"DID YOU KNOW" DOCUMENT – ACCOMPANYING TEXT

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All integration times are on source, main array integration times assuming dual polarization unless otherwise noted. Times are calculated using the online ALMA Sensitivity Calculator tool available at the time of publication; proposers should re-calculate integration times for themselves. They do not include estimates of overhead.

Image a nearby star forming galaxy in molecular gas. [image: CO(1-0) of M83 from Muraoka et al. (2009a).] *The example galaxy used in the science cases below, M83, has a declination of -29:51:57.0 and an assumed distance of 4.5 Mpc.*

– in excited CO (3-2):

CO(J=3-2): 345.8 GHz, in Band 7. Field of view is 18" (400 pc).

Muraoka et al. (2009b) measure 30-150 K km/s in the CO(3-2) line over the central kpc, over a full width of ∼150 km/s. A sensitivity of 200 mK in the central 0.5 kpc will yield a 5σ detection of T_b=1 K. Using 0.25" resolution (6 pc), 2 km/s linewidth (to simultaneously resolve the line and the cloud), and 34 antennas, achieving a sensitivity of 0.2 K in the main array takes 1.8 hours. Note that this resolution requires Cycle 2 configuration C34-5, for which the largest recoverable angular scale is 4.1" (∼90 pc). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– in dense, star forming HCN:

HCN(J=1-0): 88.6 GHz, in Band 3. Field of view is 71" (1.5 kpc).

Muraoka et al. (2009a) detect bright HCN across the central 1.5 kpc of M83 (rms ∼ 4 K km/s) but are sensitivity limited; emission is tentatively detected at the noise limit, but secure detections require pushing to higher sensitivity. To get a 5σ detection of a cloud with 4 K km/s intensity, assuming a 10 km/s linewidth, 34 antennas, and 1.4" resolution (30 pc), or 80 mK sensitivity, requires 25 minutes in the main array. Note that this resolution requires Cycle 2 configuration C34-4, for which the largest recoverable angular scale is 17.5" (∼380 pc). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– a mosaic of dense, star forming HCN along the entire bar:

HCN(J=1-0): 88.6 GHz, in Band 3. Field of view is 71" (1.5 kpc).

The optical bar is 3.1' by 1.4' (4.1 kpc by 1.8 kpc), requiring a 17-pointing mosaic. Assuming a 10 km/s linewidth, 1.4" resolution (30 pc), and 80 mK sensitivity, the Cycle 2 C34-4 configuration can achieve the goal in 2.5 hours on source. Note that at this resolution, the largest recoverable angular scale is 17.5" (∼380 pc). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

References:

Muraoka et al. (2009a). PASJ, 61, 163

Muraoka et al. (2009b). ApJ, 706, 1213

Redshifted ISM in galaxies. [image: VLA 1.4 GHz (red) and MIPS 24 μm (blue) image of a SMG overlaid with ALMA 870 μm contours (Hodge et al. 2013).]

– dust emission (thermal continuum) from a "normal" (10^{11} $L_\odot$) galaxy at z=3:

Continuum, 350 GHz, Band 7. Field of view is 18" (2.3 Mpc, assuming D_L=25.8 Gpc).

Assuming a flux density detectability curve extrapolated between those shown in Figures 4 and 8 of Blain et al. (2002) at ~350 GHz, a dusty, 10^{11} $L_\odot$ galaxy with T~40 K at z=3 has a brightness of 60 μJy. Note that the flux density as a function of redshift is fairly flat from $1 < z < 6$, so this estimation holds for galaxies of this luminosity across significant redshift space. For a 5σ detection (rms=12 μJy), with 8 GHz bandwidth and 34 antennas, a source at Dec=–20 degrees can be detected with this sensitivity in 5.6 hours; a 3σ detection would take 2 hours. Assuming a beam size of 2.0" (250 kpc) ensures that the source remains unresolved; using this beam size, the sensitivity corresponds to 30 μK (5σ). The ACA is not required.

