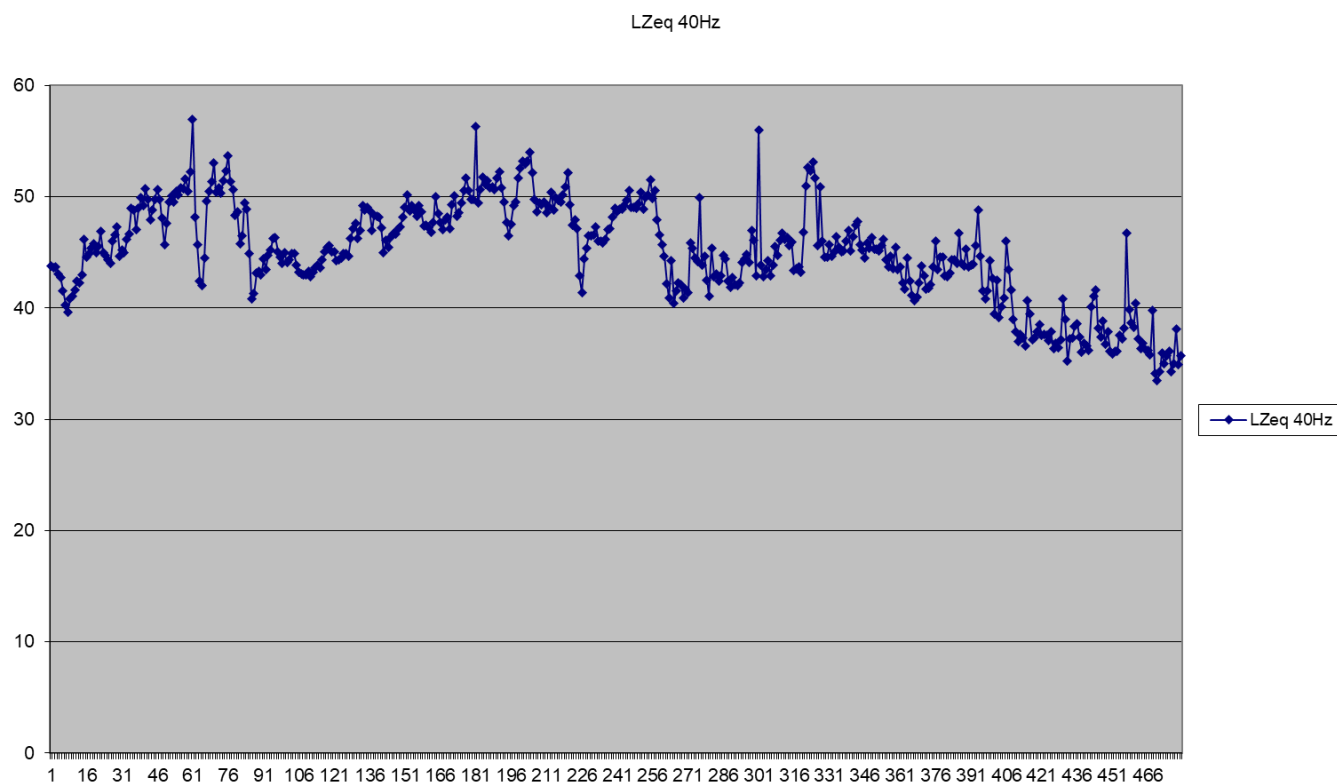
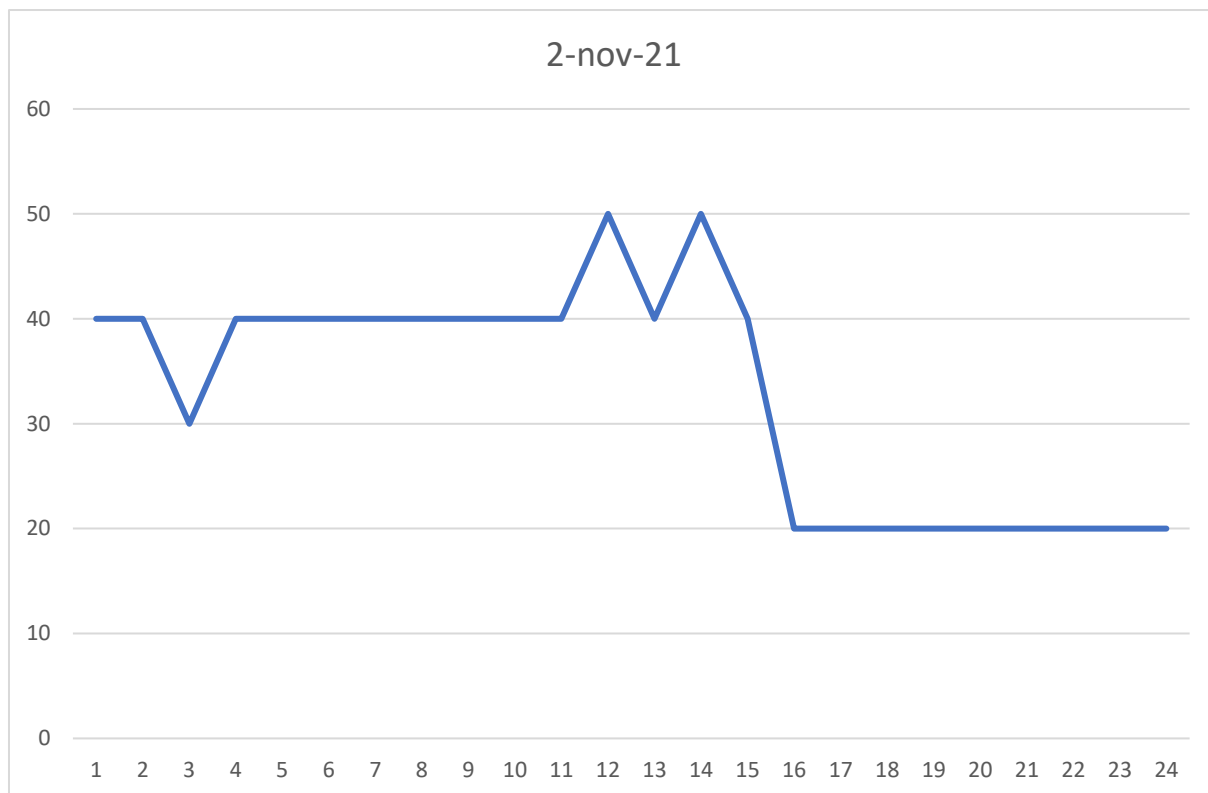


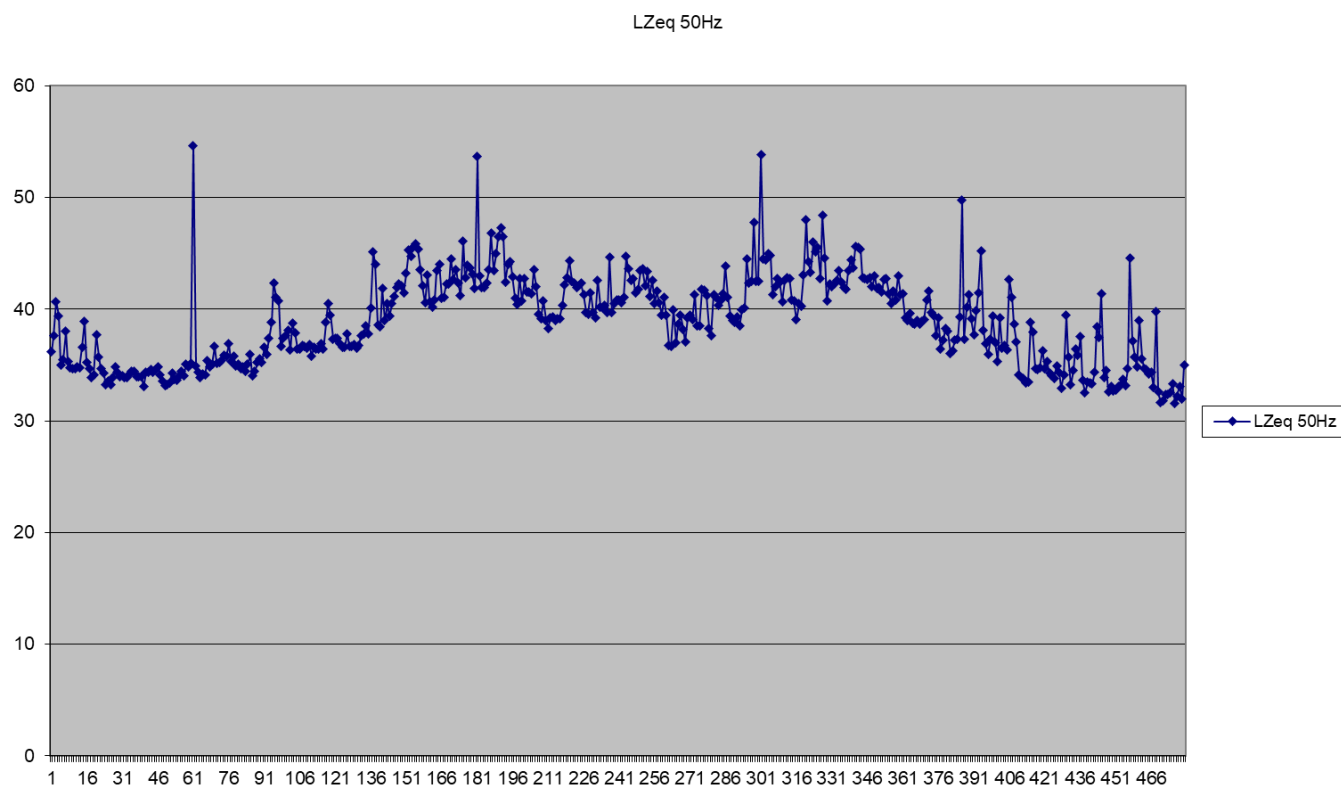
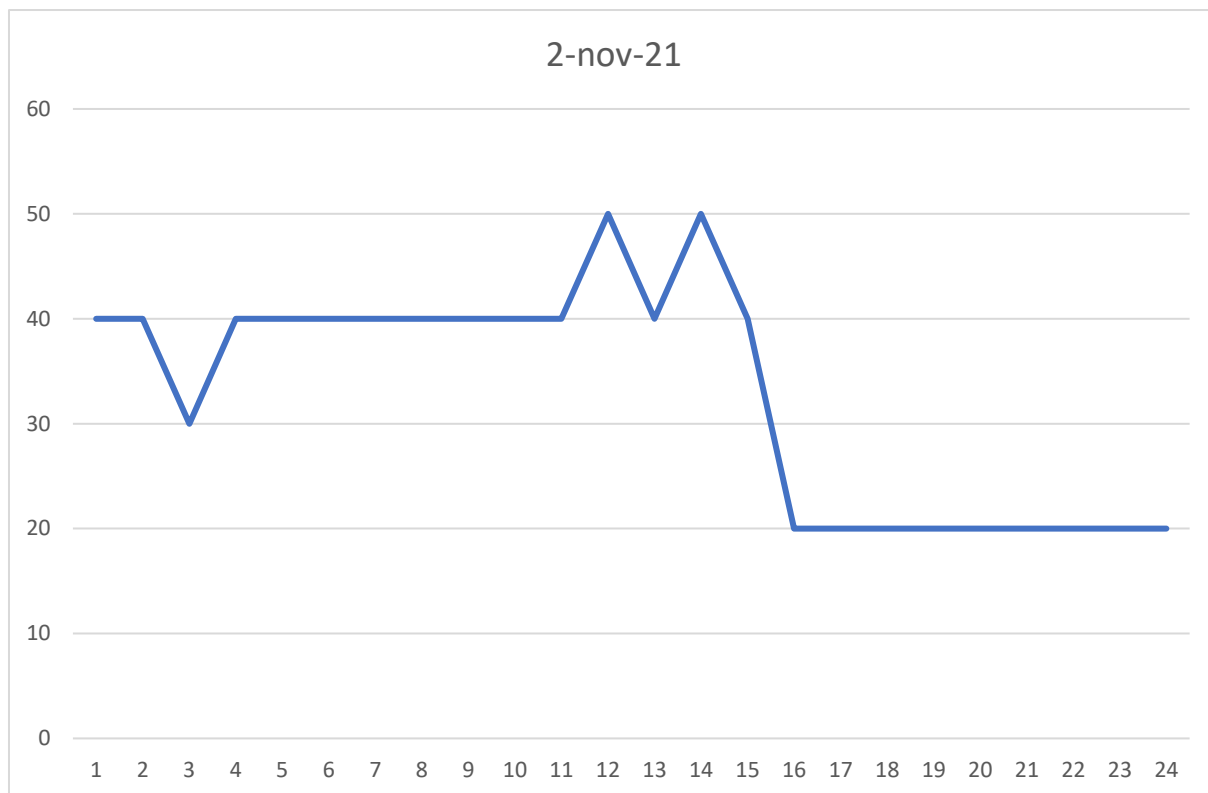


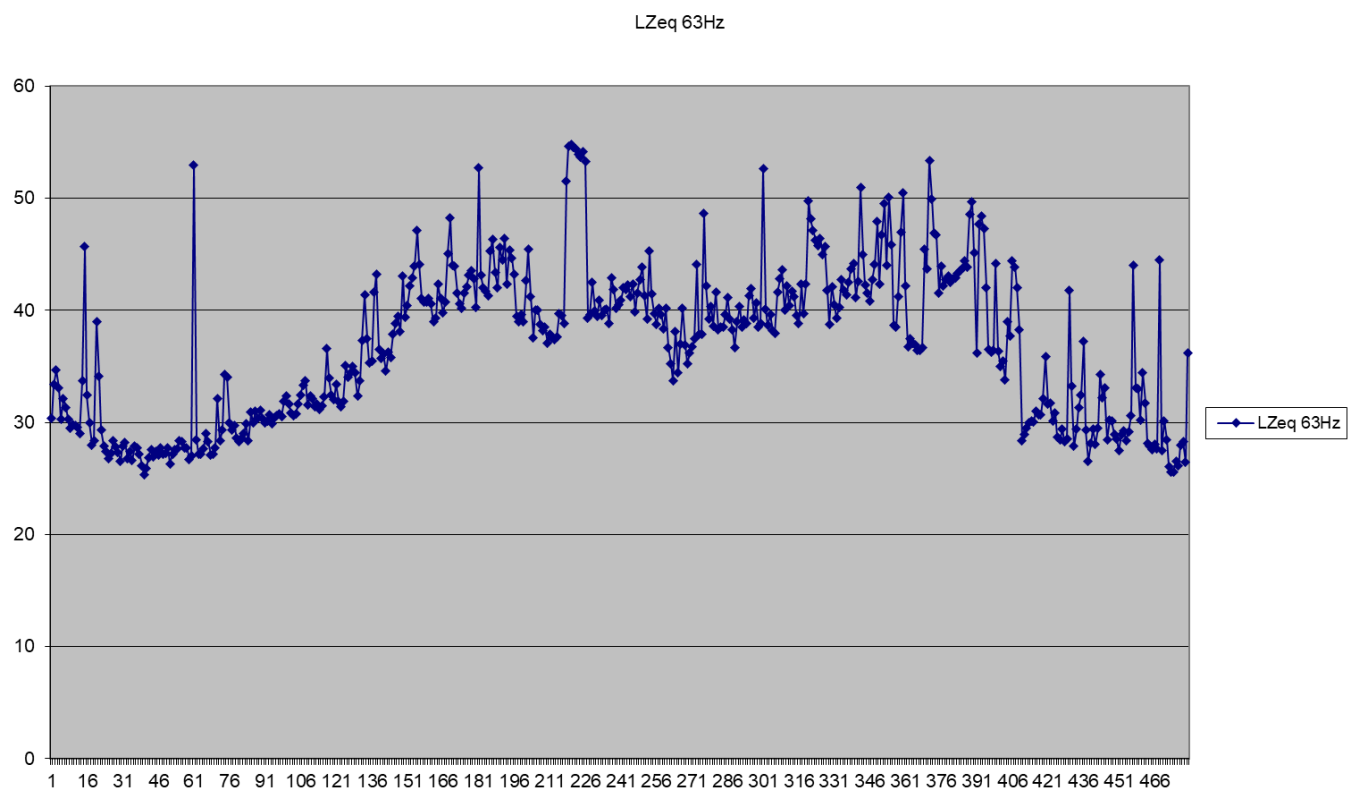
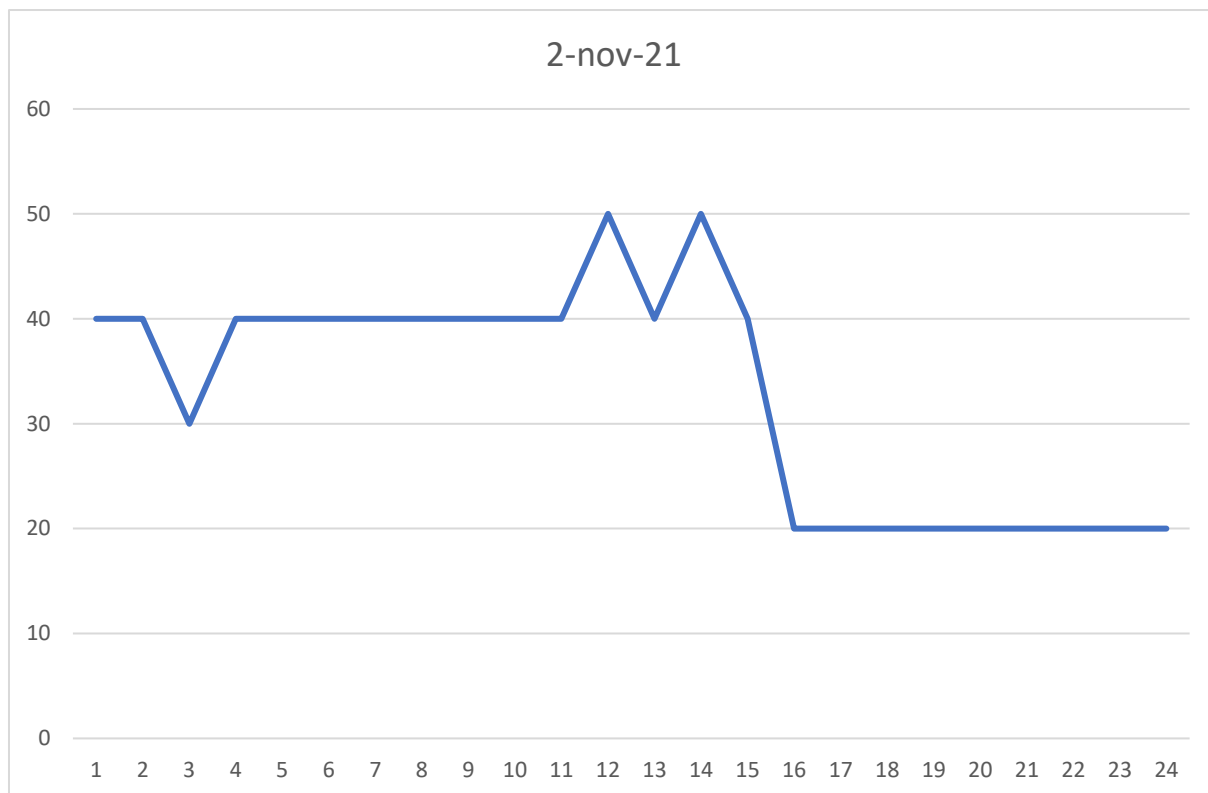


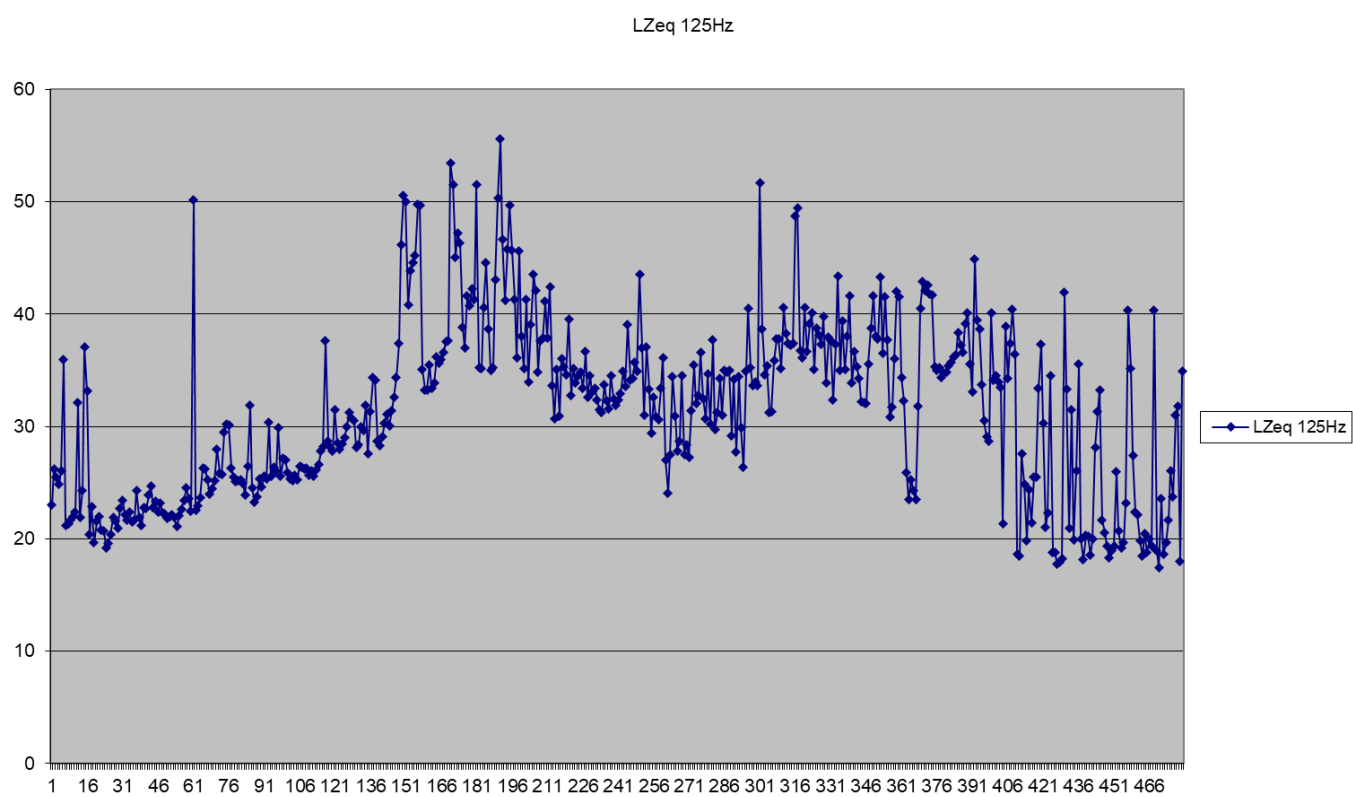
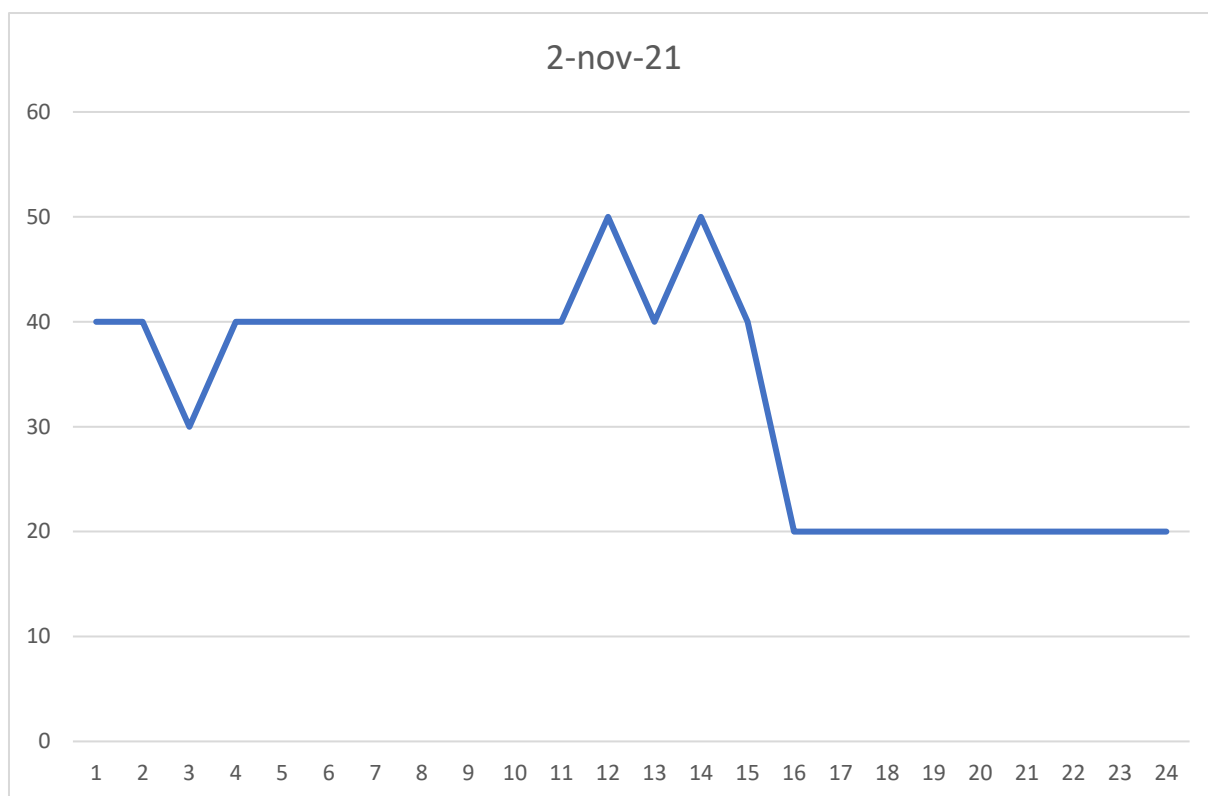