– lensed [CII] emission from a normal galaxy at z=4.2:

[CII]: 1900.5 GHz / [1+z] = 365.5 GHz, in Band 7. Field of view is 17" (3.2 Mpc, assuming D_L=38.7 Gpc).

Assuming a [CII] flux from a normal, Milky Way-type galaxy of 1×10^8 K km/s pc^2 (Fixsen et al. 1999, Baker 2009) at z=4.2, the expected flux is 38.6 mJy km/s. Assuming a 300 km/s linewidth and magnification of 10 (average value seen by Hezaveh et al. 2013), a 5σ detection of 1.3 mJy (in one 300 km/s velocity channel) requires 0.26 mJy rms sensitivity. For a source at Dec=–20, with a 1.5" beam (280 kpc), 300 km/s bandwidth, and 34 antennas, this can be achieved in less than 30 minutes on source; achieving this sensitivity and fully resolving the line with five 60 km/s channels can be done in 2.3 hours. The ACA is not required.

– dust emission (thermal continuum) from a LIRG (10^{12} $L_\odot$) at z=10:

Continuum, 273 GHz, Band 6. Field of view is 23" (12 Mpc, assuming D_L=106 Gpc).

Assuming a flux density detectability curve extrapolated from the one shown in Figure 4 of Blain et al. (2002) for a 5×10^{12} $L_\odot$ galaxy at 1100 μm, a 10^{12} $L_\odot$ luminous IR galaxy (LIRG) with T=38K at z=10 – assuming these exist at z=10 – should be five times fainter than 1.5 mJy, or 0.3 mJy. Note that the flux density as a function of redshift is fairly flat from $1 < z < 10$, so this estimation holds for galaxies of this luminosity across much of redshift space. For a 5σ detection (rms = 60 μJy), with 8 GHz bandwidth and 34 antennas, a source at Dec=–20 degrees can be detected with this sensitivity in 7 minutes. Assuming a beam size of 1.0" (500 kpc), this sensitivity corresponds to 1 mK. The ACA is not required.

References:

Baker (2009). ALMA detectability memo.
Blain et al. (2002). PhR, 369, 111
Fixsen et al. (1999). ApJ, 526, 207
Hezaveh et al. (2013). ApJ, 767, 132
Hodge et al. (2013). ApJ, 768, 91

Solar System objects. [image: CO(2-1) of comet Hale-Bopp from PdBI. (From ESO/ALMA document.)]

– measure global wind patterns in middle atmosphere of Mars:

CO(J=3-2): 345.8 GHz, in Band 7. Field of view is 18" (1.2×10^4 km).

The angular diameter of Mars ranges from 3.5" (farthest from Earth, 2.67 AU) to 14" (closest to Earth, 0.67 AU); here, we assume a 10" diameter (0.94 AU, where 300 km=0.44"). Lellouch et al. (1991) measure an absorption feature of depth -40.5 K in the CO(3-2) line over the entire disk. Assuming 0.5" resolution, 100 m/s channels, Dec=0, and 34 antennas, a 100σ detection of 0.4 K sensitivity can be achieved in less than 30 minutes. Note that this resolution requires Cycle 2 configuration C34-3, for which the largest recoverable angular scale is 5.1" ($\sim$3500 km, roughly half the diameter of Mars). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– trace the water content in the atmosphere of Venus:

HDO(J=4-3): 335.4 GHz, in Band 7. Field of view is 18" (2.2×10^4 km).

The angular diameter of Venus when it is most illuminated (superior conjunction), but farthest from Earth, is 9.6" at 1.72 AU; assuming a 10" diameter (1.65 AU), a 1.5" beam corresponds to 1800 km. From Cycle 0 ALMA observations of Venus (Encrenaz et al. in prep.), the absorption line reaches -0.1 Jy/beam (with a 1.65" beam), or 0.40 K. With 1.5" resolution, 34 antennas, Dec=0, and 500 m/s channels, a 10σ detection (rms = 40 mK) can be obtained in less than 10 minutes. Note that this resolution requires Cycle 2 configuration C34-1, for which the largest recoverable angular scale is 7.2" ($\sim$8600 km, roughly 70% of the diameter of Venus). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– detect molecular species on active comets:

Several lines (230-271 GHz) in Band 6. Field of view is 24" (1.2×10^4 km).

Following the work of de Val-Borro et al. (2013), several volatiles – HCN, CH_3OH, H_2CO, CS, and HNC – from the comet C/2002 T7 (LINEAR) are detected with the SMT. The best sensitivity reached during the observations is $\sim$15 mK in a $\sim$30" beam. The comet has a water production rate of 3×10^{29} molecules/second and was observed at geocentric distances of 0.70-0.73 AU (heliocentric distances of 0.42-0.52 AU). In Cycle 2, ALMA can achieve five different tunings in one scheduling block to capture each line; assuming a declination of –20 degrees, observing frequency of 260 GHz, 34 antennas, and 3.0" beam (1500 km at 0.7 AU, ensuring that the nucleus is unresolved), a sensitivity of 15 mK in a 0.3 km/s channel can be reached in 10 minutes per tuning, or 50 minutes on source for all five lines. Additional transitions of each molecule present across the band may allow the same science in fewer spectral tunings, but this integration time estimate is based on the specific transitions observed by de Val-Borro et al. (2013). Note that this resolution requires Cycle 2 configuration C34-1, for which the largest recoverable angular scale is 10.7" ($\sim$5400 km). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– directly measure Kuiper Belt Object sizes from their thermal emission:

Continuum, 345 GHz, Band 7. Field of view is 18" (5.1×10^5 km).

Assuming a standard thermal model for KBOs (Stansberry et al. 2008) with a beaming parameter of 1.2 and a geometric albedo of 0.08, the expected disk-averaged brightness temperature is 49 K for a body with a diameter of 200 km that is 40 AU from the sun. At its closest position to Earth (d=39 AU), the object has an apparent size of 0.0071", which yields a flux of $\sim$0.14 mJy at 345 GHz. This emission will be unresolved with the smallest possible ALMA beam. Assuming 34 antennas, 8 GHz bandwidth, and Dec=0, a 5σ detection of 28 μJy/beam in a 0.2" beam (5700 km at 39 AU, which corresponds to 7.2 mK) is possible in 1 hour of observing time. The ACA is not required.

References:

de Val-Borro et al. (2013). arXiv:1308.6282
Encrenaz et al. (in prep), private communication
Lellouch et al. (1991). P&SS, 39, 209
“Science with ALMA”. ESO Science Case for ALMA document.
Stansberry et al. (2008). ”The Solar System Beyond Neptune”, Barucci, Boehnhardt, Cruikshank, & Morbidelli (eds.), University of Arizona Press (Tucson), p.161-179

Galactic clouds and star forming regions. [image: CO map of Orion taken with the JCMT (HARP/ACSIS) in 2007.]

– polarization of (optically) dark star forming clouds:

Continuum, 343.5 GHz, Band 7. Field of view is 18" (0.013 pc), restricted to the central third (6", 0.004 pc) for on-axis polarization observations in Cycle 2.

Following the study of the polarized dust continuum of the binary protostar IRAS 16293 performed by Rao et al. (2009) with the SMA, two components are detected with flux densities of 6.85 and 4.62 Jy and with 0.5% and 1.0% polarization, respectively. The sensitivity reached in the study, which is sufficient to detect the polarized components at the $\sim 7\sigma$ level, is 4 mJy/beam in a 3.1" x 2.0" beam ($\sim$7.2 mK). Assuming a distance of 150 pc, a beam of 0.5" corresponds to a resolution of 75 AU. Reaching a sensitivity of 7 mK with a beam of 0.5" [or 4 * $(0.5/2.4)^2$ = 0.17 mJy/beam] at a declination of -24.5 degrees with 34 antennas, 8 GHz bandwidth, and single polarization is achievable in less than 4 minutes. Observing thirty protostars to a similar depth in the same star forming region would take 2 hours of on source integration time, which when added to the extra time required for polarization calibration, yields a sufficiently wide range in parallactic angle to correct for instrumental polarization. Note that polarization observations in Cycle 2 require scheduling blocks at least 3 hours in length (though only two hours are on source). In Cycle 2, a resolution of 0.5" in Band 7 requires the C34-3 configuration, which yields a maximum angular scale of 5.1"; polarization capabilities will be offered only in the 12-m Array in Cycle 2.