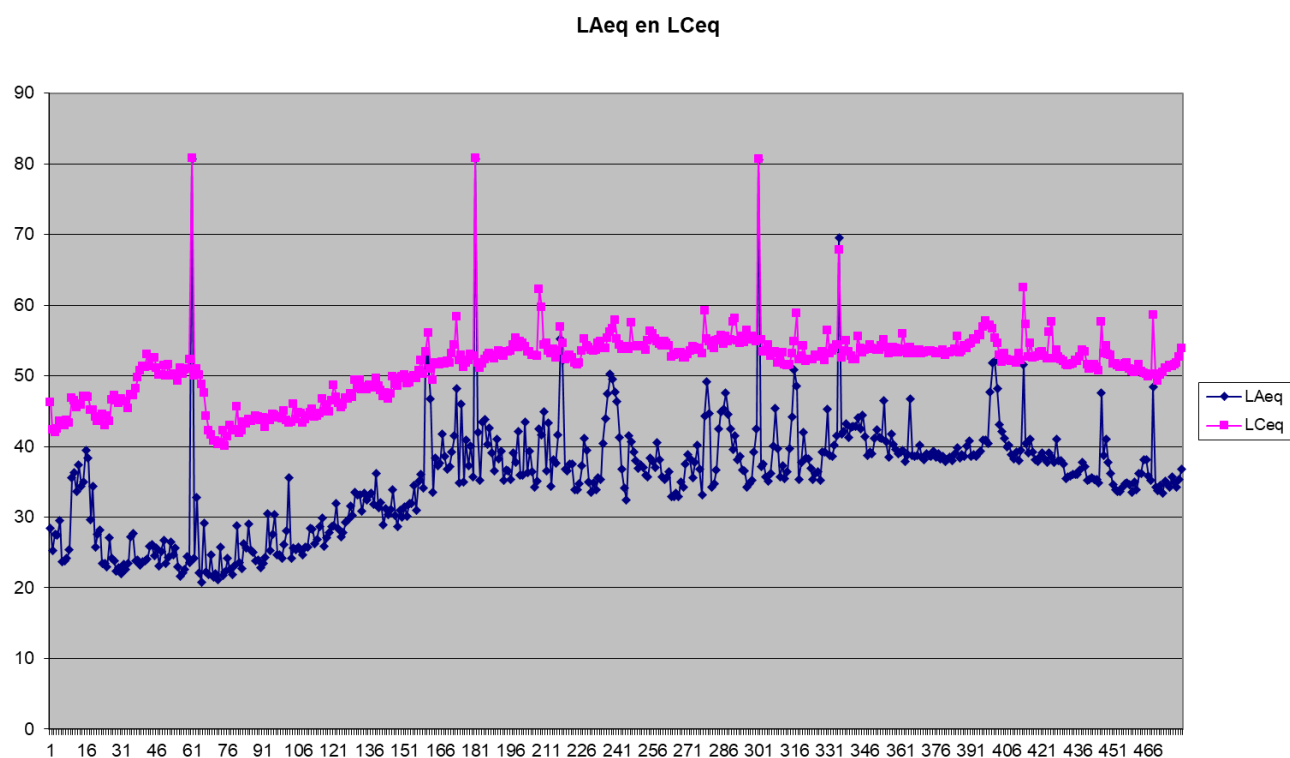
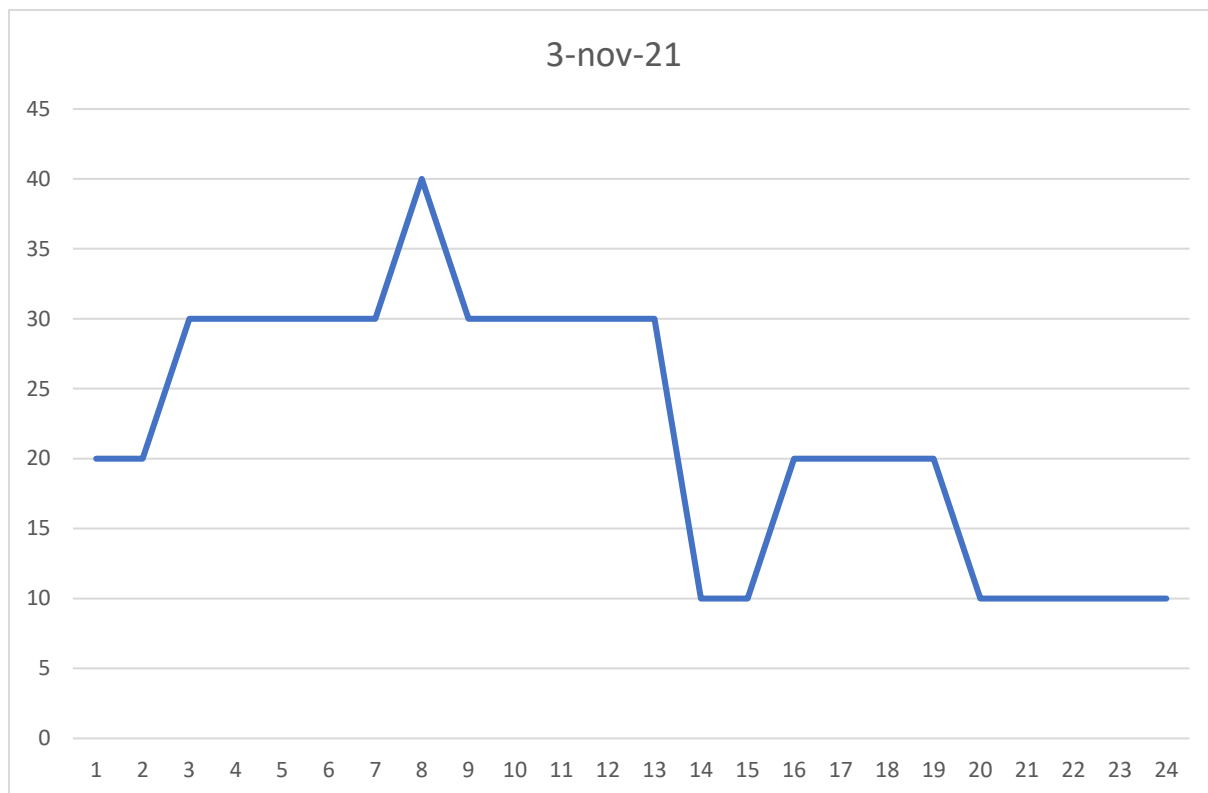


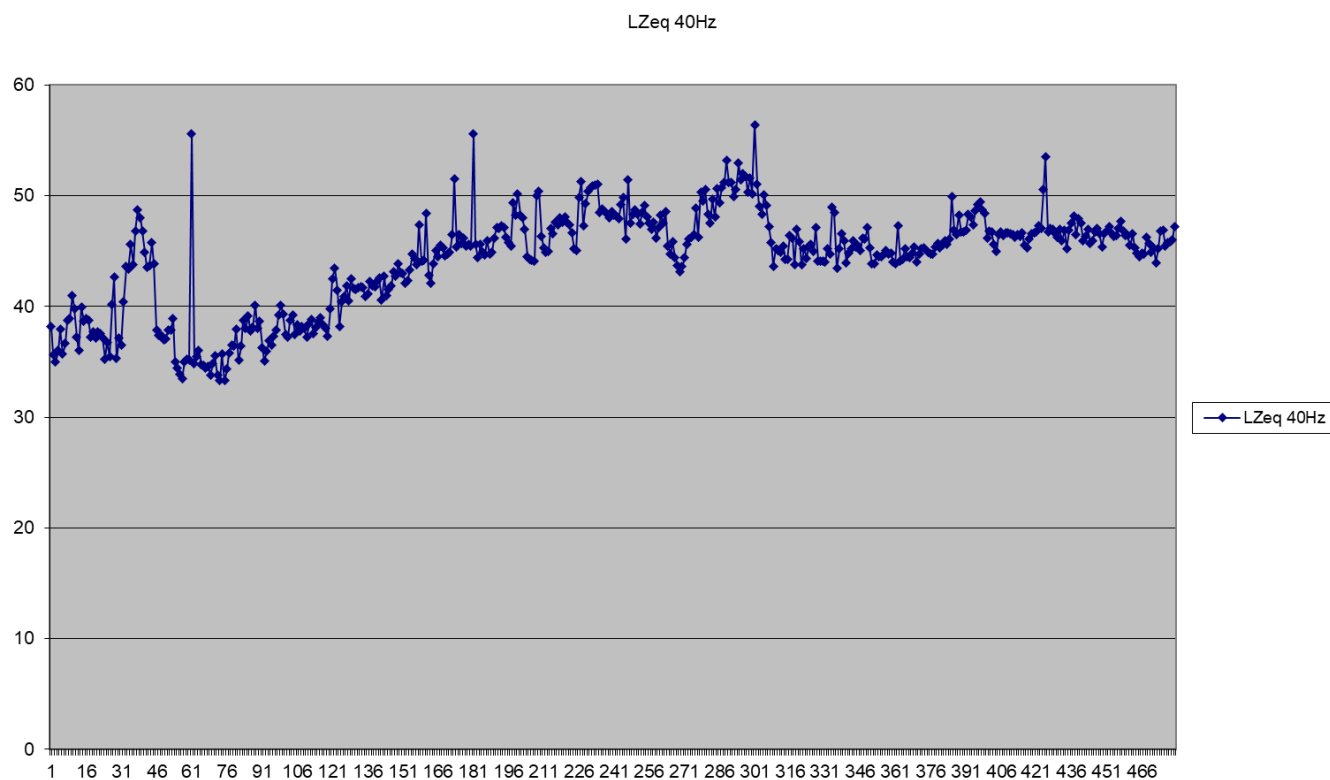
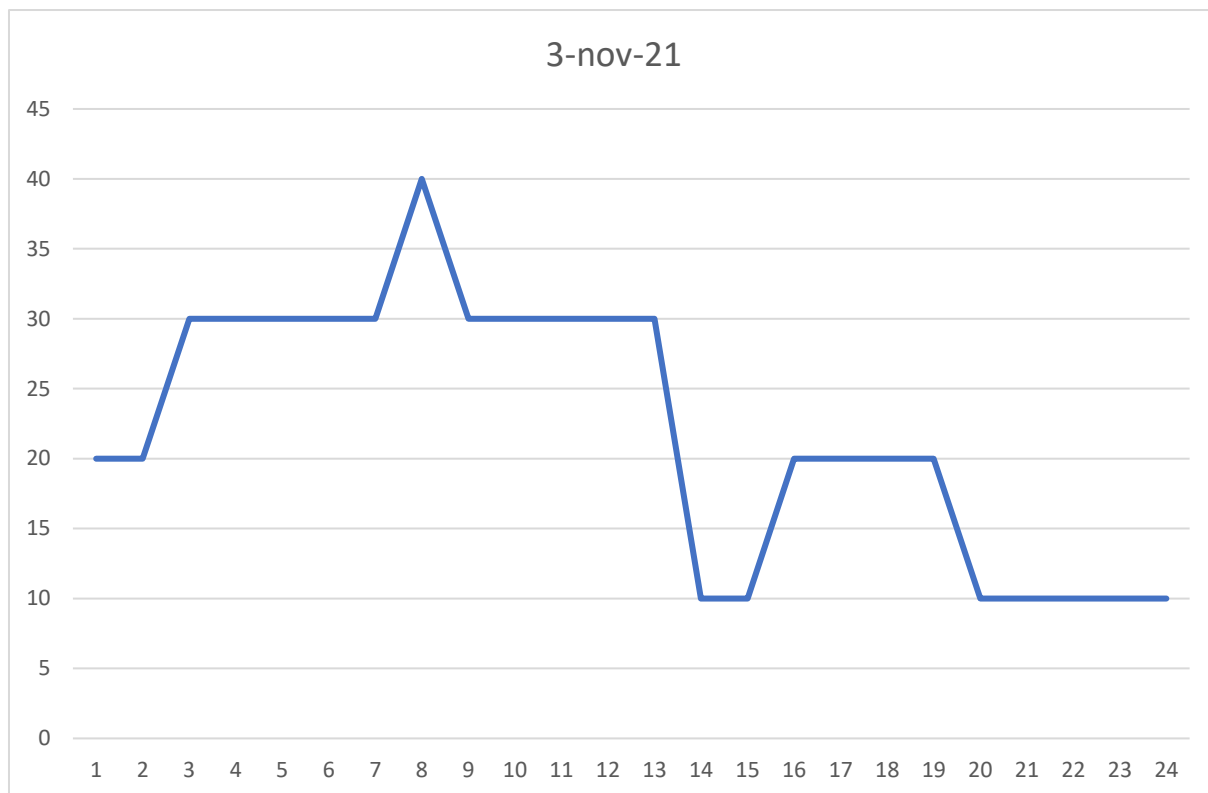


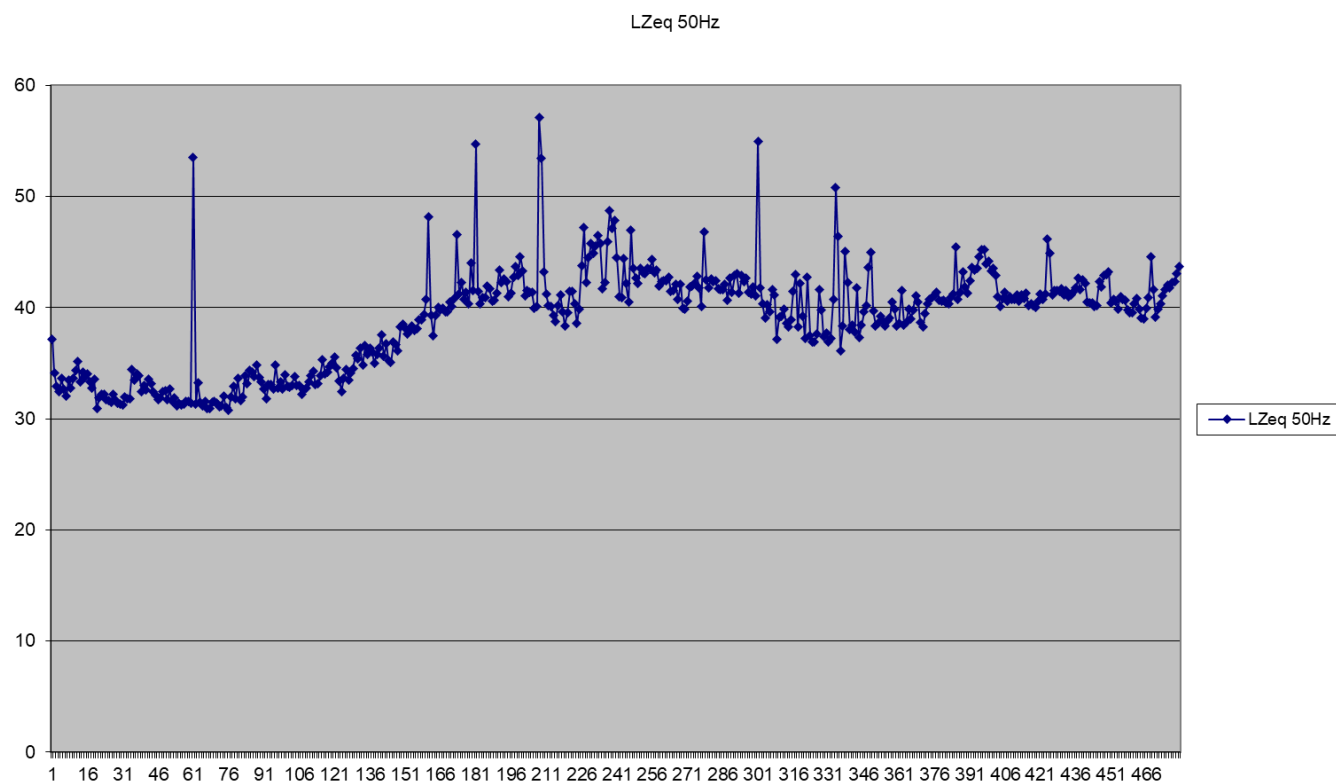
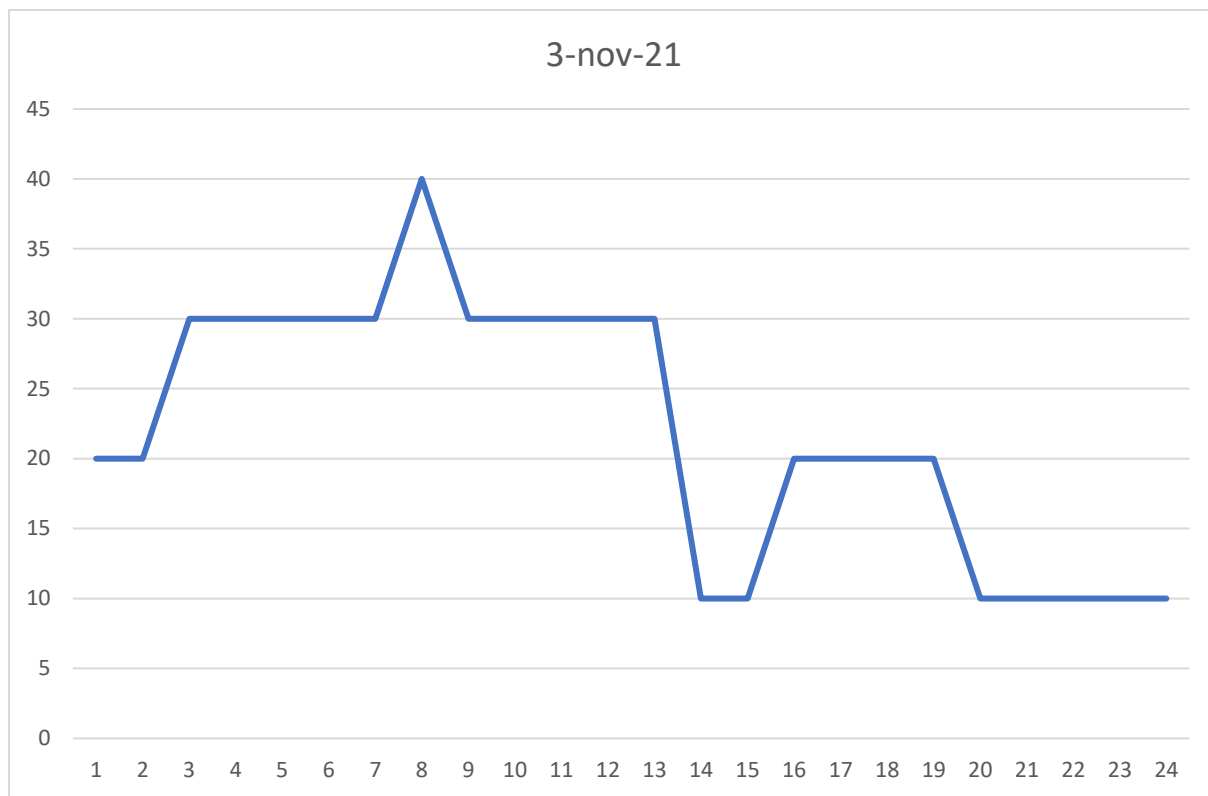


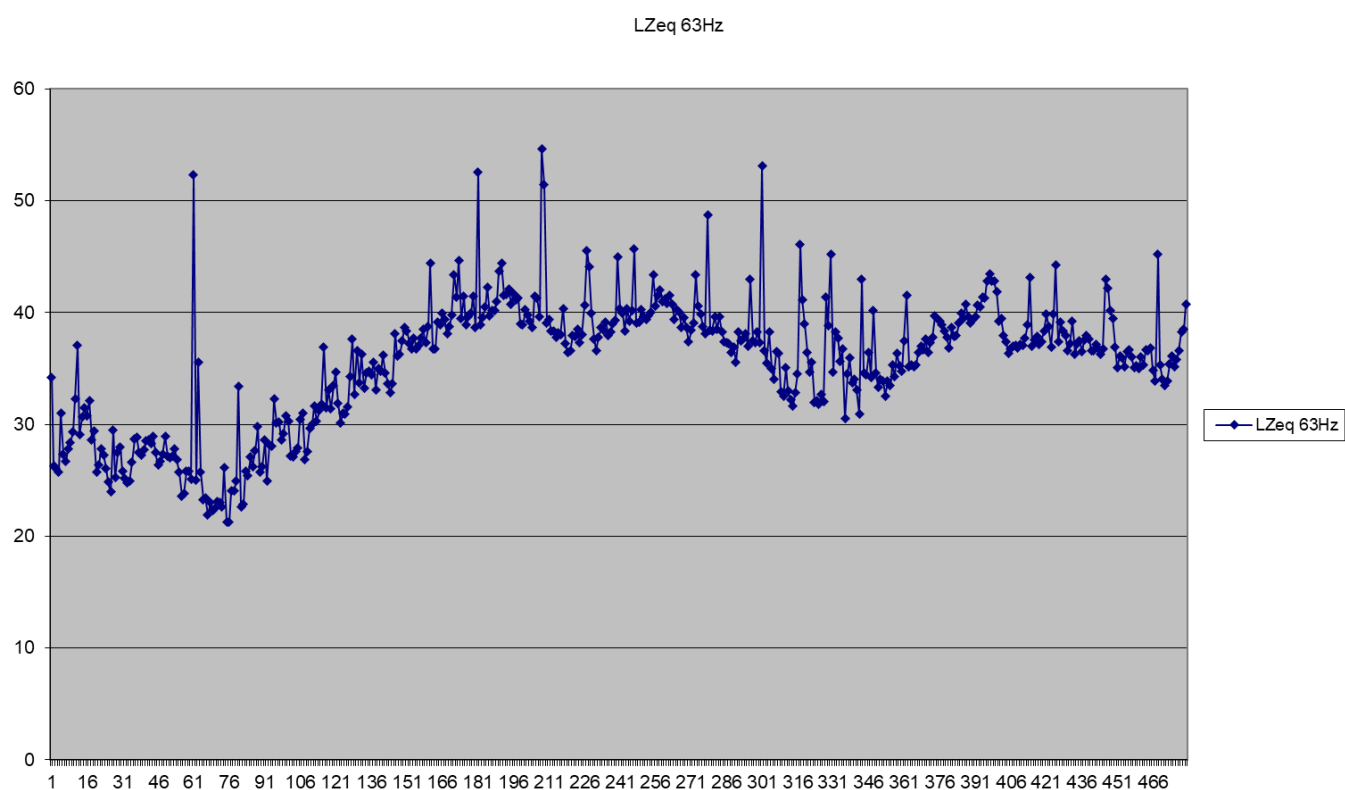
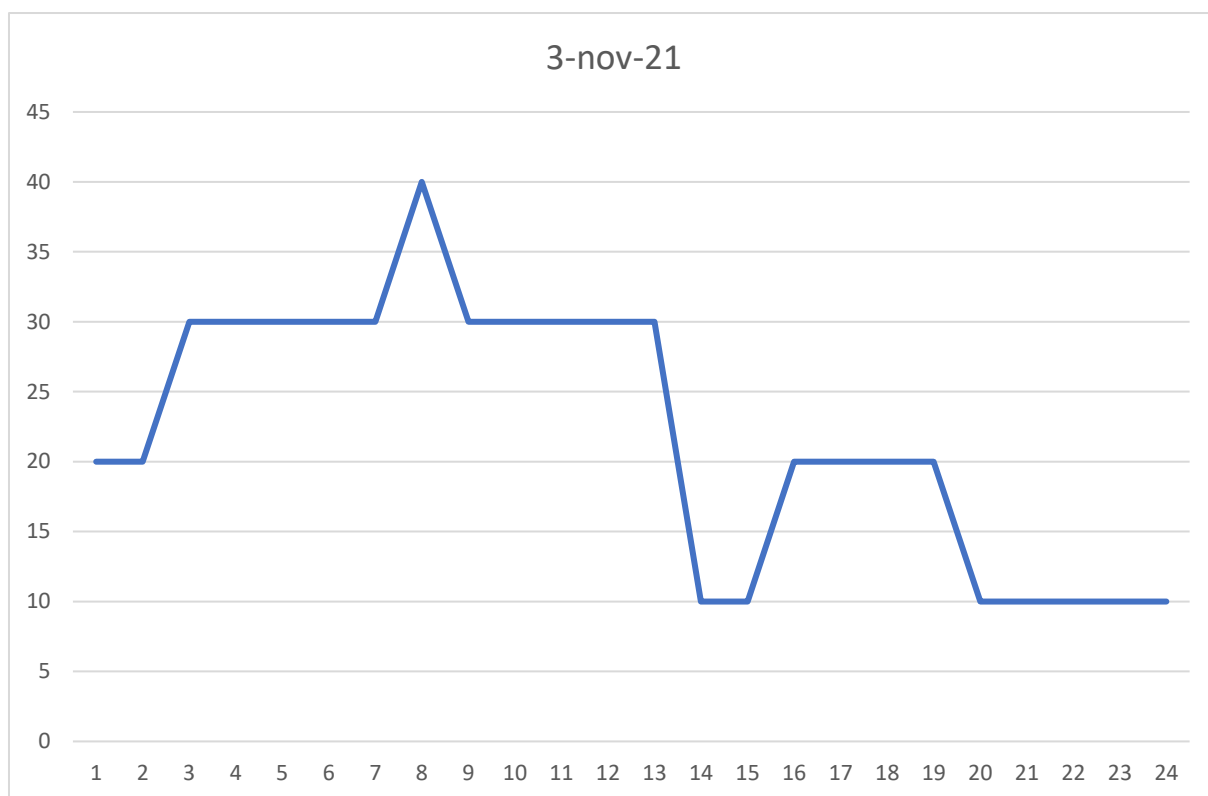


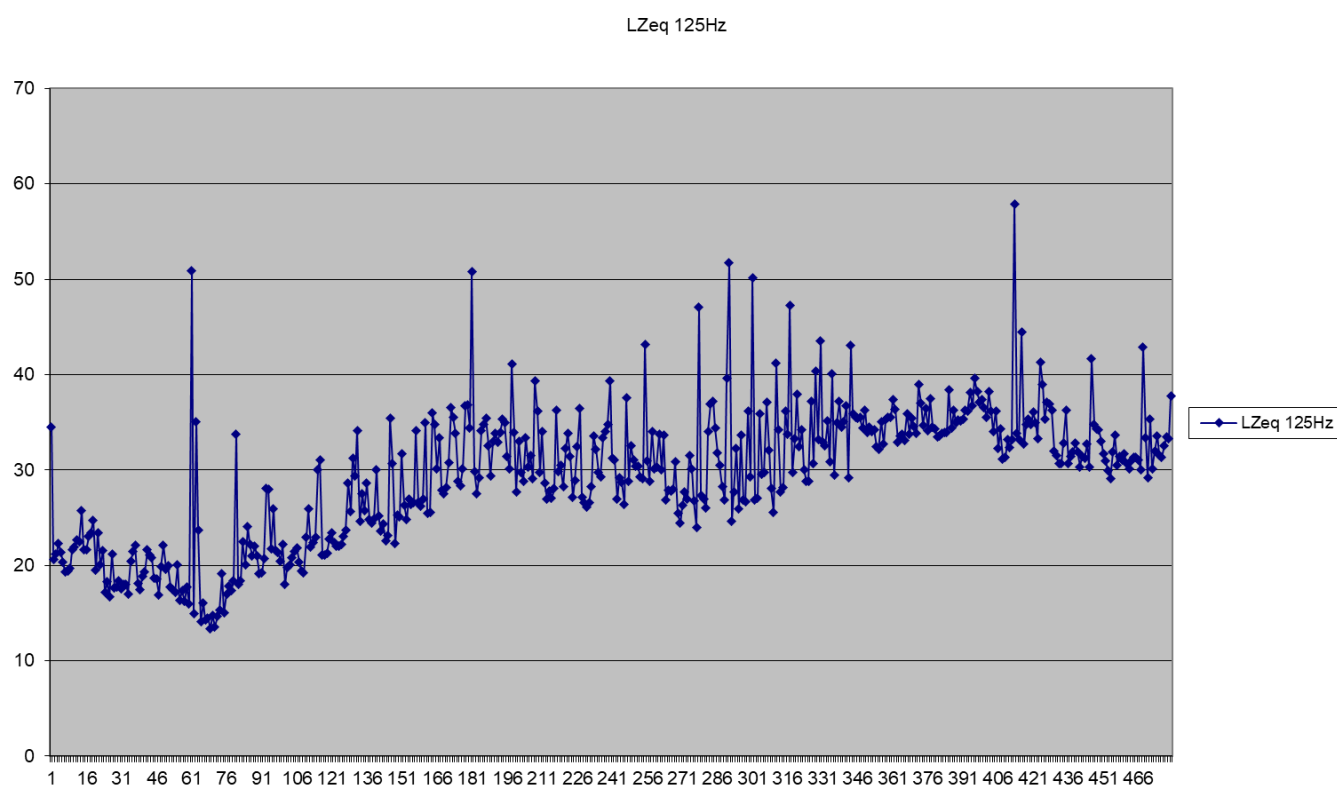
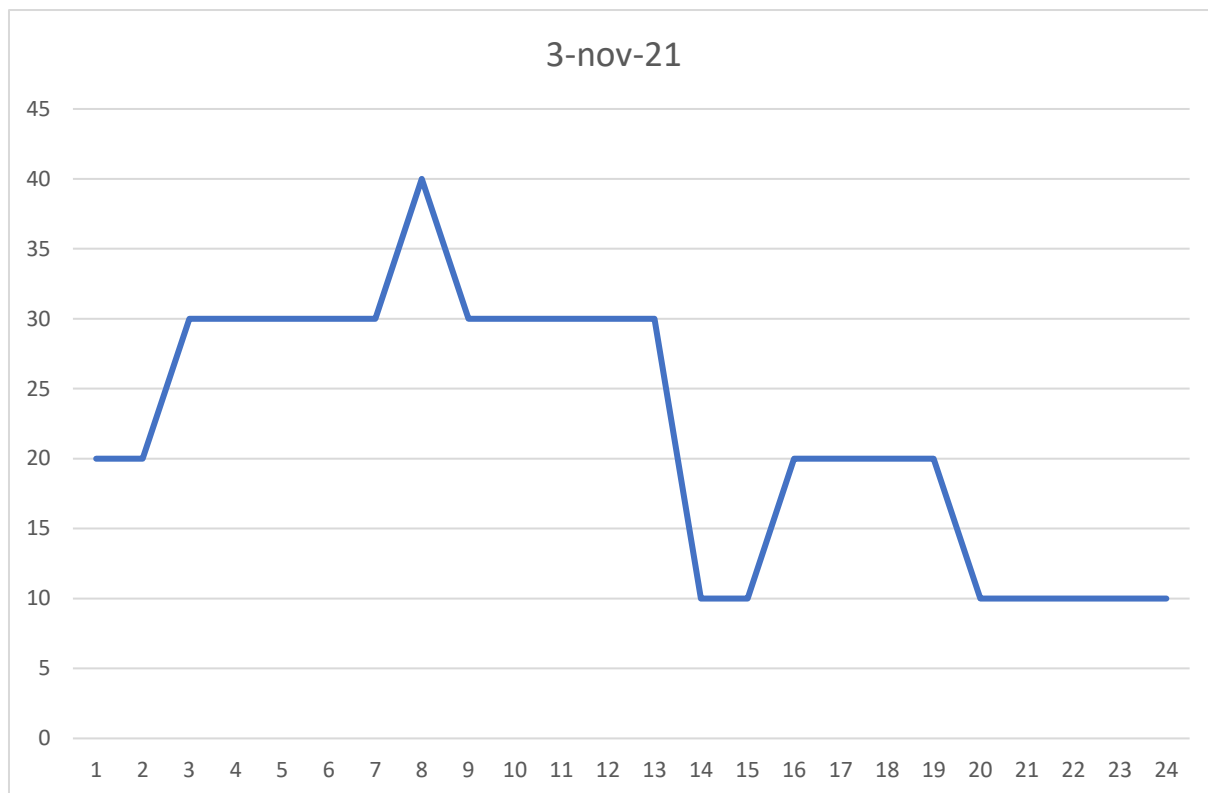


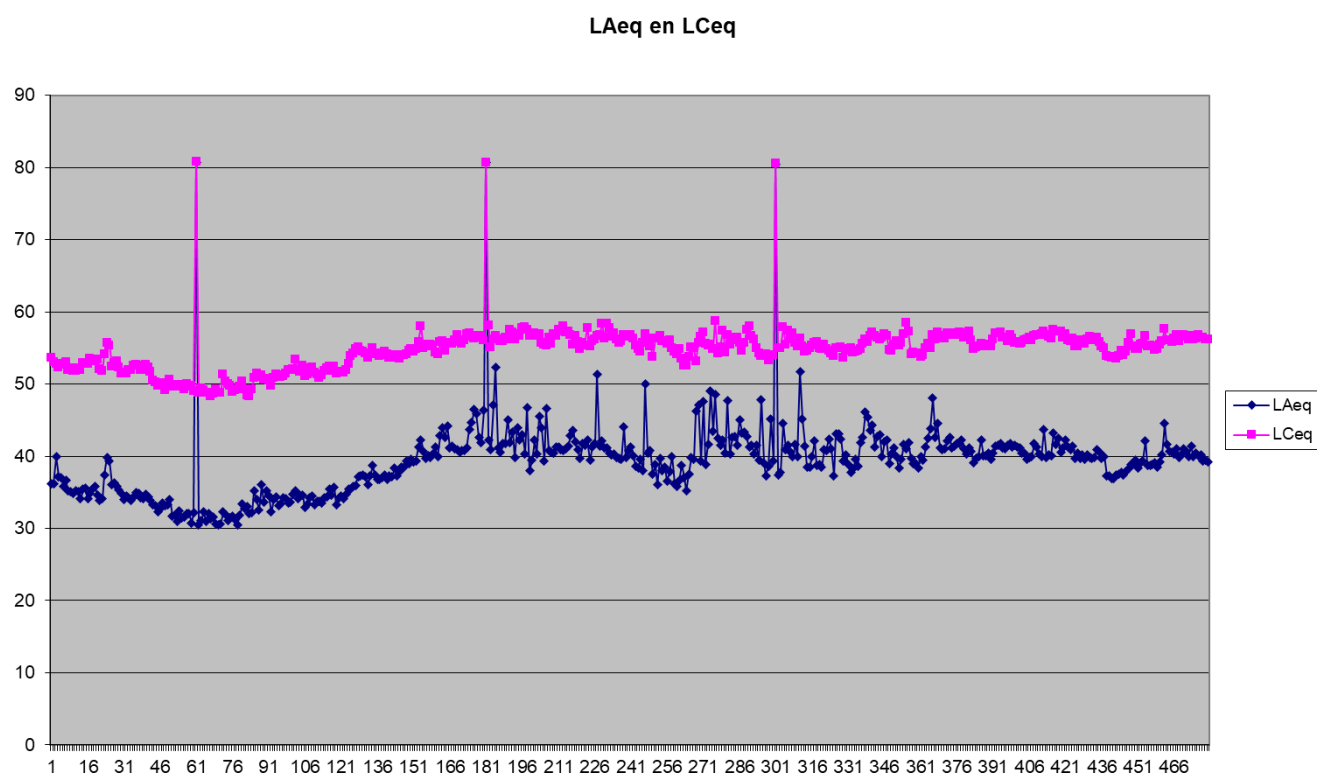
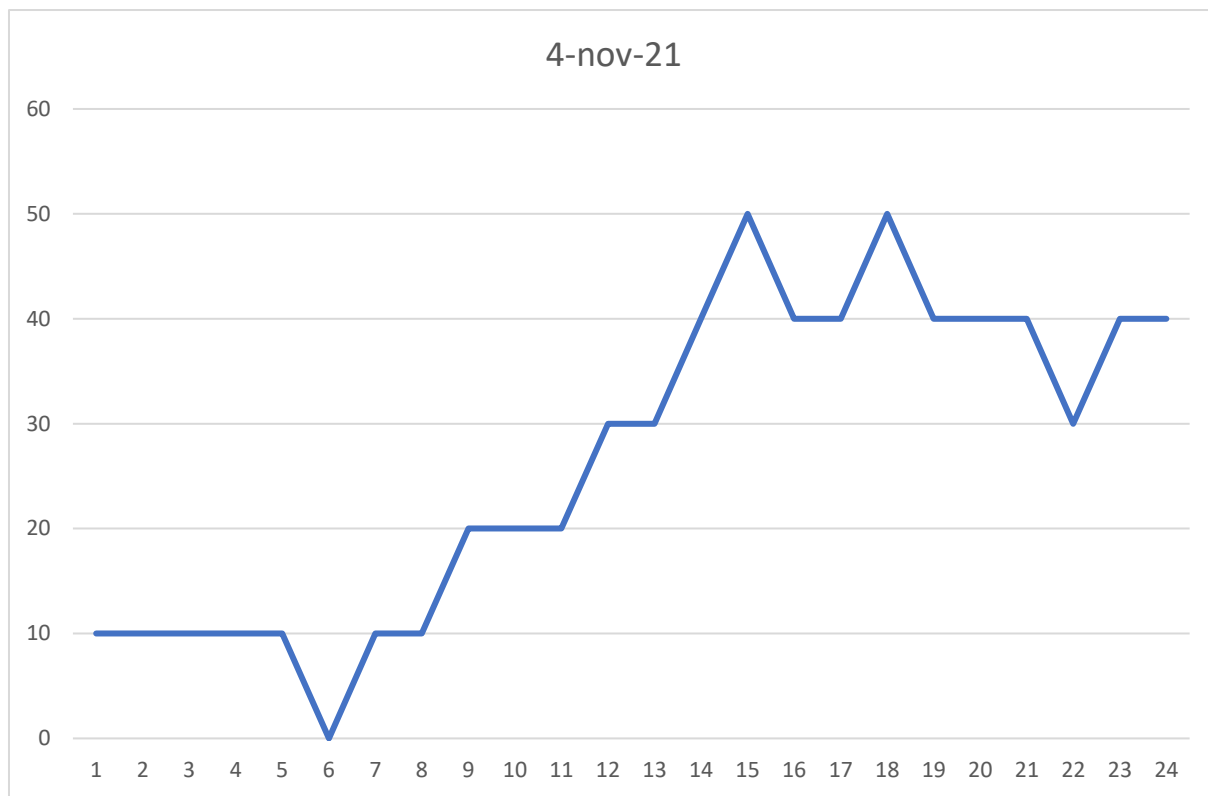


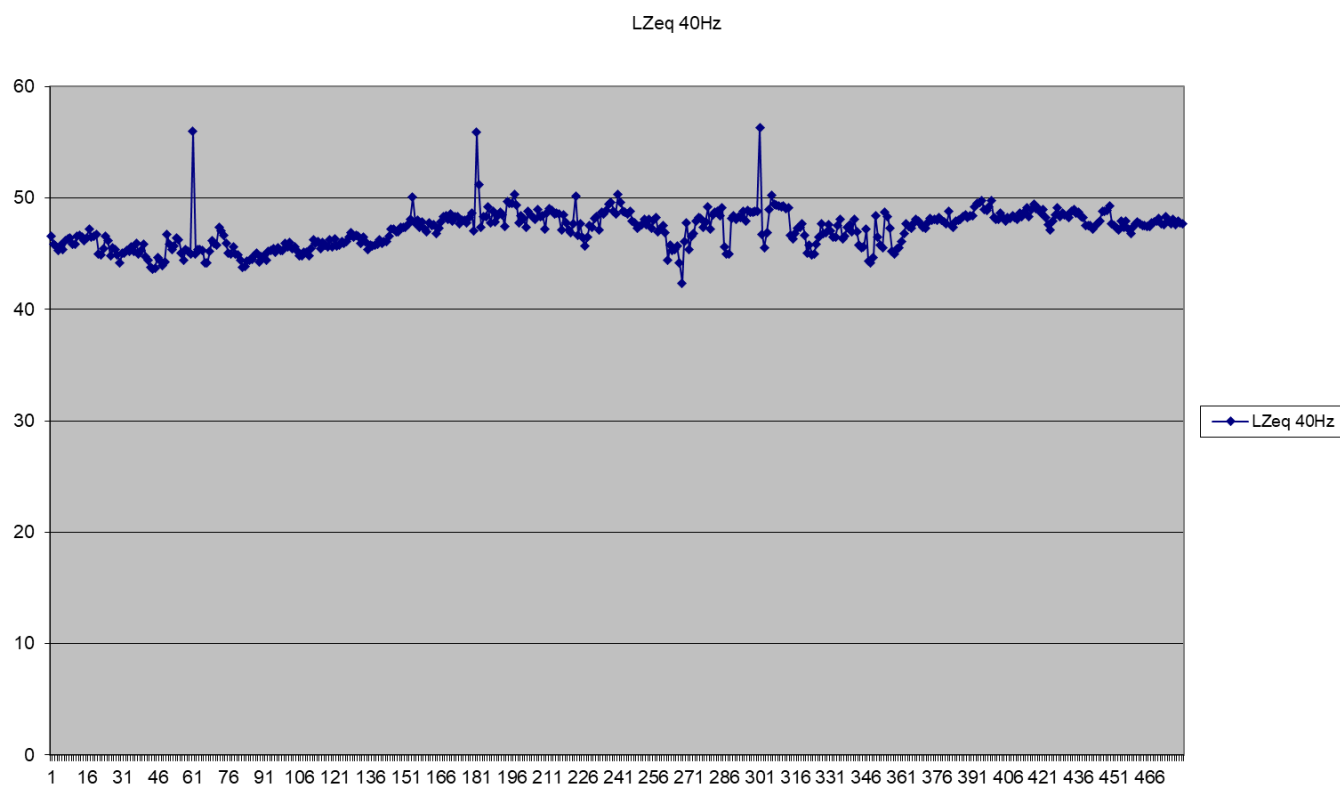
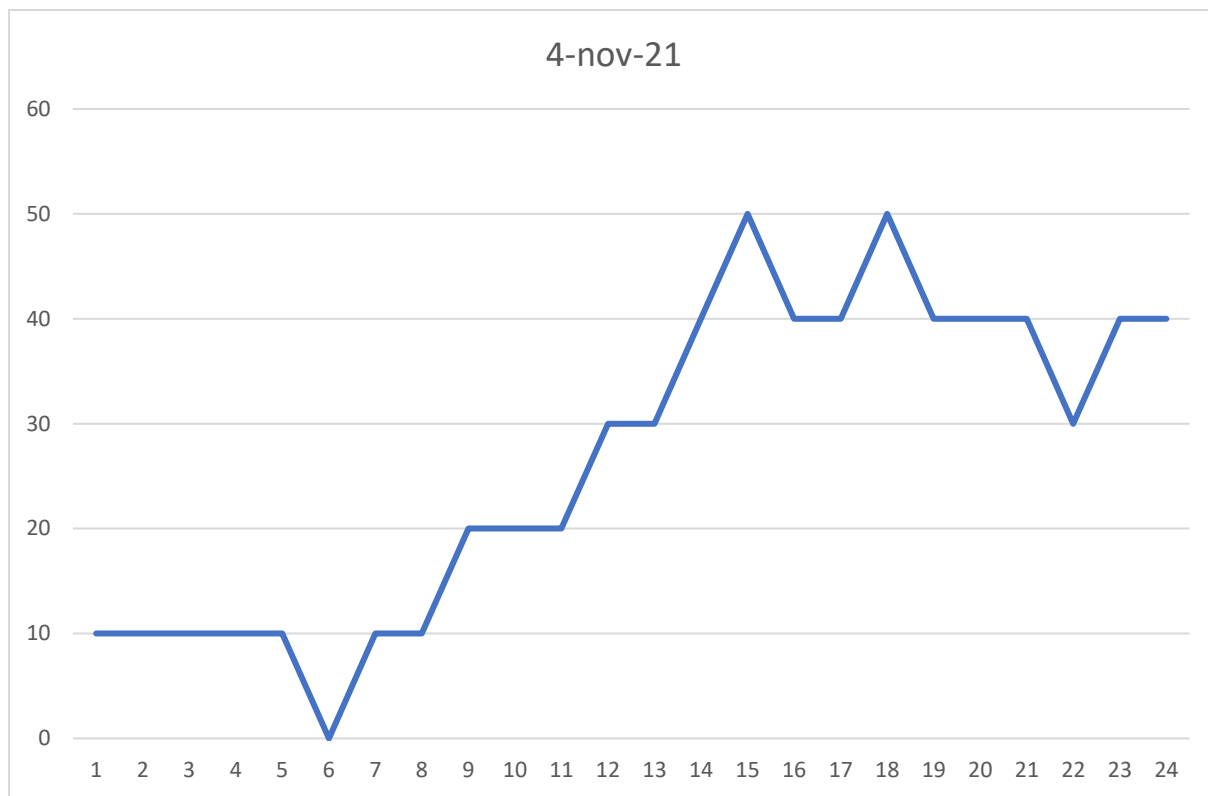


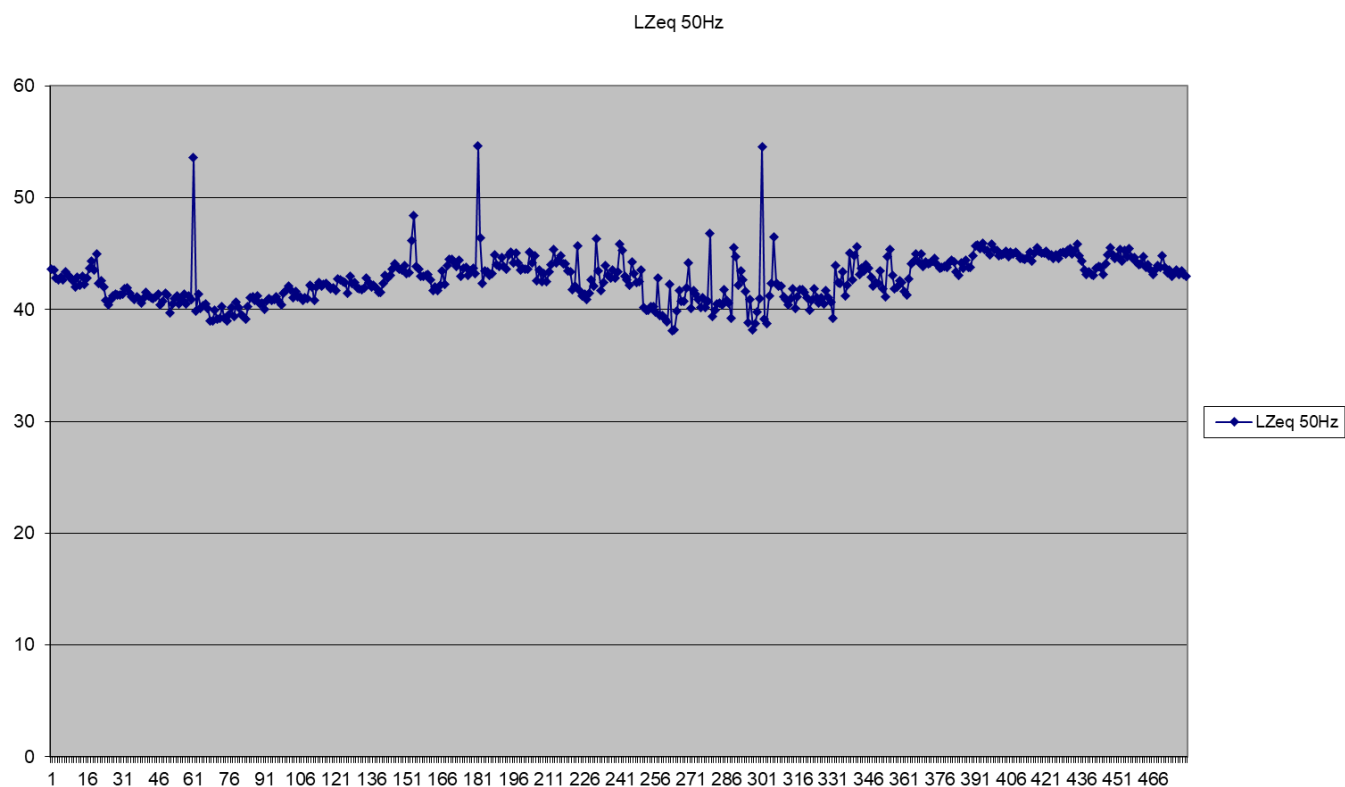
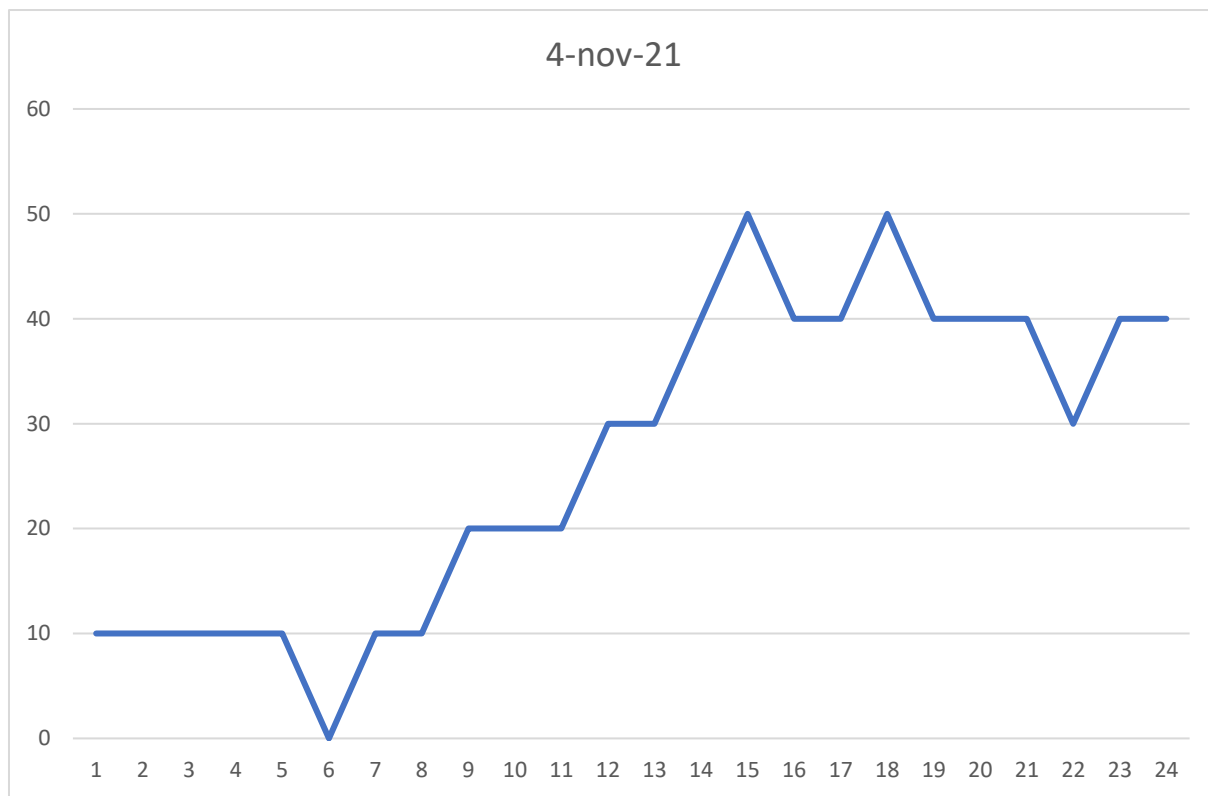


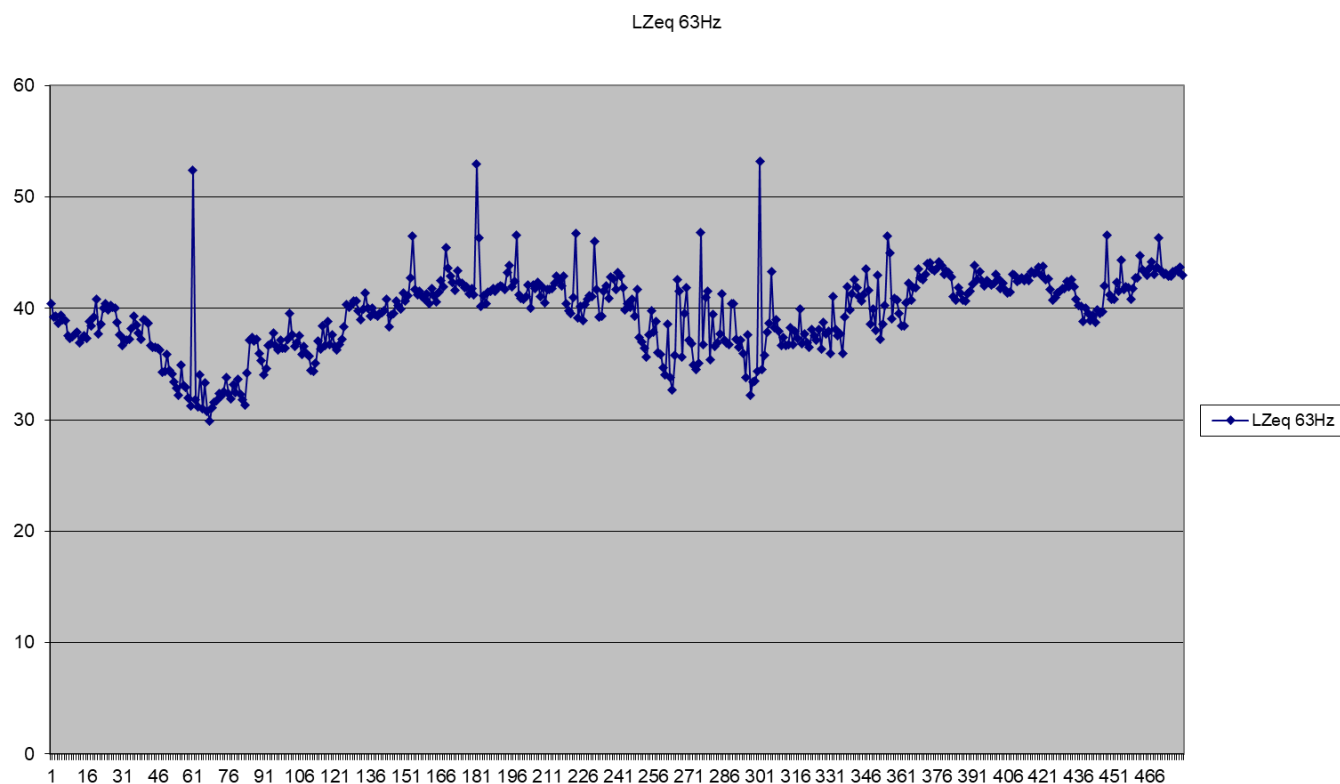
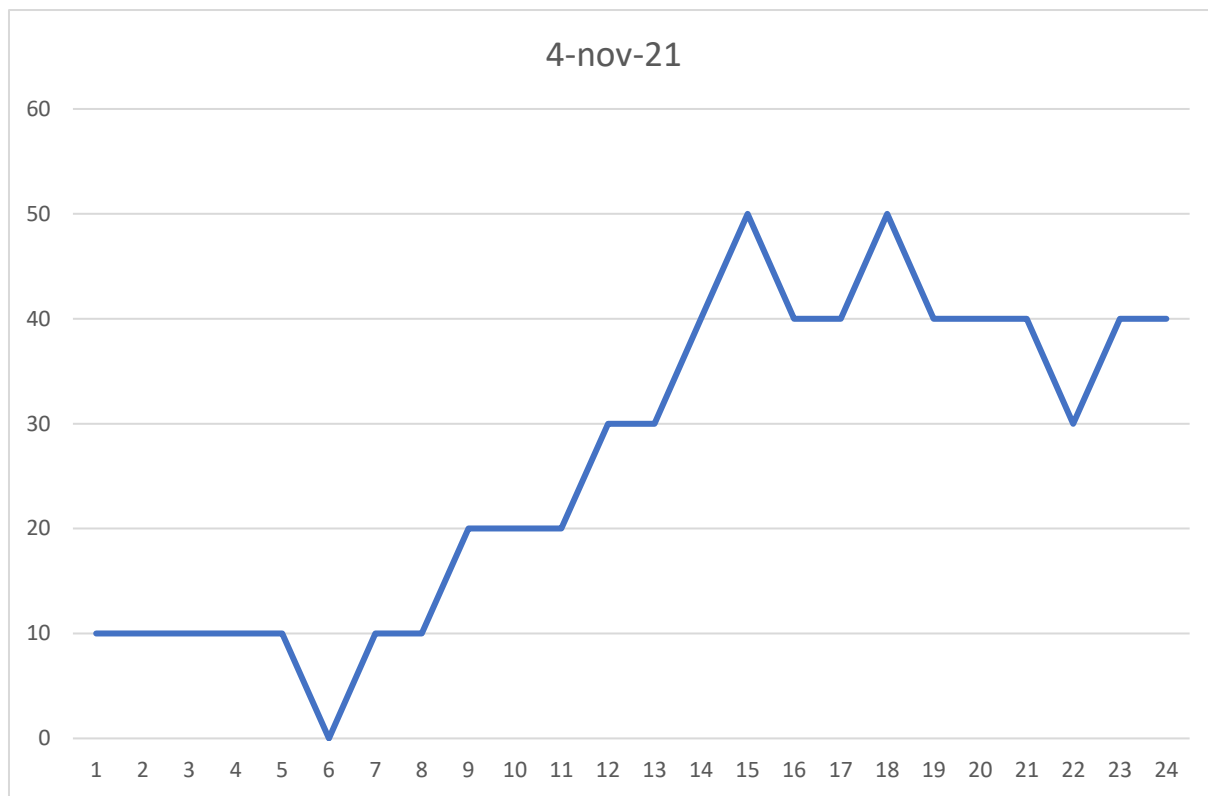