– blind spectral line survey toward the hot core in Orion-KL:

Continuum, 211-274.9 GHz, Band 6. Field of view is 26" (0.055 pc).

The declination of Orion is approximately -05:23:00. In early science verification data (with 16 ALMA antennas), Randall & Remijan (2012) detected on average 20 lines above 5σ per 200 MHz of bandwidth from the hot core Orion-KL ($\sim$5" in size) in a blind Band 6 spectral survey; in their observations, $\sigma = 50$ mJy/beam with a beam of 2.2" ($\sim$280 mK). The channels have 488 kHz spacing (0.6 km/s at 230 GHz), oriented in five separate tunings (with four 1.875 GHz spectral windows each) for a total of $\sim$40 GHz of coverage within the 64 GHz band. A spectrum measured toward Orion-KL in Cycle 2 with the same spectral parameters, 2.0" resolution (880 AU, assuming d=440 pc), and 34 antennas to three times deeper 100 mK rms sensitivity can be achieved in less than 1 minute on source. Covering the entire 64 GHz band would recover potentially 6,000 lines at the previous sensitivity; assuming that a factor of $\sim$3 increase in sensitivity would return twice as many lines yields potentially 12,000 lines across the full Band 6. This can be done with 10 tunings (taking into account 0.2 MHz of overlap between tunings), which requires less than 10 minutes on source. Note that this estimation does not take into account time necessary to calibrate, which is likely to be significant compared to the on source integration time. Note that this resolution requires Cycle 2 configuration C34-1, for which the largest recoverable angular scale is 10.7" ($\sim$0.023 pc). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

References:

JCMT outreach website. http://outreach.jach.hawaii.edu/pressroom/2007_harpacsis/
Randall & Remijan (2012). Orion B6 spectral scan report (CSV-1507)
Rao et al. (2009). ApJ, 707, 921

Formation of galaxy clusters and cosmic structure. [image: Simulated galaxy cluster at z=0.2 at 350 GHz with lensed background galaxies and SZ emission (from ESO/ALMA document).]

– image the Sunyaev-Zel'dovich Effect with high resolution in clusters at high redshift:
Continuum, 90 GHz, Band 3. Field of view is 69".

The most sensitive SZE images currently achieve noise levels as low as $\sim$40 μJy/beam with a 10" beam at 90 GHz (e.g. Mroczkowski et al. 2012, Korngut et al. 2011), which is sufficient to identify and characterize merger shocks in the central regions of merging galaxy clusters. Assuming a declination of –20 degrees, bandwidth of 8 GHz, and 34 antennas in the main array, a 4 sigma detection of 40 μJy/beam * $(5/10)^2$ = 10 μJy/beam in a 5" beam (60 μK) requires 1.5 hours on source in the Cycle 2 configuration C34-1.

– measure the bulk Sunyaev-Zel'dovich Effect from high-z clusters:
Continuum, 90 GHz, Band 3. Field of view is 117" (7-m Array only).

Measuring the more extended, bulk SZE in galaxy clusters requires sensitive coverage with a larger beam; the 7-m Array in ALMA Cycle 2 at 90 GHz has a beam size of $\sim$23". Assuming that the 7-m Array requires twice the integration time of the main array, and assuming (as above) a declination of –20 degrees, bandwidth of 8 GHz, and 9 antennas in the 7-m Array, 3 hours would be required (reaching an rms of 83 μJy/beam in a 23" beam, or 24 μK) to recover the extended emission. Note that the ACA is available in Cycle 2 only in concert with the main array, so these two SZE projects would be performed together.