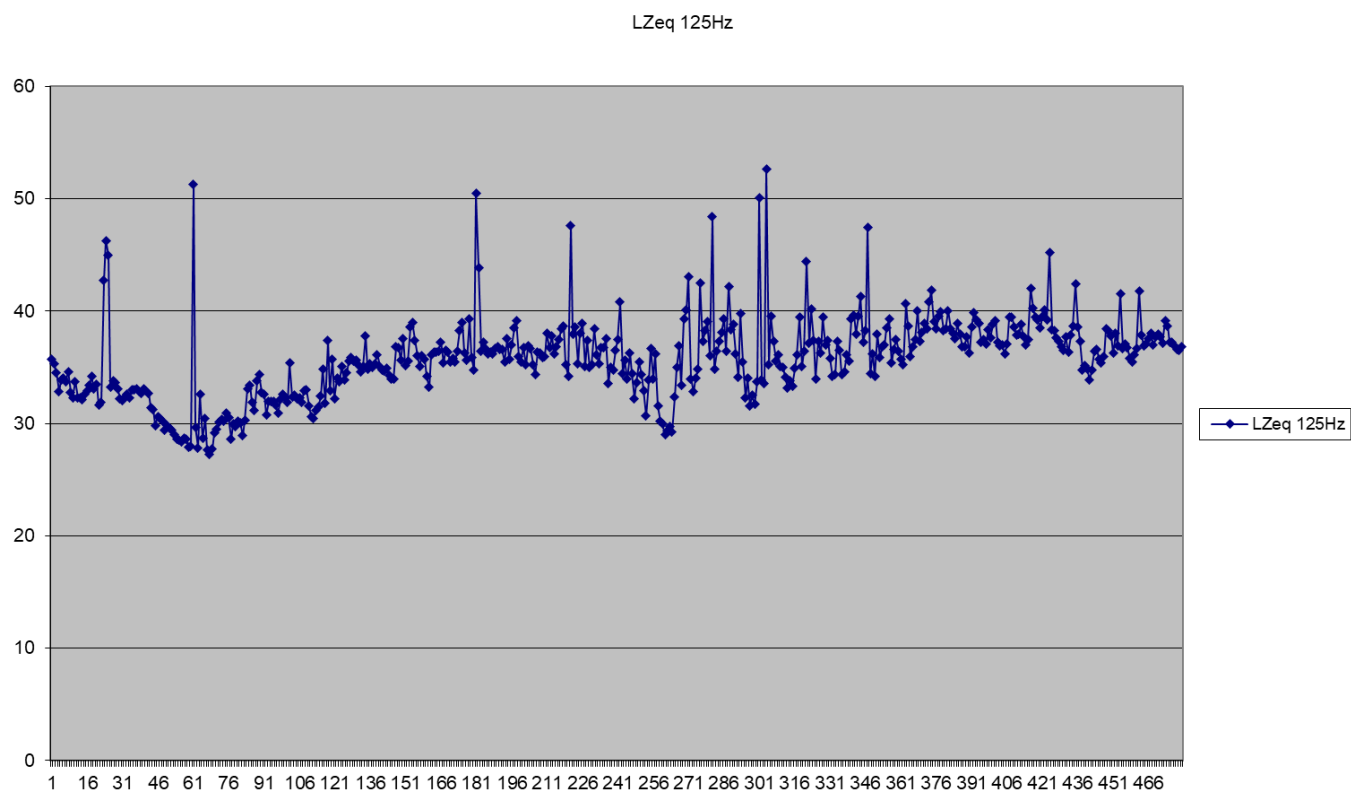
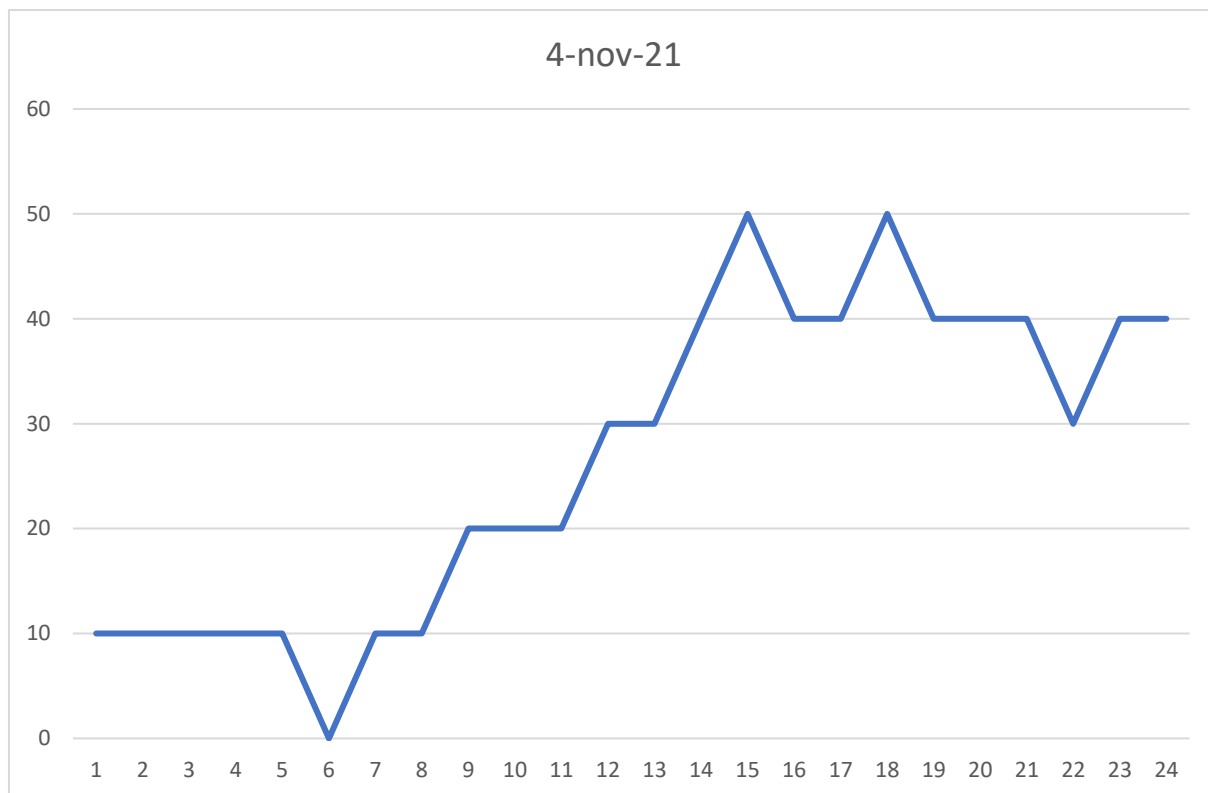


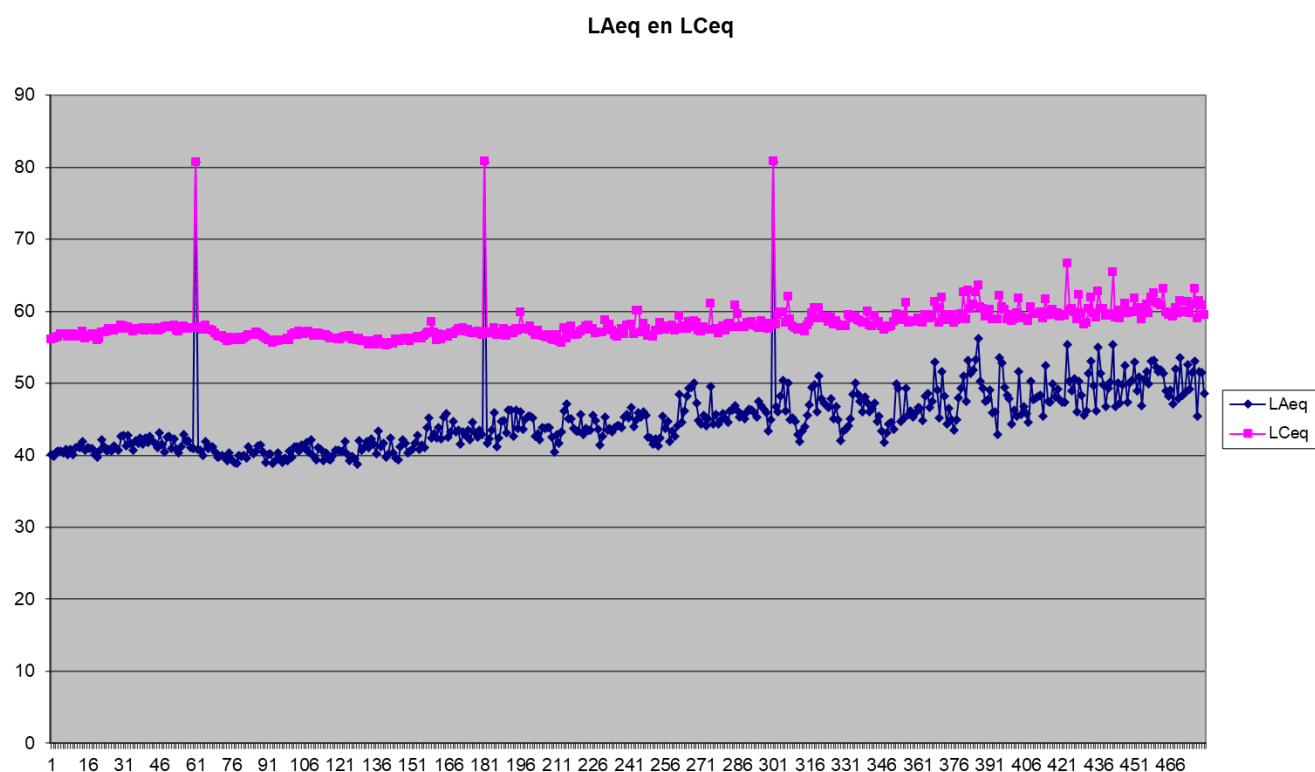
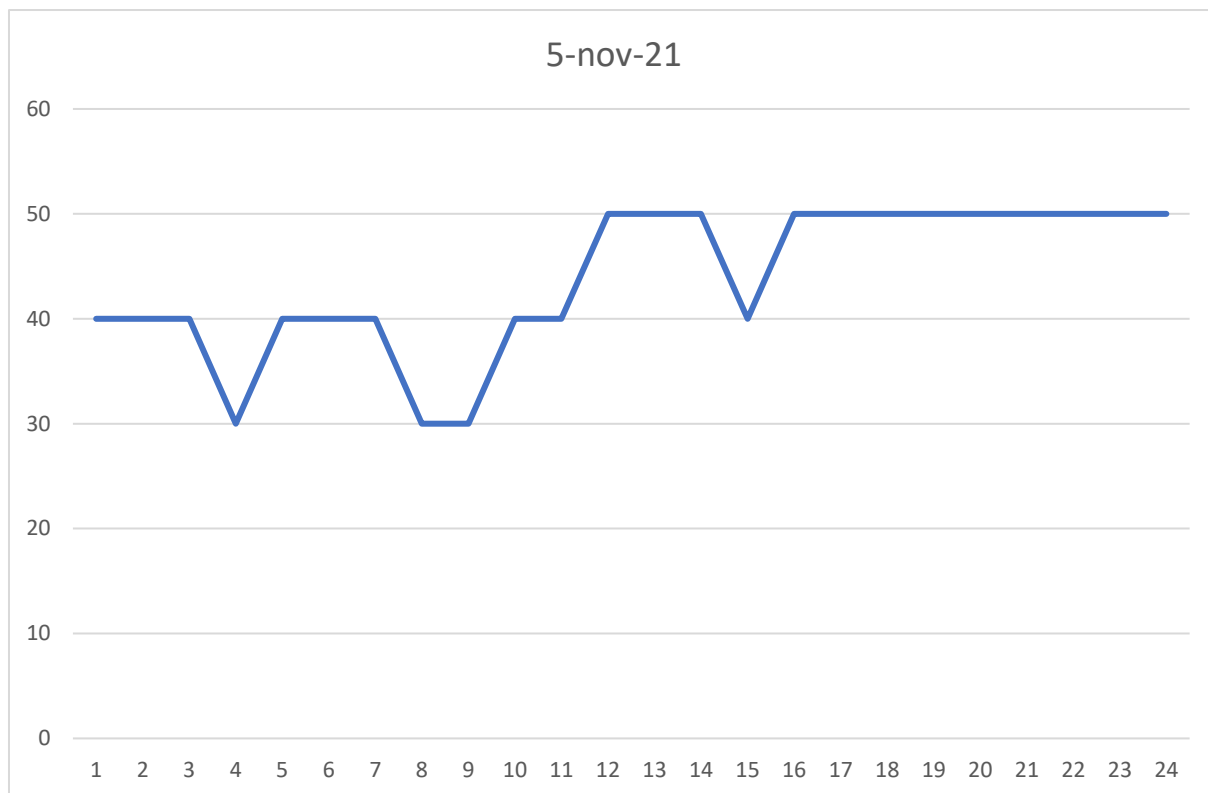


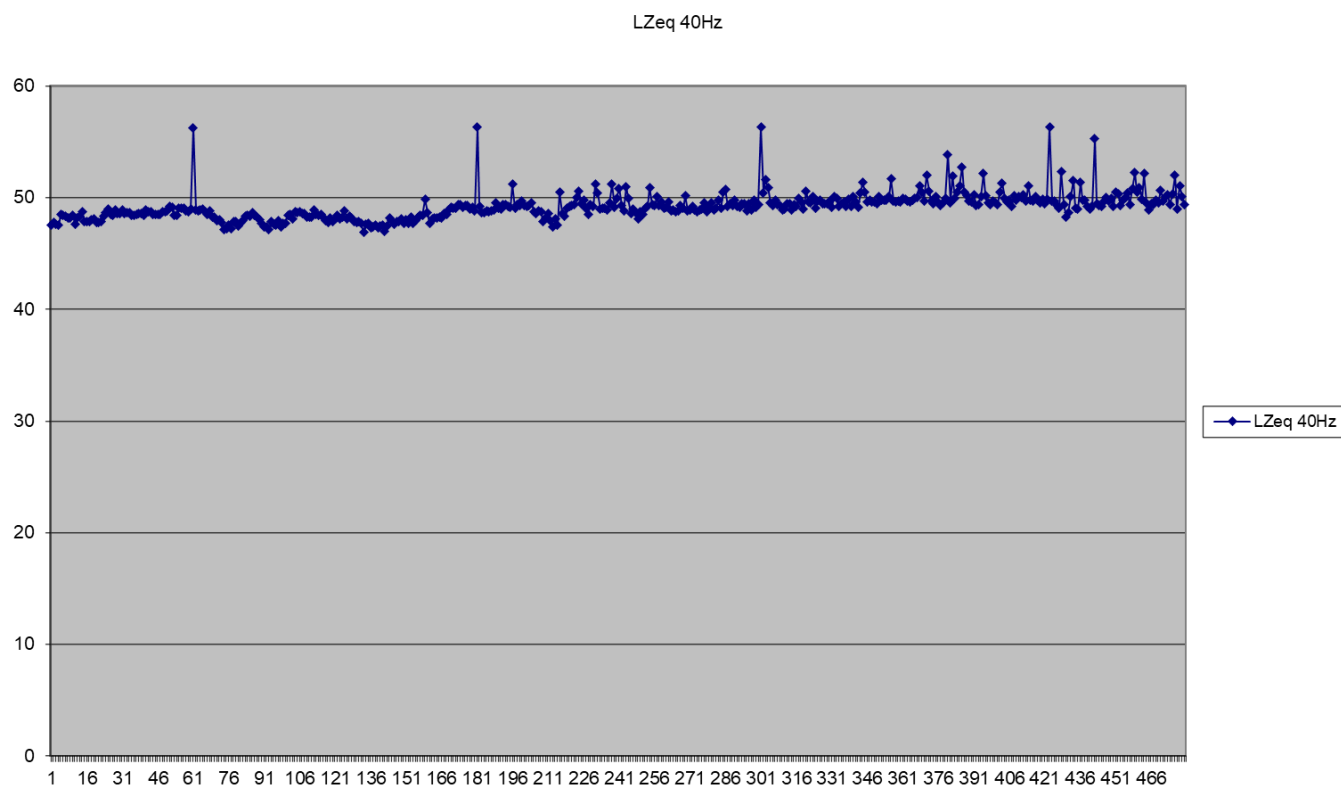
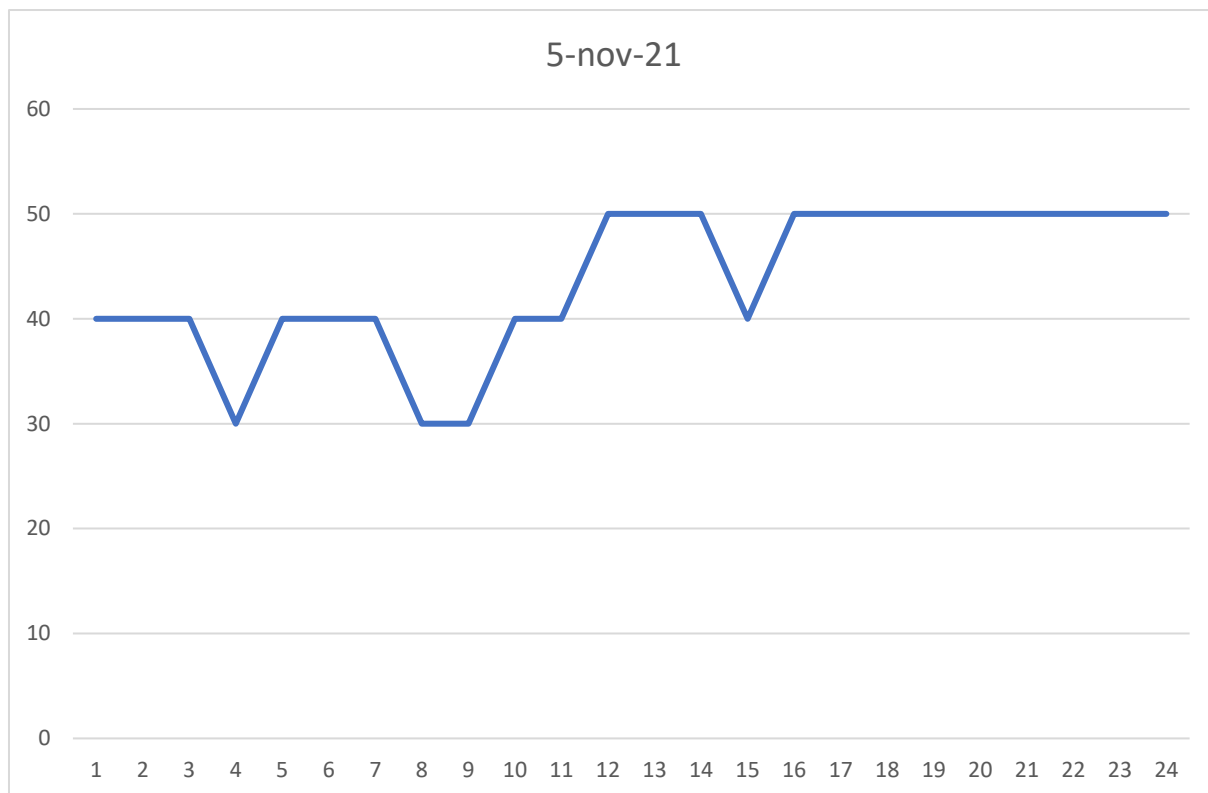


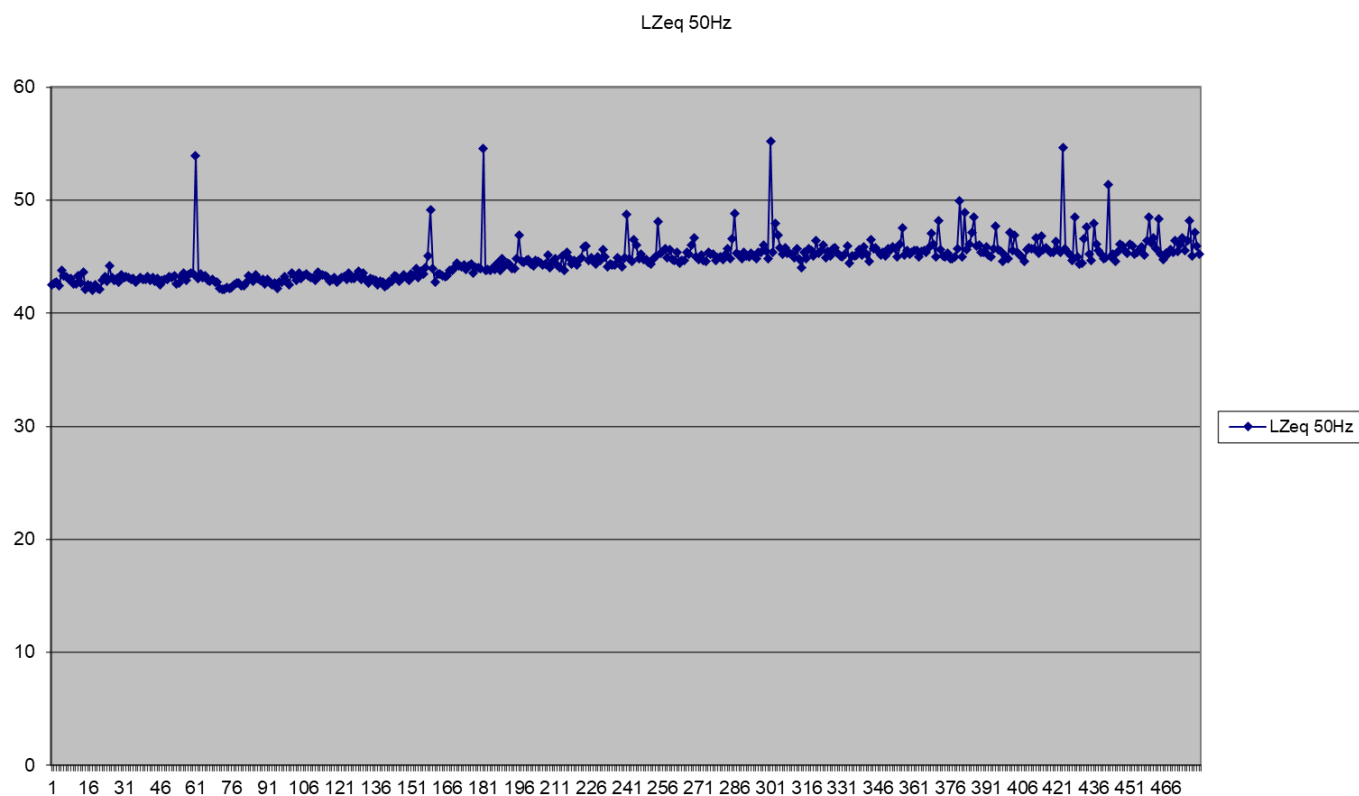
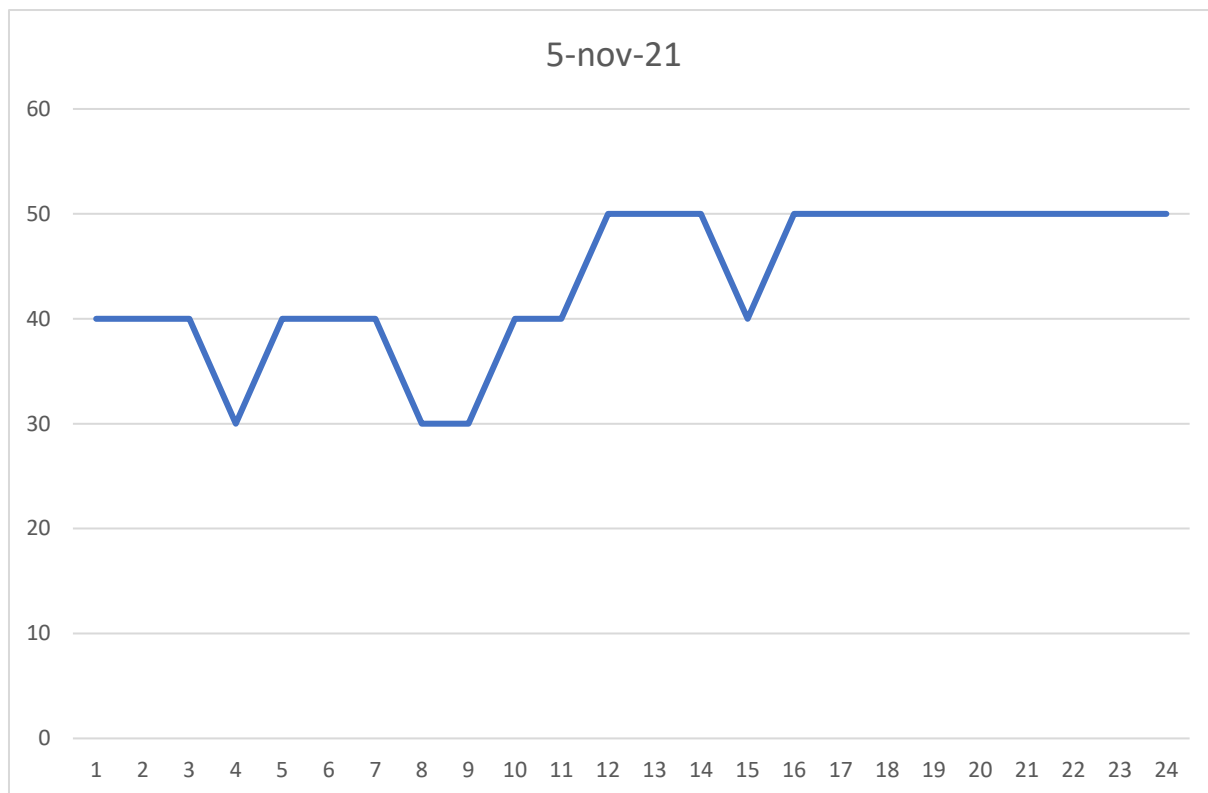


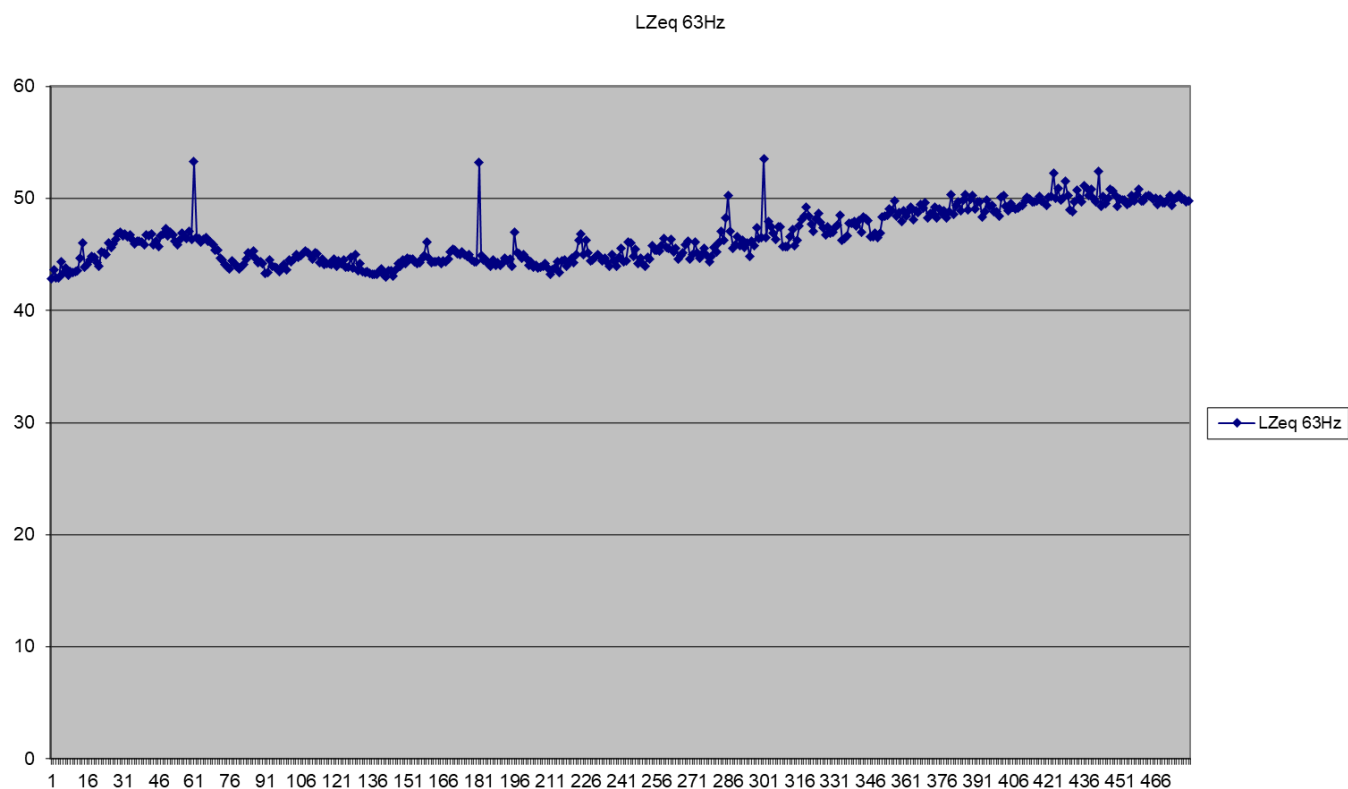
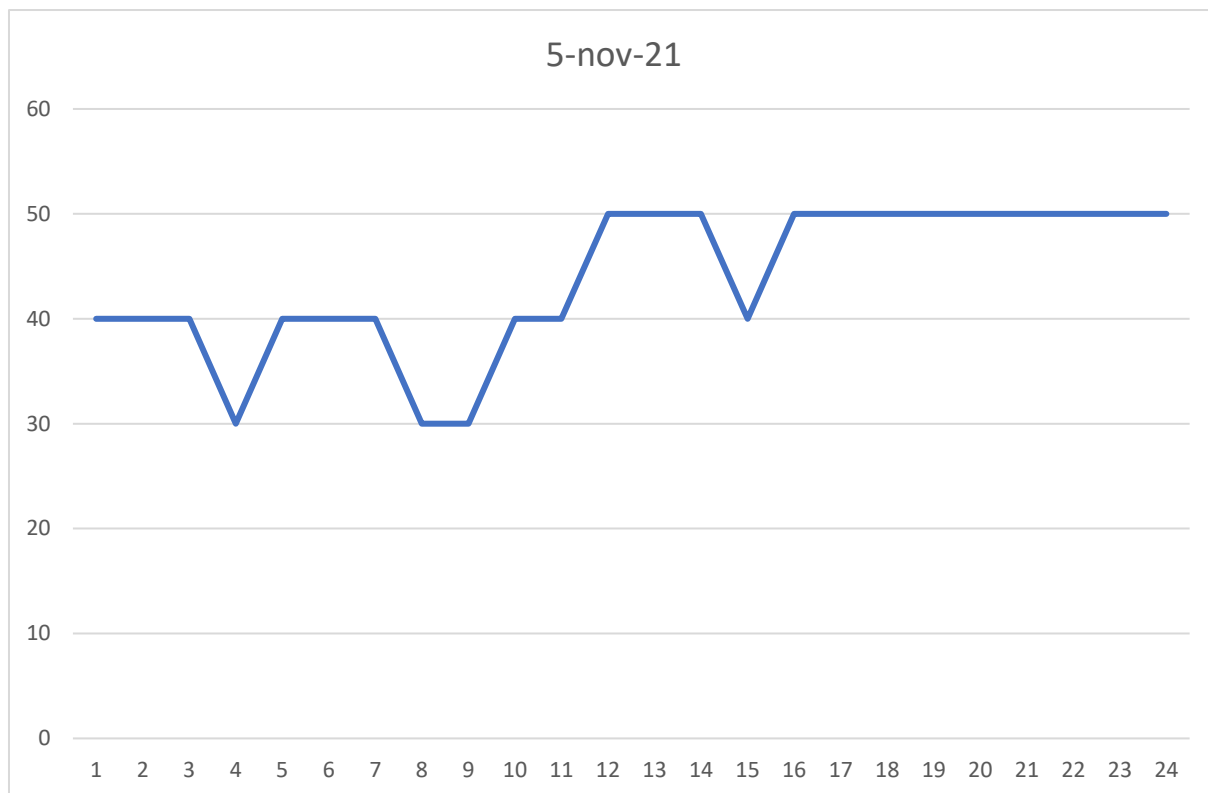


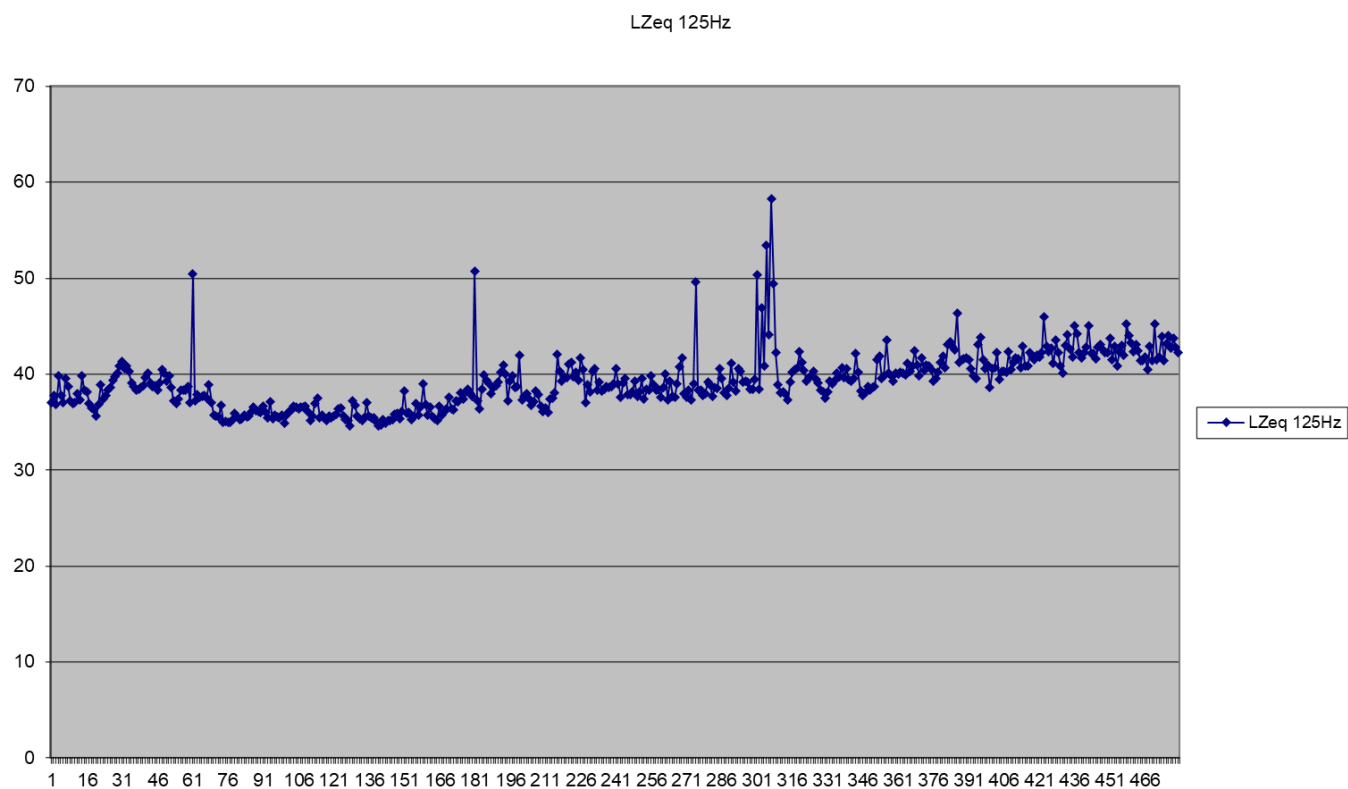
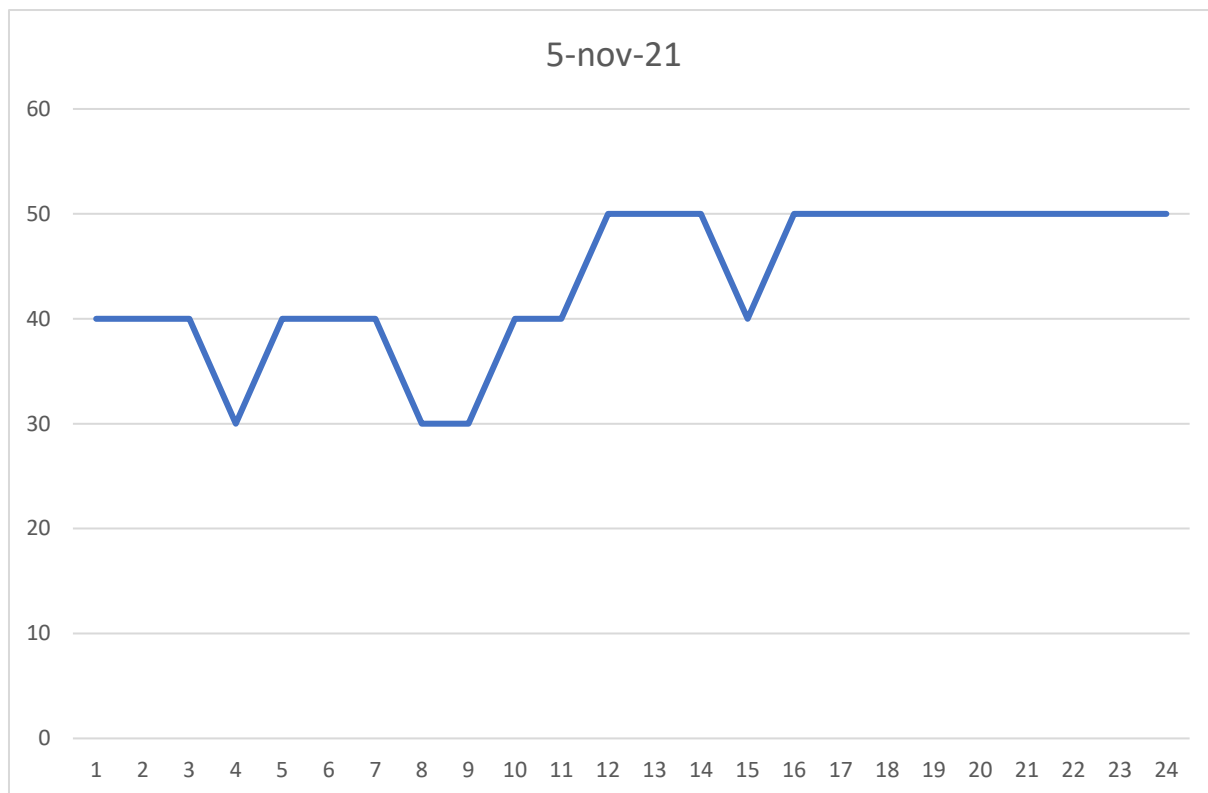


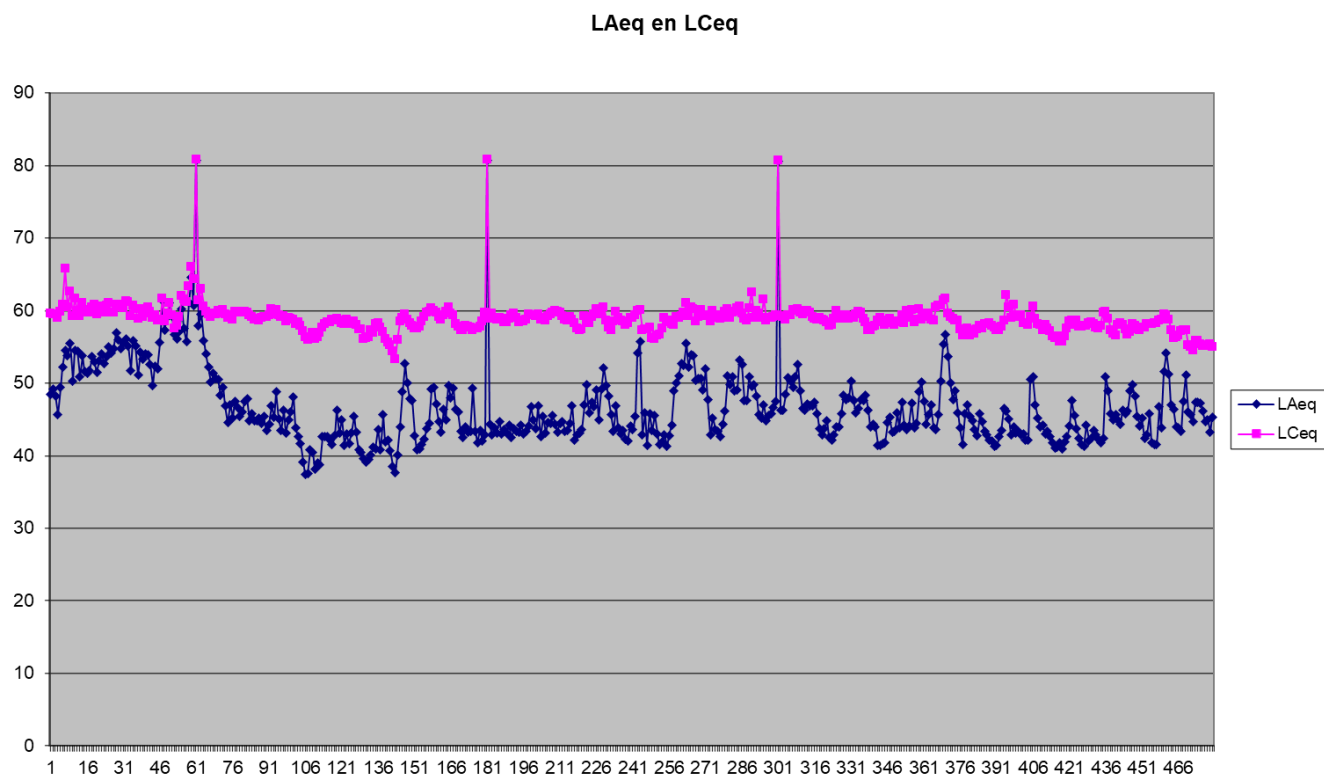
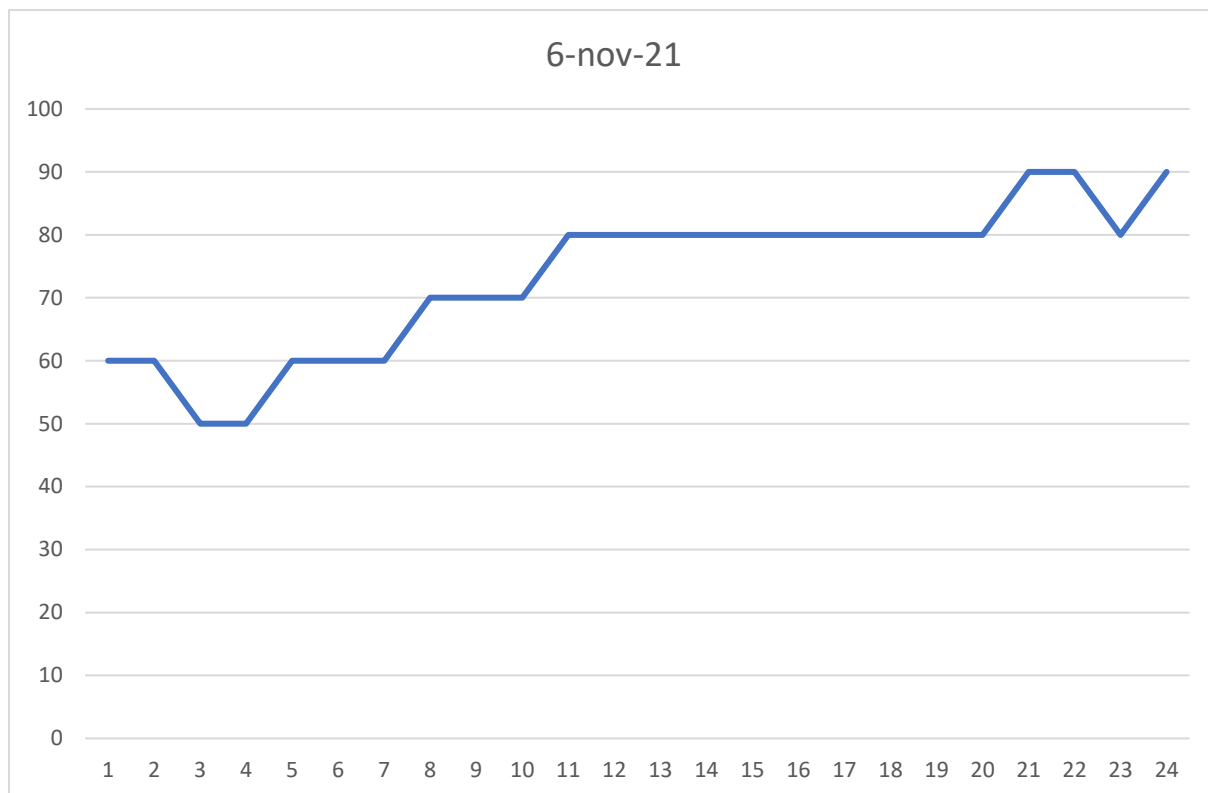


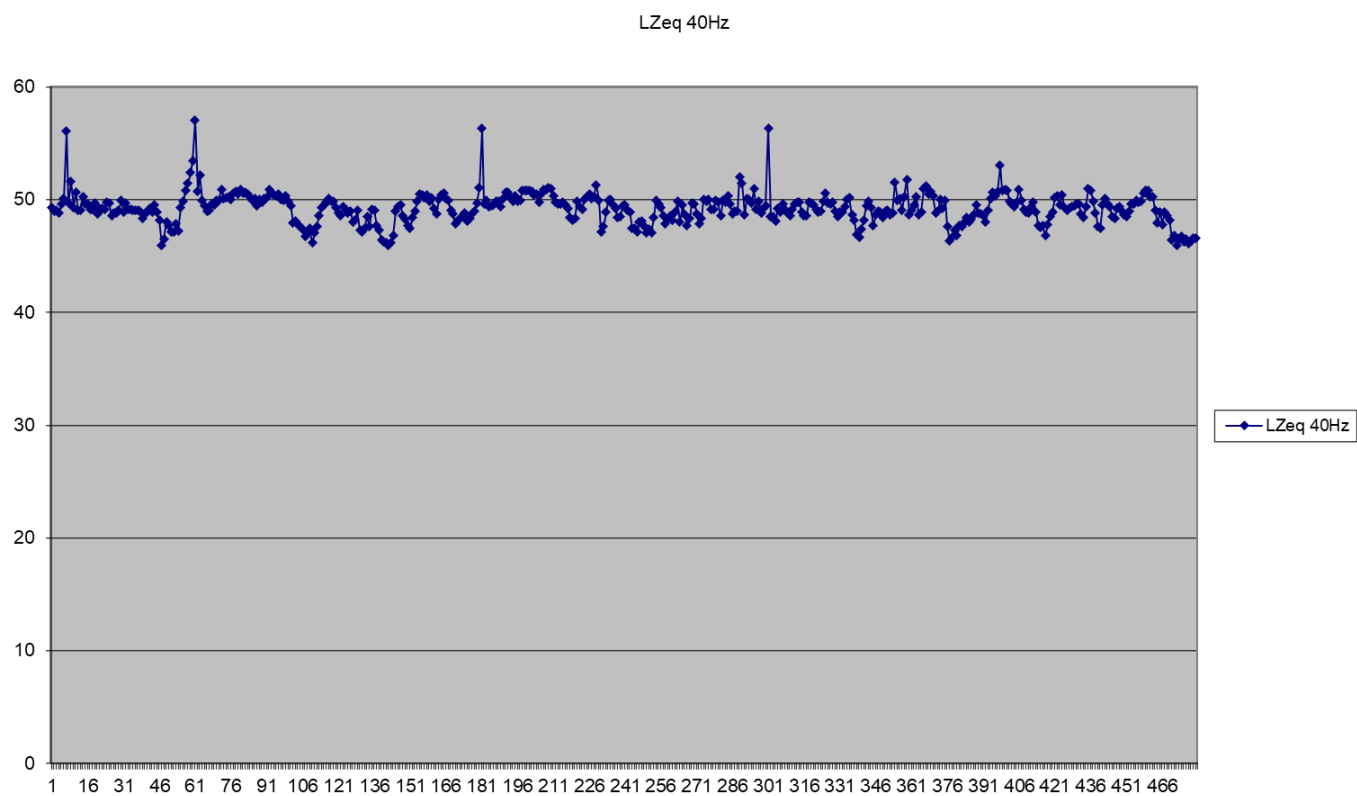
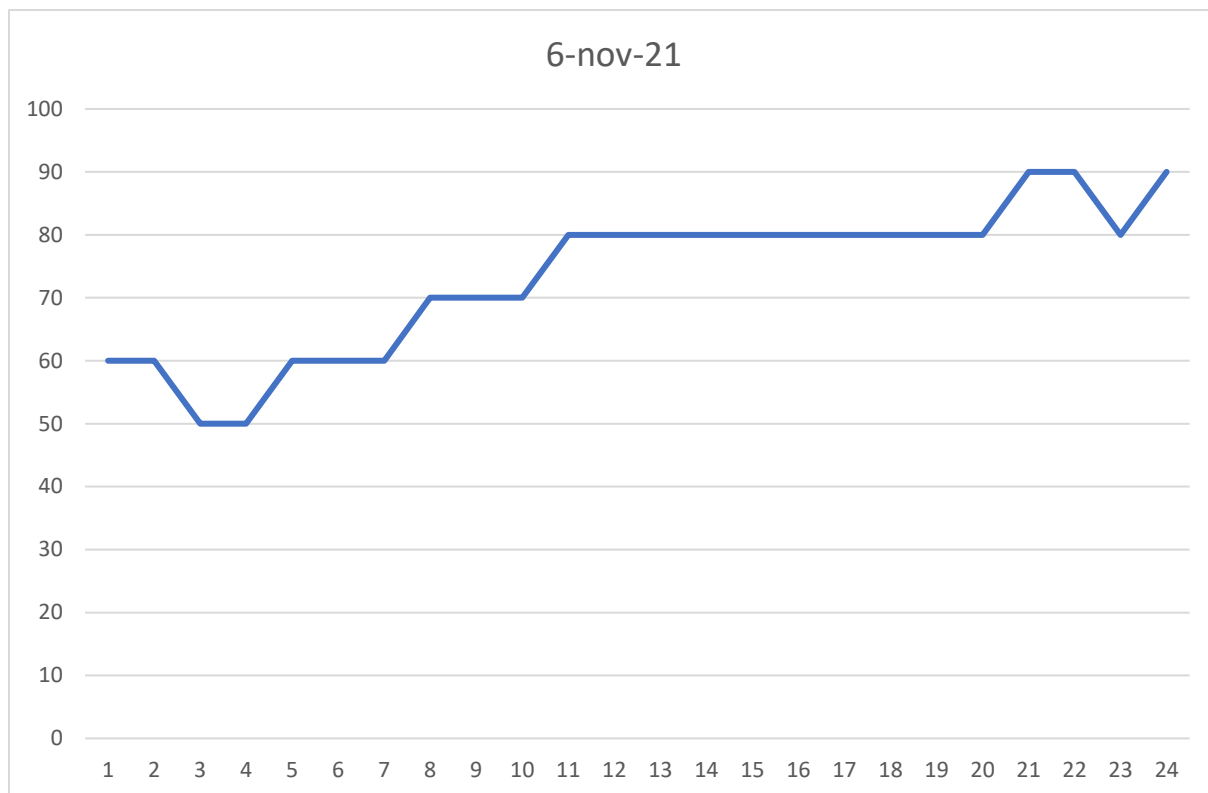