– survey Lyman-alpha Blobs (LABs) at z=3.1:
Continuum, 353 GHz, Band 7. Field of view is 18" (2.3 Mpc, assuming D_L=26.9 Gpc).

Following the study of Geach et al. (2005), in which a sample of 23 LABs in a z=3.1 overdensity were observed with the JCMT, the average flux of the targets is 3.0 mJy at 850 μm. To achieve a 20σ detection of each LAB, an rms of 150 μJy is required. Assuming an 8 GHz bandwidth and 34 antennas at the declination of the overdensity (Dec=0 degrees), the necessary integration time for one target is 2 minutes; all 23 sources can be observed to this sensitivity in less than an hour on source. Assuming a beam size of 1.0" (130 kpc) ensures that the source remains unresolved; using this beam size, the sensitivity corresponds to 1.5 mK. The ACA is not required.

References:
"Science with ALMA". ESO Science Case for ALMA document.
Geach et al. (2005). MNRAS, 363, 1398
Korngut et al. (2011). ApJ, 734, 10
Mroczkowski et al. (2012). ApJ, 761, 47

Resolve planetary disks around young stars. [image: HCO+ in transition disk HD142527 (Casassus et al. 2013), taken from visualization created by S. Perez.]

– snow line, where gas freezes out onto dust grains, in the disk of HD 163296:

H_2CO(J=3-2): 225.7 GHz, in Band 6. Field of view is 28" (0.017 pc).

Using the ALMA simulation performed by Qi, Oberg, & Wilner (2013) of the H_2CO transition in the disk surrounding Herbig Ae star HD 163296, made with 1 hour of observing time and a beam size of 0.3", the snow line is easily resolved. The SMA observations presented in the same study utilize 0.6 km/s channels, and the declination of the source is -21:57:21.9. To detect their faintest contour level, 25 mJy km/s, at 10 sigma in a 0.6 km/s channel requires an rms of 4.2 mJy in their assumed 0.3" beam (37 AU, assuming d=122 pc, or 1.12 K). This sensitivity is achievable in 15 minutes with 34 antennas. Note that this resolution requires Cycle 2 configuration C34-6, for which the largest recoverable angular scale is 3.8" (∼460 AU). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– HCO+ flows across disk gaps:

HCO+(J=4-3): 356.7, in Band 7. Field of view is 17" (0.012 pc).

The Cycle 0 ALMA observations of Casassus et al. (2013) of the HCO+(4-3) imaging of the disk around the young star HD 142527 detect (and resolve) dense gas flowing across the gap in the disk. The observations utilize 0.1 km/s channels and reach a sensitivity of 15 mJy in a beam of 0.51" × 0.33" (∼0.8 K) in 52 minutes on source. In Cycle 2, these observations (repeated for the same target) can be achieved assuming a declination of -42:19:23.3, 0.1 km/s channels, 34 antennas, a 0.42" beam (59 AU, assuming d=140 pc), and rms of 0.8 K (14.7 mJy) in 15 minutes. Note that this resolution requires Cycle 2 configuration C34-4, for which the largest recoverable angular scale is 5.1" (∼710 AU). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– Jupiter mass planet gap in disk at 120 pc:

Continuum, 353 GHz, Band 7. Field of view is 18" (0.010 pc).

Following the ALMA simulations of Gonzalez et al. (2012), a gap induced by a 1 Jupiter mass planet in a dust disk 40 AU from its parent star is detectable at 850 μm with a beam size 0.15" or better at a distance of 140 pc. From their Figure 12, the gap in a disk around a star in Ophiuchus (d=120 pc, Dec=-24 degrees) can be well resolved in an hour with 0.12" resolution. The highest resolution available in Cycle 2 is 0.12" in Band 7, equivalent to 15 AU at the distance of Ophiuchus. Assuming 8 GHz bandwidth, 34 antennas, and the other parameters specified above, the sensitivity reaches 19 μJy in 2 hours of integration time, consistent with the sensitivity shown to be necessary in Figure 12 of Gonzalez et al. (2012). Note that this resolution requires Cycle 2 configuration C34-7, for which the largest recoverable angular scale is 2.5" (∼300 AU). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– planetary presence from astrometric motion of dust clumps around ϵ Eri:

Continuum, 353 GHz, Band 7. Field of view is 18" (58 AU).