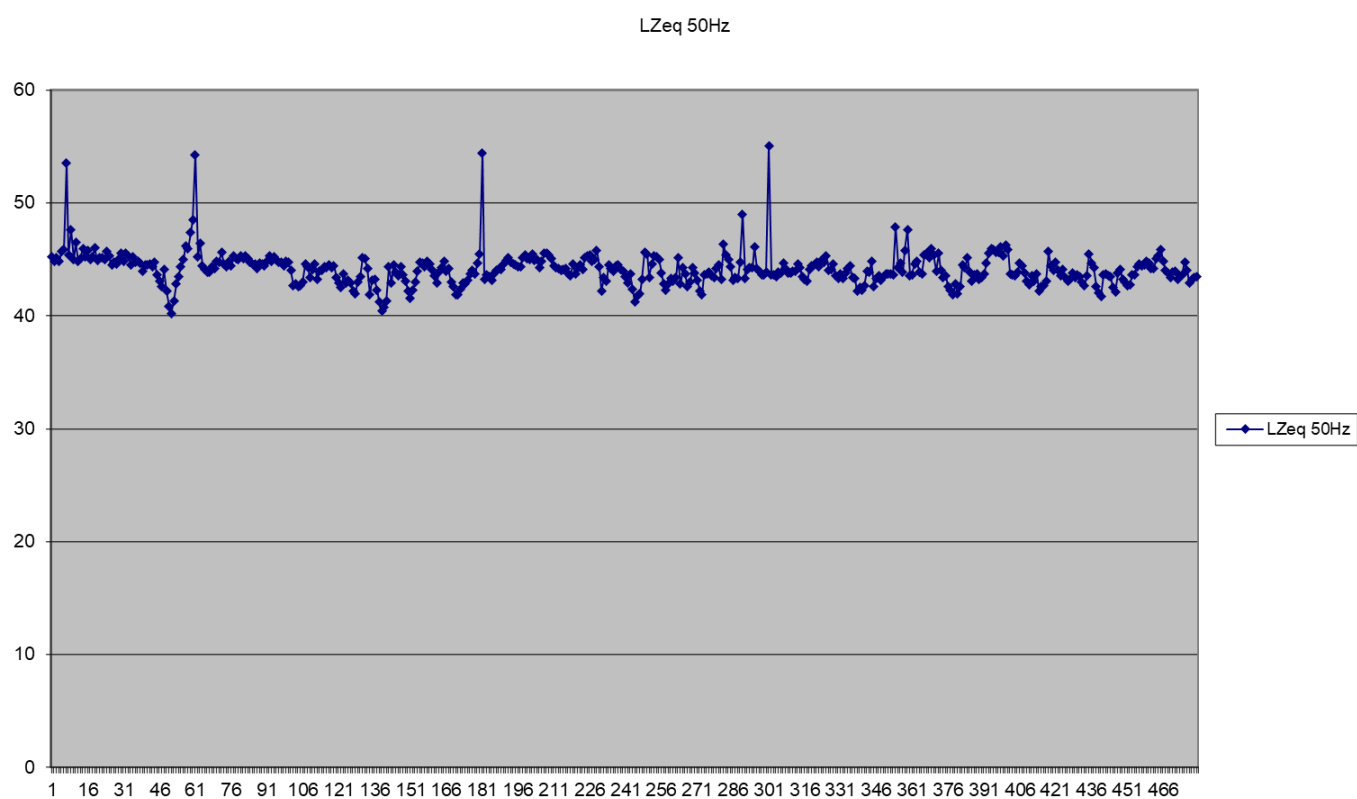
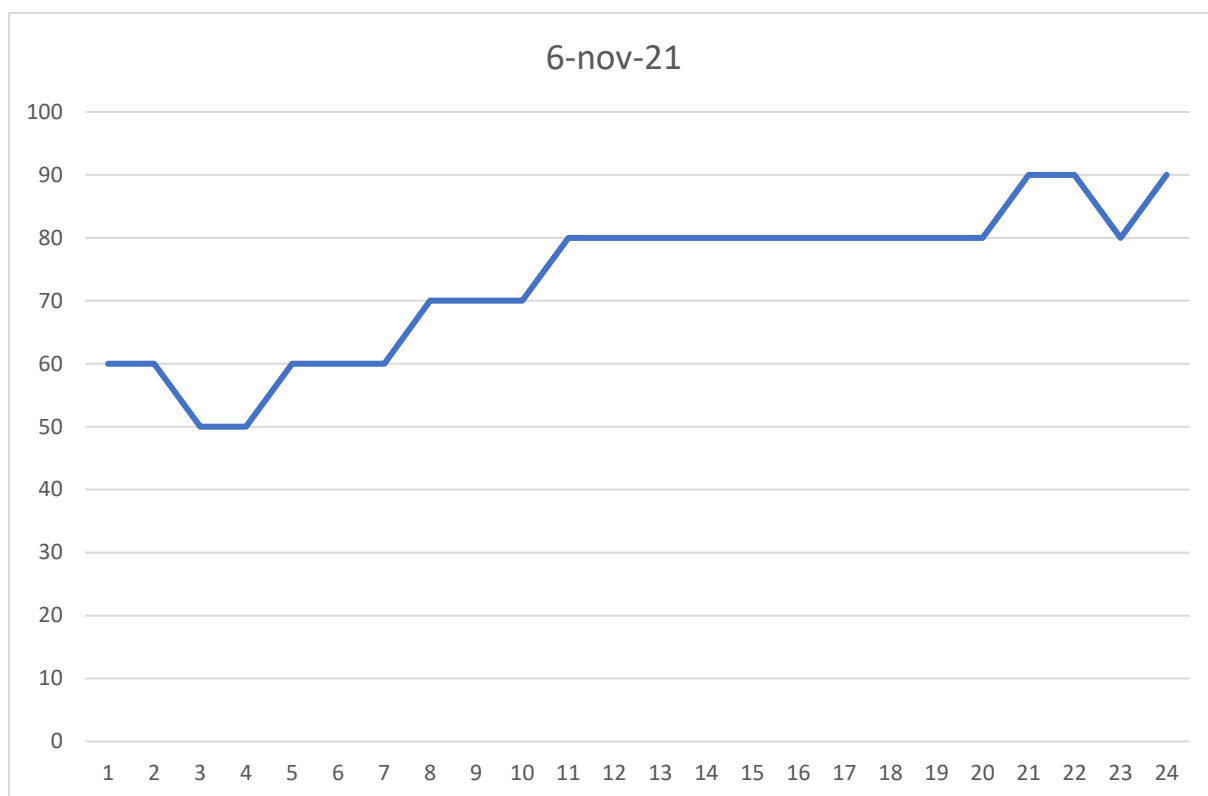


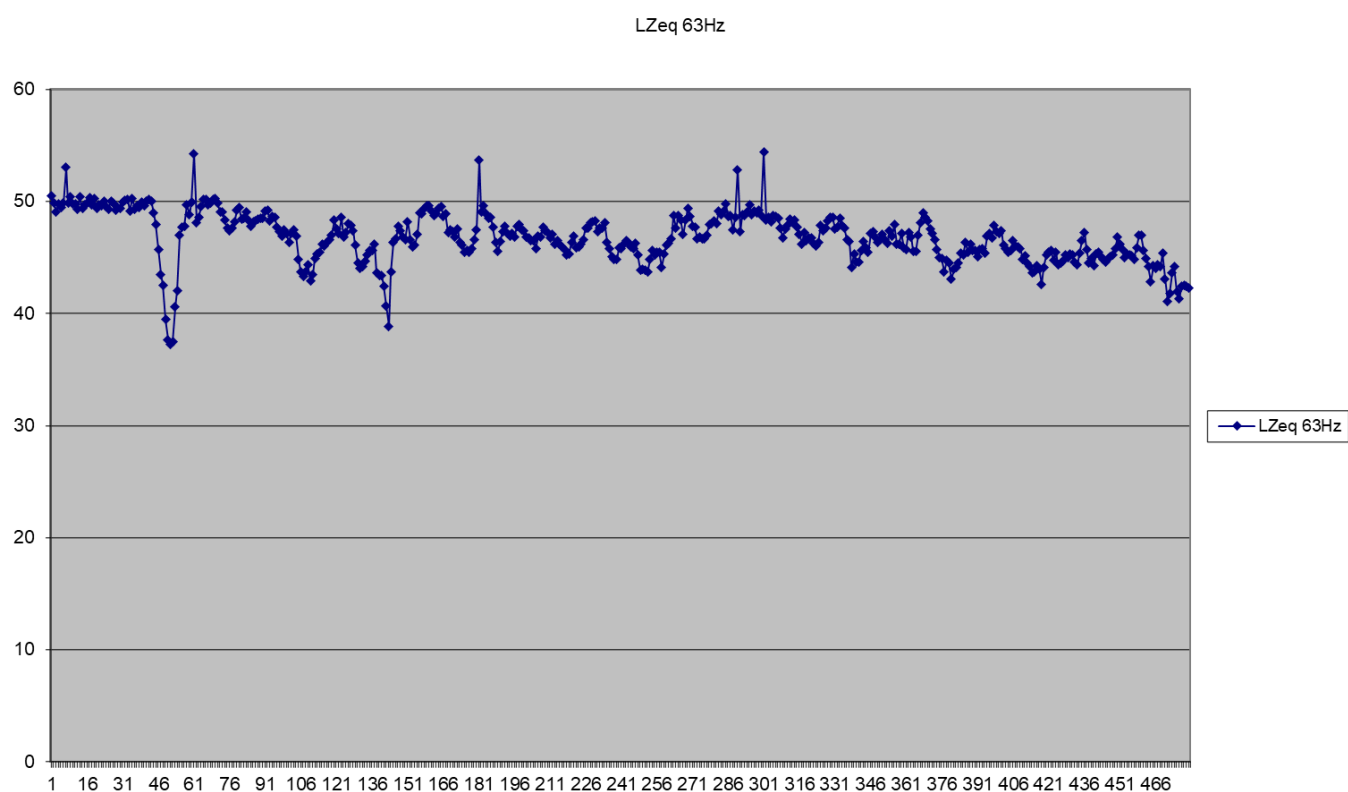
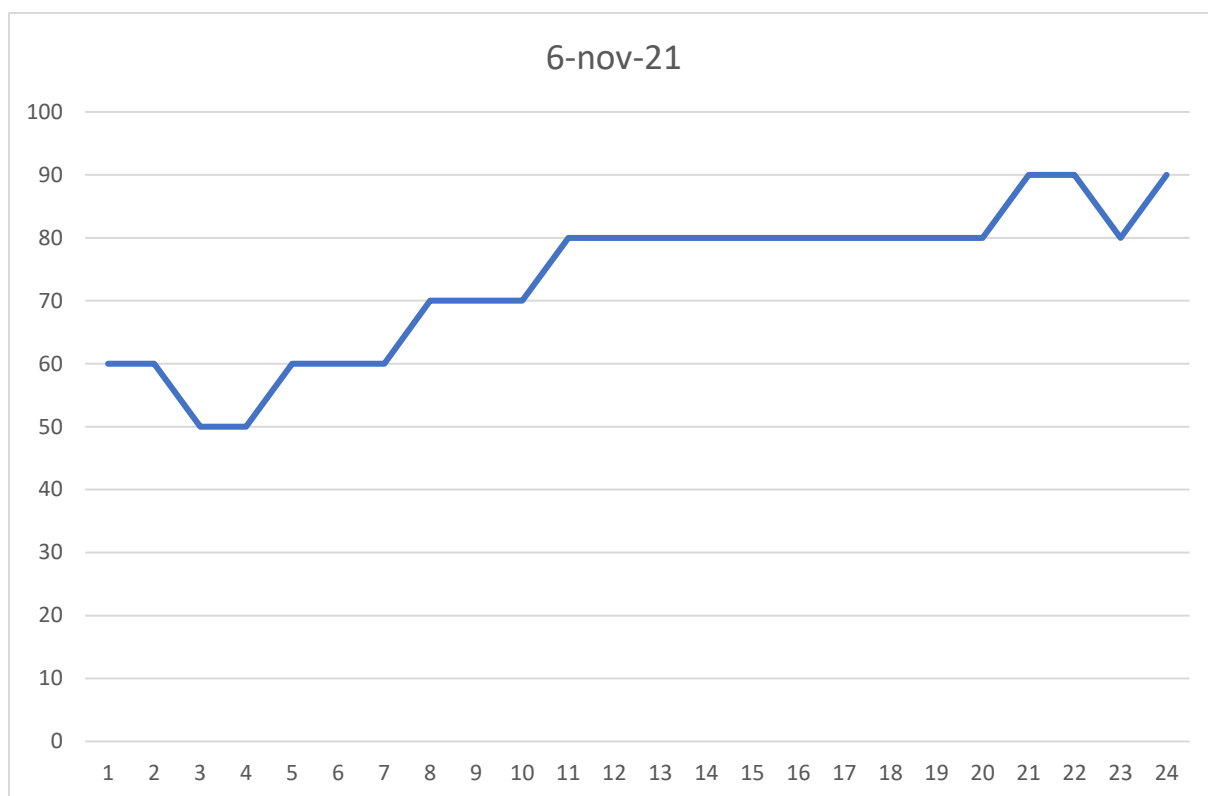


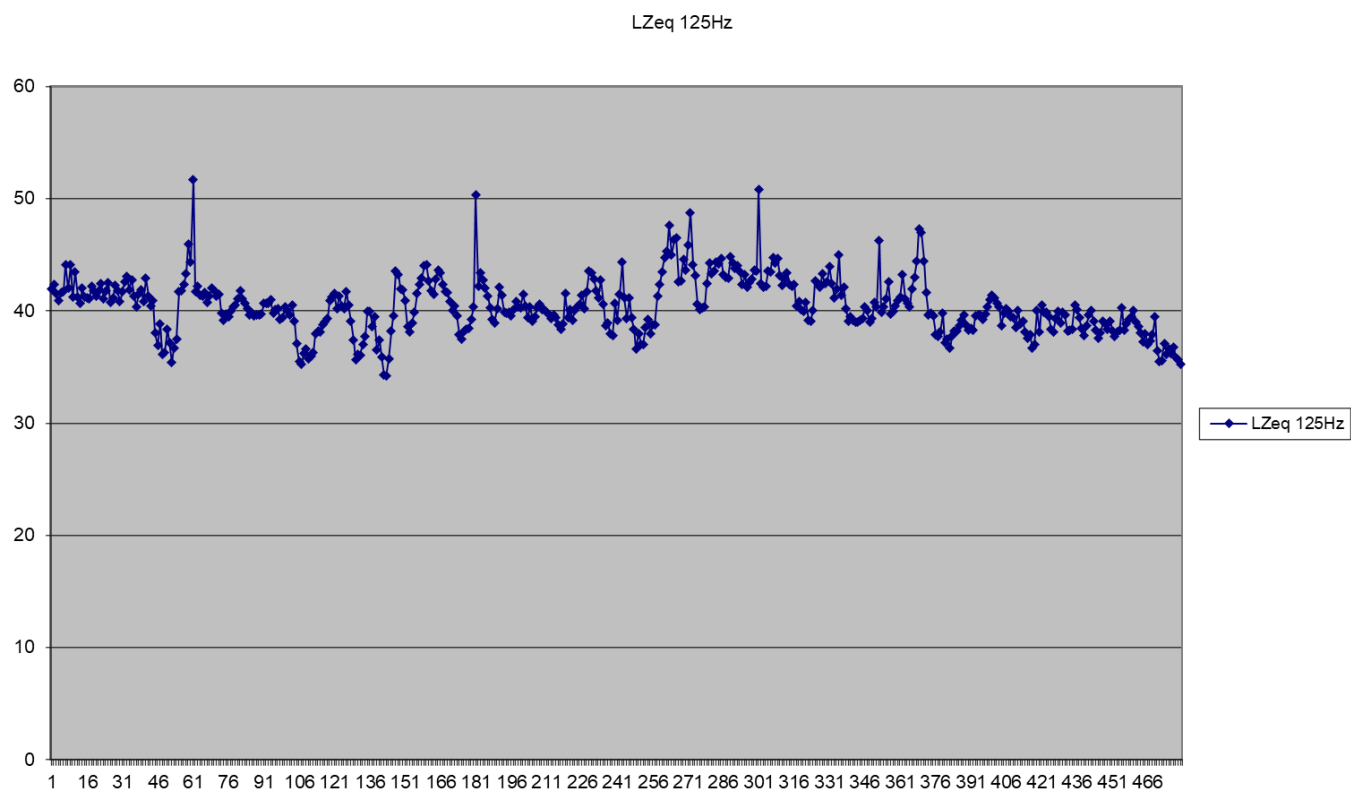
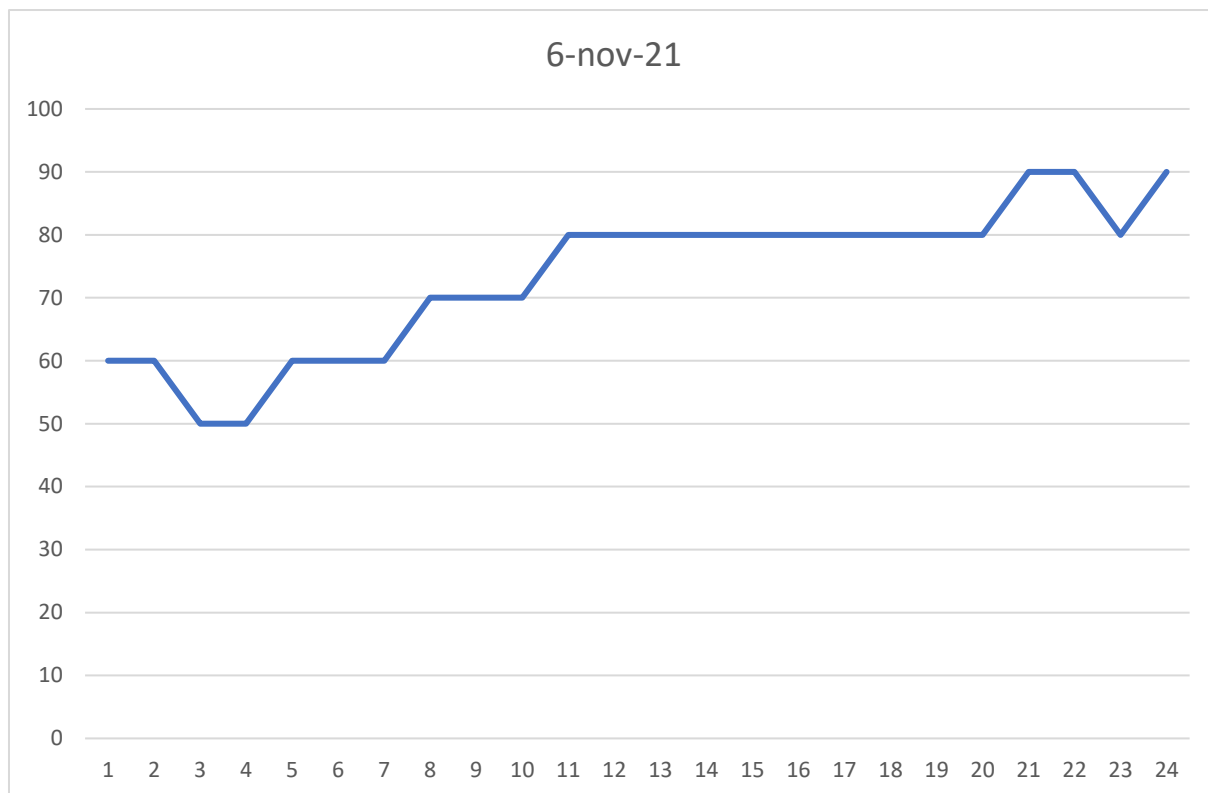




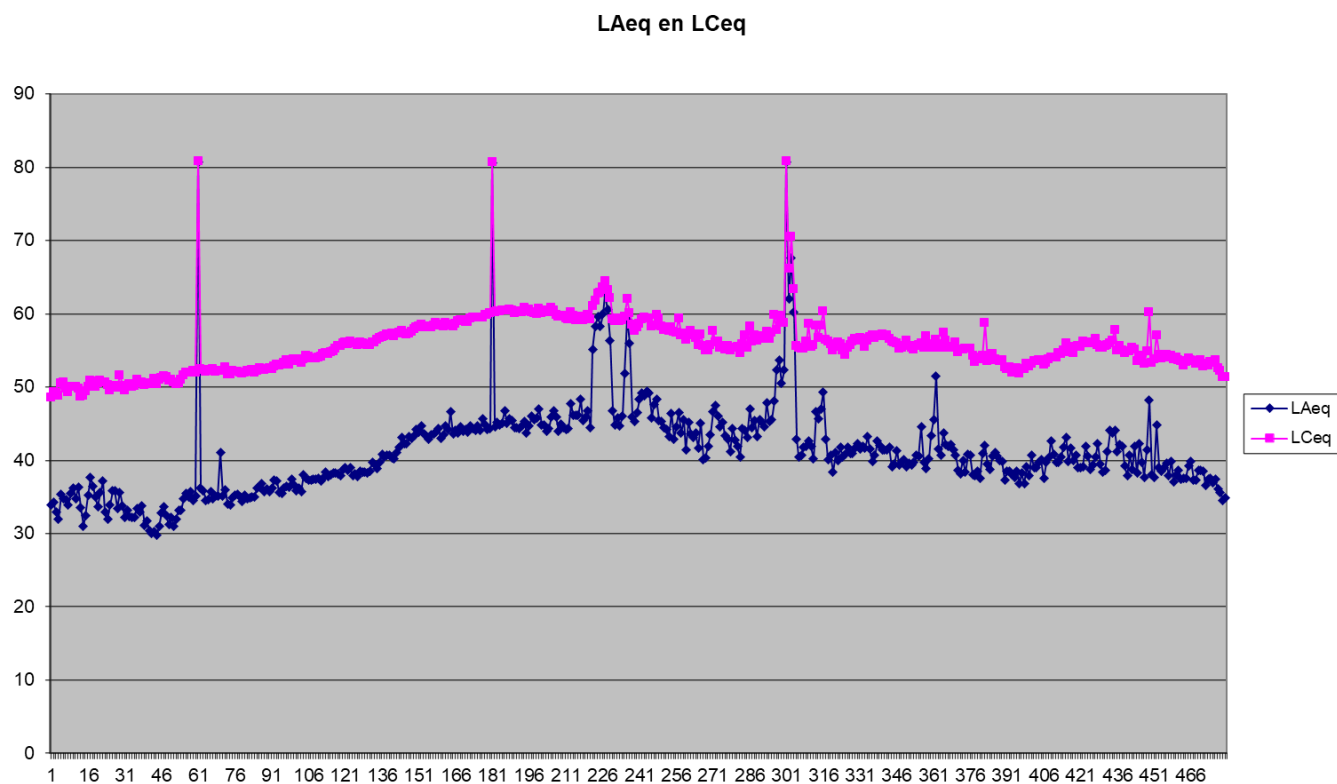
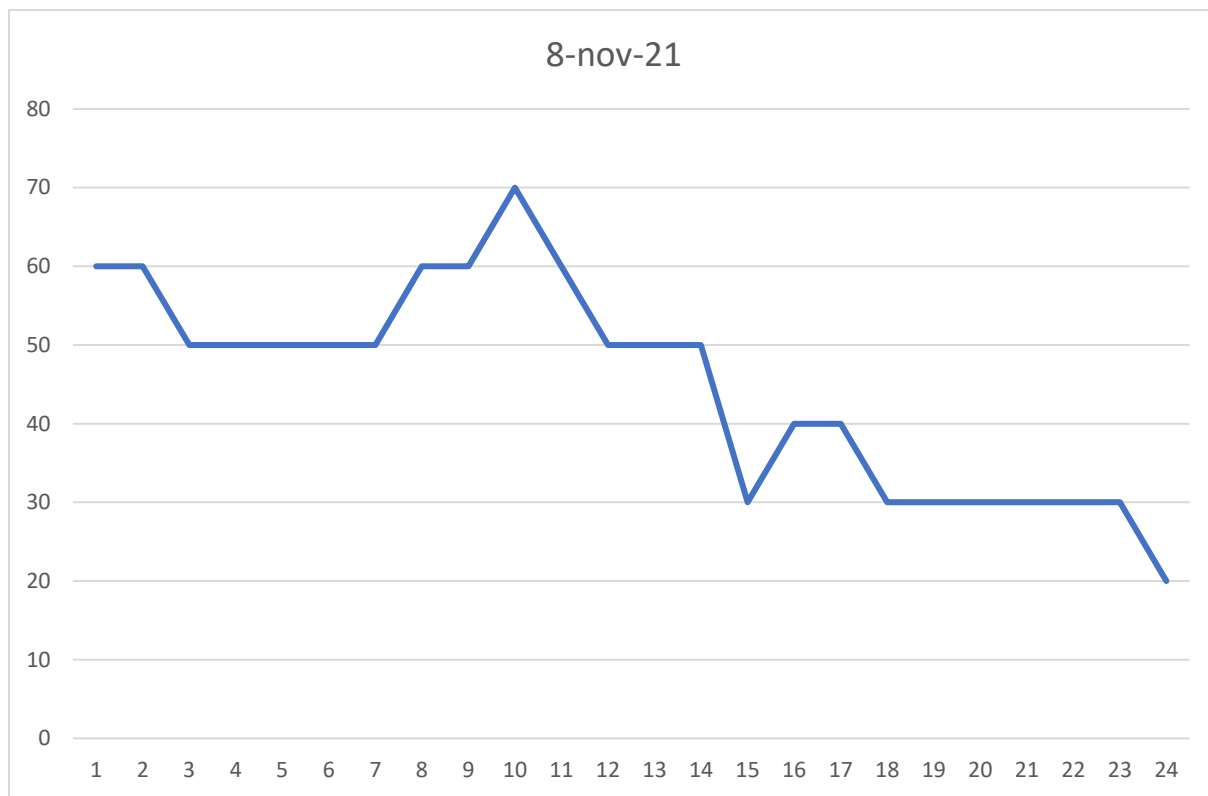