Following the model of Moran, Kuchner, & Holman (2004) of the debris disk around ϵ Eri (Dec= –09:27:29.7), which hosts dense dust clumps being dynamically affected by a massive planet, the dust distribution (in addition to the clumps) can be well resolved by ALMA in Cycle 2. At the distance of ϵ Eri (3.22 pc), 1 AU = 0.31". From the Moran model, a sensitivity of 0.7 mJy/beam (with a 1.85" beam) is required to recover the faintest emission at the edge of the disk, which corresponds to 19.7 μJy with a 0.31" beam, or 6.6 μJy rms for a 3σ detection. This sensitivity can be achieved with 34 antennas and 8

GHz bandwidth in 17 hours on source. The dense clumps within the disk (brighter than ∼48 μJy/beam) can be observed to 16 μJy sensitivity in much less time (∼3 hours). Note that this resolution requires Cycle 2 configuration C34-5, for which the largest recoverable angular scale is 4.1" (∼13 AU). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

References:

Casassus et al. (2013). Nature, 493, 191
Gonzalez et al. (2012). A&A, 547, A58
Moran, Kuchner, & Holman (2004). ApJ, 612, 1163
Qi, Oberg, & Wilner (2013). ApJ, 765, 34

Measure stellar activity. [image: CO(2-1) contours (Cox et al. 2000) over 2.15 μm continuum image (Sahai et al. 1998) of the Egg Nebula.]

– molecular outflow in a pre-planetary nebula:

CO(J=2-1): 230.5, in Band 6. Field of view is 27” (0.20 pc).

Following the Cycle 0 ALMA observations of Sahai et al. (2013) of the Boomerang Nebula (Dec= –54:31:11.4), outflowing CO(2-1) was imaged with 0.63 km/s resolution and a 2.4” $\times$ 1.6” beam to a sensitivity of 7.5 mJy/beam ($\sim$43 mK in a 2.0” beam, or 3000 AU assuming d=1.5 kpc). In Cycle 2, assuming 34 antennas, this sensitivity and velocity resolution can be reached in 5 minutes on source. Note that this resolution requires Cycle 2 configuration C34-1, for which the largest recoverable angular scale is 10.7” ($\sim$0.08 pc). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

– heating mechanisms of red giant stars:

Continuum, 250 GHz, Band 6. Field of view is 25”.

Following the model of Harper et al. (2013), the expected millimeter fluxes of nearby giant stars range from 6-80 mJy at 250 GHz. The stars considered in their study will be unresolved even with the smallest Cycle 2 beam, but assuming 0.2” resolution, even the faintest of these stars will be detectable with a S/N of 50 (rms = 0.12 mJy/beam, or 55 mK) in 2 minutes of integration time (assuming 34 antennas, 8 GHz bandwidth, and a declination of –20 degrees). The ACA is not required.

– GRB afterglow emission at z=3 and z=10:

Continuum, 100 GHz, Band 3. Field of view is 62” (7.8, 32 Mpc, assuming D_L=25.8, 106 Gpc).

Following the GRB afterglow model plotted in Figure 6 of de Ugarte Postigo et al. (2012), 1-2 days after a typical burst, a z=3 (z=10) afterglow peaks around 0.3 (0.08) mJy in Band 3. For a 10σ detection of each afterglow, assuming an observation at Dec=–20 degrees, 8 GHz bandwidth, and 34 antennas, rms sensitivities of 0.03 mJy/beam (in a 1.0” beam – 125 kpc at z=3 – yields 3.7 mK) and 0.008 mJy/beam (in a 1.0” beam – 500 kpc at z=10 – yields 1.0 mK) are required. These are achievable in 11 minutes and 2.6 hours, respectively. The ACA is not required.