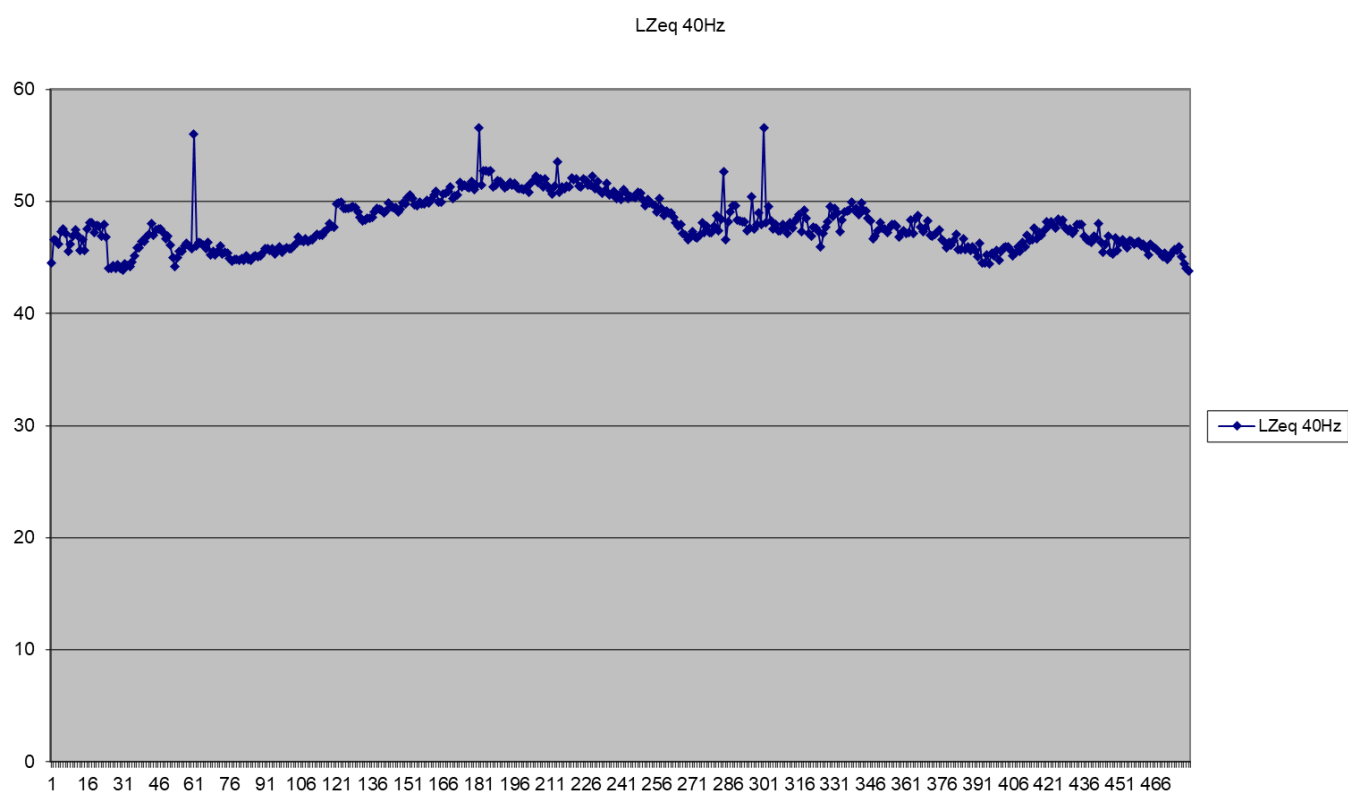
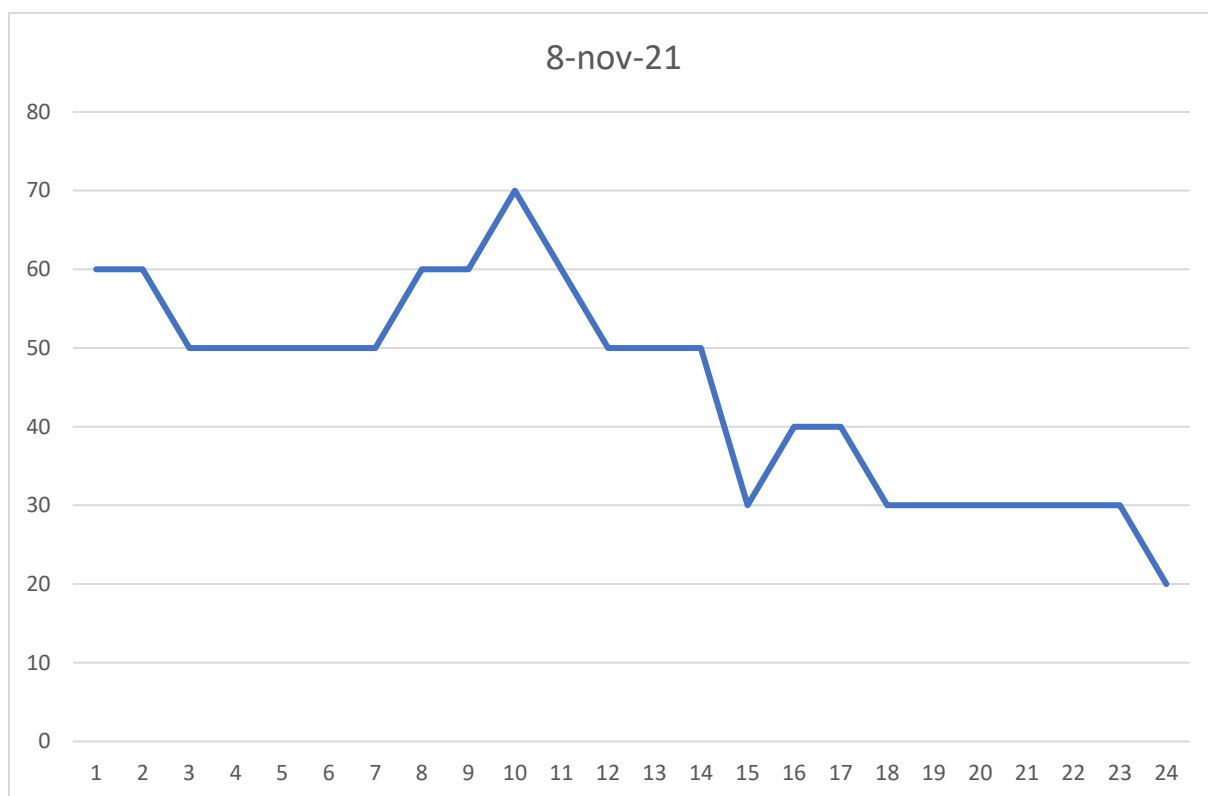


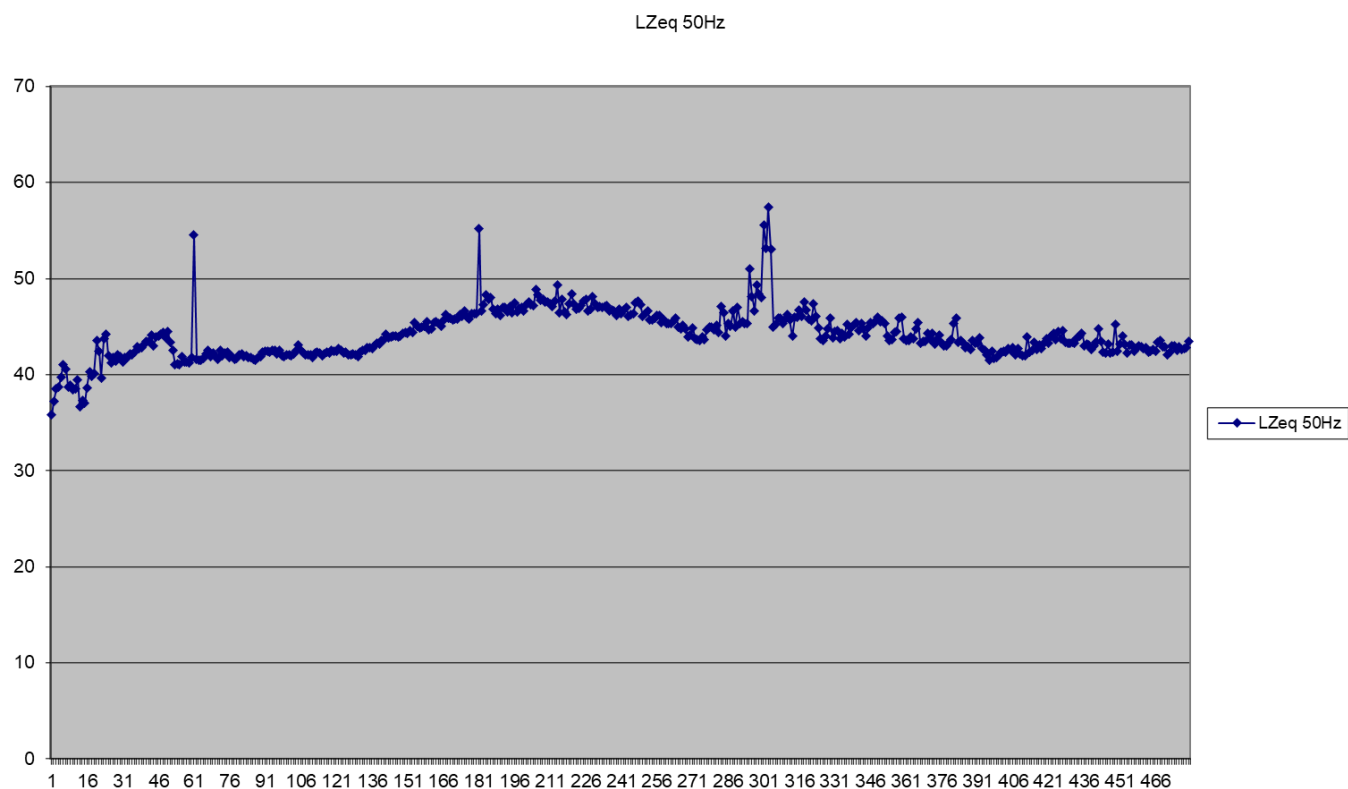
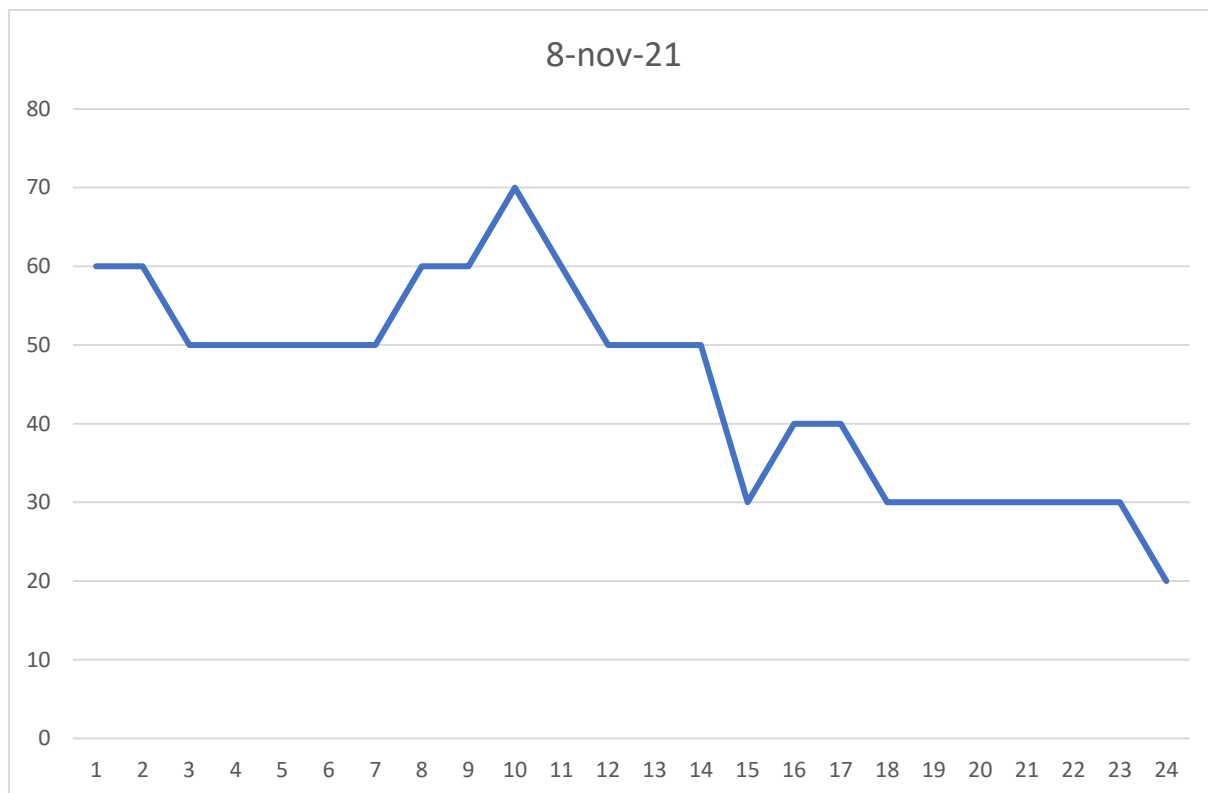


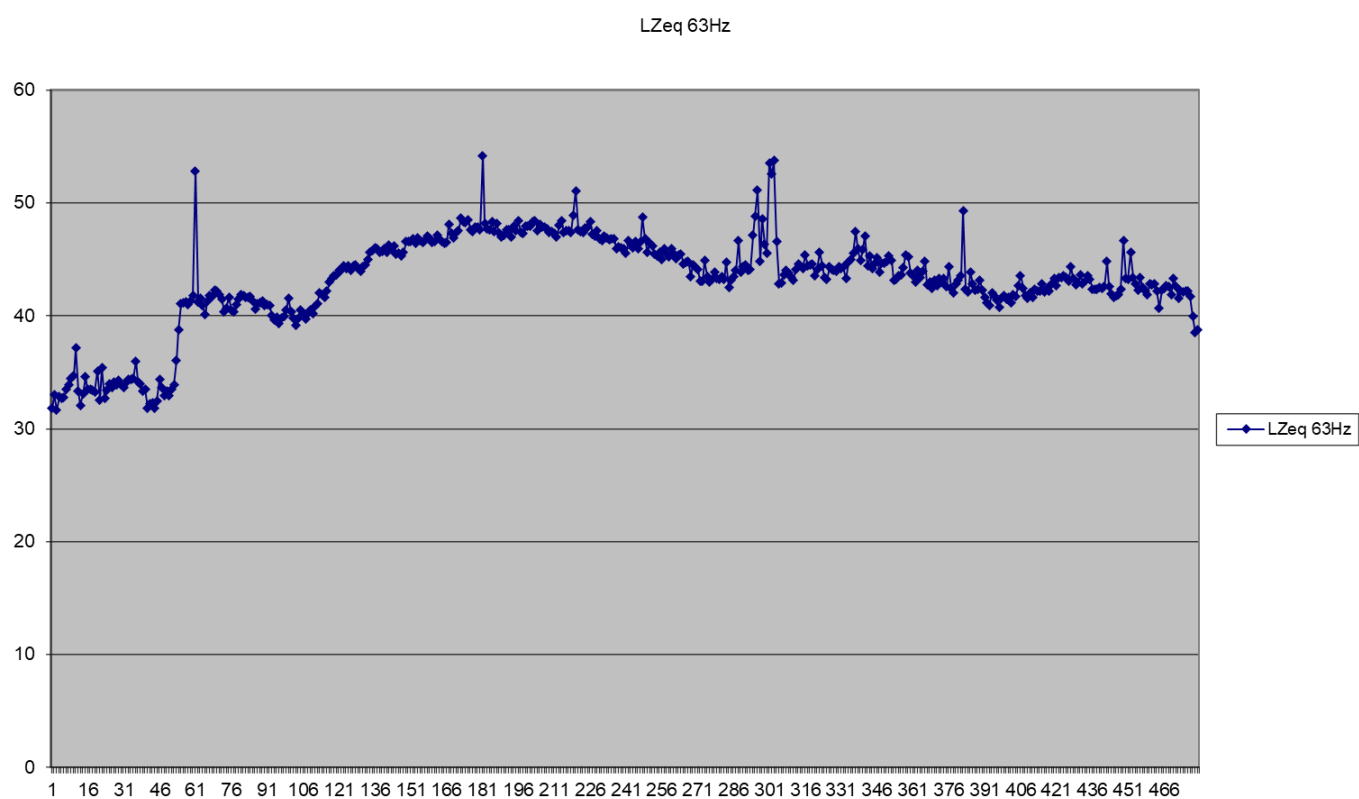
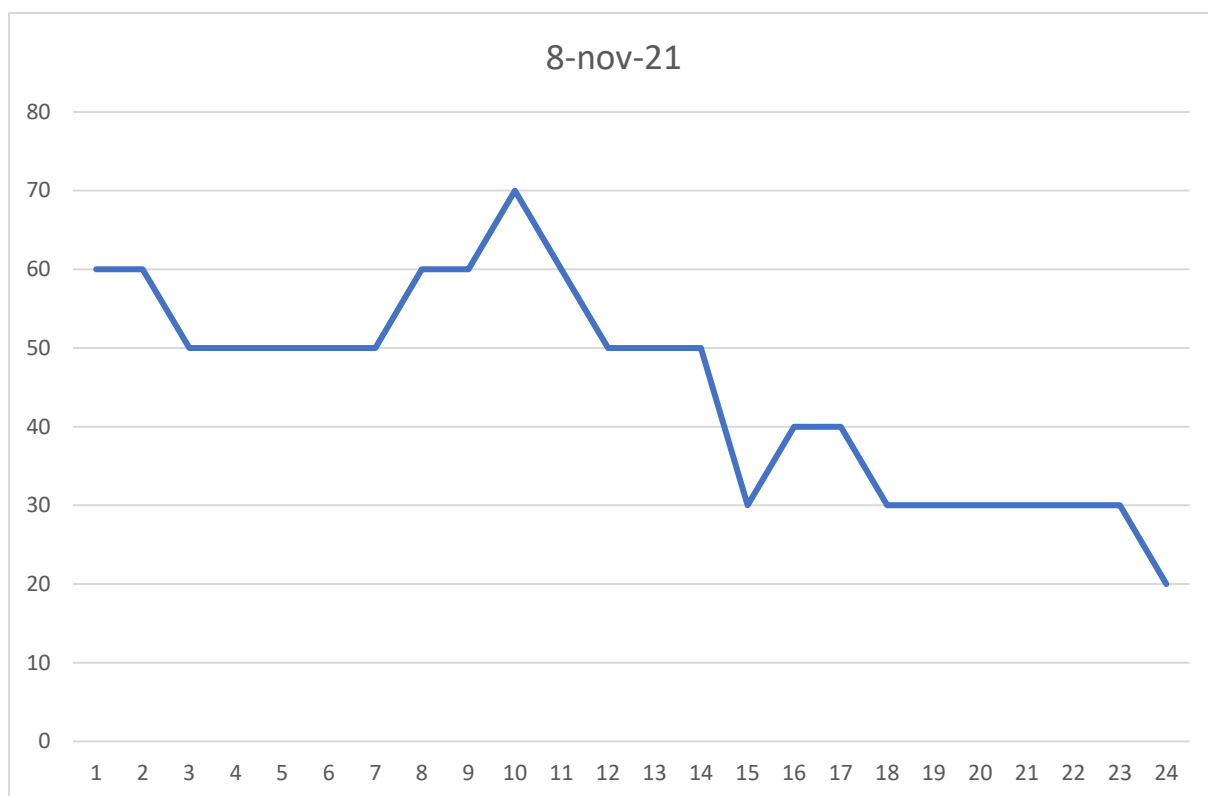


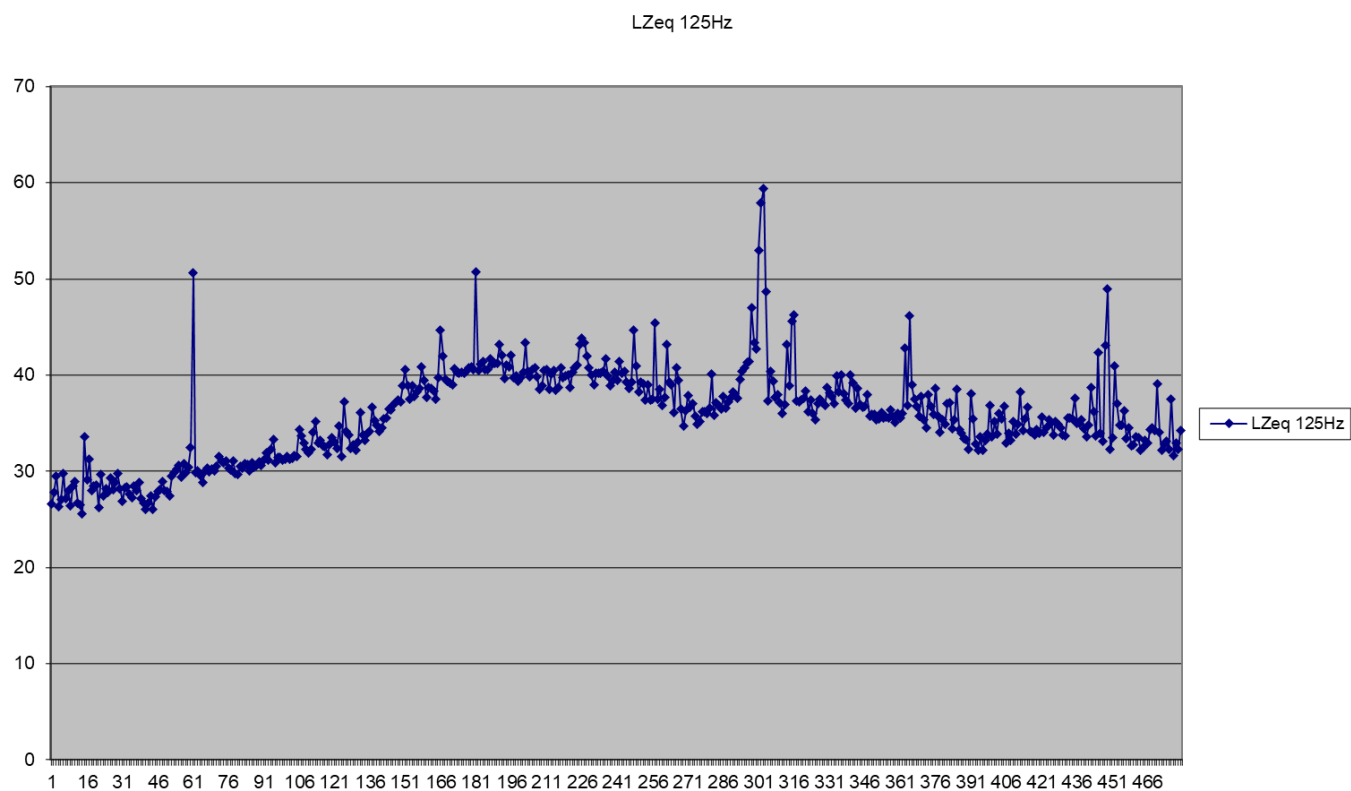
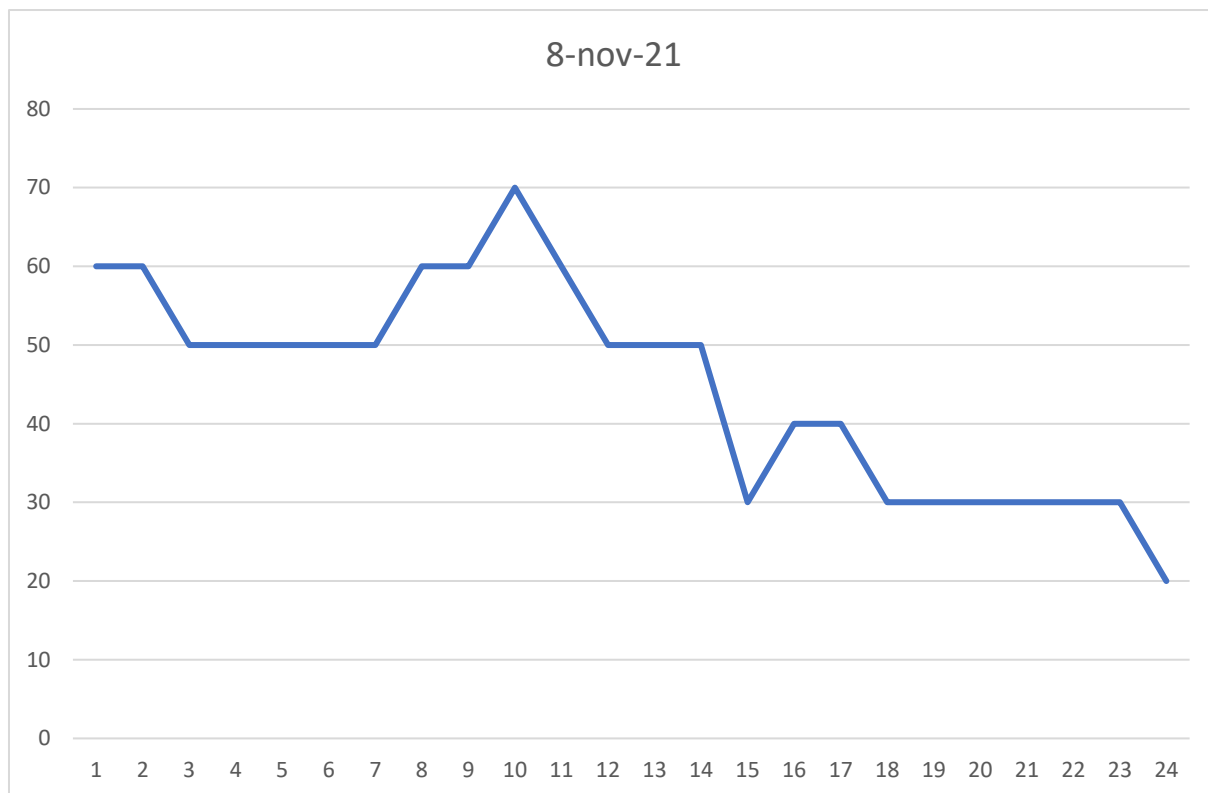
Op 7 november geen windgegevens van het KNMI dus die slaan we noodgedwongen over.











Aan de voorgaande grafieken is duidelijk te zien dat er bij meer wind meer geluid is. Dat zegt nog niet dat dat van de windturbines afkomstig is - want bij meer wind is er uiteraard ook meer omgevingsgeluid. De duidelijkste aanwijzing dat er toch een bepaald geluid van de windturbines afkomstig is, is te zien aan de 63 Hz *tertsbandgrafieken*.

Op bepaalde dagen waarbij de wind duidelijk een verandering laat zien, zowel bij een afnemende als toenemende trend, laat zien dat er zich bijna sprongsgewijs een verlaging of een verhoging van de intensiteit (sterkte) van het geluid in de 63 Hz tertsband voordoet. Dat effect was bij deze tertsband ook duidelijk te zien in de meetresultaten vóór de software-update. Maar we zien het ná de software-update nog steeds, zij het in mindere mate. Dat het ondanks dat toch zichtbaar is in *tertsbandanalyse* is opmerkelijk en toont aan hoe duidelijk het probleem is, want het lukt zelden om met de methode van *tertsbandanalyse* laagfrequent geluid goed 'in beeld' te krijgen! Veel nauwkeuriger is de methode van *FFT-analyse*.

Daarnaast speelt nog het probleem bij niet-vollast situaties, waar bromtonen voorkomen die lager zijn dan 63 Hz. We zien een scala aan tonen vanaf 20 Hz tot ca. 50 Hz. Hiervan is in de *tertsbandanalyse* niets te zien.

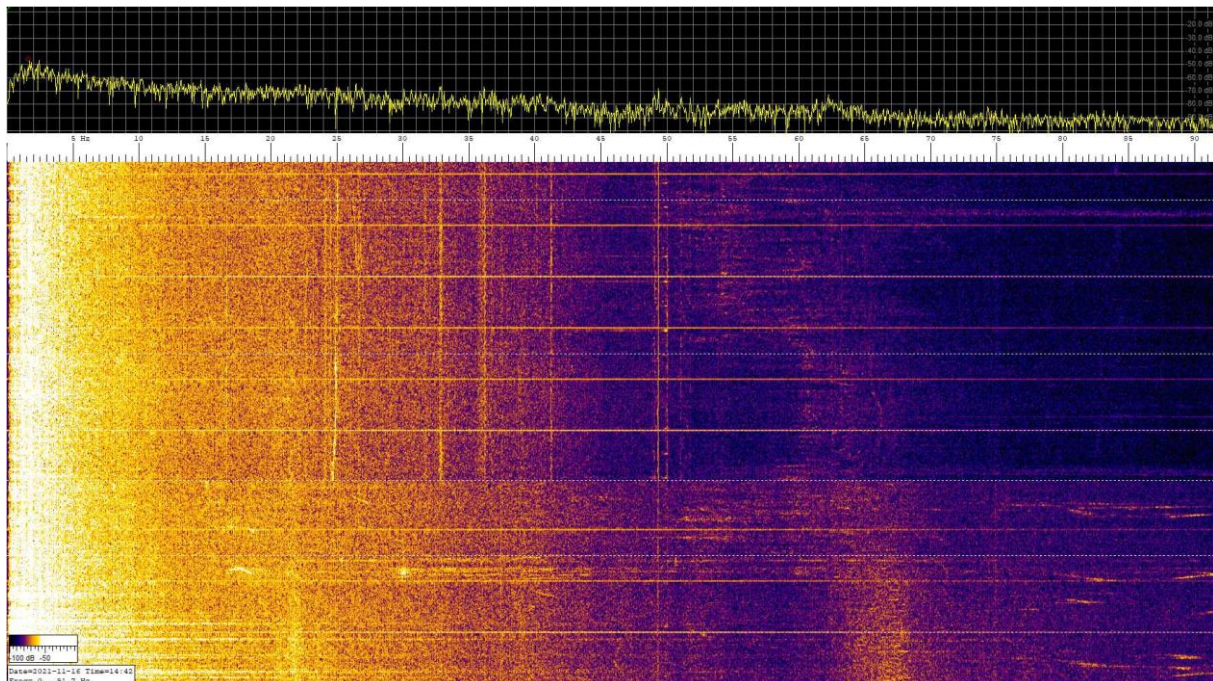
Dat is te verklaren omdat bij die niet-vollast situaties de wind vaak zeer variabel is, de turbine zoekt steeds naar de optimale situatie ('past zich aan'), wat weer tot gevolg heeft dat de bromtonen continu in toonhoogte variëren. Die tonen blijven daarom niet beperkt tot één tertsband maar zitten nu eens in de ene en even later in een andere tertsband, en daarom is de bijdrage van die (overigens goed hoorbare) bromtonen aan de diverse tertsbanden uiterst gering. Om die variërende bromtonen goed in beeld te brengen is *FFT-analyse* een veel betere methode. Zie hiervoor het vervolg van deze bijlage.

De aanvullende metingen in deze periode T2 (13 oktober t/m 9 november 2021) zijn uitgevoerd om na te gaan welk effect de aanpassing van de software van de windturbines heeft op de frequentie en sterkte van het geluid van de windturbines. Het gaat dus om een vergelijking van de situatie 'voor' (=T1) en 'na' (=T2) de software-aanpassing.

Om goed te kunnen vergelijken moeten de overige omstandigheden (windsnelheid en windrichting) zo gelijk mogelijk zijn. Op een aantal momenten in de meetperiodes T1 en T2 was dat het geval: windsnelheid en windrichting waren precies gelijk. Van die momenten geef ik de resultaten van de beide metingen uit T1 en T2 samen weer, dat wil zeggen *in één spectrogram*, om het effect van de software-aanpassing te kunnen zien. Van elk spectrogram geeft het onderste deel de situatie vóór de aanpassing, en het bovenste deel de situatie ná de aanpassing.

Vergelijking 15 feb 2021 met 17 oktober 2021

Windrichting 210 graden
Windsnelheid 5 m/s



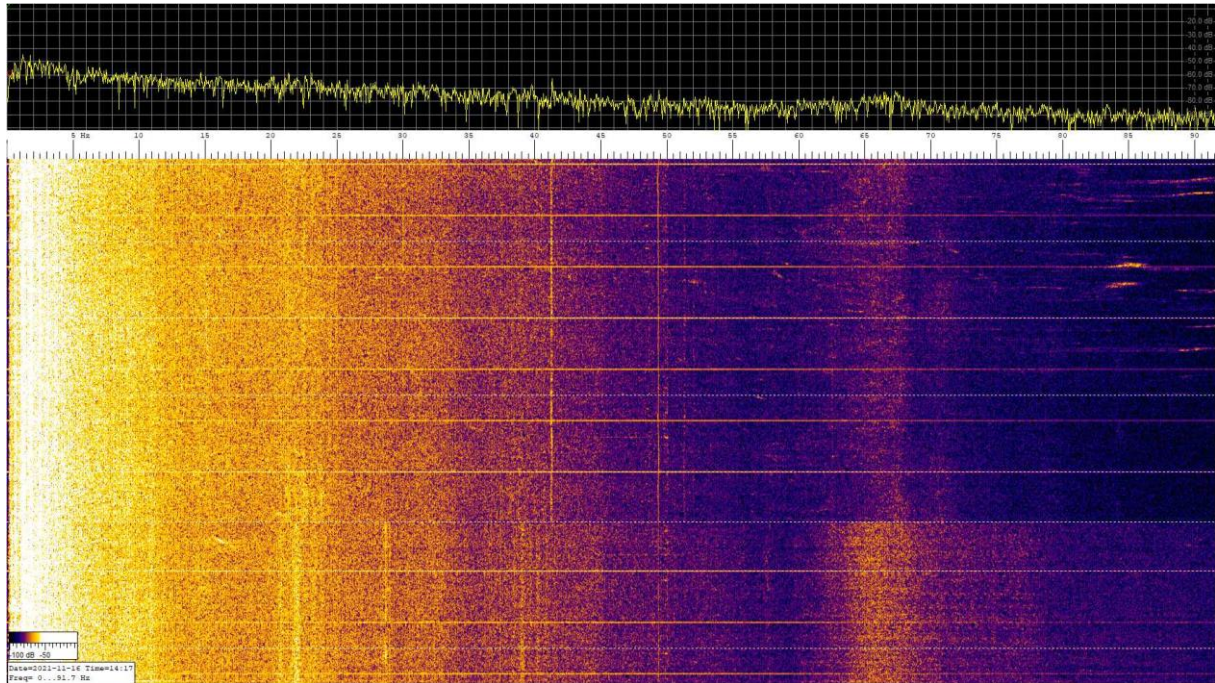
In de T1 situatie zien we een duidelijke brom rond 65 Hz, iets later zakt de frequentie naar 55 Hz.

In de T2 situatie zien we exact hetzelfde, maar de intensiteit of sterkte is minder. M.a.w. de brom is er nog wel maar hij is zwakker.

Vergelijking 17 februari 2021 met 28 oktober 2021

Windrichting 180 graden

Windsnelheid 5 m/s



Zowel in de T1 als in de T2 situatie zien we een duidelijke brom rond 65 Hz.

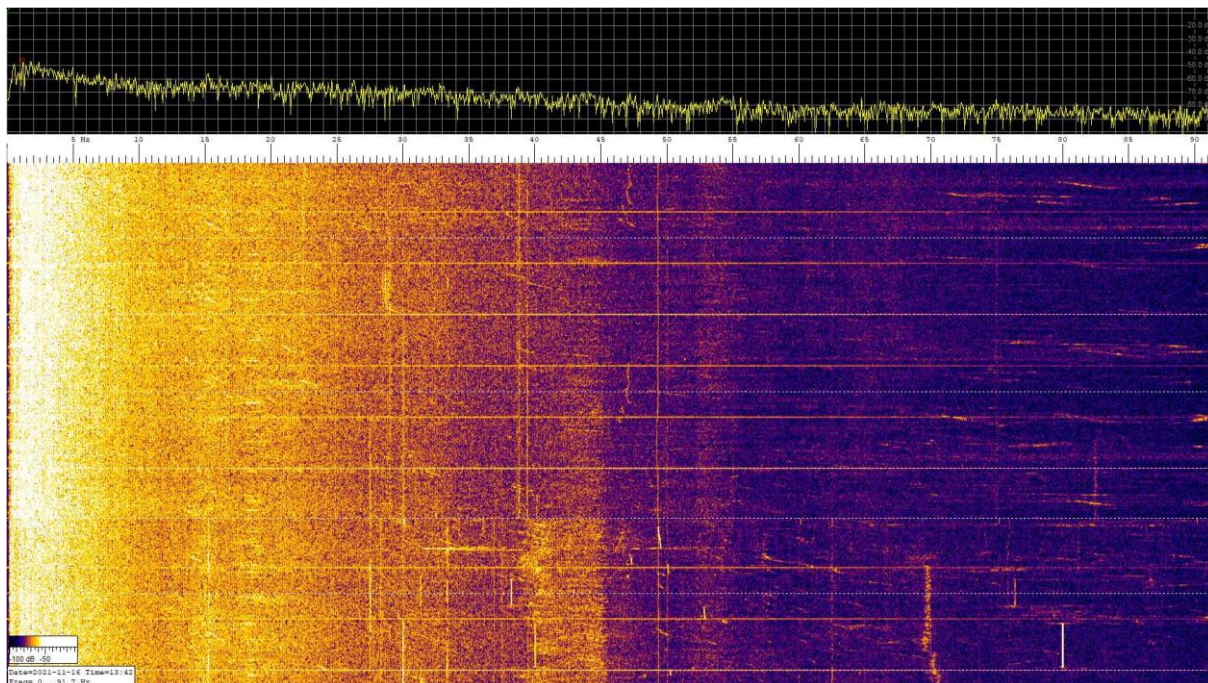
Wel is de intensiteit of sterkte minder in de T2 situatie.

De brom is er nog wel maar hij is zwakker.

Vergelijking 26 februari 2021 met 4 november 2021

Windrichting 280 graden

Windsnelheid 4 m/s



Zowel in de T1 als in de T2 situatie zien we een duidelijke brom rond 40-45 Hz.

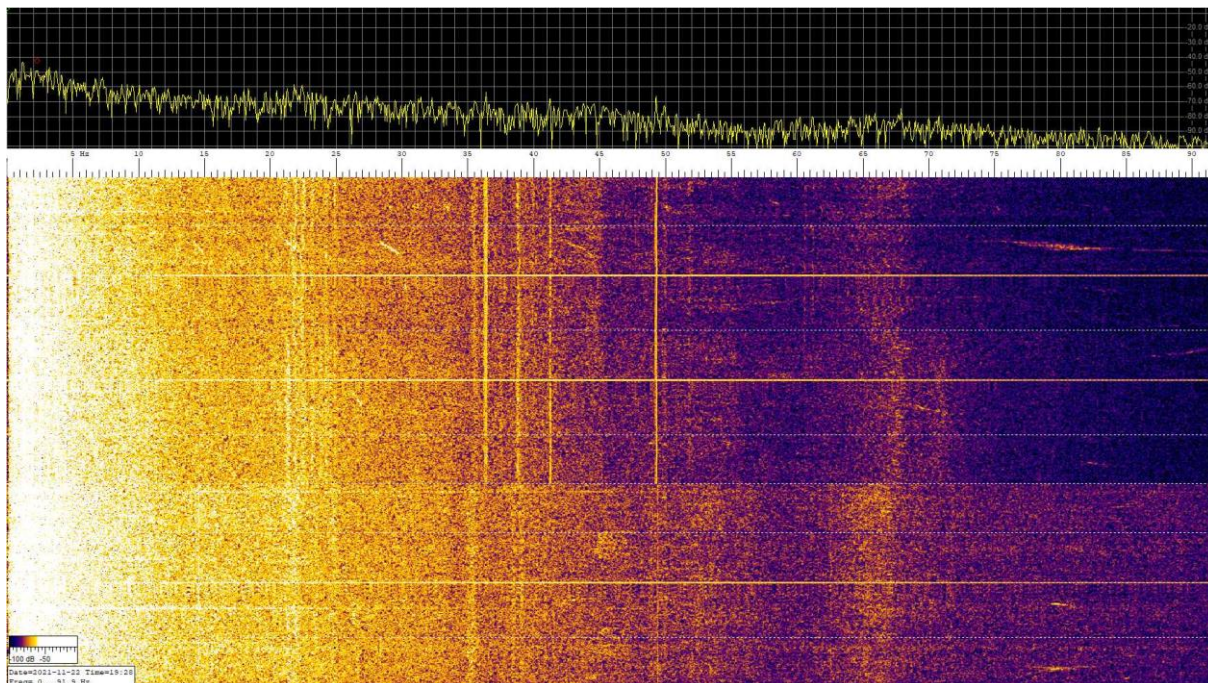
De intensiteit of sterkte is minder in de T2 situatie.

De brom is er nog wel maar hij is zwakker.

Vergelijking 14 februari 2021 met 21 oktober 2021

Windrichting 140 graden

Windsnelheid 5 m/s

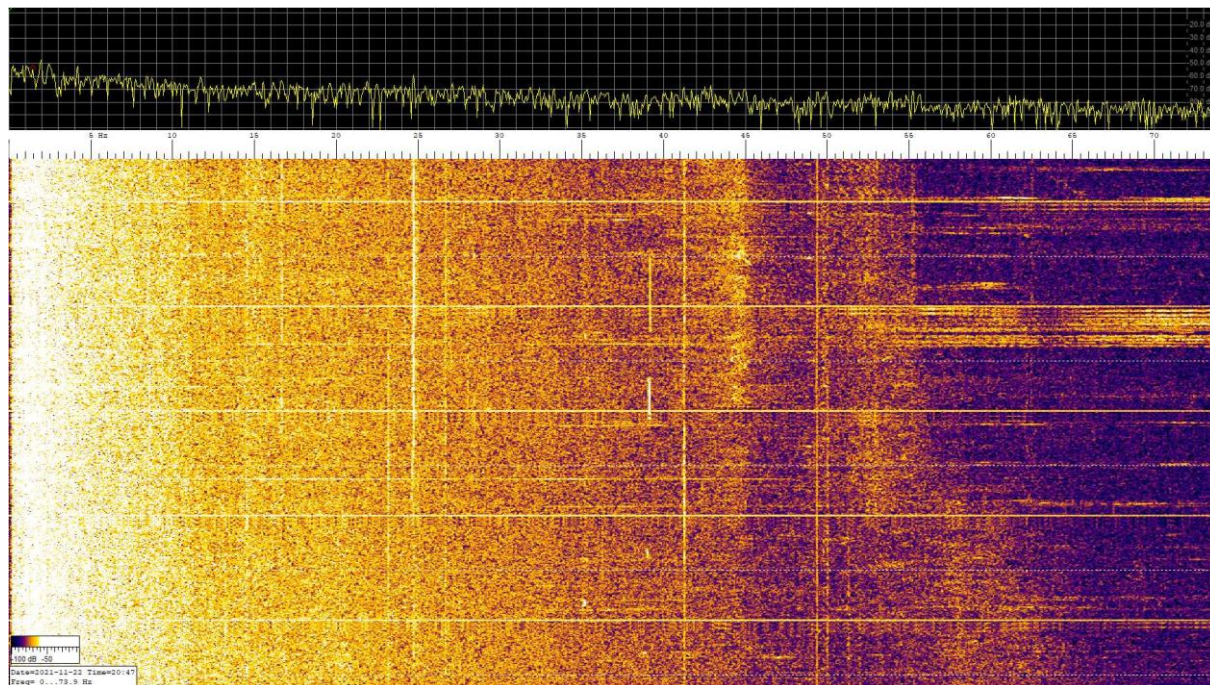


In de T1 situatie zien we een duidelijke brom bij 65 Hz.
In de T2 situatie is die er ook nog maar zwakker.
In de T1 situatie zien we een brom tussen 20 en 25 Hz.
In de T2 situatie meer brom tussen 20 en 25 Hz.

Een verbetering en een verslechtering tegelijkertijd.

Nu een paar spectrogrammen van opvallende bromgebeurtenissen tijdens T2 (dus na de software aanpassing)

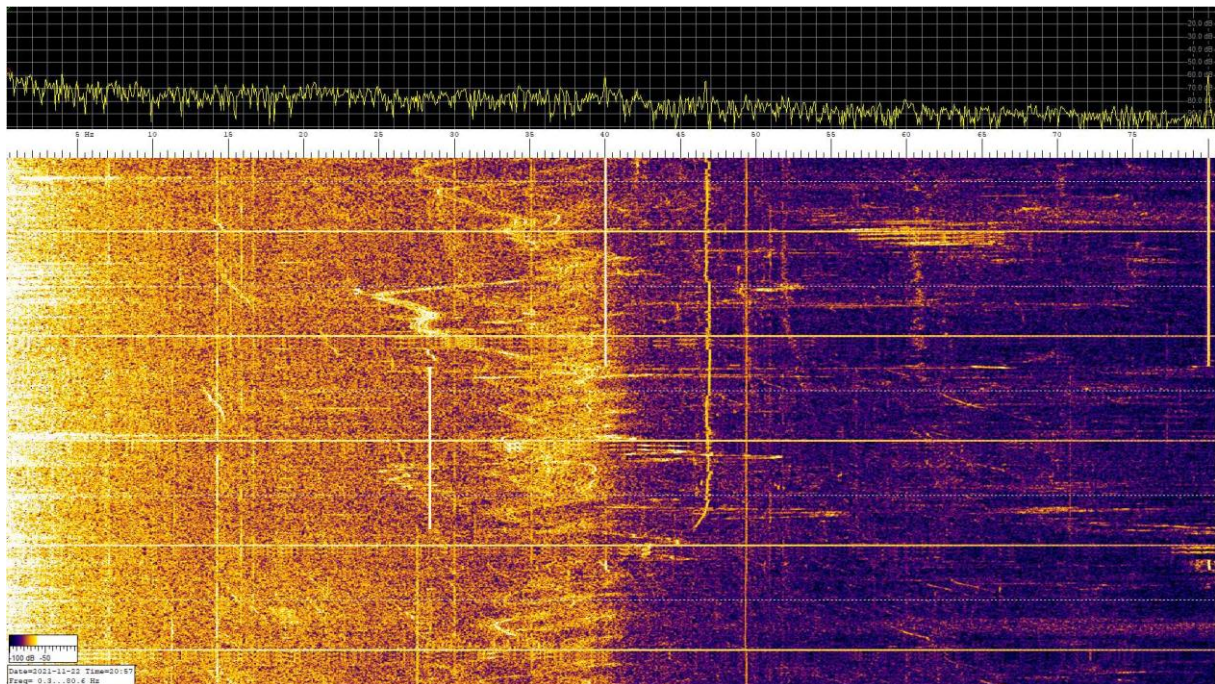
24 oktober 2021



De wind neemt af, we zien een duidelijke verschuiving van de frequentie van de brom van ca 60 Hz naar 45 Hz. Ook wordt het geluid sterker. Dit is een opvallend effect dat we steeds zien: bij lagere windsnelheden wordt het geluid van de windturbines lager en sterker

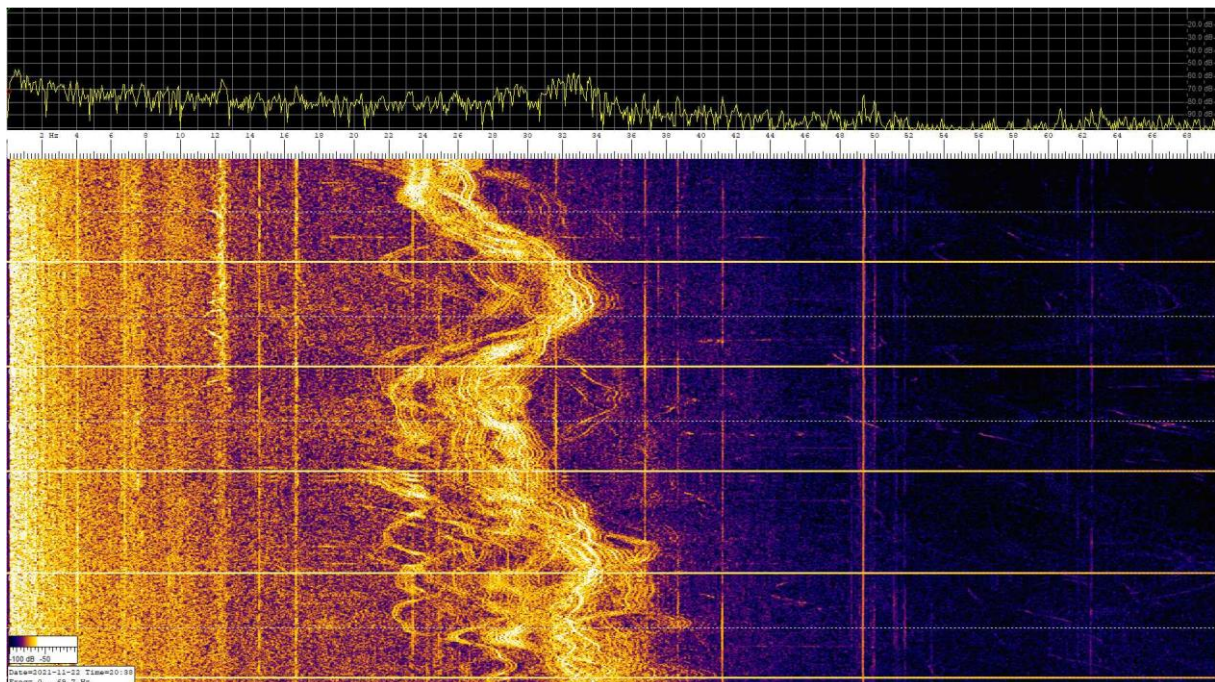
1 november rond het middaguur

Zwakke wind maar een stevige brom rond de 35 Hz.

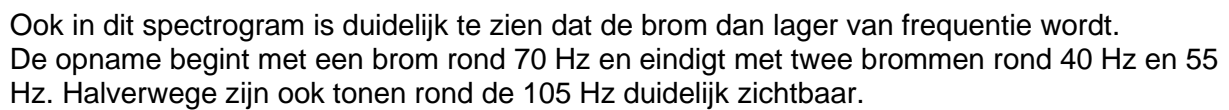


3 november 2021

Lage windsnelheid. Turbines kennelijk in 'zoekmode' met een enorme brom tot gevolg. Voor dit soort situaties werkt de software aanpassing kennelijk niet.



Een opname in het Windpark dicht bij een turbine in Meeden. (ca. 100 m)
Eind van de middag, de wind nam af.



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Vragen

Er blijven na in totaal 13 maanden meten nog veel vragen onbeantwoord.

-Hoe heeft het kunnen gebeuren dat een groot en respectabel bedrijf als Siemens brommende windturbines heeft geproduceerd?

-Waarom heeft men steeds geprobeerd om de brom (en het effect daarvan op de bevolking) te bagatelliseren?

-Waarom probeert men zich steeds achter de geluidsnormen te verschuilen (terwijl een simpel bezoek aan het windpark voor iedereen meteen duidelijk maakt: deze turbines brommen!)

Slecht nieuws

Inmiddels wordt de brom van de turbines van windpark N33 bij veel nieuw te ontwikkelen windparken door ongeruste omwonenden gebruikt om tegenstand te bieden tegen de plannen – en niet alleen in Nederland: *bad news travels fast*.

Deze tegenstand afdoen als 'gezeur van tegenstanders die toch nooit tevreden zullen zijn' is een onderschatting van een nieuw probleem: de brom van de Siemens Gamesa DD-130 R19 windturbines van windpark N33 tast het draagvlak voor alle windparkplannen aan en brengt daarmee de energietransitie in gevaar.

Ook brengt het risico's met zich mee als het gaat om de reputatie en marktpositie van een beursgenoteerd bedrijf als Siemens. Wanneer Siemens de bedrijfsstrategie *Vision 2020+*, missie, positionering en doelen (mn.doel 5) serieus neemt, dan zijn ze van harte uitgenodigd dat hier waar te maken.

Goed nieuws

Het recent aangelegde Windpark Fryslan ten zuiden van de Afsluitdijk bestaat uit 89 windturbines van exact hetzelfde type (Siemens Gamesa DD-130 R19) als die in windpark N33. Daarom is ter referentie in het weekend van 13 november te Breezanddijk met SpectrumLab gemeten: zelfde merk en type windturbines, stevige wind en dus draaiden de windturbines vollast. De verwachting was 65 Hz brom te zien. Er was echter geen 65 Hz brom te constateren met SpectrumLab. In het factsheet op de website van Windpark Fryslan¹ staat dat de afstand ca. 800 m is, dus als er een brom was, had SpectrumLab die zeker gemeten. De verrassende conclusie was dat deze windturbines, van hetzelfde merk en type bij stevige wind en op vollast, in Windpark Fryslan niet bromden! De vraag dringt zich op, of deze turbines dan toch anders zijn?

Op de website van Windpark N33 staat in de nieuwsbrief van juni 2020² dat de bouw van de funderingen 'inmiddels gereed' is (laatste paal geslagen half april), en dat de bouw van de turbines is gepland voor het derde kwartaal, en dat alles eind van het jaar klaar moet zijn.

Op de website van Windpark Fryslan staat dat de productie van onderdelen van april 2020 tot april 2021 was, de start van de bouw van de funderingen in september 2020 en de eerste windturbines in werking in begin 2021.

Windpark Fryslan is dus kort ná Windpark N33 gebouwd.

¹ <https://www.windparkfryslan.nl/wp-content/uploads/2020/05/Factsheet-Windpark-Fryslan.pdf> 23-11-2021, 13.59 uur.

² <https://www.windparkn33.nl/beheer/UserUpload/files/Nieuwsbrief%20juni%202020%20N33MW%20%5Bde%5D.pdf> 23-11-2021, 14.45

Meer vragen

Is de Siemens Gamesa DD-130 R19, genoemd in het factsheet³ op de website van Windpark N33, echt helemaal hetzelfde als de Siemens Gamesa SWT-4.0-130, genoemd in een rapport over de Global Offshore Wind⁴?

Als ze 100% identiek zijn, waarom wordt op de ene locatie een brom gemeten en op de andere locatie niet?

Wist Siemens dat de turbines van Windpark N33 een bromprobleem hadden en heeft men het voor Windpark Fryslan aangepast? En waarom doet men dan voor Windpark N33 alsof de neus bloedt?

Of wist Siemens het niet? Is er 'bij toeval' iets gewijzigd aan het productieproces van de turbines toen men Windpark Fryslan ging bouwen?

In beide gevallen is het onbegrijpelijk van een bedrijf als Siemens.

Conclusie

Het lijkt erop dat de software-aanpassing in een aantal gevallen de brom wel heeft verminderd, maar de brom is verre van verdwenen. Dit komt ook overeen met het commentaar van de bewoners in wiens tuin de geluidmeter stond opgesteld. Zij wisten te vertellen dat ze de brom nog vaak horen en er regelmatig 's morgens wakker van worden.

³ <https://www.windparkn33.nl/nl/project/n33-in-het-kort> en <https://www.windparkn33.nl/nl/project/type-windturbine> 23-11-2021, 14.30 uur.

⁴ https://w2m8n2q3.rocketcdn.me/wp-content/uploads/2021/02/WFO_Global-Offshore-Wind-Report-2020.pdf 23-11-2021, 14.15 uur.