References:

Cox et al. (2000). A&A, 353, L25
de Ugarte Postigo et al. (2012). A&A, 538, 44
Harper et al. (2013). MNRAS, 428, 2064
Sahai et al. (1998). ApJ, 492, L163
Sahai et al. (2013). arXiv:1308.4360

Accretion onto black holes. [image: CO(2-1) AGN extended torus model of NGC 1068 at ALMA resolution (Wada & Tomisaka 2005).]

– black hole mass measurement from CO (2-1) kinematics:

CO(J=2-1): 230.2, in Band 6. Field of view is 27" (2.1 kpc).

Following Davis et al. (2013), the mass of the central black hole in NGC 4526 (d=16.4 Mpc, Dec=+07:42) can be modeled using high-resolution observations of molecular gas [CO(2-1)] obtained with multiple configurations of CARMA. This work achieves a resolution of 0.25" (20 pc) and rms of 2.9 mJy/beam ($\sim$ 1 K) in 10 km/s channels. In Cycle 2 ALMA, the galaxy can be observed with 0.20" (16 pc) resolution and 2 km/s channels, and similar sensitivity (1.3 mJy/beam, or 0.75 K) can be reached in less than an hour on source. Note that this resolution requires Cycle 2 configuration C34-7, for which the largest recoverable angular scale is 3.8" ($\sim$300 pc). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended. However, the sphere of influence of the black hole in this system is 20 pc (Davis et al. 2013), so extended emission is likely not relevant in this case.

– gas properties in the host galaxy of obscured quasar AMS12 (z=2.7672):

CO(J=3-2), CO(J=7-6): 91.8 GHz (in Band 3), 214.0 GHz (in Band 6). Fields of view are 69", 29" (7.8, 3.3 Mpc, assuming D_L=23.4 Gpc).

Here we replicate with ALMA the study by Schumacher et al. (2012), which utilizes PdBI observations of the CO ladder to derive the kinetic temperature and density of the gas in the host galaxy of obscured quasar AMS12. In Cycle 2, the redshifted CO(3-2) and CO(7-6) lines fall into available bands (3 and 6, respectively). The quoted sensitivities to reach are 0.7 mJy/beam (Band 3) and 2.0 mJy/beam (Band 6), each in 30 km/s channels; the source is unresolved in the Schumacher et al. observations. We flip the +59 degree declination of the source to be -59 degrees and assume 30 km/s channels, 34 antennas, and a 1.0" beam (110 kpc, assumed to keep the source unresolved); the necessary integration time in Band 3 is 18 minutes and in Band 6 is 2 minutes, for a total of 20 minutes on source. Note that for the purposes of OT setup, these bands must be requested in separate Science Goals. The ACA is not required.

– study the sub-mm emission from Sgr A* while it flares in the infrared:

Continuum, 345 GHz, Band 7. Field of view is 18" (0.72 pc).

Haubois et al. (2012) present observations of 870 μm emission from the Galactic center with APEX, which they observe to decrease during infrared flares, with a sensitivity of 60 mJy/beam in a 19" beam. In a 2.0" beam (0.08 pc, assuming d=8.3 kpc), this corresponds to 60 mJy/beam * $(2.0/19.0)^2 = 0.66$ mJy/beam. Sgr A* has a declination of –29 degrees, and assuming 34 antennas and 8 GHz bandwidth, this sensitivity can be reached in 2 minutes. Note that this resolution requires Cycle 2 configuration C34-1, for which the largest recoverable angular scale is 7.2" ($\sim$0.29 pc). Depending on the largest angular scale required to achieve the science goal, the ACA (and/or an additional 12-m configuration) may also be recommended.

References:

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Haubois et al. (2012). A&A, 540, A41
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Wada & Tomisaka (2005). ApJ, 619, 93